Urban Morphology

in the age of

Artificial Intelligence

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Book of Abstract

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IS THE CITY A DEVICE?

Shaping, Mapping, and Evolving Human Settlements Towards AI Applications in Urban Forms

Marco Trisciuoglio | ISUF Torino 2025 Chair

In explaining urban form through building typologies, Gianfranco Caniggia describes two types of “consciousness” that influence typology: spontaneous consciousness and critical consciousness. Spontaneous consciousness refers to design and construction strategies that evolve into a practice, establishing rules and codes of urban form. In contrast, critical consciousness describes the process of modifying these codes during a “codification crisis,” a moment when existing strategies can no longer adapt to urban transformation, leading to an awareness of the need for change.
This discussion emphasizes two main aspects of urban morphology: the evolution of form through new conceptual and representational tools, and the descriptions that enable us to define and understand the role of those tools.
The ISUF 2025 Torino Conference URBAN MORPHOLOGY IN THE AGE OF ARTIFICIAL INTELLIGENCE invited researchers and practitioners to explore how AI technologies (in all their forms) are transforming the study of urban forms, spatial structures, and city dynamics. It above all raised the question: how do contemporary and emerging tools influence the evolution of urban form and the practice of urban morphology?

While the question of urban form can be answered through various definitions, it is important to note that in the twenty-first century, artificial intelligence has opened new roads for both tools and the concept of urban form, roads that are yet to be fully explored. As AI becomes increasingly prevalent in urban analysis and planning, examining its potential, limitations, ethical considerations, and broader socio-spatial impacts is essential.
ISUF 2025 conducted a bold experiment by posing a question to the global community of urban morphologists: how do these advancements challenge or reinforce traditional urban morphology, and what new paradigms are emerging as a result?
The result was in getting: advanced technological research papers, in-depth investigations into the performance of AI tools, and wide-ranging experiments on the use of AI in urban agency. Additionally, some submissions provided a reflective perspective, considering how AI reshapes our understanding of urban forms and urban life, as well as how urban professionals can respond to its challenges and opportunities.
The partial outcomes of this open call are now compiled in this Book of Abstracts.
Out of over 533 submitted proposals, 296 were selected, with 214 brought for open discussion in ISUF 2025 classrooms on the Main Courtyard of the Castello del Valentino in Torino (the historic site of Politecnico di Torino).

These proposals are organized into four main sections.
Shaping the City: Exploring Future Urban Forms is the title of the FIRST SECTUON
This section focuses on the changing physical forms of future cities. The transformation of urban environments often results from historical events, land-use changes, demographic shifts, economic and cultural trends, and political influences. However, rapid urbanization, virtual connectivity, and technological advances continually accelerate this process. Many proposals explore cutting-edge urban design concepts (such as vertical cities and mixed-use developments) and their impacts on sustainability, quality of life, and urban efficiency. They also critically examine potential challenges and unintended consequences of these innovations.
Mapping the City: Evolving Tools to Study Urban Forms is the title of the SECOND SECTION.

With cities changing rapidly, our methods for studying their forms must also evolve. Several proposals investigate how technological advances influence mapping techniques, morphological classifications, taxonomies, and urban morphometrics. Discussions highlight how these tools enhance data collection, analysis, and visualization, providing deeper insights into urban structures and patterns. Some contributions also address limitations and risks associated with over-reliance on technology in urban decision-making.
Envisioning the City: Enhancing Theoretical Models of Urban Forms is the title of the THIRD SECTION.
In the AI era, conceptual frameworks underpinning our understanding of urban layouts are undergoing significant change. Inspired by Stanislas Chaillou's 2022 work Artificial Intelligence and Architecture, this section gathers proposals on how AI and machine learning influence the transition of urban forms, emphasizing the use of morphological theories to forecast city growth. These tools support informed planning and development decisions, enabling better understanding of the rapid evolution of urban structures and assisting in long-term urban growth forecasting.
The FOURTH SECTION is devoted to AI Applications on Urban Forms: The City as a Device (and Urban Agents, and Experiments).
This section explores how AI tools can support various sectors, including heritage preservation, energy efficiency, and sustainable urban planning. Case studies illustrate how morphological analysis enhances cultural conservation, optimizes resource use, and promotes sustainable development. Critical discussions also consider how cities (conceived as "devices") can be designed or managed to ensure resilience, diversity, and social equity, especially in an AI-driven urban context.

ISUF 2025 was a challenge designed to foster further investigation into these transformative influences—exploring implications for urban morphology, design, research, and pedagogy.
It will be interesting to revisit this Book of Abstracts in 25 years. The year 2050 seems an appropriate time to reflect on what has happened (and what perhaps has not) in the evolution of urban morphology, considering the rapid pace of technological innovation and the unpredictable transformations within urban spaces and forms.

Torino, June 16th 2025

Note:

Alessandro Lovisolo, PhD candidate at Politecnico di Torino within the Transitional Morphologies Research Center, with the support of the PhD candidate Caterina Juric and the PhD candidate Ezgi Nur Güngör, edited this Book of Abstracts. Due to space and formatting considerations, only the affiliations of the corresponding authors are included. The images included are those provided by the authors under their responsibility.

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001

SHAPING THE CITY: Exploring Future Urban Forms

Planning Codes for Conglomerative Urban Tissues: The Role of Generative Design Tools in Combining Types

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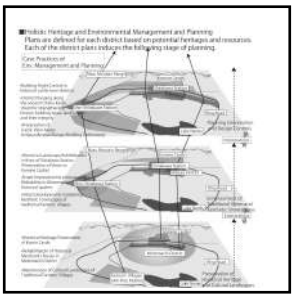
Keywords:
Type, Urban tissue, Morphological planning codes, Conglomerative urban tissues, Generative design tools

This research investigates the application of generative tools to generate compound types to integrate them into the current urban tissue through planning codes. Developing morphological planning codes encounters significant challenges across varying contexts,particularly in urban tissues characterized by a dense diversity of types, such as buildings,plots, street blocks, and street networks, where re-establishing identity through planning codes is challenging. The urban tissue in the historical and early modern parts of Iranian cities shows this diversity, which is referred to as conglomerative urban tissues. Identifying planunits (in Conzenian terms) as the foundation for zoning code areas is challenging in these contexts. A proposed solution involves combining existing types into new ones as a medium between diverse existing types and integrating them into the urban tissue via planning codes.

This approach is believed to enhance morphological planning processes by accelerating the workflow and improving the accuracy of design outcomes. This article aims to facilitate the creation of medium types by generative design tools. It studies the Taleghani Street area, a region that started to develop at the beginning of the 20th century in Tehran, Iran. It examines the impact of the current planning code on the urban tissue, analyses the plan-units of the study area, identifies the conglomerative urban form, generates medium types using Grasshopper within the Rhino environment, and models potential future urban tissue based on revised codes in CityEngine. Finally, the article discusses the role of generative design tools in creating new building types.



Holistic Environmental Design and Management for Sustainable Urbanism: Learning From the Idea of "Satoyama"

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Keywords:
Satoyama, Social capital, Sustainable Urbanism, Heritage and Environmental management, Planning system and Information platform

This paper aims at discussing a planning approach in response to the need to rehabilitate holistic urban environment focusing on the idea of Japanese "Satoyama." "Sato" in Japanese means "village" or "country area" where people used to live in harmony with local agriculture, forestry or fishery. The literal meaning of Satoyama thus implies "village hills, forests or green fields." Satoyama is also the woodlands cared for by local communities. In this sense, even today, Satoyama is considered a major common social capital that belongs to the community and suggests that our urban society can learn lessons for alternative ways of sustainable urbanism in the future. It is worth questioning inter-relationships that most of the urban settlements have with Satoyama today. In order to present a grand design for sustainable urbanism with Satoyama, there is a need for a planning system in which citizens and experts work together to manage the interrelationships among the natural environment, urban space and socio-economic activities as a whole. The key is a planning information platform that strategically directs the process of good environmental design and management by local communities. Based on the discussion, this paper draws the conclusions summarized as follows:

1. Environmental design and management concerning Satoyama clarifies the structures and elements of multi-layered resources such as topography, physical form and patterns, natural environments and landscapes, and specifies them as objectives for environmental and heritage management and planning.

2. Area management and planning examines the interrelationships among urban space and function and socio-economic activities at an urban level, and comprehensively re-plans existing built-up areas, agricultural land and water and green infrastructures.

3. Citizen-involved communicative planning specifies concepts such as "local character" and "safety and security" based on people's cognition and puts them into practice as methods for environmental management and planning for sustainable urbanism.

The green city, 15-minute city and food systems: the architectural morphology of urban agriculture and food flows in cities

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Keywords:
green city, 15-minute city, food production, urban agriculture, urban design

Cities today have a global reach and rely on imports of food and fuel from far lands. To countereffect these dependences, the green city model is a sustainable city model based on ecological design, local food and fuel production, and development of self-sufficient communities. The green city relates to the 15-minute city as a polycentric city concept that revolves around proximity and this paper explores urban spaces and local food production with morphological methods. There is a large body of literature on urban agriculture and productive urban landscapes, but they seldom use urban morphology in combination with proximity (for boosting local food safety and resilience as well as circularity of resources, reuse and recycling of urban waste) in conceptualizing urban design guidelines. Urban designers and architects have unique competence to analyse cities in three dimensions emphasizing human scale and urban morphologists describe cities as a hierarchy of design elements: streets and their layout, plots and their aggregation in blocks, buildings, and land uses. This paper with methodologically combine imagery, diagrams, and maps to analyze urban agriculture and food flows as morphological elements in relation to the generic morphological structure, derive architectural typologies of agroecological urbanism and turn typologies into design codes. The morphology of the green city does not only imply design guidelines about urban agriculture, food production and standardized design elements of the green city (community or private urban gardens, vertical farms and fields, windows farms, or roof gardens, etc.), but also an understanding of food and nutrient flows while focusing on empty spaces where food production can occur (e.g. vacant buildings, parking garages, basements, and integrated in-store containers at commercial locations). The urban agricultural systems can utilize urban residual material and energy and employ underutilized space in urban areas for food provisioning to promote a circular economy.

Density and Atmosphere: *Urban Regeneration and Spatial Morphology in Southern Nanjing*

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Keywords:
Density, atmosphere, urban regeneration, spatial morphology

The urban regeneration of Southern Nanjing provides a unique opportunity to explore how urban design, density, and atmosphere can be harmonized to shape future urban forms. This study examines the current spatial morphology of Southern Nanjing, focusing on the interplay between density and atmosphere in key areas such as Diaoyutai and Hehuatang. The findings reveal that while high-density areas can enhance urban vitality, they also risk overcrowding and reduced environmental quality. Traditional areas, with their lower density and rich cultural heritage, offer a more intimate and culturally rich atmosphere. The study identifies a critical gap in the literature regarding the integration of density and atmosphere in urban design, proposing a new framework that balances density with social, cultural, environmental and economic considerations. It can help to enhanced social interaction and community cohesion, create sense of place upon cultural heritage, improve environmental quality and resource efficiency, as well as economic viability and resilience. This research contributes to the broader discourse on urban design and regeneration by offering practical insights into creating more sustainable and livable urban environments

Accounting for externalities of urban development project: *A prototype to measure and visualize the local and city-wide impacts of urban development*

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Keywords:
15-minute City, diachronic study, network centrality, morphogenetic analysis

Today's planning practice, set within each country's current legal framework, typically treats development as a set of discrete projects, where each project needs to achieve its set goals as well as carry its own costs. This reflects an outdated understanding of urban land as a continuous area that can be divided into individual parts possible to control. Urban land should instead be considered as a system where each piece of land is dependent on many other pieces at different distances. This means that each urban development project causes externalities and system effects, typically spilling over with both positive and negative effects on other locations and projects. While this is well known, it is not reflected in current planning procedures, leading to sub-optimal decisions and solutions. The issue is acute, since cities are currently facing unprecedented challenges closely related to how we develop urban land, such as social segregation, housing bubbles increasing the risk of economic crisis, and urbanization of land being a driver in biodiversity loss. The purpose of this paper is to present a digital tool to describe, control and evaluate urban systems effects and externalities typically created in urban development projects, but not properly accounted for. The developed prototype measures and visualizes the impacts of an urban development project, with 'impacts' operationally defined as changes in the values at different locations. It should be noted that 'value' here refers to the numerical value of morphological variables (e.g. catchment, density, accessibility), not monetary or economic value. Further, the paper will discuss how these variables indirectly relate to economic values, but also social and cultural values. The tool shows how the impact distributes and varies across space and can be used in the decision-making process, especially supporting the negotiation between the objectives of the project and the city at large.

The implications of artificial intelligence in morphogenesis processes: a critical methodology for urban regeneration strategies

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Keywords:
Artificial Intelligence (AI), Urban Regeneration, Morphogenetic Sciences, Typo-Morphological Visions, Context-Sensitive Approaches

Artificial intelligence (AI) and the related "exponential technologies" infuse everyday life". AI is characterising the beginning of the twenty-first century and challenging "critical intelligence" in implementing novel methodologies and creative design solutions. Contemporary cities face an increased need for urban metabolic maintenance/transformation/ reuse processes. This process could be "augmented" through the correct and conscious use of AI, involving accurate interpretation of data and consequent problem-solving.

Integrating morphogenetic sciences and powerful AI technologies would prove crucial in improving the effectiveness of design processes in urban regeneration methodologies and critically reflecting on future typo-morphological visions. By testing AI's functionality and versatility, new urban regeneration paradigms could be defined, followed by studies on subsequent implementation processes.

As mentioned, the research on methodology aims to integrate urban morphogenetics with AI technologies rooted in morphogenetic sciences. The theoretical foundations of the methodological approach are based on a necessary balance between tradition and innovation in urban design, moving away from the universal approach of the Modern Movement. The goal is to respect diverse cultural and geographical identities by proposing an "augmented" form of modernity adaptable to specific contexts. The interaction between traditional analytical design methods and AI processes enables the development of specific protocols for operating and interrogating AI systems in urban morphogenetics. The objective is to use the fundamental principles of mutation as a framework for the examination through AI tools. Consequently, AI processes can provide projections of mutation phenomena based on the genetic constants of settlement systems and typical degeneration and regeneration processes. A series of AI-based inquiry processes will be presented. These processes will involve comparative analyses, both visual and written.

The end goal is to provide a methodology to support future theories in urban regeneration interventions further, enhancing innovative and context-sensitive approaches to urban development.

Utilizing AI-Driven Technology and Geospatial Analysis to Explore Landscape Morphology, Social Vulnerability, and Child Neglect in Los Angeles

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Keywords:
Built environment, child victimization, geospatial analysis, AI-driven mapping, social vulnerability

Child abuse and neglect (CAN) remain critical global issues, yet limited research explores how landscape morphology—proximity to green spaces, vegetation density, street networks, and neighborhood walkability—alongside human-structured spaces such as parks, transportation networks, and landscape topography, influences CAN risk. These environmental factors shape social organization patterns and cultural practices, challenging traditional explanations for the persistence of harms perpetrated against children. This study examines whether built environment features, including green space equity, connectivity, and accessibility, are associated with child neglect risk while controlling for socioeconomic vulnerability. It also explores how landscape morphology interacts with structural vulnerabilities to influence neglect in public outdoor spaces. Adopting a social vulnerability framework, we implement an approach similar to Hillier's spatial syntax methodology to analyze spatial organization and child victimization patterns. We characterized the spatial morphology of child victimization experiences and the social environments of the external spaces in which where victimization occurs. Child neglect data from the Los Angeles Police Department was analyzed using geospatial and computer vision techniques. Google Street View images of reported locations were processed using Python and the Google Cloud Vision API to identify and label environmental characteristics. Geographic analyses, including 200-meter buffer zones, were performed in QGIS to link environmental features to neglect hotspots. A random forest model quantified the association between social and environmental factors and neglect risk. Neglect hot spots were 84% more likely in areas with higher low-income density and 76% more likely in areas with higher densities of people of color. Conversely, areas with higher green space percentages showed a 16% lower likelihood of neglect. Findings highlight the potential of leveraging artificial intelligence and geospatial tools to identify environmental risk factors and inform urban design strategies—such as equitable green space distribution and improved walkability—to mitigate child neglect and promote environmental justice.

Making sense of complexity: The changing role of human intelligence in urban morphological research

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Daniel Elsea
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Keywords:
Research methods, AI-driven mapping, Urban morphometrics

Part story, part atlas – Complex City is a detailed investigation of London's changing character. Published by the Royal Institute of British Architects in 2020, this book relied entirely on human, rather than artificial, intelligence to describe how the urban morphology of the city evolved in the past - and propose how it should adapt in the future.

Five years on, we authors of Complex City would like to explore how the process and content of our publication would have differed if machine learning algorithms, large language models and generative AI had been deployed alongside the traditional research methods. Our paper would like to raise the following questions:

-How can AI expand the scope and depth of morphological research?

-Could AI's ability to recognise patterns in complex data sets have revealed unforeseen relationships between urban form and environmental or socio-economic character?

-In what alternative ways could generative or predictive AI represent or anticipate urban phenomena?

The increasing ubiquity and emergent applications of AI to urbanism means that these questions are directly relevant to all practitioners involved in the mapping of cities for policy and decision-making. The hypothesis of our paper is that an alternative, AI-based / data-led approach would have resulted in research with divergent conclusions and recommendations. We will test this hypothesis via targeted replacements of certain original information, cartography or analyses with AI-generated alternatives. As such, AI will be deployed as our research assistant, creative collaborator or co-author to re-write and recast Complex City for the age of artificial intelligence.

The purpose of the original publication was to demonstrate how metropolitan governments can meet the demands of growth while preserving their local character. If our hypothesis is correct, then it follows that other city-wide studies on the nature and future of urban form are due a fresh take.

Behaviour-oriented Urban Spatial Form Optimization Driven by Operations Research Algorithms: A Case Study of a Mixed-Use Residential Community in Nanjing

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Biao Li
Hao Ma
Peng Tang

Keywords:
Algorithmic Urban Design, Operations Research, Integer Programming, Residential Design, Mixed-Use Community

As China's urbanization shifts towards stock renewal, the growing demand for human- oriented urban development is prompting urban planning to increasingly focus on balancing spatial efficiency with social sustainability. The design of urban space renewal is becoming more and more oriented to the behaviour and experience of residents, which creates the need for algorithms to accurately assist multi-objective optimisation. This study proposes an operations research (OR)-driven approach that integrates urban spatial relationships and residential behaviour demands, aiming to create more livable community designs.

The core of this study is the two phase integer programming (IP) model developed using Java and Gurobi: (1) Macro urban geometry optimization: The model generates site layouts that meet various FAR restrictions, building area, and daylight requirements, while applying adjacency rules to ensure privacy and accessibility; (2) Micro spatial topology design: Based on the overall layout, the model fills building volumes with modular units and optimizes pedestrian networks to ensure efficient connections. This process generates a flexible algorithm capable of producing and optimizing design solutions for any given site.

The method was tested in a medium-to-high-density mixed-use residential district in Nanjing, China. Each iteration quickly generates 12-15 feasible solutions. Compared to traditional designs, the model increased spatial diversity by 23% and pedestrian interaction potential by 34%. Without changing the total building area, the method successfully balanced economic efficiency, spatial diversity, and social interaction. This approach optimizes the connection between private and public spaces, providing urban planners with a powerful tool to balance spatial economic benefits and social sustainability. The results highlight the innovative role of OR algorithms in optimizing urban form, especially in balancing market-driven density demands with community-building goals. As scientific rigor and human concerns become key directions in future urban development, algorithm- based digital urban design will be a driving force for human-oriented smart cities.

Design by scenarios. *Urban form through computational approachc*

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Andrea Tomalini

Keywords:
computational design; scenario-driven approach; urban forms; diversity

In the age of AI, urban form must integrate computational tools capable of incorporating morphological principles, regulations, and a scenario-driven approach to ensure diversity in the urban environment. The study of urban form diversity was a key principle explored by Gordon Cullen in 1961, emphasizing the importance of volumetric variety, the definition of urban sequences, and the articulation of public spaces and pathways. However, diversity and complexity remain challenging to encode within traditional planning and urban design methodologies and have only recently been empirically addressed using specific data and indicators. Within this framework, parametric modeling, supported by Visual Programming Languages (VPL), enables the management of morphological and functional complexity throughout the design process. Computational design facilitates rule-based processes by defining morphological parameters, allowing for the systematic generation, evaluation, and optimization of urban forms. The codification of typo-morphological principles translates urban forms into parameters that can be applied in computational design tools, serving as dynamic platforms for testing and refining urban design principles. Moreover, by leveraging computing power, these modeling techniques accelerate the design process compared to traditional methods, offering the possibility of defining and interacting with multiple design scenarios. This study aims to explore how the interaction between urban morphology theories and computational design is redefining urban design through scenario-based approaches. By employing parametric methodologies, architects can optimize design strategies, contributing to more adaptable and dynamic townscapes.

Defining proxies for walkable urban design: four case studies in Łódź, Poland

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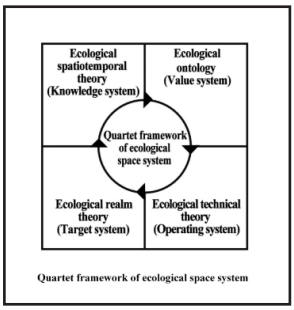
Keywords:
walkability, urban design, urban form, proxy

Three key perspectives dominate the continuous conversation about urban walkability (Forsyth, 2015). The first method emphasizes essential factors in pedestrian spaces, such as ease of access and interconnectivity (Alfonzo, 2005; Moudon et al., 2006; Ewing & Cervero, 2010), traversability (Dovey & Pafka, 2020), compactness, safety (Buehler & Pucher, 2017; Lo, 2009) and inviting environment (Southworth, 2005; Moudon et al., 2006). The next set of research examines aims associated with walkability, focusing on aspects such as health, livability, social connectivity, and resilience. The third strategy, which is especially pertinent to urban design, focuses on identifying substitutes for normative design practices. The unique traits and dimensions of the setting, combined with the goals of the study and the techniques used for analysis, influence the particular aspects that researchers select. A multitude of contextual elements renders it unfeasible to create a one-size-fits-all standard for design features that promote walkability. The elements that support walking vary based on the type of setting. Typically, the defining features vary among urban centres, adjacent multi-unit residential neighbourhoods, individual family homes, and outlying suburban regions.

Our investigation focuses on contrasting the varying conditions to establish a set of traits that are particular to the four types of city settings. To do this, we conduct in-depth analyses of walkability in four neighbourhoods in Łódź, Poland: central mix-use urban location, peripheral multifamily residential, dense, pre-war single-family housing and peri-urban historical village.



Quartet framework of ecological space system

A Study on the Green Volume Evaluation Criteria and District Morphology: Optimization Strategies for Historic Districts Based on Dual Comparative Analysis

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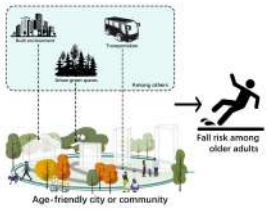
Cong Gong

Keywords:
historic districts revitalization, urban renewal, two-dimensional green volume, three-dimensional green volume, ecological benefits

This study investigates the green volume evaluation criteria and optimization strategies for historic districts through a dual comparative analysis with ecologically planned districts. Historic districts, which have evolved naturally over time, often fail to meet contemporary planning standards for green space ratios. Moreover, traditional two-dimensional (2D) green volume evaluation criteria are insufficient to fully capture the ecological benefits of historic districts. To address this gap, the study begins with an analysis of the suitability of 2D green quantity standards for historic districts. It employs three-dimensional (3D) oblique photogrammetry and field surveys to collect detailed information on plant species, 3D green quantity and spatial characteristics. Using ecologically planned districts as control samples, the study utilizes simulation equations to calculate the green volume rate data for two experimental plots. The results reveal that historic districts generate greater ecological benefits per unit of green space area compared to ecological districts, demonstrating a distinct green volume advantage. Specifically, historical districts exhibit: (1) greater diversity in the configuration of large trees within plant communities; (2) a larger proportion of total leaf area contributed by trees; (3) enhanced temporal and spatial benefits for trees; and (4) richer vertical greening. Based on these findings, the study proposes optimization strategies for district morphology in historic districts that benefit cultural, social, natural, and economic ecology. These strategies aim to provide theoretical and practical insights for the protection and development of historic districts within the context of urban renewal.

Shaping Green Cities: *The Impact of Urban Green Spaces on Fall Risk Among Older Adults and the Mediating Role of Mental Health*



Shenghao Huang | *Chongqing University*

Keywords:
Urban green spaces, mental health, falls, older adults

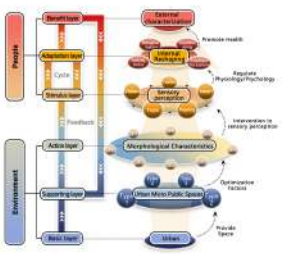
Background: Falls are one of the leading causes of injury and mortality among older adults. Although some studies have suggested that urban outdoor spaces are closely associated with falls in older adults, few studies have explored the relationship between urban green spaces and the risk of falls in this population. Furthermore, mental health, as a critical factor in assessing the risk of falls among the older adults, may play a pivotal mediating role between urban green spaces and the risk of falls.

Aim and objectives: This study aims to explore the association between urban green spaces and falls among older adults, using mental health as a mediating variable.

Methods: This study utilizes sample data from the CLASS (China Longitudinal Aging Social Survey), creating a green buffer zone based on the respondents' districts and counties to generate a Normalized Difference Vegetation Index (NDVI) map, and structural equation modeling (SEM) was employed to conduct statistical analyses of the variables.

Findings: The study found a significant negative correlation between urban green space area and the risk of falls among older adults, indicating that greener the city appears are associated with a lower risk of falls. Mental health partially mediated the relationship between urban green spaces and fall risk, suggesting that urban green spaces indirectly reduce the risk of falls by improving the mental health of older adults.

Conclusion and Implication: This study demonstrates that greener the city appears is linked to lower fall risk in older adults, with mental health serving as a significant mediator. The findings provide a theoretical foundation for future green city planning and public health initiatives, emphasizing that urban planning should prioritize increasing green space area and enhancing its accessibility. Such measures can promote the physical and mental health of older adults, thereby helping to prevent fall-related incidents.



The Morphological Characteristics of Urban Micro Public Spaces for Guiding Proactive Health Based on Visual Perception

Zihua Jin | *Hebei University of Technology*
Ping Shu
Wang Lijun

Keywords:
Regeneration of Cultural Context, Repurposing of historic districts, Unstable environmental change, Urban Resilience, Built environment formed since the 20th century

In the context of the “big health” initiative, the accelerating process of urbanization has led to the increasing importance of micro public spaces in guiding residents toward healthier lifestyles. In recent years, proactive health has emerged as a new health concept driving the high-quality development of China in the new era. However, there is a lack of detailed consideration of proactive health at the micro-scale level. This study aims to explore the morphological characteristics of micro public spaces that guide residents toward proactive health. By utilizing human visual perception as the driving central mechanism and employing temporal semantic segmentation techniques, the study quantitatively extracts the 3D compositional features of four types of urban micro public spaces and the proactive health intentions of their users. The analysis identifies key factors that guide proactive health. The findings reveal a significant correlation between visual perception, spatial form, and proactive health. Among the different space types, the characteristics of Type 3 spaces had the most pronounced effect on proactive health through visual intervention. Factors such as colour hierarchy, facility style, and spatial enclosure play a crucial role in guiding proactive health. The study further confirms the critical role of visual perception in promoting proactive health and suggests that future designs should focus on the construction of spatial visual layers, integrate visual guidance elements at key spatial nodes, and consider the visual dimensional differences across age groups. This approach aims to provide new design ideas and methods for the development of healthy cities.

Comparative Urban Regeneration: *Spatial Integration and Physical Transformation in London and Istanbul*

Yunus Emre Kozoğlu | *University of Nottingham*
Beyza Karadeniz

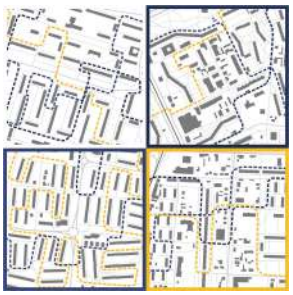
Keywords:
Spatial analysis, Space Syntax, Spacemate, Density, Urban form

Urban regeneration plays a pivotal role in shaping the future of cities, particularly in high-density metropolitan areas. While London and Istanbul pursue similar objectives in their large-scale redevelopment efforts, their approaches reflect distinct spatial, socio-economic, and regulatory contexts. London's Opportunity Areas prioritize large-scale mixed-use developments tied to transport infrastructure, whereas Istanbul's Urban Transformation and Development Areas focus on mitigating earthquake risks, renewing deteriorated urban fabric, and preserving cultural heritage.

This study conducts a comparative morphological analysis of two contemporary regeneration projects from each city, examining spatial integration, density (Spacemate), and built form transformation through advanced spatial analysis tools, including GIS-based mapping, Space Syntax, and typological assessments. Findings reveal critical differences in the distribution of urban pattern types and their relationship within the sites. Istanbul exhibits higher density values with lower open space ratios (OSR), despite having a greater average building height than the London sample. This contrast underscores variations in urban fabric compactness, public-private space interfaces, and accessibility, shaping distinct regeneration outcomes.

By analyzing these transformations within their broader urban context, this study offers insights into how different planning strategies influence connectivity, livability, and sustainability. While both cases aim to create dense and vibrant urban environments, their development logic, spatial structure, and integration within the existing urban fabric vary significantly. The research contributes to the ongoing discourse on future urban forms, emphasizing the role of spatial configuration in achieving balanced, sustainable, and contextually integrated regeneration.

Findings from this comparative study provide valuable implications for decision-making in large-scale urban redevelopment, fostering more resilient, efficient, and inclusive urban environments.



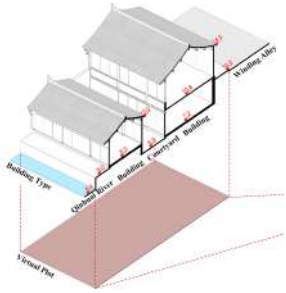
Walkability patterns in modernist housing estates: *two case studies from Lodz, Poland*

Tomasz Krystkowski | *Lodz University of Technology*
Malgorzata Hanzl

Keywords:
Walkability, Modernism, Space Syntax, Space configuration

Modernism discarded the traditional organisation of urban fabric and proposed brand-new layouts based on principles of geometry. In particular, Le Corbusier and his peers rejected culturally embedded streetscapes as an embodiment of all the ills of 19th-century industrialisation and rapid urbanisation, such as overcrowding, lack of insolation and poor sanitation. Traditional urban structures were unable to accommodate vehicular traffic. This is where the modernists' ideas for a completely new, separate organisation of transport infrastructure came from. The separation of different transportation modes, specific for functionalism, and the need to calm traffic within neighbourhood units result in circulation patterns distinctive for modernist housing estates. However, the modernist legacy in post-socialist countries, including Poland, features divergent contexts which affect the actual organisation of the housing estates and their layouts. In the current study, we compare two distinct case studies of large-scale modernist housing estates in Łódź, where approximately one-third of the population still lives in the blocks-of flats neighbourhoods. Both estates were constructed in the 70s and 80-s of the last century. We compare Teofilów, built in the town outskirts, next to the parallelly planned industrial zone, with two estates in Bałuty, raised on the remnants of 19th-century tenement houses, of which some remain preserved until now. Our focus is on circulation, especially walkability patterns; we analyse them in relationship to the housing estate layouts. In particular, we aim to verify the impact of the presence of traditional pieces of urban fabric against its lack within the modernist layouts. The methods include a simplified regression analysis of various factors that impact walkability, including, among others, space configuration, public transportation accessibility, urban landscaping, density, and connectivity. Based on this analysis, we present the recommendations for the future redevelopment and functioning of the concerned estates.

Research on Cross scale Morphological Analysis and Design Strategies of the West Five-mile Riverside Area of the “ Ten-mile Qinhuai River “ in the Old City of Nanjing



Hua Liu | *Southeast University*
Dongqing Han

Keywords:
Inland river system of old city, Urban morphology, Relevancy, Regeneration, Plot pattern

The inland rivers are one of the elements of urban form. The inland rivers in the old city have been symbiotic with the history of urban development, permeated with historical and cultural information and socio-economic development status. The riverside areas are key zones that reflect the environmental quality and characteristics of the city. This article interprets the interaction between the water system and urban form at multiple scale levels, and to study the regeneration design method of the riverside areas. At the urban level, interpret the specific correlation between water systems and the “mountain-water-city” holistic pattern, and propose practical methods for pattern protection and resource integration. At the district level, the symbiotic relationship between water system and plot pattern is explored, and the traditional texture inheritance method based on plot and virtual plot is proposed, which is extended to digital generation technology. At the architectural level, understanding the intrinsic relationship between water systems and riverside architectural elements, and proposing control rules for riverside architectural elements. Taking the urban design of the west five-mile riverside area of the “ Ten-mile Qinhuai River “ in the old city of Nanjing as an example, this paper presents a continuous process from multi-scale morphological correlation analysis to regeneration design. Ten-mile Qinhuai river” is the mother river of Nanjing and an important link for the overall revival of the Southern Historic District of Nanjing. The west five miles refer to the western half of the “Ten-mile Qinhuai river”, with a total length of about 2500 meters. Urban design progresses through the levels of “City- District-Block-Building”, interpreting the correlation between water systems and urban form at different levels of precision, and proposing strategies for the protection and regeneration of riverside areas.

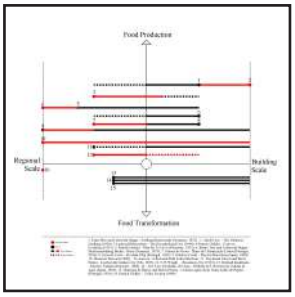
Hutong-Inspired Urban Morphology: Lessons from Dashilar for Sustainable Urban Design

Yao Lu | *Waseda University*

Keywords:
Urban Morphology, Historic Neighborhoods, Gated Communities, Connectivity and Permeability, Sustainable Urban Development

As cities worldwide grapple with social fragmentation, spatial inequality, and inactive public spaces, the proliferation of large, gated communities has exacerbated these challenges, further reinforcing spatial divisions and undermining urban inclusivity. Meanwhile, emerging digital tools and artificial intelligence–assisted analyses offer new ways to rethink spatial configurations, yet they should align with established morphological insights. In contrast, the historic Dashilar district in Beijing, with its rich road morphology, hierarchical street networks, and layered spatial transitions, demonstrates how traditional forms foster a fine-grained urban fabric characterized by diversity and sustainability. This study aims to explore how these spatial configurations address modern urban challenges and provide insights into shaping inclusive and sustainable future urban forms. This study adopts a morphological framework to analyze Dashilar's compactness, permeability, and interaction through seven key metrics: Building Density, Road Density, Intersection Density, Pedestrian Accessibility, Economic Activity Flow, Retail Density, and the Shannon–Weaver Index for Functional Diversity, while exploring potential synergies between AI-enhanced methods and traditional morphological analysis. To highlight differences, the study compares Dashilar's form with modern gated communities. The findings underscore Dashilar's superior connectivity, permeability, and social engagement, contributing to mixed-use spaces and vibrant public environments. Drawing inspiration from hutong configurations, this research proposes open-block principles to guide inclusivity and adaptability in future developments. Integrating AI-driven methods with morphological insights can optimize planning decisions, ensuring technology supports rather than overrides human-centered design. Ultimately, these results advance discussions on shaping future urban forms by showing how historic patterns can inspire sustainable, resilient city designs that address efficiency and quality-of-life challenges.

The role of urban form for the Productive City



Teresa Marat Mendes | *Iscte Lisbon University Institute*

Keywords:
productive spaces, 15-minute city, sustainability, urban agriculture, urban form

The history of human civilization testifies to a plethora of urban form solutions associated to uses of economic productivity, across the passage of time or technological advances. Within those examples there are cases of survivors but also of neglection by society itself, with deep impacts on the productivity and sustainability of the city. This presentation aims to disclose the role of urban form on the guaranteeing of a productive city, from the perspective of sustainability and the problematic of climate change. Therefore, it questions possibilities to access the role of urban form from the perspective of a productive city, which should integrate local food production (urban agriculture) and sustainable modes of transportation (low carbon emissions). The main purpose of this presentation is to discuss the results of an ongoing investigation which has compared several examples of urban form associated to food productivity and sustainable modes of transportation. Therefore, it aims to disclose which are the urban form patterns, uses, and specific relations, that appear to provide such conditions of sustainability and productivity. For doing that this study has followed a methodological approach based on two specific tasks: i) an international comparative analysis of examples of productive urban forms (focussed on urban agriculture and the 15-minute city); and ii) a comparative morphological analysis of four case studies, located in the city regions of Lisbon (Portugal); Montreal (Canada), Stockholm (Sweden) and Tallin (Estonia). Finally, this presentation will identify the surveyed urban form elements which have proved to be more resilient than others, and able to accommodate change, from the perspective of the productivity.

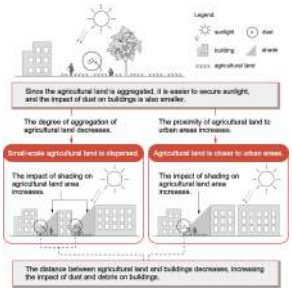
Generative Artificial Intelligence for Architecture: The role of Knowledge

Marco Maretto| *University of Parma*
William Bozzola
Nicola Marzot
Sandra Mikolajewska
Luigi Palumbo
David Viana

Keywords:
Urban Morphology, Artificial Intelligence, Urban Design, Architecture, Methodology

Artificial Intelligence is transforming the way we think, analyse and design architecture driving to a real paradigm shift in the construction of the city. Two concepts seem to be at the basis of this process: Creativity and Knowledge. A creative and imaginative capacity is strongly enhanced by AI, heavily fuelled by the transition from material to immaterial culture. On the complementing side, a huge capacity of knowledge is needed to drive the generative processes of Artificial Intelligence. Knowledge is the only tool that can control any AI. It is the quantity and quality of information it conveys that provides the content to any Artificial Intelligence. Since it crosses the entire spectrum of human Thought, from the most properly humanistic to the purely scientific one, it is its synaptic capacity to integrate this information with each other that will define a new way of designing architecture and cities. The aim of this paper is, on the one hand, to explain how scientific research and in particular Urban Morphology, can guide the Artificial Intelligence Generative processes. On the other hand, to demonstrate how AI, if supported by Knowledge, can overcome the methodological gap, between Analysis and Design, around which a significant part of the urban morphological research of the last fifty years has been debated. Following the ISUF Research and Practice Grant, of which this work is a first return, the regeneration project of the Gaia waterfront in Porto was chosen as a case study.

The actual changes in the location and distribution patterns of urban agricultural land



Komatsu Mei | *Waseda University*

Keywords:
Urban agricultural land, Urban design, Location patterns, Distribution patterns, Buffer zones

Urban agricultural land has been excluded from traditional urban planning in Japan, and the aging of farmers and lack of successors have led to its continued decline. However, in recent years, interactions with diverse people and finding fulfillment in nature have become important aspects of urban life. Urban agricultural land is a key element of urban planning to realize this lifestyle. Therefore, a new approach to planning agricultural land, with urban residents as key players, is needed to realize urban areas where agricultural land coexists with buildings. This study is foundational research aimed at developing planning methods for urban agricultural land to improve urban life. This study aims to identify the factors preventing agricultural land from persisting in urban areas by examining the transformation of agricultural land location and distribution in the Karasuyama area of Setagaya Ward, Tokyo, where many agricultural lands remain, based on their relationship with urban infrastructure. Two methods were employed in this study. First, a detailed visual analysis of maps clarified the relationship between the transformation of urban infrastructure and the persistence, disappearance, and new establishment of agricultural land parcels. Second, using the concepts of land aggregation and proximity, the study quantitatively analyzed map data to examine how agricultural land location and distribution patterns changed. The analysis revealed that agricultural land along major roads tended to disappear in the past, but this trend has recently stopped. Additionally, agricultural land near rivers was less likely to disappear. Compared to 1983, by 2016, it became clear that small-scale agricultural lands had become more dispersed and agricultural land was located closer to buildings. Based on the above, this study concluded that the absence of adequate buffer zones between agricultural land and buildings, necessary for sunlight and mitigating cultivation impacts, makes it difficult for agriculture to persist in urban environments.

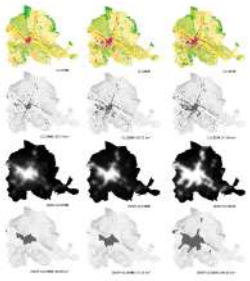
The urban transformation of Cairo as a project of projects

Manlio Michieletto | *German University in Cairo*

Keywords:
Cairo, satellite city, sustainability, urban planning, urban transformation

Cairo's urban transformation reflects a multifaceted and ambitious approach to addressing the city's rapid expansion, socio-economic disparities, and infrastructural challenges. This study examines the evolution of Cairo's urban landscape as a "project of projects," where multiple large-scale initiatives—including new satellite cities, infrastructural megaprojects, and the development of a new administrative capital—intersect to redefine the most populated African megalopolis. A sort of "collage city" that combines different examples of urban forms intertwined by the complex infrastructural network of roads. A city that has always built itself north-south along the Nile banks, as Hassan Fathy also reminded us, is experiencing an opposite growth in the east-west direction, settling the desertic areas. The research aims to analyse the drivers behind these transformations, assess their socio-spatial impact, and explore their implications for urban sustainability. The study employs a mixed- methods approach, integrating spatial analysis and case study evaluation to uncover the patterns shaping Cairo's contemporary urban form. A form that, due to a dichotomous opposition between the historical nucleus and the modern sprawl, makes it less recognisable and understandable. Findings highlight the tension between the ongoing urban expansion and the existing urban fabric, revealing how these projects influence housing typologies and morphologies, mobility networks, and socio-economic integration. The study concludes that while Cairo's urban transformation seeks to alleviate congestion and modernise infrastructure, it raises critical questions about inclusivity, ecological resilience, and long-term urban viability. The research contributes to broader discussions on urban planning in the Global South, offering insights into the complex interplay between the city's history and urban realities.

International Exhibitions and Open Public Spaces: *Echoes of the Times or Forerunners?*



Javier Monclus | *University of Zaragoza*

Keywords:
Open Public Spaces, International Expos, Paradigms

International Exhibitions (Expos) have long been recognized as dynamic laboratories for architectural and urban design innovation. While the iconic structures and transformative urban strategies of Expos have been extensively studied, the critical role of public open spaces within these global events has received comparatively little attention. This paper contends that Expo open spaces are far more than passive backdrops for architectural showcases; they are integral to the Expo experience, crucial for managing visitor flow, serving as hubs for social interaction, and experimental platforms for pioneering urban design concepts. Moreover, these spaces often leave a more enduring legacy on host cities than the temporary pavilions themselves. Through a historical analysis of Expos through the specific lens of open space design, this paper demonstrates how these spaces have both mirrored and shaped broader trends in urban public space design. By examining their dual role as reflections of contemporary urban ideals and catalysts for innovative urban models, this study highlights the profound and lasting influence of Expo open spaces on the development of urban design principles and practices worldwide.

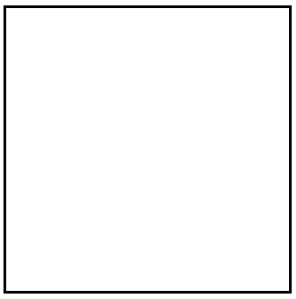
Urban morphological and functional consequences of the introduction of the post-war "retroversion" method in Poland

Łukasz Musiaka | *University of Lodz*
Vitor Araujo de Oliveira

Keywords:
post-war reconstruction, retroversion, functional-morphological transformation, old town, Elbląg

The scale of destruction of many historic cities as a result of World War II was unprecedented. Particularly affected by the destruction were areas of the Recovered Territories, incorporated into Poland after 1945. Elbląg was one of the most damaged cities, with 98% loss of the old town built-up area. Only a few buildings were rebuilt and the former historic centre was serving as an "inner city meadow". In the 1980s a comprehensive, conservation project called "retroversion" has been introduced in the city, for the first time in Poland. Other cities like Szczecin or Głogów, has also adopted retroversion approach, but to the lower extent. The reconstruction was preceded by large scale archaeological and architectural analysis of the old town area. The new form of restoration was based on activities undertaken with respect to historical conditions but without reproduction of the former urban tissue. The reconstruction of the old town in Elbląg continues to this day and analysis of this unique process and its spatial functional consequences constitute the main goal of the paper. The main method of the research adopted was an original qualitative-quantitative analysis of the built up area transformation, as well as the study of the functional and morphological consequences of the observed process of change. As a result of more than 40 years of dynamic transformation, residents have finally regained their key, representative urban space. Despite the controversies regarding the form of recovery, Elbląg should be considered an interesting example of post-war reconstruction.

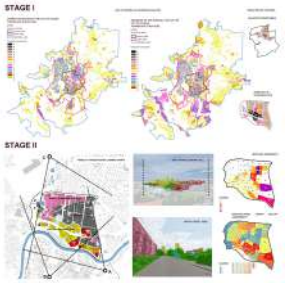
Human Centred Algorithms and Machine Centered Algorithms in Urban Design



Hans Joachim Neis | *University of Oregon*

Keywords:
Healing gardens, landscape design, metaverse, psycho-physical wellbeing, university campus

An algorithm is a set of instructions or steps that are followed to solve a problem, perform a specific task, or achieve a particular goal, which is true for human applied algorithms as well as computer algorithms. In city building and architecture 'The Laws of the West Indies' (1573) was one of the early scripted algorithms that describes the essential ingredients and building types of colonial towns in Latin America. The actual design and building had to be done by architects, engineers and huge labour force. Based on my own experiences with CES projects, I explore how urban design and architectural projects are generated in analogue (words and numbers) algorithms, with computer applications limited to practicality. In this way we hardly ever apply parametric algorithms, but use our own human centred techniques to create the design and buildings in analogue direct form. Starting with the Book A New Theory of Urban Design and its human algorithm application to the San Francisco Waterfront, the Guasare New Town Development in Venezuela, and other projects in Frankfurt, Portland or Rome, all these examples, are based on human generative processes, experience and quality. AI, artificial intelligence, building and planning seems to force the more serious issue of human centred algorithmic design vs machine centred algorithmic process advantages, because AI design uses machine learning to process data and generate solutions. It means that AI as a learning machine will find all the design and building solutions by itself. The Design of the AI planned City 'California Forever,' or other, may serve as an example and contra point. The huge difference to the Laws of the West Indies algorithm is that it is not that huge amounts of engineers and people are needed, instead, it will require huge amounts of electric energy and less human input.



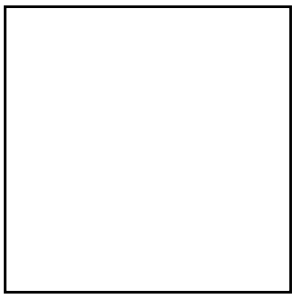
Shaping Contemporary Townscape: Possibilities and Methods

Lina Panavaitė | *Vilnius Gediminas Technical University*

Keywords:
Contemporary townscape, urban design, modern city, development

A reflection of the modern global world is the modern construction of the late 20th - 21st century in cities, characterized by high-rise and massive hall-type buildings. Nowadays attention is paid to the preservation of heritage by setting development restrictions, because most often these new objects appear in the already formed urban structure, often even in historical centers. It is important that new architectural objects are rarely viewed comprehensively, and especially as an opportunity to form new townscapes with specific characteristics of the period. The process of creating townscapes in old cities involves solving current issues, but the desired result is to create a mosaic of era-specific townscapes that enhances the city's identity. The purpose of the study is to determine the development possibilities of the modern townscape. The study consists of two stages, and the chosen object is Vilnius city. The first stage involves identifying the limits of physical development potential in Vilnius city's current and planned urban structure using the spatial data multi- criteria clustering analysis method (GIS). The results of the multi-criteria analysis are compared with each other and the territories that are expected to experience the greatest change are selected, from which a potential territory for the development of a modern townscape is selected according to the additional evaluation criteria. The second stage involves evaluating the potential for change in the selected territory in relation to the existing structures. The study's initial findings indicate which city area has the highest potential for transforming into a modern townscape. The second part's results reveal structures that, with city growth, have the most potential for transformation and could form a modern townscape. The work aims to answer the question of what possibilities of continuity and change of the formation (self) of modern townscapes in the 21st century.

