

Morphogenesis, Evolution and Co-evolution of Cities

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Urban systems have their own complexity and specific characteristics, but still have been described and modelled using analogies and models imported from other disciplines. In particular, biological metaphors have been widely used in urban planning and design. We argue that fruitful transfer of concepts between biology and urban science can be achieved within a complexity interdisciplinary framework. We illustrate this idea by synthesising a recent stream of research focusing on urban morphogenesis, urban evolution and urban co-evolution. First, urban morphogenesis can be understood as the growth of urban form, at the scale of a city or an urban area. [1] compares and calibrates morphogenesis models at the district scale. [2] shows for urban areas in Europe that reaction-diffusion models can accurately reproduce existing urban forms. Then, the concept of urban evolution can be related to cultural evolution in urban systems, but also to cities themselves as evolving entities. [3] proposed an *evolutionary theory of cities* to understand the dynamics of urban systems, in the sense of adaptive complex systems. In that context, a model of urban evolution is introduced by [4] in which the main ingredients are innovations propagating between cities. Finally, [5] introduces a multi-level definition for a concept of urban co-evolution, with at the intermediate level the possibility of *statistically co-evolving population of urban entities within territorial niches*. A method to characterise it on spatio-temporal data was introduced by [6]. At the mesoscopic scale of urban areas, the morphogenesis model of [7] effectively captures such a co-evolution between indicators of urban morphology and the topology of road networks. At the macroscopic scale of the system of cities, [8] study a co-evolution model between cities and inter-city networks, and show that diverse regimes of co-evolution can be produced. We suggest that other several interdisciplinary bridges could be relevant to urban science. For example, biomimicry has been put forward as an effective tool for urban design and architecture, while the concept of autopoiesis has not been applied yet to urban systems. Urban computing and collective intelligence, as research fields such as smart cities and digital twins are emerging, may also be linked to studies of collective computation in biological systems. Altogether, understanding urban systems as complex systems implies an interdisciplinary integration of concepts, methods and models.

References

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