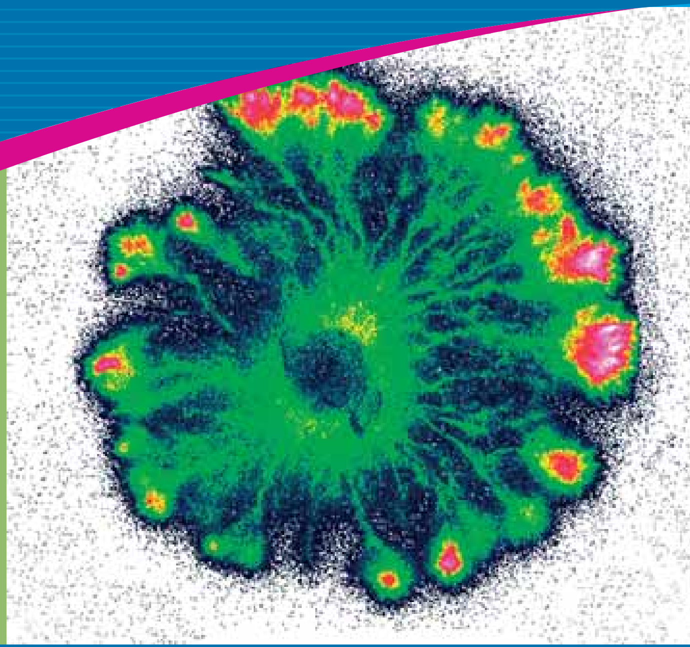
NEST Pathfinder

MMCOMNET

TACKLING COMPLEXITY IN SCIENCE



Fungal growths show common features with commercial networks.

Network news

Recent advances in the science of complexity facilitate the measurement of networks. Certain classes of complex networks seem to share common structural characteristics, and more importantly may also exhibit analogous functional properties. The quantification and modelling of networks enables general rules to be formulated concerning their dynamic and functional behaviour. The MMCOMNET project uses a multidisciplinary approach to measure and model biological, socio-economic and business datasets, with the aim of predicting, managing and designing behaviour in a wide range of real-world networks.

Fungal growth, supermarket supply chains and the clustering of biotech companies may sound like disparate areas of study. However, an understanding of each can be obtained by analysing them as networks. Biological networks share common features with other complex networks, in terms of their overall structure and dynamics. Once the general principles governing different kinds of complex networks are understood, steps can be taken to improve real-world networks.

The MMCOMNET project has set out to measure and model complex networks from different domains, with the goal of understanding their structure, function and behaviour. The multidisciplinary consortium forms part of the NEST PATHFINDER initiative on 'Tackling complexity in science'. This aims to encourage the study of complex systems and the transfer of knowledge between different disciplines.

Measuring networks

Networks can be studied using macroscopic or top-down approaches, or using bottom-up approaches utilising recent findings from the science of complexity. The MMCOMNET project seeks to integrate these approaches, in order to develop statistical techniques and software tools to analyse complex networks. Methods for measuring local (individual nodes) and global behaviour are also being assessed using existing datasets.

Data from three domains, representing biological, socio-economic and innovation networks, are being measured. The specific examples were chosen for ease of data collection, and their promise as generic models. The biological system is a fungal network: one of the simplest living systems to show adaptive behaviour. The main socio-economic system is a supply-chain network, involving the flow of information, money and goods from manufacturing, distribution and retail organisations across Europe. Datasets on public transport in Poland and traffic networks in Germany are also being analysed. The innovation system involves datasets showing the clustering of high-tech businesses, as occurs in California's Silicon Valley. In particular, a comprehensive dataset of the population and businesses in Stockholm over a 10-year period is being used.

Bottom-up analysis

The three types of system consist of multiple interconnected layers, comprising autonomous agents which allocate resources within the network. Agents distribute

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Traffic-network modelling provides insight into understanding complex networks.

MMCOMNET

AT A GLANCE

Official title
Measuring and Modelling Complex Networks across Domains

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Duration
36 months

Project Cost
€1 712 352

EU Funding
€1 499 226

Project reference
Contract No 12999 (NEST)

Web: http://www.cordis.lu/nest

resources on the basis of incomplete or noisy information. They typically act without a central control mechanism. The characteristic behaviour of networks emerges through the interactions of agents. Agents may be cells, people, or companies, in the case of biological, socio-economic and business networks, respectively.
The project exploits advances in complexity science to elucidate the individual and collective behaviour of agents. The participants are developing models which simulate the different combinations of agents and network dynamics that can account for desirable behaviour. Criteria for choosing between alternative combinations provide insights into how agents and networks adapt, and the trade-offs that occur between different network functions. In the case of the supply-chain model, for example, the conditions that enable networks to retain their integrity in the face of local disruptions are being investigated.

> Once the general principles governing complex networks are understood, steps can be taken to improve real-world networks.

Manipulating networks

Model networks can be used to identify ways of altering the structure or behaviour of real-world networks to enhance desirable properties, such as robustness, persistence, flexibility, responsiveness and efficiency. Adjustments in the local decision-making behaviour of agents, for example, may be effective in achieving desirable global stability.
The overall aim of the project is to generate modelling approaches and formulate universal principles to aid in the management of complex networks in real-world situations. The desirable properties observed in model networks can potentially be transferred, for example, to networks involving computers, information, business and enterprise, power grids, and railway and other transport systems. The potential long-term benefits from this project are therefore great, and could improve the quality of life of almost everybody in the EU.

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SIXTH FRAMEWORK PROGRAMME