Designing for Circularity: *Exploring Sustainable Solutions for Mid-Rise Multi-Residential Housing*



Sevgim Pekdemir | *Queensland University of Technology*

Keywords:
Circularity, Mid-Rise Typologies, Sustainable Design, Multi-Residential Housing

Circularity, inspired by natural cycles, offers a sustainability strategy that challenges the linear model of resource consumption by reintroducing materials into the cycle through reuse, recycling, and reduction, thereby minimizing waste and extending resource lifecycles. In the urban context, it extends beyond waste management to emphasize resource efficiency, environmental regeneration, and adaptable spatial configurations. Mid-rise building typologies, typically ranging from 4 to 10 stories, emerge as optimal for achieving these goals, balancing density, liveability, and circularity. These typologies foster a compact urban form, walkability, social interaction, and urban connectivity while enabling modular construction, regenerative materials, and decentralized systems that promote circular material flows and lifecycle thinking. This paper investigates how circular principles can shape mid-rise building typologies for multi-residential housing, addressing urban challenges through resource efficiency and social cohesion. Using a contextual review of international best practices, it identifies key circular urban design principles and strategies. The research contributes to self- sustaining communities that promote urban morphologies optimizing resource use, incorporating compact spatial configurations, and enhancing quality of life by presenting prototypes demonstrating the application of these principles. These findings provide practical insights for urban designers, architects, and policymakers aiming to create sustainable and inclusive urban environments.

Exploration of the "Atmosphere-First" Concept and Operational Methods in the Creation of Urban Cultural Tourism Consumption Spaces under the Context of Urban Renewal and Artificial Intelligence Technology

Junjin Qiu | *Southeast University*

Keywords:
Urban Renewal; Urban Morphology; Cultural Tourism Consumption Spaces; AIGC; Intelligent Atmosphere Creation

In recent years, urban cultural tourism consumption has become a rapid growth point in China' s urban economy. Driven by the intrinsic pursuit of sales and profits, the demand for quality and atmosphere in cultural tourism consumption spaces has significantly increased. This presents a new challenge to traditional design thinking and methods, while also raising concerns about the threat of "design trending" to urban spatial order and historical features. This paper situates its research within the context of rapid urban renewal and the application of artificial intelligence (AI) technologies. Grounded in morphological typology theory and with a respect for urban historical continuity, the study proposes the "Atmosphere-First" concept for the creation of urban cultural tourism consumption spaces.

In exploring specific operational processes, this paper emphasizes the role of AIGC (AI-Generated Content) technology in facilitating design language transformation and keyword extraction, enabling more precise and creative atmosphere creation. It highlights that such atmosphere creation aims to enhance and enrich the recognizability of urban historical and cultural characteristics. Tools like MidJourney and Stable Diffusion are utilized to ensure that the final atmosphere aligns with users' emotional and sensory expectations. The paper also demonstrates the application of AIGC-driven strategies in real-world projects. These case studies illustrate how AI- generated content can improve the aesthetic and functional qualities of cultural tourism spaces, fostering deeper emotional connections between users and their environments. Additionally, the study explores the behavioral mechanisms of urban residents and tourists, revealing how atmosphere-driven design influences user engagement and satisfaction.

The paper argues that the application of AI technology in the design of cultural tourism consumption spaces should actively adhere to the principles of urban morphology and architectural typology. This approach can better align with urban economic development and the preservation of historical and cultural characteristics, ensuring a harmonious integration of innovation and tradition.

The use of AI in the process of creating (pre-)urban form: a didactic experience

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Rocío Santo-Tomás Muro

Keywords:
AI image generation, form modeling tools, semiothics in architecture

With the rise of generative image processes through Artificial Intelligence (Midjourney, ERNIE-ViLG, YandexART, etc.), numerous questions have arisen regarding the semantic field, the creative role of machines and their reflection in physical reality. Understanding creation in architecture as a response to the real problems of human life and the city as the most complex stage of this process, this work seeks to turn to an understanding of form in its primitive character. We believe that these studies, which go beyond the syntactic field by recognizing the meaning of form, are fundamental for subsequent application in the pragmatic field - human use. In this way, we seek to understand how artificial intelligence mechanisms can contribute to the construction of new plastic compositions - future cities -, highlighting two specific moments in their use: the previous one - prompt - that is, the message that feeds the machine to generate the result; and the subsequent one - criticism - that is, understanding the degree of applicability of the result obtained to the intended result, always supported by the minimum requirements and the importance of the semantic field (form and meaning). As a context, we considered three practical exercises (invisible city, labyrinth and parklet) – whose final results must be presented in physical form - developed in the first of our Architecture Studio courses. In this process, we also intend to highlight two fundamental concepts: architecture as a language (supported by a semiotic understanding of form) and architecture as a phenomenon (supported by the phenomenological value of use). Although applied to preliminary exercises, we believe that this understanding is essential for future studies in the digital production of architectural, urban and landscape projects, which are already provided for in the curriculum of our course, which has only been in existence for one year.

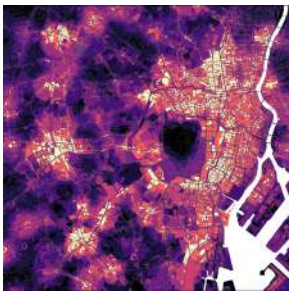
New urban forms in the periphery of Madrid through the inclusion of the concept of Urban Green Infrastructure in relation to housing.

Eva Juana Rodriguez Romero | *Universidad San Pablo-CEU*

Keywords:
peri-urban landscape, residential landscape, urban form, perceptive analysis Madrid

An analysis of significant cases of the peri-urban landscape of Madrid is proposed, in terms of open public space -relational spaces, parks, squares, corridors- in relation to residential spaces, to verify the role of the new urban greening plans, such as the municipal project “Bosque Metropolitano” (Metropolitan Forest). In the case of Madrid, the peri-urban landscape, apart the large productive and service spaces, is also characterized by extensive green areas, with great historical and ecological value, and newly created green corridors that try to alleviate the negative effect of large infrastructures, while serving for the enjoyment and benefit of the population living in the peripheries. Knowing how this symbiosis between the high density of peri-urban population, the extensive green areas throughout history, and the new housing developments has come about, will make it possible to determine which factors have a favorable impact on their inhabitants, so that they can be considered in future developments and improvements to the existing fabric. The recent emergence of the concept of Urban Green Infrastructure as a planning and urban design tool is influencing an opening up of urban form in new peripheral developments, which in turn must connect to denser consolidated fabrics. The potential of urban greenery to improve connectivity and quality of life in residential spaces is very high and should be harnessed to produce inclusive and resilient design. In order to determine and analyze the most representative cases, an evolutionary analysis will be combined through cartography, with perceptual analysis, which will allow to combine the technical vision with the everyday vision of the urban landscape. Green spaces, and specifically the Urban Green Infrastructure, understood as an interconnected network of green spaces, appears as a tool that dialogues with new housing developments, and serves as an opportunity to solve problems.

Characteristics and Metrics of Three-dimensional Urban Block Form

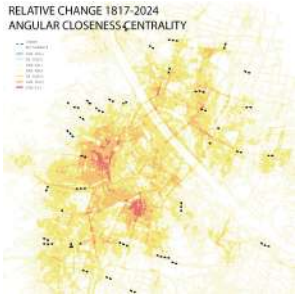


Yacheng Song | *Southeast University*
Yuxuan Song
Xiaoxuan Wang
Ruoxan Wu
Jingchun Zhou

Keywords:
Three-dimensional Form, Future Urban Blocks, Morphological Metrics, Three- dimensional Base, Morphological Typologies

The three-dimensional development of urban space is a crucial spatial strategy for further enhancing land use efficiency in the future, representing a form of morphological organization that spans across streets/plots and sites/ buildings. It not only manifests as a high-density aggregation and mix of various functions and spaces under limited land resources but also exhibits characteristics of layered utilization and efficient connections in the vertical dimension. With ongoing enhancements in rail transit systems and the development of urban polycentrism, three-dimensional urban blocks have become prevalent, rendering the examination of their characteristics essential both theoretically and practically. This article delineates three primary form characteristics of three-dimensional cities: vertical stratification of urban spaces, multilevel connectivity, and overlapping urban spaces with architecture.

This study establishes a metric system for spatial aggregation and morphological typologies, including Multilevel Projection Ratio and Multilevel Area Ratio, alongside metrics for layering, connectivity, and overlap, providing a foundation for identifying and comparing features of three-dimensional spaces. Finally, based on the established measurement index system, this study assesses typical examples from global contexts. It employs hierarchical clustering algorithms to delve into the similarities and differences among various types of samples. This analysis contributes to constructing a cognitive framework for the three- dimensional urban block form, thereby providing a scientific foundation for the design practices of future urban forms.



The role of network centrality shifts for local morphological transformations: A case study of 10 linear settlements in the metropolitan area of Vienna

Ioanna Stavroulaki | *Chalmers University of Technology*
Daniel Löschenbrand
Tanja Hellsten Romeborn
Angelika Psenner
Susanne Theresa Theresa Tobisch

Keywords:
15-minute City, diachronic study, network centrality, morphogenetic analysis

The 15-minute City is a novel urban planning approach aiming at sustainable mobility while enhancing urban life. However, implementing this concept in car-dependent suburbs poses significant challenges because these areas are lacking essential morphological features.

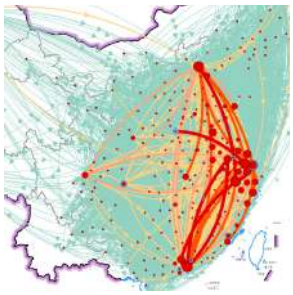
In this paper, we aim to draw lessons from a diachronic study focusing on the development of linear settlements in the metropolitan area of Vienna (Austria), covering four timeframes between 1800 and 2024. The argument is as follows. When cities grow - most often by extending out into the periphery - existing places get better connected. Or in other words, some streets become more centrally located, changing their relative location, which in turn leads to increased traffic flows and economic activities.

The transformation of the network on the city scale is compared with changes in the building structure of 10 linear settlements spread across the metropolitan area of Vienna. The study combines a quantitative and qualitative method to better understand whether shifts in network centrality using space syntax affect morphological changes using urban morphogenetic analysis. First, space syntax analysis is used to measure the changes in centrality indicating shifts in with movement flows of pedestrians or vehicles as well as concentration of economic activities. Second, the individual settlements and their surroundings within a 15-minute catchment area are subjected to a morphogenetic analysis.

Some of the linear settlements lose their role as main street as it is replaced by more recently added street or another existing street increased more in centrality than the linear settlement itself. The change in the building structure is illustrated, analysed and contextualised by the historical and political events of the time.

The results will be used to inform urban planners how to support new main streets as central element for the 15-minute City in a suburban context.

Knowledge Complexity as a Catalyst for Reshaping Urban Forms: *Evidence from Technology Transfer Networks in China*



Kang Sun | *Southeast University*
Yingcheng Li

Keywords:
Urban morphology; knowledge complexity; technology transfer networks; city shaping; spatial inequality

The evolution of urban forms in the 21st century is increasingly driven by the interplay between technological innovation and the systemic complexity of urban knowledge ecosystems. This study investigates how disparities in knowledge complexity among cities shape technology transfer networks, thereby influencing the spatial and functional reconfiguration of urban systems. By conceptualizing cities as nodes within a dynamic bipartite network, we argue that technology transfer is not merely an economic process but a spatial mechanism that redistributes innovation capacity, ultimately redefining urban hierarchies and regional morphologies.

Using patent transfer data from 252 Chinese cities (2001–2020), we develop a Knowledge Complexity Gradient (KCG) framework that quantifies how cities' technological profiles determine their roles as innovation sources or sinks. Our network analysis reveals that moderate complexity gaps between cities create symbiotic relationships that enhance polycentric urban development, while extreme disparities lead to core-periphery patterns that fossilize rigid urban forms. Crucially, we identify a morphological tipping point where technology transfer transitions from fostering distributed urban networks to reinforcing centralized megacity dominance.

These findings challenge conventional smart city paradigms by demonstrating that urban form evolution depends fundamentally on the asymmetric integration of knowledge systems rather than uniform technological diffusion. The study proposes a "Complexity-Sensitive Urban Planning" approach, advocating for tiered innovation corridors and adaptive zoning policies that align with cities' evolving knowledge architectures. By decoding how technology flows sculpt urban spatial structures, this research provides a new lens for designing future cities that balance network connectivity with localized innovation ecosystems.

Complexity and Future Urban Forms: A Design Science Approach Integrating AI for Future Cities

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Ulysses Sengupta
Solon Solomou

Keywords:

Cities are complex adaptive systems, shaped by dynamic interactions across spatial scales and temporal dynamics. However, conventional analytical frameworks often struggle to capture their emergent and adaptive properties, limiting their ability to inform future oriented design. This paper introduces an AI integrated design science approach, combining complexity theory and futures thinking to explore the evolving morphology of cities through computational experimentation. Through this framework, AI, simulations, and urban big data are leveraged to test and extrapolate urban form futures, moving beyond deterministic models to uncover emergent spatial structures. Futures methodologies provide a structured approach to engaging with uncertainty, positioning AI as a tool for designing with complexity rather than against it. This paper presents the theoretical foundation and methodological framework, embedded within design science, and illustrates its application through examples of AI driven experiments in morphological adaptation. These examples demonstrate new ways to conceptualise and shape urban environments, highlighting the potential of computational methods to bridge pattern recognition, generative design, and spatial data. By introducing a methodological framework for exploring and experimenting with urban forms for different future scenarios, this study contributes to ongoing debates on the role of AI in urban design. It advocates for an approach that is not only data informed but also exploratory, iterative, and future oriented, presenting AI as a key component within computational tools for testing, simulating, and generating new urban morphologies within the context of urban transformation.

The Multifaceted Relationship Between Food Systems, Urban Morphology, and Architectural Layout: A Case Study of 11 Municipalities in Italy

Yuexin Wang | *Southeast University*
Yu Zhang
Ye Tang

Keywords:
urban food system; sustainable development; food transformation; circular dynamics; urban design

With the rapid development of urbanization and the widening gap between urban and rural areas, urban food issues have become increasingly severe and are closely linked to energy crises, resource waste, and environmental pollution. However, as food-related topics are more implicitly rather than explicitly associated with urban development, the role of food in shaping urban morphology has received insufficient attention. Advances in technology and digital analytical methods have made it possible to establish quantitative relationships between food systems and urban form. This study, based on the theory of the circular city, aims to explore the potential relationship between the food transformation chain and urban morphology through multi-source data analysis, focusing on the spatial implications of food processing. Centered on Venice, the research selects 11 representative municipalities in Italy. A clustering analysis based on spatial, social, economic, and environmental characteristics was conducted, including the food processing chain, land-use types, plot patterns, business types, transportation accessibility, energy consumption, and socioeconomic backgrounds of residents. Pearson correlation analysis is then performed using different indicators for different types of plots, with results visualized in QGIS and Python. The visualization results reveal the cross-scale interactions between food systems, spatial structures, and socio-economic and environmental characteristics at both micro and macro levels. Based on these findings, the study proposes methods to optimize urban systems, improve efficiency, and reduce energy consumption from the perspective of the food supply chain. The research aims to provide valuable insights for policymakers, urban designers, and planners to promote sustainable urban development from the perspective of circularity.

Effect of building configuration of idealized superblock on outdoor wind environment

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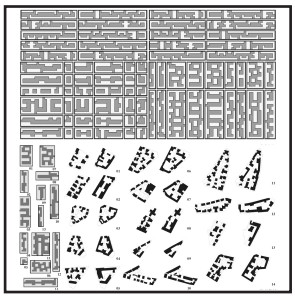
Dongqing Han
Xing Jin
Yacheng Song

Keywords:
superblock, CFD simulation, tower-podium, building configuration

As urbanization continues, superblocks with high-density commercial shell and lower-density residential core structure have become commonplace in Asian megacities. The “shell” layer of the superblock is usually converted to tower-podium type buildings for their potential to increase capacity during the densification process. However, the wall effect caused by alignment of these tower buildings would deteriorate the wind environment within the superblock. So, it is important to study how the form adjustments of the surrounding tower podium buildings could affect the wind environment within the superblock. This study therefore investigates the effect of building configuration layout on the wind environment within the superblock in order to better protect the wind environment within the superblock and to better guide future urban renewal. The computational fluid dynamics (CFD) simulation method is applied to the idealized models with the morphological features of the superblock in this study. Four topics of massing adjustment of tower-podium type buildings on the periphery plots of the superblock are discussed: (1) podium setback from adjacent street. (2) the relative positions of the towers. (3) the relative positions between the towers and the podiums. (4) the height zoning of the towers. The results of the study show some pattern where several design principles can be derived for the renewal of buildings on the periphery of the superblock. To optimise the wind environment and improve pedestrian comfort within the Superblock, the towers and podiums on the peripheral plots should be appropriately set back from the adjacent roads on the windward side, and the towers should be set back from the edge of the podium on the windward side relative to the arterial roads. The heights of the towers should be staggered and excessive differences in height between towers should be avoided.

Wave Function Collapse in Urban Design: A Bottom-Up Approach for Pixel-Level Texture Generation and Adaptive Cityscape Development



Chongjian Wang | *Southeast University*

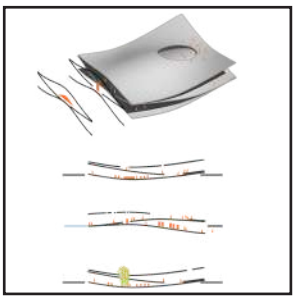
Keywords:
urban design, wave function collapse algorithm, generative design

Wave function collapse (WFC), an algorithm that has emerged in recent years, can generate diverse results based on rule constraints and has development potential in urban design. Unlike conventional methods that impose rigid master plans, the WFC algorithm operates on a bottom-up principle, generating urban textures and filling in gaps based on local rules and constraints, representing a paradigm shift from traditional top-down planning approaches. This emergent process is similar to the underlying logic of AI, it allows for the organic development of urban forms that are more adaptive to the unique characteristics of a site, fostering diversity and flexibility in cityscapes.

This study implements a pixel-level pattern extraction and texture generation method, applying and optimizing the Wave Function Collapse (WFC) framework. By inputting a simple pixel diagram, the program extracts features from small pixel windows and rapidly generates a large number of outputs that conform to the figure-ground relationship depicted in the diagram. The outputs exhibit variations in block scale and specific textures, demonstrating high diversity. This approach can serve as a reference for texture-level urban design or provide methodological support for subsequent automatic texture filling.

The method was tested in a suburban area of Florence, Italy. The runtime for a single output mostly falls within the range of 300-400 milliseconds, with an average of 360 milliseconds. On average, approximately 48 block units are generated per run, and the program achieves a success rate of around 82%. The efficiency of texture generation shows significant improvement compared to traditional methods.

This method has good scalability and can be combined with machine learning, it can be applied to many fields such as historical block renewal and urban infill development, providing new ideas for the future development of intelligent urban design.



Situational Transition from Urban Fringe to Archaeological Boundary: *Cultural Space Reconstruction between Xi'an Airport Area and Tang Dynasty Imperial Tomb Sites*

Qi Wei | *Xi'an University*

Keywords:
urban fringe ,archaeological sites, situational transition

Xi'an, a modern city developed around the ancient capitals of the Sui and Tang dynasties, is surrounded by numerous imperial tombs in the suburban wilderness. With rapid urbanization, the city has expanded to the edges of these vast tomb sites, reshaping their role at the urban periphery—transitioning between modern urban life and historical contexts.

Economic-driven urban expansion challenges the historical settings of these heritage sites, while the "parkification" of ruins alters spatial transitions between ancient and modern areas. Based on the planning of Xi'an Airport T5 Terminal Business District and the Tang Dynasty Shunling Tomb Park, this study focuses on designing an archaeological museum and its surroundings, exploring a new boundary space between contemporary urbanization and historical heritage.

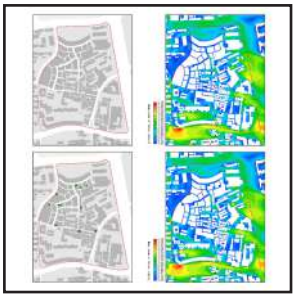
This paper further examines a new spatial value system—a design approach that highlights the contrasts between contemporary and historical settings, between holistic meanings and independent fragments. It deliberately integrates and redefines the site as a convergence of modern urban development and historical heritage. The changes introduced by this approach are not merely material but rather reshape and transform the situational narratives of different places. A "situation" is understood as "assigning a theme to a place, thereby providing an appropriate context for specific objects or landmarks. We understand space through its relationship with objects, and we can better understand objects through their presence in space." The transformation of these spatial contexts acts as a "bridge" between the historical city outskirts and large-scale heritage sites, creating an intermediary space between history and contemporary reality while redefining the urban morphology of both. This approach provides a practical framework for defining historical boundaries and transitioning across different historical periods in urban expansion, ensuring compatibility between the synchronicity of contemporary urban spaces and the diachronic accumulation of historical and archaeological sites.

Facility-Morphology-Behavior Dynamics: Mapping The Interplay of Urban Form and Social Infrastructure in Social Incubation for Urban Renewa

Xinkai Yang | *Southeast University*
Li Bao

Keywords:
Social Incubation, Social Infrastructure, Spatial-temporal data

Traditional urban analysis methods often focus on static, physical spaces, neglecting dynamic, intangible factors such as crowd behavior and social networks. These factors, however, are crucial in shaping urban functionality and vitality, and have become a key focus in contemporary urban renewal research. This study systematically deconstructs the mechanism of social incubation within the "facility-morphology-behavior" dynamic interaction framework, highlighting how social infrastructure, through its configuration and spatial morphology, catalyzes the formation and maintenance of social networks. Using the seven living-oriented streets of the Chaotiangong area in Nanjing as a case study, the research divides facility configuration, street morphology, and crowd behavior into three sub-dimensions and integrates methods such as spatial syntax, kernel density gradient analysis, and multi-source spatio-temporal behavioral data for mapping analysis. The study finds that facility density, diversity, and walkability are key factors in fostering social capital, with street network topology playing an important regulatory role in social network formation. Kernel density analysis shows that nodes with higher facility diversity have higher social capital indexes compared to single-function facility zones. Furthermore, street facilities and courtyard spaces blur the boundaries between public and private spaces, promoting informal social interactions through a "spatial incubation effect." Overall, the "facility-morphology-behavior" overlay map effectively visualizes the interactions among these factors, supporting refined urban renewal decisions. However, it is necessary to integrate participatory design and other methods to address the shortcomings in cultural perception and prevent the oversimplification of social spaces through technical rationality.



Research on Plot-Scale Open Space Morphological Design Strategies Based on Block-Scale Wind Environment Performance Optimization in Historic Areas: A Case Study of the Northern Area of Jinhua Ancient City, Zhejiang Province

Yang Yu | *Southeast University*
Hua Liu
Weiren Zhuang

Keywords:
Urban design, Wind simulation, Open space, Historic area, Multi- objective optimization

Urban morphology classifies hierarchical scales into blocks, plots and buildings based on research precision, where microclimates interact, persist, and superimpose dynamically across scales. The configuration logic of upper-scale spatial morphology, rooted in climatic adaptability, constrains the organizational framework of lower- scale spatial forms; concurrently, lower-scale morphologies must align with upper- scale morphological imperatives to ensure the functional integrity of holistic ventilation networks. In practical applications, the spatial layout of local spaces designed to optimize microclimates may exert positive influences on the climatic environment of larger spatial areas, but it could also potentially lead to negative impacts. Historic areas, as one of the critical carriers for urban renewal, often face insufficient ventilation efficiency due to their high-density spatial morphology. Therefore, this study integrates the practice of historic area renewal to explore bottom-up morphological feedback and optimization methods aimed at enhancing the performance of the overall wind environment. Initially, machine learning method was utilized to perform cluster analysis on the morphological types of historical areas, aiming to derive ideal models. Secondly, wind environment simulations were conducted using the scSTREAM software, with the objective of examining the block- scale wind environment performance associated with various configurations of plot- scale open spaces. Lastly, the NSGA-II multi-objective optimization algorithm was employed to investigate the strategy of maximizing the block-scale wind environment performance in historical areas, with a focus on plot-scale open spaces as the pivotal aspect for renewal initiatives. The final research findings were applied in regenerative design for the northern area of Jinhua ancient city, Zhejiang Province, offering a reference for refined morphological design of open spaces.

Automated Site Planning Using Context-Aware Configuration Stable Diffusion (CAC-SD) Model

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Bo Wan
Qiang Sheng

Keywords:
Generative AI, Urban Site Planning, Stable Diffusion, Spatial Configuration, AI- Driven Design

Urban site planning is a complex, multi-criteria optimization problem that requires the integration of environmental context, planning constraints, and design objectives. Traditional computational methods often face challenges in generating adaptive, high-quality spatial layouts that balance functional efficiency, aesthetic appeal, and contextual coherence. This study proposes an AI-driven automated site planning framework based on the Context-Aware Configuration Stable Diffusion (CAC-SD) model, which generates high-fidelity spatial layouts that comply with regulatory requirements. CAC-SD integrates generative diffusion techniques with contextual constraints to ensure urban structural coherence and functional adaptability. By incorporating Stable Diffusion XL for generative synthesis, ControlNet for morphological constraints, LoRA for style adaptation, PAdapter for visual reinforcement, and a latent space super-resolution mechanism for enhanced image quality, the model achieves precise spatial structuring and highly realistic scene synthesis. To evaluate design effectiveness, the system includes a spatial configuration assessment framework that quantifies urban sustainability metrics, enabling iterative design optimization and ensuring that early planning decisions align with long-term development goals. Experimental results demonstrate that CAC-SD excels in the controllability of AI-generated urban design, ensuring structural accuracy, spatial logic clarity, and material realism. The findings highlight the potential of generative AI in urban planning, providing an automated yet interpretable approach to site planning that enhances human-AI collaborative intelligence. This research opens new avenues for AI- augmented spatial design, driving urban development toward greater sustainability, adaptability, and human-centered solutions.

Method of Constructing Multi-scale Continuous Wind Corridor Networks in Innovation Blocks: A Case Study of the Form Design of the Innovation Block in a Northern City of China

Weiren Zhuang | *Southeast University*
Hua Liu
Yang Yu

Keywords:
Wind corridor, Urban design, Multi scale, innovation block

Over the past few decades, China's rapid urbanization has triggered a host of urban environmental challenges, which have led to an increased focus on the comfort of microclimatic environments in urban planning and design. As an emerging model of urban block development, innovation blocks feature the integration of functional spaces, resulting in a trend toward high-rise, high-density compact forms, which in turn brings a series of urban ventilation challenges. Under the guidance of sustainable development, how to achieve linkage between urban form design and wind environment climate efficiency from the macro to the micro scale is of crucial importance and represents a significant direction for exploring the shaping of future low-carbon cities. This article reviews the methods and theories for optimizing urban form and wind environment, aiming to achieve overall spatial climate adaptability across different scales. It proposes a multi-scale continuous construction method for wind corridor networks in innovation blocks. Taking the urban form design of a innovation block in a northern city of China as a practical case study, the article explores the technical and methodological pathways for optimizing the linkage between urban form and wind environment from the district to the building scale. First, based on climate performance assessment, optimization targets are screened and classified according to their functional importance within the district. Secondly, leveraging the Grasshopper platform and using the .net/C# language, ventilation corridors that meet design requirements, providing climate analysis results and decision support for the overall form of superblocks. Then, at the block and building scale, wind environment optimization of the plot buildings is carried out through design elements such as courtyards, ground-level voids, and setback terraces. Finally, simulation analysis was conducted to test the design results, revealing the morphological relationship of the wind corridor network in the continuous construction across multi scale.

002

MAPPING THE CITY: Evolving Tools to Study Urban Forms

Assessing Urban Connectivity and Accessibility Using Open-Source workflows in Data challenging environments

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Nadia Charalambous
ilaria Geddes
Gareth Simons
Sepher Zhand

Keywords:
Evidence-based, open-data, spatial analysis, GIS

In data-challenging environments like Cyprus, the effectiveness of evidence-based design and planning (EBDP) depends on the availability of reliable data and methods for spatial modelling. Recent advances in open-source data and workflows have made progress in the context of these challenges, facilitating spatial analysis that supports both research and practice. This study addresses the use of open-source workflows for spatial analysis in addressing key urban design questions related to Larnaca's new waterfront master plan, focusing on accessibility to amenities and street network connectivity to the surrounding context. We employed the automated workflow developed through the TWIN2EXPAND project, funded by Horizon Europe and UKRI, that was developed to maximize the use of open-source data and methods within the EU context. The workflow integrates fetching data related to road centerlines from open-source platforms (e.g. OpenStreetMap, Overture Maps). Data cleaning is performed using Cityseer, a package designed for street network-based spatial analysis in Python. To assess urban accessibility, we applied the Place Syntax Tool within the QGIS platform, performing street network centrality analysis (closeness and betweenness centrality) at local and global scales. The results provide a quantitative evaluation of the proposed street network, identifying areas where connectivity enhancements are needed and calculating accessibility metrics for existing and planned amenities. Findings demonstrate that open-source spatial models offer a robust, scalable, and cost-effective approach to urban analysis, reinforcing their value in EBDP applications. This study highlights the potential of integrating open-source geospatial workflows into urban design and planning, bridging the gap between spatial data accessibility and evidence-based decision-making.

Typo-morphology as a Futuristic Methodological Framework to evaluate Urban Sustainability

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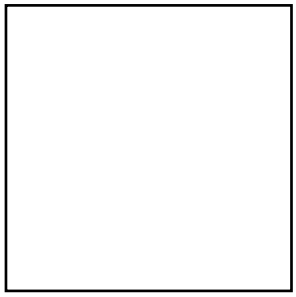
Keywords:
typo-morphology, urban patterns, sustainability, methodology, longitudinal study

Typo-morphology has been traditionally used as an analytical classification methodology to make sense of urban space. It involves understanding the changes in an urban environment through the implied social effect of evolution of underlying repeated physical patterns. However, typo-morphology also depicts urban areas as socially constructed spaces as formal characteristics are physical indicators of human beliefs and actions. Considering typo- morphological content through physical indicators of capacity, stability, sensibility, choice, and diversity in urban development, we can reveal beliefs and actions connected to urban sustainability. Typo-morphology was applied to connect urban sustainability to a spatial semantic framework, using the City of Ann Arbor, Michigan, USA as a case study for a longitudinal cartography-based analysis. Infrastructural evidence was linked to socio-political priorities and actions through a focus on the evolution of street patterns and urban grain development. These were then analysed for grain directionality, permeability, locality, and activation in relation to natural and infrastructural edges and boundaries as indicators of embodied sustainability factors. The research revealed how typo-morphology depicts cities as socially constructed spaces, engaging different hierarchies of urban elements and socio- economic priorities in the formation and future transformation of the city. The specific outcomes underline human-assigned values, embedded in the physical elements and infrastructure of the city, influencing ability of the city to support, enhance and sustain increasing population (capacity), to adapt to generate different options (choices), to provide a condition of equilibrium (stability), and maintain its relevance through varied formal and infrastructural strategies (diversity). Through this research, typo-morphological analysis can be recognized as a method to evaluate the successive and sustainable nature of urban form.

Drone Vision and Machine Learning: Analysing Urban Morphology and Spatial Behaviour – Insights from Zurich



Francisco Alaniz Uribe | *University of Calgary*
Marco Grond
Megan Horacheck

Keywords:
Spatial behaviour, machine learning, drones

This study examines two interconnected research questions: (1) What emerging technologies can enhance our understanding of public space usage? (2) Which morphological elements influence individuals' interaction with urban environments? The two key objectives are: first, it seeks to evaluate and learn from innovative technologies that analyze spatial patterns and spatial behaviour. Second, it explores potential correlations between observed spatial behaviours and the morphological characteristics of built forms, contributing to a deeper understanding of urban design and planning. The methodology merges advanced technological tools with traditional urban analysis techniques. Data collection involved video recording of a site using a drone equipped with a 4K camera. The resulting extensive dataset was processed using machine learning and computer vision algorithms, transforming the video data into spatial datasets for further analysis within a Geographic Information System (GIS) framework. Conventional two- dimensional morphological analysis was performed to evaluate urban form elements, such as land subdivision, land use, and building configurations. Key findings demonstrate the utility of drones in collecting extensive datasets on spatial behaviour and morphological characteristics. Machine learning and computer vision technologies effectively translated video data into spatial formats. The analysis revealed correlations between spatial behaviour and morphological features, including land subdivision, ground-floor land use, building footprints (figure-ground relationships), and street-wall quality. The study concludes that while these technologies offer considerable potential for urban research, they also present challenges. Drones provide a practical means for data collection; however, integrating machine learning and computer vision necessitates specialized expertise and a transdisciplinary approach. The implications underscore the need for collaboration across urban design, planning, and computer science to fully leverage the potential of these tools. This research emphasizes both the opportunities and limitations of using advanced technologies in urban morphological analysis and spatial behaviour studies.

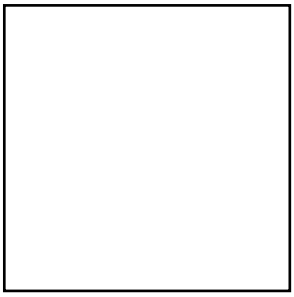
Mapping urban trees: *Systematization and democratization of data in Campos dos Goytacazes/RJ, Brazil.*

Danielly Aliprandi Cozer | *Instituto Federal Fluminense*
Fagner Das Neves de Oliveira
Daniela Bogado Bastos de Oliveira
Layla Soares
Rebecca Godoi
Marcelly Adão de Oliveira Pereira

Keywords:
Urban trees, Geographic Information System, Database, Urban-environmental planning and management, Open Space System

In the digital era, the possibility of storing and sharing systematized data in real time optimizes communication and access to information of public interest, such as that related to urban and environmental policies. However, Brazilian cities demonstrate difficulties in the digital transition of urban infrastructure data, which simplifies the democratic management of the city. The city of Campos dos Goytacazes, in the northern region of the state of Rio de Janeiro, Brazil, faces this challenge due to the lack of an integrated and systematized database of its urban infrastructure, generating delays in urban projects or making public actions and policies unfeasible due to lack of complete and updated data. This research carries out mapping of the city's urban trees, considering urban trees by tree-sized vegetation cover existing in the cities, through the Geographic Information System (GIS), aiming to create a digitalized database. The use of a base of georeferenced satellite images makes it possible to collect data on urban trees, organizing, storing and making information available, being relevant for participatory urban-environmental planning and management, anchored in the principles of publicity, transparency and efficiency. The cartographic production is based on a qualitative analysis of the Campos dos Goytacazes urban trees network, based on parameters and criteria defined in the bibliographic review, allowing identifications and comparisons between geographic sectors, on the permeability and scope of urban trees, its influence on the active mobility of the city and its relationship with the other elements of the Open Space System. This database, with consolidated information, will enable the review of parameters and the construction of proposals that are more coherent with reality, developing a set of guidelines that assist legislation and the preparation of an urban trees manual and the Urban Trees Master Plan, in favor of urban-environmental public actions and policies.

Mapping main streets: *Combining configurational street classification and streetscape morphometrics*



Alessandro Araldi | *Université Côte d'Azur*
Flavia Lopes,
Gianna Stavroulaki,
Giovanni Fusco,
Meta Berghauser Pont

Keywords:
15-Minute City, Suburbs, Configurational Analysis, Street-Based Morphometrics

The 15-minute City (15mC) approach is aiming at affordable and sustainable mobility while enhancing urban life. However, implementing this concept in car-dependent outskirts and suburbs poses significant challenges due to their lacking essential morphological features, especially on the micro-scale. The Evolutive Meshed Compact City (emc2) offers a networked pedestrian-based 15mC model suitable for many European peripheries. The emc2-model relies on a set of guiding principles and detailed specifications, which are interrelated across different scales.

In this paper, the focus is on two of these principles. First, a meshed foreground network of main streets is the backbone of an uninterrupted system of pedestrian public space and, second, the main street is pedestrian-friendly and enhances public life.

The extent of the analysis is a whole metropolitan area, focusing on its vast suburban space. A specific methodology based on Space Syntax angular centrality through scales, allows to identify different centrality profiles within the street network, among which a foreground network of main axes. Street-based morphometrics are then used to assess the most important features of the skeletal streetscape of each element of the network.

Analises are carried out on five European metropolitan areas: Vienna, Gothenburg, Lille- Roubaix-Tourcoing, the French Riviera and the Versilia conurbation.

The results provide insight into how different street centrality profiles combine with morphological streetscapes. It is also highlighted how most of the suburban foreground networks, despite their centrality potential, lack the morphological characteristics of main streets according to the emc2-model.

Characterizing the urban landscape of Antequera: Malaga Province through the lens of M.R.G. Conzen

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Vitor Oliveira

Keywords:
morphological regionalization, MRG Conzen, urban form, urban morphology, Antequera

Morphogenetic exploration of the urban landscape is essential for maintaining the spirit of societies. MRG Conzen focuses on morphogenetic aspects of the urban landscape in his urban morphological research. He has made a sound contribution to the rise of urban morphology in the second half of the twentieth century. He developed many concepts. These are the morphological region, fringe belts, tripartite division of the urban landscape, and burgage cycle, to name the most important. Among these, the climax concept is the morphological region or the method of morphological regionalization. That method is based upon an understanding of the urban landscape as the 'objectivation of the spirit of a society'. Despite the substantial research on the concept, its applications in planning practice remained insufficient. This is probably due to the lack of understanding of how the concept can be applied exactly. The main focus of this paper is the characterization of Antequera, by proposing an explicit and a systematic method of morphological regionalization. In this regard, eight criteria have been identified based on the ground plan, the building fabric and the land and building utilization. These are as follows: expansion phases of the town, street geometry, plot shape, block plan types – based on ground plan; building types, building material, building height – based on building fabric; and, finally, land and building utilization. The contribution of this paper is three-fold. The first is to characterize the landscape of Antequera that can play a substantial role in planning practice. The second is to move the method of morphological regionalization further. The third is to identify the role of the method of morphological regionalization in a wide range of planning practices, such as conservation area delimitation and control, heritage management, planning proposals, redevelopment projects, and so on.

Urban fringe belts: *an Amazonian perspective*

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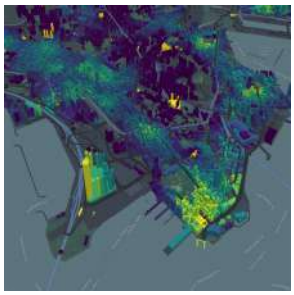
Felipe Costa de Almeida
Ana Claudia Duarte Cardoso
Josè Julio Ferreira Lima

Keywords:
Brazil, landscape metrics, fringe belts, geospatial analysis, green areas

Fringe belts are zones of extensive land use, acting as hiatuses or edges of densely occupied areas. They temporarily restrict urban expansion due to physical, economic, geological, and environmental factors. The study of fringe belts has contributed to urban planning research by identifying land uses in these zones and recognizing their ecological potential. However, the reasons for the formation, persistence, or transformation of fringe belts differ when comparing urban spaces in the Global South and North contexts. In the Brazilian Amazon region, factors such as territorial disputes, patterns of urbanization (rapid and late), economic cycles, and development projects have reshaped the internal structure and surroundings of cities, consequently altering the structure of fringe belts. This research aims to analyze fringe belts and highlight specific characteristics related to the eight capital cities of the Brazilian Amazon states: Belém (PA), Boa Vista (RR), Cuiabá (MT), Macapá (AP), Manaus (AM), Palmas (TO), Porto Velho (RO), and Rio Branco (AC)—the largest cities in the Brazilian Amazon. The study covers the period from 1984 to 2024. The methodology involves identifying urban patches and occupation interstices using remote sensing techniques applied to Landsat satellite images. The landscape measurement was conducted using a 500 by 500-meter cellular grid. Landscape metrics were applied within a supervised decision tree algorithm to classify and quantify urban patches and interstices. The results indicate that all cities have experienced a reduction in fringe belts, with urban expansion intensifying due to real estate agents' influence. The remaining fringe belts are either under government protection, house large-scale infrastructure such as airports, or comprise ecosystems (floodplains and hills) requiring significant resources for urbanization.



Data Skylines: *Tools, Data and Analytic Applications to Study Urban for Vertical Cities*

Gerhard Bruyns | *The Hong Kong Polytechnic University*
Jiaxiu Cai
Darren Nel

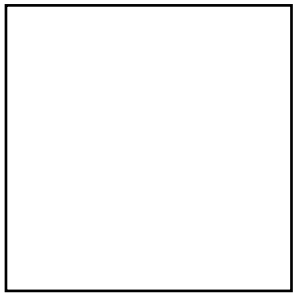
Keywords:
Vertical Data, Vertical Urbanism, Data Scoping, Data morphometrics

The rapid vertical and horizontal expansion of urban environments, coupled with shifting densities and social movements, demands a reimagining of urban morphological analysis. Traditional typological and typomorphological approaches are increasingly insufficient to address the complexities of contemporary built landscapes. This paper explores how advanced technological tools and analytical methods, including AI, machine learning, and big data analytics, can transform our understanding of urban form, particularly in the context of super-tall and super-dense environments.

Part 1 of the study focuses on the integration of interdisciplinary spatial frameworks, combining geospatial, socioeconomic, and environmental data through disciplines such as Spatial Design, Architectural Design, Landscape Architecture, Regional Planning, and Geospatial Sciences. Technological instruments like ArcGIS, QGIS, and remote sensing technologies play a pivotal role in data integration and analysis, enabling the examination of complex urban settings beyond traditional methods. Part 2 conducts a scoping analysis of methods associated with different spatial features, tabling and situating these approaches for application in urban morphological contexts. By leveraging advanced analytical techniques, including possible AI crossovers and machine learning, the research aims to extract significant insights from extensive datasets, enhancing pattern recognition and classification.

This paper seeks to question how new perspectives and tools can steer the discipline of urban morphology forward, offering a framework for understanding the vertical and volumetric dimensions of cities. By reimagining urban form through the lens of advanced technology, the paper will conclude with recommendations on how to integrate data and spatial forms to sustain a more comprehensive and dynamic approach to urban analysis, addressing the challenges of contemporary urban landscapes and informing future planning and design strategies.

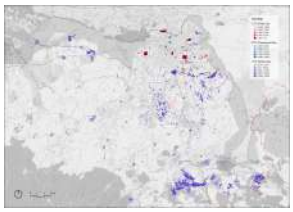
From Matrix to Modernity: AI in the Epistemology of Urban Form



Paolo Carlotti | *Sapienza University of Rome*

Keywords:
Artificial Intelligence (AI), Urban form, Grammatical rules, Urban transformation

Background: The use of artificial intelligence (AI) in dedicated programs presents new opportunities for understanding urban form by treating the city as a "text" that reflects its historical evolution. Traditional urban analysis has typically focused on physical forms through historical and morphological perspectives. AI, however, enables a more precise and automated study of urban transformations over time, improving our understanding of the relationship between original city structures and subsequent development overlays. Aims and Objectives: This study seeks to enhance traditional urban analysis, particularly cadastral plots, by using AI to differentiate between original "matrix" paths (as defined by Caniggia) and more recent trapezoidal overlays. The objective is to explore how AI can identify the rules behind urban transformations through the analysis of urban nodes, networks, and architectural hierarchies. Methods: The research uses AI-driven subroutines, written in Lisp, to analyze urban systems and spatial relationships within historical urban fabrics. These subroutines allow rapid processing of complex data, revealing patterns and connections that are challenging to detect with manual analysis. AI automates the recognition of geometric forms, aiding in understanding the evolution of the city's structure. Findings: The study demonstrates that AI improves the detection of geometric patterns, alignments, and spatial relationships, revealing an "urban grammar" that has guided the city's evolution. This approach provides insights into how historical processes have shaped the built environment and clarifies the interaction between different urban layers. Conclusion and Implications: The study concludes that AI is a valuable tool for understanding historical urban transformations and offers a framework for contemporary urban design. By identifying and interpreting the rules of urban form, AI can guide future planning, suggesting design strategies that respect historical layers while addressing contemporary needs in continuity or discontinuity.



Mapping Governmental Land for Strategic Urban Development: A Data-Driven Approach

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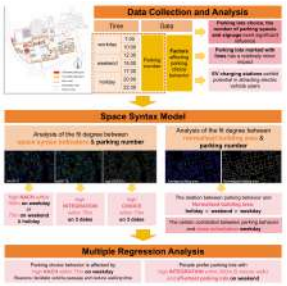
Iason Giraud
Marina Pasia
Michalis Psaras

Keywords:
Evidence-Based design, Multicriteria Analysis, Strategic Urban Development, Stakeholder Engagement

As cities expand and urban infrastructure demands grow, the strategic allocation of governmental land is critical for sustainable development and effective land-use planning. However, the identification of suitable parcels for development remains a complex challenge, requiring a systematic, data-driven approach. Traditional land suitability assessments often rely on fragmented datasets and qualitative criteria, limiting the precision of decision-making. This study addresses this gap by integrating geospatial analysis, urban morphometrics, and stakeholder engagement to evaluate governmental land in Cyprus's four major cities to identify high-potential sites for government services while optimizing accessibility, efficiency, and congestion reduction. The study employs an evidence-based, multi-criteria evaluation framework integrating spatial, economic, and infrastructural parameters. In the first phase a Linear Progression Filtering methodology is applied drawing on stakeholders continuous input to systematically assess and rank 61,661 government-owned parcels based on: Zoning Eligibility; Land Area Classification; Accessibility and Centrality; Land Value and Density. In the second phase a multicriteria analysis (MCA) is applied to systematically assess and rank the parcels based on: Network Analysis (such as centrality, population and amenities reach); Affordability and buildable potential (such as Planning Zone, Building Density); Market Statistics (such as Land Value). A multi-scenario criteria analysis refines parcel selection by integrating stakeholder-defined priorities, ensuring alignment with governmental policies and urban planning objectives. The findings are visualised through a Web GIS platform to facilitate stakeholder engagement and multi-scenario analysis, enhancing the adaptability and long-term sustainability of land-use strategies. The geospatial analysis reveals high-priority parcels suitable for governmental services and office development, with potential parcel agglomerations emerging as strategic urban hubs. The study underscores the significance of integrating machine learning (principal component analysis, correlation analysis, clustering) and urban morphometric tools for transparent and data-driven decision-making but it also highlights limitations, particularly the risks of over-reliance on algorithmic outputs in spatial planning.

A Study on Parking Choice Behavior in Campus Parking Lots Based on Space Syntax



Yuhan Chen | *Beijing Jiaotong University*
Wen Zhang

Keywords:
Vitality, YOLOv8, public space, urban morphology

Small-scale public space is an important carrier of urban life, and its morphological characteristics have a profound impact on crowd vitality. This study aims to explore the correlation mechanism between the morphology of small-scale public spaces and crowd vitality, and selects 23 small-scale public spaces in the South Lake community of Nanjing as a typical research unit. On the one hand, we quantify the morphology characteristics from the perspectives of shape, density, greening rate, functional mixing, and accessibility, and on the other hand, we collect the video data of the sample spaces at two-hour intervals every day, and use the CNN algorithm to detect and identify the targets, and finally, we use the CNN algorithm to detect and identify the targets. On the other hand, the daily interval video data of the sample space is collected to quantify the morphological features from the dimensions of crowd density, crowd speed, crowd distance, crowd behaviour diversity, and crowd composition diversity, etc. Finally, the correlation effect between morphological and vitality features is further analysed by using the correlation analysis methods of machine learning such as Random Forest, XGBoost, and so on. It is found that high accessibility, high functional mix, and appropriate density and shape are conducive to the enhancement of multi-dimensional vitality, while high greening rate improves the environmental quality but inhibits vitality due to the lack of hard paved space. Based on the small-scale public space, the study reveals the dynamics of community space life from a microscopic perspective, and provides reference suggestions for future community renewal planning.

