1 Modeling and Analysis of Social, Economic and Financial Networks

Problem. Social, economic and financial networks are important. How can we model them? How can we reach deeper understanding and develop more efficient algorithms?

1.1 First Model

Information was deemed as a concept too complex to formalise. Then information theory came along, and the progress in the fields of communication and computing followed.

Can networks be formalised?

Take social networks, for example. Influence is one of the characteristic notions used to describe social relations. How can we come up with the precise definition of influence and derive implied properties?

All networks seem to have distinct similarities: there exist agents making decisions according to their decision algorithms (utility functions) and there are flows of objects (information, goods or funds).

So we can form the following hypothesis: networks solve an optimisation problem in a distributed manner by deciding on information/good/funds to offer and consume, there are links that are being created on which flow of information/goods/funds occurs. In this way, communities, influence, and reputation emerge as *solution concepts*: information/-communities are easy to find, information spreads fast and efficiently, decision-making on which links ot create is easy and accurate.

In information networks, agents produce and consume content. Agent have different interests in the content they want to consume, and there are different abilities to produce content. There is a cost for consuming content (agent independent), and there are rewards for getting interesting content (agent-dependent). Thus, the model of such a network must include:

- interests of agents (ring R with the ring metric $\|x_1 - x_2\|$ for $x_1, x_2 \in R$)
- distance between interests
- association between agents and interests (content is characterised by its type $x \in R$)
- interaction between agents (either agents decide to interact selfishly on their own, or there are other factors involved)
  - Which content to produce?
  - Which agents to connect to?
  - What content to forward on each link?

This model predicts that communities emerge as a Nash equilibrium. Producers/consumers in a community have similar interests. Agents specialise on producing a unique content. Produced/consumed content in a community is focused/concentrated on *main* interest of a community. There is a lso a differentiation between the content produced in different communities. There is a dichotomy between homophily and influence. In this way, reputation and influence become *optimality concepts*.

1.2 Future Research

There are several questions crying for an answer:

- How dos information spread in a community?
- How do communities form?
- Why are communities easy to find?
- How do hierarchies form?