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Qualitative and quantitative methods in complex socio-economic systems

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Several phenomena of real world and many concrete problems, in different contexts, can be addressed through the concept of "complex system", i.e. a multiplicity of agents interacting both among themselves and with the environment they are embedded in. This is confirmed by the continuously growing interest showed by the scientific community towards "complexity" and its applications to real issues. Moreover, in recent years the toolbox of both qualitative and quantitative models designed to describe and better understand complex systems has found various fields of application, particularly within the socio-economic area. Network models, stochastic and dynamics systems, social network analysis, multivariate statistics, inference and stochastic processes, fuzzy theory, relational calculus, partial order theory, multi-criteria decision methods… all of these tools find their place in the study of real complex systems. In this Special Issue, mainly dedicated to complex socio-economic, financial and environmental problems, you will find an application for most of them.

Most papers in this issue were originally presented at the 6th International Workshop on Dynamics of Social and Economical Systems held in Ushuaia, Tierra del Fuego, Argentina organized by Asociacion Dyses (Argentina, http://www.dyses.org.ar), Group of Studies in Multifractal and Complexity (GEMC) of Universidad Nac. de Gral. Sarmiento, Laboratorio de Sistemas Complejos, Facultad de Ingenieria-UBA (Argentina)(http://laboratorios.fi.uba.ar/lsc/), and GECSI, Grupo de Estudio de la Complejidad en la Sociedad de la Información, Facultad de Ciencias Jurídicas y Sociales Universidad Nacional de La Plata (Argentina).

Many papers in this volume apply complex network theory to economic or financial fields.

L. Catalano and A. Figliola in "**Analysis of the nonlinear relationship between commodity prices in the last two decades**" describe the construction of a network useful for the study of the correlations among the price indexes of different commodities, obtained by using the Multi-fractal Cross-Correlation method. They consider different networks, where nodes represent commodity groups and links represent cross-correlations, and study their evolution from 1991 to 2012.

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The paper "**Diffusion of innovations in dense and sparse networks**", by M. Eboli, compares the performance of sparsely and densely connected social networks in promoting the diffusion of innovations of uncertain profitability. To this end, the author adopts a threshold model of innovation diffusion, to evaluate the probability of diffusion of an innovation in three different classical network structures, thus showing that under suitable conditions complete and star networks with informed agents perform better than circle networks.

A. M. D'Arcangelis and G. Rotundo, in **"Mutual funds relationships and performance analysis**" employ bipartite networks and tools from Social Network Analysis to explore the equity exposure of Italian equity mutual funds, as emerging from their portfolio holdings on December 31st, 2010. By assessing several performance measures, they also compare active/passive institutional portfolios management styles.

The model proposed in "**A multiple network approach to corporate governance**", by F. Bonacina, M. D'Errico, E. Moretto, S. Stefani and A. Torriero, focuses on the Corporate Governance ties among companies and is based on the construction of a multiple network structure analyzed *via* tensor analysis. The authors take into account the TOPHITS model, based on the PARAFAC tensor decomposition, and provide some empirical results from the Italian financial market, showing the effectiveness of the approach.

In "**Structural and non-structural temporal evolution of socio-economic real networks**" R. Grassi, M. Fattore and A. Arcagni address the problem of tracing the time evolution of real networks, using measures both of structural and of non-structural changes, in addition to the classical topological indicators. As an application, they study the time evolution of three sub-networks, extracted from the Italian corporate board network, showing that both structural and non-structural changes must be accounted for in order to offer a satisfactory description of their temporal evolution.

Some of the papers apply more general quantitative methods to socio-economic and environmental problems.

E. Ciavolino, M. Carpita, M. Nitti, in "**High-order PLS Path Model with qualitative external information**", present a procedure based on orthogonal projectors in the framework of second order PLS-PM, in order to detect the data's external information which may affect the estimation of model parameters. The authors support the procedure with a case study pertaining to the measurement of the subjective quality of work.

O. A. Ihsan, B. Simonetti and R. Jannelli in "**Determining critical success factors related to the effect of supply chain integration and competition capabilities on business performance**" use structural equation models to analyse critical success factors in supply chain integration and competition capabilities. They find positive associations between supply chain integration and competition capabilities, and they highlight the most critical factors, which affect business performance.

Finally, many papers focus on multi-criteria decision making methods applied to various fields.

The paper "**Incomparable - what now II? Absorption of incomparabilities by a cluster method**" of R. Brüggemann and L. Carlsen addresses the problem of how to manage incomparabilities in multi-criteria decision making, within a partial order framework. The paper focuses on how to reduce the number of incomparabilities of a partially ordered set, without losing too much of its structure, using hierarchical cluster analysis and poset theoretical tools.

B. Cavallo, L. D'Apuzzo and M. Squillante in "**A multi-criteria decision making method for sustainable development of Naples port city-area**" use Analytic Hierarchy Process to support the complex decision-making process in connection to the problem of a sustainable urban development of the port area of Naples.

The problem of energetic and environmental requalification is addressed in "**Modelling a sustainable requalification problem by Analytic Hierarchy Process**", by V. Racioppi, G. Marcarelli and M. Squillante, where a multi-criteria approach is adopted, integrating economic and environmental issues.

"**Creation of Models for Calculation of Coefficients of Terrain Passability**", by A. Hofmann, S. Hoskova-Mayerova, V. Talhofer and V. Kovarik, proposes a mathematical model of terrain passability, accounting for geographical and meteorological conditions, and based on data available in the GIS databases.

Complexity is interdisciplinary. The papers of this Special Issue indeed come from a variety of different research fields, however all of them share the same vision: complexity is a key to understand human behaviours, societal dynamics, and the economies of an interacting world. We hope this volume contributes to shed light on these issues, thus attracting more research on the topic.

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