Thesis Progress Meeting

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Achieved Work (by projects)

- Network Necessity [1.2w]
- Density Generation (paper and toy-models tests) [0.4w]
- Biblio/Meetings/Organisation [1.2w] ; Reading Records [0.3w]
- Cybergeo Project [1w] (ETA 1w)
- Side projects (Discrepancy, Transportation Equilibrium, Ecology) [4w] (ETA 3w)

Network Necessity

Simple toy models to test theoretical assumption of network necessity

$\rightarrow$ Extended Gibrat model for population growth within a city system (simplified Favaro-Pumain model or projected Cottineau-1.y.z model) with interactions. *Idea :* Test if physical Network (feedback of physical flows) allows a better fit.

Rq. : a lot of confusion on Gibrat Model :

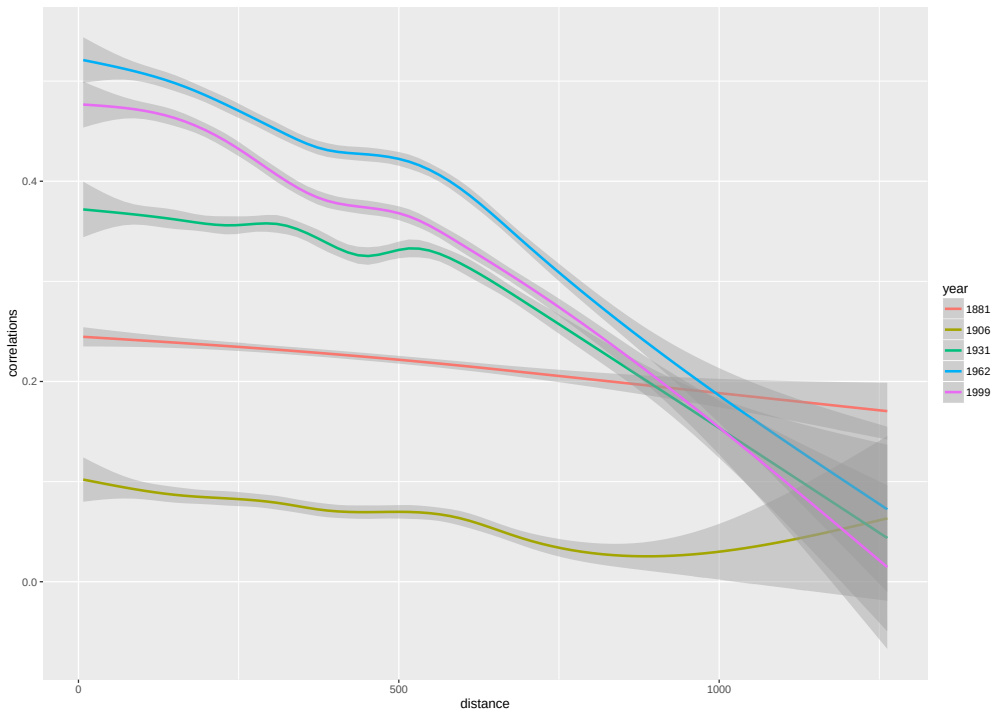
1. Under classical independence assumptions, $Law(P)$ is known at any t whatever the distribution of growth rates : no need to simulate).
2. Furthermore, various formulation are possible : independent realizations across cities of the same random process $P(t)$ with varying non-stationary parameters $\mu(t)$, with interdependence captured in recurrence relation between successive expectancies ; or multi-dimensional random process $(P_i(t))$ with covariance structure $\mathrm{Cov}[P_i, P_j]$ estimated in time.

Empirical Results

Work on Pumain-INED French cities database.

