

Preface

This issue of *Networks and Heterogeneous Media (NHM)* collects selected papers of the *European Conference on Complex Systems '07*, which took place in Dresden, Germany, from October 1 to 6, 2007.

Studying complex systems has enormously changed our view of the world. The discovery that actions and reactions are often disproportionate and that small perturbations can cause tremendous responses, has led to new scientific disciplines such as catastrophe theory, chaos theory, and the theory of phase transitions.

The behavior of complex systems is often dominated by their internal dynamics and hence only poorly controllable from outside. This has been addressed by the concepts of self-organization and emergence. In many cases, a complex system can even evolve into one out of several (meta-)stable states, which is in clear contrast to linearly behaving systems with a unique solution. In addition, random perturbations, diversity (heterogeneity) in the properties of the individual system elements, network effects, time delays, and incomplete or uncertain information can lead to unexpected and sometimes paradoxical effects.

During more than 30 years, the research devoted to complex systems has led to many exciting, surprising, and fundamentally deep results. What is still lacking, however, is the intensive transfer of knowledge across the boundaries of the relevant scientific disciplines, like physics, mathematics, biology and computer science. Also, the results only occasionally found their way into disciplines such as economics, psychology, political sciences and engineering. The latter also concerns the education of students. As a result, there are relatively few industrially or economically relevant applications.

Because of the evident potential of the science of complex systems and because of the increasing problems, e.g., in the management of complex electronic or software systems, and in the control of political and economic networks, the European Union has decided to strengthen the research in complex systems and to foster the transfer of knowledge. Correspondingly, within the programs NEST (New and Emergent Science and Technology) and IST-FET (Information Society Technology – Future and Emerging Technologies), significant investments have been made to support new fields of research such as networks, cognitive systems, artificial cells, autonomously interacting robots, and many other areas.

The Complex Systems Society (CSS) that runs the annual *European Conference on Complex Systems* has to be seen in this context. It aims at bringing together the various related disciplines, at focusing the diverse research activities, and at fostering them. The goals of this annual conference were to reflect the recent progress in the field of complexity science and to significantly increase the actively involved

community. The first three conferences took place in three different countries, namely Italy (Torino), France (Paris), and Great Britain (Oxford). The conference in 2007 was decided to take place in Dresden (Germany). It attracted more than 500 participants from all over the world.

More than 100 contributions focussed on networks, and only a small selection of them can be presented in this special issue on *Networks and Complexity*.

These contributions range from

- **theoretical network analysis** (motifs in evolving cooperative networks, spectral plot properties, tree-like sampling, uncovering of latent structures),
- **characterization of empirical network structures** (k -composition of internet graphs, science mapping, or flux determination in metabolic networks),
- **modeling of network generation** (network rewiring, growing networks, generating graphs with predefined k -core structure),
- **computer-based investigations of network dynamics** (in gene expression networks or random recurrent neural networks, or addressing the efficiency and stability of evolving innovation networks, or systemic risks in credit networks), and
- **applications** (such as biased query search).

This special issue on *Networks and Complexity*, therefore, offers many interesting contributions reflecting the wide variety of fields in the new science of networks.

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