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## Introduction to the special issue on *Graphs & Social Systems*

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### I INTRODUCTION

The principle of the *Journal of Interdisciplinary Methodologies and Issues in Science* (JIMIS) is that each issue is a special one, dedicated to a specific topic and handled by guest editors. This issue (the second of the journal) focuses on the use of graphs (and associated analysis tools) to model and study social systems. The guest editors for this issue are Rosa Figueiredo and Vincent Labatut (cf. Section III for affiliations and other details).

A social system can be viewed as a set of entities such as persons, social groups and institutions, interconnected through various types of relationships, in such a way that the whole constitutes a coherent structure. Social system analysis is an inherently interdisciplinary academic field, which emerged from sociology, statistics, social psychology, graph theory, and other domains. For the last few decades, and in parallel with the development of the network science field, graph-based approaches dedicated to this purpose have gained a significant following in social sciences and humanities, and there are now automatic tools commonly available for end-users.

Thanks to the very generic nature of graphs, it is possible to take a method designed to handle a specific system, and apply it in a completely different context (with various levels of adjustment). For instance, a method allowing to detect functionally important proteins in a biological network can be used to identify key-players in a social network. However, due to lexical, methodological and cultural differences, being aware of the methods developed in other fields can be truly challenging for a researcher.

The goal of this special issue is to try to bridge this gap, by exposing researchers from Computer Sciences and from Humanities and Social Sciences to different tools and usages of the concept of graph, coming from out of their field. The selected articles describe graph analysis methods and models, as well as their application to specific social systems.

## II IN THIS ISSUE

This issue originates from the *Seminar on Graphs & Social Systems* that took place on the 18<sup>th</sup> of March 2016 in Avignon, France<sup>1</sup>, and that focused on the same topic: using graphs to model and study social systems. During this day of presentations, a variety of works was described to a relatively large and interdisciplinary audience. This motivated the guest editors to propose a special issue to JIMIS, aiming at presenting the same types of works.

In order to widen the audience, the call for paper was open. We initially received a total of 9 answers, 4 of which went all the way through the editorial process. This includes two rounds of reviews by at least 3 reviewers representing at least two disciplines, in order to give the authors both methodological and application-related feedbacks. There was an additional invited contribution (Patrick Doreian's article), which underwent the same process. Overall, the 5 articles of this special issue cover a large scientific range, from theoretical to applied aspects, fitting the scope of the journal.

In his article *Reflections on Studying Signed Networks*, Patrick Doreian (2017) takes advantage of his extensive experience of signed graphs to propose a review of the works related to structural balance. In a signed graph, each link is associated to either a positive or a negative sign, which allows to model antagonistic relationships. This makes this type of graphs particularly appropriate to represent polarized social systems. *Structural Balance* is a theory proposed by Heider (1946) to explain the distribution of signs in such networks. Doreian reviews the main methods and results related to structural balance, but he also identifies limitations and open problems. In particular, he identifies the separation between substance and methods as a major issue, i.e. developing data analysis methods independently from social science theories, and defining such theories without any regards for empirical results. This observation particularly fits the objective of this issue, since it is intrinsically interdisciplinary.

Alain Guénoche (2017), in his article entitled *Analyse des Préférences et Tournois Pondérés* (in French), assumes the existence of multiple rankings on  $n$  items and studies two ranking problems. The first problem consists in establishing a total order on a set of  $n$  items, the second one is the selection of the  $k$  best elements among the  $n$  items. Both problems reduce to minimizing the number of preferences that go against the individual choices and appears in experimental studies as procedures for vote counting. The developed methods are based on the representation of majority preferences as a complete oriented graph. Although the subject has been treated many times in the literature, there is a new contribution here, taking the form of an optimal selection method in the case where  $n$  is sufficiently small.

In their work *Brazilian Congress structural balance analysis*, Mario Levorato & Yuri Frota (2017) study the behavior of Brazilian politicians in the period between 2011 and 2016. Inspired by a previous work (Mendonça et al., 2015), they extract and analyze a collection of signed networks representing voting sessions of the lower house of the Brazilian National Congress. The solutions obtained by solving Correlation Clustering problems on the extracted signed networks are the basis for investigating deputies voting networks, as well as questions about loyalty, leadership, coalitions, political crisis, and social phenomena such as polarization. Their work contributes to filling the gap identified by Patrick Doreian (2017) between substance and methods in the application of the structural balance theory.

