

Tracking of a dynamic graph: application to a bike sharing system

ECCS 13 WarmUp - Flash Talks

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Ideas

1. **Transformation** from a **graph** to a collection of **signals**
2. Track of the **structure** of the dynamic graph using **frequency analysis** of signals
3. Application to a **real** dynamic graph : study of a **bike sharing system**

Bike Sharing System (BSS)

- Many cities : Paris, London, Barcelona, Lyon,...
- Stations spread over the city
- Rent a bike from a station and return it to another station

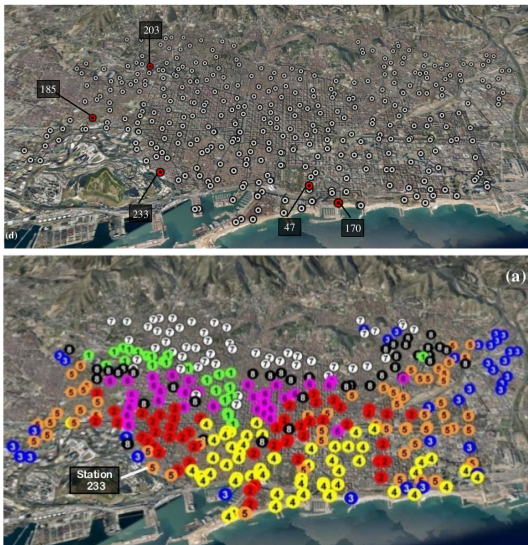
A **complex system**

Exemple 1 : Barcelona

bicing



[Froehlich et al. 2008]

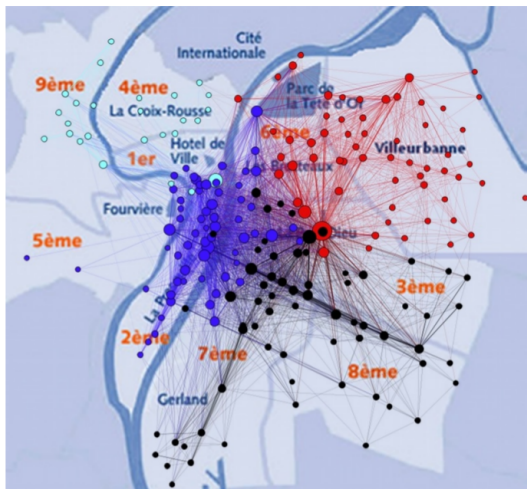


Exemple 2 : Lyon



[Borgnat et al. 2013]

Dataset : 7 millions of trips in 2011

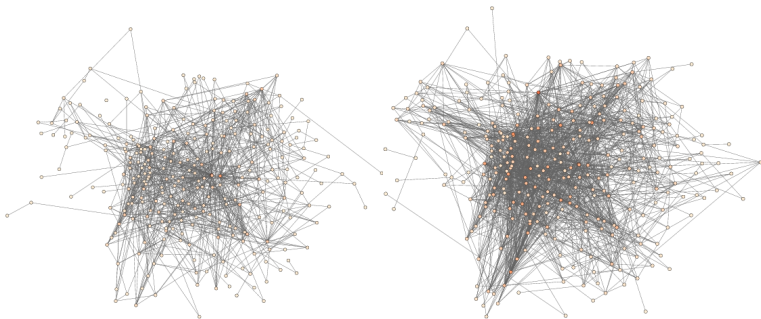


Vélo'v dynamic graph

Graph at time t

Nodes Stations

Edges A trip is made between two stations at time t

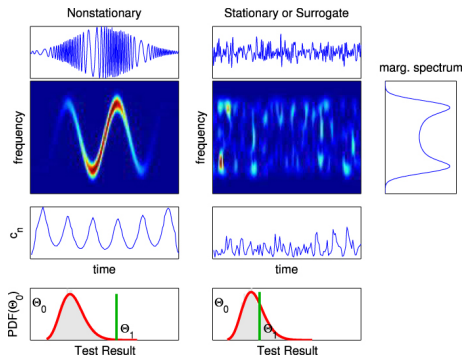


7 am

7 pm

Why signal processing ?