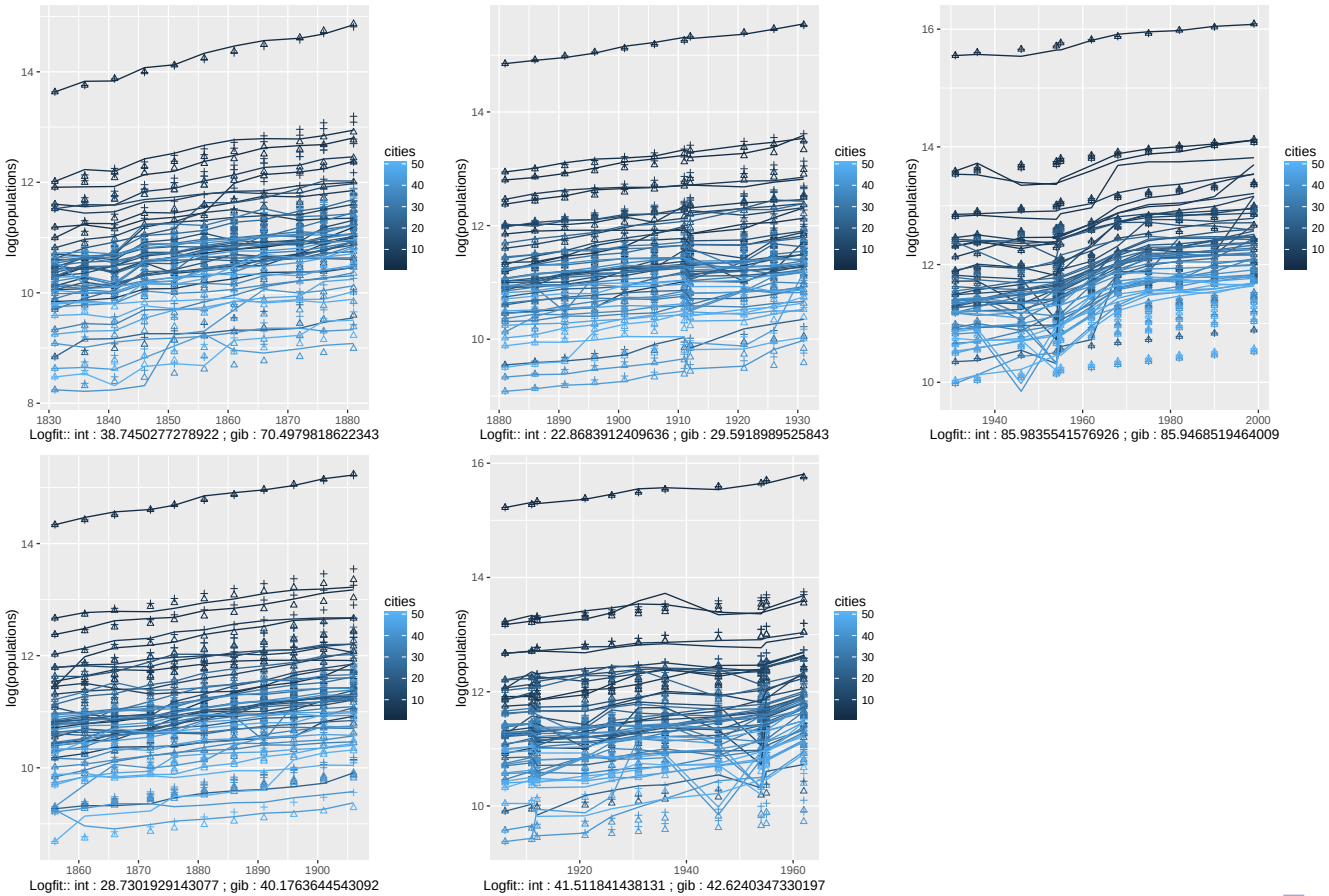
Growth Rates are more log-normal than normal ! (simple likelihood tests) - in fact $\Delta \log P$ closer from levy fat-tail distribution.