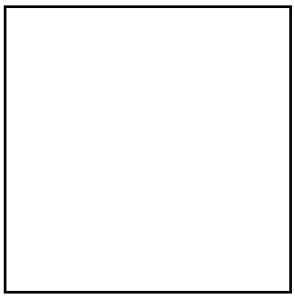
Exploring the Spatiotemporal Patterns and Nonlinear Driving Mechanisms of Campus Spatial Morphology Perception: An Empirical Study Based on Multisource Big Data from Nanjing Universities

Yi Chen | *Southeast University*
Hua-xing Sheng
Ting-jin Wu

Keywords:
University campus, spatial morphology, environmental perception, spatiotemporal analysis, multisource big data

The spatial morphology of a campus not only reflects its layout and internal structure but also directly influences the behaviors and experiences of students and faculty by revealing critical aspects of environmental quality and usage efficiency. However, conventional methods such as surveys and field observations are hampered by high costs, limited timeliness, and subjective biases, which restrict their ability to capture the dynamic evolution of campus environments.
To overcome these limitations, the present study utilizes multisource big data from universities in Nanjing—including social media, remote sensing, and location data—and establishes a comprehensive framework for data preprocessing, fusion, and feature extraction. Initially, raw data are cleaned and processed through text sentiment analysis, spatiotemporal tagging, and image segmentation to ensure high-precision data integration. Subsequently, an advanced spatiotemporal clustering algorithm (ST-DBSCAN) is employed to delineate functional zones within campuses, uncovering the evolution of perception across various temporal and spatial scales. Furthermore, an improved convolutional neural network (CNN) architecture is introduced to automatically recognize and classify different perception patterns, while SHAP values are applied to quantify the contribution of key factors, thereby elucidating the complex nonlinear interactions between environmental elements and user behavior. The findings provide robust, data-driven scientific evidence for optimizing campus spatial design and management, and offer innovative technical pathways for the dynamic evaluation and enhancement of urban public space morphology, underscoring the study' s methodological advancements and broad practical significance.

Research on the correlation between small-scale public space morphology and multidimensional crowd vitality: *based on video data and deep learning*



Yuting Chen | *Southeast University*
Di Guo

Keywords:
Vitality, YOLOv8, public space, urban morphology

Small-scale public space is an important carrier of urban life, and its morphological characteristics have a profound impact on crowd vitality. This study aims to explore the correlation mechanism between the morphology of small-scale public spaces and crowd vitality, and selects 23 small-scale public spaces in the South Lake community of Nanjing as a typical research unit. On the one hand, we quantify the morphology characteristics from the perspectives of shape, density, greening rate, functional mixing, and accessibility, and on the other hand, we collect the video data of the sample spaces at two-hour intervals every day, and use the CNN algorithm to detect and identify the targets, and finally, we use the CNN algorithm to detect and identify the targets. On the other hand, the daily interval video data of the sample space is collected to quantify the morphological features from the dimensions of crowd density, crowd speed, crowd distance, crowd behaviour diversity, and crowd composition diversity, etc. Finally, the correlation effect between morphological and vitality features is further analysed by using the correlation analysis methods of machine learning such as Random Forest, XGBoost, and so on. It is found that high accessibility, high functional mix, and appropriate density and shape are conducive to the enhancement of multi-dimensional vitality, while high greening rate improves the environmental quality but inhibits vitality due to the lack of hard paved space. Based on the small-scale public space, the study reveals the dynamics of community space life from a microscopic perspective, and provides reference suggestions for future community renewal planning.

Towards an Integrated Framework combining Remote Sensing and Urban Morphometrics to improve Urban Fabric Analysis

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Benjamin Wayens
Eleonore Wolff

Keywords:
Urban Morphometrics, Remote Sensing, Brussels, Principal Component Analysis, Hierarchical Clustering

Over the last 10 years, new tools have been developed to analyse urban forms in a computa- tional, reproducible manner (termed Urban Morphometrics). These techniques primarily rely on vector data to build indicators and then characterise and classify the urban fabric. While the Earth Observation community has a long-standing tradition of (macro-)morphological analysis of cities using remote sensing data, raster data are largely underused in the Urban Morphometrics approaches. Our communication explores the potential of using satellite data and some derived features, in addition to vector-based morphometric characters, to explore urban form. To this end, two urban fabric classification schemes are successively applied to the study-case of Brussels, Belgium, and compared. The first method consists of three steps: 1) we compute intrinsic and contextual morphometric characters from vector data; 2) we perform a Principal Component Analysis (PCA) on the characters to reduce information di- mension and avoid collinearity; 3) we apply a Spatially Constrained Hierarchical Clustering (SCHC) on the resulting PCA scores to create the clusters, i.e. urban fabric types. The second method consists of the same three steps but also uses buildings' polygons and their derived tessellation cells as an image segmentation input to compute raster-based textural and spec- tral features, that are then incorporated into the classification process as additional charac- ters. The comparison of results shows that image-based features mostly help at characterising unbuilt in-between and open spaces as fully-fledged parts of the urban form and differenti-ating them based on their physical and environmental properties. Nonetheless, attention should be paid to radial deviation, in that it matches variably the precise limits of input vector regions and thereby accounts for the meaningfulness of computed image-based features, and to the availability of satellite data in (very) high resolution to make sure such an integrated framework is open and reproducible.

Digital technology associated with analogical means for the study of urban form in small cities

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Eneide Maria Souza Mendonça
Leandro Teixeira Grandi
Rafael Pestana Fabres
Renata Mattos Simões

Keywords:
digital cartography, satellite images, analogical methods, urban form

The study of urban form requires, among other aspects, access to historical and contemporary cartography. Despite technological advances, such as the wide availability of satellite-generated images and the increasing use of AI, many countries still face challenges due to limited technical infrastructure for creating and maintaining databases. The absence of updated cartography resources, particularly digital surveys, hinders the study of urban form and undermines local administration capacities for effective planning. This study presents a mapping methodology designed to address research needs regarding urban form and landscape references in Colatina, a city in south-eastern Brazil. By overcoming technological limitations, the proposed method adopts an analogical approach, that relies on human-scaled participation. This paper wishes to outline methodological mapping procedures, applicable to small urban centres, focusing on studies of urban form, for design and planning purposes. The methodology consists of: 1. Conducting a bibliographic review on mapping techniques applicable to urban morphology and on the area's history, 2. Searching for photographic and cartographic bases to analyse the evolution of the urban form, 3. Redesigning and vectorization of an updated map, aligned with the latest satellite imagery, 4. Conducting field surveys to collect measurements, photographic images and data on property conservation, 5. Organizing a comprehensive written, drawn and visual database and 6. Updating the initial design with the newly acquired data, incorporating them into maps and topographic profiles with visual references. The application of this method in the study area enabled the identification of structural axes of urban development, platforms linked to the historical occupation process, and patterns of continuity and ruptures in local way of life. It also fostered the identification of key landscape references. In an era dominated by AI, this methodology highlighted the relevance of analogical processes in contexts marked by digital exclusion and limited availability of municipal resources.

Enhancing Research Capacity in Urban Form: The Strategic Evolution of the SURF Lab (UCY)

Martina Crapolicchio | *Politecnico di Torino*
Marco Trisciuoglio

Keywords:
Urban morphology, Evidence-Based Design and Planning, spatial analysis, interdisciplinary research, community engagement

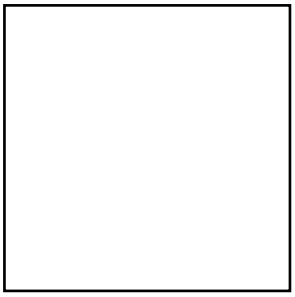
In an era of rapid urban transformation, the Society and Urban Form (SURF) Lab at the University of Cyprus emerges as a pioneering research entity dedicated to Evidence-Based Design and Planning (EBDP). Positioned within the Horizon Europe framework, the lab seeks to enhance research capacity, foster international collaboration, and tackle critical urban challenges especially in the Eastern Mediterranean and Middle East (EMME) region. This paper presents a strategic development framework for SURF Lab, outlining its evolution into a leading research hub in urban morphology, sustainable governance, and participatory urban design.

A SWOT analysis highlights the Lab's strengths in interdisciplinary collaborations and strong local stakeholder networks, while also addressing challenges such as institutional support and funding diversification. The strategic plan delineates short-, mid-, and long-term objectives, focusing on expanding research excellence, strengthening interdisciplinary partnerships, and securing sustainable funding through European and international grants in urban morphology and EBDP.

This research, informed by a benchmarking study of forty research labs worldwide, identifies key methodologies and governance models that shape the strategic roadmap for the SURF Lab's implementation. Additionally, the study explores the Urban Living Lab (ULL) framework as a participatory mechanism for urban research, emphasizing its role in bridging academia, policy, and practice. By embracing open science principles and leveraging GIS, AI-driven spatial analytics, and digital tools, the lab aspires to develop adaptive urban models that promote resilient and inclusive cities.

Contributing to the discourse on urban governance, morphology, and sustainability, this research advocates for an evidence-based approach to capacity building in research institutions. It underscores the critical role of urban research hubs in knowledge exchange, policy innovation, and shaping the cities of the future.

Toward a Parametric Urbanism

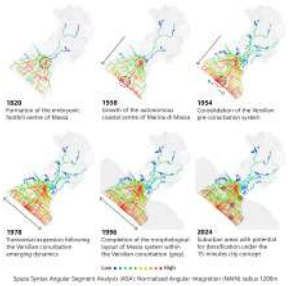


Luca S. D'Acci | *Politecnico di Torino*
Stephen Marshall

Keywords:
parametric morphogenesis, algorithmic urban growth, isobenefit urbanism, future cities, pattern language

Parametric algorithms can be used for the optimization of urban forms throughout the implementation of simple repetitive processes fulfilling a chosen objective functions. If, for example, the latter functions are proximity to natural land, urban hubs-centralities and daily services-amenities, the Isobenefit Urbanism (IU) morphogenetic code can be used. It is a basic set of elementary rules whose parameters can be adjustable by the user aiming at testing and exploring different urban morphogenesis processes satisfying the same objective function. In parametric urbanism, we can alter the objective function itself, or removing any objective function and 'merely' observe how certain – including random – parametric algorithms could generate morphological structures. Although rules-based approaches to urban growth have been applied to some extent using contemporary software, we can also find rules for proximity and adjacency within what are otherwise considered qualitative approaches, such as Alexander's Pattern Language.

This paper first develops a version of parametric urbanism in relation to Isobenefit Urbanism, with examples of how changing a few key parameters in a Python open access IU code will create different urban forms. Then, we report on an experimental student project which combines the logic of pattern-like urban form elements with Isobenefit Urbanism-like rules for adjacency and proximity, in a project context encouraging bottom-up urbanism as opposed to conventional master-planning. We reflect on the potential for rule-based or parametric urbanism.



The configuration of urban form: Morphogenetic and Configurational Analysis for Identifying 15-Minutes City Opportunities for Densification Street frontage properties: combining surface-based and perceptual-based methods

Federica Deri | *University of Pisa*
Chiara Anselmi
Federico Mara

Keywords:
15-minute city, suburbs, configurational analysis, Kemeny-based centrality, shift in centrality

The Evolutive Meshed Compact City (emc2) model reinterprets and operationalizes the 15- minute city concept to transform suburban and peripheral low-density areas – predominantly residential and highly car-dependent – into pedestrian-oriented, compact urban environments. The model envisions a spatial structure centred around main streets and dynamic public spaces, fostering a diverse mix of services, activities, and connectivity to urban and metropolitan mobility networks, ultimately enhancing inhabitants' quality of life.

This study identifies suburban areas with potential for densification under the emc2 model, focusing on historical filaments that exhibit spatial characteristics of main streets. The methodology, applied to the case study of Massa (Tuscany, Italy), unfolds in four key phases: (1) a historical analysis tracing settlement and infrastructural evolution; (2) a configurational analysis assessing shifts in centrality over time to determine key moments in the city's spatial evolution; (3) a diachronic network comparison across significant temporal snapshots, revealing intrinsic spatial properties and identifying historical centralities with latent potential for densification under the emc2 model; and (4) the application of Kemeny-Based Centrality measures to validate the diachronic findings, specifically identifying fragments with the potential to function as main streets.

The findings demonstrate that integrating historical and configurational analysis offers a robust framework for orienting the transition from dispersed suburban forms to compact, walkable urban structures, uncovering intrinsic spatial predispositions for sustainable transformation. This methodological approach provides valuable insights for urban planning, supporting the general emc2-framework in designing pedestrian-friendly environments aligned with the 15-minute city paradigm. Moreover, it underscores the potential of configurational techniques as a complement to existing planning instruments, offering a data- driven foundation for interventions aimed at sustainable suburban redevelopment.

Decoding the figure-ground plan: *The spatial impact of urban regeneration projects on mass-housing estates.*

Citè des 4000

Gonzalo Díaz Correas
Alvaro Clua Uceda

Keywords:
Visibility Graph Analysis, Figure-Ground Diagram, Cartographic Analysis, Urban Regeneration, Mass-housing Estates.

In the last few decades, the regeneration of housing estates has become a central focus of urban agendas. These initiatives usually require substantial resource investments to address complex and multifaceted urban challenges, including those related to architectural aspects. While the primary objective is to improve socio-economic conditions, the morphological transformations of spatial structures are equally critical, given the significant influence of spatial configurations on human behavior. This study aims to provide empirical evidence of the spatial implications for the 2D configuration of open spaces in a selection of recent mass housing renovation projects. This is achieved through the development of eight geometric, topological, and perception-based metrics applied to a high-resolution figure-ground plan in both pre- and post-renovation states.

The normalized data enable comparisons between the case studies and allow for preliminary insights into the relationship between the magnitude of the urban transformation and its impact on spatial configuration. When integrated with complementary socio-economic analysis, this multivariate approach has the potential to significantly contribute to a comprehensive understanding of urban periphery regeneration, offering a valuable impact assessment for urban designers.

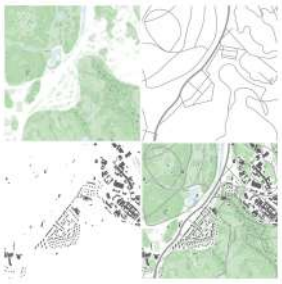
Forms of urban densification: *From spatial patterns to actor involvement in England, France and Germany*

Denise Ehrhardt | *Leibniz Institute of Ecological Urban and Regional Development*
Vera Götze
Mathias Jehling

Keywords:
Urban densification, international comparison, geospatial analysis, actors

Urban densification is a key strategy to balance housing needs and land take. Depending on the form densification takes and where it is implemented, it comes with differing ecological, economic and social effects and changes neighbourhood characteristics to varying extents. The occurrence of these effects is highly impacted by land policies and by the actors involved. While land policies vary across countries, few studies compared differences in the spatial outcome and involvement of different actors in densification. One reason for this are limited availability of comparable data and methods to map and compare the processes. This study suggests an approach for examining spatial densification patterns in England, France, and Germany, which allows linking densification types conceptually to actor involvement. Using geospatial analysis, we identify densification at the building level (2011–2021), employing change detection, urban form metrics, and machine learning to classify building types and cluster projects by size. This approach enables cross-country comparisons of densification patterns and actor influence. In the German and French case study we find similar shares of most densification types, with also small-scale densification on a one-by-one basis playing an important role – a type associated with actors interested in self-use. The English case shows a substantially higher proportion of large-scale single-family housing development, pointing to a higher relative importance of developer interests, resulting in fewer, but larger projects (see Figure). In the French case, we see a high share of densification resulting in the construction of multi-family houses, which points to the importance of densification with relevance for the rental market. By providing a systematic approach to mapping densification across countries, this study enhances understanding of spatial transformation and actor- driven processes based on urban form.

A review on the influence of morphological parameters on the interaction between humans and ecosystems in urban green spaces



Ilse Ellenbroek| *Chalmers University of Technology*
Meta Berghauser Pont
Ioanna Stavroulaki

Keywords:
review, pedestrian, ecosystems, urban green, morphology

As cities become more compact, green spaces within cities are shrinking. Urban population growth will put even greater pressure on urban green spaces, increasing the interaction between ecosystems and human presence in these areas, which might negatively impact the health of the ecosystem. Furthermore, diminishment of the amount and quality of green areas has negative implications for human health and well-being. It is known that ecosystems and human presence in urban green areas are influenced by urban form (e.g. size of green spaces, accessibility to green, and density), but the role of urban form in social-ecological interaction is less studied. Therefore, this paper presents findings of a semi-systematic review aiming to identify morphological parameters that are most influential in the interaction between humans (focussing on pedestrian movement) and ecosystems in urban green areas by addressing the following questions: *What is known about the interaction between pedestrian movement and ecosystems in cities? How is urban green described, and which morphological parameters are studied, for instance, geometric and configurational variables, to investigate this interaction?* The review included scientific articles covering the following three aspects: 1) Spatial (Urban green); 2) Social (Pedestrian); and 3) Ecological (Species). The majority of the currently identified articles base their results on observation data, such as bird and pedestrian count, while only few use a rich morphological approach to analyse both pedestrian movement and ecology. Further, studies that discuss the impact of morphological parameters on the presence of pedestrians and species, do this by focusing on pedestrians disruption of the ecosystems, while the positive effect of ecosystems in urban green areas on pedestrians' well-being and health is less studied.

The invisible circle: Mapping the complex shape of transfer isochronous circle in suburban TOD area

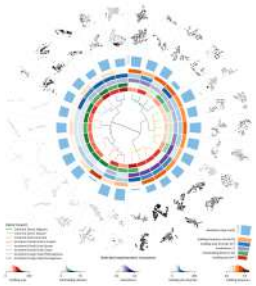
Min Feng | *Nanjing University*
Youpei Hu

Keywords:
suburban TOD, transfer isochronous circle, on-line navigation map

The isochronous circle for subway station transfers is an invisible form. However, it is a precondition for TOD area urban planning. Almost all TOD supporting facilities, and land use are based on the concept of isochronous circles. The isochronous circle of suburban stations exhibits complex morphological characteristics that differ from those stations in urban area. Due to suburban residents' adoption of multiple modes of transfer (walking, bus, bicycle), the coverage area of the isochronous circle is larger than the conventional 400-800 meters concentric circle in urban TOD areas. Meanwhile, accurately mapping suburban TOD isochronous circles has always been a technical challenge, given the involvement of multiple transportation modes and their combinations. We are uncertain about the shape and morpho-characteristics of the isochronous circle under the multi-modes of transfer, and there is no effective and convenient method for mapping it.

This study focuses on the complex morphology of suburban TOD isochronous circles. Initially, tools for isochronous mapping were developed based on API application of online navigation maps. These tools can efficiently address the problem of multi-modes of transfer. Supporting by the tool, mapping and morphological analysis of isochronous circles was conducted for several suburban TOD cases of major Chinese cities. Through comparative study, the morpho-characteristics of the isochronous circle in suburban TOD area was revealed and several suggestions for improving transfer condition were given.

Understanding cross-regional patterns of urban form using hierarchical morphotope classification



Martin Fleischmann | *Charles University*
Krasen Samardzhiev

Keywords:
urban morphometrics, classification, taxonomy, data science

The way buildings are laid out, the patterns of streets, unique open spaces and transformations we observe when we move between neighbourhoods are among the strongest impressions a city leaves. Yet, when looking at the ways science deals with this particular aspect of primary human habitat, there's still a lot we don't know. One of the reasons is the complexity urban form encapsulates. The patterns of form are rich, complex and complicated. We need to reduce the complexity of the matter we study, through methods like classification. While various classification methods exist, they often oversimplify urban patterns or lack scalability.
This paper presents the hierarchical morphotope classification (HiMoC) - a novel method for detailed, scalable, and adaptive classification of urban form.

HiMoC builds on the M.R.G. Conzen's concept of morphotopes - the smallest morphologically homogeneous pieces of land. The method combines 59 morphometric characteristics of building footprints with a three-step classification approach using gradually loosening spatial restrictions (GLSR). This approach enables classification from individual buildings to regional patterns while maintaining local context.

The method was applied to 6 countries in Central and Eastern Europe, analysing over 90 million buildings from national cadastral databases. The classification identified more than 600,000 morphotopes across 867 regions, organised into 64,726 baseline types within a single taxonomic tree. This hierarchical structure allows for flexible analysis at different levels of detail, from broad urban patterns to specific local variations.

The resulting classification successfully identifies distinct urban patterns, such as traditional perimeter blocks characteristic of different cities, while capturing their local distinctions. The method has been validated against existing classifications and is released as an open data product with reproducible code, enabling its application in urban research and planning practice.

Towards a global morpho-typology of urban river spaces

Claudiu Forgaci | *Delft University of Technology*
Francesco Nattino
Yehan Wu

Keywords:
urban rivers, river space, morphological delineation, clustering, typology

Urban river spaces have been increasingly at the forefront of urban transformations worldwide. More and more, they are seen as vital green-blue corridors and central public spaces in cities. A good understanding of this global phenomenon can provide invaluable information for planners, designers and decision-makers of urban river space transformations. Yet, finding the balance between local specificities and generic transformations enabling transfer of knowledge remains a challenge. In this paper we aim to address that challenge by putting forward a methodology to characterize a global morphological typology (henceforth referred to as morpho- typology) of urban river spaces. The construction of such a morpho-typology is challenged by at least three factors: the global availability of morphological data, the existence of a reliable spatial unit and the sheer size of data. Accordingly, the proposed methodology leverages globally available open data (namely OpenStreetMap data and 30-meter resolution Global Digital Elevation Models) to delineate urban river corridors and segments as spatial units, that are then used to characterize types via clustering as an unsupervised machine learning method. The methodology is implemented using the open-source CRiSp (City River Spaces) R package. Using a sample of cities spread worldwide, we provide a preliminary indication of specific and generic characteristics of urban river corridors. Based on these preliminary results, we discuss how the study can be scaled up to a larger sample, both from a methodological and computational perspective. Finally, we discuss opportunities and challenges brought by such a global morpho-typology, highlight limitations and potential pitfalls involved in employing the methodology, and outline research directions it can enable.

Assessing Form Patterns for the Suburban 15-Minute City: *The Case of Drap (France)*

Giovanni Fusco | *CNRS*
Gregoire Picard

Keywords:
15-Minute City, Suburbs, Public Space, Pattern Language, Behaviour in Public Space

The 15-minute city is an urban model aimed at reducing motorized traffic and fostering more convivial, human-centered environments. However, transforming suburban areas into 15- minute cities presents a greater challenge than applying the model to compact central cities. Functionalist approaches that focus solely on distributing different functions within walking distance often fail if they do not consider the urban form requirements necessary for a truly walkable environment. To address this, the Evolutive Meshed Compact City (emc2) has been proposed as a more specific 15-minute city model for European suburban peripheries, emphasizing urban form. It features a mesh of vibrant central streets that integrate existing linear centralities in suburban areas.

Assessing the transformation potential of suburban areas first requires identifying suburban villages structured around main streets. Drap, a village on the outskirts of Nice, France, serves as a case study for this approach. This study codifies emc2 into a pattern language, mapping and assessing public space patterns in Drap. Urban morphometrics played a crucial role in generating detailed spatial maps, while fieldwork provided preliminary data and direct observations of human activities in public spaces.

A statistical cross-analysis of human behavior and urban form patterns identified key factors for Drap's transformation: the articulation between main and ordinary streets, a web of activities around main streets, ample pedestrian space (which Drap lacks), and active façades along public spaces. While Drap has strengths in its urban structure, its main street remains largely utilitarian rather than vibrant.

By integrating urban morphometrics, fieldwork, and statistical analysis, this innovative approach provides targeted planning recommendations to transform suburban villages like Drap into integral components of a successful 15-minute city. It offers a replicable method for reshaping suburban environments to support walkability, accessibility, and local vitality.

Mapping Peri-urban Landscapes: *open-source web for knowledge dissemination*

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Keywords:
Operative mapping, peri-urban landscapes, web-mapping, knowledge transfer, stakeholder engagement

Peri-urban areas are key transitional spaces, where urban and rural dynamics converge, often giving rise to complex morphological, ecological, cultural, and governance challenges. Understanding and addressing these transformations requires analytical tools that go beyond conventional urban studies. The PER-START research project examines these strategic peri- urban areas at risk in six Spanish metropolitan regions, identifying eco-cultural values that shape their present and future trajectories. To achieve this challenge, PER-START has taken advantage of advanced cartographic methods. In this context, cartography is not merely a representation tool but an operative method to reveal hidden structures, patterns, and interactions. Within the project, we apply a multi-layered mapping approach focusing on four key dimensions: morphological processes, ecological values, cultural values and planning tools and governance. To enhance knowledge transfer and engagement, we propose a web- based cartographic platform using Quick Web Viewer, an open-source QGIS plugin developed by 300.000 Km/s. This tool enables stakeholders and users to explore, interact with, and reinterpret the generated data in an open, transparent, and user-friendly format. By disseminating results in an accessible and open format, we empower planners, policymakers, and local communities to integrate the project's insights into the daily management and decision-making processes of these at-risk peri-urban landscapes at risk.

Assessing citizen services provision across urban and rural areas based on accessible density measures

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Wakid S. Abdeldayem
Nadia Charalambous
Ana Ricchiardi
Iason Giraud

Keywords:
Evidence-based, open-data, spatial analysis, GIS

This study presents an application of evidence-based design and planning (EBDP) using spatial models to evaluate the reach of new Citizen Service Centres (CSCs) and Citizen Centres (CCs) across Cyprus. Commissioned by the Ministry of Transport, Communication and Works (MoT), the study's objective is to inform the selection of new service locations to provide greater accessibility to the population of Nicosia and clusters of communities outside urban areas aligned with their density. Given the scarcity of limited spatial data and institutional resources in Cyprus, we used an automatically generated and cleaned street network model derived from open data sources and covering the entire island, developed through the TWIN2EXPAND project funded by Horizon Europe and UKRI. This approach enabled us to analyse the population reach of existing service locations and develop informed scenarios for potential new locations. The automated model was derived and cleaned from OpenStreetMap road-centre line data. Then it was analysed using the Place Syntax Tool within Geographic Information Systems. The analysis incorporated population data from the 2021 census and the routes and stops of public transport systems. The criteria in the analysis included population accessibility by various modes of transport through analysis at different scales, number of communities reached and distance from other CSCs/CCs. The results provide visualisations and quantitative values of population reach and a matrix evaluating potential service locations against criteria set by MoT. The resulting policy aims to achieve a balance between supporting declining rural communities and smaller urban cores and meeting the needs of larger populations in urban areas, thereby ensuring sustainable density patterns in both cities and rural settings. The study highlights the applicability of EBDP methodologies in contexts with data constraints and offers a promising pathway for cities grappling with similar challenges, offering a method for more efficient and responsive planning processes.

Porosity in Transition: *Identifying Ambiguous Edges through AI-Driven Plot Clustering*

Ezgi Nur Gungor | *Politecnico di Torino*
Azmi Can Ozgen

Keywords:
porosity of fracture, ambiguous edges, plot group clustering, Istanbul, similarity recognition

Porosity, an urban phenomenon, is often associated with the adaptability of urban fabric, the reuse of voids, and the urban forms' capacity to accommodate diversity. It marks a shift from perceiving the city as a static entity to understanding urbanization as a dynamic process. However, existing discussions often overlook how porosity can be systematically measured or detected. This study argues that AI-driven analysis can provide an objective method for assessing porosity using contextually defined parameters.

Describing porosity as an urban agenda, Paola Viganò coins "porosity of fracture" as disruptions/discontinuities within the urban fabric. This research argues that fracture porosity manifests differently depending on the context. Particularly in neoliberal cities where land speculation reshapes urban porosity through creating enclaves, plot configuration is of vital importance. While porosity is often examined through spatial voids and infrastructure, the role of plot configurations remains underexplored. Analysing fracture porosity thus requires a systematic evaluation of plot patterns.

Since the 1980s, neoliberal policies in Istanbul have intensified enclave formation, producing ambiguous edges—areas that deviate from a coherent urban fabric. Despite this, the city continues to expand by consuming and reshaping its porosity, generating internal barriers that fragment its urban structure.

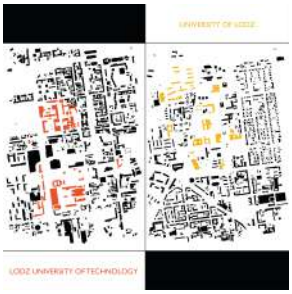
To address how enclaves exploit porosity, this study employs AI-based clustering techniques to categorize plot group patterns, detect enclave formations, and classify fracture porosity. It assumes that plot diversity and configuration reveal ambiguous edges, as plot structures regulate urban development. Furthermore, it examines the scale of plot groupings, arguing that larger, less subdivided clusters contribute to greater urban ambiguity by reducing constraints on building size and distribution. To assess the intensity of diverse and large plot groups, the study employs deep learning techniques for similarity recognition. Rather than analysing individual plots, it identifies and classifies plot groups forming urban blocks, aiming to detect ambiguous edges.

Historical Plots as Relics of Medieval Town Planning in Mecklenburg

Philip Hansen | *Norwgian University of Life Sciences*

Keywords:
archaeology, morphology, plots, medieval

Recent research into medieval towns within the field of urban morphology has demonstrated a heavy reliance on a purely cadastral study to understand the development of towns. These studies are characterized by an over reliance on these cadastral maps both modern and historical, largely ignoring written documents and archaeological sources. Therefore, the aim of this paper is to demonstrate a new approach on how the medieval plots of the medieval town of Parchim in Mecklenburg can be used to demonstrate urban formation processes. The town of Parchim was chosen due to the town developing in multiple stages and can be a great case study for future work in other towns. The methodology would be based on dividing the town into major construction events where the details from the written and archaeological sources would be placed within the relevant sections, producing a matrix to collect the information in an easily readable format. The results from the archaeological excavations would be used to gain an understanding of Parchim's development in the various sectors, seeking to divide the visible plots into the various periods of construction. This allows for a discussion of plots in terms of major construction projects, such as churches, that are known to influence urban development. With the combination of these methods, it allows for discussing the evolution of the town in the context of major actors. It would also allow to see when plot stability was reached within Parchim, especially in the area close to the Slavic Burgenwall to the north of the town. The results have indicated that the width of the plots varied only slightly from the original founding until the oldest cadastral maps available. From this, it could be implied that towns with similar charters would have a similar development, allowing for comparisons across multiple towns.



Students mobility and its implications for university design

Malgorzata Hanzl | *Lodz University of Technology*
Agnieszka Pikala
Maria Stasiak

Keywords:
Walkability, urban design, urban form, morphometry

The relationships between citizens' mobility patterns and urban form are multiple and reciprocal. Users' behaviour affects transformations of urban structures, their density, functions and appearance; and vice versa, urban form, adjusted to a given cultural context, encourages residents' choices and, therefore, behavioural patterns. In the current study, we investigate the spatial behaviours of university students in two different urban contexts. Our special focus is on walkability and sustainable mobility choices. The comparative research addresses two distinct forms of university campus organisation in Lodz, Poland. One form, represented by the University of Lodz, features edifices of separate faculties distributed in the urban fabric of the city centre; in the other, in the Lodz University of Technology, two campus parts include all faculties within walking distance and are surrounded by city structures. The research methodology integrates workshops, surveys, interviews and participatory observation with comprehensive analyses of morphological features of urban form.

The latter addresses the scale of urban districts, campus neighbourhoods and urban blocks. Each of the scales involves different sets of morphometric and formal analyses. We examine such features as connectivity, density, permeability, streets' profiles, public transport accessibility, etc. We then look closely at the relationships between these two sets of data - social and morphological - for the conditions of mobility choices. The careful study of qualitative and quantitative elements enables us to define recommendations for future design interventions.

Late-capitalist urban morphological types in the global South: *the case Marginal Pinheiros in São Paulo, Brazil*

Alexandre Hepner | *Mackenzie Presbyterian University*

Keywords:
urban morphology, building type, office building, public-private partnership, central business district

São Paulo is the largest city in Brazil and represents an important node in the global business and financial system, concentrating the regional headquarters of many multinational companies overseeing operations in the whole country, Mercosur, or South America. Most of this economic activity is concentrated along the 'Southwest vector' of the city, an area roughly encompassing the city's historical Downtown and extending towards the margins of the Pinheiros River (Marginal Pinheiros). The relentless expansion and consolidation process of this so-called 'vector' over the last fifty years could be regarded less as the growth of a typical urban Central Business District, and more as the sprawling of a late-capitalist 'city within a city', a gentrified and exclusionary version of the original and diverse urban fabric, with its own contrasting spatial organization and morphological characteristics. Since the mid-1990's, this process has been somewhat oriented by a public urban design policy mechanism called 'Urban Consortium Operations' (Operação Urbana Consorciada Faria Lima and Água Espraiada), which consist of public-private partnership initiatives based on the auctioning of additional construction rights for this sector of the city. New urban morphological types that can be recognized along Marginal Pinheiros include walled groups of upper-class residential buildings, stand-alone skyscrapers isolated in the middle of large urban plots, skyscraper clusters, and mixed-use urban citadels, all of which usually have a very tenuous relation with the surrounding public open space and often disrupt or suppress the social dynamics of the original neighborhood. This ongoing research intends to recognize, catalogue and evaluate the type- morphological characteristics and locational distribution of these new late-capitalist urban types in São Paulo using 3D modeling and parametric mapping of buildings using data from OpenStreetMaps and the local public GeoSampa platform, in an effort to assess the morphological results and impacts of the 'Urban Consortium Operations'.

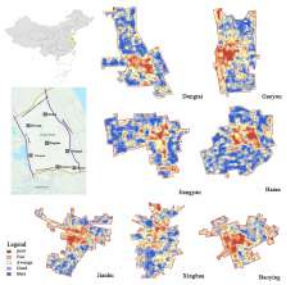
Employing Deep Learning to Unveil the Performance-Oriented Block-Scale UGS Structural Optimization in Urban Shrinkage

Jiayin Hou | *Southeast University*
Li Shen
Yongchan Zhang
Conghui Zhou

Keywords:
Deep Learning, Green space, structure, Urban morphology, Urban Shrinkage

Urban green spaces (UGSs) play a pivotal role in addressing vacant land issues in shrinking cities, contributing to ecosystem optimization, recreational network improvement, and economic promotion. However, existing studies on UGS structure primarily focus on the urban scale, failing to meet the demand for refined regulation in urban shrinkage scenarios. To bridge this gap, we integrated multiple deep learning algorithms and proposed a novel performance evaluation and structural regulation framework tailored specifically to block- scale UGS structures in urban shrinkage, addressing the unmet needs at the local scale. Taking Zhangjiakou as the study area, we first incorporated the unique characteristics of land use types of shrinking cities and employed the yolov11 algorithm to construct a land-use identification model for fine-grained land-use type recognition. Second, we quantified the block-scale UGS structural characteristics from three dimensions: scale configuration, type composition, and spatial organization, which have a direct influence on UGS performance. Third, according to the specific service demands of UGS, we calculated the pre-and post-performance of block-scale UGS structures from the “production-living-ecological” perspectives. Finally, employing a random forest regression algorithm, we identified the key influencing factors and underlying mechanisms of how the UGS structural characteristics impacts these three service performances, revealing the coupling degree variation patterns of block-scale UGS structure under urban shrinkage. This study not only deepens our understanding of the impact of urban shrinkage on the coupling degree of green spaces at the block scale but also offers an innovative and practical methodology for cost-effective and high-quality UGS planning and regulation. It provides a new perspective for urban planners to optimize urban green spaces in shrinking cities, which is of great significance for improving urban liveability and sustainability.

Urban Green Space Morphology in Small–Medium Cities: A Multi-Dimensional Assessment from China's Lixiahe Region



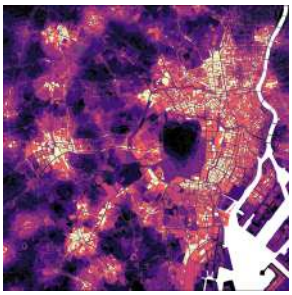
Mengjun Hu | *Southeast University*
Xiaojun Wang

Keywords:
Urban green space morphology, Geospatial analysis, Small and medium-sized cities

Urban green space morphology is of great significance to sustainable urban development; however, practical research on the morphology of green spaces in small and medium-sized cities remains relatively scarce. This study integrates urban morphology and landscape ecology methods to construct a comprehensive evaluation system for urban green space morphology, encompassing six dimensions: dominance, connectivity, compactness, evenness, fragmentation and complexity. Taking seven cities in the Lixiahe region of China as a case study, the research conducts quantitative analysis and comprehensive evaluation to reveal the characteristics and differences in green space morphology among small and medium- sized cities, providing a scientific basis for green space planning and management. By employing multi-dimensional indicators and geospatial analysis, the study systematically assesses the spatial morphology of green space.

The results show significant variations in green space morphology across the study area: Gaoyou excels in dominance and fragmentation, Dongtai performs best in connectivity and evenness, while Xinghua scores poorly on most indicators. Spatially, high-value areas are concentrated on the urban fringe, dominated by parks and protective green spaces, whereas low-value areas are primarily located in city centre, characterized by scattered small green spaces or affiliated green spaces. Additionally, the study identifies common issues, such as insufficient integration of green space morphology with water systems and the over- concentration of high- and low-value areas.

This research provides a novel approach to evaluating urban green space morphology, offering significant implications for advancing scientific green space planning. Future studies could refine the evaluation system and expand sample validation to enhance its applicability.



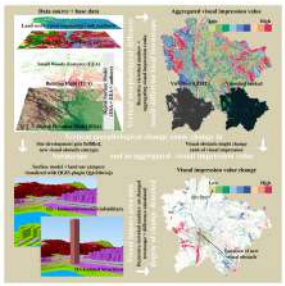
Identification and Characteristic Cognition of Multi-station Aggregated Areas of Urban Rail Transit: A Case Study of Tokyo 23 Wards

Yiwen Huang | *Southeast University*
Dongqing Han
Yacheng Song
Chuan Wang

Keywords:
Urban Rail Transit, Multi-station Aggregated Areas, Identification Method, Distribution Characteristics, Tokyo 23 Wards

With the continuous construction of rail transit, cities are showing a development trend of denser rail transit stations and a gradually more complex network. Areas affected by the superposition of the radiation from multiple rail transit stations have become important regions in cities where resource elements, human flow vitality, and economic activities gather. Their intensive and efficient development will bring about demonstration and agglomeration effects, promoting the overall high - quality and sustainable development of the city. However, current academic research still focuses on the type of a single station and the delineation of its influence scope. There is a gap of comprehensive analysis of the relationships between stations from an overall urban perspective. That is, discussions on the types of multiple related stations in an area and explorations of the superposition effect of adjacent stations' influence scopes are relatively lacking. Identifying and understanding this new physical entity emerging from urban development with scientific methods is fundamental and crucial for exploring intensive, efficient urban use and enhancing urban operational efficiency. Drawing on a review of domestic and international methods for defining station influence scopes, this study selects 9 indicators across 3 attributes: transportation, function, and space. It then establishes a multi-factor superposition-based method to identify the rail transit multi-station aggregated areas. Hierarchical cluster analysis is used to classify the types of areas. The study applies the above-mentioned method to Tokyo 23 Wards to analyse and interpret the types, spatial distribution characteristics, and organizational mechanisms of multi-station aggregated areas. The results prove that the quantitative graphical method can effectively identify urban multi-station aggregated areas from a morphological scale. It can be used for urban spatial relationship analysis, providing technical support for the identification and understanding of key urban areas, and further exploring the spatial potential for enhancing urban efficiency.

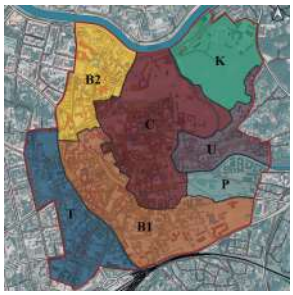
Urban morphology on the cube



József Attila Jankó | *BME*
György Szabó

Keywords:
visual impact assessment, land use ranking, spatial analysis

Urban morphological assessment usually evaluates horizontal aspects of planar morphological elements. The authors approach the behaviour of the third- dimensional (vertical) property of a settlement. The aim of the article is to present an assessment method that rates the change of townscape due to the new visual impression caused by a new high-rise building. The assessment employs the land use category of the morphological element as the fourth dimensional parameter. The evaluation is based on geographic information published by the European Space Agency and the European Environmental Agency. The derived detailed digital surface model is complemented with land cover/land use categories ranked by the nature of its visual impression. Urban green spaces are ranked higher then construction sites for example. The principle of analysis is determining the line of sight recursively pixel by pixel. The next phase is the summary of the pixels of the viewshed weighted by the rank of land cover/ land use categories perceptible visually. The summary provides a numeric value based on the quantity of high and low ranked elements of the visual impression. This location-value changes location by location based on the extent and the content of its viewshed. When a new high-rise building emerges, it effects some location's townscape both by appearing in the view and by hiding distant land cover. The new location-value can be recursively determined in the viewshed of the new high-rise building. Thus the difference gives an expression about the visual impact of the new visual obstruction. The preference in ranking land cover/land use categories and ranking the new morphological element can reflect the intent of the individual bystanders or the goal of professional town planning. The reliance on digital model carries some risk of misinterpretation of real impact, but gives means for more detailed examination.



Towards an Understanding of the Morphology of Cultural Landscape: Between the Methodologies of Urban Planning and Geography

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Keywords:
cultural landscape, morphology of cultural landscape, geospatial methods, interdisciplinary methods, urban planning

This study is an interdisciplinary research between urban planning (and design), and geography. Perhaps it is obvious that the two disciplines have many intersections. Urbanism is very much like geography in its complexity and interdisciplinarity. Geography, as a system of sciences that investigates phenomena in a spatial dimension, is an excellent basis for developing competences in urban science and practice. One of the common aspects of the discipline's research and practice is the cultural landscape. Landscapes created by humans and reflecting their coexistence with the environment are dominant in the modern world, making their understanding an important and relevant scientific field. This study is important because it draws attention to the morphology of cultural landscapes (both urban and rural), an area that has been less studied than landscape morphology in general. This work is a systematic identification of the objects/scales and tools/instruments used by geographers and urbanists in cultural landscape research. More specifically, an analysis of the methodologies of these disciplines for the study and zoning of cultural landscapes (explores the territorial morphological units of cultural landscapes). This phase of the research focuses on mapping morphological classifications and taxonomy of cultural landscape. Traditional principles of geospatial analysis and modern methods for their application (GIS technologies) are being explored. The study highlights the methods used by researchers from different fields and countries although it focuses mainly on the context and issues of Lithuania's cultural landscape. The study is illustrated with digital maps and drawings – from the national to the urban neighbourhood scale. In summary, this study provides a set of intended guidelines for the use of this zoning in city planning.

Urban signals: *Mapping urban spatio-temporal transformations using street view imagery and computer vision – a case of Karaköy*

Elifnaz Kancan | *Bilkent University*
Yiğit Acar
Burcu Şenyapılı Özcan

Keywords:
Urban transformations, computer vision, remote sensing, mapping

Traditional urban studies have relied on fieldwork and archival research to analyze urban transformations, but recent advancements in artificial intelligence offer scalable methods for tracking physical changes in rapidly evolving cities. By comparing historical and recent street-view imagery, computer vision facilitates the systematic detection of spatial modifications, yet these methods risk producing decontextualized snapshots if not critically linked to historical, socio-economic, and political frameworks. This study integrates computational detection and contextual interpretation by introducing the concepts of pings and signals within a mapping-based framework. Micro-scale physical modifications, such as building demolitions, signboard replacements, and function shifts, are identified as discrete pings, which, when aggregated over time, form urban signals that indicate broader transformations in land use, commercial activity, and socio-economic dynamics. Karaköy, Istanbul, illustrates how major redevelopment projects and the expansion of creative industries have reshaped the urban fabric, altering both spatial configurations and social dynamics. These transformations redefine Karaköy's identity, reconstruct perceptions, access, and movement patterns across different social groups. The findings demonstrate that minor spatial changes can act as early indicators of larger socio-economic transitions, but their interpretation requires a critical approach to address data biases, uneven temporal coverage, and qualitative dimensions. While these representational constraints exist, street-level imagery remains valuable when examined through a reflective and critical perspective. Ultimately, this article reveals how computational and experiential data contribute to a detailed analysis of urban transformation by tracing both observable physical changes and the contextual urban narratives shaping spatial changes, while also utilizing mapping as a relational act that enables the integrated reading of these interconnected data layers.

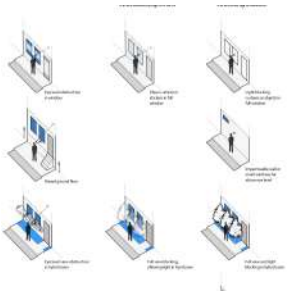
AI-Integrated Pattern Prediction Model: Exploring the Influence of Building Fabric Morphology on Land Use Patterns

Selen Karadoğan | *Middle East Technical University*
Eren Efeoğlu
Ozan Yetkin
Aybüke Balahun Çoban

Keywords:
AI Integrated Model, Spatial Analysis, Urban Morphology, Typological Patterns

Morphological analysis using AI is an emerging but rapidly evolving field in urban studies, whereas analyzing urban tissues to differentiate the characteristics of various cities has long been a core approach in urban morphology. The relationship between form and function remains central to urban morphology discussions; however, the quantitative and dynamic application of AI across different urban patterns remains unexplored. In this context, this study explores the influence of morphological metrics of the building fabric on land use patterns across different urban contexts. It aims to investigate the relationship between land use and its most relevant morphological elements by analyzing 3D spatial data using an AI- driven model. The proposed method extracts 3D data from OpenStreetMap and processes it with classification methods using Scikit Learn. It leverages land use types using morphological features by using the building as a unit of analysis including frontage ratio, height/width ratio, built-up coverage, compactness, accessible number of neighboring buildings, closeness, and betweenness centralities to predict land use types. The model will be developed by using 10 km radius catchment areas from the central business districts of Berlin, Istanbul, Amsterdam, Rome, Barcelona, London, Paris, and Moscow. It is trained using morphological parameters to achieve high-accuracy land use classification which is later tested across multiple cities to identify how effective the typological patterns of the building fabric condition land use patterns. The AI model not only predicts land use but also uncovers typological patterns at an urban scale, offering a comparative and data-driven approach to urban morphology. By evaluating the accuracy of AI-generated predictions, this study contributes to the advancement of computational methods in spatial analysis. Ultimately, this research enhances our understanding of what makes an urban tissue unique or similar across different cities, bridging AI-driven analysis with the long-standing theories of urban morphology.

Comparing morphological, social, and experiential dynamics and values of frontages in Toronto and Amsterdam



Conrad Kickert | *University at Buffalo*
Cristopher Daniel

Keywords:
public-private interface, frontage, retail, comparative research

This presentation compares the morphological, social, and experiential dimension of the public-private interface in the two Trans-Atlantic cities of Toronto and Amsterdam. While both cities contain large amounts of walkable urban fabric, they are seeing a rapid change of their public-private interfaces due to new development and the transformation of commerce in frontages. Specifically, retail establishments are declining in both cities' cores, with storefronts now hosting an increasing number of dwellings, offices, libraries, workshops, and spaces for education, health, and wellness. This study aims to provide urban designers and decisionmakers with empirical knowledge on the social and experiential value of these new types of uses in the public-private interface. Furthermore, the study extends the growing body of knowledge on the public-private interface, as presented by various scholars at prior ISUF conferences.

