

Networks

Traditionally, mathematical and computer science techniques have been applied to 'technical' networks, like telecommunication and railway networks. They are centrally organized, and all users have the same objective, or at least, act follow agreed rules, thus allowing the use of classical methods of operations research, such as linear programming and queueing theory. This has led to a good understanding of basic issues in network analysis like capacity, reliability, strength, congestion, and performance of networks and of steering and controlling operations like flows and circulations in networks.

Also distributed networks, which are not centrally organized but in which the actors yet act following commonly agreed rules, like computer and traffic networks, have been studied to some extent. The actors (computer users, car drivers, etc.) utilize a common network, each with their own objectives, but obeying accepted rules or protocols (generally). Here the methods of systems and control theory apply.

In both cases, a number of methods have been developed as a result of problems in actual networks.

The study of communication networks is highly relevant to new forms of communication, which often use the same network but with different types of messages: telephone, data, images, video, fax, etc., each with their own characteristics and priorities.

An important new aspect of traffic, communication, and railway networks is that several parties that use the same network (like internet or mobile phone providers, railway companies, car drivers) compete for its capacity, and that capacity assignment and priorities are controlled by new mechanisms like auctioning (train-line frequencies), pooling (mobile phone antennas), or market effects. This requires the development of new techniques in mathematical economics, game theory, and control theory. Also, software agents offer important new possibilities in capacity assignment and market effects. Apart from the design of the system, the investigation of emergent behaviour by simulation is relevant here. Thus, techniques from computer science are required, especially in systems of software agents, computational economics, and simulation of network systems by social learning techniques.

Then there are the transportation and logistics networks, with wide unexplored areas of problems and applications of network techniques, where different types of actors participate (transportation firms, factories, distribution centers, retail trade etc.), each type consisting of different, often competing actors.

In several other sectors of society too, networking is technologically underdeveloped: the health sector, agriculture, education, etc. A prominent initial issue is often that the network still has to be created: it contains psychological, cultural, and social components, in order to make the actors realize that the network, including its conventions and protocols, is in their interest. This can be approached by (new) techniques like evolutionary simulation, to address the social, economical, and psychological roles of actors in society, especially to address the social interactions and market properties in a society.

These issues merit attention, if only because of their potentially profound impact on society. CWI offers a highly integrated research environment, where experts in all disciplines can be found to actively work together on operations research, queueing theory, performance analysis, stochastics, network theory (including multicommodity flows in networks), optimization (linear, integer, and constraint programming),

algorithmics, systems and control, agent-based computational economics (ACE) and social learning (evolutionary simulation), computational intelligence (evolutionary, neural; for a.o. classification, optimization, negotiation, auctions, market mechanisms), electronic markets and e-business and applied algorithmics.