IWSOS 2013

7th International Workshop on Self Organizing Systems

Palma de Mallorca, 9-10th of May, 2013

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IWSOS 2013

IWSOS 2013 is the seventh International Workshop on Self-Organizing Systems, a multidisciplinary event dedicated to self-organization in networks and networked systems, including techno-social systems.

Self-organization relates the behavior of the individual components (the microscopic level) to the resulting networked structure and functionality of the overall system (the macroscopic level), where simple interactions at the microscopic level may already give rise to complex, adaptive, and robust behavior at the macroscopic level. The growing scale, complexity, and dynamics of (future) networked systems have been driving research from centralized solutions to self-organized networked systems. The applicability of well-known self-organizing techniques to specific networks and networked systems is being investigated, as well as adaptations and novel approaches inspired by cooperation in nature. Models originating from areas like control theory, complex systems research, evolutionary dynamics, sociology and game theory are increasingly applied to complex networks to analyze their behavior, robustness and controlability.

Self-organization principles not only apply to the internet and computer networks but also to a variety of other complex networks, like transportation networks, telephony networks, smart electricity grids, financial networks, social networks, and biological networks. “Network Science” and “Complex Networks theory” constitute new research areas that provide additional insights into self-organizing systems.

This edition aims to be highly multidisciplinary and innovative on its focus and format.

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PROGRAM. Thursday May 9

9:30-10:00 Welcome and registration

10:00-10:15 Introductory speeches by Maxi San Miguel and Hermann de Meer

10:15-11:00 Keynote Talk. Chair: M. San Miguel
Prof. Alessandro Vespignani (Northeastern University, Boston)
Modeling and forecast of socio-technical systems in the data-science age

11:00-11:30 Coffee break

11:30-13:00 3 Talks (25 + 5 minutes long) Chair: F. Dressler

Automated Trading For Smart Grids: Can It Work?	S. Dave et al.
A Semantic-based Algorithm for Data Dissemination in Opportunistic Networks	M. Conti et al.
Characteristic Analysis of Response Threshold Model and its Application for Self-organizing Network Control	T. Iwai et al.

13:00-14:30 Lunch break

14:30-15:30 4 Short Talks (12 + 3 minutes long) Chair: W. Elmenreich

A Hybrid Threat Detection & Security Adaptation System for Industrial Wireless Sensor Networks	M. Bahria et al.
Mapping of Self-Organization Properties and Non-Functional Requirements in Smart Grids	S. Lehnhof et al.
A Self-Organising Approach for Smart Meter Communication Systems	M.G. Tauber et al.
Unifying sensor fault detection with energy conservation	L. Fang et al.

15:30-15:45 Short break

15:45-17:15 3 Talks (25 + 5 minutes long) Chair: V. Loreto

Systemic delay propagation in the US airport network	P. Fleurquin et al
Emergence of global speed patterns in a traffic scenario	R. Holzer et al.
On the efficiency of information-assisted search for parking space: a game-theoretic approach	E. Kokolaki et al.

17:15-17:45 Coffee break

17:45-18:30 Round table on "*Techno-social systems*". Panelists: Vittorio Loreto (Chair), Alessandro Vespignani, Alex Arenas, Bernhard Plattner, Jose Ramasco.

20:30 Social dinner

PROGRAM. Friday May 10

9:30-11:00 3 Talks (25 + 5 minutes long) Chair: J. Ramasco

The Relative Disagreement model of opinion dynamics: where do extremists come from?	M. Meadows et al.
Modeling the emergence of a new language: Naming Game with hybridization	L. Pucci et al.
Trust-Based Scenarios - Predicting Future Agent Behavior in Open Self-Organizing Systems	G. Anders et al.

11:00-11:30 Coffee break

11:30-13:00 3 Talks (25 + 5 minutes long) Chair: C. Gershenson

Addressing Phase Transitions in Wireless Networking Optimization	M. Michalopoulou et al.
On the Local Approximations of Node Centrality in Internet Router-level Topologies	P. Pantazopoulos et al.
Modeling Critical Node Attacks in MANETs	D. Zhang et al.