Specifically, the study measures the designed and user-adapted transparency, personalization, and hybrid zone sociability of more than 1400 non-retail ground floors in Toronto and Amsterdam. The study categorizes ground floors into 20 types of non-retail uses and conducts measurements using Google Street View imagery. These measurements are synthesized into an index of visibility, as well as personalization and sociability measurements, and compared between Toronto and Amsterdam. The research outcomes demonstrate that non-retail ground floor uses still visually and socially interact with passersby, dispelling the 'all-or-nothing' myth that urban ground floor vibrancy can only come from stores, bars, and restaurants. The research also demonstrates similarities in visibility and sociability indices between Toronto and Amsterdam for many uses, although the residential public-private interface differs significantly, likely due to cultural differences in dwelling. Finally, the research builds a new toolkit for analyzing the public-private interface, which is a critical dimension of urban morphology and its experience.

Creating Meaning from Building Pre-Blocks to Urban Project

Caspar Kleiner | *Leibniz-Institute*
Mariana Pizzo Diniz
Mathias Jehling

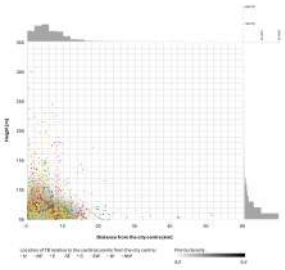
Keywords:
Building-Block, Morphometrics, delineation algorithm, cross-border building model

Quantitative approaches to urban morphology often focus on the building-block level, i.e. the land below groups of spatially close buildings. While the term “building-block” is broadly used, definitions and scalable delineation approaches are often influenced by the individual use case, and data-availability. As a result, different methods may produce different outcomes, leading to variations in analytical results and challenges in comparing studies. When it comes to large-scale quantitative analyses, precise definitions of building-blocks are therefore key to generating meaningful and reliable results. Three grades of definitions are mostly used: pre-blocks, building-blocks and urban- development-blocks. While data-availability varies in different contexts, the use of delineating building-blocks remains a fundamental aspect of quantitative analysis of urban form. This study aims to apply building-block delineation methods in the quantitative analysis of urban projects and assess how they perform. The question “how do building-block delineation-algorithms compare and create meaning for large-scale quantitative and morphological analysis to urban projects?” is pursued.

For this, diverging building-block delineation algorithms for data-rich and data-scarce environments are compared. A review provides an overview of different definitions and the granularities that are used (e.g. building, parcel, street-network, address-data). We test this for a study-area in the French-German border-region, applying well-established delineation approaches to a harmonised, cross-border model of 2million buildings. To test plausibility, we a) use morphological measures to compare distributions within the building-block delineations and b) compare these to the values of reference urban projects.

The results show that the interpretability of the distributions within and across countries improves highly for urban projects when integrating parcel-data. However, while more data generally improves delineations, the logic of “the more the merrier” cannot be applied. Rather, specific data-sets like address-data can help to significantly. The study thus helps research on urban form to mainstream large-scale geo-data analysis approaches and elevate their comparableness.

Clustered or Dispersed? A Morphometric Perspective on Tall Buildings Distribution in European Cities



Piotr Kryczka | *University of Wrocław*

Keywords:
clustering, high-rise building, spatial statistics, skyscraper, urban form

The distribution of tall buildings (TBs), defined here as structures exceeding 55 meters, still remains a critical issue in European urban planning. Despite growing TB development all over the world, there is limited research on their spatial patterns at the macro-regional scale in Europe. In this study, TBs distribution will be assessed using morphometric and geostatistical methods to determine clustering or dispersion trends and their implications for sustainable urban growth in European urban areas. 8,615 TB locations were collected through desk study from open-source databases. Spatial and statistical metrics, including DBSCAN and k-Nearest Neighbours (k-NN), were applied in GIS to quantify clustering intensity. The analysis identified optimal clustering distances using elbow points (e values from 140.5 m to 2692.8 m), refined through the Silhouette Score and Davies-Bouldin Index. Results indicate that 72% of European TBs are somehow clustered (2 or more TBs) rather than dispersed. Findings confirm that TB development tends to concentrate, reinforcing existing urban structures. These results provide valuable insights for urban planning, emphasizing the need for strategic TB placement in historical cityscapes. By refining geostatistical methodologies, this study contributes to evolving tools for analysing urban form and guiding rational TB development.

Discovering geomorphological traces in urban morphology using AI technologies: the case of the city of Turin

Nataliya Kudryavtseva | *Politecnico di Torino*
Davide Poggi

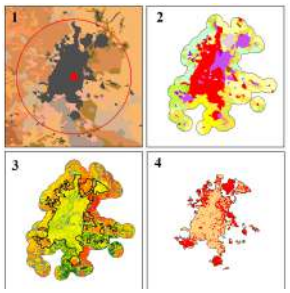
Keywords:
Geospatial analysis, AI web scraping, Urban morphology, Historical maps

Artificial intelligence can be used, as we see every day, to create virtual images that are either completely imaginary or disturbingly lifelike. However, AI can also be used more constructively, to speed up and improve our methods of visualising and analysing historical data. The use of historical and geographical maps has allowed, since the end of the nineteenth century, important developments in the theoretical and analytical aspects of urban morphology. The contributions of Muratori and Caniggia, in Italy and of the English school of Conzen are today well known and consolidated.

The aim of this work is to use a classical methodology, based on the analysis of geographical and historical maps, together with modern AI-based web scraping techniques, to understand the urban form of the city of Turin near the Dora Riparia river. The latter shows the powerful impact of artificial intelligence on historical research, making complex data more accessible to researchers. The procedural chain of this work is based on: Modern AI technologies for web scraping of historical and geographical maps of the area of interest; precise georeferencing of the maps in a GIS environment; reconstruction of the temporal evolution of the urban fabric in the last centuries.

The work shows that it is possible to trace through the centuries and up to the present the origins of the urban structure within the urban fabric of Turin, in the area along the river Dora Riparia that crosses the city in the north. In general, the use of the historical maps that can be obtained from web scraping through AI, together with consolidated or innovative approaches based on GIS analysis, can allow an in-depth study of the present day urban morphology of a city.

The Impact of Urban Form and Land Use on Urban Heat Island Intensity: Evidence from Turkish Cities



Azem Kuru | *Kırklareli University*
Mete Korhan Özkök

Keywords:
Urban form, land use land cover, urban heat island, spatial metrics, land surface temperature

This study explores the intricate relationship between urban form, land use, and Urban Heat Island (UHI) intensity, a matter of pressing concern for sustainable urban development in the context of climate change. The objective of the research is twofold: first, to ascertain whether Land Surface Temperature (LST) varies between land uses, and second, to identify correlations between UHI and spatial metrics characterizing urban form. To this end, thirty- three Turkish cities were selected based on population size. The investigation further explores properties such as urban population size, geographic location, climate zone, proximity to water bodies, mean air temperature, and elevation to ascertain the existence of any clustering between similar urban areas. The identification of artificial surfaces and non- urban land uses was conducted using CORINE land cover data to compute mean LST values derived from Landsat 8 imagery for July 2018.To quantify UHI intensity, four distinct metrics were defined through the evaluation of temperature differences between artificial surfaces and major land cover types. Urban form characteristics were assessed through 16 spatial metrics calculated using ArcGIS Patch Analyst tools. Correlation analyses revealed significant relationships between UHI intensity and several spatial metrics. The findings indicate that road density, perimeter-area ratios, area-weighted mean shape index, edge density, and patch size variability strongly influence UHI formation and intensity. These results underscore the importance of both urban form and land use composition in determining thermal conditions within urban environments. This study underscores the imperative for climate-sensitive urban planning strategies to mitigate UHI effects, underscoring the pivotal role of spatial patterns and land use configurations in nurturing sustainable and resilient urban landscapes. The findings offer critical insights for urban planners, policymakers, and environmental scientists seeking to design and implement interventions that reduce urban overheating and promote thermal comfort in cities.

Exploring Morphological Restoration Strategies for China's Historical and Cultural Cities

Kun Li | *Xian University*
Shanshan Wu

Keywords:
urban form, morphological restoration, historic district regeneration, design enhancement, Chinese city

In China, historic districts are often viewed as de-spatialized texts of memory, frequently lacking material authenticity. This absence, combined with an overestimation of their intangible value, has provided justifications for unreasonable demolitions, replacements, and re-historicization through replicas. Over the past few decades, many cities have experienced severe de-historicization during urban transformation movements. Recently, the "small-scale, incremental" renewal model of the Xiaoxihu District project in Nanjing has become an exemplary case for micro-renewal and active preservation in historical and cultural protection projects in China and across Asia. This success underscores the critical importance of maintaining the traditional fabric and scale of cities in preserving China's historic urban environments. Inspired by this case, the present study focuses on regenerating historical districts in China's historical and cultural cities, using the Sanxue Street area in Xi'an as a case study. By conducting a multi-phase urban morphological investigation of the area, overlaying historical planning maps, current maps, property distribution maps, and existing preservation plans, the study deduces the typological features of the area's morphological evolution. Based on this, the study proposes intervention methods for "morphological restoration" on various dimensions: restoring the area's morphological structure, scale, and the spirit of the place. Through incremental design cases involving street systems, site environments, courtyard units, and architectural blocks, the research explores a path for restoration of the historical environment to achieve harmonious development between historical heritage and community life.

Optimizing Walkability in Vertical Cities: Spatial Morphology Assessment and Design Strategies for High-Density Urban Districts in China

Jun Jin | *Southeast University*
Siming Lin
Jue Zhou

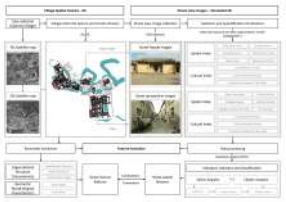
Keywords:
Vertical cities, High-Density Urban Districts, Walkability Assessment,Human-centered design

The increasing concentration of urban residents, coupled with the diminishing availability of land resources, has accelerated the trend of vertical urban development. The evolution of this urban morphology necessitates innovative approaches to balance extreme density with human-centered functionality. While compact city models prioritize spatial efficiency, walkability — an essential indicator of urban sustainability — is frequently compromised due to fragmented street networks and monotonous spatial configurations. This study proposes a comprehensive walkability assessment framework to address these contradictions, focusing on pedestrian-friendly design strategies for high- density urban areas.

By integrating deep learning-based streetscape semantic segmentation with spatial network analysis (sDNA), the study constructs a multi-scale evaluation system that links street typologies, functional diversity, and infrastructure performance with pedestrian comfort.

Empirical data from four vertical urban districts in China reveal how computational tools can decode the relationship between spatial morphology and walkability, providing actionable spatial design thresholds to optimize inefficient and unsatisfying high-density environments. On-site surveys and user evaluations further validate the framework's accuracy and applicability. Key findings highlight the necessity of multi-indicator coordination in walkability enhancement. Micro-scale design interventions — such as modular block size optimization (1.5-3 ha), increased green permeability (>12%), and pedestrian network revitalization (density >30 km/km2)— demonstrate significant potential to improve walkability while maintaining high-density efficiency.

This study advances urban morphology from static typological analysis to a dynamic framework, offering a forward-looking perspective on the evolution of future urban spaces. By embedding walkability metrics into vertical city design, it equips policymakers with data-driven planning tools to shape resilient, sustainable, and human-centered urban futures. Against the backdrop of high-density urbanization and technological transitions, this research presents an innovative theoretical framework.



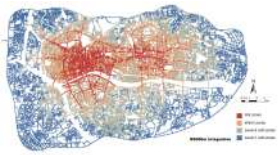
Quantitative Analysis of Street Spatial Features of Traditional Chaoshan Villages Based on Spatial Texture and Street View Images: A Case Study of Qianmei Village, Guangdong

Xiaoyu Lin | *Harbin Institute of Technology*
Yuqian Mao
Gang Yu

Keywords:
traditional village, street space, spatial texture, street view image, deep learning

Traditional villages exhibit unique village landscapes influenced by natural conditions and regional culture. As the spatial framework and primary public space of traditional villages, street spaces carry the historical context and social vitality. An accurate and efficient cognition of street spatial characteristics is fundamental to the sustainable development of traditional villages. While morphological parametric analysis can quantify the organizational structure and geometric features of streets in village spatial texture, the results are limited to two-dimensional plane characteristics. In contrast, street view images, as a crucial source of spatial data, can be combined with deep learning techniques to objectively quantify the three-dimensional spatial features of street spaces in traditional villages from human perspective. This study constructs a multi-dimensional cognitive system for the spatial features of traditional village streets, taking Qianmei village, a national-level historical and cultural village in Chaoshan region as an example, analyzing the combination patterns and quantitative features of the village street texture using parametric modeling techniques. Additionally, street view images were collected through classical field research, using deep learning and semantic segmentation to automatically extract the features of street facades and perspective images in traditional villages, applying a combination of factor analysis and cluster analysis methods for indicators reduction and classification to summarize typical spatial features of village streets. The study further examines the relationship between street spatial features and texture characteristics. The results show that typical street and alley spatial features exist in traditional Chaoshan villages, which are closely related to the village spatial texture and overall layout. This research provides a scientific basis for the cognition, management, and planning of traditional village streets in Chaoshan, contributing to better protection and development.

Deciphering Urban 'Cold Spots': A Morphological and Functional Analysis of Underutilized Spaces in Guangzhou, China



Michelle Xiaohong Ling | *South China University of Technology*
Jingjing Jia

Keywords:
Identification of 'Cold spot' areas, Spatial configuration, Functional layout

In the era of stock-oriented urban development, addressing the diverse and evolving needs of urban spaces has become critical. Employing innovative technologies and analytical methods to evaluate and optimize existing urban areas offers valuable insights for urban planning and sustainable regeneration. While considerable academic attention has been directed toward identifying and analysing urban hotspot areas, comparatively little focus has been placed on 'cold spot' areas—zones characterized by low pedestrian activity, weak accessibility, and underdeveloped functionality.

This study focuses on the central area of Guangzhou and introduces a spatial configuration- based methodology to identify 'cold spot' areas. By integrating road network data with points of interest (POIs), the research examines the spatial configuration patterns and functional layouts of these underperforming areas. Furthermore, by investigating correlations between spatial characteristics and functional composition and distribution, the study aims to reveal the spatial dynamics and developmental drivers of urban 'cold spot' areas.

The study has preliminarily shown that cold spots in Guangzhou exhibit three distribution patterns: clustered, linear, and dispersed. As the analysis radius increases, cold spots shift from central areas to the periphery. The spatial pattern of cold spots is influenced by their distribution and size. In terms of spatial configuration, integration in 'cold spot' areas is evenly distributed, with a complementary relationship between global and local parameters, whereas choice values show some extreme clusters. Functionally, mixed-use development dominates. The link between spatial and functional factors is conditional rather than universal, suggesting that cold spots are influenced by complex and diverse factors.

Based on the above analysis, this research aims to contribute to the discourse on urban spatial optimization, offering actionable insights for the revitalization of low-activity zones in high- density urban environments.

Machine Learning-Based Recognition and Fractal Analysis of Building Height Composition Patterns in Urban Blocks: A Case Study of Nanjing Old Town

Xinzhe Liu | *Southeast university*
Dian Shao
Chenyang Zhang
Junyan Yang

Keywords:
Building height regulation, Fractal dimension, Machine learning, Morphological typology, Nanjing Old Town

In urban renewal and conservation practices across historic cities globally, three-dimensional morphological regulation of old towns confronts dual challenges: maintaining spatial identity while preventing chaotic high-rise developments from eroding traditional height hierarchies. While existing height governance employs “height zoning” principles, current typological frameworks remain limited by manual classification and conventional metrics’ inability to quantify self-organized complexity in three-dimensional morphological configurations. This results in oversimplified zoning systems producing monotonous urban forms, perpetuating morphological governance dilemmas in old towns. Targeting technical bottlenecks in typological feature extraction, this study develops a fractal dimension-based method to characterize building height composition patterns. Using a three-dimensional box-counting algorithm, we calculate fractal dimension values of building clusters to create a fractal height composite index quantifying morphological self-similarity, which underpins height composition typologies. We further design a fractal-integrated generalized graph convolutional neural network for mathematical characterization and machine learning-driven pattern recognition. Through a case study of Nanjing old town, findings reveal: Historic areas exhibit stable fractal dimensions with marked self-similarity, contrasting with fluctuating values in new developments areas reflecting morphological disorder; Six height composition patterns are identified, revealing spatial differentiation mechanisms including “gradient transition” in historic areas and “clustered mutation” in commercial hubs. This machine learning-enhanced fractal approach resolves dual challenges of mathematical describability and machine recognizability in height pattern analysis, offering transferable solutions for balancing heritage preservation with vertical development in old town renewal.

Identification of Plot Patterns and Strategies for their Morphological Control in the Historic Urban Area of Chongqing

Peng Liu | *Chongqing University*

Keywords:
plot patterns, typo-morphology, protection and regeneration, mountainous historic urban area, K-means clustering

Plot pattern refers to the pattern of land division and arrangement formed during the evolution of urban development. As a morphological element reflecting land ownership structures, it serves as the foundation for maintaining traditional spatial scales and physical textures in historic cities, and plays a crucial role in shaping the quality of built environment by interacting with other morphological elements such as buildings and functions. Therefore, identifying plot pattern is of great significance for the protection and regeneration of historic urban areas. Current research on plot pattern identification primarily relies on qualitative methods, with a focus on localized districts. There is an urgent need to introduce quantitative approaches to identify plot characteristics on a large scale historic urban areas. Additionally, it necessitates the inclusion of plot indicators reflecting topographical features to establish a more systematic framework for plot pattern identification tailored to mountainous cities. This study develops an analytical framework that integrates the K-means clustering method with typo-morphological approach to quantitatively identify plot patterns in large-scale mountainous old towns. Taking Chongqing's Yuzhong historic urban area as a case study, the framework identifies six plot types — including subdivided plots, super plots, and open plots—and five plot pattern types, namely fine-grained pattern, coarse-grained pattern, and open pattern. By analyzing the differences in spatial forms corresponding to different plot patterns, the study reveals that the formation and evolution of various plot pattern types are influenced by a combination of factors, including land development regulations, urban development policies, and construction control models. Over three morphological evolution periods

distinct characteristics have emerged, shaping the differentiation in the overall structure of plot patterns of the old city. Finally, plot pattern control strategies from three perspectives are proposed: spatial forms, historical protection, and planning regulation, aiming to promote the regeneration of historic urban areas.

Decoding Nonlinear Urban Density-Functional Mixity Relationships via Explainable AI: A Case Study of Chengdu, China

Yupeng Liu | *Southeast university*

Keywords:
Urban densification, Functional mixity, Explainable AI, non-linear relationship

With the increasing trend of densification in contemporary urban development, density evolution profoundly influences urban land use layout, industrial structure, and building forms, and then acts on the land use functional mixity through complex non-linear mechanisms. Appropriate density can effectively enhance the level of functional mixity, improving urban operation efficiency and boosting block vitality. However, existing research mostly focuses on the measurement of multi-scale density and functional mixity, lacking a systematic exploration of the interaction mechanism between the two, and rarely establishing a scientific measurement framework for non-linear relationships. This study innovatively constructs a coupling analysis model of land density-functional mixity based on an explainable machine-learning regression algorithm, taking Chengdu as an empirical object. Firstly, a 15-dimensional density index system is established, including physical density and perceived density. A measurement model of land use functional mixity is constructed based on the Shannon entropy of POIs. Secondly, multi-source urban big data is integrated, and the indicators are quantified with various urban land uses as spatial units. Then, the XGBoost algorithm is used to establish a non-linear correlation model between density and functional mixity. Finally, the contribution degree of each density index to the functional mixity is analyzed through SHAP values. The study findings are as follows: 1) There is a significant threshold effect between density and functional mixity. For example, a turning point occurs when the density of commercial land reaches 2.5. 2) The dominant index factors of density for different land use types show significant heterogeneity. Density optimization strategies need to refer to the characteristics of the density interval, with a focus on optimizing the dominant index factors. This study provides a quantitative decision- making tool for precise density regulation.

Mapping the Evolving Urban Scene: A Case Study of Shanghai's Anfu Road through Scene Theory and Digital Analysis

Kun Liu | *Shanghai University*
Yitong Lin
Jianjia Wang
Qin Wei
Tianfu Zhou

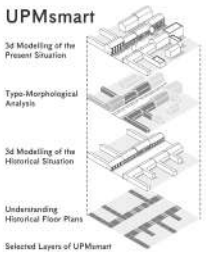
Keywords:
small-scale retail businesses, scene theory, 'internet-famous' street, AI-assisted image analysis

This study examines the urban morphology of Shanghai's Anfu Road, a representative 'internet-famous' street, through the lens of scene theory and contemporary digital analysis methods. The research combines scene theory with the urban context of China, establishing an element matrix to evaluate the 'scene shaping' of small-scale retail business spaces. It investigates how these businesses shape street environments and influence community evolution during urban renewal processes.

The methodology integrates traditional urban analysis with emerging digital tools. AI-assisted image analysis tracks street view transformations, while semantic generation models help visualize potential design scenarios for street landscapes. These digital methods complement quantitative assessments, including on-site surveys of building facades, commercial format analysis, and in-depth interviews with local stakeholders, creating a comprehensive understanding of the street's evolution.

Findings reveal that small-scale retail spaces play a crucial role in creating distinctive 'scene' characteristics through the element matrix framework. These characteristics, which may originate from historical features or incidental factors, attract homogeneous businesses and activities, accelerating street community evolution. The integration of digital visualization tools provides new insights into potential development trajectories and their impacts on urban morphology, particularly in understanding how virtual popularity translates to physical space transformation.

This research contributes to the understanding of urban street evolution in the digital age, offering a methodology that bridges traditional scene theory with contemporary analysis techniques. The findings provide valuable insights for urban planners and policymakers seeking to balance commercial development with community preservation in urban renewal processes, particularly through the lens of scene shaping elements. The study demonstrates how digital tools can enhance our understanding of urban morphology while maintaining the human-scale perspective essential for sustainable urban development.



UPMsmart: *Qualitative street space analysis on large-scale*

Daniel Loeschenbrand | *TU Wien*
Angelika Psenner
Susanne Tobisch

Keywords:
Streetscape, qualitative analysis, building typologies, CIM, urban fringe

To be able to overcome the urban challenges of tomorrow (climate change, overheating, vacancies, CO2-dilemma, mobility-issues) a thorough knowledge of the Stadtparterre and its characteristics is needed. In order to maintain and enhance the potential of our Bestandsstädte it is necessary to be able to read and understand their (internal) organisation. By covering the public street-space, the adjacent ground floor zone and the courtyards, the UPM (Urban Parterre Modelling) method enables a coherent analysis of streetscapes. This qualitative approach aims to capture the microstructure of the urban parterre in order to visualise the systemic interdependencies of its parts. In doing so, street-spaces AND their buildings are reconstructed in their historical and current states. The approach is rather labour-intensive, as hundreds of archive plans have to be checked on site for accuracy and use-structure and transferred to a coherent three-dimensional model.

By simplifying this process without losing the key elements, UPMsmart makes the qualitative approach scalable and opens it up to quantitative research. It operates on a typological layer by producing a collection of highly detailed pre-modelled building typologies (covering structural design, and historic/current uses) using publicly available data like building footprints and street façades. This information is connected with the three-dimensional building object, resulting in simplified digital twins (CAD-model). This opens up the option of expanding the original scope of the UPM from selected street segments to larger scales, and of reconstructing and analysing entire urban tissues, thus contributing to the idea of CIM (City Information Modelling).

The paper introduces UPMsmart as a new method to analyse streetscapes as well as urban patterns in a larger scale. As part ofthe research project emc2, the method is being applied in Vienna's urban periphery, where a wide variety of settlement, street and building-typologies present a particular potential for the development of street-spaces.

Morphological Factors Affecting Reconstruction Projects in Historical Centers of Small Italian Towns

Tomoyuki Mashiko | *Waseda University*

Keywords:
Morphological factor, Reconstruction Project, Historical Center, Italy

Natural disasters are the source of a high degree of uncertainty for cities and regions, with increasing risks in recent years. Advanced artificial intelligence (AI) technologies enable both ex-ante and ex-post evaluations of complex urban transformations and their practical applications. However, the effective simulation of future scenarios using AI must account for influencing factors. Charles et al. (2022) reviewed post-disaster reconstruction projects and categorized 24 influencing factors into five groups: reconstruction approach, innovation, resource management, governance, and stakeholder expectation. Although this study provides a comprehensive meta-analysis, spatial aspects related to urban morphology remain unaddressed.

Some researchers examined urban transformation processes in small Italian towns after earthquake disasters. Mashiko (2022) analyzed Venzone's historical center, which was damaged in the 1976 Friuli earthquake, identifying the key factors influencing spatial transformation. These included an annual program for project implementation, block architects assigned to specific areas, and a coordinator managing planning and project execution. However, spatial aspects were not explicitly recognized as factors. In contrast, the 2012 Emilia-Romagna earthquake reconstruction followed a different approach, whereby projects approved through the system proceeded sequentially without predefined annual programs or block architects, thus suggesting the existence of different influencing factors, particularly physical ones.

This study aims to identify the morphological factors affecting reconstruction project implementation through multivariate analysis using open data of Emilia-Romagna Region. The focus is on privately owned buildings in the historical center of Novi di Modena.

The key findings include the assessment of whether factors such as damage level, floor area, project category, budget, and occupancy affect project duration; spatial visualization of project implementation to examine the relationships between project duration and urban morphology; and evaluation of the necessity of prioritization programs.

It highlights the importance of morphological factors in planning reconstruction projects for historical centers and explores AI-based simulations that integrate these factors.

Pre-disaster Recovery Machizukuri Based on Escape Mapping in Potential Tsunami Affected Areas: Harms and Benefits of Simulation Technology

Kosuke Masuo | *Aichi Institute of Technology*

Keywords:
Pre-disaster, Recovery, Machizukuri, NIGECHIZU Tsunami

Tsunami simulations were used in the recovery from the Great East Japan Earthquake, and the emphasis was placed on hardware protection against relatively frequent tsunamis, with seawalls and relocation to higher ground being constructed in many areas. However, reconstruction projects that relied on hard civil engineering structures resulted in excessive maintenance costs, loss of historical character, and decline of communities after reconstruction. There is a need for a way to properly operate tsunami simulation technology. The objective of this study is to formulate an alternative "pre-reconstruction Machizukuri concept" based on soft measures for evacuation, rather than measures that rely on hard projects of civil engineering structures. The target area is the Mikisato district of Owase City, Mie Prefecture, which is a tsunami hazard area for a huge Nankai Trough earthquake. As a research method, a risk communication tool called "NIGECHIZU WORKSHOP" will be used, which can visualize the evacuation time to the target evacuation point and the shortest evacuation route. Then, based on the premise of evacuation, a "Pre-disaster Recovery Machizukuri Vision" will be formulated by combining projects that can be promoted as an extension of daily community development, through the accumulation of small projects by resident initiative and public-private partnerships. This vision is comprised of projects to improve evacuation routes, utilize vacant houses on higher ground, relocate evacuation and welfare facilities to higher ground, and relocate to higher ground with inserts into the existing slope topography. Conclusions, in this study, we will implement a pre-disaster reconstruction Machizukuri program that utilizes tsunami simulation and risk communication tools. And then we report on the resilient decision-making process and the willful morphology produced by the process, in which citizens resist crises.

Street frontage properties: *combining surface-based and perceptual-based methods*

Julia Micklewright | *Technical University of Munich*
Alessandro Araldi
Alice Vialard

Keywords:
frontage, line of sight, setback, street aspect ratio, vegetation

While the “street frontage” lacks a definitive definition, it represents the intricate relationship between private and public spaces, as well as between built forms and open spaces in relation to boundaries. Its characteristics shape the form, vegetation cover and perception of streetscapes, making it relevant across disciplines. Streetscapes can be characterised by their skeleton, i.e., their morphological characteristics, or their skin, i.e., their visual characteristics. We focus here on methods for mapping skeletal properties.The two principal approaches to skeletal characteristics of frontage are either surface- based (plan) or perceptual-based (street aspect ratio or line of sight). Surface-based approaches are used mainly by urban and landscape planners, morphologists and geographers to identify street space width and land cover and to regulate building setbacks. Perceptual-based approaches are used mainly by architects, urban designers and environmental psychologists to consider street sections and building facades relevant to human-centred perception in public spaces. Over the past two decades, the increasing availability of datasets and computational power supported by AI, alongside the growing need to address multiple urban objectives, has led to the convergence of these two approaches enabling an analysis of urban morphology centred on human experience and environmental quality.

These methods effectively integrate skeletal and perception properties, while skin-based approaches are still data-intensive and challenging to translate into planning policies. The study aims to assess different data-driven approaches for describing the skeletal components of streetscapes and frontages (street-based morphometrics). Beyond the built masses, particular focus is given to integrating vegetation elements in order to bridge the gap between morphological and environmental disciplines. Munich is used as a case study to illustrate each measure. The study achieves a protocol which combines multi-disciplinary objectives by introducing a perceptual-based approach to urban planning and environmental policy-making, ensuring a balance between analytical depth and practical applicability.

Nolli-Type Map of the Central Zone of New Belgrade: Testing AI-Based Chatbot in Map Creation

Nikola Mitrović | *University of Belgrade*
Djordje Mitrović

Keywords:
AI-driven mapping, AI-based chatbot, Nolli map method, New Belgrade Block

This study focuses on a specific morphological aspect of the New Belgrade blocks, using them as a case study to identify, represent, and map the open areas within these spaces. It integrates centuries- old mapping techniques with cutting-edge AI-driven methods to explore the morphological complexity of New Belgrade's urban landscape. The research contributes to a wider discourse on the evolving tools for urban analysis by combining the principles of traditional Nolli maps with innovative digital mapping strategies. The primary aim of the study is to evaluate the capability of an AI-based chatbot to generate detailed, scale-sensitive maps using open-source data. This process seeks to capture the traditional dichotomy between public and private spaces, as well as the nuanced distinctions between semi-public and semi- private areas. The methodology relies on iterative interactions with the chatbot, executed in a Python environment on a cloud-based platform, utilising open-source geodata—mainly from OpenStreetMap—to extract building footprints, street networks, and the configurations of open spaces. The findings are presented as coded outputs that clearly delineate spatial hierarchies and effectively represent the unique arrangement of open spaces within large urban blocks. The results indicate that AI-driven mapping can not only replicate but also enhance traditional mapping methods, offering a quicker, more reliable, and sophisticated alternative for urban spatial analysis. This innovative integration of AI tools in cartographic practices underscores the potential for future mapping techniques to reshape studies of urban morphology, ultimately providing valuable insights for urban design and planning in rapidly evolving city environments.

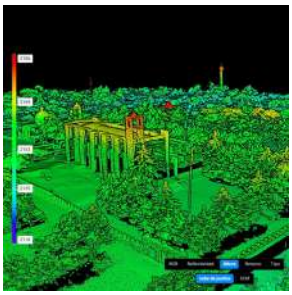
Artificial intelligence and environmental mapping tools- political and environmental control

Alice Monacelli | *Sapienza University of Rome*

Keywords:
Environmental analysis, spatial segregation, mapping tools

Can artificial intelligence be a spokesman for spatial democratisation? The current socio- political condition sees the risk of a scattering of satellites around the globe, potentially building a dangerous database of information whose exploitation could lead to a possible celestial hegemony. At the same time, however, the control of the fate of the earth's soil remains unresolved, which continues to undergo gutting and deforestation, forest reduction, natural cataclysms, and territorial, physical, and cultural segregation. On the other hand, the database of information at our disposal could help us to control, monitor and regenerate the land as an entity that suffers most from the consequences of human anthropisation. With the help of the GIS tool, artificial intelligence can be used to power, for example, the "risk assessment analysis" of areas most prone to environmental and social resource depletion. In this contribution, an attempt is made to use space as a point of observation of some of the effects of climate change such as Urban flooding and Urban drought, demonstrating how AI can facilitate monitoring at the service of the community, moving from the individualistic desires of the few towards the needs of the community. Tokyo, and in particular the Shinagawa area, was chosen as an exemplary case study, carried out on two scales: the urban scale and the morphological scale. The focus is on selected urban districts, in which possible measures will be investigated to favour the state of climatic comfort (thus acting on heat islands), possible areas subject to flooding, and a more efficient management of public space and its elements. The investigation clearly highlights the existing correlation between climatic effects and its variations due to a spatial division that does not follow the natural structuring lines of the territory.

Characterization of historical urban forms with digital processing of RPAS LIDAR point cloud



Milton Montejano-Castillo | *Instituto Politécnico Nacional*
Mildred Moreno-Villanueva

Keywords:
LIDAR technology, drones, heritage conservation, segmentation, Cuauhtinchan

The geographical definition of many historic centers has been based mainly on expert criteria and some objective indicators such as the location and permanence of heritage structures as a reference, and other urban or natural structures as borders. Even within this generality, specialized human resources are required, which in large cities are relatively easier to find and economically and technically feasible. However, in small and inaccessible towns - but no less important in terms of their heritage value - the work of delimiting the historic center and its eventual protection becomes more expensive and less likely to be carried out, putting its heritage at risk of loss in the short or medium term due to urbanization and/or densification processes. This document proposes a methodology to support the characterization of historic urban forms that can support decision-making of urban heritage protection instruments without consuming too much time and resources. The proposal is based on the analysis of point clouds obtained with unmanned aerial vehicles (Light Detection and Ranging). This characterization is based on the technique of segmentation of the point cloud taken during the flight, that allowed to distinguish "morphological territories" with homogeneous features. In turn, this permitted to establish spatial differences in the historical urban form of Cuauhtinchan, Mexico, a small city in the State of Puebla that was taken as case study because it houses a former convent of the 16th century. Subject to validating this proposal with more flights and case studies, the preliminary results allow us to offer a potential and relatively economical tool in its use and processing under a scheme of cooperation between universities and local governments.

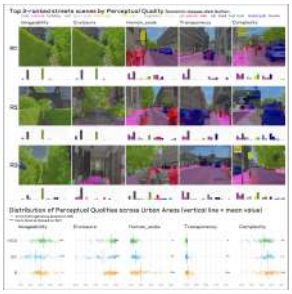
On New York's Ground: Dense, Diverse and Sustainable

Vitor Oliveira | *Universidade do Porto*

Keywords:
urban morphology, urban form, socioeconomic diversity, environmental sustainability, New York

Since its emergence over a century ago in Central European urban geography, urban morphology has sought to describe and explain, as rigorously as possible, a set of urban phenomena and dynamics. While morphological studies generally focus on the physical form of human settlements, some extend beyond form, seeking to connect this physical layer with other key dimensions of urban life. This presentation aligns with that line of research, aiming to identify the cumulative influence between the physical dimension, on the one hand, and the social, economic, and environmental dimensions, on the other. This is the paper's core contribution. The exploration of a cumulative influence proceeds in several stages of analysis. First, the analysis employs the concept of the town plan (formulated by M. R. G. Conzen in the mid-20th century) to distinguish the fundamental parts of a given territory. Each part is defined by a specific combination of the street system, plot patterns, and building organization on the ground. Next, each of these parts is analysed using a set of social (race, education, employment, income), economic (establishments density, sectors of activity), and environmental (land as a resource, energy for buildings and transport) indicators. The hypothesis to be tested is that different densities of the town plan coexist with varying levels of socioeconomic diversity and environmental sustainability. For example, an area with a low-density town plan – characterised by reduced street system connectivity, a low number of plots, and buildings set back from the street – may exhibit lower level of socioeconomic diversity and environmental sustainability. This hypothesis is explored in the world's first megacity – New York. A selection of territories across the city's five boroughs are analysed. This presentation is based on the book On New York's Ground: Dense, Diverse and Sustainable, to be published by Springer in 2025.

AI-Powered Perceptual Mapping: Assessing Urban Form through Street-View Imagery



Nicolas Palominos | *ERA-co*

Keywords:
Street-View Imagery, Image Segmentation, Urban Characterization

This study explores the visual perception of streets as a key component in assessing urban form. By leveraging computer vision, image segmentation, and large language models applied to open-source street-view imagery, it introduces a scalable and replicable methodology for conducting street-level perceptual assessments. The study examines archetypical urban forms across diverse global case studies, enabling comparative analysis.

Findings reveal that AI-driven perceptual assessments effectively capture key spatial and visual attributes—such as enclosure, imageability, and human scale— contributing to a deeper understanding of urban morphology. The methodology demonstrates sufficient accuracy to support urban characterization and inform area- based placemaking strategies. By integrating principles of evidence-based design, the study provides a data-driven framework for evaluating the impact of urban form on perceptual and behavioural responses. These insights align with existing urban design theories on the relationship between street environments and human experience, offering a computational approach that complements traditional qualitative assessments.

This research highlights the potential of artificial intelligence in urban studies, offering new tools for planners and designers to map, evaluate, and shape cities with data- driven precision.

Developing a virtual - spatial - expert focus group for exploring urban form types and their role in spatial planning

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Efthimios Bakogiannis

Keywords:
urban form, typo-morphology, focus group, spatial analysis, participatory Web GIS

The conceptual schema of patterns and urban types has been proposed as a powerful tool for understanding, planning, and discussing the city, even from the 1960s. What is more, recently, we have seen an ever-increasing research trend of using spatial analysis and quantitative approaches for typo-morphology research. In this context, this paper aims to describe a comprehensive methodological workflow for assessing a developed geospatial workflow for identifying granular urban form types in the city of Athens, Greece. Meaning to what extent the identified urban form types are successful in identifying the corresponding urban patterns of the case study, as well as whether it provide significant value as a planning support tool in various stages of integrated planning. To this end, a qualitative assessment methodology is developed that utilizes the focus group research technique, with the participation of experts and, more importantly, with the use of a participatory Web GIS as the spatial board for running the focus group. The methodology followed a rigorous process of expert selection, engagement, and structured discussion to assess the developed GIS planning-support tool. A carefully curated pool of potential expert participants is established, leveraging an analysis matrix with various criteria classifying the participants' discipline-based and role-based profile. The main contribution of this paper is the comprehensive development of a replicable and reproducible method for a spatial expert focus group, facilitating interaction among a diverse panel of experts. Despite focus group being a very well-known qualitative research technique, the proposed spatially-enabled expert focus group approach is missing from the literature and is essential for assessing GIS-based workflows especially regarding urban patterns and typologies.

Pretrained Convolutional Neural Networks vs. Experts in settlement type classification: friend or foe?

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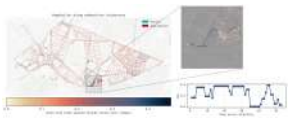
Maja Debevec

Keywords:
Settlement types, classification, convolutional neural network, Orange data mining

Slovenia has a long tradition of morphological settlement classification. Three broad classes of settlement, the nucleated, along the road and historically dispersed in combination with farms, hamlets, and suburbanization, create the main set to define the character of a region in Slovenia. So far, the classification has been carried out by experts descriptively. Due to the number of settlements, it is virtually impossible to do expert classification for each settlement. However, the morphological pattern is one of the key concerns in decision-making with policy repercussions ranging from conservation to development at the local and regional levels. In computer sciences, convolution is one of the key mathematical concepts used for visual pattern recognition. It is ideally suited to recognize lines, edges and textures close to each other. In machine learning, a convolutional neural network (CNN) is a widely used method to classify images into pre-trained classes. Does the CNN classification hold its ground against an expert's classification? Can such an approach be used to help experts more precisely define the character of the region? This paper will present research that used Orange data mining, an open-source visual programming environment for data mining and machine learning. The paper will firstly examine a comparison between different pre-trained CNN models (Inception V3 by Google and VGG-19) and against professional assessments in order to secondly, establish where and when the pre-trained CNN models are helpful and what are the limits of their applicability. Lastly, the paper will speculate on the implications of CNN classification for the scientific and professional work.

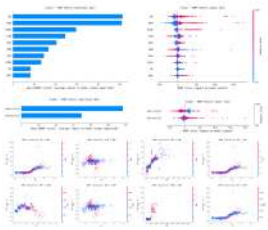
Mapping Urban Transitions: An AI-Driven Approach to Fine-Scale Urban Morphology



Roberto Ponce Lopez | *Tecnologico de Monterrey*
Juan Uriel Legaria Peña

Keywords:
Street-level imagery, Transitional zones, Computer Vision, Large Language Models

Traditional studies of urban form have focused on employment concentrations to delineate urban centralities at a city scale, using quantitative methods and job data. This study explores additional dimensions of urban morphology by examining changes in urban configuration at finer scales, such as districts. It investigates the continuous transitions within urban areas—where shifts in the social fabric, building facades, the built environment, and land use become perceptible to pedestrians— and seeks to differentiate between cities with continuous transitional spaces and those that are fragmented and segregated, as often observed in Global South cities. The study integrates Google Street View imagery with computer vision, Large Language Models (LLM), and Visual Language Models (VLM) to extract and analyze built environment features that influence human perception of urban spaces. The continuity of walking infrastructure features, façade characteristics and environment metrics obtained from street-level images is explored within street networks. By considering transitions along different network paths, the analysis accounts for the complex morphology and form that cities exhibit. Exploring changes in these microscale dimensions of urban form has recently become feasible, enabled by increased availability of street-level imagery and newer machine-learning models, which can efficiently analyze large, complex datasets. Promising preliminary results obtained for Monterrey, Mexico demonstrate that the developed method can automatically detect façade characteristics, and walkability-related attributes in city streets, allowing to characterize transitional zones between neighbourhoods. These findings suggest that incorporating perceptual elements into urban form analysis can offer insights into spatial cohesion, and social/physical interaction, beyond those obtained from traditional employment-based metrics. The developed framework has the potential to inform planning decisions to increase livability and reduce segregation. Furthermore, it illustrates how applying AI models to street-level imagery opens new dimensions in studying urban form, facilitating the characterization of transition zones between distinct urban areas.



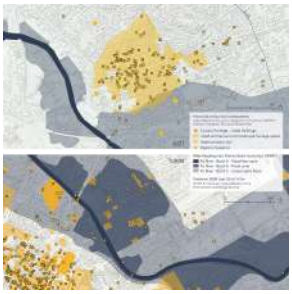
Adaptation and Transformation of Commercial Spaces: An Integrated Analysis of Morphological Characteristics, Business Synergy, and Vitality Mechanisms

Qi Qin | *Southeast University*

Keywords:
Commercial space, spatial morphological characteristics, machine learning, intelligent assessment model, vitality mechanisms

With the continuous advancement of urbanization and the increasing diversification of commercial demands, commercial spaces have become crucial hubs for urban economic and social activities. Within the built commercial environment, factors such as spatial morphology, business mix, and locational attributes are closely linked to consumer behavior, social interactions, and regional development. These factors collectively shape the spatial characteristics and vitality of commercial spaces. However, existing studies often focus on the influence of single variables while overlooking the nonlinear effects of multiple factors and their complex interactions. In particular, the specific mechanisms and multidimensional impacts of commercial space morphology on neighborhood vitality require further investigation. This study employs machine learning algorithms to classify commercial neighborhoods and utilizes social media data to quantify vitality characteristics, constructing an intelligent assessment model for commercial space vitality. Key variables such as building density, intersection density, and walkability are selected as spatial morphological attributes, while business mix and the richness of surrounding facilities are considered functional configuration features. Geographic location attributes are also incorporated to comprehensively analyze their relationships with commercial space vitality. The results reveal that spatial morphological features significantly influence neighborhood vitality. Moreover, business mix and the configuration of surrounding facilities enhance commercial space vitality through synergistic effects, leading to a notable increase in overall vitality levels. Additionally, the impact of spatial characteristics on commercial vitality exhibits threshold effects. This study systematically elucidates the formation logic of commercial space vitality and clarifies the synergies and trade-offs among different variables and proposes strategic recommendations for optimizing commercial spaces. These insights provide theoretical support and practical references for enhancing neighborhood vitality and promoting sustainable urban development.

Digital tools for the analyses of riverbed and built heritage interaction



Federica Ravizza | *Università La Sapienza Roma, Politecnico di Torino*
Antonia Spanò

Keywords:
geomatics tools, mapping urban heritage, urban river flooding risk, geo-spatial information, change detection

In the increasingly dynamic scenario that fuels flood risk phenomena in urban areas, the risk/hazard/vulnerability paradigm for the built heritage has long been investigated. Innovative Geomatics tools have advanced geographic and spatial data acquisition, mapping urban morphological changes, and assessing the exposure of built environment (particularly historic fabric) to flooding, river overflow, and pluvial events. Predictive territorial maps assess urban river flooding risk by integrating historical data and updating the vulnerability of built heritage; even hydro-morphological and geological studies benefit from geomatic techniques, using automated change detection based on Digital Terrain and Surface Model (DTM/DSM) comparisons to identify urban form transformations. Aligned with these objectives, the research emphasizes historic urban heritage conservation.

Turin's urban structure, characterized by four rivers, includes a built-up area along the Dora Riparia at medium flood hazard, where listed buildings and historic fabric are located. Similarly, the Tanaro River threatens Asti's historic center. The studies presented utilize modern airborne LiDAR (Light Detection and Ranging) data, recently released in open access by the Ministry of the Environment and Energy Security, along with combined LiDAR and photogrammetric acquisitions developed for the city of Asti by the CNR-Research Institute for Hydrogeological Protection. The analysis of these products outlines flooding and river overflow effects on the urban structure of the mentioned cities, stressing the watercourse's influence and allowing for a shift in focus to a broader scale of representation compared to traditional analysis scales. Additionally, the comparison of historical data on embankments and protection infrastructure reveals notable changes in the relationship between the built environment and the riverbed. The study investigates the historic construction period in areas exposed to water risk, to identify potential degradation of built heritage/soil.

The research aims to assess whether innovative geo-information tools can help monitor urban areas at risk of water-related issues, promoting preventive actions.

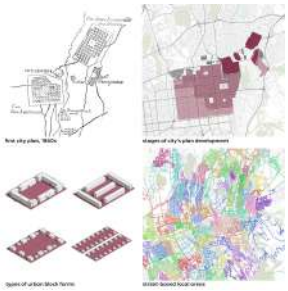
Collective Housing Typologies in Contemporary Urban Space: Understanding Housing Adaptation in Mexico City's Historic Centre

Daniela Resendiz Garcia | *The Bartlett School of Architecture*

Keywords:
Geospatial Analysis, Urban Morphometrics, Urban Taxonomy, Data Visualization

How have self-produced housing typologies adapted to economic and environmental pressures in Mexico City's historic centre? This space has undergone significant transformations from its pre-hispanic origins to the present day, including its colonial reorganisation and modernist interventions. Despite these changes, many collective housing typologies continue to function as crucial living spaces for a large portion of the population. This study analyses the evolution of emerging typologies projects and their relationship with urban morphology, emphasising their role in addressing the ongoing housing crisis in the city. From pre-hispanic calpullis (indigenous house) to 20th-century vecindades houses, this research evaluates which typologies have successfully addressed housing accessibility for most of the population. It highlights how urban policies and economic factors have shaped these housing solutions over time, sometimes reinforcing inequality while at other times serving as mechanisms for social integration. Using a morpho-typological approach, the study employs GIS-based cartographic analysis, fieldwork involving site analysis, and documentary policy and economic analysis, and environmental conditions, such as earthquakes and flooding. These methods help evaluate the resilience of these typologies. The findings reveal that typologies such as platter-and-cup housing (vivienda de taza y plato) and mansions adapted into vecindades remain essential for marginalised sectors, mitigating the housing crisis in one of the city's most unequal areas. These typologies demonstrate a remarkable capacity for adaptation, maintaining their relevance despite urban renewal and gentrification pressures. The study proposes a hybrid urbanism approach, where heritage conservation is integrated with inclusive policies that ensure accessible housing. By recognising the importance of historical and self-produced housing solutions, policymakers can develop strategies that reinforce urban resilience and social equity. This perspective challenges conventional urban planning approaches that prioritise aesthetic and historical preservation over the actual needs of residents, advocating instead for a more dynamic and inclusive vision of the historic city.