Non-stationarity of correlations in time and space :



First Modeling Results

Interaction model with $\mathbb{E}\left[\vec{P}(t+1)\right] = (r_0 \cdot \mathbf{Id} + \mathbf{R})\,\mathbb{E}\left[\vec{P}(t)\right]$, specified with gravity interactions $(\mathbf{R}[\cdot])_{ij} = \frac{1}{V_0} \cdot \left(\frac{\mathbb{E}[P_j]\,\mathbb{E}[P_i]}{P^2}\right)^{\gamma} \cdot \exp\left(-\frac{d_i j}{d_0}\right)$ (note : taking $\gamma = 1$ yields linear formulation).



Methodological Issue

Next step : Introduce feedback terms due to effective physical flows passing through the city (in a first approximation only geographically computed with elevation data), test directly for network necessity. Fitting that model should also allow to quantify tunnel effect (strength of feedback).

Methodological Flaw : Issue with overfitting in models of simulations (seems to be an open question) : how do we know fit improvement is not only due to additional degree of freedom ? In stats : AIC provides Kullback-leibler information gain by correcting log-likelihood with number of parameters, nothing similar for models of simulation. Possible solutions :

1. Empirical version of AIC : Brutal version with empirical likelihood ? Estimation of statistical models on parameter space of each model of simulation, use of corresponding AIC ?
2. Sparse non-linear machine learning to produce a kind of "absolute" benchmark explainable variance at a given number or parameters (rq : simple 2nd degree polynomial autoregressive model give far better results than two models above !)

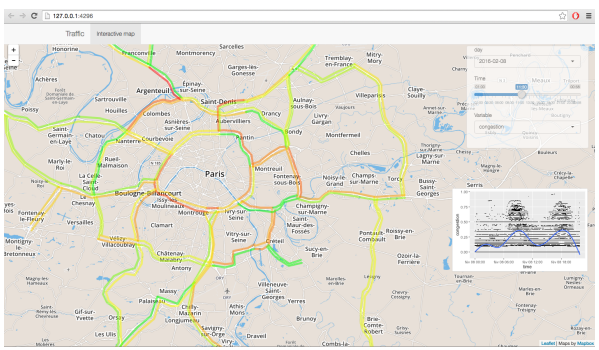
Terrain in China

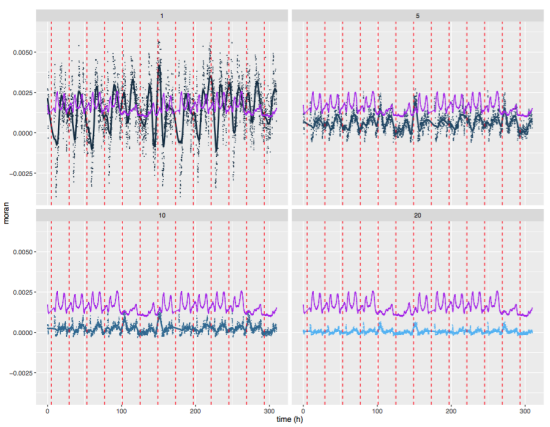
5-6 month in China from mid-september, in the frame of Medium project
Possible specific projects :

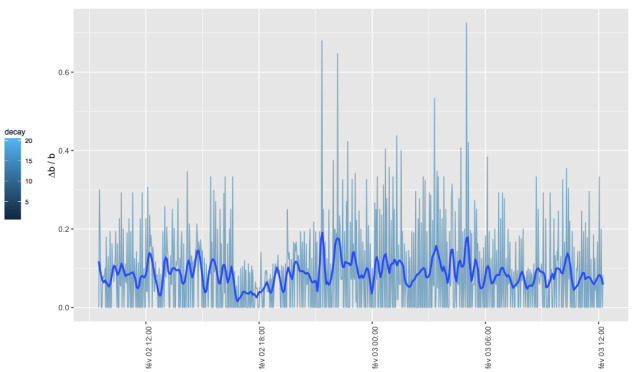
- **Zhuhai** : in neighborhood of Shenzen/Hong-Kong MCR : particular application of the Lutecia model ;
- **Hangzhou**