13:00-14:30 Lunch break

14:30-15:15 3 Short Talks (12 + 3 minutes long) Chair: V.D.P. Servedio

Evolution as a Tool to Design Self-organizing Systems	I. Fehérvári et al.
Self-Organization Promotes the Evolution of Cooperation with Cultural Propagation	L. Cortés-Berrueco et al.
Not all paths lead to Rome: Analysing the network of sister cities	A. Kaltenbrunner et al.

15:15-16:15 Poster session

16:15-16:45 Coffee break

16:45-17:45 Final round table on "*Future Control Challenges for Smart Grids"*. Panelists: Sebastian Lehnhoff (Chair), Gerrit Anders, Saraansh Dave, Wilfried Elmenreich.

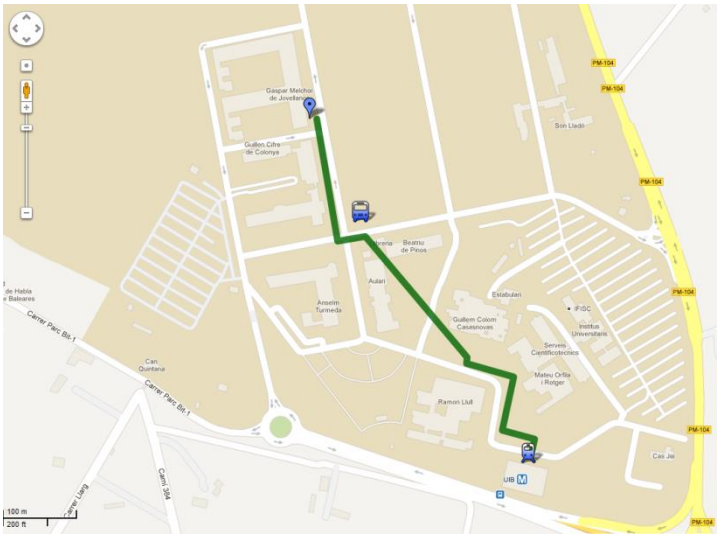
VENUE

The workshop will take place in the University of Balearic Islands Campus. The UIB Campus is located 7.5 km north of Palma downtown, in the middle of a scenic landscape, and quite close to the mountains in the "Serra de Tramuntana" range.

Talks will take place at the Auditorium of the *Gaspar Melchor de Jovellanos* building. The poster session will take in the same building in the hall next to the Auditorium of the *Gaspar Melchor de Jovellanos* building. The map of the UIB Campus is shown below.

Gaspar Melchor de Jovellanos Building

Gaspar Melchor de Jovellanos Auditorium



TRANSPORTATION

Airport

Palma de Mallorca is very well connected with the rest of Spain and Europe (specially Germany, the UK, Austria, Switzerland and Scandinavia) with its "Son Sant Joan" International Airport (airport code PMI), the only airport in the island of Mallorca. The airport is located 8 km east of Palma.

How to go from the airport to Palma downtown and back

Bus

At the Airport take the **bus Line 1** to Plaça d'Espanya (this is Palma's downtown). The stop is outside the Airport Arrivals' Hall. There is one bus every 12-15 minutes. Ticket price: 2.50 EUR. Tickets can be purchased from the bus driver (bills larger than 20 EUR are not accepted. For more information on buses visit the EMT web page:
http://www.emtpalma.es/EMTPalma/Front/index.en.jsp

Taxi

Taxis can be found also outside the Arrivals Hall. Average price to Hotels: 25 EUR (plus supplements for luggage, night time and Sunday rides).