Mapping morphotypical urban areas in Almaty, Kazakhstan: *combining historical plan analysis with machine-based street pattern clusterization*



Ivan Riaposov | *AlmatyGenPlan*

Keywords:
morphological periods, street-based local areas, post-soviet cities

The urban fabric of post-Soviet cities is often uneven and fragmented, making urban development regulation a significant challenge. Almaty's unique history makes this issue particularly critical: originally established as the Russian Empire colonial settlement of Vernyi on fertile foothill land once used by nomadic communities, Almaty evolved through the Soviet era and the transformative 1990s to become the largest city in independent Kazakhstan. To address the challenge of capturing this complexity, the study proposes an approach that merges traditional urban morphology methods with modern computational techniques. It aims to map the city's morphotypical areas for practical regulation purposes while also exploring the specific morphological characteristics of Almaty, a Central Asian post-Soviet city. To achieve this, historical city plans were examined following the Conzenian school of morphology. This analysis mapped key morphological periods and explored their characteristics including street patterns, plots, planning units, and building alignment. Machine-based clustering of the street network using the concept of street-based local areas (SLA) was also performed. The results from both methods were compared to assess the overlap between historical morphological areas and the modern city plan's SLAs. The analysis revealed significant overlap between historical development periods and calculated SLAs, although notable differences in layout were shown. Factors contributing to these differences include the coexistence of extensive and intensive development types where new urban expansions followed contemporary planning paradigms, while redevelopment efforts combined existing street networks with modern building types. Furthermore, detached housing development, which has continued from the city's establishment to the present, shows varying layouts influenced by the landscape, particularly due to Almaty's pre-mountain location. Overall, the results demonstrate the potential of combining traditional morphological methods with machine-based data-driven techniques in mapping manifold urban structures.

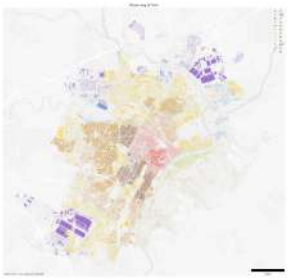
Describing Swedish and Danish character areas: *Typo-morphology for morphologically informed urban design*

Gunvor Riber Uggerhøj | *NIRAS*
Todor Stojanovski
Sofie Kirt Strandbygaard

Keywords:
Typo-morphology, character areas, neighbourhood types, urban design, Transit- Oriented Development (TOD)

Typo-morphology is a branch of urban morphology that understands physical form, formation and transformation in cities through types, typologies and typological processes. There is a long typo-morphological tradition in Sweden. Many Swedish architects, planners, architectural and urban historians, and geographers have created urban models of typical cities and typologies of buildings, streets, spaces between buildings and neighborhoods. However, typo morphology in Denmark it is seldom used as a method of analysis. This paper looks at historical approaches and new conceptualizations in Sweden and presents a new neighborhood typology of character areas for Danish cities to discuss implication for urban design practices particularly in designing Transit-Oriented Developments (TODs). It starts with describing three historical Swedish typo-morphological approaches. The first is historic- architectural emphasizing architectural styles. The second focuses on classifying neighborhood types by physical attributes. The third argues that the Swedish neighborhood typology describes not only physical form, but also social structure. It also presents a parallel Danish typology of character areas. Both Sweden and Denmark have developed professional linguistic terms that over time are used broadly in the society e.g. “villastäder” or “småhusområde” in Swedish or “herskabsvillaer” in Danish which makes the building and neighborhood types possible to identify and recognize by the general public and future urban designs can be discussed. The paper discusses the differences between well-established Swedish neighborhood typology versus newly crafted Danish typology and concludes with implications for urban design practices. Practicing architects and urban designers can apply morphological research, and both detailed and generic local neighborhood typologies can be very useful conceptualizations.

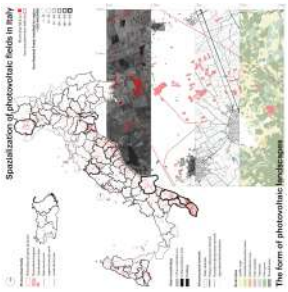
Describing Turin's Urban Morphology: A Data-Driven Approach



Carolina Rigoni | *University of Strathclyde*
Sergio Porta
Ombretta Romice

Keywords:
Urban Form, urban morphology, urban morphometrics, Data-driven classification, Quantitative Analysis

Understanding urban morphology is crucial for urban analysis, city planning, and ultimately, sustainable development. This study develops a data-driven classification of Turin's urban form, using the innovative Urban MorphoMetrics approach. Developed in 2020 at University of Strathclyde in Glasgow, Urban MorphoMetrics is a digital ecosystem designed to generate the numerical taxonomy of urban forms, described through distinctive urban types. The application deploys momepy, a Python library specifically designed for urban morphology analysis, to describe urban form comprehensively, through 74 primary and 296 contextual characters. This method delivers both a granular and scalable numerical characterization of urban form, generally using buildings and street networks as input data. The Turin analysis though, focuses solely on buildings, excluding the street network for a misalignment between the street network data sourced from OpenStreetMap's and the building footprint data from EUBUCCO. Consequently, only 54 of the original 74 primary and 216 contextual characters are computed. Each of the twelve urban types is described in detail through quantitative, qualitative, and mixed methods. For each type we also identify the six most significant and distinctive morphological characteristics. The Urban MorphoMetrics analysis identifies twelve distinct urban types, whose similarities are explained through hierarchical dendrogram. This reveals how these twelve urban types cluster into three main morphological groups: (1) the historical city centre, characterized by a compact and regular form; (2) residential areas with diverse and irregular structures; and (3) industrial zones and suburban developments with scattered urban forms, aligning with the historical periodization of Turin's expansion. This research enhances urban morphology methodologies and provides actionable insights for planners, geographers, and architects, supporting data-driven urban development and policymaking, for example, through the creation of evidence-informed urban design codes to promote successful design.



Mapping the Solar Pattern: *A reasoning about spatial data accuracy and availability.*

Riccardo Ronzani | *Politecnico di Torino*
Ilaria Tonti

Keywords:
Design strategies, Mapping methods, Photovoltaics, Energy transition

In the context of the growing interest in renewable energy issues and international policies to encourage energy transition, this contribution questions how geoinformation technologies enable the production of multiscalar and accurate mapping of energy morphologies to support the design of future operative strategies. Over the past 20 years, the impacts of small and large-scale renewable energy plants have shaped new territorial forms and built new landscapes. Ground-based photovoltaic systems are considered the most rapidly implementable and reversible energy systems regarding land use. Data accessibility and quantitative and spatial knowledge assume a strategic, evidence-based role in studying the impacts of rapid morphological transformations at the territorial scale. The availability and accuracy of mapping data become essential factors to trigger interdisciplinary and collaborative project processes. As an opportunity to reflect on this topic, the contribution presents the mapping methodology adopted in a national research project aimed at the knowledge of impacts and the decommissioning and revamping design strategies of end-of-life photovoltaic fields. The fragmentary nature of the available data and their limited (or insufficient) level of detail - which does not distinguish, for example, reversibly land-consuming elements from more permanent ones - makes it difficult to support design reflections for planning future strategies. The contribution highlights the potentials and limits of geospatial technologies used in the field of solar landscape representation, emphasizing the criticalities and the scope for operative man-made actions still needed today to produce maps and to achieve the appropriate level of detail required at the different scales. This work is preliminary to question which limits should be overcome before implementing algorithms and artificial intelligence tools capable of automatically extracting spatial features and forms geometrically verified, accurate, and with an accurate level of trans-scale detail that can be used to support architectural projects which define new urban and territorial forms.

Transforming Urban Planning with Digital Twins: A Case Study of Smart Design in El Palmar, Manta

Gabriel Gregorio Salvatierra Tumbaco | *Universidad Laica Eloy Alfaro De Manabi*
Tatiana Cedeño
Genesis Cevallos
Kevin Desiderio

Keywords:
Digital Twins, smart urban design, urban planning, sustainability, citizen engagement

This research investigates the integration of Digital Twins in smart urban design, focusing on the commercial sector of El Palmar in Manta, Ecuador. The study aims to assess how this innovative technology can optimize urban planning, enhance sustainability, and foster citizen engagement in decision-making processes. Employing an analytical-synthetic methodology, the research involved 288 survey respondents, interviews with urban planning experts, and a Digital Twin evaluation using virtual reality with 15 participants. Direct observation further supported the analysis of the current urban conditions in the study area.

The findings highlight the potential of Digital Twins to simulate and visualize urban scenarios with precision, providing stakeholders with a clearer understanding of proposed changes. This approach fosters informed decision-making while promoting transparency and participation. Key results include improved perceptions of urban infrastructure and spatial organization, alongside the identification of opportunities to advance the interactivity and immersive capabilities of the technology. Nevertheless, challenges persist, including visual pollution, insufficient pedestrian infrastructure, and unstructured commercial zones, emphasizing the need for comprehensive urban strategies.

The study concludes that Digital Twins significantly enhance smart urban design by enabling real-time data integration and scenario simulations that support strategic planning. This innovative approach facilitates the creation of sustainable, functional, and inclusive urban environments, aligning technological advancements with community needs. The research underscores the importance of continued exploration into the applications of Digital Twins, focusing on their role in addressing urban challenges and improving the quality of life for citizens.

This case study demonstrates the transformative potential of Digital Twins in urban planning and highlights their capability to redefine the traditional approaches to designing resilient and dynamic urban spaces.

Curvilinear morphological itineraries: *An alternative taxonomy of Rome's urban form*

Cristian Sammarco | *Sapienza University of Rome*

Keywords:
urban taxonomy, curve, Rome, itineraries

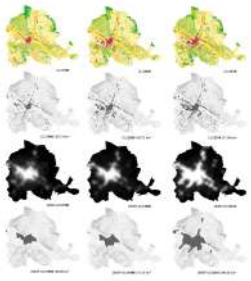
Goethe stated that "only in Rome can one prepare to understand Rome", but one might add that only in Rome can one fully understand other cities. The contribution is presented as a selective journey within the urban form of Rome, observed through an investigative camera that starts from the Grande Raccordo Anulare, progressively narrowing the field of vision to discover new (or forgotten) exploratory itineraries of the city's DNA.

According to the myth, Rome was born square, but it is the geometry of the curve that has characterised its evolution, becoming a design tool as much as an imaginative one. From Piranesi's visionary reveries, to the critical rereading of historical maps, a Rome emerges where the magical persuasio reveals a new face, dominated by curvilinear forms

The urban form of curvilinear Rome is investigated through two possible morphological itineraries. The first is developed by following the GRA, which becomes the matrix route for the development of successive urban forms (or connecting existing ones such as the Capannelle hippodrome): an exploration that goes from large complexes such as the Vigne Nuove and Serpentara neighbourhoods in the north-east of Rome to Giuseppe Perugini's buildings at Laurentino. The second itinerary is transversal and, following the bends of the Tiber, brings together the building typologies of contemporary sport up to the urban fabrics of substratum settled on the great curvilinear forms for ancient spectacles. From Pier Luigi Nervi's works such as the PalaTiziano to the Theatre of Pompeo and Navona Square.

The contribution is structured as an alternative investigation tool for an interpretation of the urban morphology of the city of Rome. A radiocentric city that has exploded into an archipelago city in which it is necessary to trace signs of hidden morphologies such as the curve in order to open up new themes of spatial and architectural investigation.

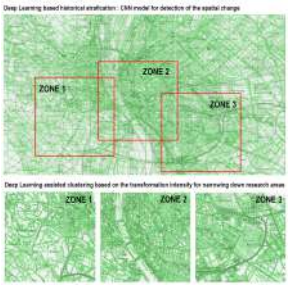
Cartographic analysis of peri-urbanization processes in Zaragoza and its metropolitan region



Cecilia Sanz-Garcia | *University of Zaragoza*
Javier Monclùs-Fraga
Carmen Diez-Medina

Keywords:
peri-urbanization processes, cartographic analysis, geodata visualization

The emergency of urban sprawl, with the consequent dissolution of city boundaries into the surrounding territory due to peri-urbanization, has become an increasingly central topic in urban studies. The metropolitan area of Zaragoza has already been extensively studied from a geographical and economic perspective, generating a considerable body of literature on the subject. However, many aspects related to urban and peri-urban forms remain unexplored. This paper analyses the dynamics of Zaragoza's urban expansion in relation to its metropolitan region through a cartographic approach, using different types of sources. Multiple methodologies are employed, including GIS tools, geodata from the European CORINE Land Cover project and its Spanish equivalent (Sistema de Información sobre Ocupación del Suelo de España), as well as information from the Defense Meteorological Satellite Program-Operational Linescam System. The analysis evaluates different factors and dimensions of peri-urbanization processes experienced in recent decades, including the decentralization of activities, land consumption, and the proliferation of infrastructure around major transportation routes next to the fluvial corridors of the Ebro, Gállego, and Huerva rivers. The findings reveal that the central city continues to concentrate not only the majority of the population but also the most attractive functions, pointing to a moderate decentralization. However, paradoxically, it also experiences an intense process of peri-urbanization. These results contribute to a better understanding and interpretation of territorial transformations in Zaragoza, a case that can be considered representative of trends observed in other Spanish cities.



Modeling the Historical Stratification of Towns: *Leveraging Urban Morphology, Deep Learning, and Artificial Intelligence*

Elif Sarihan | *University of Debrecen*
Eva Lovra

Keywords:
Urban Morphology, Convolutional Neural Networks, GPT-4o

The historical stratification method is important for identifying and determining urban structural changes in towns since their recognition and processing are challenging. The challenge in studying the layered city lies in its complexity and multi-dimensional nature, which cannot be fully measured through single-method approaches.

In this study, we applied an integrated urban morphological method to establish urban type determination in Central European examples by presenting systems of urban structural changes via a comparison of different time periods. This study suggests that artificial intelligence and deep learning techniques offer a robust alternative for examining the historical stratification approach and provide an experimental tool to test and compare the results generated by humans. By leveraging the artificial intelligence model, GPT-4,o we created a preliminary clustering of the towns to distinguish basic urban types based on prompts derived from a pre-established preliminary set of criteria.

To narrow the area within the towns, we employed deep learning to detect where transformation during a certain period – specifically street and urban block transformation – is significant by training a Convolutional Neural Networks (CNNs) model for classifying urban features using Semantic Segmentation Analysis (SSA) through different time periods. Streets and blocks are automatically segmented using OpenCV (Python).

Our findings show that there is a strong similarity in clustering results between GPT-4o outputs and human assessments. Integrating deep learning-based SSA increased GPT-4o's accuracy in object detection during the overlay comparison process of different maps, allowing for a more precise definition of key areas with major changes.

This research not only provides a deeper understanding of the historical stratification process and urban structure changes but also offers an innovative approach to modeling towns.

Towards the classification of superblock typologies: *Characterization of Abu Dhabi's urban form using Principal Component Analysis.*

Martin Scoppa | *United Arab Emirates University*
Amnah Gargoum

Keywords:
Superblocks, Urban form classification, Abu Dhabi, Principal Component Analysis

Urban form studies in the Gulf Cooperation Council (GCC) countries, which include the United Arab Emirates (UAE), remain limited. In Abu Dhabi, where urbanization follows neighbourhood planning unit and modernist superblock principles, urban form has yet to be systematically analysed. Notably, recent studies have introduced numerous variables and methods that support robust urban form description and classification, and provide a valuable framework to study this and other similarly planned cities in the region. This study applies Principal Component Analysis (PCA) to better understand urban form, prior to classification, and evaluates the behaviour of variables describing built form density and geometry, and the characteristics of the networks that connect them. Numerous indicators that characterize urban form were calculated using GIS and a sample of 165 superblocks. Key parameters studied include building heights, floor area ratios, ground space use, obstruction angles, plan depths, and road network densities. The application of PCA transformed these highly correlated variables into two distinct components that collectively explained 90% of the data variance. In more detail, Kaiser's Varimax rotation highlighted two principal components (PCs) describing, respectively, the characteristics of built form elements, and patterns of land subdivision. Indeed, PC1, explaining 47% of data variability, captures built form through floor area ratios (22%), building heights (25%), obstruction angles (21%), and plan depths (13%), while PC2 captured horizontal compactness and ground space continuity as defined by ground space use (26%), block sizes (21%) and network density (14%). These components thus define Abu Dhabi's urban form, as a continuous, interconnected system of built structures and open spaces. The results of this study support a focused and regionally contextualized discussion on the link between built form and environmental performance and assist in developing of well-defined superblocks typologies using unsupervised model-based clustering methods.

Research on Block Morphology Type Analysis Method Based on Graph Network Structure: Taking Typical Innovation Spaces in Nanjing, China as an Example

Huaxing Sheng Sheng | *Southeast University*
Yi Chen Chen

Keywords:
Graph theory, Morphological Typology, Block Morphology

With the accelerated urbanization process in many developing countries, innovation spaces have become a key form closely linking industry and urban spaces, serving as a core platform for driving innovation activities. These spatial forms exhibit highly complex characteristics, differing greatly from traditional industrial parks. They place more emphasis on face-to-face communication, knowledge spillover, and urban convenience, fully reflecting the significant trend of “integration of city and innovation.”However, traditional research methods struggle to comprehensively characterize the diverse features and inherent patterns of such complex block forms. Therefore, how to effectively analyze and design block morphology to promote sustainable urban development and improve the quality of life for residents has become an important issue that urgently needs to be addressed.This study aims to explore the network structural characteristics of urban innovation space morphology in depth and innovatively proposes a block morphology analysis method based on graph network structure. We identify key characteristics of block morphology, build a comprehensive morphological analysis framework, and conduct empirical research to validate the effectiveness of this method.In the research process, we adopt a graph network structure model to abstract the complex block morphology into a network of nodes and edges. By integrating advanced technologies such as image semantic recognition, neighborhood segmentation, social network analysis, principal component analysis, and K-means clustering, we achieve a quantitative analysis of block morphology.Through in-depth research, we found that the morphology of innovation blocks can be summarized into six typical patterns: multi-cluster connection, business enclosure, cluster expansion, network topology, service parallelism, and cluster topology. Each pattern exhibits unique characteristics in terms of network complexity, centrality, connectivity, and scale variation.The block morphology analysis method based on graph network structure not only effectively reveals the organizational patterns and characteristics of block morphology, but also opens new quantitative pathways and deconstructive perspectives for urban morphology research.

Engaging Architecture: *Bridging Spatial Computing and Emotion-AI in Sites of Cultural Heritage*

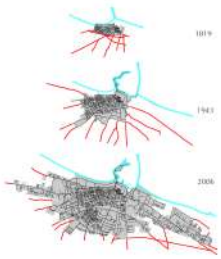
Jennifer Shields | *California Polytechnic State University*
Javier Gonzalez Sanchez

Keywords:
AI, Mixed Reality, EEG, Cultural Heritage

Integrating technology into cultural heritage sites can transform the visitor experience, offering deeper engagement and accessibility through innovative tools. Spatial computing, including mixed reality technologies, enhances multi-sensory experiences by merging digital and physical worlds, enabling all visitors, especially those with cognitive or sensory impairments, to connect with heritage in meaningful ways. Simultaneously, Emotion-AI — artificial intelligence designed to analyze neurological and physiological signals — can provide real-time insights into visitors' cognitive and emotional states through the analysis of neurological and physiological responses. This dual approach can facilitate the creation of personalized, adaptive experiences that cater to individual needs and preferences.

Our project investigates the combined application of spatial computing and Emotion- AI to cultural heritage, focusing on a case study at Hearst Castle on the central coast of California. In collaboration with Cara O'Brien, Director of Hearst Castle, we are developing a permanent exhibit in the Visitor Center Museum as a pilot that serves as a prototype for broader applications in heritage interpretation. This exhibit, centered on the 15th-century Spanish Wildmen statues and other historical elements of the facade of Casa Grande, integrates video and audio projections to enhance historical context and accessibility.

Rather than static storytelling, the system dynamically adjusts content based on visitor engagement, detected through eye-tracking technology, wireless EEG devices, and physiological response monitoring to refine methods of blending digital enhancements with the physical environment. By advancing the intersection of technology and heritage, this work aims to set a new standard for accessible and engaging cultural experiences. By combining Emotion-AI-driven analysis with spatial computing, our work explores how technology and AI can adapt a cultural heritage site or urban form to the needs of its users, exploring the exciting frontier of creating adaptive and inclusive cultural heritage experiences.



The Effect of Intercity Arterials on Urban Form: A Comparative Study of Adriatic and Ionian Coastal Cities

Ermal Shpuza | *Kennesaw State University*

Keywords:
treet network, physiographic context, arterial road, comparative study

From a broad perspective, the overall form of the city results not just from the aggregation of various urban fabrics, which is the focus of most urban morphology studies, but also from how these fabrics relate spatially to one another. Given that, during urban growth, patches of urban fabric are accrued alongside intercity arterial roads radiating out of the city, the intercity arterials play a significant role in shaping its overall form. Quite unlike urban fabrics, whose form reflects concerns of block and plot subdivision and building typologies, intercity arterials are the product of pragmatic concerns related to connectivity between settlements and are affected by the physiography of the surrounding region and the subdivision of agricultural land. Due to their special geographical context, coastal cities exhibit various configurations of intercity arterials, quite different from the ideal model of equally radiating roads of 'central place' cities located in the middle of hinterland plains. The study takes on a sample of seventy coastal cities in the Adriatic and the Ionian littoral regions between the Balkans and Italy. Based on the configuration of the intercity arterials, it classifies cities into five groups: flat-radial (Peloponnese, Istria, Puglia, and Emilia), hilly-radial (Dalmatia), snake (Dalmatia), lagoonal (Gulf of Venice), and comb (Sicily and Marche- Abruzzo). Using a comparative approach of syntactic measures of street networks, the study shows that the configuration of the intercity arterials has a significant effect on the overall spatial structure of the city, over and above the extent and kinds of urban fabrics. On the one hand, the study proposes a typological classification of urban form based on intercity arterials with direct implications for comparative urban form studies. On the other hand, it brings to light important considerations for urban design and planning related to the physiographical context of cities.

Territory as heritage: *socio-morphological mapping of the arrangement and network of indigenous and quilombola nuclei in central-western Brazil*

Patricia Silva Gomes | *University of Brasilia*

Keywords:
urban morphology, etonography, indigenous-quilombola traditional people, remote sensing, cultural heritage

Brazil's central-western region was formed from a complex process of internalization, which began with the discovery of gold (18th) continued with the practice of subsistence agriculture (19th) and the opening up of new towns and the agricultural frontier (20 and 21th). The result is the configuration of a diverse morphological mosaic, reflecting the different ways in which each cultural group relates to the land - indigenous people, who remain in the territory; quilombolas, who are traditional nuclei of black people escaping from slavery; family farmers, who settled as posseiros (land occupiers after regularized) and later through acquisition and agrarian reform; large landowners, who fixed through the granting of sesmarias (soil donation from portuguese crown) and later through the acquisition/dispute over cheap land and the concession of agricultural colonies. The classic studies of social morphology analyzes the indissociability between the environmental base and the cultural way of life of the social organization; something also examined by classic ethnographic studies of traditional brazilian people; while studies of urban morphology make it possible to analyze form from its constituent two-dimensional elements (roads, blocks and plots) and its three-dimensional arrangement (fabric). Based on this theoretical approach, the objective is to carry out a morphological/ethnographic mapping of three indigenous communities - Karajá de Aruanã III, Carretão I-II and Parque do Xingu - and three quilombola communities - Kalunga, Cedros I- II and Porto Leucádio. The method included morphological mapping in QGIS® of the formal arrangement, sectorization of private/community buildings, typologies, network between nucleations, based on historical documentary research and institutionalized field validation by drone, as opposed to graphic/photographic records of the way of life and its relationship with the environment, based on field observation. The result identified the particularities of each community as well as common heritages, contributing to the inventorying and safeguarding of cultural heritage.

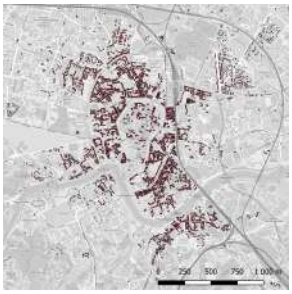
Introducing SOAR: *A Scalable, Open, Automated, and Reproducible urban data model for the EU*

Gareth Simons | *UCL*

Keywords:
urban analytics, morphometrics, network analysis, geospatial mapping, large datasets

Evidence-based approaches in Urban Design and Planning (EBDP) rely on spatial analytic workflows to extract actionable insights. Analysis of street networks, land use proximities, and census data is key to understanding urban form and socio- economic patterns. However, developing such models for a large number of towns and cities is often time-consuming, resource-intensive, and requires specialist skills, limiting broader applicability and generalisability. To address these challenges, scalable and automated models based on data sources with wide geographic coverage have gained traction. These models streamline urban dataset creation, enable cross-city comparisons, and support machine learning (ML) and artificial intelligence (AI) applications that depend on large, diverse datasets. The SOAR (Scalable, Open, Automated, Reproducible) urban data-model addresses this opportunity within the context of the European Union; SOAR integrates open EU datasets, including Eurostat's 2021 High-Density Clusters and 1x1km census statistics (population density, employment, demographics, and population change), and Copernicus Urban Atlas providing data on urban blocks, building heights, and tree canopies. These are complemented by Overture Maps data, supplying detailed information on street networks, infrastructure, points of interest, and enhanced building footprints supplemented with data from Google and Microsoft. Using the open-source cityseer Python package, SOAR processes 11.37 million street segments across 699 EU towns and cities. It computes per-segment street centralities, land-use proximities and counts (for a range of pedestrian distances) for 24 land use themes, access to green spaces, nine building and five block morphological metrics, and interpolates twelve census categories. The resulting dataset offers an unprecedented resource for comparative urban analytics across the EU. It enables the assessment of spatial patterns and urban dynamics at a continental scale, supporting EBDP decision-making in planning, research, and policy. The dataset's openness and reproducibility fosters collaboration across institutions and provides a foundation for further research, including the development of ML and AI models.

From Morphological Analysis to AI: *Future Prospects in Central European Historic Buildings' Typology*



Filip Suchoń | *Cracow University of Technology*
Kinga Racòn-Leja
Ernestyna Szpakowska-Loranc
Krzysztof Barnaś
Krzysztof Klus

Keywords:
Historic building typology, GIS-based analysis, FuturHist, Artificial intelligence, Central European architecture

Cities seek new tools to address urban development complexities as traditional methods of studying urban form evolve. This research aims to develop an integrated approach for analyzing historic building typologies in Central Europe, supporting clean energy transition while preserving cultural heritage. The study combines on-site observation and GIS-based analysis of building typology within Central Europe's historic building stock, drawing from extensive data collection in the FuturHist HORIZON-RIA project ('An integrated typology- based approach to guide the future development of European historic buildings towards a clean energy transition 2024–2027'). The methodology analyzes five key dimensions: general information, morphological urban structure and building configuration, energy performance, social aspects, and cultural values. Historical building types prevalent between the 19th century and mid-20th century were identified and mapped. Distinct typological classifications were established, and distribution patterns for each typology were analyzed in Krakow, Poland, using Geographic Information Systems. The findings demonstrate the potential for integrating artificial intelligence-based classification systems to enhance methodology through automatic identification of similar typologies across Central Europe, enabling more efficient matching of retrofit solutions to specific building types. We establish a methodological base for future urban form studies, contributing to systematic approaches for historic building retrofit strategies. Integrating AI with traditional analytical methods offers promising opportunities for heritage-sensitive building classification across Central Europe.

From Classical to Contemporary Methods in Suburban Morphology Research: *Analyzing the Transition from Conzen's Approach to AI-Enhanced Solutions*

Robert Szmytkie | *University of Wroclaw*
Potr Kryczka
Agnieszka Lisowska-Kierepka

Keywords:
suburban morphology, Conzen's theory, graph theory, GIS, spatial analysis

The study of (sub)urban morphology has undergone a long journey, evolving from classical analytical methods to modern digital tools that revolutionize the way spatial urban structures are analyzed. In the classical approach, such as in Conzen's theory, the main goal was to understand the relationships between different elements of the city. Graph theory, in turn, allowed for modeling and analyzing networks of connections between urban elements, such as roads, buildings, or service areas. With the development of technology, classical methods began to be integrated with modern tools, and GIS became widely used to analyze suburban morphology. GIS allows for the collection, storage, and analysis of spatial data, enabling more precise studies of changing land-use patterns, as well as phenomena such as the spread of urbanized areas. It allows for the identification of spatial trends and the impact of urban planning on the shaping of suburban spaces.

This presentation aims to compare and analyze different approaches in morphological research, tracing the evolution of the discipline from its early manual methods to the development of GIS tools and the transformative potential of AI in morphological analysis. We focus on identifying key contributions from each methodological phase and formulating research recommendations for the future of (sub)urban morphology.

We explored modern artificial intelligence tools, and introduce an additional layer of analysis in the study of suburban morphology. Through advanced text analysis and the generation of responses based on large datasets, AI can assist in information processing, hypothesis creation, and automation of analyses. However, modern methods come with certain limitations, such as dependence on the quality of input data and difficulties in interpreting results generated by algorithms. Nonetheless, their advantage lies in the ability to quickly process large amounts of data and uncover new trends that are difficult to detect manually.

The (Re)Discovery of Streetscape Qualities: Historic paradigms, contemporary shortcomings, and future potentials

Susanne Tobisch | *TU Wien*

Keywords:
Streetscape, Public Space, CIM, Inter- and transdisciplinary, 3D Model

The history of street space is characterised by a series of planning paradigms that, based on the prevailing zeitgeist, assigned completely different uses and functions to streets. From approaches that regard streets as spaces that should be orchestrated in order to be visually pleasing, to those that are dominated by the aim of maximising profit by achieving the highest possible yield of developable land, to those that consider streets as traffic axes only, to the most recent ones that once again understand streets as spaces that are supposed to serve the people that use them.

This paper provides a framework for a comprehensive understanding of street spaces by exploring these qualities. On the basis of an examination of a series of streets built at different times, the question is explored as to how different planning paradigms have influenced street design and how this is reflected in the actually spatial qualities observed today. Furthermore, a tool is being developed that enables a holistic understanding of street space. The SSSEIC-Tool consists of two different models: a concept model and a 3D model. The concept model aims to comprehensively capture the various parameters that define the quality of the streetscape. To create this framework, interviews and a cooperative workshop were conducted with experts from practice, research and administration. The resulting concept presents a novel, holistic and systemic approach to documenting and analysing street space qualities, highlighting their interrelations and correlations.

Building on this theoretical foundation, a 3D model was developed to visualise the relevant qualities and parameters in streetscapes. As a city information model (CIM), the model is also meant to highlight the influence and correlations of factors and thereby offer a viable planning framework for future inter- and transdisciplinary cooperation.

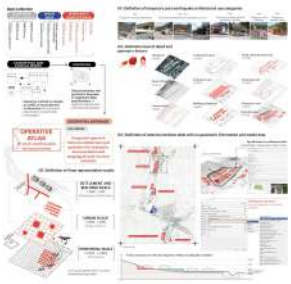
Mapping the functional evolution of Ulaanbaatar's historical Gandan neighbourhood through analysis of street-level views with AI tools

Munkh-Erdene Togtokhbayar | *Mongolian University of Science and Technology*
Amgalan Sukhbaatar

Keywords:
Organic urban form, street-level views, function, Ulaanbaatar, AI tools

The rapid advancement of technology has facilitated the documentation of spatial activities and their morphological characteristics in organically self-organizing urban spaces that are not officially recorded, thereby creating new approaches for understanding spatial dynamics. The morphological structure of the Gandan neighbourhood, the focus of this research, originated as a monastic quarter surrounding Gandantegchinlen Monastery, established in the mid-19th century in Ikh Khuree (present-day Ulaanbaatar). This quarter initially consisted of yurts, wooden houses, fences, and streets, forming the organic and traditional spatial form of Mongolian pastoral nomads, known as the Khuree form. Following Khuree form, the Gandan neighbourhood evolved into a Buddhist religious centre by the early 20th century, inhabited exclusively by monks. Despite socialist urban development policies between the 1940s and 1990s, the neighbourhood retained its original urban form and transformed into laypeople's residential area. Following Mongolia's transition to a free-market economy in the 1990s and the launch of an urban redevelopment project by the municipality in 2015, new commercial buildings and activities emerged along Gandan neighbourhood's main streets, transforming its historical morphology. These morphological changes are particularly evident along key streets: the vertical street leading to Gandantegchinlen Monastery, the horizontal street connecting the monastery to the city's eastern and western parts, and the circular street surrounding the neighbourhood. The emergence of new religious centres, auto repair shops, and commercial establishments exemplifies this ongoing transformation. However, the organic reconfiguration of these key streets, shaped by economic and infrastructural changes, remains largely undocumented. This research employs AI tools to map and analyse street-level images and video recordings from the main streets of the Gandan neighbourhood, systematically documenting emerging architectural typologies and functions in the QGIS program. The findings will contribute to a deeper understanding of how the historical Gandan neighbourhood evolves beyond official planning frameworks, driven by economic and local demands.

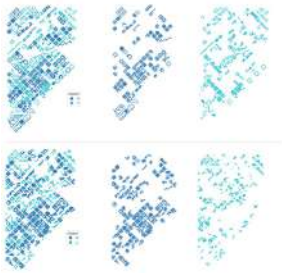
Post-disaster documentation and geo-mapping the form of temporary settlements in emergency contexts



Ilaria Tonti | *Politecnico di Torino*

Keywords:
geomapping and cartography, GIS-based tools, post-disaster documentation, temporary housing

The increasing complexity of post-disaster scenarios and the growing relevance of risk and disaster communication highlight the need for improved geoinformation tools to document and map emergency responses. This research critically examines current disaster mapping methodologies, exposing the limits of existing cartographic and GeoAI tools in documenting the form of temporary settlements, mainly their impact on land consumption. Despite advancements in digital cartography, emergency data and knowledge platforms remain fragmented, failing to provide a holistic view of the phenomenon. By integrating architectural studies with geomatic tools, the research defines the morphological and topographical elements necessary to map urban form transformation due to the post-emergency phase. It presents the methodological framework of the Operative Atlas of Post-Earthquake Temporariness, the outcome of the author's doctoral thesis. Adopting a systematic and evidence-based approach, the research employs a multiscale and interoperable data infrastructure, harmonizing heterogeneous datasets -including standardized cartography, satellite imagery, aerial data - within GIS-based tools. This framework establishes a common cartographic language to codify and map the morfo-topographic configuration shaped by temporary architectures. This integrated approach emphasizes the conceptual dichotomy between cartography and mapping, bridging the knowledge gap in documenting post-emergency conditions. The proposed methodology has been tested in the Central Apennines in Italy, an area affected by recurring seismic events, where these temporary settlements introduce irreversible land transformations, reshaping urban landscapes for decades. In conclusion, aware of the potential application of GeoAI technologies, especially for large-scale emergency mapping using high-resolution orthophoto data, the contribution aims to highlight how the consolidation of the morphological feature coding is still needed. Aligned with international disaster risk management initiatives, the research integrates architectural design, geospatial analysis, and emergency planning, laying the conceptual base for a digital and scalable geospatial documentation model, enhancing the emergency responses visualization, and supporting decision-making for policymakers, researchers, designers, and local communities.



AI Powered Urban Morphology through Deep Learning and Earth Observation for Scalable Urban Form Analysis

Didem Turk Grigoletto | *Transitional Morphologies Research Centre*

Keywords:
Urban morphology, artificial intelligence, deep learning, remote sensing, morphometrics, Earth Observation

The increasing availability of geographic data and advancements in computational techniques have transformed urban morphology, fostering more quantitative, data- driven approaches. However, traditional methods often struggle with scalability and precision, limiting comprehensive analysis and timely decisions. The integration of Artificial Intelligence (AI) and Earth Observation technologies addresses these challenges by enabling large-scale, high-resolution spatial analysis. In this context, this study develops and validates a workflow that leverages machine learning models, to interpret complex textural patterns of urban blocks from satellite imagery. The approach automates the detection, classification, and measurement of urban form, improving the accuracy and depth of morphological insights across diverse urban block typologies. The methodology encompasses data acquisition, semi-automated annotation supported by OpenStreetMap, supervised learning, and finally morphometric analysis on extracted urban form to reveal scalable patterns in urban structures. Unlike prior studies focusing on single-scale analyses or manual techniques, this workflow integrates multi-scale perspectives, macro, meso, and micro, offering a comprehensive understanding of urban patterns, from organic cores to peripheral developments. Preliminary findings suggest that AI has the potential to efficiently classify urban blocks and reveal key morphological attributes such as size, shape, and spatial configuration, though the extent of its applicability across diverse urban contexts remains to be fully explored. While the model demonstrates strong potential, interpreting morphological complexities in heterogeneous environments such as organic and highly dense patterns remain a challenge, indicating opportunities for refinement and broader application. This study will deliver a replicable framework for incorporating AI into urban morphology, tested across different urban block types and scales, and demonstrating its ability to classify and map diverse morphological patterns. It will highlight both the capabilities and limitations of AI-driven morphological analysis, contributing valuable tools for urban research and planning.

Old Buildings, New Opportunities: Exploring the Relationship between Building Age Diversity and Retail Patterns across Amsterdam, Rotterdam and The Hague

Onur Tümtürk | *Bilkent University*
Hulusi Eren Efeoğlu
Mert Akay
Olgu Çalışkan

Keywords:
building age diversity, morphometrics, retail intensity, retail diversity, k-means clustering

The relationship between urban form and retail patterns, measured through the intensity and diversity of retail activities, has been a central focus in urban form studies. While three of Jane Jacobs' conditions for urban diversity – mixed uses, small blocks, and density – have attracted substantial empirical investigation, her fourth condition of buildings that vary in age fundamentally differs and remains less examined. Unlike other design-guided conditions, building age diversity cannot be created instantly; instead, it emerges as a dynamic process that reveals how cities and their retail patterns incrementally evolve.

We propose building age diversity as a fingerprint of incremental development, revealing how urban form and retail patterns co-evolve through successive adaptations. By analysing comprehensive building age and retail data within accessible reach, we examine how patterns of building age relate to retail intensity and diversity. The Netherlands offers an ideal context, combining historic fabric with modern development patterns and supported by comprehensive building-scale data. Analysing approximately 700,000 buildings across Amsterdam, Rotterdam, and The Hague, we employ k-means clustering to explore how bivariate analysis of mean building age and age diversity reveals distinct temporal development patterns, such as old and heterogeneous areas evolved incrementally, old but homogeneous historic districts, new areas with mixed ages showing recent layered development, and new homogeneous areas developed instantly. We hypothesize that areas characterized by gradual development, particularly those with higher age diversity and mean age, will better support intense and diverse retail activities.

This study advances urban research by revealing how building age patterns shape retail opportunities, echoing Jacobs' insight that 'new ideas must use old buildings'. It introduces a practical method for identifying and differentiating the temporal character of urban form patterns. Moreover, it opens a critical discussion on urban diversity, exploring how diverse age configurations prioritizing older buildings might uniquely shape retail patterns.

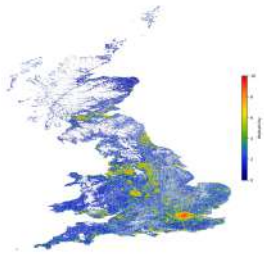
A method for identifying harmonious streetscapes of a pedestrian's perspective

Hiroyuki Usui | *Chiba Institute of Technology*

Keywords:
streetscape, skeleton, neighbourhood relation, pedestrian, perspective

A moderate physical complexity of streetscape depending on the arrangement of buildings along streets is a necessary condition for authentic streetscape by feeling harmony with variety, a recurring discussion theme in urban studies. Conventionally, evaluation of the arrangement of buildings along a street in 3D urban space, called streetscape skeletons, has been based on the arrangement of buildings on the 2D plane. However, a set of buildings composing a 3D streetscape skeleton from a pedestrian's perspective is not necessarily adjacent to one another on the 2D map. Hence, conventional methods for evaluating the variability in 3D streetscape based on the 2D map may fail to reflect the real 3D streetscape of pedestrian perspective. To fill this research gap, each 3D streetscape at a location on a street centreline is regarded as its projection on the virtual screen vertical to the ground and street centreline. When buildings composing the 3D streetscape are projected on the virtual screen, they are regarded as being adjacent to one another on the screen, called the neighbourhood relations in terms of 3D streetscape composition. In the literature, the neighbourhood relations in terms of 3D streetscape composition have yet to be quantified and visualised. The objective of this paper is therefore (1) to develop a method for visualising the neighbourhood relations in terms of 3D streetscape composition on the 2D map; and (2) to identify harmonious streetscapes of a pedestrian's perspective based on what a pedestrian sees and its spatial association. To this end, a new type of local indicator of spatial association (LISA) based on the new neighbourhood relations is developed. The findings of this paper can contribute to help urban planners identify where buildings forming harmonious/inharmonious 3D streetscape skeletons are spatially clustered based on what pedestrians see on a street via the 2D map.

Developing an Urban Form-led Walkability Index: *Integrating Morphological, Functional, and Environmental Metrics*



Alessandro Venerandi | *University of Strathclyde*
Hal Mellen | Ombretta Romice | Sergio Porta | Barbara Piga | Marco Boffi | Gabriele Stancato | Nicola Rainisio

Keywords:
Walkability, Urban Morphometrics, Functional Accessibility, Environmental Preference, Streetscape Analysis

Walking is the most fundamental and sustainable mode of transport. It is widely associated with health benefits, such as reducing cardiovascular risks, managing weight, and improving mental well-being. In urban design and planning, walkable environments are often linked to human-scale spaces and concentrations of social and economic activities. Consequently, measuring walkability is essential for fostering sustainable cities, healthier and prosperous communities. Existing walkability indices primarily focus on functional accessibility to everyday destinations (e.g., the 15-minute city or 20-minute neighbourhood), overlooking the morphological structure of streets and people's preferences for particular places which in turn play a significant role in shaping how pedestrians navigate the urban environment. To address this gap, we propose the Urban Form-led Walkability Index (UFWI). This index combines functional accessibility metrics with a detailed morphological analysis of streetscapes, weighted based on the findings of an environmental preference survey conducted across three UK cities.

The UFWI is a composite of two sub-indices: urban form, incorporating 19 metrics (e.g., street canyon height-to-width ratio, street level greenery, building to building alignment) and functional accessibility, with 14 metrics assessing access to everyday destinations (e.g., primary schools, GP surgeries, green spaces). We tested UFWI in Winchester (UK), a medium-sized city in Hampshire County. The highest walkability scores were observed in the historic city centre, particularly near the western section of the High Street, as well as in the historic suburbs of Hyde and Fulflood. Lower scores were identified in mostly residential and industrial areas, including Teg Down, Harestock, and Winnall. Using open data, UFWI is scalable across Great Britain, offering a practical tool for evaluating walkability. Urban designers and planners can use it to identify features that enhance walkability locally, while administrators can pinpoint streets requiring targeted interventions to improve walkability and support sustainable urban development.

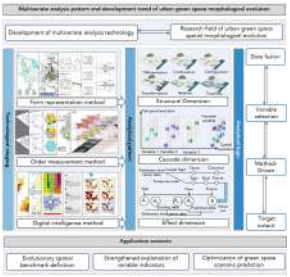
Evaluating morphological methods for climate-based classification of urban heat

Caroline Walder | *Delft University of Technology*
Daniela Maiullari

Keywords:
urban heat exposure, morphological classification, urban climate analysis, thermal variability, climate adaptation strategies

Understanding urban heat exposure is essential for addressing public health risks, energy consumption, and environmental sustainability in cities. Morphological methods for climate-based classification have widely been used in urban climate research, providing structured approaches to describe and assess thermal behaviours. However, existing classification methods struggle to capture the spatiotemporal dynamics of urban heat exposure, limiting the understanding of intra- urban thermal variability. This study systematically reviews climate-based classifications that rely on morphological parameters to analyse urban heat patterns. Through a comprehensive literature review, the research identifies and categorises widely used classification approaches, including frameworks based on predefined urban types, statistical clustering techniques, and computational modelling methods. The study describes how these morphological methods define and represent heat exposure, and provides an overview of their characteristics such as data requirements, spatial resolution, and their ability to capture and represent temporal variability. Additionally, it critically reviews key factors influencing classification accuracy, including data availability, methodological assumptions, and computational processes. Preliminary findings indicate that while classification methods offer valuable insights, the selection of variables and spatial units of aggregation lead to inconsistencies in capturing urban fabric heterogeneity. Finally, the study identifies challenges in representing urban heat exposure and discusses potential advancements through hybrid modelling approaches, and refined classification techniques. By comparing the strengths and limitations of existing methods, this research contributes to the field of urban climate morphology, offering a structured evaluation of urban form classification approaches for heat exposure analysis. The findings provide valuable insights to enhance the representation of urban heat dynamics, and inform the development of context-specific climate adaptation strategies.

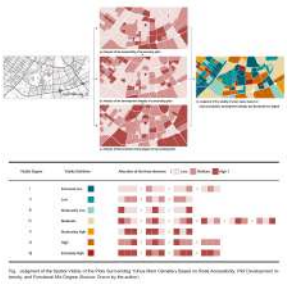
Research on the Multivariable Analysis Pattern and Development Trend of Urban Green Space Morphological Evolution



Liya Wang | *Southeast University*
Zhe Li
Haini Chen
Haonan Ding

Keywords:
urban green space, morphological evolution, multivariate analysis technology, pattern analysis, research trend

Green space morphology, as one of the dynamic development fields in urban space, has undergone a constant evolution in its ideas and methods. Morphological evolution analysis not only forges a basis for urban green space research but also serves as a method of understanding the development law of urban green space. The multivariable analysis of green space morphological evolution, emphasizing the driving factors and its mechanism, has become a key approach to quantifying the relationship between green morphology and studying the evolution characteristics of green space. However, it is urgent to study relevant technological advances and analysis pattern. From the perspective of landscape architecture, this paper reviewed hot topics and value orientation of research on green space morphological evolution, analyzed the development process of the application of multivariable analysis, tentatively built a multivariable analysis pattern of urban green space morphology evolution, and used the multivariable analysis pattern to explore and envision the technical goals, research, and application scenes of urban green space morphological evolution at the present stage. This research constructed a multivariable analysis matrix successively transforming from formal representation and order measurement methods to digital intelligence, figured out the “structure-cascade - indicator” analysis variable of urban green space morphological evolution and the multivariable analysis logic of “integration, selectivity, malleability and interactivity”, analyzed the opportunities and challenges to the multivariable analysis pattern of green space morphological evolution, and proposed the corresponding three scenes: defining evolution standards, optimizing explanatory variables, and optimizing Landscape scenario simulation. By constructing the technical process framework and multivariable analysis pattern of urban green space morphological evolution, this paper intends to study the analysis mechanism of urban green space morphological evolution while focusing on the application and development of multivariable analysis technology, to provide reference for the theoretical expansion and practical application in this field.