- Large knowledge about the study of **non stationary signals**



[Borgnat et Flandrin, 2009]

Transformation (Idea)

Graph \leftrightarrow Signals

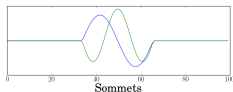
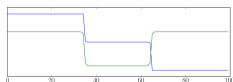
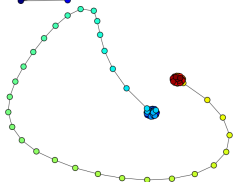
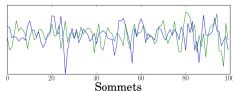
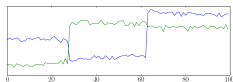
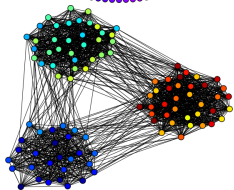
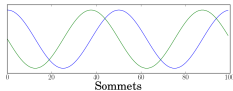
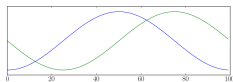
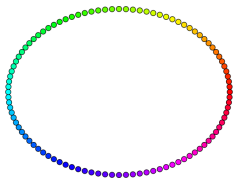
Transformation (Method)

Method

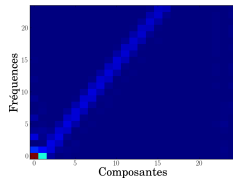
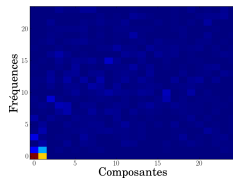
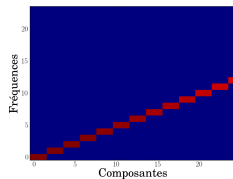
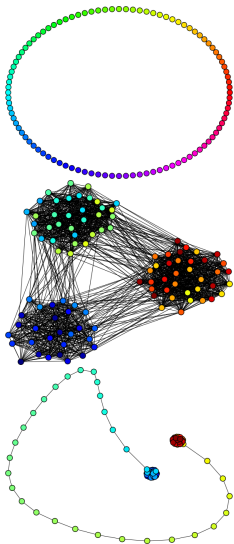
Projection of the graph in an Euclidean space using
MultiDimensional Scaling

Graph with n vertices \leftrightarrow $n - 1$ **series** with n points

Exemples

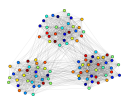


Frequency analysis : exemples

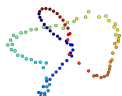


Tracking the structure of a dynamic graph : exemple

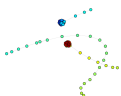
Snapshots of the dynamic graph at different times



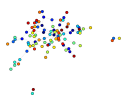
$t = 49$



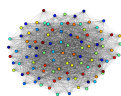
$t = 99$



$t = 149$



$t = 199$

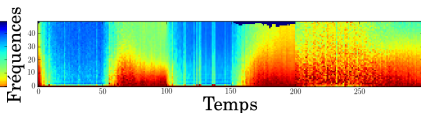
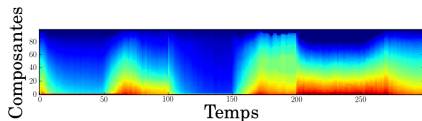


$t = 249$

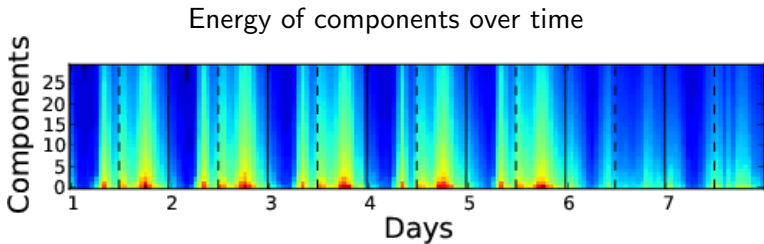


$t = 299$

Energy according to components and frequencies



Application to the Vélo'v graph



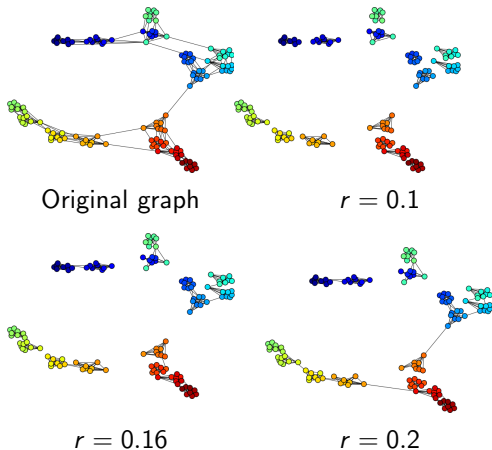
Conclusion

1. Transformation of **graph** into **signals**
2. Tracking of **frequency patterns** of these signals over time
3. **Real data** : highlight of the activity of the bike sharing system

Thank you for your attention

Bonus : inverse transformation

Keeping only a ratio r of signals



Detection of **communities** at different **scales**