How to go from Palma downtown to the UIB campus

Metro (subway)

This is the recommended transportation between Palma downtown and the UIB Campus where the workshop will take place. Take **line M1** which starts in Plaça d'Espanya (marked as *Estació Intermodal* in ticket machines) and ends in the UIB campus. Travel time is 13 min. Ticket price is 1.50 EUR. Tickets can be purchased at the ticker machines located in the station hall (bills larger than 20 EUR are not accepted). Keep the ticket until the end, since it is needed to leave the station. When you exit the metro station you should walk to the *Gaspar Melchor de Jovellano*s building as indicated by the green line (see map shown below of the next page).

Bus

You can also take the **bus line 19** (labelled as "Universitat") to go to the UIB campus (ticket price 1.50 EUR). Bus frequency is about one every 15 minutes. Trip time is about 30 minutes. Tickets can be purchased from the bus driver (bills larger than 20 EUR are not accepted). Once in the UIB campus you should go out at the bus stop signaled as *Edifici Beatriu de Pinós* and then walk to the *Gaspar Melchor de Jovellanos* building (see map shown below).

SOCIAL DINNER

The social dinner will take place on Thursday, 9, at 8:30 p.m. at the Bens d'Avall Club de Mar Restaurant, located in Muelle Pelaires in the Paseo Marítimo of Palma. The map of Palma is shown below.

Entrance to Club de Mar


View from Bens d'Avall Restaurant's terrace

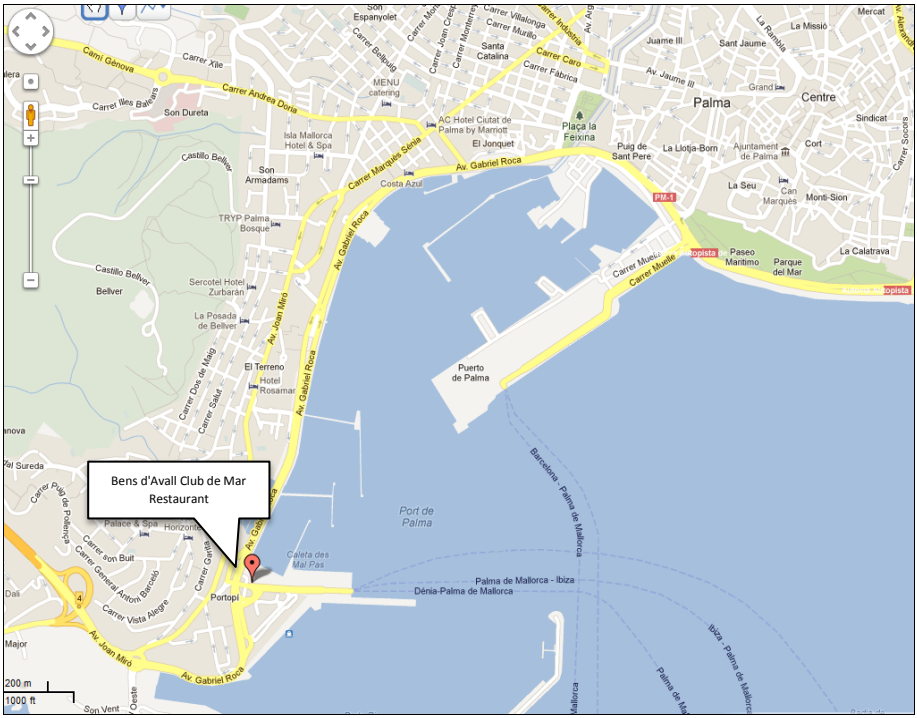
It is possible to go to the restaurant walking along the Paseo Marítimo in direction Pelaires/Porto Pi. From the center of Palma it is a pleasant, albeit long (about 3 km, 45 minutes), walk on the maritime promenade.