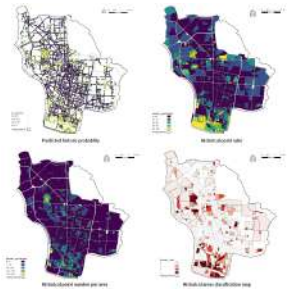
Current Status and Future Prospects of Urban Cemeteries Based on Urban Morphology and Spatial Vitality Measurement: A Case Study in the Main Urban Area of Nanjing

Hongbu Wang | *Southeast University*
Hao Deng

Keywords:
urban cemetery, urban morphology, spatial vitality measure, volunteered geographic information (VGI), NIMBY facilities

Under the dual influences of traditional Chinese perspectives on life and death and four decades of rapid urban expansion, urban cemeteries, as a unique element of urban morphology, have undergone significant transformations. These changes have profoundly impacted residential land planning, urban functional layouts, and the daily activities of residents. Despite their importance, urban cemeteries have not received adequate attention in the fields of urban planning and morphological studies. Building on previous research into the historical evolution of urban cemeteries, this study focuses on three urban cemeteries within the main urban area of Nanjing. Utilizing morphological knowledge, multi-source quantitative analysis and data visualization methods, the study provides empirical evidence that urban cemeteries exhibit internal stability but are characterized by low vitality and high negative externalities in their surrounding areas based on volunteered geographic information (VGI). These findings are corroborated through analyses of housing prices and the morphological characteristics of adjacent residential areas. The research not only offers quantitative support for the qualitative assessment of urban cemeteries as Not-In-My- Backyard (NIMBY) facilities in Chinese cities but also underscores the necessity of integrating cemeteries into comprehensive urban planning, landscape design, and urban renewal processes. This integration should be undertaken with due respect for traditional views on life and death, as it is essential for safeguarding residents' mental health and enhancing their overall well-being. The paper concludes with a forecast on the future of urban cemeteries in China, considering emerging trends in urban renewal.

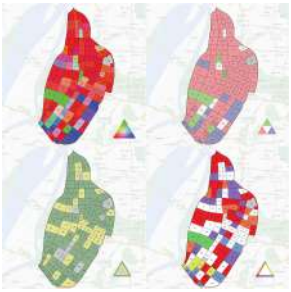
Towards Fine-grained Mapping of Urban Historic Fabric through Semantic Learning on Street View Images



Yujiao Wang | *Southeast University*
Peng Tang

Keywords:
Historic area preservation, deep learning, street view images, semantic embedding, urban morphology mapping

In the continuous evolution of urban form, cities with historical contexts often have a mix of buildings and spaces from different periods. In contrast to the preservation of a single historic building, the preservation of historic area aims to provide a holistic historic experience. However, the definition of historic fabric usually exists in textual descriptions without a clear spatial delineation. Thanks to the development of geographic information systems (GIS) and machine learning technologies, some data-driven urban form studies have utilised city map base data to delineate form maps. This approach ignores the material and component characteristics at the building level, which have a strong impact on historic fabric, thus cannot be fully applied to the study of historic area. This study attempts to achieve fine-grained morphology map for historic fabric through semantic learning of street view images. We first segment the streets in the historic area at a certain spacing and collects images of buildings on both sides of the segments. Then we annotate the images with semantic information, such as function, tradition, and historical period, by combining social media data, existing open-source data, and experts' experience. Furthermore, the feature vectors and semantic embeddings of the images are fused, and semantically similar images are found using comparative learning to achieve image classification. Finally, the classification results are mapped to the sides of the street segments and various type of fabric are delineated accordingly. The study takes the central city of Nanjing, where history and modernity are fused, as an example to develop a refined morphological map for the protection of urban historical area. It also further studies the correspondence with the form of buildings, road network and spatial scale. Our works provide significant support for the establishment of rules to control and guide the spatial changes of urban historic area.



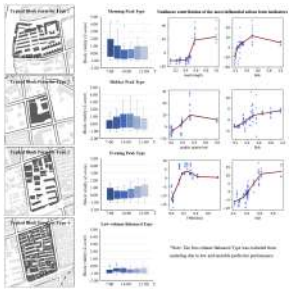
A Typological Analysis on the Functional mix of Superblocks Based on MXI Measurement: The Case of Hexi New City, Nanjing

Zheng Wang | *Southeast University*
Yiwen Huang

Keywords:
Typology, functional mix, measurement, mapping, superblock

Functional mixing is generally considered a key factor in enhancing the vitality of urban spaces and promoting high-quality and sustainable urban development, thus providing a dimension for examining functional layout. The superblock as a walkable neighbourhood in China is the key scale level for investigating functional mixing. Taking Nanjing Hexi New City as the case, this study present and interpret the characteristics of functional composition in the superblocks as well as the functional layout in the new city by measuring the mixed-use index of superblocks and the typological analysis of the measurements. The study firstly analyses the road network and hierarchical composition of blocks in Hexi New City, and divided the area into 109 superblock units for measuring. Then, based on the processing of POI data, the study employed the mixed-use index to measure the functional mix of three functions, namely, residential, work, and visit, within the superblocks. The measurement results are mapped on the GIS platform according to the correspondence between the indexes and colours in the ternary graph. The mapping visually and comprehensively presents the mixing degree and the composition of three functions in the superblocks. To make the measurement and mapping results easier to interpret, the study makes a typological analysis of the measurement results from the perspectives of functional composition and mixing degree, and presented the distribution of the superblocks with different mixing types through mapping. The research results show that the functional mixing characteristics of the superblocks in Hexi New City are significantly related to their locations and construction years. Meanwhile, the typological analysis based on MXI measurement helps in the identification of different functional components within a superblock and contributes to the understanding of the overall functional layout characteristics.

Exploring the Correlation Between Urban Form and Temporal Patterns of Block Vitality



Lexun Wang | *Tongji University*

Keywords:
Block vitality, Urban morphometrics, Urban form, Machine learning, Spatio-temporal analysis

Recent transformations of metropolises have led to the evolution of urban forms towards new typologies. The refined evaluation of the relationship between these urban form types and urban vitality has become crucial for urban renewal decision-making. Previous studies have identified the correlation between block vitality and the urban environment. However, the influence of time-series variations in block vitality on urban form types remains underexplored, which is essential for exploring the potential of urban morphometrics to identify patterns of temporal block vitality and the renewal needs of blocks.

This research aims to investigate the impact of various urban form elements on block vitality by analyzing the association between urban morphological types of blocks and the daily vitality curves. The study focuses on blocks within a 500-meter radius of typical metro stations in Shanghai. It employs time-series clustering methods to analyze the daily vitality curve types of these blocks, aligns them with the morphological characteristics of blocks with different vitality periods, and quantifies the urban form types of blocks using a series of indicators. Furthermore, machine learning is used to analyze the nonlinear relationship between these form indicators and the daily vitality of blocks.

The results show that typical blocks with high vitality during morning and evening peak periods consist of slab-style, high-rise, and widely spaced residential buildings. Additionally, blocks with high vitality during midday peak periods feature a few large, independently distributed mixed-use complexes, whose vitality is positively correlated with sidewalk width but significantly negatively correlated with building density. Blocks with low-balanced vitality, typically low-rise and high-density historical districts, show a positive correlation between vitality and floor area ratio. These insights are crucial for informing targeted urban regeneration strategies, ensuring that urban planning and design interventions are tailored to meet the temporal vitality characteristics and potentials of different urban blocks.

The space schema and representation of ancient Chinese city: iconological analysis of chronicle maps of Huizhou, Anhui

Hong Wu | *Tianjin University, Zhejiang University*

Keywords:
local chronicle maps; space schema; iconological analysis; Chinese ancient city

Huizhou local chronicle maps are precious historical records that reflect ancient Chinese regional group consciousness and their understanding, construction, and representation of urban space. With changing spatial concepts and the destruction of heritage, it is crucial to interpret spatial information in these maps for unban context continuation. The study aims to illustrate the meanings of the icons, explore the spatial schema and urban form characteristics of regional groups as depicted in Huizhou local chronicle maps. The study collects 35 Huizhou local chronicle maps, uses the logical framework of iconology, decodes the meaning and logic of the map icons, deciphers the layout principles of spatial schema, interprets spatial concept and urban form characteristics influenced by regional factors. Several key findings were as follows: 1) In spatial drawing schema, icons are categorized into four types(environment, structure, building and legends) and five levels of spatial expression (city agglomeration, county, prefecture, building group, and landscape). The drawing adopts the relative coordinate system and the variable scale, and selects the position and orientation to connect icons. 2) In city construction schema, city agglomeration correspond to the astronomical phenomena and determine position by mountain and river. City takes city wall as enclosed boundary and public buildings as the core. Buildings are organized by visual cognitive experience. 3) In regional space schema, the form of Huizhou ancient city integrates with the surrounding landscape environment, presents the integration layout of prefectures and county in one territorial and coherent plan. The three schemas emphasize a centripetal and hierarchical spatial logic, demonstrate a systematized understanding of regional and urban form organization, reveal the cultural and practical principles that guided Huizhou ancient city's construction and representation.

Restorative Benefit Evaluation of University Campus Outdoor Public Space Based on Multi-source Data and Deep Learning

Tingjin Wu | *Southeast University*
Deqing Lin
Yi Chen
Jinxiu wu

Keywords:
University campus outdoor public space, Restorative benefits, Multi-source data, Deep learning

Outdoor public spaces on university campuses are a physical spatial medium that creates a connection with students' mental health, and its spatial characters critically influence restorative perceptions. Previous research has mainly evaluated and compared restorative benefits across various spatial types and elements. However, a comprehensive and systematic assessment of the campus remains underexplored. Additionally, the relationship between objective metrics and subjective perceptions has yet to be fully clarified. Traditional methods face challenges in solving the above challenges, and developing deep learning techniques and new urban data brings new research opportunities. This study selected three campuses in Nanjing, China, as cases: the Jiulonghu Campus of Southeast University, the Xianlin Campus of Nanjing University, and the Xianlin Campus of Nanjing Normal University. Spatial perception maps were constructed by integrating Baidu street view image data with deep learning algorithms based on five objective metrics (GVI, SVF, BVI, Enclosure, and Walkability) and four dimensions of subjective perceptions. These integrated data were further utilized to generate predictive maps of restorative benefits. On the one hand, based on the objective data, the image semantic segmentation technique (PSPNet) was employed to extract features and quantitatively analyze the objective metrics. On the other hand, the subjective data was obtained from the respondents' restorative evaluation of the selected sample images with the help of the PRS-11 scale. The correlation and multiple linear regression model analysis identified key metrics affecting restorative perceptions. On this basis, the XGBoost algorithm was used to predict the restorative benefits at the campus scale comprehensively. Integrating subjective and objective data with deep learning algorithms enables the evaluation and quantitative assessment of human-oriented campus environments. This approach provides methodological references and empirical data for campus renewal practices and offers valuable insights for optimizing urban public spaces.

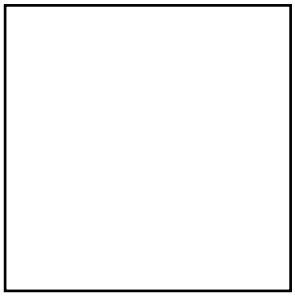
Morphological Similarity Analysis of Villages Based on Deep Learning and Historical Research

Xinyu Wu | *Southeast University*
Yan Zhou
Guya Sun
Siyi Wang
Hong Jiang

Keywords:
village morphology, cluster, deep learning

The study of village morphology provides a “living gene pool” of historical evolution for urban development. Its spatial layout, ecological and community structure reveal the sustainable code of human-land relationship, helping modern cities to activate the deep memory of heritage value during the process of renewal. Taking the Lixiahe area in Jiangsu Province as an example, this research explores a universal typological analysis method, combining quantitative morphological analysis and similarity clustering based on deep learning with historical research, to explain the causes and extract spatial genes for different types of village morphology. In the similarity clustering section, we constructed a dataset of 1659 villages with satellite images and related geographic coordinate information. And satellite images were pre-processed, resulting in two kinds of figure-ground maps: one reflecting the configuration of water and land, the other capturing building distribution. A deep convolutional neural network, GoogLeNet, was implemented with the villages’ figure–ground images, by quantifying the morphological features into high-dimensional feature vectors with 2048 dimensions. We conducted a similarity analysis of villages by calculating the Euclidean distance between the high-dimensional feature vectors. After that, six distinct village forms were identified. By integrating historical maps into GIS analysis, we explored the underlying causes of these forms, selected representative cases for each type, and compared their spatial characteristics and differences. This method overcomes the subjectivity of traditional qualitative clustering, offering a robust reference for rural governance and the historical value reconstruction of cities.

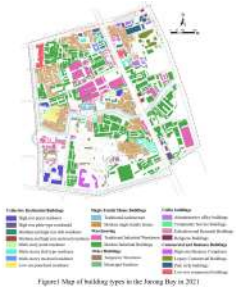
Rule-Based Synthetic Urban Morphology Dataset for Historical and Predictive Modeling of Xiaoxihu, Nanjing



Xiao Xiao | *Politecnico di Torino*

Keywords:
urban morphology, rule-based simulation, synthetic dataset, historical urban form, graph neural networks

Understanding the dynamic evolution of urban morphology requires systematically structured datasets that encapsulate historical transformations while enabling predictive modeling of future urban configurations. This study develops a rule-based synthetic dataset generation framework combined with machine learning applications, demonstrated through the case of Xiaoxihu Historical Block in Nanjing, where four core morphological principles— derived from spatial heuristics and hierarchical form-generation algorithms—structure the synthetic data: 1) courtyard typology variations, 2) cross-scale spatial network emergence, 3) adaptive corner configuration logic, and 4) density gradient patterns. These computational rules formalize socio-spatial dynamics observed in Xiaoxihu's historical development, capturing plot morphology through land parcel constraints, adjacency relationships, and socioeconomic stratification. The generated dataset addresses gaps in conventional records by enhancing temporal continuity, completing spatial patterns, and expanding typological variations, while a dual-data training architecture within a Graph Neural Network (GNN) framework processes both historical maps and synthetic instances to validate predictive capabilities. Preliminary experiments reveal improved spatial coherence and typological recognition through synthetic augmentation, with the rule-based system ensuring scalability and morphological authenticity across contexts. This research advances urban morphology methodology through three contributions: 1) a synthetic data protocol bridging historical preservation and predictive modeling; 2) a hybrid GNN architecture for spatio-temporal analysis; and 3) a transferable framework supporting heritage conservation via morphological decoding and urban planning through scenario forecasting, with future work focusing on multi-scale GNN implementations and cross-contextual validation.



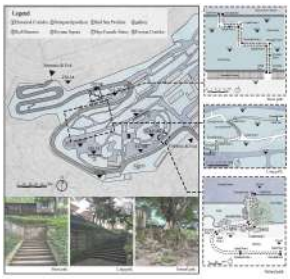
Types,Motivations,and Behavioral Processes of Agents in the Morphological Evolution of Urban Historic Industrial Lots: the Case of Julong Bay Area,Guangzhou

Chai Xuerui | *South China University of Technology*
Tian Yinsheng

Keywords:
Agents, Motivation, Behavior, Morphological region

Urban historical industrial lots, as witnesses to China's urban development across historical stages, hold significant conservation and research value. With accelerating urbanization, the regeneration of urban historical industrial lots has become a critical challenge, necessitating systematic research on the agents in the process of morphological evolution of urban historical industrial lots. Using Julong bay(Guangzhou) area as a case study, this study employs the morphological region theory from Conzenian urban morphology to conduct a morphological analysis of the evolutionary process and typological characteristics in Julong bay area from 1970 to 2021,based on the motivation theory, the interview data and secondary data are analyzed to explore the shaping of the morphological characteristics of the Julong bay area by different types of agents under a series of behavioral activities.This study provides a theoretical basis for pluralistic governance in urban renewal by analyzing the process of urban morphogenesis under the influence of multiple subjects. The findings of this study can be summarized as follows: The morphology of the Julong Bay area exhibits historical stratification characteristics, shaped by agents including national entrepreneurs, villagers, the government, and developers. Driven by objectives and motivations such as production, livelihood, municipal construction, and real estate speculation, agents have built and shaped the physical space of Julong Bay. The self-organized construction by villagers formed an "organically growing" morphological fabric, which contrasts with the "planning-controlled" morphological fabric dominated by developers. The essence of this difference lies in the iterative transformation of morphological structures across different historical stages: the former is influenced by China's collective land system and Lingnan clan culture, the latter reflects the reorganization of urban physical space through the land expropriation system. The diversification of agents has led to the morphological heterogeneity of Julong Bay, manifested as the coexistence of different functional spaces and the blending of traditional and modern

Morphology and Perception: *Research on Staircase Spatial Perception in Mountainous City Parks Based on Real-Scene EEG Monitoring*



Xinyu Yang | *Southeast University*
Cong Gong
Changjuan Hu

Keywords:
Spatial Morphology, Mountain city park, Stairway space, EEG monitoring, Real environment

Stairway spaces are a crucial component of the vertical transportation network and spatial morphology in mountainous city parks. These systems are closely integrated with the undulating terrain, and their constantly changing spatial forms significantly influence participants' behavioral characteristics, thereby affecting their perception. EEG signals have been proven to reflect various involuntary physiological states of the brain and are widely used in studies related to stress recovery effects and emotional perception. Existing research predominantly explores the influence of spatial morphology and landscape elements on participants' perception in plain city pathways and greenways using EEG signals in simulated environments, revealing an initial connection between spatial morphology and perceptual preferences. However, on-site human factor studies in mountainous environments remain relatively underdeveloped. To address this issue, this study focuses on the stairway spaces in Pipashan Park, Chongqing. Real-time EEG data were collected from participants in a real-world environment using wearable wet-electrode EEG devices, and a GLMM model was constructed to investigate perceptual differences among participants across different paths and modes of movement, as well as the impact of visual and auditory environmental factors on their perception. The model analysis results indicate significant differences in EEG data across paths and movement modes. Key mountainous spatial features, such as openness, green view index, and elevation change, were identified as major factors influencing EEG data. Additionally, higher levels of natural sounds and green view index were found to effectively alleviate participants' perceived stress in mountainous stairway spaces. The findings reveal the intrinsic relationships among morphology, behavior, and perception in stairway spaces of mountainous city parks and provide a theoretical foundation for optimizing the spatial morphology of mountainous stairway spaces.

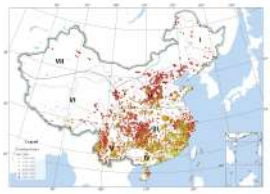
From Iconography to Typology: A Historical Study of the Morphology of Traditional Street buildings and space in Suzhou

Wantian Yang | *Southeast University*

Keywords:
Iconography, Typology, Street space, Suzhou

The fragmentation of historical districts, coupled with the lack of precise historical maps and archives, makes it challenging to interpret the typology and micro-formal history of street buildings in traditional Chinese cities. The classification of traditional street buildings remains vague, hindering a full understanding of the richness of urban space. This article proposes a method that integrates iconographic analysis with typological research, drawing on a series of urban scrolls created during the late imperial period. By analyzing the intentions and expressive techniques behind these images, and combining historical photographs, maps, and textual narratives, the study identifies the types of street buildings based on real prototypes and examines the morphological differences of traditional street layouts from a micro perspective. The study argues that the typology of traditional Chinese street buildings cannot be understood solely through architectural forms and urban plans. Instead, it should be studied within its specific historical and cultural context, through the establishment of a three-dimensional typological framework of "location-form-social space." Shophouses, wineshops, teahouses, and playhouses, as social representations of spaces in various locations, played a significant role in shaping the street morphology. This study provides a new perspective for the in-depth description of traditional street spatial forms.

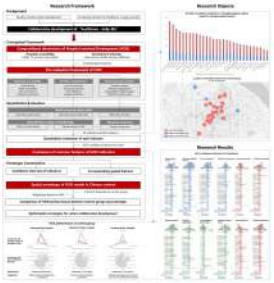
GeoAI for Mapping Climate-Responsive Traditional Courtyard Morphology Across China: A Deep Learning and Remote Sensing Approach



Poyu Yang | *Southeast University*
Jinxiu Duan

Keywords:
GeoAI, Courtyard morphology, Deep learning, Geospatial feature extraction, Climate-responsive design

Understanding how urban morphology responds to climatic factors is crucial for climate- adaptive urban design and the sustainable development of human settlements. Courtyards, a fundamental element of traditional architecture, play a significant role in microclimate regulation and environmental adaptation. However, latitudinal and climatic variations in courtyard morphology remain underexplored. Existing studies primarily rely on local field surveys, lacking comprehensive large-scale datasets spanning diverse climatic regions, which limits the understanding of courtyard morphology's spatial patterns and climatic drivers. To address this gap, this study introduces a method based on Geospatial Artificial Intelligence (GeoAI) for courtyard morphology mapping, integrating deep learning, high-resolution remote sensing, and geospatial analysis. Using a deep learning model (Mask Region-based Convolutional Neural Network), we extracted courtyard boundaries from satellite imagery and computed morphological parameters through automated processing techniques. This study presents the first nationwide dataset of courtyard morphology, covering 6,613 traditional villages in China, and applies it to quantify the latitudinal gradient of courtyard size and its relationship with climatic variables. The analysis reveals significant spatial variations in courtyard morphology that correspond to climatic factors, providing empirical evidence for climate-responsive urban forms. The proposed method resolves the challenges in large-scale automated extraction of courtyard morphology data and provides a scalable analytical framework for AI-driven urban morphometrics. By integrating GeoAI and urban morphology, we establish a systematic mapping and spatial analysis approach that supports future research on urban morphology and climate-adaptive design, and large-scale morphological classification in urban planning. This framework can be applied to other urban forms, advancing data-driven studies on climate-adaptive built environments.



Urban Form as a Driver for Quantitative Measurements of HOD Performance: a Methodological Innovation via Multi-sourced Urban Data

Yu Ye | *Tongji University*
Ziyi Chen
Yizhuo Wang
Hua Zhang
Jingmeng Lei
Haochun Tan

Keywords:
Urban Form, Hospital-oriented Development (HOD), Evaluating Methods, Quantitative Measurements, Multi-sourced Urban Data

Accompanying with the Chinese urbanization from 'quantity-oriented expansion' towards 'human-centered development', the collaborative development of healthcare and daily life has become a critical focus within the emerging of an aging society. Nevertheless, the conceptual framework, evaluating methods and spatial prototypes of 'healthcare - daily-life' development were rarely discussed. As a response, this study proposed Hospital-oriented Development (HOD), which referred to the hospital accessibility within a 15-minute travel radius and the intensity of urban development surrounding hospitals to meet various needs during healthcare, while integrating urban morphology for its indicator translation, quantitative expression, and prototype construction. First, using morphological features as a driver, HOD's conceptual framework was developed, consisting of three main dimensions, i.e., network accessibility, facility completeness and environmental comfort, containing twelve detailed indicators. Then the detailed values of these indicators were quantitatively measured among 20 excellent cases of hospitals in Shanghai which were selected by user-generated content. Finally, correlating HOD performance with corresponding urban forms, a HOD prototype was constructed. This study measured the urban form characteristics under HOD framework, including the confidence intervals of each indicator and recommended spatial features. Additionally, a spatial prototype of HOD model in Chinese context was developed. In short, this study provides operational guidance for hospital-adjacent spaces' planning and contributes to the revitalization of existing urban areas by enhancing the healthcare environment from a human-centered perspective.

Geographical Urban Morphology in Understanding Children's Walking School Travel Behaviour

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Keywords:
Geographical urban morphology, Urban morphometrics, Urban form, Children's walking school travel

Geographical urban morphology, rooted in the late 19th century, established a systematic framework for examining urban forms in their inherent complexity. Although widely used to examine the genesis and transformation of urban structures, geographical urban morphology has seen limited application in exploring how urban form influences human behaviour. Instead, contemporary quantitative research typically employs variable-based regression methods grounded in frameworks such as the 3D theory, which quantifies urban form in terms of Density, Diversity, and Design. Yet, these approaches often overlook the deeper structural characteristics that traditional geographical morphology can capture, leaving underlying association mechanisms ambiguous. A major challenge in bridging geographical urban morphology with these fields lies in aligning methodologies with large-scale analyses. Recent advances in urban morphometrics have overcome the scale limitations associated with the traditional manual approach, enabling high-resolution analyses across extensive spatial areas. Drawing on this context, this study addresses the gap by investigating children's walking school travel behaviour in Auckland, using travel data from New Zealand's 2018 Census. It introduces a geographical urban morphological framework structured around three analytical dimensions, (1) form, which examines urban patterns and functional mobility spaces (school routes); (2) temporal dynamics, which captures the evolution of urban form; and (3) resolution, which accounts for multi-scale variations from city to street levels. These dimensions intersect to analyse how the evolution of school routes across different urban patterns correlates with variations in children's active school travel. The findings offer continuous and integrated insights into how urban form shapes mobility spaces and travel options across spatial hierarchies from city to neighbourhood scales, with future research set to explore street-level analyses. This example demonstrates how geographical urban morphology can be applied to study the impact of urban form, providing a systematic and structured framework for related research.

Nicosia Fringe Belt Formation and Transformation: An AI-Driven Approach to Urban Morphology

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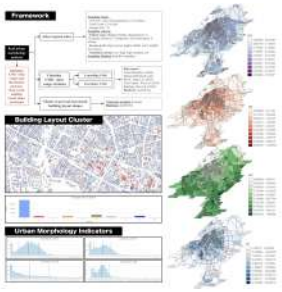
Keywords:
Fringe Belt, Autodesk Forma, Nicosia

By the point of Whitehand view, fringe-belt concept offers a more integrated cultural and environmental perspective of cities, where the various individual elements that make up the urban landscape gain deeper cultural meaning through their relationships with one another, ultimately blending to create historically layered urban environments. Fringe Belts studies, which have been handled with observation-based qualitative studies since the 1960s, have now begun to shed light on urban morphological studies by collecting data with qualitative studies using programs working with different algorithms. Understanding the formation of Fringe Belts is a method used to examine historical growth patterns, land use transitions and environmental urban development in urban morphology. Within this scope, the main aim of the study is to examine how fringe belts are formed with in urban morphological studies using qualitative methods by indicating fringe belts formation and transformation on Nicosia, Cyprus. In this context, the study was used to understand the development of the fringe belt formation with land use and density mapping used as land use classification, plot transformation as a tool to identify the fringe belts character by identifying low to high density development areas or large institutional / industrial developments on the city of Nicosia. In addition, this study seeks to understanding the street network analysis provides a general overview of the street connectivity and layout to identify where the urban fabric transitions from dense core areas to more fragmented, suburban or industrial areas through fringe belt transformation. The findings of the study address to understand the fringe belt formation by using Autodesk Forma's AI-driven predictive models to simulate future urban growth and see how fringe belts might evolve. Also, it suggests identifying the potential for urban development by considering fringe belt character.

Building a Global Urban Block Morphology Database: A Multidimensional Indicator and Machine Learning-Based Classification Approach



Can Zhang | *The University of Hong Kong*
Isabelle Y. S. Chan

Keywords:
Urban block morphology, Database, Machine learning

Urban block morphology (UBM) is becoming increasingly crucial for sustainable urban research, which significantly influences energy efficiency, environmental quality, and citizen well-being. However, existing studies are often limited to specific regions, lacking systematic and global perspectives. Therefore, the research findings are often difficult to generalize to other areas, limiting their universality and comparability. This study aims to develop a UBM indicator system and construct a database, including value ranges and distribution patterns of UBM indicators, as well as typical building layout shapes.

This study first establishes a multidimensional indicator framework for analyzing UBM. The indicators are categorized into controlling indicators and descriptive indicators. Controlling indicators define the fundamental morphological characteristics, while descriptive indicators can be derived from the controlling ones. This study used a stratified random sampling method to select 50 sample cities from a pool of 596 global cities with populations exceeding 1 million. The samples cover various climate zones, economic levels, and population densities. Data sources include global databases (e.g., OpenStreetMap and Google Maps) and local databases (e.g., Hong Kong's CSDI). ArcGIS was used to calculate UBM indicators, defining their value ranges and distribution patterns. Python was employed to standardize building layout images, and convolutional neural networks (CNNs) were used to extract high-dimensional geometric features. Dimensionality reduction techniques (e.g., PCA or t-SNE) were applied to obtain key morphological information. Finally, clustering algorithms (e.g., K-means or DBSCAN) were utilized to identify typical building layout types (e.g., point, courtyard, L-shape, etc.). This database can serve as a reference for the future development of global urban block prototypes and provides a foundation for comparative studies across diverse urban contexts.

Quantifying Pedestrian Accessibility in Urban Networks: A Graph-Based Analysis of Walking Routes from Residential Building Entrances to Metro Stations

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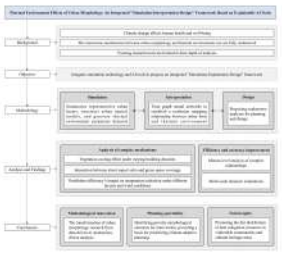
Keywords:
Pedestrian Accessibility, Graph Theory, Metro Station Areas, Walking Routes, Residential entrances

The urban morphological characteristics of residential areas surrounding metro stations - including scale, configuration, density, entrance/exit locations, and pedestrian network density - exhibit intrinsic correlations with pedestrian accessibility between communities and stations. Quantitative methodologies and metrics from urban morphology provide essential tools for precisely characterising this pedestrian accessibility. Conventional quantitative indicators include land-use density, functional mix, street network density, and street network integration within station catchment areas. In recent years, indicators such as Walk Shed, Pedestrian Route Directness, and high-frequency path lengths have emerged to describe walking accessibility and walking routes. However, given the characteristics of Chinese gated communities, there is a need for further exploration of quantitative methods that precisely describe the walking paths from the entrances of each residential building, through the community entrances, to the metro stations. This paper utilises Graph theory to attempt to describe and quantify the walking paths from the perspectives of topological structure, functional attributes, and enclosure constraints. Methodologically, we first select six diverse station areas in central Nanjing, simulating the shortest pedestrian routes through GIS-based network analysis. Subsequently, we implement a heterogeneous graph model enabling multi-layered representations where nodes and edges encapsulate diverse physical entities and relational attributes. Finally, the quantitative description of path morphology aims to establish and identify indicators that can reveal the morphological structural differences of urban residential areas and paths across six slices. Key findings demonstrate that graph-based metrics - particularly path depth values and node connectivity indices -effectively complement existing pedestrian accessibility measures. These indicators effectively represent the hierarchical paths from the station, via the community entrances, to the individual buildings. The research findings provide assessment methods and measurement criteria for optimizing urban walking space in transit-oriented developments, laying the foundation for studying the correlation between residential morphological characteristics and station accessibility.

Thermal Environment Effects of Urban Morphology: An Integrated "Simulation-Interpretation-Design" Framework Based on Explainable AI Tools



Zhao Zhou | *Southeast University*
Jiawei Leng

Keywords:
Urban Morphology, Explainable AI, Thermal Environment Simulation, Urban Heat Environment, Climate-Adaptative Planning

The escalating climate crisis has led to frequent extreme heat events, posing severe threats to public health, urban resilience, and the achievement of United Nations Sustainable Development Goals. Urban morphology—such as building density, street canyon ratios, and vegetation coverage—interact to influence microclimates, yet their underlying mechanisms remain inadequately understood. Existing studies using tools like ENVI-met rely on discrete data points and static imagery, limiting the exploration of spatial interactions between urban forms and environmental factors. This study proposes an integrated ""simulation-explanation-design"" framework combining numerical simulations with explainable artificial intelligence. Using graph neural networks to model the complexity of urban spaces, the framework learns nonlinear couplings among microclimate factors through message-passing mechanisms. Explainable AI tools provide mechanistic insights into the roles of morphological elements, advancing research from descriptive to explanatory and supporting climate-adaptive planning.
We parametrized urban models and generated thermal data through simulations, training deep neural networks to establish nonlinear relationships between urban forms and thermal environments. This approach extends existing findings while offering interpretable insights for urban design. The analysis based on this framework confirms existing research and further explores the variations in the cooling effects of vegetation under different building densities, the complex interactions between street aspect ratio and vegetation cover, and the contribution of ventilation efficiency to temperature reduction under different street layouts and wind conditions. Additionally, the AI tool performs complex relationship analysis within minutes, significantly improving efficiency compared to traditional manual analysis, and supports dynamic simulations from the block to city scale.
The framework highlights the potential of explainable AI in decoding urban form-thermal environment relationships, offering innovations for urban morphology research. It identifies priority interventions, such as preserving green corridors and limiting impervious surfaces, while promoting equitable heat mitigation in vulnerable communities and heritage areas.

Decoding Historical Urban Fabric through Building Typology: A Morphometric Analysis of Architectural Patterns in Three Chinese Historic Districts

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Lian Tang

Keywords:
Building Typology, Historical Urban Fabric, Morphometric Analysis, Plot Patterns

Urban morphology provides a systematic approach to describing and interpreting the morphological characteristics and evolution of urban fabrics, particularly historical fabrics. Explorations in quantitative methods based on morphological theories have focused on multiple scales such as dimension, shape, and connectivity. However, existing quantitative approaches have yet to establish refined descriptive methods for specific historical fabric features. This study proposes a quantification framework using architectural typology as a benchmark, grounded in the characteristics of Chinese architecture, to analyze similarities and differences in historical fabrics across varied terrains, cultures, and climatic zones. The unique typology of traditional Chinese architecture—determined by construction principles like scale, material systems, bay (jian) configurations, and hierarchical building typologies— validates the potential of architectural typology as a measurable standard. The methodology involves: 1) Selecting 20ha historical fabric samples in Nanjing, Datong, and Chengdu. Converting historical maps into vector formats suitable for statistical analysis; 2) Identifying traditional courtyard residential units through typological classification; 3) Conducting statistical analysis across four scales (block, plot, courtyard unit, yard-building) focusing on width, depth, and Jin count. Correlation analysis examines relationships between courtyard Jin counts and block dimensions. The study establishes metrics such as jin counts, depth values, and building frequency, deriving threshold ranges across scales in all three cities. Key findings include: 1) architectural typology serves as an effective benchmark, with bay (jian) and depth acting as measurable parameters, courtyard depth values correlate with jin counts; 2) threshold values in courtyard area and width-to-depth ratios reflect terrain and climatic variations among the cities; 3) plot patterns show limited influence on fabric characteristics.This typological quantification framework advances morphological analysis of historical urban fabrics through culturally-grounded parametric interpretation.

Research on intelligent optimization strategies of urban rail transit spatial morphology based on B-S Model (Betweenness - Solar Performance Model)

Yuan Zhu | *Southeast University*
Yufei Liu

Keywords:
Urban morphology, rail transit space, B-S Model, intelligent optimization

With the development of high density, the urban morphology of urban rail transit area on the one hand meets the demands of high-intensity development, on the other hand, makes people fully feel the comfortable experience of public space based on the public transit in the slow-traffic space system. Therefore, the fine optimization of the public space in the rail transit area has become an unavoidable issue in the development of the rail station, thus to explore the interactive mechanism between the urban morphology and the comfort experience of public space.

This paper takes the correlation between solar performance and spatial form as the research object, to explores the interactive mechanism between each other, and finds the response of public space morphology based on the solar demand of public space of urban rail transit area in different seasons and the optimization of architectural form simultaneously. Therefore, the B-S model is constructed as a platform for interactive evaluation. B represents the degree of Betweenness in terms of population density with the influence of different factors indicating that the public space with high-density population activities is the area requiring high solar comfort. S represents solar performance in terms of the comfort and efficiency of sunshine in public space. Therefore, according to the solar performance of the public space, we can judge the typical renewal strategy of the building form. The corresponding change of population brought by the change of building volume not only causes the change of Betweenness, but also affects the evaluation result of the overall urban morphology.

Therefore, it appears that based on the interactive evaluation B-S model, urban morphology in rail transit area will be optimized in an intelligent updating way with the analysis of solar performance.

Impact of regulations on the shaping of urban landscape

Tolga Ünlü | *Çukurova University*
Tülin Selvi Ünlü

Keywords:
Practice, regulations, standards, Turkey

Many actors contribute to shaping urban form through their diverse interests, motivations, expectations, and value judgments. Among them, professionals like planners and architects play a significant role. However, their approach often relies on rote procedures and established standards, leading to a lack of understanding of how urban forms are shaped in historical and cultural contexts. They repeat their actions without or with little attention to the essential nature of urban space. This lack of awareness results in the emergence of 'insensitive planning,' where professionals prioritize quantitative measures over the quality of the built environment.

This study examines the impact of changing attitudes in planning, influenced by evolving laws and bylaws, on the shaping of urban form. It focuses on Turkish cities, particularly Adana, over three development periods: the 1930s to the present day. The residential environments in newly developing areas are examined to reveal the changing planning attitudes in each period. Older town plans and aerial imageries as well as digital maps of the present day are used for examination of the change in the urban landscape. While transformations in older areas are also acknowledged, the focus is on the plot-level changes, where older forms are replaced with newer ones, governed by standards.

The findings reveal that these plot-level transformations, driven by the pursuit of standards, disrupt the consistent relationships between morphological elements, leading to a breakdown in their hierarchical nesting. The regulations, implemented by professionals, intentionally or unintentionally support real estate mechanisms that prioritize constructing as many buildings as possible for profit maximization. The use of mathematical model to question the use of standards revealed that the plot is exploited to its boundaries so as to use the space as maximum as it could be, which resulted in the 'abuse of regulations'.

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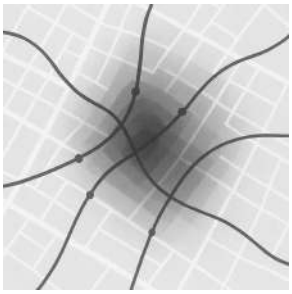
003

ENVISIONING THE CITY: Enhancing Theoretical Models of Urban Forms

Urban Morphology of Food and Beverage and the Impact on Urban Vitality



Nihansu Banu Albayrak Evren | *Yıldız Technical University*
Ömür Barku

Keywords:
Urban Form, Urban Morphology, Food and Beverage, Urban Vitality, Mobility

In contemporary cities, urban morphology plays a critical role in shaping the distribution and accessibility of food and beverage stores, which in turn influence urban vitality. While previous studies have examined pedestrian movement and commercial clustering separately, limited research has explored the specific interplay between urban form and the spatial distribution of food and beverage stores. This study seeks to address this gap by analyzing how the spatial configuration of cities affects the location and impact of these establishments, focusing on their role in fostering pedestrian movement and social interaction. Through an analysis of the city center of Kırklareli, Türkiye, the study examines how urban form conditions food and beverage retail activity, emphasizing the concepts of natural movement force (NMF) and directed movement force (DMF). The study employs Space Syntax Theory to analyze street connectivity and integration values, assessing their correlation with pedestrian density at different times of the day. The findings indicate that areas with high street integration tend to attract more food and beverage stores, which in turn increase pedestrian flow. During weekday lunch hours, pedestrian density was observed to be six times higher on third-degree integrated streets and twice as high on fourth-degree streets. In the evening, this difference was 1.5 times, and on weekend nights, it reached up to two times. Findings highlight the mutual reinforcement between urban morphology and economic activity, since the street pattern determines retail clustering and pedestrian behavior. Food and beverage spaces are not merely commercial entities but integral components of urban morphology that influence urban vitality. Their strategic placement within well-integrated street networks enhances pedestrian engagement and social interaction, contributing to a more dynamic and sustainable urban environment. This study provides empirical insights into how urban morphology can guide the strategic placement of food and beverage retail to enhance urban vitality.

Human dimension of urban form: *creativity and social innovation in community self-organization*

André Araújo Almeida | *Mackenzie Presbyterian University / Leibniz Universität Hannover / University of Fortaleza*
Angelica Tanus Benatti Alvim
Jörg Schröde

Keywords:
local community, self-building, civic protagonism, social innovation, local development

Urban form reflects historic complexity of societies. During the last century, the extreme importance given to politic-economic development brought several limits to innovation in urbanism. Conventional development models resulted in deep lack of community attachment, which increases social inequalities and conflicts of interests. This perspective requires from designers and planners more realist approaches. These issues are particularly important in Latin America, marked by neighbourhoods' morphologies characterised by sell-built landscapes, lack of public investments and opportunities, and strong oblivion processes. Stigmas over such territories are usually based on organic form's prejudice, associated to marginalisation and residents' inabilities to community design and planning. This vision ignores local lore over territorial features, which are responsible for contextualized creativity and social potentialities for innovation. Therefore, the purpose of this paper is to discuss positivity of increasing local communities' right to decision, as they are social manifestations of urban dynamics that frequently show common and creative responses to urban challenges. In this panorama, this study aims to bring theoretical approaches and referential experiences that deal with social protagonism and innovation in urbanism. The main specific objectives are: 1) to bring theoretical models that connect local territory concepts with social protagonism and innovation; 2) to portray some Latin American experiences of social participation and self-organization in local communities; and 3) to discuss strengths and weaknesses of civic engagement approaches as well as means to materialise community innovation through local empowerment. For this, the research brings a short bibliographic investigation and urban experiences analysis to examine different forms of community organisation and materialisation of social innovation in their own local territories. The main important findings of this research demonstrate the importance of active citizenship, its impasses and challenges to contribute to local development as well to overlap negative stigma over organic form in Latin America.

Territorial Archetypes

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Keywords:
Urban Morphology, building typology, Architectural composition

"Epic poetry and Tragedy, Comedy also and Dithyrambic poetry, and the music of the flute and of the lyre in most of their forms, are all in their general conception modes of imitation". Aristotles, Poetics, I, i.

The use of models in architectural composition, not to be confused with the copy, derives from an ancient school of thought feeding the best tradition of modern architecture. In the first book of Poetics, Aristotles, referring to literary genres, concludes that the different written forms are in fact diverse imitation modes. Tragedy imitates sad human activities, comedy imitates happy-ending events: literary genres depend on the human stories therein imitated, and therefore on the models. From the different imitation modes, arise the different literary genres. Extending the same notion to the arts, we can consider also architecture as an imitation mode. Architects have always referred to older architectures, using them as models. Nevertheless, which were the archetypes, or the first models? The first architect could not refer to architectures that did not exist yet, so he found his models in nature. Architecture's archetypes could only be the natural configurations of the primitive landscape, or the territorial archetypes. The paper will illustrate such notion exemplifying the morphological relationships of meaning and form between some building types and the natural territorial morphologies, using some notions of the Muratorian school of urban morphology blended with the theoretical assumptions of the "Gruppo Architettura" (Aymonino, Dardi and Panella, 1973). In fact, Artificial Intelligence operates in a similar way as architects have always done, finding models in a predefined database and deforming them according to a given algorithm, but is it capable of identifying the archetypes?

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ATLAS - A Digital Archive for the Future of Urban Morphology

Giancarlo Cataldi | *Università degli Studi di Firenze*
Gian Mario Aspesi
Giulia Cataldi
Massimo Gasperini
Patrizia Tamburini

Keywords:
atlas, archive, urban theories, machine learning

ATLAS: Atlas of the Formation Processes of The Italian Territory is the result of applied research in Territorial Sciences, aiming to reconstruct the various phases of transformation of the Italian territory from its origins. The different territorial contexts and their respective urban centers highlight the reciprocal and indissoluble relationship between settlements, fabrics, routes, and territorial boundaries: the Alpine Valleys with Macugnaga, the Po Valley with Padua, Emilia- Romagna with Faenza, the Arno Valley with Florence and Pisa, and Upper Lazio with Rome. The volume illustrates the fundamental elements of the research method used, starting from Saverio Muratori's definition of territory: territorial components (settlements, routes, fabrics, and boundaries) and territorial theories (ridge theory for the pre-Roman phase, square-form theory for the Roman phase, and the theory of medieval building transformations for the medieval phase). The transformation of ATLAS into a digital archive represents a crucial evolution to make this research accessible and usable by artificial intelligence systems, facilitating the analysis and modeling of Urban Morphology. By digitising and structuring its data, it will be possible to integrate maps, texts, and territorial models into a system capable of recognising patterns and making predictions based on historical, morphological, and geographical data. The use of advanced GIS, machine learning, and NLP (Natural Language Processing) will enable more efficient and dynamic data management, accelerating cartographic processing.
We believe that AI should remain a tool to support research rather than replace critical thinking. The interpretation of urban morphology requires a deductive and multidisciplinary approach, which only human intelligence can ensure. AI will provide increasingly advanced tools for territorial analysis, but the process of understanding the territory must continue to be guided by human experience and analytical skills, making ATLAS's intellectual heritage an innovative support for research on the formation of the Italian territory.

Urban vs. Rural climates and their impacts on the urban building design energy assessment

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Ali Jahani Rahaei

Keywords:
Urban Heat Island, Building Energy Simulation, Urban Weather Generator, Urban Climate Modeling, Weather Data Morphing

Designing the built environment at different scales generally requires integrating devoted analyses to verify and optimise design choices' behaviours and performances. Based on the energy and comfort point of view, simulation tools, such as Energy Plus, typically combine design inputs with the local climatic conditions. Nevertheless, in building simulations, using standard typical weather files derived from airport data, such as almost all the available data, is a common approach, often neglecting the distinctions between urban and rural environments. This practice can lead to inaccurate simulations, impacting design decisions and policy recommendations. While phenomena like the urban heat island (UHI) and urban dry island (UDI) are widely recognised, many simulations still rely on rural weather data for all buildings within a city and its suburbs. This study addresses this issue by exploring the use of tools that adjust weather data to reflect urban conditions. Specifically, the Urban Weather Generator (UWG) is employed to assess the sensitivity of weather data based on varying urban morphologies within the city of Torino. The study focuses on the mapping and transformation of the case study to incorporate urban climate data, providing a more accurate representation for designers and professionals. To ensure consistency, typical key performance indicators (KPIs) are applied for different scales, generally require integrating devoted analyses of urban morphologies, including the use of energy certification tools, such as Termolog, and a comparison is made between simulations using morphed urban weather files, original rural weather files, and the local official ones released within the energy and building correlated standards (e.g. UNI 10349). This approach aims to refine building simulations, offering more reliable urban design and planning insights.

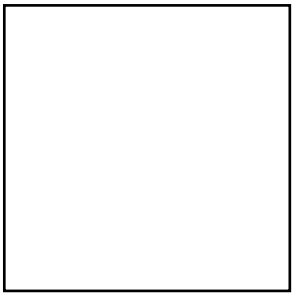
Envisioning Residual Spaces: *Integrating Analytical Approaches and Emerging Technologies in Urban Morphology*

Alessandra Di Cerbo
Kayvan Karimi
Sepher Zhand
Marco D'Ambrogio

Keywords:
Urban Morphology, Residual Spaces, Artificial Intelligence, Human Intelligence, Cognitive Urbanism

In the constantly evolving urban landscape, residual spaces, especially areas beneath flyovers, emerge as complex fragments of urban morphology, presenting multifaceted challenges that call for thoughtful investigation and strategic interventions. This research examines the nature of these often-overlooked spaces and presents an analytical framework that combines conventional methods with Space Syntax techniques to better understand their socio-spatial dynamics and potential in urban regeneration. The proposed approach focuses on identifying, analysing, and modelling these spaces to explore informed redesign possibilities aimed at improving their integration and function within the wider urban context. Specifically, the study evaluates spatial, social and perceptual parameters, using key metrics that capture intrinsic qualities, patterns of use, and semantic values, aiding to define a nuanced residuality assessment process for a deeper comprehension of residual areas. While grounded in established analytical practices, the framework also explores the potential of emerging computational tools, including AI technologies, to extend the proposed methodology and enhance innovative design processes. As research highlights, AI-driven methods are recognised for their capacity to assist in large-scale assessments and uncover hidden patterns that may not be immediately apparent, offering valuable insights to inform future data-driven redesign strategies. By leveraging this methodological integration, the study provides a novel approach aimed at optimising spatial performance and integration while considering community needs. In conclusion, residual spaces, such as those under flyovers, often waste valuable urban land and can negatively impact safety perception and the overall quality of life in surrounding areas. Addressing these neglected sites through targeted spatial and socio-economic strategies is crucial for fostering more inclusive and resilient cities. By blending conventional approaches with selective computational insights, this study aims to contribute to more evidence-based, adaptable analytical and redesign processes for transforming neglected urban areas into functional, vibrant, and sustainable components of the city.

