

the whole is greater than the sum of its parts

“Complexity research is essential to the growth of the knowledge-based society, where new complex methods and technologies are increasingly important in a highly competitive global market.”

Understanding complex systems has only recently become possible through the use of computers with massive data-handling capacity. It offers great potential in unravelling systems in which the operation of the whole is more involved than the sum of the multiple contributing factors, such as the regulation of metabolic pathways, or control of manufacturing processes.

As a newly emerging approach, progress in complexity research has been variable until now, and mainly carried out on a national basis. The Complexity-NET Specific Support Action (SSA) will identify and analyse these national support programmes, setting the scene for future coordination at the European level.

Scientific research has traditionally examined simplified elements extracted from systems in an attempt to define the principles on which they operate and, if possible, to create a mathematical model capable of reproducing the functions of the original system. In cases where numbers are too great, e.g. in population studies, statistically valid samples are extracted to generate understanding of the whole system. Reduction to simple parameters in this way has enabled the very significant unlocking of the secrets of the natural and physical world.

However, the advent of powerful computers has empowered researchers to consider what can be discovered by looking at the whole mass of data, and the entire array of factors contributing to a system, rather than a sub-sample. Such systems, comprising a large number of interactive elements which may be organised on many scales and are not reducible to a simple summary, are known as complex systems. They can be described as self-organising, as they can respond to changing external or internal factors while retaining (or perhaps modifying) their vital characteristics. Complex systems evolve in a logical way, but in a way that may not be predictable from the original conditions. A wide variety of

computer programming and modelling techniques are now available to simulate the characteristics of these systems. Genetic algorithms, for example, generate a range of programming solutions and select the ones that prove accurate. Cellular automata are networks of sub-routines, each limited to one of the problem's real parameters; and Boolean networks, a third option, examines the problem in terms of basic binary logic and links yes/no options to build the larger picture. These methods all allow insight into the likely outcome according to the behaviour of the whole system.

The intriguing thing about the concept of complex systems is that it includes examples from almost all aspects of the real and conceptual world; from biological organisms, communities or processes (like natural selection, crowd behaviour, neural transmission), to physical phenomena (materials science, air turbulence), information systems (bioinformatics), sociology, education and business or financial management, manufacturing (intelligent process control), technology and design.



Specific Support Action COMPLEXITY-NET

Full title:

Developing ERA-NET on Complexity

Research field:

Complex systems and processes

Coordinator:

Denmark: Danish Natural Science Research Council/Danish Research Agency

Partners:

- Belgium: Fonds National de la Recherche Scientifique
- Estonia: Eesti Teaduste Akadeemia
- Greece: Ministry of Development, General Secretariat for Research and Technology
- Ireland: Irish Research Council for Science, Engineering and Technology
- Netherlands: The Netherlands Organisation for Scientific Research
- Portugal: Fundacao para Ciencia e Tecnologia
- Spain: Ministerio de Educación y Ciencia
- UK: Engineering and Physical Sciences Research Council

Further information:

Dr. Preben Alstrom
Vibeke Kalsbeek
Danish Research Agency
Artillerivej 88
DK-2300 S Copenhagen
e-mail: alstrom@coreas.dk
website: www.forsk.dk/eng/snf

Duration:


9 months

EC funding:

€153 720

Project reference:

SSA-011810-COMPLEXITY-NET



“ Our ambition is the formation of a Complexity-NET coordinated action that will raise European research and research training on complex systems to the absolute best level. ”

Emerging technology

Within the last ten years, the study of complexity has become one of the newly emerging technologies, at both a national and European level. Some Member States have begun specific national research programmes or included complexity in more general initiatives. One such is EXYSTENCE, the IST Programme's Network of Excellence which was set up to develop collaboration among European researchers interested in complex systems, from fundamental concepts to applications, and involves academia, business and industry. Another is the FP6 new and emerging science and technology (NEST) initiative on 'Tackling complexity in science'.

More coordination of national effort is now essential if Europe is to match US progress. This will be the role of the Complexity-NET Specific Support Action (SSA) which will bring together the main active national programmes of nine Member States, plus the Statistical and Non-linear Physics Division of the European Physical Society, representing physicists throughout Europe.

Complex coordination

Complexity-NET will survey the national complexity programmes in Europe, including those in the new Member States. The SSA will supplement this by identifying and making contact with all the major research groups in Europe which are receiving national funding, in order to explore with these key players both the limitations of a national approach and the advantages of European coordination. The intention is eventually to produce a Coordination Action (CA) on complexity to develop the collaborative use of experimental facilities and encourage communication and coordination. A further and more demanding aim will be to promote public awareness of this difficult concept and, at the same time, to stimulate further innovation. In laying the foundations for a CA on complexity, the SSA will also establish a database and procedural framework on which to base European coordination initiatives, including mechanisms for the dissemination and exploitation of results.