Proposition de stage de M2
Localisation: Centre de Physique Théorique, Marseille
Directeur de stage: Alain Barrat, alain.barrat@cpt.univ-mrs.fr

Temporal network backbones

Abstract:
In many data sets, crucial information on the structure and temporality of a system coexists with noise and non-essential elements. In networked systems for instance, some edges might be non-essential or exist only by chance. Filtering them out and extracting a set of relevant connections, the "network backbone", is a non-trivial task. A number of methods have been proposed in the case of static networks [1,2].
The case of temporal networks, in which edges between nodes can appear and disappear, has however only recently been tackled [3]. In [3], a method was proposed to extract significant ties in a temporal network, using a temporal null model as reference.

The goal of this internship is to study in more details this filtering technique. The first step will be to implement the filter, if possible in python. The filter will then be studied on a series of data sets of temporal networks, and compared with other filtering methods, along the following lines:

- measure of various properties of the backbone as the level of filtering varies, in particular size of the largest connected component and total weight carried by the significant ties in the aggregated network;
- measure of properties of the backbone when taking into account temporality: measure of the fraction of pairs of nodes that can send a message to each other in a causally possible way;
- investigation of the properties of spreading processes along the backbone (using simple toy models of spreading processes), taking into account or not the temporal aspects;

In addition, we will investigate whether a representation of the network considering only the backbone and additional random edges can be close enough to the original network to be used in numerical simulations of spreading processes instead of the real original data. This could provide a way to represent complex data in a simpler way.

Required profile: statistical physicist with good numerical (coding) skills, preferentially in python.

References
[1] Extracting the multiscale backbone of complex weighted networks. Proc. Natl. Acad. Sci. USA 106, 6483–6488 (2009), http://www.pnas.org/content/106/16/6483.short
[2] Irreducible network backbones: unbiased graph filtering via maximum entropy. https://arxiv.org/pdf/1706.00230.pdf
[3] The structured backbone of temporal social ties, https://arxiv.org/abs/1804.08828