From Types to Patterns: *A Hierarchical Approach to Understanding Urban Form*



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Silvia Spolaor

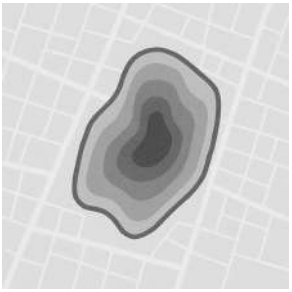
Keywords:
Typologies, GIS, machine learning, classification

Urban form is shaped by the interaction of key components, including street networks, blocks, plots, and buildings. Understanding the patterns emerging from these elements is essential for analyzing the spatial and temporal evolution of cities. Urban morphology studies reveal that cities consolidate cyclical changes over time, creating a mosaic of patterns that encode unique spatial identities.

Advancements in computational techniques are transforming how urban form is studied, enabling more systematic and scalable analysis. Identifying urban patterns through a morphological perspective is crucial for understanding historical development and long-term occupation. This approach also supports typological urban design and connects urban morphology with planning and heritage conservation.

The concept of Morphological Regions, which classifies urban areas based on their internal morphological similarity, has long been a fundamental tool in urban morphology. However, its traditional manual delineation is labor-intensive and difficult to scale. To address this, this research develops an algorithmic classification method that systematically analyzes urban form through a hierarchical framework. Using machine learning, pattern recognition, and statistical analysis, urban form components—streets, blocks, plots, and buildings—are individually classified into types and then combined to identify recurring urban patterns.

The study proposes a standardized method for representing urban form, selecting quantitative morphological measures, and applying GIS-based analytical tools. Empirical studies in Birmingham, Istanbul, Amsterdam, and São Paulo demonstrate the effectiveness of this hierarchical approach in classifying and describing urban patterns. The results provide a quantitative and scalable framework that can integrate with other urban research and planning tools. By applying computational techniques to urban morphology, this research enhances our ability to analyze, design, and plan cities based on their historical development and future potential.



Urban Morphology of Romani Ghettos: A Cross-Border Study

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Nihansu Banu Albayrak Evren

Keywords:
Romani Ghettos, Urban Morphology, Space Syntax, Social Exclusion, Urban Integration

The relationship between Romani ghettos and urban form is often examined through a sociological perspective focusing on social and spatial segregation. There is limited literature addressing the connection between urban morphology and Romani ghettos. This study aims to fill this gap by exploring the impact of the urban location and typo-morphological characteristics of Romani ghettos on urban form. The research investigates the urban location and typo-morphology of Romani ghettos from six medium-sized cities on both sides of the border between Türkiye (Edirne, Kırklareli, Lüleburgaz) and Bulgaria (Stara Zagora, Sliven, Yambol) employing Space Syntax theory. The analysis, based on accessibility, integration, and configuration, evaluates the spatial connection and isolation of Romani ghettos from the city context. Additionally, the geometric features of the urban fabric and street network of ghettos are examined. The Space Syntax analysis reveals that Romani ghettos are located on the periphery of the city, far from the center, with low accessibility. The urban fabric of ghettos consist of narrow and complex street patterns, which cause isolation from the city contexts and limits the connectivity. The main significant difference is that the Turkish-Romani ghettos have a more complex street pattern compared to the Bulgarian-Romani ghettos. Typo-morphological configuration serves as a barrier to urban integration and contributes to spatial exclusion. Urban location of Romani ghettos, characterized by distance from city center and the low level of connectivity, significantly hinders participation of Roma people to social, cultural and economic dynamics of city. Isolation plays a crucial role in reinforcing social exclusion. The study provides a concrete approach to understanding the interaction between socio-spatial exclusion and urban morphology, offering valuable insights for urban planning aimed at creating more inclusive and accessible neighbourhoods.

Urban form and Drones: Mapping Indian cities

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Keywords:
Urban form, drones, mapping Indian cities, theoretical review

Urban form or the physical fabric of the city is widely studied across the world. In cities of the Global South, mapping urban form often becomes a constraint due to lack of precise data available through aerial images. Drones help collect precise data at a large scale in less time and generate realistic city models. The findings could possibly aid urban planning policies. The objective of this paper is to give an overview of recent scholarly articles in this area and analyse application of the same technology. The technology and its application are discussed in the context of mapping of cities of India. The study method involved a systematic and critical review of the scholarly articles published from 2018 to 2025 available in Google Scholar. The keywords chosen in the search engine were ‘drones’, ‘urban form’ and ‘Indian cities’. The selection of articles was not influenced by any Boolean operators. The relevant articles were shortlisted and critically reviewed. The results of the scoping review and systematic review are presented and discussed in detail in the paper. The discussion section summarises the possible applications of drones to study urban form and planning in Indian cities. The implications of the findings suggest the possibility of using the mapping technique in other cities of India as well as similar contexts lacking precise aerial imagery. The paper concludes with a way forward for further studies on mapping urban form in cities of the Global South. The methodological limitations as well as the implications for future research and planning practice are detailed.

Virtual recurrences: *About building typologies in the AI era*

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Cristiano Tosco

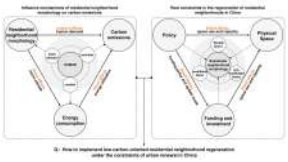
Keywords:
storage, cataloguing, typology, digital maps, simulation

Sequences, repetitions and typological differences are the basis of urban fabrics' aggregation and development, particularly historical ones. Many authors have brought to light how study, design and cumulative knowledge of planimetric recurrences are precious tools for investigating both urban forms and design procedures (prefiguration and intervention) on the built fabric. Technological shifts in reading and planning built fabrics require a focus on how and whether the refinement in cataloguing and prefiguration of planimetric aggregations has built links with the traditional typological study. This is true, especially in a cultural context where AI is assuming a role that makes irreversible some of these shifts.

In a society dominated by data, in architecture and urban studies, it is easy to see how these are mostly aggregated to return plausible images of possible scenarios as quickly as possible, according to the increasingly frequent iconographic and textual demand, starting with the most popular commercial software such as ChatGPT. This general 'visual trend' is also motivated by the fact that architectural images have progressively become one of the primary references for the project, making use of representations selected by algorithms that are refined according to individual searches and their frequencies, in a process that becomes cyclical.

The contribution investigates the potential – although underdeveloped or unexpressed – of AI in the study of the recurrence and combination of architectural and urban systems mainly from a cultural point of view. Thanks to some examples, simulating scenarios and testing some of the common tools that adopt AI, the aim is to highlight how the discipline of architectural and urban design needs a more profitable in-depth study of these tools so that it can be enriched as much in practice as in theoretical debate, without, however, becoming a quotation of itself or a mere communication tool.

Research on the Relationship Between Urban Form and Residential Building Carbon Emissions at the Neighborhood Scale and Regeneration Strategies: A Case Study of Nanjing, China



Jiwen Han | *Southeast University*
Li Bao

Keywords:
neighborhood scale residential building carbon emissions, urban form factors, numerical simulation, substitution compensation, regeneration strategy

Urban residential buildings are significant contributors to carbon emissions. As a crucial component of urban regeneration, the carbon emissions from residential neighborhoods have a substantial impact on overall emissions reduction. However, existing studies on the carbon reduction potential of residential neighborhoods of urban renewal exhibit certain limitations. First, the measurement standards used focus on the reduction of operational carbon emissions from energy retrofitting of individual buildings, leaving the relationship between life-cycle carbon emissions of residential buildings at the neighborhood scale and urban morphological factors unclear. Second, research on the interactive relationship between urban form and carbon emissions faces rigid constraints in applications due to property rights and historical preservation limitations. This study establishes a method for calculating the life-cycle carbon emissions of urban residential neighborhoods and investigates their relationship with urban form characteristics: (1) Typical layout patterns of residential buildings in Nanjing, China, are extracted, and GIS technology to establish a building model and urban form factors and (2) building life-cycle boundaries and scenario parameters are defined, and Urban Building Energy Modeling (UBEM) is applied to simulate carbon emissions across neighborhood samples. Additionally, (3) statistical methods are used to analyze the correlations between urban form factors and the carbon emission results, including the identification of high-sensitivity factors to delineate rigid and flexible factor sets and (4) considering constraints imposed by real-world conditions such as property boundaries and technology, the "constraint adaptation-multi-dimensional compensation" framework is proposed, which emphasizes the formation of substitute compensations through flexible factors and presents practical low-carbon urban residential neighborhood regeneration strategies. The relationship explored between urban form and carbon emissions provides guidance for low-carbon retrofitting of old residential neighborhoods, contributing to urban energy conservation and emission reduction efforts.

AI and morphological research of Italian School in the paradigm of the world of Tech

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Keywords:
Morphological research, Technique, Italian School, maximum "performance, Caniggia

Starting from the postulate that AI would be part of the paradigm of the original Promethean will of instrumental utility to man, there is no doubt that its use in the world of architecture represents a concrete advancement in the search for general ingredients capable of offering unexpected results. Furthermore, if considered from the research perspective of the School of Muratori and Caniggia - applied, for example, to the reading of the urban organism over - the hypothesis of the collection and systemization of the series of data on the configuration of cities, the formation of urban fabrics and building types, framed in the historical and socio-economic dynamics and in the different geographic-cultural areas, would offer the opportunity to reflect on anthropic dynamics, extended to a time horizon not limited to the present.

In addition to the advantages of using AI, however, it should be noted that one is never preserved from the risk of falling into the indeterminacy of a dependency that would see man succumb to a drastic reversal of the instrumental device turned into an end. For there can be no doubt that AI is authentically one of the most evolved ways of expressing Technology, whose sole purpose is the will to power aimed at the constant conquest of new goals. It follows that all the efforts proposed by certain currents of thought, based on ethical reasons, fail because one cannot dominate the development of scientific knowledge with moral actions. The paper will offer examples of urban readings and design outcomes and attempt to question these critical aspects. In other words, an attempt will be made to understand whether there is a real possibility that Prometheus will be in chains again, or whether the world of architecture can pursue an alternative perspective to this inescapable risk.

Exploring Urban Morphology with AI: *ChatGPT as a Tool for Analyzing the Urban Forms*

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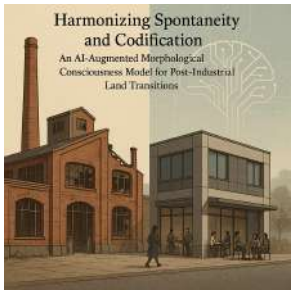
ArCoD
Cansu Türker

Keywords:
Artificial Intelligence (AI), ChatGPT, Urban Morphology, İstanbul, Barcelona

Numerous factors have been introduced to urban planning studies in the modern world for a variety of reasons, including the risk of disasters, the steadily shifting dynamics of cities, and the growing population and demands of people. Urban planning for megacities, which have been evolving and transforming quickly and have become a focus of local authorities' profit, may present a number of difficulties, complicated issues, and time restrictions that must be resolved within a specific amount of time. Now, a crucial component of urban studies, artificial intelligence (AI) since 2011, has advanced quickly and permeated our daily lives. AI analyzes available data, identifies idealized and optimum solutions, and can produce a variety of designs based on certain parameters. In this regard, this paper explores the influence of ChatGPT on urban morphology by assessing its capability to analyze historical maps, categorize street networks, and support decision-making in urban design. This research investigates ChatGPT in evaluating the effectiveness, limitations, and potential regarding morphological studies. As a case study, two cities İstanbul, Turkiye, and Barcelona, Spain with their different urban forms are selected. Two cities are introduced to ChatGPT by showing their maps, street networks, and land-use patterns. Then, ChatGPT is fed with images and textual descriptions of urban fabrics of cities for classification. Afterward, describing city growth patterns is asked based on the provided urban data to ChatGPT. Finally, AI-generated design recommendations for urban regeneration are evaluated by comparing them with the traditional design morphology. Consequently, the accuracy, strengths, and weaknesses of ChatGPT in urban research are detected. Thus, this research can contribute to the critical debates on AI bias and reliability.



Harmonizing Spontaneity and Codification: An AI-Augmented Morphological Consciousness Model for Post-Industrial Land Transitions

ShengBin Jiang | *Southeast University*

Keywords:
morphological consciousness, algorithmic governance, spontaneous land transitions, human-AI collaboration

The global resurgence of post-industrial zones in shrinking cities has unveiled a paradoxical tension between grassroots spatial improvisation and institutional governance systems. This investigation develops an innovative framework that synergizes artificial intelligence with urban morphological analysis, aiming to bridge the gap between organic spatial adaptations and regulatory mechanisms while proactively addressing ethical dilemmas. Drawing insights from a transitioning industrial district in China, the research employs multi-source spatial data – including decade-long satellite observations and street-level imagery – to decode emergent patterns of building typology conversions. A visual recognition model specifically designed for architectural form analysis identifies recurring transition archetypes, while comparative algorithms measure the evolving disconnect between informal spatial practices and codified regulations. Empirical comparisons highlight that computational detection techniques achieve markedly higher sensitivity in capturing spontaneous functional shifts compared to conventional field surveys, albeit with persistent challenges in distinguishing community- beneficial conversions from purely commercial ventures. Simulation experiments further suggest that the proposed framework could enable faster policy responsiveness without compromising local adaptability, as indicated by enhanced functional diversity indices. Nevertheless, over-reliance on algorithmic systems may inadvertently prioritize administrative efficiency over organic urban vitality, potentially constraining bottom-up innovation. The study advances urban morphology discourse by introducing a dynamic “adaptive consciousness” model that reinterprets Caniggia’s classical duality through computational lenses, offering practical protocols for revitalizing obsolete industrial lands through context-aware AI mediation. These insights enrich contemporary debates on technologically-mediated urban transitions, advocating for hybrid governance models that ethically balance computational rationality with human-centric spatial intelligence.

AI-augmented Space Syntax: A Theoretical Approach to Adaptive Urban Form through Function-oriented Spatial Accessibility

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Taimaz Larimian

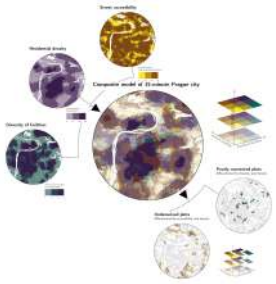
Keywords:
Space Syntax, Artificial Intelligence, Spatial Functionalities, Spatial Accessibility, Adaptive Urban form

Space Syntax has long provided a robust framework for understanding spatial networks, urban morphology, and human activity patterns. However, as urban environments grow increasingly complex, legacy methods must evolve to incorporate dynamic, data-driven approaches. Artificial intelligence (AI) offers a transformative opportunity to advance Space Syntax analyses by automating data processing, refining spatial pattern recognition, and integrating real-time datasets. By incorporating spatial functionalities such as land use across scales from buildings to districts, Space Syntax metrics—connectivity, integration, control, choice, and depth—can be enhanced, enabling a more adaptive approach to spatial accessibility. AI strengthens Space Syntax by capturing land use variations and hidden spatial patterns, and improving urban modelling.

A theoretical case study on adaptive urban form and spatial functionality examines how AI- augmented Space Syntax can automate spatial analysis, uncover spatial network–land use correlations, and predict urban transformations. Investigating global cases with similar urban forms—Loughborough (UK), Freiberg (Europe), and Northampton (USA)—within small-scale under 50 Km2 and 60,000 people, highly accessible urban environments, this study explores how AI enhances Space Syntax techniques to identify functional shifts across different contexts. The Space Syntax and AI-oriented land use analysis revealed that spatial networks in urban forms exhibit potential shifts in spatial accessibility patterns, driven more by land use diversity than by the configurational networks themselves. The AI-enhanced analysis further demonstrates that function-oriented spatial networks play a crucial role in shaping urban adaptability, particularly in areas with mixed land uses, hidden social spaces, temporally varying access, and advancing spatial prediction through function-oriented urban form recognition.

Beyond technical advancements, this research addresses the ethical implications of AI in urban analytics, including data privacy, algorithmic bias, and spatial inequality. By engaging with these challenges, this study advocates for AI-enhanced spatial analysis as a data-driven, adaptive, and responsible tool for shaping advanced urban forms.

Draft



15-minute Prague: A Methodological Framework for the Applied Concept of the 15-minute City

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Keywords:
15-minute city, walkability, public amenities, urban morphology, urban sustainability

Originally theoretical concepts of walkable, multifunctional, compact and diverse cities are nowadays widely applied in the practice of urban design and planning agenda. Within their scope, much attention is focused on land use and public amenities, i.e., the location and level of spatial accumulation of various activities within the urban fabrics. However, we argue that there is a lack of connection between theory and practice. Is Prague a 15-minute city? This paper introduces an innovative framework for assessing public amenities within the context of the 15-minute city concept and explores the possibilities of decomposing it for the application in urban planning, promoting sustainable development initiatives and informed planning decisions. The theoretical concepts of walkable, mixed-use, and compact cities are now widely integrated into urban planning and design, and at the same time serving as foundational elements of the 15-minute city concept. These frameworks emphasize the spatial distribution and accessibility of essential public amenities in relation to urban density and walkability. While current models effectively identify spatial deficits in public amenities, they fall short in diagnosing whether these deficits are due to the absence of facilities, poor street network connectivity or are related to low population density. In our case study of Prague, the Czech capital, we: (1) define a common spatial unit of analysis that is granular, continuous and internally consistent; (2) operationalize the concepts of public amenities accessibility, population density and street network connectivity; (3) apply these concepts in a novel composite model that keeps the multidimensional essence of the concept, (4) integrate this model into an open source web application. The results indicate that: (1) the accessibility of public amenities is limited and spatially diversified, (2) in many areas, improving the connectivity of the street network itself can enhance the accessibility of public amenities, thereby saving public funds.

Sitte Traces: *The international reception and influence of Camillo Sitte*

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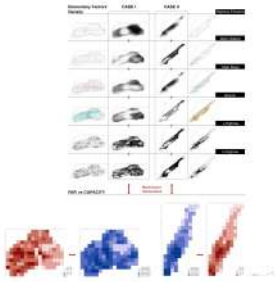
Angelika Psenner

Keywords:
Camillo Sitte, Urban Design, Urban Planning, Sitte Family of Architects

"Sitte Traces" examines the international reception and influence of Camillo Sitte's major oeuvre, the theoretical treatise „Der Städtebau nach seinen künstlerischen Grundsätzen". The project will examine and enhance the so far known history and seek to establish new correlations within the various editions, translations and interpretations. Between 1889 and 1922, five editions were published under the aegis of the Sitte family of architects, with the first French translation appearing in 1902. After Camillo Sitte's death in 1903, his sons Siegfried and Heinrich took the lead in disseminating their father's theories. On their initiative, further editions in other languages were planned, but not realised until after the First World War. This international breakthrough established the work as a classic of urban planning theory literature. A fundamental study for the project was written in 1988 by Ralph Wurzer: "Camillo Sitte and America: A Study of the Reception of Sitte's Ideas in American Planning Literature". Wurzer traced how Sitte's ideas found their way into urban planning literature, particularly in the USA. Building on these findings, the project takes a much broader approach and attempts to identify the traces in the existing literature, the further translations of "Städtebau" and its interpretations. Of particular interest for "Sitte Traces" are, for example, the detours taken by Sitte's publication into English via French. Even the first French version differs significantly from the original text due to changes made by the editor, Martin Camille. The correspondence with Camille proves that this was approved by Camillo Sitte. Previously unpublished documents suggest that Camillo and later his sons also sought dialogue with Martin Camille for the unfinished sequel to "Städtebau".

This calls into question the extent to which the Sitte family influenced the dissemination of the original text of "Städtebau", subsequent translations, and their ensuing interpretations in various cultural contexts.



Integrating AI and Statistical Physics for Urban Spatial Density Distribution Analysis

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Jianjia Wang
Yuhuang Chen

Keywords:
urban spatial density distribution, statistical physics model, urban spatial density's self-influencing mechanism, AI-driven methods

The spatial distribution and formation mechanisms of urban density represent pivotal aspects of contemporary urban morphology research. This study reinterprets urban spatial density through the lens of statistical physics, analogous to gas pressure as a macroscopic manifestation of microscopic entities' spatial distribution. Unlike traditional multi-factor weighted approaches that oversimplify urban complexity through linear assumptions, this research employs advanced statistical physics models enhanced by AI-driven methodologies to capture the intricate dynamics of urban systems.

A distinctive morphological characteristic of modern cities, as identified in this study, is the marked heterogeneity in spatial density distribution, primarily driven by modern transportation systems and high-rise building proliferation. Through AI-enhanced data analysis, the research examines six critical factors related to transportation systems and building accessibility heights, establishing their correlations with urban spatial density. An innovative entropy-based statistical model, augmented by AI algorithms, is developed to estimate urban spatial capacity distribution, demonstrating exceptional precision in case studies conducted in Shanghai and New York.

The study further extends its analytical framework by integrating AI's predictive capabilities, particularly optimization algorithms such as genetic algorithms, to formulate a self-influencing mechanism hypothesis for urban spatial density. This hypothesis, grounded in statistical physics principles, enables the projection of density trends in the absence of external interventions, providing a forward-looking perspective on urban development patterns.

By combining statistical physics with AI-driven methods, this research explores new approaches to understanding urban forms. The findings offer initial insights for urban renewal planning, highlighting how AI might contribute to urban morphology studies and sustainable development. This interdisciplinary effort provides a tentative framework for analyzing urban spatial dynamics, though further research is needed to validate and refine its applications in urban planning and policy.

From Traditional Courtyard House to Modern Private House: Analysis of Morphological Elements in the Typological Process

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Wowo Ding

Keywords:
Typological Porcess, Plot Boundary, Traditional Courtyard House, Mordern Private House

In modern society, house types tend to change as lifestyles change. In China, traditional courtyard houses in historic towns have been gradually being replaced by modern private houses, and the consistency of the plot widths of the two house types confirm that the modern private houses is always confined within the plot boundaries constituted by the traditional courtyard houses. So why were the traditional plot boundaries not broken? How did the modern private house follow the traditional plot boundaries to be constructed? What characteristics has this evolution brought to the historic town? An interpretation of these questions can provide a key cognitive foundation for the historic towns regeneration. This study aims to explore the applicability of morphological theories in the transformation of Chinese traditional housing types, to analyse the typological process. The article takes the Changting Town, China as an example. The article first delineate the plot boundaries, and count and compare the plot widths of traditional courtyard houses and modern private houses. Secondly, through deductive analysis, respectively at the level of building block and spatial layout, the article analyze the reorganisation way of buildings within the plot, and compare the similarities and differences between old and new housing types. Finally, the study returns to the level of town plan and building fabric, to analyse what characteristics the evolution has brought to the old town. The study shows that the reason of plot boundaries limitation is related to the division and use of property rights. Within the plot scope, the modern private house produces a variety of building combinations, while the centred layout of the courtyard houses are gradually replaced by the functional zoning. The plot limitation continues the characteristics of the town tissue, and maintains the historical memory at the streetscape level.

Morphogenesis Driven by Deep Learning: Graph-Based Decoding and Generative Design

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Yuxuan Pan
Bin Tang

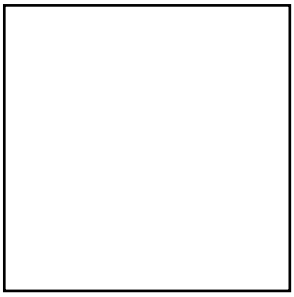
Keywords:
morphogenesis, morphological pedigree, deep learning, graph, generative design

Conventional quantification of urban forms is typically limited to univariate analysis of elements themselves while ignoring complex relations between elements. The dimensional reduction inherent in classic numerical models often leads to informational attrition, reducing both descriptive accuracy and generative fidelity. Deep learning provides an alternative data- driven approach that is capable of extracting comprehensive multi-dimensional features. This research uses the method of deep learning to encode spatial relations as graph network features for quantifying the morphological and typological characteristics of water-towns. The composite relations between hydrological elements and built elements (streets, courtyards and buildings) are key determinants affecting the spatial configuration of water- towns. By extracting morphological genes as generative design constraints, the framework enables morphological prediction.

This research creates a model of Graph Convolutional Network (GCN) that extracts spatial features of the relations between buildings, courtyards, streets and waterways at multiple scales based on datasets of water-town prototypes. Through contrastive learning in hyperbolic embedding space, the model distinguishes diverse typologies of water-towns and establishes their morphological pedigree linking local attributes to global patterns. The classified morphological indices serve as predefined parameters for automated generation, with subsequent adversarial optimization through Generative Adversarial Networks (GANs) ensuring dynamic refinement under certain morphological restrictions.

The proposed method demonstrates the capacity of deep learning for targeted analysis of complex and fussy morphological features and effective substitution of subjective judgments in generative design workflows, thus advances an integrated multi-objective system of analysis and generation. This neuro-guided approach to morphological analysis and morphogenetic mechanism reveals how computational graph representations may decode implicit planning wisdom and provide transferable technical modules for terrain-informed morphological quantification and generative urban design.

The role of road network in describing natural cities: a perculation model application



Giampiero Lombardini | *University of Genoa - Department Architecture and Design*

Keywords:
Percolation, Fractals, Road network, Urban System, Rank-size Rule

The transition from a world of cities to the realm of the urban (as suggested, from different perspectives, by both Choay and Brenner) has given rise to a new category of settlement, which can be included in the term “urban agglomeration”. Administrative boundaries are no longer able to account for the recent multifaceted processes of urbanization that have led to the formation of these new settlement forms. The shape, size and structure of urban agglomerations must be freed from a reading based on the administrative grid (for example, that used for census surveys). An emerging concept in literature is that of “natural cities”. These are complex urban agglomerations, composed of different polarities, a highly structured network of connections, an articulated composition of mixed land uses. Several scholars have recently proposed different methods and tools to describe these new forms of settlement, for example using satellite images (satellite nighttime maps) or reconstructing the shapes of the agglomerations through a morphometric reading of the built areas. The contribution intends to explore a new method to perimeter and identify these urban agglomerations based on a percolation model. Starting from the analysis of the road network and its nodes, through the application of some fractal and percolation measures it allows to identify different levels of urban agglomeration. The centrality of the road network is considered the primary indicator for understanding the urban agglomeration pattern. The purpose of the contribution is to find and experiment a spatial searching method that allows us to identify the different shapes and sizes of contemporary settlement, with an application on Italian and French city system. The hypothesis is that the conurbations of contemporary settlement tend to merge and fragment in a dynamic process of continuous evolution, caused by the fact that urban limits follow flows and networks.

The role of urban form in distinguishing between capital and land: *a conceptual contribution to a theory of land*

Lars Marcus | *Chalmers University of Technology*

Keywords:
Land, capital, urban form, network descriptions, economic theory

It is becoming increasingly clear that there is much need to develop our theoretical understanding of land, just as the last century saw the need to develop its understanding of another fundamental production factor, capital. Land is critical for the understanding of the acute issues of both social an environmental sustainability. In the first case, in relation to the depletion of natural resources, in the second case in relation to land as spatial extension and the uneven distribution between centers and peripheries in cities. This paper will draw from an extensive theoretical work recently published at MIT Press, addressing this issue by emphasizing the specific role and new descriptions of urban form. The specific aim is to generate a more distinct definition of the particular form of capital that enhances the value and performance of land, an entity here named spatial capital. There is great unclarity when it comes to the conceptual relation between land and capital, which is a major reason why the development of our understanding of land has been scarce for a long time; land has simply been conceived of as a form of capital. The reasons for this is that land appears in two distinct forms in economic theory, on the one hand as natural resources, and on the other as pure spatial extension. But perhaps even more important is the fact that the latter form never really exist as pure land but is always improved by what in economics is called land improvements, typically in the form of buildings. But land improvements such as buildings are in economic theory by definition capital. The paper will show how network descriptions of urban form will help differentiate between land and capital in this context, identifying a new identity called spatial capital.

Michael P. Conzen and the Historico-Geographical Approach to Urban Morphology

Clàudia Monteiro | *CIAUD - Polo Universidade Lusófona*

Keywords:
M. P. Conzen, M. R. G. Conzen, J. W. R. Whitehand, historico-geographical approach, urban morphology

A key foundation of the International Seminar on Urban Form (ISUF) and its scientific journal Urban Morphology lies in the historico-geographical approach to urban morphology, often referred to as the Conzenian School. While the core theories, concepts, and methods of this approach have gradually been adopted by researchers worldwide, the development of its disciplinary history is still in its early stages. This article aims to contribute to that development. This article focuses on the life and work of Michael P. Conzen, examining the triangle he formed with two other key figures in the historico-geographical approach: M. R. G. Conzen and Jeremy W. R. Whitehand. Over the years, Jeremy Whitehand has written extensively about how M. R. G. Conzen developed his interest in urban morphology and how his work laid the foundation for the historico-geographical approach in a series of publications from the mid-20th century. More recently, Michael Conzen published an article exploring a similar process in the career of Jeremy Whitehand. This study completes the triangle by exploring the origins and evolution of Michael Conzen's morphological thinking and his major contributions to the historico-geographical approach. The article draws on Michael Conzen's personal archive and direct conversations as crucial research sources. The exploration of Michael Conzen's intellectual journey highlights his early curiosity about the urban landscape, as expressed in his A Survey of Askrigg, prepared when he was just twelve years old. This article explores the reasons and motivations that led Michael to become an urban morphologist. If, from an early age, he absorbed his father's fascination with urban morphology, a strong desire to follow a largely independent path also shaped much of his career. He maintained a continuous activity in urban morphology, even after moving to the United States, cementing his key role within the historico-geographical approach and ISUF.

Predicting morphology outcomes of regeneration policies at plot and building scale in historic areas

Zhiyu Pang | *Southeast University*
Yacheng Song

Keywords:
regeneration policies, morphology outcomes, prediction, historic areas

The conservation and regeneration of historic areas have attracted considerable attention in China. One of the key challenges in this context is to devise appropriate policy incentives for urban regeneration while safeguarding the authentic transmission of historic and cultural heritage. Previous institution-morphology causal studies have predominantly been conducted at a large scale. Against this backdrop, this research seeks to concentrate on the causal relationship between regeneration policy and urban morphology at the plot and building scales within historic areas. Drawing upon the “”Institutional Arrangement, Stakeholder Interaction, Morphology Outcome”” relationship model proposed by Tennekes and Harbers, this study introduces “”Space Value-Added Pathway”” as a mediating variable. This is aimed at elucidating the underlying commonalities that drive the seemingly intricate morphological transformations at the plot and building scales. By taking 32 cases in the XIAOXIHU block, China as an empirical example, five distinct types of Space Value-Added Pathways have been identified, namely Optimizing pattern, Intensifying intensity, Changing use, Enhancing quality, Adjusting property rights. These Space Value-Added Pathways effectively bridge regeneration policies, stakeholder interctions, and the ultimate morphology outcomes.
The research findings reveal that the morphological outcomes resulting from regeneration policies at the plot and building scales are predictable. This, in turn, provides a reference for policy design and lays the foundation for the development of digital tools for predicting morphological outcomes.

Embodied Urbanism: *A Bodily Phenomenology in the Age of Artificial Intelligence*

Roberto Podda | *XJTLU_Xi'an Jiaotong - Liverpool University*
Alessandro Cece

Keywords:
Phenomenology of the body, Urban and digital space, Artificial intelligence (AI), Implemented spatiotemporal corporeality, Hybrid ecosystem

This paper explores the evolution of the phenomenology of the human body and its "bodily and intercorporeal subjectivity" within the "implemented urban space," focusing on the intricate relationship between corporeality and artificial intelligence (AI). Grounded in the concept of humans as "constructors of reality," it frames physical space as a system of "structured facts," distinguishing between tangible (constructed) realities and intangible (digital infrastructures) that support and mediate them. The study highlights the body's role in shaping knowledge and experience through perceptual, sensory, and cognitive interactions with its environment, emphasizing how urban space is experienced through an embodied perspective. Drawing on phenomenological sciences, the research examines the active and constructive nature of bodily engagement with space, from basic movements to the spatiotemporal dimensions of spatial experience. It investigates how exponential technologies, particularly AI, contribute to this process, leading to a reconfiguration of spatial and temporal perception. The study proposes a model in which the body's experience of space is re-mapped through a contemporary lens, integrating digital augmentation and algorithmic mediation. Through theoretical analysis and an exploration of technological innovations, the study reveals that AI functions as a "super-prosthesis," extending the body into the digital realm and reshaping spatial perception, navigation, and memory through real-time data, predictive algorithms, and dynamic urban interfaces. The concept of "implemented spatiotemporal corporeality" emerges as a critical framework, illustrating how digital flows reconfigure time, space, and movement in hybrid urban environments. The study concludes that the traditional concept of the "city" is no longer adequate, replaced by an expanded, co-created ecosystem where human bodies, technology, and spatial dynamics merge into a fluid and evolving entity. This transformation redefines proximity, memory, and interaction, challenging conventional spatial paradigms and offering new ways to experience increasingly interconnected "exponential" urban spaces.

Enhancing Urban Morphology through AI-Driven Adaptive Design: *A Case Study of Nanjing, China*

Mengjia Qiu | *Southeast University*
Li Bao

Keywords:
Urban renewal, Adaptive decision-making, Hierarchicalgovernance, AI-augmented

In the context of global urbanization, the renewal of aging communities has become a key strategy for addressing housing crises and enhancing urban functions. However, traditional urban morphology, rooted in static typologies, struggles to respond to the dynamic complexities of urban renewal, particularly in balancing historical preservation, social equity, and economic feasibility. This study proposes a dynamic adaptation model for urban forms, integrating AI-driven tools into a hierarchical framework, to overcome the limitations of traditional urban morphology in addressing these challenges. Building on Gianfranco Caniggia's concept of "critical consciousness," this study introduces a dynamic adaptation model enhanced by AI tools. The hierarchical framework, from city scale to building level, is augmented with machine learning models to analyze cross-level interactions. For example, AI models simulate the impact of public space redesign on housing affordability, providing empirical evidence for dynamic adaptation. Additionally, generative design tools explore the balance between historical preservation and functional optimization, demonstrating how historical street patterns can be preserved while improving spatial efficiency by 30%. The Xiaosongtao district in Nanjing serves as a case study for applying this enhanced model. The project uses a "Retention, Remould, Demolition" strategy, with AI tools optimizing functions based on social equity and economic feasibility. AI models analyze the impact of different renewal strategies on spatial efficiency and social equity, ensuring that the renewal process aligns with these goals. This study advances urban morphology by proposing a dynamic adaptation model enhanced with AI tools, addressing the limitations of static typologies, and providing a practical framework for urban renewal. Future research should focus on applying this model in diverse cultural and economic contexts, while addressing ethical considerations in AI's role in urban decision-making.

Beyond the Orthographic Map: *Generative AI and Urban Morphological Analysis*

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Hazem Ziada
James Stevens

Keywords:
Orthographic Map, Diversifying Representation, Architect Agency, Generative AI, Ideology

Representing the city in plan view has long been a primary tool for architects to analyse, envision and celebrate urban forms. A city's orthographic map allows architects and stakeholders to view the formal logic of the city quickly, to envision its spatial relations comprehensively and to gauge a scalable sense of measurement. Recently, Geographic Information Systems (GIS) have provided robust information to orthographic maps, permitting more informed analysis and decision-making. Throughout this history, the agency of shaping urban form remained with the architect, while different orthographic maps implied different ideologies. Using Artificial Intelligence (AI) in urban analysis and design initiates shifts in representation, agency and ideology. It displaces the formal design of cities from the architect's humanist process to a post-human algorithm whereby AI ideates and generates urban fiction based on language-based and image-based models, representing urban form in infinite types of representational views. This paper seeks to position AI as an opportunity to extend a city's representation beyond historic methods while preserving the architect's agency. This paper reflects on how orthogonal maps have historically been used to analyse urban form. It explores how emerging AI representational tools have diversified the primary representations upon which analysis and design rely to include three-dimensional views among others, thus challenging the dominance of the orthogonal map. The paper analyses the architect's sphere of agency exercised through scripted prompts and speculates on the ideologies implicit in AI-generated representations. Our analysis will investigate historical orthogonal maps which signalled paradigm shifts in envisioning city form. Examples from AI generated urban proposals will be used for comparative analysis. The paper also probes literature on the transparency of AI data-sets and algorithms to discern agency and characterise ideology. The results will reflect on the impact of a diversifying toolkit of representations in AI urban analyses.

Mapping the Future: *AI-Driven Insights into Colonial Fabrics, Urban Transformation, and Demographic Dynamics*

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Lamiae Ainine

Keywords:
AI-driven model, Forecating, Evolutionnary algorithm, Colonial Fabrics, Demography

Colonial fabrics in Morocco refer to the urban forms built by French and Spanish colonizers in Morocco during the period from 1912 to 1956. These fabrics are located outside the walls of traditional Moroccan cities, known as the Medinas. Today, colonial fabrics are an integral part of a complex urban framework that shapes Moroccan cities.

The rapid urbanization and transformation of colonial fabrics pose significant challenges in understanding and predicting their future urban morphology. By exploring the application of artificial intelligence techniques, this study aims to shed light on how urban form and demographic dynamics can be leveraged to forecast the evolution of these complex urban environment.

The main aim of this research is to investigate the potential of AI-driven models in spatial analyzing and the demographic characteristics of colonial fabrics and using these insights to predict their future urban morphology. Objectives:

-To analyze spatial structures and demographic patterns within colonial fabrics using AI- based methodologies.

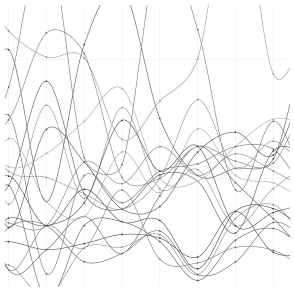
-To develop predictive models that forecast the evolution of urban morphology in colonial districts.

-To assess the implications of AI-driven urban analysis on urban planning and heritage conservation.

The study employs a combination of machine learning algorithms and spatial analysis techniques to process large datasets on real estate transactions, population demographics, and urban development patterns. It integrates geospatial analysis using GIS tools, evolutionary algorithms (EAs) tools in the context of artificial intelligence in their application to urban morphology.

The findings suggest that AI-based models can effectively capture the intricate relationships between the evolving urban morphology and demographic dynamics of colonial fabrics, enabling reliable forecasts of their future urban trajectories. Rather than relying solely on a single parameter, cross-referencing multiple variables allows for the creation of research strings that provide a more comprehensive vision of the future of colonial fabrics.

Thematic trends in urban morphology 1994-2024: analysis of keywords from papers presented at ISUF conferences 1994-2024



Paul Sanders | *Deakin University*
Sylvia Spolaor
Vitor Oliveira
Susanne Whitehand
Peter Larkham

Keywords:
Thematic analysis, Urban morphology, Research trends

This study presents a thematic analysis of all papers submitted and presented at the International Seminar on Urban Form (ISUF) conferences between 1994 and 2024. By systematically examining the themes and topics that have emerged over this 30-year period, the aim of this study is to identify dominant research themes, shifts in focus, and emerging areas of interest in urban morphology. Using an inductive thematic analysis, the specific objective of the research is to categorize and synthesize recurring themes in the discourse, tracing the intellectual development of the field over time. The findings of the study will highlight predominant themes that are central to ISUF discussions, while also indicating shifts in methodological approaches. The research provides a historical perspective on the development of urban morphology as a discipline, and by identifying emerging areas of interest, it can inform future research directions. This thematic record serves not only as a retrospective analysis but also as a strategic roadmap for the continued evolution of urban morphological studies.

Draft

Rethinking the Role of Artificial Intelligence in Mobility: *An Assessment of Germany's Smart City Model Projects and their Potential for Creating More Accessible Cities*

Thomas Schonberger | *German Federal Institute for Research on*

Keywords:
AI-driven mobility system, urban morphology transformation, sustainable and inclusive mobility, smart cities

Artificial Intelligence (AI) is reshaping how cities conceptualize and implement mobility strategies, with profound implications for urban morphology. In Germany, 73 federally funded Model Projects Smart Cities serve as experimental sites for integrated urban development, offering a unique setting to explore AI-driven mobility solutions. This study investigates how AI is leveraged within these projects to foster more sustainable, healthy, just, and inclusive mobility systems while transforming urban structures into more accessible and adaptable forms. By analysing the planning strategies, key performance indicators for monitoring and evaluation, and AI-driven interventions, this research identifies key approaches in predictive mobility planning, real-time traffic management, and dynamic urban design adaptations. Preliminary findings suggest that AI facilitates a shift from car-centric urban forms to people-centred, multimodal environments, improving walkability, public transport efficiency, and equitable access to mobility. However, the extent to which these technological advancements translate into systemic urban form changes remains uncertain. This study critically examines whether AI-driven mobility interventions reinforce existing urban structures or actively contribute to a new paradigm of spatial justice and morphological adaptability. By bridging AI applications with urban morphology theories, this research highlights the potential and limitations of algorithmic planning in shaping cities that are more inclusive, resilient, and future-ready. The findings provide valuable insights for urban planners, policymakers, and scholars in rethinking the evolving relationship between AI, mobility systems, and urban form in an era of digital transformation.

Urban Morphology, Microclimate, and Energy: The Potential of In-Between Spaces in the Context of Climate Change

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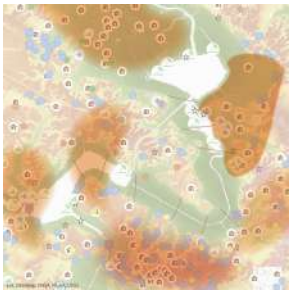
Keywords:
Urban Morphology, In-Between Spaces, Microclimate, Energy Efficiency, Climate Change Mitigation

This contribution investigates the role of urban morphology, intermediate spaces, and architectural interfaces in mitigating the effects of climate change, improving outdoor thermal comfort, and reducing urban energy consumption. In-between spaces, defined as physical and thermal transition zones between indoor and outdoor environments, public and private realms, built and natural contexts – such as courtyards, loggias, porticoes, balconies, gardens, and streets – offer significant opportunities for sustainable and resilient urban regeneration. The central question is: how can these spaces and elements influence urban microclimates, optimize energy efficiency, and contribute to reducing energy poverty and climate inequities? Traditionally designed to enhance indoor comfort, these elements can extend their benefits to outdoor spaces, fostering social interactions and integrating with broader environmental systems. The methodology combines a critical review of the literature with a comparative analysis of completed projects where urban morphology plays a central role in regulating microclimatic aspects. The projects are analyzed and compared using scientific parameters such as volumes, open spaces, air temperature, relative humidity, natural ventilation, urban heat island mitigation, Predicted Mean Vote, and Predicted Percentage of Dissatisfied. Artificial intelligence is employed to support climate modeling, design simulations, and predictive analyses. An applied case study will enable the practical implementation and validation of the theoretical strategies. The expected results demonstrate how the strategic design of intermediate spaces can improve outdoor thermal comfort, reduce energy consumption, and provide actionable guidelines for urban regeneration. By overcoming the traditional dichotomies between indoor and outdoor spaces, public and private domains, the research highlights the potential of in-between spaces as key tools to address global challenges related to climate change and to foster more sustainable, resilient, and inclusive cities.



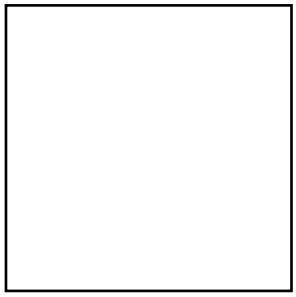
Ecosystem Subregion: *A regional framework for AI-assisted regenerative design examined through Japanese Castle Towns*

Keisuke Sugano | *University of Tsukuba*

Keywords:
Ecosystem Subregion, Regenerative design, AI-assisted planning, Japanese castle town, River basin management

In recent years, theoretical discussions have explored a framework linking regenerative design and urban morphology, emphasized the organic evolution of urban form alongside the environment, yet concrete case studies remain limited. Advancements in AI now enable documentation of urban-environment co-evolution, forming a foundation for future scenario analysis while highlighting the importance of case studies and the structural archiving of their spatial and temporal dynamics. Japanese castle towns, designed for environmental symbiosis in the early modern period and later forming the basis for modern urbanization, offer valuable insights in this case study. This study focuses on Sakura, a castle town located within Japan's largest river basin, Tone River basin. It proposes the concept of the "Ecosystem Subregion", an autonomous regional unit that harmonizes with environmental dynamics, as a framework for analysing the interaction between urban form and river basins. A diachronic GIS analysis of the relationship between urban form and the river basin environment from the early modern period to the present reveals three key findings. First, Sakura's urban form has been shaped and continues to evolve alongside two distinct systems: the ecosystem of Yatsuda (narrow valley-bottom rice fields), which is connected to the watershed of Inbanuma Swamp (a swamp adjacent to the castle town), and the water system of Inbanuma Swamp and Tone River, linking the watershed to external basin. Second, multiple similar settlements are interconnected within the Inbanuma Swamp watershed, forming an autonomous region that also interacts with the broader river basin. This region was defined as an Ecosystem Subregion as described above. Third, GIS-based analysis and systematic data archiving provide a foundation for AI-assisted studies exploring future scenarios. Structuring urban analysis around the Ecosystem Subregion concept contributes to developing AI-assisted methodologies in regenerative design, fostering urban-environment co-evolution.

Street networks: *A processual approach*



Primas Urs | *ZHAW, Zurich University for Applied Sciences*

Keywords:
Complex networks, Temporal networks, Fringe belts, Process Typology

The street systems interweaving our cities and urban landscapes form multi-layered structures of extraordinary depth. Appropriate network models allow for the representation and investigation of morphological properties of these structures and facilitate the assessment of relevant qualities, shortcomings and development potentials. In recent years, the analytical toolbox for the study of complex networks has seen important extensions, not least owing to the rapidly developing field of machine learning. Meanwhile, current applications of network analysis to street systems often limit themselves to the exploration of their present configuration while neglecting the processual character of their evolution and transformation. This paper discusses a couple of geometrical and topological properties of street networks that can only be grasped if the historical sequence of their formation is considered. Any given state of such a sequence constrains the range of possibilities for future development while at the same time establishing a hierarchy of centralities and preferred vectors of growth. Based on classical concepts of urban morphology, a general model of street network evolution is proposed along the following lines: Topographical and hydrological conditions scaffold a primary network of matrix roads, thereby leading to the emergence of centralities. In time, densification around these centralities leads to the formation of fringe belts consisting of arterial ribbons interspersed with patches of open land and large, specialized plots. While further urban growth may lead to the incorporation of adjacent settlements and their respective fringe belts, the reprogramming of interstices between arterial ribbons facilitates a restructuration of the network through the tracing of new connections, in time leading to a reorganization of centralities and growth vectors. The paper concludes with a comparison of current approaches to the modelling of street networks regarding their application to temporal network analysis.

Correlation Study Between Traditional Courtyard Houses and the Historic Districts Morphological Characteristics

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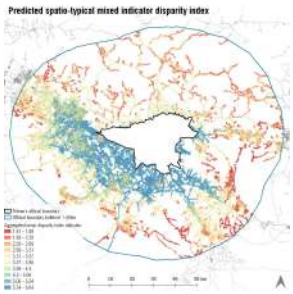
Lian Tang
Wowo Ding

Keywords:
Historic Districts, Traditional Courtyard Houses, Urban Morphological Characteristics, Building Types

There is a consistent gene behind typological and morphological research, both of which study the causes of formation and growth mechanisms of their respective elements. The study of building typology is inseparable from how buildings are used, the local climate, and culture. In contrast, the study of urban morphology is inseparable from analyzing the economic activities, the stage of social development, the geomorphological conditions, and the climate of the local city. Among the elements of urban morphology (street/block, plot, building), building is one of the key elements, so in a particular stage of social development, the urban morphology characteristics of the same region and the region's building type must have a necessary connection. Accordingly, this study takes the traditional Chinese building type (Courtyard house) as the research object deeply analyses the inseparable correlation factors between the traditional Chinese building type and the traditional Chinese urban morphological characteristics, and explores the paths and methods of interpreting the urban morphological characteristics based on the building type. This study selects three representative historic districts in Chinese cities with different climatic and cultural zones for investigation. It reveals that the geometric features of courtyard houses in the region are essential in interpreting the street and alley features and musculoskeletal morphology features of the traditional historic districts in the region.Meanwhile, this study also reveals that regional climatic and cultural differences lead to differences in the size of the courtyards, the combination of buildings, and the clustering of the courtyards in different regions. This difference becomes an essential factor in the geographical characteristics of urban morphology. Finally, this study demonstrates the methods and paths for interpreting urban morphological features based on the characteristics of building types, providing new perspectives for a comprehensive understanding of the characteristics of Chinese historical and cultural cities and their elements.

