MAP-fis Essay Proposal, 2016-2017

(*please write in English*)

Supervisor

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Title

Impact of structure on dynamics in directed networks

Area

Complex Networks

Summary of Proposal

Many natural and manmade systems can be represented as directed networks. Examples include the World Wide Web (WWW) [Bro00], neuronal networks [Spo04], social networks, such as the control network of transnational corporations [Vit11], and many other real complex systems [Dor02, New03]. To properly understand such systems, we must understand the interplay between their network structure and the functioning of the system as a whole.

One distinctive aspect of the structure of many real directed networks is that these can be decomposed into components having different topological structure: a giant strongly connected component, which is the central core of the network, and the periphery, which consists of two sets of nodes IN and OUT, which are connected to the core [Bro00]. Given the directed nature of edges in these networks, the aforementioned decomposition imposes a direction of information flow, where IN nodes all connect into the core, acting as an input terminal, and OUT nodes receive information from the core, acting as an output terminal. This in turn is expected to influence the dynamics of systems that can be represented as directed networks.

Another aspect of network structure is heterogeneity. While it been shown that structural heterogeneity strongly impacts the critical behaviour of complex network systems [New03, Dor08], the current understanding of collective phenomena is mainly based on investigations of undirected random complex networks. Understanding of the topologically defined roles of directed network components in collective phenomena and the functioning of real social, biological, and technological systems is elusive.

The student is expected to survey the literature with particular emphasis on:

- Algorithms for detecting directed network structure;

- Dynamical models which are both well studied on undirected networks and which have been extended to/studied on directed networks (for example, Kuramoto and Ising models);

- The effect of directed network structure on dynamics;

- The topologically defined role of directed network components in synchronization and phase transitions;

The student is then expected to identify outstanding issues in the current understanding of the impact of structure on dynamics in directed networks and propose approaches to tackle them.

References

(t*o allow students first look at topic*)

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