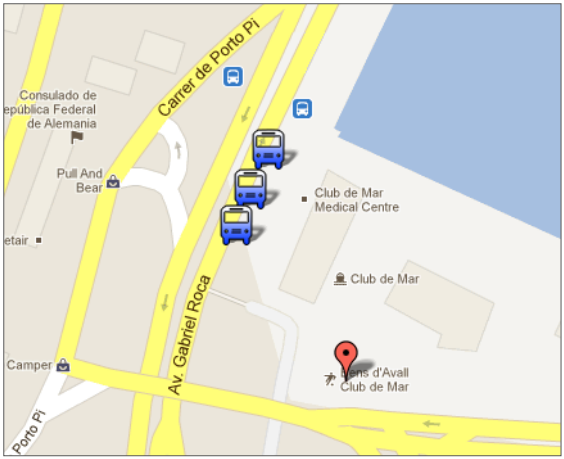
One can also get there by **bus line 1**, Airport-Palma-Port, and **bus line 50**, Touristic Bus. In the **Night bus line 41**, "*Bus de Nit*", stops near the restaurant. Bus stops near the restaurant are indicated in the map.

The restaurant can also be reached by taxi.

See map on next page.

SOCIAL DINNER





KEYNOTE TALK

MODELING AND FORECAST OF SOCIO-TECHNICAL SYSTEMS IN THE DATA-SCIENCE AGE

Prof. Alessandro Vespignani
Northeastern University, Boston, USA

In recent years the increasing availability of computer power and informatics tools has enabled the gathering of reliable data quantifying the complexity of socio-technical systems. Data-driven computational models have emerged as appropriate tools to tackle the study of contagion and diffusion processes as diverse as epidemic outbreaks, information spreading and Internet packet routing. These models aim at providing a rationale for understanding the emerging tipping points and nonlinear properties that often underpin the most interesting characteristics of socio-technical systems. Here I review some of the recent progress in modeling contagion and epidemic processes that integrates the complex features and heterogeneities of real-worldsystems.

BIOGRAPHY

Alessandro Vespignani is Sternberg Distinguished Professor at Northeastern University in Boston, where he leads the Laboratory for the Modeling of Biological and Socio-technical Systems. He is fellow of the American Physical Society, member of the Academy of Europe, and fellow of the Institute for Quantitative Social Sciences at Harvard University. He is also serving in the board/leadership of a variety of journals and the Institute for Scientific Interchange Foundation. He is president elected of the Complex Systems Society. Vespignani is focusing his research activity in modeling diffusion phenomena in complex systems, including data-driven computational approaches to infectious diseases spread.

ROUND TABLES

TECHNO-SOCIAL SYSTEMS

Interconnected techno-social systems have an increasingly pervasive influence on our culture and everyday life. Technology plays a fundamental role in connecting people and circulating information, and affects more and more the way humans interact with each other. Everyday, a huge amount of information is exchanged by people through posts and comments on-line, tweets or emails, or phone calls as a natural aptitude of humans to share news, thoughts, feelings, or experiences. In addition, nowadays low-cost sensing technologies are being developed to allow citizens to directly assess the state of the environment; social networking tools allow effective data and opinion collection and real-time information sharing processes. The possibility to access to digital fingerprints of individuals is opening tremendous avenues for an unprecedented monitoring at a "microscopic level" of collective phenomena involving human beings. We are thus moving very fast towards a sort of a tomography of our societies, with a key contribution of people acting as data gathering "sensors". The panelists will discuss about the new challenges as well as the new opportunities that techno-social systems bring forward.

Panelists: Vittorio Loreto, *Sapienza University of Rome* (Chair)

- Alessandro Vespignani, *Northeastern University*
- Alex Arenas, *Universitat Rovira I Virgili*
- Bernhard Plattner, *ETH Zurich*
- Jose Ramasco, *IFISC (UIB-CSIC)*

FUTURE CONTROL CHALLENGES FOR SMART GRIDS

Future Smart Grids will be composed of large collections of autonomous components, e.g. PV systems, CHPs, or controllable consumers such as heat pumps or air conditioners. Sensors and actuators, aware of their environment, with the ability to communicate freely, will have to organize themselves in order to perform the actions and services that are required for a reliable and robust power supply. Monitoring and efficiently operating power networks with a high density of distributed renewable generation and controllable consumption is neither efficient nor robust or adaptive with centralized management. In order to achieve the necessary resolution and level of control, prospective smart energy networks need to be controlled by autonomous yet coordinated software agents acting on behalf of consumers and producers of electric energy. Self-organization provides a paradigm based on the urgent necessity to find methodologies for managing the complexity and controlling the behaviour of large scale distributed systems. However, in order to use such methods for controlling Smart Grids detailed analysis of key features as e.g. predictable synergetic behavior, avoidance of oscillations, or robustness against local failures are required. The panelists will discuss the issues of promotion self-organization in the industry as well as introducing domestic customers to autonomous control solutions.