Transportation Equilibrium

Investigating the Empirical Existence of Static User Equilibrium.
3 month of 2-min traffic data for IDF freeways ; explored interactively with shiny app ; spatial and temporal stationarity investigated through spatial and network analysis.
[accepted (first round) at EWGT 2016]

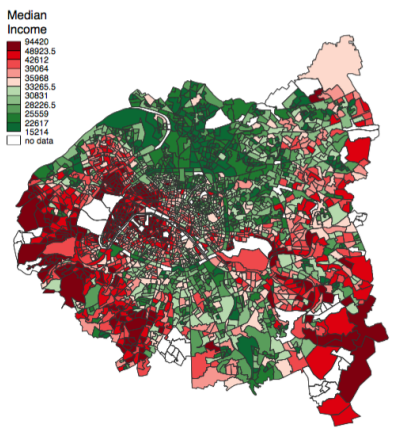


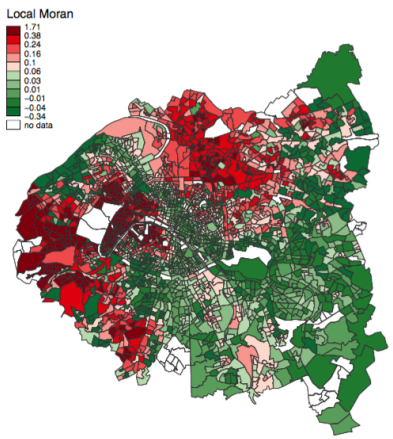


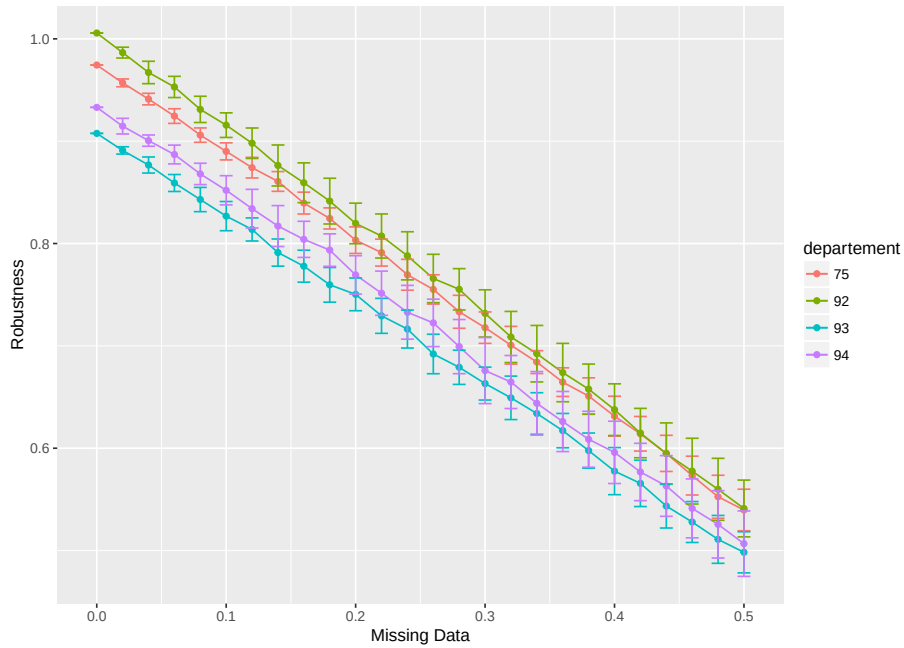


Discrepancy

Back on Discrepancy framework for robustness assessment : *real geographical application on segregation indicators for metropolitan areas* [submitted to CSDM 2016]





