Generative coupled model for Urban configuration optimisation

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Supplementary Material 1

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Description of the agent-based model for economic evaluation

Purpose of use

We want to propose a model similar in behavior to SCHELLING's segregation model ([3]), based on the work by BENENSON on residential dynamics ([2]). The question of the influence of the underlying spatial structure on the output of the model appears as crucial. BANOS showed in [1], unlike previous results, that the network structure add strong effects on the convergence speed of the model and on the final result.

Therefore, our approach is to proceed to a simple coupling that consists in evaluating the spatial structure by measures on the final configuration given by the dynamical economic agent-based model .

Description of the model

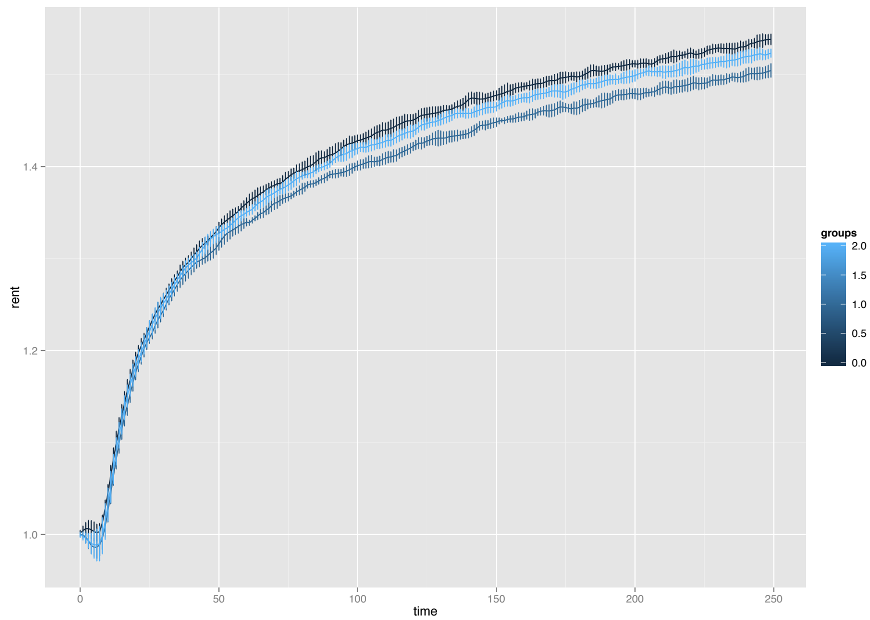
We are still located in the lattice world, in which cells values, houses positions and network are fixed.

A new variable is associated to houses (i. e. occupied cells), which is the rent $r(i, j, t)$. Mobile agents are households $h_k \in H$ that have a wealth function $w(k, t)$ and occupy the house $(i(k), j(k))$.

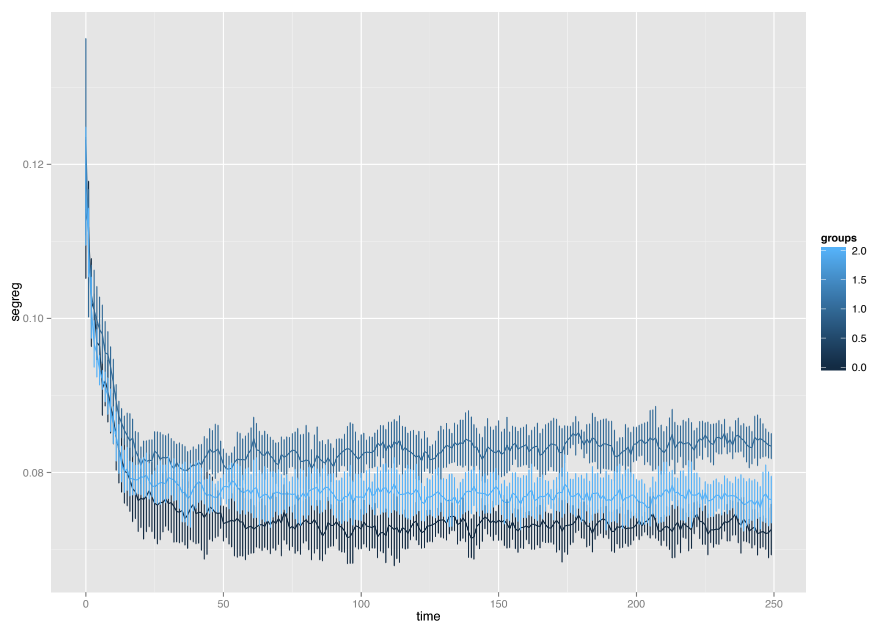
We begin with no occupied house, initial rents are a mean value m.

At each time step:

- Already present households may decide to move to an other inoccupied house, depending on the condition $\frac{v(i(k),j(k))}{v_{max}} \cdot \frac{w(k,t)-r(i(k),j(k),t)}{max_k(w(k,t)-r(i(k),j(k),t))} < \epsilon$, where espilon is a threshold parameter fixed. They occupy the better house possible according to $\frac{v}{r}$. If no house is disponible, they die (leave the city)
- N_i new immigrant come, with a random wealth $w \sim \mathcal{N}(m, \sigma)$ whith σ parameter small regarding m, and occupy best free houses (maximal number of immigrant is fixed by disponible houses).
- Rents are updated, set to the mean within a given radius r_e of wealth of households and rents of surrounding houses (gentrification effect).
- Wealth are not updated considering the supposed small time scale.



(a) Time-series of rents.



(b) Time-series of segregation indexes.

Figure 1: Convergence of the model. For each plot, each three curves correspond to a configuration of parameters. The values are calculated on 20 repetitions of the economic ABM, and the calculation is repeted on 100 initial spatial configuration, for which the error bars of distribution are ploted for each point.

Convergence and evaluation of segregation

After a certain number of time steps (around 100 in practice) the system freezes concerning indicators of cumulated wealth and segregation index, as it is explained in the litterature. Figure 1 shows the convergence of segregation index and mean rent of houses on many repetitions of the model for different values of parameters.

We are then able to calculate the segregation index on the frozen state, and defined by the classic spatial diversity index calculated on households:

$$d = \frac{1}{2max_h(w(h))} \cdot \frac{\sum_{h' \neq h} \frac{\left|w(h)-w(h')\right|}{d(h,h')}}{\sum_{h' \neq h} \frac{1}{d(h,h')}}$$

References

[1] Arnaud Banos. Network effects in schelling's model of segregation: new evidences from agent-based simulation. *Environment and Planning B: Planning and Design*, 39(2):393–405, 2012.

[2] Itzhak Benenson. Multi-agent simulations of residential dynamics in the city. *Computers, Environment and Urban Systems*, 22(1):25–42, 1998.

[3] Thomas C Schelling. Models of segregation. *The American Economic Review*, 59(2):488–493, 1969.