# AKSOE 12: Social, Information-, and Production Networks III

Time: Thursday 10:15–11:45 Location: H8

AKSOE 12.1 Thu 10:15 H8

**Evolving R&D Networks** — •Michael König, Stefano Battiston, and Frank Schweitzer — Chair of Systems Design, ETH Zurich, Kreuzplatz 5, 8032 Zurich, Switzerland

We model economic network interactions related to R&D (research and development) activities of firms. Firms can increase each others productivity e.g. by providing a new technology or transferring knowledge, which is modeled as catalytic processes on a directed dynamic network. Specifically, we study the way firms select their interactions with other firms and the impact on the network structure. Our model considers the costs for R&D interactions, and firms optimize their interactions as utility-maximizing agents. We show that (i) the time horizon in which firms evaluate their utility and (ii) the emergence of cycles are critical factors for obtaining viable R&D networks. For the emergence of cycles, two cases are discussed: Firms can either mutually exchange technologies (direct reciprocity, 2-cycle) or share a technology with other firms and hope that they will benefit from the support of another firm (indirect reciprocity, cycle of order $k \geq 3$). Therefore, investigating the role of direct/indirect reciprocity is deeply connected to the investigation of the emergence/stability of cycles in the network.

AKSOE 12.2 Thu 10:45 H8

**A Trust-based Recommendation System on a Social Network** — •Stefano Battiston, Frank Walter, and Frank Schweitzer — Chair of Systems Design, ETH Zurich, Kreuzplatz 5, 8032 Zurich, Switzerland

Recommender systems are today widely spreading in web services. They are mostly based on centralized collaborative filtering, where an agent is recommended items which were chosen by other agents similar to her. In contrast, we present a model of a recommendation system based on trust relationships among agents of a social network. Trust evolves in time through a learning process and as a result agents can use their social network to reach information and their trust relationships to filter it. We identify the impact of network density, preference heterogeneity among agents, and knowledge sparseness on the performance of the system. We demonstrate that the system selforganises into a state close to the optimum. This is an emergent property of the system, achieved without explicit coordination from the local interactions of the agents.

AKSOE 12.3 Thu 11:15 H8

**Quantifying autonomy and differentiation in social networks - an information theoretic approach** — •Eckehard Olbrich, Nils Bertschinger, Nihat Ay, and Jürgen Jost — Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany

The modern theory of social systems achieves substantial insights through abstract concepts like differentiation and integration, operational closure or autonomy as exemplified in particular by the work of Niklas Luhmann. Yet these concepts, including the fundamental one of complexity, are only verbally defined and therefore do not yet readily connect with newer developments from network analysis and other mathematically formulated complex systems approaches.

We present a tentative proposal for a quantitative measure of autonomy. This is something that, surprisingly, seems to be missing from the literature, even though autonomy is considered to be a basic concept in many disciplines, including social systems. We work in an information theoretic setting for which the distinction between system and environment is the starting point. As a measure for autonomy, we propose the conditional mutual information between consecutive states of the system conditioned on the history of the environment. Levels of differentiation can be distinguished by using iterated differences of (conditional) entropies that reveal finer and finer distinctions between the behaviors of elements of an interaction network.

In simulations using an abstract model of a social network we show how these measures can be used to study the interrelation between the differentiation of a system and the autonomy of its subsystems.