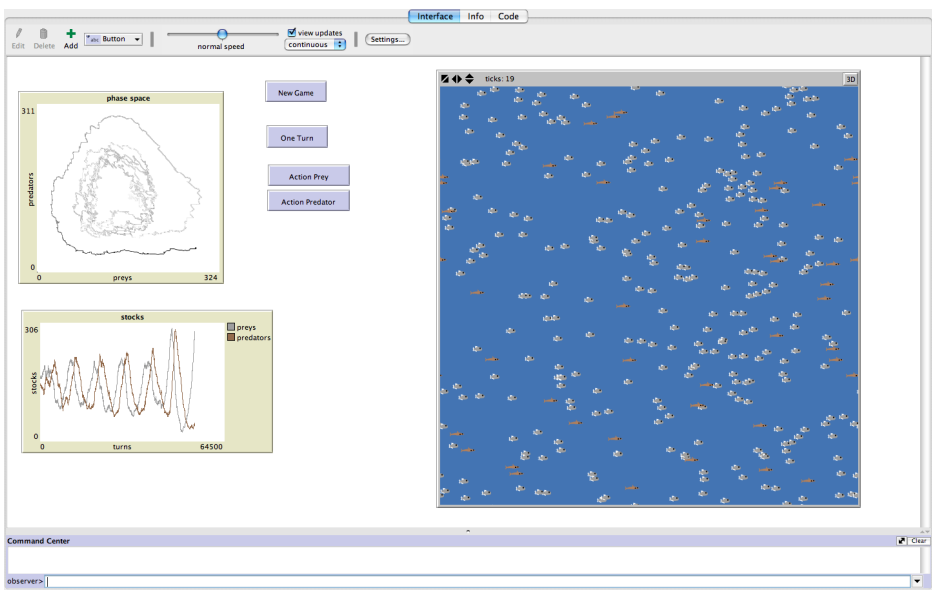


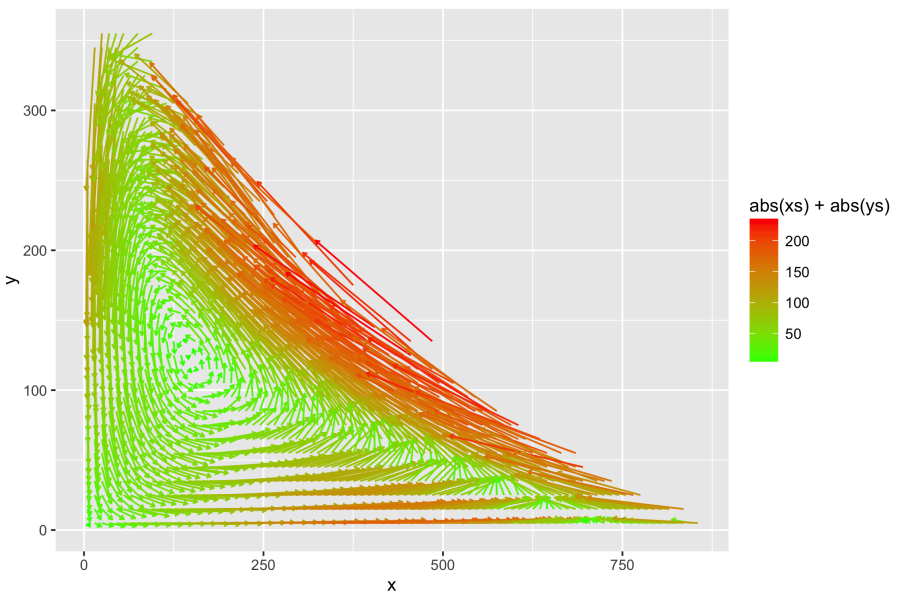
Scientific Mediation in Ecology

Game-based tools as media to transmit freshwater ecology concepts.

Agent-based computer game to mediate notions on dynamical stability of ecosystems (prey-predator model) ; complementary with qualitative board-game.

[poster at SETAC 2016]





Next steps (until June 10th 2016 - SFICSSS departure)

- Theoretical Paper if not crazy ? [1w]
- Spatial Statistics / Case studies (Le Corre and Baffi data) [2w]
- Cybergeo et al. [1w]

References I