EDITORIAL

SOCIAL NETWORKS: METHODS AND APPLICATIONS

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1. INTRODUCTION

Social networks are everywhere in modern society and network data can arise in many different research areas, e.g. online communities, social support, social movements and collective actions, collaboration among scholars or organizations. Social networks consist of units (actors) with one or more relations (set of ties) observed among those units. This definition is extremely flexible and units and relationships linking them can be of different types (economic, political, emotional and so on).

Because of this pervasiveness, the number of methods and tools for Social Network Analysis (SNA) have grown rapidly in the last decades. SNA is a recent methodological perspective for the study of networks, and it has four defining properties (Freeman, 2011, p. 26): "1) it involves the intuition that links among social actors are important; 2) it is based on the collection and analysis of data that record social relations that link actors; 3) it draws heavily on graphic imagery to reveal and display the patterning of those links; and 4) it develops mathematical and computational models to describe and explain those patterns".

The expansion of the SNA methodology began in the 1960s, but it was only in the recent years that its use and popularity began to rise phenomenally (Scott and Carrington, 2011). Currently SNA is one of the fastest growing research areas in the social sciences, and is developing in a way that could not have been predicted

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a few years ago. It is a truly interdisciplinary science, where findings and tools developed in the social sciences and in the natural sciences are used to discover the patterns of relationships (Borgatti et al., 2009; Hidalgo, 2016). The use of network tools enables researchers to study new dimensions in several domains, including sociology, economy, physics, computer science, biology and medicine. The visualization tools originally developed to map connections between people, e.g. the Moreno sociogram (Moreno, 1946), are used to map connections among proteins, diseases or species. Contributions dealing with networks appear regularly in leading international journals, such as Science, Nature, and PNAS (Proceedings of the National Academy of Sciences of the United States of America).[2]

An exciting area is the application of the statistical approaches for the analysis of social networks (Kolaczyk and Csárdi, 2014; Snijders, 2001). Compared to standard attribute data analysis, which focuses on statistical units and their characteristics, challenging methodological issues in both network data collection and analysis present new research problems to be explored (Robins, 2015).

The special issue of the Italian Journal of Applied Statistics on "Social Networks: Methods and Applications" aims to promote the use of statistical methods for the analysis of network data.

2. THE ARS GROUP

The six papers included in this special issue come from a selection of contributions presented at the Young ARS events hosted by the Sixth International Workshop on Social Network Analysis, ARS'17, "Challenges in Social Network Research", held in Naples (Italy) on May 16-17, 2017.[3] ARS (*Analisi delle Reti Sociali*, Social Network Analysis in Italian language) is a multidisciplinary group of scholars that promotes research on social networks through the organization of meetings, summer schools and biennial workshops hosted by Italian universities, and the publication of dedicated special issues on the topic (De Benedictis et al., 2015; D'Esposito and Zaccarin, 2011; Ferligoj and Batagelj, 2011; Maggioni et al., 2013).

The ARS'17 workshop promoted the Young ARS group, whose members organized events for PhD students and young researchers in order to broaden the knowledge of network analysis and discuss with others "where" and "how" this methodological perspective ought to be applied both in practice and in theory. In particular, the poster session and the Young ARS solicited session on "Analyz-

[2] For instance see: `https://dnac.ssri.duke.edu/about.php`.

[3] For more details see `http://www.unisa.it/centri_e_vari/ars17/index1`

ing Social Networks: Methods and Applications" gave the opportunity to young researchers to present their recent results on methodological developments, data collection issues, and novel network analysis applications. In addition, the prize for the workshop's best poster on "Galois lattice and positional dominance" was awarded to Maria Mircea and Jürgen Pfeffer.

3. ANALYSIS OF PAPERS' TOPICS

For a brief introduction to the content of this special issue, we present a network representation of terms used in the six selected papers. The units under analysis are terms taken from the abstracts, titles and keywords of the papers, while ties among pairs of terms represent the number of papers in which both terms appeared. Before the generation of the network, the texts were normalized by lemmatization using an online lemmatization service (Juršič et al., 2010)[4] and cleaned of stop words using a slightly broadened list of words.[5] The network of papers-by-terms is a two-mode network consisting of data on the six papers and 287 terms.

