University laws in commuting flows
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We propose an individual based model to generate commuting networks from data giving numbers of in and out commuters of every locations of a region. It is inspired from the gravity model. We exhibit from the calibration of 80 various case studies that the only remaining parameter can be suppressed since it follows an universality law that we have extracted from calibrated case studies.

Gravity model: The traffic of commuters between two places $I$ and $J$ depends on:
- population of the residence place, $s^I$
- population of the working place, $s^J$
- distance between the two places, $d_{IJ}$

The modeling approach

Why do we need models?
- FROM AVAILABLE AGGREGATE DATASETS:
  - Total number of in-commuters $s^I$
  - Total number of out-commuters $s^J$

TO ORIGIN-DESTINATION TABLES

The traffic of commuters between two places $I$ and $J$ depends on:
- population of the residence place, $s^I$
- population of the working place, $s^J$
- distance between the two places, $d_{IJ}$

A new individual based morphogenetic model

All the individuals make a compromise between the job offer in each location and the distance between the residence and the location.

To each node are associated:
1- $x^I$ individuals looking for a job (out-commuters)
2- $x^J$ jobs available (in-commuters)

Temporal evolution
1- Random choice of a residence $I$ place with at least one available out-commuter ($x^I > 0$)
2- Random choice of the working place with probability:

$$P_{I\rightarrow J} = \frac{s^J e^{-d_{IJ}}}{\sum_K s^K e^{-d_{IK}}}$$

3- Random choice of the residence $I$ place
4- Update of the node quantities: $s^I, s^J$:

The parameter follows an universality law that we have extracted from calibrated case studies

UNIVERSALITY PROPERTIES OF THE PARAMETER

$$\beta = \beta^* < 8 >^\nu$$

$$\nu = 0.000115m^{-4}$$

The parameter can be fixed in an endogenous way as a function of the average surface of the locations

A cross-validation test

The traffic of commuters between two places does not depend directly on the distance but only on the cumulative population in a circle centered in the residence place (I) and with radius $d_{IJ}$:

$$(T_{I\rightarrow j}) = T_I \frac{N^J_{II^*} N_J}{(N_I + s_I)(N_I + N_J + s_{I^*})}$$