Jérôme Kunegis, Fariba Karimi & Sun Jun (2017) propose a model to explain the mechanism of preferential attachment, in their article *The Problem of Action at a Distance in Networks and*

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<sup>1</sup><https://jgss.sciencesconf.org/>

*the Emergence of Preferential Attachment from Triadic Closure*. In the context of complex networks, the concept of *Preferential Attachment* was introduced by [Barabási and Albert \(1999\)](#) to explain the scale-free property in real-world networks (power law-distributed degree). It states that when a new node appears in an existing network, it tends to get attached to nodes already possessing many connections. The thesis defended by Kunegis *et al.* is that there actually is a lower level process behind preferential attachment. They argue that it is the consequence of the joint occurrence of two events: first, the considered network is only partially known (some nodes are hidden), and second, new links are formed by triadic closure in this underlying network, giving the impression of a non-local process. They formalize their idea as a model and show its validity both analytically and empirically. Although this sounds very mathematical, we encourage people from all fields to read this article, because its authors managed to introduce its core concepts and discuss its main results in a very intuitive way, putting every idea in perspective with concrete, illustrative observations.

The article *Analyse de réseaux criminels de traite des êtres humains: modélisation, manipulation et visualisation* (in French) by Bénédicte Lavaud-Legendre, Cécile Plessard, Guy Melançon, Antoine Laumond & Bruno Pinaud (2017) is very illustrative of what an interdisciplinary work can be. It gathers specialists from 3 distinct fields: Law, Sociology and Computer Science, whose goal is to identify and study prostitution networks. The article describes the methods used to build a database from a large quantity of very raw data, and to extract various types of social networks from this database. The raw material is constituted of all the investigation material gathered by the police when working on related cases, including: interviews, transcriptions of phone tapping, seized documents, surveillance reports, and so on. This extreme heterogeneity makes the network extraction task very difficult, and the authors describe how they tackled this challenge in an incremental way. They also give the first results obtained by studying the obtained networks: in particular, they identify a limited number of operational roles, such as prostitute, sponsor, recruiter, etc. An important characteristic of this work is its applied nature: it aims at providing a platform which will be used by the French *Police Judiciaire* (judicial police).

### III SCIENTIFIC COMMITTEE

Each issue of JIMIS deals with a special topic, and as such it has its own scientific committee. Here are the members of the scientific committee selected for this *Graphs & Social Systems* issue (in alphabetical order):

#### **Nicolas Dugué**

*Social network analysis, Community detection, Text mining*

Institut d'Informatique Claude Chappe / EA 4023 Laboratoire d'Informatique de l'Université du Maine (LIUM), Le Mans (France)

#### **Rosa Figueiredo**

*Combinatorial optimization, Linear and integer programming*

Université d'Avignon et des Pays de Vaucluse / EA 4128 Laboratoire Informatique d'Avignon (LIA) / FR 3621 Agorantic, Avignon (France)

#### **Michel Grossetti**

*Economical sociology, Sociology of sciences, History of scientific institutions, Social geography, Social networks, Public policy*

UMR 5193 Laboratoire Interdisciplinaire Solidarités, Sociétés, Territoires (LISST), Toulouse (France)

### **Vincent Labatut**

*Complex networks analysis, Information retrieval*

Université d'Avignon et des Pays de Vaucluse / EA 4128 Laboratoire Informatique d'Avignon (LIA) / FR 3621 Agorantic, Avignon (France)

### **Guillaume Marrel**

*Politics and history, State politics and policy, Representation and electoral systems*

Université d'Avignon et des Pays de Vaucluse / EA 3788 Laboratoire Biens, Normes, Contrats (LBNC) / FR 3621 Agorantic, Avignon (France)

### **Pierre-Henri Morand**

*Game theory and social networks, Public economics*

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### **Michael Poss**

*Integer programming, Robust optimization, Network design*

UMR 5506 Laboratoire d'Informatique, de Robotique et de Microélectronique de Montpellier (LIRMM), Montpellier (France)

### **Cristina Requejo**

*Combinatorial optimization, Integer linear programming, Network design*

Center for Research & Development in Mathematics and Applications (CIDMA)

Department of Mathematics, University of Aveiro, Aveiro (Portugal)

### **David Savourey**

*Integer Linear Programming, Scheduling*

UMR 7253 Heuristique et Diagnostic des Systèmes Complexes (HeuDiasyC), Compiègne (France)

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