Capturing the social fabric: Population-scale socio-economic segregation patterns

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Segregation is a widely studied issue traditionally explored from the point of the spatial distribution of different groups, defined by individual attributes such as race, religion or social class. Instead, in this work we argue that the issues of persistent segregation, specifically socio-economic segregation, are in fact networked phenomena and should thus be studied as such [1,2]. We present a methodological contribution that moves away from a traditional spatial understanding of segregation, and instead considers segregation measurement within the direct social network of individuals.

The study is based on Dutch population register data sourced from multiple existing registers that contain information on formal ties of ~17 million residents. Data covers multiple social contexts (layers): kinship, household, neighborhood, school, and work. With the multilayer network of geospatially embedded formal ties in hand, we study to what extent social segregation is clustered in social networks, and how each network layer contributes to it. Specifically, we measure to what extent people are exposed to individuals of different socio-economic statuses (SES) for each of the social contexts. Moreover, we look at what social contexts provide diverse social contact opportunities with respect to the socio-economic status and, inversely, what social contexts play a role in sustaining so-called "socio-economic bubbles".

To capture socio-economic segregation patterns on a population scale, we introduce a concept of "social opportunity structures" that builds upon the Opportunity Structure Theory proposed by Ken Roberts [3]. Individual ego networks we observe in this study are assumed to be a realization of a particular aspect of Roberts' opportunity structures – they represent the anatomy and composition of social circles within which individuals exist, evolve, and are required to make successive choices. We aggregate household-level social opportunity structures in each of the selected contexts to the level of a municipality to measure to what extent households of a certain socio-economic status (captured by the equivalised household income) are, on average, exposed to households across all income deciles. In this abstract, we focus on the municipality of Amsterdam.

Estimated social opportunity structures for each of the selected contexts are represented by what we call *social opportunity matrices,* in which the vertical axis represents analyzed households divided into ten income deciles, sorted in ascending order. Then, the horizontal axis indicates income deciles of connected households in the increasing order. Each cell at the intersection of two income deciles displays the share of contacts a household of a certain income bracket (on the vertical axis) shares with the households in the income decile on the horizontal axis. Values are normalized by row. The diagonal elements represent the share of contacts each income decile has within its own income bracket. To capture the overall segregation for a particular context, we measure the extent of link assortativity [4] with respect to income.

Figure 1 presents social opportunity structures with respect to income for the households in the city of Amsterdam (~460k households) in the kinship, school, work, and neighborhood (both administrative neighborhoods typically containing several hundred to thousands of households as well as the ten closest neighbors) contexts. The estimated social opportunity matrices present a number of interesting findings.

First, in Fig. 1a we see that all income brackets are highly exposed to the neighbors that belong to the two lowest income deciles in the context of being in the same administrative neighborhood. Second, once the context is narrowed down to the subset of the ten closest neighboring households only (Fig. 1b), the matrix reveals a significantly different pattern: close neighborhood social context is much more assortative with respect to income, as evidenced by the assortativity value of 0.12 vs 0.04 in the case of the administrative neighborhood.

Third, the family layer (Fig. 1c) exhibits similar income assortativity pattern, with a high prevalence of within income bracket connectivity with 25-30% of family members living separately from an observed household belonging to the same income bracket.

Although the overall assortativity in the school layer is again comparable, the distribution of the preference for the own income class along income range is significantly dissimilar: the strongest preference to be classmates with children and adolescents that belong to the same socio-economic class is observed in the lowest income decile as well as in the richest 10% of the households. Finally, the workplaces' (Fig. 1d) assortativity is relatively high, however, we do not observe an apparent prevalence of diagonal elements, likely due to several very large workplaces being present in the data.

Concluding, we find that the analyzed social contexts are highly dissimilar in terms of socio-economic assortativity. The most assortative layer is the family network. Other layers, while being less assortative overall, reveal interesting patterns. Close neighbors and small workplaces exhibit highly assortative mixing patterns with respect to income that limits the exposure to individuals from different socio-economic backgrounds. On the other hand, school networks display relatively lower income assortativity and provide individuals with diverse social contact opportunities.

The broad implication of the present study is the potential to capture and quantify social segregation patterns on a large scale with the ability to distinguish between different social contexts, advocating the study of multi-layer administrative data for the purposes of obtaining a more global policy-relevant insight into population-scale social cohesion.

References

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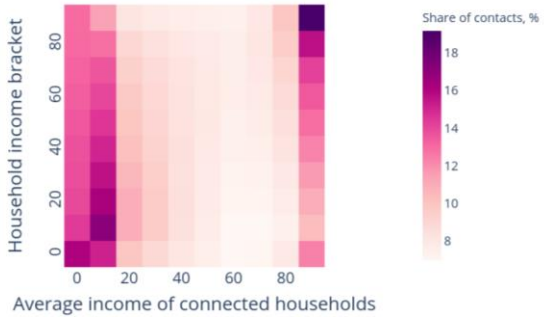
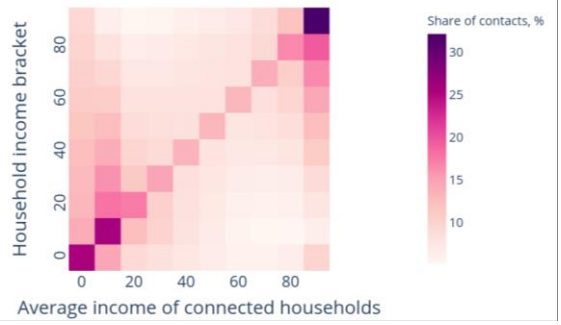
Figure 1. *Social opportunity structures of the households in Amsterdam, each subfigure displaying a different context:*

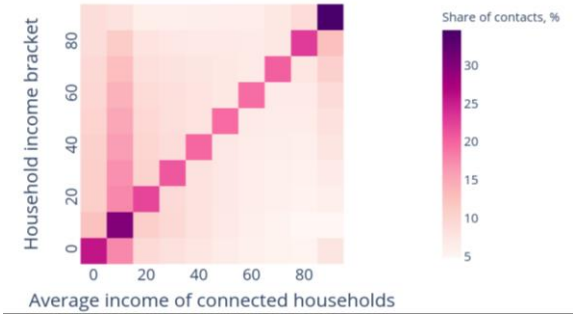
a) administrative neighborhood (assortativity: 0.035)



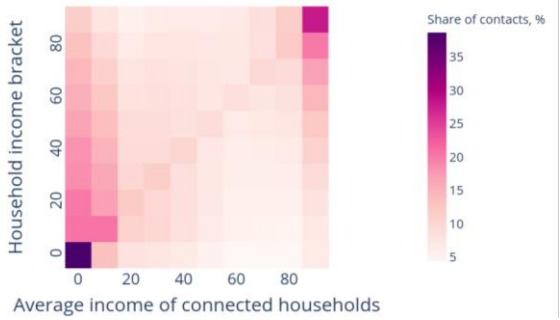
b) close neighbors (assortativity: 0.118)



c) family (assortativity: 0.124)



d) school (assortativity: 0.114)



e) workplace (assortativity: 0.123)