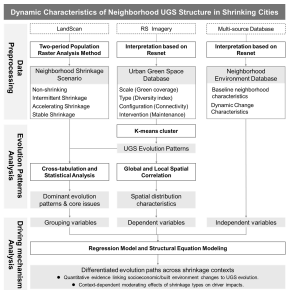
Genotypical study of urban form using analytical AI tools



Sepher Zhand | *University College London*
Kayvan Karimi

Keywords:
Space Syntax, Analytical AI, Genotype, Machine Learning, Spatial Data Science

Spatial configuration has proven effective in explaining urban structures, particularly concerning social, political, and economic phenomena. As a scalable concept, it provides insights into the evolutionary processes shaping the built environment and its underlying dynamics. This study examines spatial configuration as a framework for understanding how these overarching processes influence the formation of distinctive urban forms or genotypes. By integrating machine learning and analytical AI with conventional spatial analysis methods of space syntax, this research investigates the limitations of traditional workflows in urban studies. While data science tools offer scientific rigor and analytical precision, their direct application within space syntax remains in its early stages. Using Tehran as a case study, this research highlights the potential of combining data science and spatial configuration analysis to better understand complex urban structures. It argues that although AI-driven approaches enhance spatial analysis, their integration requires refining iterations to optimize results. These iterative refinements reveal critical structural characteristics inherent in the built environment, demonstrating that the analytical depth of space syntax can be expanded through carefully adapted data science methodologies. The results suggest that the frequently used unsupervised methods in data science cannot be directly implemented in this field without expert interpretation, intervention, and methodological adaptation. Ultimately, this study underscores the need for interdisciplinary approaches in urban spatial analysis. By bridging conventional spatial analysis with AI and machine learning, it provides a pathway for addressing existing methodological gaps and enhancing our understanding of urban spatial dynamics.



Machine learning Driven Insights into the Dynamic Characteristics of Neighborhood UGS Structure in Shrinking Cities

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Xinye Fang
Conghui Zhou
Jiayin Hou

Keywords:
Urban shrinkage, Green spaces, Dynamic evolution, Deep learning, Machine learning

Urban green spaces (UGSs) play a vital role in enhancing urban resilience and livability. The evolutionary patterns of neighbourhood UGSs differ significantly between shrinking and expanding cities, driven by contrasting socio-spatial dynamics. In shrinking cities, UGSs primarily emerge through bottom-up regeneration, where spontaneous vegetation colonizes vacant lands. In contrast, rapidly expanding cities tend to adopt top-down greening, with hierarchically planned UGS systems deployed to support urban growth. However, most existing studies on UGS structure focus on the urban scale, neglecting the need for more refined regulation in shrinking cities. Therefore, comprehensively investigating the dynamic characteristics of UGS structure at the neighbourhood scale, such as scale, type, and spatial distribution, in shrinking cities is crucial for promoting sustainable development. Taking Hengyang, China as the study area, we first classified neighborhood shrinkage types based on land use types, built-up density, and population density change. Next, we identified UGS types, including natural and artificial vegetation, using YOLOv11 deep learning techniques. We then calculated the area and proportion of different UGS types and analyzed their spatial distribution and dynamics through multi-temporal land use overlays. Subsequently, we categorized neighbourhood UGS structural evolutionary patterns using a hybrid K-means and DBSCAN clustering approach. Finally, we identified the dominant influencing factors of UGS structural evolution under different shrinkage scenarios using explainable machine learning models. The research establishes an analytical framework for neighbourhood UGS structural evolution in shrinking cities, integrating multiple advanced machine - learning algorithms like YOLOv11, hybrid clustering, and explainable models. It reveals the mechanisms of neighborhood UGS structural changes, providing scientific support for targeted spatial regulation. Moreover, based on empirical evidence from transitional developing countries, it enriches the international urban morphology theory in urban shrinkage and proposes a spatial intervention approach for policy formulation.

004

AI APPLICATIONS ON URBAN FORMS: City as a Device (Agents & Experiments)

Transforming Urban Planning with LLMs: A GPT Model for Plan Notes in Turkiye

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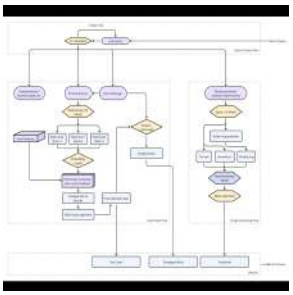
Can Aydin
Gizem Erdoğan Aydın
Murat Kılıç

Keywords:
Plan Notes, Large Language Models, Urban Morphology, Artificial Intelligence

In the urban planning process in Turkey, plans are integrated with plan notes and reports, and the plan notes produced during the plan-making process undertake a critical function in shaping the urban forms in terms of ensuring the applicability of plan decisions and their compliance with spatial features. Plan notes provide professionals with either a restrictive or detailed framework in the design process of urban forms. However, the writing of these notes is a time-consuming process that requires intensive specialized knowledge and is open to interpretation. Differences in the content and style of plan notes in different cities also make standardization difficult. This study aims to develop a GPT-based language model prototype that can support planners' plan note production processes by associating plan notes from various cities in Turkey with urban morphology indicators and fine-tuning them on OpenAI GPT models. First, plan notes were collected from different cities and these notes were matched with the urban form features (morphological indicators such as urban density, number of floors, building block typology) of the generated plan. The resulting prototype generates draft plan notes that can be used in plan-making processes based on spatial inputs received from the user (low density residential area, maximum 3 floors). Preliminary results show that the GPT model can provide planners with fast and consistent recommendations for producing plan notes supported by urban form data. In particular, providing morphological factors such as land use characteristics, city block typology and density as input data to the model has enabled the model to produce content that is more compatible with local planning decisions. This study provides an important application example in the field of urban planning and design on the use of large language models in specialized fields such as urban planning by fine-tuning them with local data.



From Retrieval to Generation: *Multi-Modal AI System for Context-Aware Urban Renewal in Historic Districts*

Yuqiang Ben | *School of Architecture, Tsinghua University*

Keywords:
Urban Forms, City as a Device, AI-driven Design, Urban Morphology

This study constructs an intelligent assistance framework for historic district renewal based on generative artificial intelligence, taking Shanghai Lilong as the research object. Innovatively integrating data-driven design, diffusion generative networks, and large language model technologies, we establish a multidimensional urban renewal decision support system. Through systematic investigation, we first build a knowledge repository of Lilong renewal cases containing spatial morphology, renewal strategies, and implementation outcomes. By employing RAG (Retrieval-Augmented Generation) integration technology, we achieve intelligent matching between design conditions and historical cases. Subsequently, we develop a figure-ground relationship generation module based on style transfer, combined with the deep analytical capabilities of large language models, forming a dual-channel feedback mechanism integrating “form generation and strategy analysis”. Furthermore, we propose an innovative facade generation method that combines modular parametric design with stable diffusion models, breaking through the bottleneck of balancing stylistic continuity and innovation in traditional design processes. The research realizes closed-loop design assistance from case retrieval to form generation and strategy analysis through technological integration, providing an intelligent solution for organic renewal of high-density historic urban districts that balances cultural continuity and spatial adaptability. Empirical studies preliminarily validate the technical feasibility while revealing greater application prospects of generative AI in urban renewal, offering a scalable technical exploration pathway for AI- empowered urban renewal.

Integrating Artificial Intelligence in Urban Design: *Balancing Innovation with Human Sensitivity*

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Keywords:
Artificial Intelligence, urban design, sustainability, generative design, human creativity

The advancement of Artificial Intelligence (AI) introduces new approaches to understanding spatial organization and the process of designing urban planning projects. By utilizing algorithms and machine learning, AI enables the simulation of different urban strategies, considering factors such as population growth, mobility, sustainability, and the efficient use of natural resources. On the other hand, it does not provide solutions based on subjective perceptions, creativity, intuition, and experimentation — elements historically associated with more innovative and humanized urban spaces. This study aims to analyse how AI can assist, modify, and enhance the design process and decision-making, its relationship with traditional design methods, and the possible loss of human sensitivity and uniqueness. The adopted methodology includes evaluating and selecting traditional methods — such as map and sketch reading and interpretation and drawing software — as well as AI-based methods — such as generative design, simulations, and algorithms. It then compares the urban design process developed using both traditional and AI-based methods. The qualitative and quantitative analysis of the design processes highlights that AI proves more advantageous than traditional methods in some aspects, such as optimizing the use of project space. It also aids in simulating solutions by presenting a greater number of possibilities at lower cost and time, analysing data and programmatic needs, and conducting environmental assessments. However, AI was outperformed by human capabilities in bringing sensitivity and cultural identity, in addition to exhibiting greater standardization of solutions. The study highlights the potential for hybrid methodologies that combine the key strengths of both methods, leveraging AI's efficiency while preserving human creativity and contextual sensitivity. In conclusion, the study contributes to the debate on the inclusion of Artificial Intelligence in the urban design process and the importance of collaboration with traditional methods to create more inclusive and efficient cities.

From Pixels to Participation: A Blueprint for Integrating Generative AI in Community Consultations

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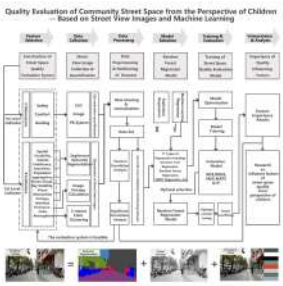
Ksenia Nikolaeva
Dan Nyandega

Keywords:
Generative AI, Co-Design, Community Engagement

Community consultations are a fundamental component of contemporary planning systems, offering a pathway to more democratic and socially responsible urban environments while reducing conflict. However, engagement processes often remain limited to informing or consulting citizens, with only advanced participatory approaches sharing agency and control. Co-design methods have demonstrated success in planning by fostering idea development and broad principles. Still, they are constrained by challenges in visualising outputs, often relying on rough sketches or schematic plans that fail to address urban form and its complexities fully. This study explores the potential of generative artificial intelligence (AI) as a strategic tool to enhance community engagement and advance discussions on planning, urban form, and design. Over a one-year project, the 'Midjourney' Generative AI model was employed in workshops held in Australia and Indonesia to enrich consultation processes, visualise community ideas, and facilitate deeper discussions. Participants included built environment professionals—planners, urban designers, architects, and landscape architects—alongside diverse community representatives such as residents, academics, merchants, and people with disabilities. The proposed method integrates generative AI into co-design approaches to scaffold discussions, enhance engagement, and provide efficient, real-time input into planning processes. By producing realistic, AI-generated visualisations during sessions, participants engaged in more detailed and precise discussions of urban form, addressing spatial, functional, and aesthetic dimensions often overlooked in traditional co- design. Results indicate that this approach enriches dialogue and effectively involves hard-to- reach cohorts, offering a new avenue for inclusive and participatory design. These findings highlight the transformative potential of generative AI in fostering more inclusive and impactful urban planning and design practices.

Quality Evaluation of Community Street Space from the Perspective of Children Based on Street View Images and Machine Learning



Di Guo | *Southeast University*

Keywords:
Children, Street space, Quality evaluation, View images, Machine learning

Community streets are the first playground for children. The study explores the correlation between street-space environment and children's subjective perception which is great significant for child-friendly community public spaces. In terms of approach, the study combines machine learning with street view images not only facilitates the acquisition of basic street data, but also ensures efficient and refined utilization of data, responding to the needs of inclusive and sustainable urban development.

Firstly, the study establishes a quality evaluation system of street space based on the behaviour and psychology of children. Then, the street-view images of children's height were studied, and semantic segmentation was performed using the Cityscapes dataset and SegFormer algorithm to accurately analyse the built environment elements; Using K-means clustering algorithm and visual entropy algorithm to comprehensively extract street spatial features; At the same time, the Elo image preference selection algorithm is used to quantitatively score children's subjective perceptions. On this basis, the study uses quantified objective data and subjective data as input and output variables for the machine learning model, and combines the random forest regression model algorithm to construct an evaluation model that accurately reflects the quality of street-space from the perspective of children. Furthermore, empirical research was conducted on six communities in Nanjing, and ArcGIS visualization was used to correlate the evaluation results with the coordinates of the measurement points. It was found that there were significant differences in child- friendliness among communities during different construction periods, and there were also significant differences in the spatial quality between different types of streets within the community; The quality of street space is the result of multiple factors working together, but the impact of different environmental factors on child-friendliness varies. Finally, the study proposes optimization strategies for overall and diversity, providing design for improving street space sharing.

AI based evaluation of the Viennese Gründerzeit facades for their complete inventorying, understanding and preserving

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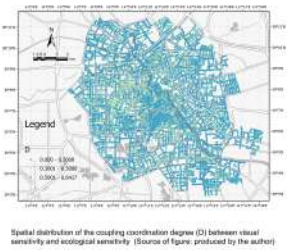
Sandra Guinand
Robert Musil

Keywords:
facades, heritage conservation, machine learning, preservation

Rapid urban growth, climate change, densification, housing shortage and commodification, have been affecting historic buildings located in our urban cores. In Vienna, the historic Gründerzeit buildings have undergone significant transformation in their inner but also external structure, especially their facades. These different interventions on the facades call for a better understanding of their original typologies, localisation, development and transformation to improve and secure their future preservation as heritage. The project aims at creating a systematic AI model to inventory, catalogue and analyze the facades of Viennese Gründerzeit buildings as a means to improve and secure their preservation as urban cultural goods.

To do so, machine learning algorithms are trained and used on existing stock of street view imagery to create an innovative model. Currently, the city of Vienna does not hold an exhaustive facade repository. This modeling and repertorying outside the simple cataloguing offer multiple perspectives. It creates a scalable and transferable model that traces and maps specific features and characteristics of these buildings that can be geolocated. It can also be an important tool for decision-making in terms of buildings' refurbishment in a much needed circular-economy while also informing on the improvement of the city protection zones. Finally, it can link the data set with other existing data to develop strategies for the maintenance of this cultural heritage. Our presentation intends to present a work in progress report on the research design, a detailed machine learning model and preliminary test results.

AI-Driven Streetscape Perception: *Analyzing Urban Morphology and Public Sentiment through Social Media Data*

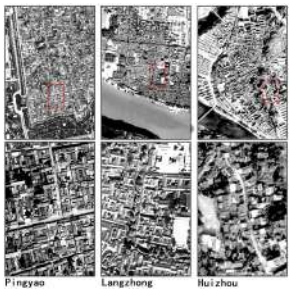


Spatial distribution of the coupling coordination degree (D) between visual sensitivity and ecological sensitivity. (Source of figure: produced by the author)

Yike Hu | *Tianjin University*
Zhihao Kang
Nadeem Ullah

Keywords:
AI-driven Urban Perception; Social Media Sentiment Analysis; Streetscape Morphology; Plutchik's Emotion Wheel; Human-centered Urban Design

Artificial intelligence (AI) transforms urban planning and morphological analysis, equipping cities with dynamic perception and optimization capabilities to enhance urban management. Social media data, with its spontaneity and multicultural diversity, offers real-time insights into public sentiment toward urban spaces, surpassing traditional surveys. By integrating computer vision, natural language processing (NLP), and machine learning, researchers can quantify emotional experiences and develop a public-driven urban morphological optimization model, advancing human-centered planning. However, existing studies are limited by survey-based evaluations, a lack of frameworks to leverage spontaneously uploaded data, and geographic constraints (single-region studies or cross-cultural) failing to establish a comprehensive system for analyzing the impact of streetscape morphology on collective emotions from a multicultural perspective. This study addresses this gap by proposing a deep learning-based multi-dimensional sentiment perception model, leveraging social media data to assess the evolving relationship between urban morphology and emotional responses. It analyzes 2,817 Instagram posts, combining images and textual comments. The ADE20K segmentation model extracts ten key streetscape elements: Road, Building, People, Mountain, Sky, Plant, Traffic Sign (TS), Water, Advertising Board (AB), and Vehicle. GPT-4o classifies sentiment using Plutchik's Emotion Wheel, identifying eight emotions—joy, trust, anger, sadness, surprise, fear, disgust, and anticipation—along with visual sensitivity (VS). A multi-layer perceptron (MLP) model links streetscape morphology with sentiment responses. Expanding this analysis, the study evaluates 56,210 street-level images from Tianjin's central districts (2013–2021), assessing trends and how urban transformation affects public sentiment over time. The findings indicate that higher vegetation coverage fosters positive emotions, while high-density urban spaces amplify fear and sadness. Pedestrian-friendly infrastructure correlates with increased joy and trust, while urban congestion intensifies emotional fluctuations. This study underscores AI's potential as a real-time urban sentiment optimization tool



Typomorphological Studies of Chinese historical areas Driven by Artificial Intelligence: Precision Restoration and Evolution Analysis

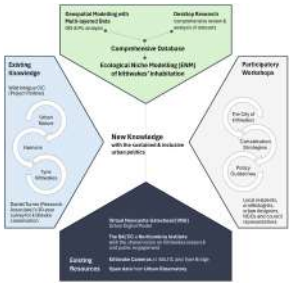
Ruotong Hu | *Politecnico di Torino*
Zhihao Zhou
Yuzhu Wen
Wenshuo Zhang

Keywords:
Convolutional Neural Networks, Generative Adversarial Networks, Multimodal Data Fusion, Typomorphology, Heritage conservation

The study of typomorphology in Chinese historical areas faces challenges such as missing or low-information pre-1949 maps, low-resolution satellite imagery, and scarce historical documentation. These limitations have resulted in reliance on subjective speculation and manual reconstruction of pre-1949 typological maps and roof plans, which are inefficient and inaccurate. This paper introduces an AI-driven method using Shanxi Pingyao, Sichuan Langzhong, and Anhui Huizhou as case studies to integrate existing typological maps, roof plans, pre-1949 satellite imagery, and historical documentation and speculated pre-1949 typological maps and roof plans, constructing a universal framework for historical reconstruction. By training Generative Adversarial Networks (GANs), the framework enables efficient and accurate restoration of pre-1949 tomorphological data for other historical areas.

The methodology includes extracting features from existing and speculated typological maps and roof plans using Convolutional Neural Networks (CNNs), employing GANs to generate data for damaged or missing historic areas, and integrating multimodal data such as remote sensing imagery, architectural plans, and archival records to address single-source data limitations. Results demonstrate the GAN model's high generalizability and accuracy, offering a broadly applicable automated tool for researchers. By combining AI with deep learning, the study establishes a universal typomorphological reconstruction model that significantly enhances precision, efficiency, and reproducibility while reducing subjective errors. This innovative approach advances typomorphological research and provides new solutions for cultural heritage preservation, urban renewal, and sustainable development.

Mapping the Habitation Patterns and Socio-ecological Dynamics of Kittiwakes along the River Tyne



Jiayi Jin | *Northumbria University*
Ayse Ozbil Torun
Bing Zhai

Keywords:
Urban Ecology, Geographical Information Systems, Kittiwakes, Socio-ecological Dynamics, Ecological Niche Modelling

The project, funded by the Arts and Humanities Research Council (AHRC, #UKRI271), explores the socio-ecological dynamics of urban kittiwakes along the River Tyne, highlighting their unique integration into the urban environments of Newcastle and Gateshead, UK. Since their initial settlement on industrial riverside structures in the 1960s, these unique seabirds have expanded to occupy a range of urban sites, including the Tyne Bridge and the BALTIC Centre for Contemporary Art (Coulson, 2019; Turner, 2010; Turner, 2020). While celebrated by many, their presence has also led to tensions over noise and waste, prompting the use of deterrent measures to prevent them from landing and nesting on man-made structures (Turner, 2002; Newcastle City Council, 2019; Wilson, 2022). Adopting a "more-than-human" perspective, the research employs ethnographic methods, Geographic Information System (GIS) mapping, and machine learning approaches to study kittiwake habitats and interactions. Advanced tools, including AI-based image analysis algorithms and Ecological Niche Modelling (ENM), reveal the geo-spatial distribution of kittiwakes within the urban areas and key environmental factors (eg, urban green spaces, proximity to water, human presence) enabling or deterring the presence of these birds. The findings suggest that kittiwakes' presence in urban areas is influenced by particular aspects of urban morphology and environmental conditions. As such, effective conservation and inclusive urban planning strategies should take these ecological factors into account. This research aims to inspire urban planning strategies that embrace biodiversity, fostering inclusive ecologies and sustainable coexistence in urban spaces.

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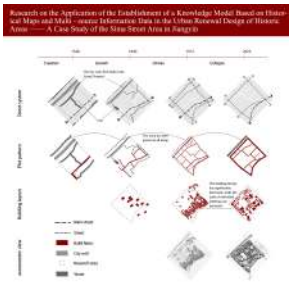


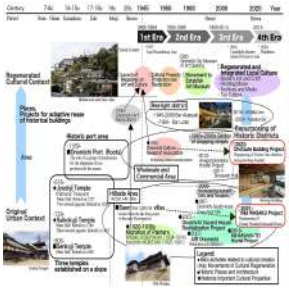
Research on the Application of the Establishment of a Knowledge Model Based on Historical Maps and Multi-source Information Data in the Urban Renewal Design of Historic Areas: A Case Study of the Sima Street Area in Jiangyin

Yvbei Lyu | *Southeast University*
Hao Deng

Keywords:
Historical maps, Knowledge model, Urban renewal, Large language models, GIS platform

Historical maps and historical documents are important media for urban morphology research and also crucial bases for urban historical heritage conservation and urban renewal, often constrained by conventional interpretation methods. This study develops a knowledge model to enhance the utilization of historical maps in urban renewal, with a focus on the historic district of Sima Street in Jiangyin. Based on the classic reading and analysis methods of historical maps and photos in urban morphology, this study applies large language models (Deepseek & ChatGPT) and natural language processing technology (NLP) to process text information in local chronicles, diffusion models (MJ & SD) for historical street scene generation, and the GIS platform to integrate information and quantify urban features, along with some other methods, attempting to explore the feasibility of evolving two - dimensional historical maps and images into multi - dimensional historical urban area knowledge models. Meanwhile, the utilization of existing updated design plans is also an important part of this study, aiming to further verify the operability of such a knowledge model in specific design practices and obtain feedback. The study finds that by conducting comparative research between this model and the current situation of the corresponding urban area at different resolutions, the research results can provide a more scientific reference for determining the work paths, starting plots, and key areas in historical conservation and urban renewal. This framework establishes a replicable workflow, transforming historical map resources into actionable urban design knowledge and providing a data - driven solution for balancing heritage conservation and sustainable reconstruction in historical urban landscapes.

Preservation of historical cities and the regeneration of cultural contexts during 80 years after the WW2: Responding to the challenges of resilience and re-purposing in the face of unstable environmental change



Yosuke Mano | *Institute of Science Tokyo (Former Tokyo Institute of Technology)*

Keywords:
Regeneration of Cultural Context, Repurposing of historic districts, Unstable environmental change, Urban Resilience, Built environment formed since the 20th century

This research raises issues about the conservation and repurposing of historical districts in Japanese local cities, which are becoming increasingly fragmented, from the perspective of regenerating cultural contexts. In the age of AI in Japan, urban morphology needs to respond to the unstable changes that are occurring in the built environment that has formed since the 20th century and is appearing in urban spaces, due to the rapid increase in building demolition and vacant lot and houses after 2020.

In this research, I analyzed urban transformation of slope areas and commercial areas close to the port in Onomichi City, Hiroshima Prefecture, where citizens are actively engaged in environmental conservation activities in response to the decline in sustainability caused by recent unstable environmental changes. The purpose of this research is to visualize the process of cultural context regeneration by understanding the interrelationship between spatial transformation and cultural activities in these districts, which are divided into four periods since the WW2, and to examine the possibility of cultural context integration.

First, based on research into maps and documentary materials, I represented the spatial composition and cultural context of each era and reproduced them on maps. Next, I summarized the development of cultural activities since the end of the war in a diagram. Alongside this analysis work, I conducted case studies of repurposing projects for historic buildings that contributed to the regeneration of cultural contexts and I analyzed the interrelationship between district revitalization and the regeneration of cultural contexts.

As a result, it became clear that the reevaluation of cultural resources and activities since the WW2, carried out through two building repurposing projects in the 2020s, would lead to the regeneration and reintegration of cultural contexts, and would have new direction.

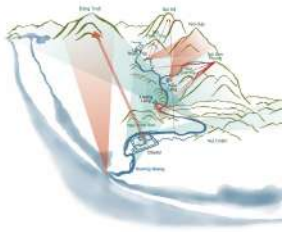
Urban Form Between Persistence and Extinction: *The Role of Artificial Intelligence in the Post-Disaster Reconstruction of Historic Urban Core of Antakya*

Mert Nezih Rifaioğlu | *Iskenderun Technical University*

Keywords:
Post-disaster, Urban Form, AI, Antakya

The historic city form of Antakya was damaged by the February 2023 earthquakes. The streets, cul-de-sacs, monuments, traditional residences, historical trade zone, natural landscape and topography in the historical urban fabric were destroyed by the earthquakes. In addition to the physical features of Antakya's historic city form, the social life of the historic city form has also been destroyed, and those living in the historic city form have had to move to other cities. Today, there is a sadness, emptiness and loneliness in the historic city form. All landmarks that provide spatial reference to the historic city form have disappeared. Except for a street corner stone or a tree left in the urban void, the parameters that we can perceive the integrity of the urban space have also disappeared. The historical urban form suddenly lost its cumulative cultural accumulation over the centuries with earthquakes. Under these conditions, in the reconstruction process of an urban form that has lost its integrity, it is necessary to utilize artificial intelligence tools to perceive and represent the urban form as it was before the earthquake. In this research, the ways of representing the urban form and urban memory by creating digital twins of the ruins left behind in the destroyed Antakya historical urban fabric with AI tools will be discussed. Within the scope of the research, studies on the realization of digital reconstruction of Antakya urban form with the combination of three-dimensional point clouds, old photographs, memories and natural landscape elements will be presented. Integrating the potentials of AI into urban form studies for healing the traumas that occur in the urban form after disasters and evaluating them for the protection of cultural heritage and reconstruction of urban form will be one of the main research topics of current and future urban form studies.

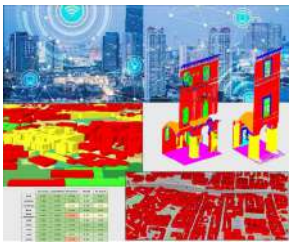
Creation of an Urban Morphology Archive in a Symbiotic Region Combining "Shan Shui (Mountain–Water)" and AI-Driven Interactions: A Case Study of the Huong River Basin in Hue, Vietnam



Shigeru Satoh | *Waseda University, Tokyo*
Keisuke Sugano | Huy Nguyen Quang | Tomoyuki Mashiko | Hieu Bui Thi | Tung Nguyen | Truong Hong Truong | Yukihiro Hirai | Susumu Kawahara | Kenta Kitani | Shigeo Tanaka

Keywords:
Urban Morphology, Huong River Basin, Shan Shui Spheres, GIS, 3D models

Urban morphology investigates the forms that emerge from human activities and iterative processes. Although its analytical methods effectively address discrete challenges, the complexity of contemporary urban and regional management calls for new approaches. Recent AI advancements provide opportunities to integrate interdisciplinary findings and manage these complexities more efficiently, bridging gaps among fields such as geography, ecology, and morphology.
This study focuses on the Huong River Basin in Hue, Vietnam—a UNESCO World Cultural Heritage site renowned for its historical Citadel, landmarks, and rich cultural heritage. The old Citadel and its surroundings are closely linked to hydrology, microclimate, and evolving human activities. We propose the concept of "Shan Shui (Mountain–Water) Spheres," emphasizing the integration of urban and regional morphology with ecological and cultural landscapes.
"Greenery Mountain (Shan) is walking, and moving above Water (Shui)" (Dōgen) Using historical, geographical, and morphological approaches, we developed "Shan Shui Archives" through GIS mapping and 3D analyses of each "Shan Shui (Mountain–Water) Sphere." This enabled us to examine intricate relationships shaping the Huong River Basin. We also designed an AI-driven dialogue system based on these archives, fostering iterative learning, adaptive applications, and multi-stakeholder interactions for dynamic, transformative urban morphology.
Key findings include: (1) clear visual and structural relationships between Hue's built forms and sacred mountains, rivers, and lakes; (2) deeper insights into cultural landscapes through 3D models and drone footage; and (3) the establishment of an AI-based archive supporting responsive design in urban morphology.
This research demonstrates that "Mountain–Water Spheres" can serve as vital models for regenerative and sustainable urban and regional systems amid global environmental challenges. It also underscores AI's potential to advance knowledge and design in complex urban environments, bridging traditional morphological approaches with novel computational methods. Our findings hold significance for planners, policymakers, and scholars seeking strategies for urban resilience.



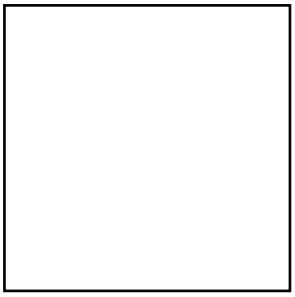
GEO AI tools for urban spaces and their built heritage

Antonia Spanò | *Politecnico di Torino*
Giacomo Patrucco
Marco Cappellazzo

Keywords:
ML/DL methods, GenAI, Classification, 3D city models, heritage conservation

As happened in many disciplines, also in the Geomatic field, the use of Artificial Intelligence (AI) methods such as Machine Learning (ML) and Deep Learning (DL) had a rapid, disruptive and pioneering development, substantially overturning the entire science of geoinformation. These innovations contribute to optimizing consolidated methods, opening new research avenues and enabling new solutions and products that were previously unattainable. However, this progress also increasingly raises significant challenges, including ethical considerations and questions on AI implementation. The present contribution analyzes the relevant operational advancements in the context of urban space and its building heritage, highlighting the research directions that influence the development of the tools for urban planning control and addressing challenges affecting its evolution. A complex set of research directions emerges in the realm of 3D city models, which aim to integrate cognitive systems that allow the combination of geometric and semantic information. These efforts focus on making model creation more time-efficient and sustainable in terms of effectiveness while enhancing their usability and application potential. A closely related field of study which, due to its complexity and range of investigation tools, could almost be considered a new science, is autonomous navigation for robotic systems (aerial, terrestrial, wheeled, or other mobility types). This research relies on AI for real-time navigation control, which is highly challenging due to the scarcity of frequently updated urban or territorial 3D models characterized by appropriate accuracy and richness of information. Finally, the contribution will summarize some experimental investigations in the scenario of automatic classification supported by ML and DL techniques, as well as applications of GenAI (Generative Artificial Intelligence) for sustainable digital preservation. These studies are part of the research activities of the Geomatics Lab for CH, and have been developed through 3 doctoral theses focusing on multi-scale investigations of built heritage.

City Information Modeling (CIM): *Computational urban morphology, digitizing urban design and Artificial Intelligence (AI)*



Todor Stojanovski | *KTH Royal Institute of Technology*

Keywords:
Artificial Intelligence (AI), City Information Modelling (CIM), urban design, morphological structure, data structure

Artificial Intelligence (AI) inspires reflections on computational urban morphology. We are in a midst of a new revolution in machine learning with “neural nets” and Large Language Models (LLMs) capable of understanding human speech and written language and analysing content on images and videos. These artificial neural nets can semantically parse scenes on images recognizing objects, creating scene graphs, and describing content with text. Neural nets can recognise morphological elements and conceptualization only if they are supervised by experts and specialized neural nets and LLMs for urban morphology do not exist. This paper explores paradigms in AI and computational urban models, urban morphology as methodology for interactive virtual cities and peculiarities of professional urban design practices for developing City Information Modelling (CIM) software. CIM seeks to create disruptive digital tools for urban planners and designers with design elements and drawing boards that derive from morphological research and to develop software for analysis and design of cities that integrates data structure compatible with LLMs. Urban morphology understands the city as organism. The smallest cell is the individual parcel of land, together with its buildings and open spaces. The morphological structure implies a hierarchy with the street as underlying element followed by plots and their aggregation in blocks and buildings with land uses. Urban design can be defined as the art of making and shaping cities by creating compositions of morphological elements in physical space. Urban designers mix imagery and diagrams, maps and plans, typologies of buildings and streets in analysing and designing cities. The paper aims to inspire discussions on linking data structure and computational models with hierarchical morphological structure, establishing a connection between design elements and drawing boards with data structures, and describing suitability of AI and LLMs for the specific practices and deliverables of urban planners and designers.

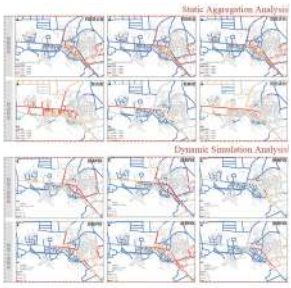
Decoding Urban Form Drivers of Building Energy Demand: Machine Learning-Driven Insights from Nanjing's Morphological Big Data

Fengmin Su | *Southeast University*

Keywords:
Urban Morphology, Building Energy use, Machine learning, XGBoost, Low-carbon design

Urbanization has exacerbated building energy demand, posing significant challenges for low-carbon urban development. This study uses Nanjing, China, as a case study to explore the relationship between urban morphology and building energy demand. Urban Building Energy Modeling simulations were performed to obtain building energy demand data, while the Momepy library was employed to quantify various urban morphological features, including building density, height, street network connectivity, and plot shape indices. An XGBoost-based machine learning model was developed to predict building energy demand based on urban morphology, achieving a prediction accuracy with an R^2 of 0.83. The SHAP interpretation framework identified building height, street network connectivity, and plot compactness as the most influential morphological drivers, with their nonlinear interactions significantly influencing energy demand. These findings provide quantitative targets for spatial optimization. The integrated framework - combining UBEM, morphological analysis, and explainable AI - offers valuable tools for climate-responsive urban design. Validated in the high-density context of Nanjing, this methodology demonstrates its potential for application in other megacities working toward carbon neutrality.

Research on the Optimization of Morphology and Atmosphere in Historical Streets Based on Multi-Source Data: A Case Study of Tangshan Old Street in Nanjing



Zhitong Sun | *Southeast University*
Yuting Chen
Hao Deng

Keywords:
Urban Morphology, Space Symtax, UNA, Urban Atmosphere, Stable Diffusion

As China shifts its urban development strategy from new expansion to the renewal of existing urban areas, historical streets and alleys remain key urban cultural intentions. Their renewal plays a crucial role in enhancing urban vitality and reshaping collective memory. Meanwhile, with the rapid advancement of artificial intelligence (AI), integrating AI into urban morphological renewal has emerged as an new research topic. This study examines Tangshan Old Street in Nanjing, China, as a case study, with a focus on residential historical districts. Based on multi-source data, an urban renewal framework is constructed from two dimensions: morphological renewal and atmosphere optimization. Quantitative morphological tools, including Urban Network Analysis (UNA) and Space Syntax, are employed to analyze spatial characteristics. Additionally, emotional demand texts from social media and government platforms are collected and examined to explore the role of emotional atmosphere construction in shaping residents' sense of belonging and collective memory as part of the urban renewal strategy. AI-based Stable Diffusion technology is utilized to generate atmospheric scene renderings, integrating physical space renewal with atmosphere optimization to explore new urban design approaches. By combining quantitative analysis and perceptual cognition, this research develops diverse spatial scenarios that support urban design strategy decisions, providing a new perspective on sustainable historical district renewal.

Predicting Changes in Elderly Housing Needs Using AI and Large-Scale Model Training

Siyuan Sun | *Southeast University*
Li Bao

Keywords:
Artificial Intelligence, Elderly Housing Needs, Large-ScaleModel Training, Architectural Design, Quality of Life

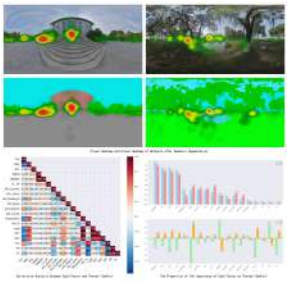
With the global trend of aging populations, understanding and addressing the evolving housing needs of the elderly has become a critical focus in architectural research. This study explores how artificial intelligence (AI) technologies, particularly through large-scale model training, can predict these dynamic changes. Technological advancements offer new solutions for enhancing the quality of life for the elderly. However, their housing needs are influenced by multiple factors such as health conditions, lifestyle habits, and social support, which evolve over time. Accurate prediction of these changes is crucial for architectural design, community planning, and policy-making. The primary objective is to develop a predictive model using large-scale data analysis. By collecting and analyzing multidimensional data on the physiological, psychological, and social aspects of elderly individuals, we constructed a robust model capable of forecasting changes in their housing needs. The model identifies key influencing factors and predicts future demands based on trends in these factors. Our methodology involved employing machine learning and deep data analytics to analyze elderly housing data. Complex neural network models were developed to achieve precise predictions. We also considered regional, cultural, and social differences to ensure the model's universality and accuracy. This research provides scientific evidence for architectural design, community planning, and policy formulation by accurately predicting the changing housing needs of the elderly, thereby enhancing their quality of life. Additionally, it introduces innovative AI applications in architecture, offering new perspectives and methodologies.

Utilizing AI for the Digitization and Analysis of Collective Memory: *The Case of İznik, Turkey*

Sinem Tapkı | *Bursa Technical University*
Ebru Kamaci Karahan

Keywords:
Urban heritage, collective memory, digitalisation, artificial intelligence, Iznik

The study, aimed at enhancing İznik collective memory of İznik with the help of AI technology, focuses on the city's extensive historical heritage. By collecting, digitizing, and analysing many forms of collective memory, including photos, films, and oral recordings, a comprehensive digital archive of the city's cultural past has been built. The project involved three main phases: the collection and digitisation of İznik's urban historical resources, the application of analytical approaches using AI, and the exploration of local views and values related to the city's past. Artificial intelligence technology has greatly enhanced the digitisation and analysis of İznik's extensive collective memory, revealing the cultural fabric of the city in ways that conventional approaches might have missed. To ensure the accuracy and cultural appropriateness of the AI interpretations, the project underwent rigorous validation and monitoring. The researchers faced technical difficulties in organising and analysing extensive, diverse data, which required a synthesis of technological analysis and the retention of nuanced insights from human knowledge and local context. Despite these obstacles, the research illustrates the considerable potential of AI technology for historical interpretation and preservation. Other historic city centres around the world can use this study as a framework to enhance the collective memory of their own historic areas. The advancement of artificial intelligence (AI) technology offers significant prospects for the preservation of urban history and culture by deriving new insights from collective memory and improving the protection of heritage assets.



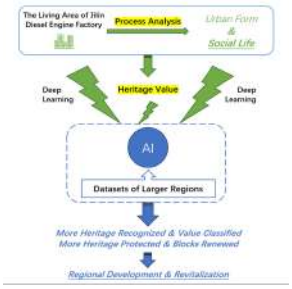
Research on the Visual-Thermal Perception Mechanisms and Spatial Elements of Campus Public Spaces in Hot-Humid Regions Based on VR and Physiological Measurement Technologies

Min Wang | *Southeast University*
Tinjin Wu

Keywords:
Thermal comfort, Visual-Thermal Perception, Campus public spaces, Virtual reality simulation, Human-centered design

University campuses in hot-humid regions serve as critical experimental sites for urban morphology studies, where public spaces frequently generate thermal stress environments during summer extremes. Light, temperature, humidity, and campus spatial configurations collectively impact students' outdoor thermal comfort. This study investigates the mechanistic effects of campus spatial elements on human visual-thermal perception, aiming to establish evidence-based strategies for human-centered campus design. Focusing on universities in Nanjing, a human-machine-environment collaborative framework integrating virtual reality (VR) simulations, machine learning algorithms, and physiological ergonomic measurements was developed. VR-simulated campus scenarios enabled machine learning-driven quantification of morphological features, including the Green View Index (GVI) and other spatial element indices. Concurrently, Electrodermal Activity (EDA) measurements, subjective questionnaires, and Laboratory Equipment Control (LEC) systems were employed to capture subjective perceptions and objective physiological data under precisely regulated temperature, humidity, and light intensity conditions. The Random Forest (RF) model revealed hierarchical impacts of spatial elements on summer thermal comfort: vertical vegetation (IAOI_Tree%=0.125) > green spaces (IAOI_Grass%=0.124) > Sky View Factor (IAOI_SVF%=0.11) > building elements(IAOI_Building%=0.07) > ground surfaces (IAOI_Land%=0.059) > water Features (IWater%=0.026) . Light intensity (r=—0.717) demonstrated significant moderating effects on thermal comfort. By syergizing VR simulation, machine learning,and physiological sensing, this research establishes a human-machine-environment interaction model, demonstrating the relationship between spatial morphology and thermal comfort in visul-thermal synergistic environments. The fndings provide quantifiable design criteria for optimizing campus public spaces in hot-humid regions advancing methodological integration for human-centered urban morphology studies, while supporting sustainable, data-driven spatial interventions.

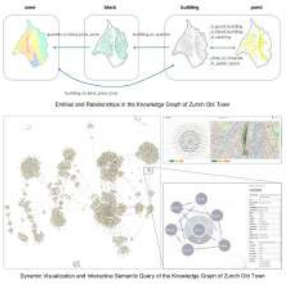
Exploring AI Applications for Conservation of Socialist China Heritage: *A Case Study of the Living Area of Jilin Diesel Engine Factory*



Xin Wang | *Peking University*

Keywords:
AI Applications, Conzenian School, Heritage Conservation, Socialist China, Workers' Living Area

The heritage of socialist China holds significant importance for the cultural identity of China and its industrial cities, but its value remains insufficiently explored, with workers' living area being a typical example. This study applies the Conzenian approach, integrating field research and local historical records, to analyse the changes in material space and social life within the living area of the Jilin Diesel Engine Factory. It aims to identify its unique heritage value and to discuss the application of AI in the conservation and development of urban heritage. The findings reveal that as agency changed during the reform period, transformations in the living area encompassed not only alterations in spatial layout but also notable changes in resident composition, residential density, and room usage compared to the original plan. Analysing these social factors fills the current research gap in urban morphology, as social life and collective memory are also essential components of heritage value which should be recognized. Furthermore, by applying AI deep learning techniques to the digital data of urban form and social statistics from this representative workers' living area, it becomes feasible to identify its distinctive features and heritage value, analyse future evolution trends, and propose conservation and development strategies. This foundational work allows for the integration of relevant information from broader areas, enabling AI to identify similar heritage sites from socialist China and categorize them by value levels. This approach facilitates coordinated protection and management, enriches the cultural heritage of the city, fosters cultural identity of the country, and contributes to improving residents' lives, thereby supporting urban renewal and revitalization in Northeast China.



Knowledge-Driven Urban Cognition Reconfiguration: A Knowledge Graph-Based Experiment on Information Integration and Decision-Making in Zurich Old Town

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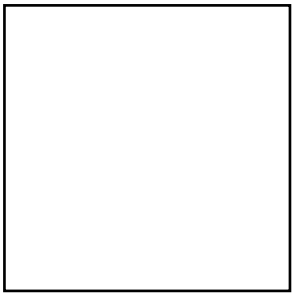
Keywords:
Knowledge Graph, knowledge-driven decision-making, urban tangible forms, urban intangible factors, conservation and renewal of historical areas

The AI era demands more comprehensive and well-structured knowledge for understanding complex urban systems, with technology tools represented by AI gradually shifting from purely data-driven approaches to knowledge-driven paradigms in urban morphology research. This study addresses the lack of correlation in analyzing urban tangible spatial forms and intangible influencing factors by proposing an intelligent analytical framework based on Knowledge Graphs. Taking Zurich Old Town as a case study, we construct a knowledge graph using the Neo4j graph database, transforming morphological elements (buildings, blocks, zones) and their associated environmental, functional, and historical-cultural attributes into a heterogeneous graph. This establishes a knowledge network integrating spatial topology, temporal sequences, and functional semantics. The research employs multi-dimensional semantic retrieval for information querying and graph theory algorithms for contextual reasoning, enabling the identification of morphological hierarchies, central spatial nodes, and culturally linked spatial sequences. The heterogeneous graph effectively integrates multi-source heterogeneous data, providing an extensible foundation for AI applications in historical areas conservation and urban renewal through non-linear knowledge networks. This computable and interactive urban knowledge system pioneers a knowledge-driven paradigm shift from empirical judgment to algorithmic decision-making in urban morphology cognition, offering innovative pathways for intelligent urban analysis and design.

AI Applications on Urban Morphology: Rethinking the City as a Device for Decarbonization and Transformative Research



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Keywords:
AI Applications, Research & Pedagogy with AI, Carbon-neutral Urban Environments

The integration of Artificial Intelligence (AI) into spatial morphology studies is reshaping both research and pedagogy, particularly within the context of decarbonization and emissions reduction. As AI technologies evolve, they present a dual challenge and innovative opportunities for educators and researchers navigating the studies and complexities of socio-spatial dynamics through data-driven, adaptive approaches. This paper investigates the impact of AI on research and pedagogical frameworks at a Research Center for Sustainable Communities in North America with a particular emphasis on resilient, safe, and smart cities. By exploring the intersection of AI and research on spatial morphology, the study inquires in what ways AI is reshaping the Center's transdisciplinary research strategies; and fostering new forms of partnerships. Through this case study, we reflect on how AI has not only redefined the Center's approach to morphological studies but also catalyzed integration of multi stakeholders, accelerating collaborative efforts among students, faculty, and community partners. Focusing on pressing urban challenges such as environmental pollution, decarbonization, and emissions reduction, this study reflects on AI's role in enhancing capabilities in data collection, analysis, and visualization, thereby deepening the understanding of urban form. Thus, the paper unfolds that AI is not only impacting spatial morphology research but is also redefining the role of higher education in shaping the next generation of scholars, planners, and practitioners focused on building resilient, and carbon-neutral urban environments.

An Interpretable Machine Learning Framework Based on Local Climate Zone Classification for Predicting Urban Energy Consumption and Solar Potential

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Keywords:
Urban energy simulation, Local climate zones, Machine learning, Solar radiation potential

Urban areas face significant challenges in managing energy demand and achieving sustainability amid climate change and rapid urbanization. Effective urban planning requires accurate simulations of energy consumption and solar potential that consider cities' unique climatic and morphological characteristics. This study presents a comprehensive framework that integrates local climate zone analysis, energy use simulations, solar radiation modeling, and Interpretable machine learning techniques.The study aims to incorporate the urban heat effect into energy simulations and apply machine learning to predict energy use and solar potential across diverse urban settings. The process begins by classifying downtown Nanjing into local climate zones. These zones are used to adjust standard meteorological data using an urban weather generator, producing modified weather files that capture the urban heat effect. These files serve as inputs for simulations that estimate energy use intensity and solar radiation capture. A suite of six machine learning models including extreme gradient boosting, light gradient boosting, random forest, gradient boosting decision trees, support vector machine, and artificial neural networks is rigorously evaluated using robust cross-validation techniques. The model with the highest prediction accuracy and computational efficiency is selected, and an interpretability method is employed to identify the key factors influencing energy consumption and solar potential. The findings indicate that integrating the urban heat effect significantly enhances the accuracy of energy and solar simulations, yielding a more realistic representation of urban climates. The results also reveal a strong relationship between local climate zones and building energy demand, where increased building density or height is associated with reduced annual cooling and heating requirements. This framework offers a scalable and adaptable approach for urban energy modeling that can be applied to diverse urban environments with minimal recalibration.