Panelists: Sebastian Lehnhoff**,** *OFFIS - Institute for Information Technology, Germany* (Chair)

- Gerrit Anders, *Universität Augsburg University*
- Saraansh Dave, *Toshiba Research Europe Ltd.*
- Prof. Wilfried Elmenreich, *Lakeside Labs, University of Klagenfurt*
- Prof. Sebastian Lehnhoff, *OFFIS – Institute for Information Technology*

TALKS

AUTOMATED TRADING FOR SMART GRIDS: CAN IT WORK?

Saraansh Dave[1], Mahesh Sooriyabandara[1], Barry Laffoy[2]
1. Toshiba Research Europe Ltd, Bristol, UK
2. University of Bristol, UK

This paper applies basic economic principles which have been developed in financial markets to a future smart grid scenario. Our method allows for autonomous bidding for electricity units to create an emerging market price for electricity. We start with replicating the popular Zero-Intelligence-Plus algorithm and setting it in a electricity supplier-consumer scenario. We identify significant weaknesses of applying this in an electricity market especially when intermittent sources of energy are present or when the supplier to consumer ratio is very small. A new algorithm (ZIP-260) is proposed to include a measure of fairness such that the deviation across all un-matched demand for a given period is minimized. This approach means that no consumer in the system is constantly experiencing an electricity supply deficit. We show and explain how market conditions can lead to collective bargaining of consumers and monopolistic behavior of suppliers and conclude with observations on automated trading for smart grids.

A SEMANTIC-BASED ALGORITHM FOR DATA DISSEMINATION IN OPPORTUNISTIC NETWORKS

Marco Conti, Matteo Mordacchini, Andrea Passarella, Liudmila Rozanova
IIT-CNR, Pisa, Italy

The opportunistic data dissemination problem for mobile devices is an open topic that has attracted many investigations so far. At the best of our knowledge, none of these approaches takes into account the semantic side of the data shared in an opportunistic network. In this paper, we present an algorithm that, starting from the semantic data annotations given by the users themselves, builds a semantic network representation of the information. Exploiting this description, we detail how two different semantic networks can interact upon contact, in order to spread and receive useful information. In order to provide a performance evaluation of such a solution, we show a preliminary set of results obtained in a simulated scenario.

CHARACTERISTIC ANALYSIS OF RESPONSE THRESHOLD MODEL AND ITS APPLICATION FOR SELF-ORGANIZING NETWORK CONTROL

Takuya Iwai, Naoki Wakamiya, Masayuki Murata
Osaka University, Japan

There is an emerging research area to adopt bio-inspired algorithms to self-organize an information network system. Despite strong interests on their benefits, i.e. high robustness, adaptability, and scalability, the behavior of bio-inspired algorithms under non-negligible perturbation such as loss of information and failure of nodes observed in the realistic environment is not well investigated. Because of lack of knowledge, none can clearly identify the range of application of a bio-inspired algorithm to challenging issues of information networks. Therefore, to tackle the problem and accelerate researches in this area, we need to understand characteristics of bio-inspired algorithms from the perspective of network control. In this paper, taking a response threshold model as an example, we discuss the robustness and adaptability of bio-inspired model and its application to network control. Through simulation experiments and mathematical analysis, we show an existence condition of the equilibrium state in the lossy environment. We also clarify the influence of the environmental condition and control parameters on the transient behavior and the recovery time.

