# Complex Systems Made Simple
# Project final report
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# Generative coupled model for Urban configuration optimisation
# Supplementary Material 1
# Description of the agent-based model for economic evaluation

November 19, 2013

## 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 $m$.

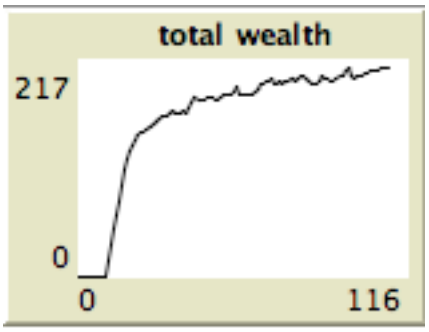


Figure 1: Convergence of cumulated wealth

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 $\sigma$ 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.

## 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 cumulated wealth.

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

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

## 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.