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Editorial

Complex, inter-networked economic and social systems

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Complex Networks have experienced an explosive growth since the end of the 20th century. While the application of graph theory to the understanding of everyday world has a long history, it was of wide application only in specific fields like sociology [1,2]. Hence, it is not a surprise that the seed paper of network science [3] is co-authored by Duncan Watts, a scientist with a strong sociological background. However, what probably allowed for the explosion of the field was the physical sciences approach of the other author – Steven Strogatz. Physicists' sensibility in analysing data and producing mathematical models of the reality allowed a blossoming of research studies using network models to understand the most disparate aspects of reality. Most of such scientists had a statistical physics background or teamed with statistical physicists; hence, on the background of network science was the lesson learned from critical phenomena and renormalization group: simple mechanisms and structures that are at the heart of many apparently different phenomena allow to group their collective behaviour in a few universality classes.

However, the key paper signing the birth of network science was based on Barabasi & Albert's intuition on the mechanism that induced scaling laws in complex networks [4]. Although only one out of four of the examples of the paper were truly power-law networks [5], the mechanism introduced in [4] opened a very prolific era of investigations [6]. Since then, complex networks have become a common language in the interdisciplinary fields [7]; the research has evolved toward several directions, from the most esoteric quantum networks [8], to the more applied field of Network Medicine [9–13], to the recent field of Networks of Networks [14] stimulated by the need of describing interdependent systems [15] – and many more.

Nowadays, among the most successful field of application of complex networks are economics and finance; surprisingly, complex networks have revealed much less effective in their original field of birth – social systems.

In this issue, we have collected research papers on several topical trends in complex economic, financial and social systems. It is interesting that a consistent fraction of these papers does not need to apply complex networks but resort to much more

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classical ideas from statistical mechanics – like fat tail distributions or mean field models – to cope with the complexity of their research question.

The first three papers touch the three main components of networks science: theory, algorithms and applications. In particular, the first paper by Modanese et al. lays down a framework to treat discretized kinetic theory on scale-free networks. The second paper, by Pugliese et al., thoroughly investigates the design and the stability of the algorithm needed to classify the competitivity of nations using complex network analysis of world-trade web data. The third paper by Facchini et al. shows how complex networks can be applied to a very concrete problem, i.e., understanding and taming complex flows on power networks induced by the introduction of renewable energy sources.

The central body of this special issue is dedicated to the application of complexity and networks in understanding economic and financial systems. The paper by Oliva et al. (Clusters in Interdependent Economic Sectors) applies clustering algorithms to I/O economic data with the aim of understanding the natural economic sectors and their interdependencies. The following paper by Bertotti and Modanese (Economic inequality and mobility in kinetic models for social sciences) addresses techniques for the statistical evaluations of the economic mobility of a society. Uneven economic distribution is the topic of the paper by Clementi et al. (k-generalized models of income and wealth distributions: A survey) which discusses mathematical foundations for the emergence of power law distributions observed in social systems and examines why these distributions explain well the uneven sharing of wealth in our societies. The paper by Annunziata et al. (How log-normal is your country? An analysis of the statistical distribution of the exported volumes of products), by analysing the volumes of the different products exported by 148 countries, finds that the statistical distribution is not unique but heavily depends on the level of development of the nation. The contribution by Nava et al. (Time-dependent scaling patterns in high frequency financial data) investigates scaling laws in the intra-day dynamics of financial assets, identifying patterns related with specific properties of the markets. The last paper of the section is by Scala et al. and resorts on the very general BTW model to understand distress propagation in financial networks suggesting possible mitigating strategies for cascades.

Finally, our special issue concludes with three papers inspired from computational social science [16], an emerging field of science that aims at solving old sociological research issues thanks to the analysis of big amount of cognitive and behavioural data implicitly present on online social networks. The first paper by Tibely et al. (Comparing the hierarchy of author given tags and repository given tags in a large document archive) tackles the technical issues of organizing a large number of tags in natural hierarchies to make the implicit knowledge of a database emerge. The paper of D'Agostino and De Nicola (Interests Diffusion on a Semantic Multiplex) is a first step in an ambitious program of analysing and modelling information diffusion on interacting semantic networks. The section on computational social science is concluded by the paper of Quattrociocchi et al. (Homophily and polarization in the age of misinformation) reporting on the first data-driven experimental verification of the presence of echo-chambers on online social networks.

Many studies are still necessary to investigate thoroughly the themes considered in the fields covered in this issue, however while network science is increasingly becoming the favourite tool for taming the complexity of our world, we must always keep in mind that very often the system is better described without resorting to networks.

The idea to publish topical issues – like the present one – in peer-reviewed international journals, collecting high-level, accurately selected, original research papers devoted to hot themes in statistical physics, was born during the 2015 Conference on Statistical Physics, held in Rhodes in July 2015. The idea immediately found a

broad consensus within the conference sessions. For the considerable effort during the review process, we wish to warmly thank the referees along with all the other people who contributed in different ways to the preparation of this issue of EPJ-ST.

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