The visualization of the network (Figure 1) reveals six clusters of words (nodes) belonging to the six papers. In the centre of the network some terms that appeared in more than one paper are found. The nodes' size represents the betweenness centrality value, whereas the lines' width represents the number of papers in which two words co-appear. The most central words are *network* and *analysis* connecting all papers. The high centrality of words like *propose*, *method* and *insight* indicate that a number of published papers are linked by the innovativeness of their proposed methodologies. Interestingly, the words linking different contributions are somewhat related to important topics in both applied statistics and SNA. In particular the terms *hierarchical* and *level* identify the importance of multilevel modeling in networks; *personal* and *alter* are evidence that ego-centred networks have become a popular design in network data collection. From the application perspective, the papers are linked mainly by the words *Italy*, *region*, and *economic*. This testifies that a popular branch of application in networks is represented here by the analysis of economic data collected in local contexts.

[4] For details see also: `http://lemmatise.ijs.si/`
[5] `https://www.ranks.nl/stopwords`

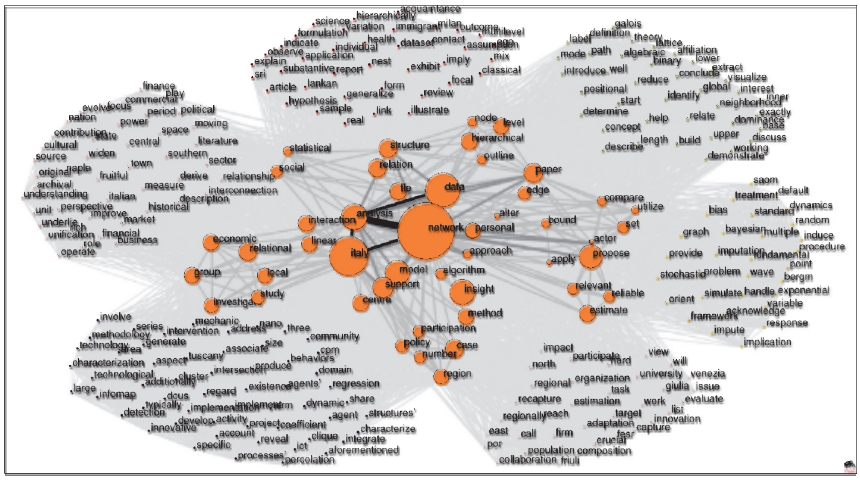

Fig. 1: Network of terms extracted from the six selected papers

4. THE PAPERS' CONTENTS

The present issue includes six papers written by young researchers and their collaborators from different research communities worldwide. In each contribution, methodological issues as well as novel applications of the network analysis framework are presented. The papers can be characterized as belonginto three main groups.

The group of methodologically-oriented papers comprises those by Mircea and Pfeffer, *Galois lattice and positional dominance*, Krause, Huisman and Snjiders, *Multiple impuation for longimdinal network data*, and Vacca, *Multilevel models for personal networks: Methods and applications*.

More specifically,the paper by Mircea and Pfeffer (top-right cluster in Figure 1) discusses the relationship between the theory of Galois lattices and binary two-mode networks by proposing two algorithms, one to build a Galois lattice and another to extract positional dominance from a reduced Galois lattice.

The paper by Krause, Huisman and Snijders (right cluster in Figure 1) presents a multiple imputation procedure for missing data in longitudinal network research in the framework of stochastic actor-oriented models by introducing a procedure applicable to all waves. The authors demonstrate the implications of the procedure for the analysis of network dynamics under the hypothesis that some data are missing along with a simulated example and the comparison to the original networks.

The paper by Vacca (bottom-right cluster in Figure 1) reviews the statistical formulation, the assumptions and the hypotheses of multilevel models adopted for the analysis of personal network data and presents an application on personal networks and social support of Sri Lankan immigrants in a town in northern Italy.

The papers by Pelle, De Stefano and Zaccarin, *Estimating the size of regional innovation network through a capture-recapture approach*, and by Righi, *A methodological approach to investigate interactive dynamics in innovative socio-economic complex systems* (top-central and bottom-left clusters in Figure 1, respectively), discuss some methodological issues and the analysis of real data regarding two Italian regions. The former paper proposes a novel adaptation of the statistical capture-recapture approach to estimate the size and the composition of the personal networks of firms involved in a regional innovation network before and after a regional programme call. The latter introduces a combination of community detection procedures to investigate agents involved in innovative dynamics. The approach is applied in a case study regarding a cycle of policy interventions aimed at supporting innovative network projects among local economic agents.

Finally, the paper of Primerano, Caiazza, Giordano, Schisani, and Vitale, *Inter-firm networks in Naples before and after Italian political unification: A network analysis perspective* (top-let cluster in Figure 1), gives a novel application of SNA. Using two temporal historical networks, the authors describe the role of the financial sector and its interconnections in the local business network, analyzing whether it played a central role and whether it evolved when the space of power and economic relationships widened in the local context after the Italian political unification.

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