

Network models for bike and car sharing systems.

Thématique. Networks.

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Domain description. Bike sharing systems as Velib' appear as an alternative green mode of urban transportation and have seen explosive growth over recent years. Indeed such programs have been launched in many cities around the world. System sizing and management are far to be easy. The users have to face the lack of vehicles or available slots in the stations, due to the difference of attractivity among the stations, or simply randomness. Maintaining both ressources, vehicles and empty slots, available in the stations to the users is a challenging problem for the operator. It is called regulation. Balancing the stations could be obtained either by incentives to the user to take ressources of a station which is better choosen, or by redistribution of the vehicles. Redistribution is made by trucks for bike sharing systems or someone for car sharing systems. The two systems have different rules, for example reservation for car sharing systems. However they can be both described as stochastic networks, similar to particule systems or communication networks. The aim is to understand their behavior, using models and methods developped for large stochastic networks, which are a hot topic of recent research. The intership is in this research area.

Goal of the intership. The goal of the intership is the following:

- To propose simple probabilistic models for Velib' and Autolib'. The aim is to address sizing and regulation problems. These models will take into account the main system parameters as
 - the total number of vehicules
 - the total number of stations
 - the numbers of slots in the stations
 - the arrival rates of users at the stations
 - the probability to choose a destination.
 - the trip durations.

The probabilistic models may describe the system policy, the behavior of the users, and investigate different scenarios regulating the system.

- These models will be studied under simple assumptions when the system gets large. The system behavior will be measured by the proportion of loss users, or the proportion of stations without one of the ressources.
- The models related to bike sharing systems will be studied. Both reservation and smaller station capacities made the problems more serious for car sharing systems. It will be shown. How to choose the number of vehicules in the system according to the load, and which load can be afforded by a

given system will be determined. The influence of parameters like station capacities will be discussed.

- The heterogeneity of the system imbalances it. It is difficult to propose an analytically tractable model for this. Heuristics allow us to study the impact of heterogeneity on regulation policies.
- Results will be validated by simulations. JC Decaux provide open data for Velib' since May 2013. Data analysis will allow us to extract realistic parameters for the simulator calibration. Furthermore, from data analysis, realistic models including the influence of geometry will be designed.

Bibliography.

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Expected skills. algorithms, probability, programming, stochastic networks (optional).