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A network based study of mobility in cities near green public areas

Keywords: complex networks, urban studies, multilevel networks, diffusion

Extended Abstract

A smart city is an urban area that uses technology, data and digital infrastructure to improve the quality of life for its citizens, enhance the efficiency of city services and promote sustainability. Complex networks can enable the extraction of useful information from technologies, such as the Internet of Things, artificial intelligence and big data analytics, in a comprehensive way. This would enable common urban challenges, such as traffic congestion, pollution, waste management and energy usage, to be addressed. Network theory offers a strong framework for analyzing and visualizing complex relationships in urban environments, including transportation, social interactions and infrastructure. This interdisciplinary approach aids in comprehensive city modeling and serves as a vital tool for policymakers to improve the robustness and resilience of urban landscapes [**1**]. This study highlights how the complexity and efficiency of integrated network infrastructues, such as transportation, energy and communication systems, affect city development. Complex networks can reproduce and explain the properties of city networks?that is, their dynamics, interaction and adaptation to changing conditions and the interplay between human behavior and technological advancements. We also consider the connections between different urban areas, focus-ing on the role of complexity and network theory in managing intra-city dynamics effectively.

One example of the application of network theory and statistical physics to city life is the analysis of the use of green areas in cities. Indeed, green areas are a crucial element in a city?s evolution, improving citizens? lives, reducing the effects of climate change, and making possible the survival of other species in urban areas. Unfortunately, these effects are difficult to assess quantitatively for regulators, stakeholders, and experts, making the planning of city development. Here we present a method to estimate the impact of these areas on city life based on the network topology of the city itself and on a simple model of the dynamics of this structure. Movements between various areas of the city are simulated using an agent-based biased-diffusion process where citizens try to reach the nearest public green area (PGA) from their position, and the model is fed with real data about the density of populations in the cases of study. First, we define a centrality measure of city blocks based on average farness measured on the city network; this approach outperforms information based on the simple topology. We then improve this quantity by considering the occupation of PGAs, thereby providing a quantitative measure of PGA usage for regulators.[**2**]. In this specific case We obtained a quantitative measure of GPA access by using centrality measures taken from network theory. At the beginning, we started by using the standard farness centrality; we then introduced a substantial modification with the concept of average farness, obtained by introducing optimal path distributions. Finally, to further characterize centrality through population difference, we also introduced a simple agent model, where agents compete in a noncooperative manner for access to PGAs following low-cost paths toward these. Then we compared all the above-defined centrality measures, and we derived information regarding the effective distance of PGA to city zones. Our analysis can help policy regulators a better planning when considering urban development.

References

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[2] Moi, J., Chiesi, L., Chirici, G., Francini, S., Borghi, C., Costa, P., ... & Caldarelli, G. (2024). Urban topology and dynamics can assess the importance of green areas. *Physical Review E*, **110**, 064128.

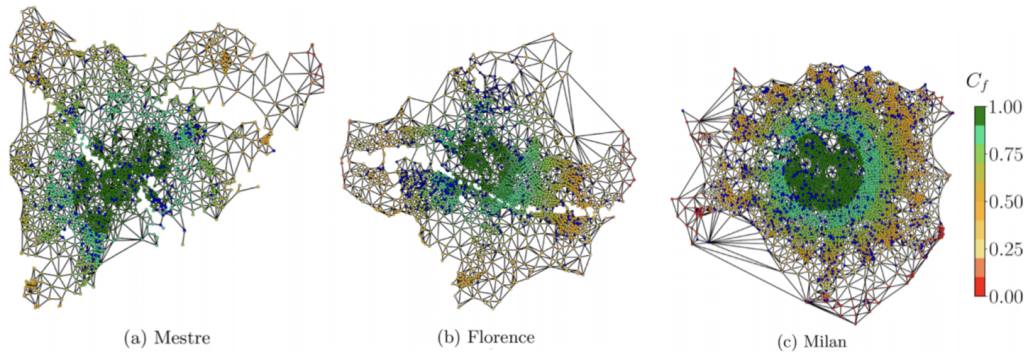

Figure 1: **Title.** Farness centrality Cf mapped onto the respective spatial networks with Public Green Areas nodes (blue).