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Modeling Gentrification as a Relocation Flow-Based, Spatio-Temporal Process

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Gentrification, "the rapid increase in cost and standard of living in a disadvantaged neighbourhood", causes the relocation of lower-income inhabitants in favor of wealthier citizens[1]. Relocation is caused by socio-economic inequalities and may be influenced by the presence of amenities and infrastructures. In this work, we focus on relocation trajectories and develop an agent-based gentrification model. We model society as a mixture of agents belonging to three (Low-, Middle-, High-) income profiles, with different needs and possibilities to improve their living conditions [2]. We represent the urban system as a regular lattice, in which each cell represents a neighborhood. Agents of different types base their choice of whether to move (relocate) on the current cost of living at different spatio-temporal scales. For example, high-income agents have access to temporal information regarding the fluctuations of cost-of-living across the cells, i.e., their rate of change. These relocation strategies align with two primary socio-economic gentrification theories: the economical "Rent-Gap"theory, which attributes gentrification to the disparity between a property's actual value and its potential rent under a more lucrative use, and the sociological "Demand-Side"theory, which suggests that middle-income residents exploring new neighborhoods attract high-income individuals. The overall model outcome is a collection of relocation trajectories of the three types of agents over time, which can naturally be translated into the framework of temporal networks. Our model does not have a specific termination condition. In fact, we model gentrification as a continuous process over time to capture its emerging and re-occurring spatio-temporal patterns. Ultimately, we introduce a temporal, directed, multilayer network-based gentrification indicator, $Gi(t, \Delta)$ of a neighborhood defined as the product of the out-flow of L agents leaving the neighborhood, and the coordinated in-flow of M and H agents observed in a time window of length Δ. We thus define gentrification of neighborhood i as a period of increase of $Gi(t, \Delta)$ followed by a local maximum and decline, indicating an increase in the number of incoming M and H agents, and simultaneous increase of displaced L agents, until both flows relax to zero: the relaxation corresponds to the completion of the gentrification process in the neighborhood.
We show how such flow-based measure allows us to capture the emergence of gentrification patterns, defined as transient peaks of $Gi(t, \Delta)$, well in advance compared to other, node-wise measures, such as the ratio between the fractions of M and L income agents populating the neighborhood.

References:
[1] N. Smith, "Of yuppies and housing: gentrification, social restructuring, and the urban dream,"Environment and Planning D: Society and Space, vol. 5, no. 2, pp. 151–172, 1987.
[2] G.Mauro, N. Pedreschi, R. Lambiotte & L. Pappalardo,"Dynamic Models of Gentrification", https://arxiv.org/abs/2410.18004.

Presenter: PEDRESCHI, N.

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