NEST Pathfinder

DYSONET

TACKLING COMPLEXITY IN SCIENCE

Human behaviour depends on a range of networks with different networks coming into play in given situations.

In recent years it has become clear that common principles underlie the behaviour of many systems in the real world, which are composed of units connected into complex networks. Such networks occur in nature, physics and in many aspects of human social behaviour. DYSONET is applying mathematical principles to understand the dynamics of social networks. Study of real examples will improve understanding of how to optimise real-world networks, for example in limiting the spread of epidemics.

Understanding the dynamics of human behaviour

The Dysonet project is looking at a range of complex social networks. Its interdisciplinary team aims to develop techniques for specific problems, like the dynamics of crowd behaviour, which can then be tested in other more general systems. There are many unanswered questions about the structure of networks and about flows through them (e.g. of information). Ultimately the methods will be made available to researchers in all fields of study through the internet. Dysonet is part of the NEST PATHFINDER initiative on 'Tackling complexity in science'.

Real data analysis

Dysonet participants will first (with permission) collect real-world data from social networks in Sweden, covering networks of people who share the same household, work at the same workplace, live in the same building, attend the same hospitals, or are part of networks of sexual partners. It will also collect financial data for study of the dynamics of different types of portfolios traded in financial markets.
Most of the individuals in social networks (nodes) have a small number of connections, but a few have a very large number. Network models will be developed by Dysonet to allow study of robustness (the number of nodes which must be removed before connectivity of a network is destroyed) and the capability for network flow (the features of the optimal flow path, using the least time, energy or cost). To do this, the team will make use of large-scale computer simulations and grid computing, and develop new analytical, numerical and simulation techniques. The information gained will be used to identify designs of network models showing the best robustness and flow. The network analysis will then be applied to the real-world data, and should make large advances in understanding complex human systems.

Practical applications

Dysonet addresses five areas of collective human behaviour. The first will look at the spread of information and rumours across networks which, enhanced by mobile communications, can escalate out of control. Knowledge of this phenomenon will prevent further rumours like the one in Hungary in June 2003, which caused nationwide panic about a nuclear explosion. Understanding the relay of information through a crowd in

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DYSONET

Crowd behaviour may contribute to deteriorating situations such as traffic jams.

AT A GLANCE

Official title
Human behaviour through dynamics of complex social networks: an interdisciplinary approach

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panic will help develop more efficient evacuation methods, for example from football crowds, earthquakes or terrorist attacks.

The behaviour of networks can contribute to organised search strategies, e.g. for missing persons. In a random search, a new direction and distance are selected by the searcher every time the target is not found; better understanding of this behaviour will help to design more effective collective search methods.

Traffic flow is an example of crowd behaviour where enhancing flow is important. If a large number of drivers are heading in the same direction, their choice of route will be influenced by the same information, from their observations and traffic reports. Collective behaviour emerges, making the bottlenecks worse. This study will contribute to more effective distribution such as of food and medical aid.

An area where the aim is to minimise flow, is that of epidemics. The epidemic spread of disease is almost inevitable if individuals are immunised randomly, but if the most-connected individuals are targeted, immunisation is much more effective. However these key individuals are very hard to identify. Dysonet studies will improve the efficiency of such targeting.

In finance, collective behaviour is shown by adaptation to market changes, and in extreme cases to response to unexpected events, leading to changes in stock prices and even public hysteria. Such responses depend on the structures underlying information flow. Better understanding of the behaviour of this information flow would inform market regulatory policies. To be able to do so, Dysonet is investigating the structure of portfolios from leading and emerging financial markets. Later, the findings and methods will be applied to a commodity market, to examine common features of the two systems, so that the methods can then be applied to other types of networks.

> The analysis will make major advances in understanding complex human networks involving spread, for example of information or disease.

SIXTH FRAMEWORK PROGRAMME