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TOWARDS QUANTITATIVE URBANISM

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Abstract

There are always more data about cities and urban systems. This is unprecedented in our history and opens the exciting possibility of a 'Science of Cities', with the aim of understanding and modeling phenomena taking place in the City. Urban morphology and morphogenesis, activity and residence location choice, urban sprawling and the evolution of urban networks, are just a few of the important processes that are discussed for a long time but that we now hope to understand quantitatively. Now is the time to participate to the first steps towards quantitative urbanism. This effort towards understanding an object as complex as a city is necessarily interdisciplinary: we will need to build up on early studies in quantitative geography and spatial economics, on the knowledge of architects, urbanists and urban sociologists, and on the tools of geomatics together with modeling approaches coming from statistical physics.

Many, different actors are operating in urban processes and various layers of complexity add up in these systems. Understanding the main and dominant mechanisms governing urban systems was already on the agenda of quantitative geographers 40 years ago, and one way to reach it now is to analyze empirical data, extract stylized facts and to propose models in agreement with these observations. This approach reveals various problems, and in particular, the crucial question of the possibility of modeling cities and the importance of self-organization. In other words, a central issue is the possibility to consider the city as a single emergent phenomenon that takes place on various substrates determined by geography, culture, and history.

We can divide the available data about cities according to their temporal scale and in this talk I will briefly present recent results pertaining to this new science of cities by following this order, from time scales of order a day to long times such as decades and centuries.

- At a typical time scale of the order a day, mobility data gathered by mobile phones, gps, or RFID's inform us about where and when people move in the city, revealing in depth the spatio-temporal structure of activities in a city and statistical patterns of mobility. The availability of mobility data renewed the interest for understanding the laws governing the trips of individuals, such as the gravity law, and questioned its validity, leading to new, more accurate models. Also, these datasets provide a clear picture of the spatial distribution of activities, and of the existence of multiple activity subcenters, allowing us to discuss the possibility of a typology of cities in terms of degree of polycentrism.

- At a larger time scale, of a year, socio-economical surveys provide us with relevant informations such as the total yearly gasoline consumption, the total yearly number of miles driven, the relation between density and area, etc. The key of understanding how these different quantities scale with population is the mobility spatial pattern, and I will show how a simple model, inherited from previous studies in spatial economics is able to explain these behaviors. In particular, we can propose theoretical arguments to show that for large cities, the cost of diseconomies such as

congestion can overcome the scale economies for infrastructure. As a result, cities based on car traffic are not sustainable for populations beyond a value typically of order a few millions.

- Finally at very long scales such as decades and centuries, remote sensing and the recent digitization of old maps allows us to study the evolution of urbanized areas, transportation and road networks. We can then observe that large subway networks seem to converge to the same structure, characterized by similar values of morphological indicators, revealing the existence of dominant mechanisms independent from cultural and historical considerations. We can also observe the large-scale evolution of road networks, allowing us to characterize quantitatively the natural, ''organic'' evolution of an urban system. For some other systems, the influence of urban planning was crucial and this type of analysis permits to observe quantitatively the effect of such external, top-down processes.

This list of examples illustrates the extent of our agenda for a new science of cities. At stake, is the possibility of a quantitative urbanism with practical implications for the planning of future cities.