TALKS

A HYBRID THREAT DETECTION & SECURITY ADAPTATION SYSTEM FOR INDUSTRIAL WIRELESS SENSOR NETWORKS

Mohammed Bahria, Alexis Olivereau, Aymen Boudguiga
CEA LIST, France

Wireless Sensor Networks (WSNs) led the way to new forms of communications, which extend today the Internet paradigm to unforeseen boundaries such as a Health, intelligent building or smart grid, to name a few. The legacy industry, however, is slower to adopt this technology, mainly for security reasons. Self-managed security systems allowing a quicker detection of and better resilience to attacks, may counterbalance this reluctance. In this paper, we propose a hybrid threat detection and security adaptation system, designed to run on top of industrial wireless sensor networks. We explain why this system is suitable for architectures mainly composed of constrained or sleeping devices, while being able to achieve a fair level of autonomous security.

MAPPING OF SELF-ORGANIZATION PROPERTIES AND NON-FUNCTIONAL REQUIREMENTS IN SMART GRIDS

Sebastian Lehnhoff[1], Sebastian Rohjans[2], Richard Holzer, Florian Niedermeier[3], Hermann de Meer[3]
1. University of Oldenburg, Germany
2. OFFIS, Germany
3. University of Passau, Germany

Future electrical power networks will be composed of large collections of autonomous components. Sensors and actuators, aware of their environment, with the ability to communicate freely, will have to organize themselves in order to perform the actions and services that are required for a reliable and robust power supply. Monitoring and efficiently operating such a system is a challenging task for the underlying information and communication infrastructure as well as its intelligence to efficiently perform these tasks while guaranteeing the necessary power quality. Self-organization is an organizational concept that promises robust systems with the ability to adapt themselves to system perturbations and failures and thus may yield highly robust systems with the ability to scale freely to almost any size. In this position paper the authors describe the well-established process of use case based derivation of non-functional requirements in energy systems and propose a mapping strategy for aligning properties of self-organizing systems with the ICT- and automation system requirements. It is the strong belief of the authors that such a mapping will be a key factor in creating acceptance of and establishing self-organization in the domain of electrical energy systems.

TALKS

A SELF-ORGANISING APPROACH FOR SMART METER COMMUNICATION SYSTEMS

Markus Gerhard Tauber[1], Florian Skopik[1], Thomas Bleier[1], David Hutchison[2]
1. Austrian Institute of Technology GmbH, Austria
2. Lancaster University, UK

Future energy grids will need to cope with a multitude of new dynamic situations. Having sufficient information about energy usage patterns is of paramount importance for the grid to react to changing situations and to make the grid `smart'. We present preliminary results of an investigation on whether autonomic adaptation of intervals with which individual smart meters report their meter readings can be more efficient than commonly used static configurations. A small report interval provides close to real-time knowledge about load changes and thus the opportunity to balance the energy demand amongst consumers rather than `burning' surplus capacities. On the other hand a small interval results in a waste of processing power and bandwidth in case of customers with rather static energy usage behavior. Hence, an ideal interval cannot be predicted a priori, but needs to be adapted dynamically. We provide an analytical investigation of the effects of autonomic management of smart meter reading intervals and make some recommendations on how this can be implemented.

UNIFYING SENSOR FAULT DETECTION WITH ENERGY CONSERVATION

Lei Fang, Simon Dobson
University of St Andrews, UK

Wireless sensor networks are attracting increasing interest but suffer from severe challenges such as power constraints and low data reliability. Sensors are often energy-hungry and cannot operate over the long term, and the data they gather are frequently erroneous in complex ways. The two problems are linked, but existing work typically treats them independently: in this paper we consider both side-by-side, and propose a self-organizing solution for model-based data collection that reduces errors and communications in a unified fashion.

SYSTEMIC DELAY PROPAGATION IN THE US AIRPORT NETWORK

Pablo Fleurquin, Jose Ramasco, Victor Eguíluz
IFISC, Spain

Flight delays bring about grievous economic costs for airlines and passengers and lead to an excess of fuel consumption and to larger CO2 emissions. The situation can turn even grimmer in the next decade due to an air-traffic increase. Delays propagate through a network formed by airports as vertices and flights as directed dynamic edges. Although the structural properties of the network are important to understand delay propagation patterns, other factors such as aircraft and crew rotations, passengers' connections, airport congestion and flight schedules contribute also to their spreading. Previous studies have considered the effect of large airports (hubs) on delay propagation. Here we take instead a network-wide perspective to analyze the performance of a transportation system. We define metrics able to quantify the level of spread of the delays in the network and introduce a model that reproduces the delay propagation patterns observed in real data regarding the U.S. airport network. The model shows also a notable capacity to evaluate the risk of development of system-wide congestion. Our simulations indicate that there is a non-negligible risk of systemic instability even under normal operating conditions. Furthermore, we identify passenger and crew connections as the most important internal factor contributing to delay propagation.
Our analysis provides insights on how to study the performance and stability of large networked transport systems with predefined schedules as well as their response to large-scale disruptions.

TALKS

EMERGENCE OF GLOBAL SPEED PATTERNS IN A TRAFFIC SCENARIO

Richard Holzer[1], Hermann de Meer[1], Cristina Beltran Ruiz[2]
1. University of Passau, Germany
2. Sociedad Ibérica de Construcciones Eléctricas S.A. , Spain

We investigate different analysis methods for traffic data. The measure for emergence of velocities can be used to identify global dependencies between the velocities of different vehicles. The measure for target orientation can be used to identify dangerous situations in traffic. We apply both measures in a use case on a data set of the M30 highway in Madrid. The evaluation shows that the measures can be used to predict or to identify abnormal events like accidents in traffic by an evaluation of velocity data measured by detectors at the road. Such events leads to a decrease of the measures of emergence and target orientation.

ON THE EFFICIENCY OF INFORMATION-ASSISTED SEARCH FOR PARKING SPACE: A GAME-THEORETIC APPROACH

Evangelia Kokolaki, Merkourios Karaliopoulos, Ioannis Stavrakakis
National and Kapodistrian University of Athens, Greece

This paper seeks to systematically explore the efficiency of the uncoordinated information-assisted parking search in urban environments with two types of parking resource facilities: inexpensive but limited facilities (public) and expensive yet unlimited ones (private); an additional cruising cost is incurred when deciding for a public facility but failing to actually utilize one. Drivers decide whether to go for the public or directly for the private facilities, assuming perfect knowledge of prices and costs, total parking capacities and demand; the latter information can be broadcast by an ideal centralized information dissemination mechanism, assisting the otherwise uncoordinated parking search process. Drivers are viewed as strategic decision-makers that aim at minimizing the cost of the acquired parking spot. We formulate the resulting game as an instance of resource selection games and derive its Nash equilbria and their dependence on the environmental parameters such as the parking demand and supply as well as the pricing policy. The cost at the equilibria states is compared to that under the optimal resource assignment (dictated to the drivers directly by an ideal centralized scheme) and conditions are derived for minimizing the related price of anarchy. Finally, the numerical results and the presented discussion provide hints for the practical management and pricing of public and private parking resources.

TALKS

THE RELATIVE DISAGREEMENT MODEL OF OPINION DYNAMICS: WHERE DO EXTREMISTS COME FROM?

Michael Meadows, Dave Ciff
University of Bristol, UK

In this paper we introduce a novel model that can account for the spread of extreme opinions in a human population as a purely local, self-organizing process. Our starting point is the well-known and influential Relative Agreement (RA) model of opinion dynamics introduced by Deffuant et al. (2002). The RA model explores the dynamics of opinions in populations that are initially seeded with some number of "extremist" individuals, who hold opinions at the far ends of a continuous spectrum of opinions represented in the abstract RA model as a real value in the range [-1.0, +1.0]; but where the majority of the individuals in the population are, at the outset, "moderates", holding opinions closer to the central mid-range value of 0.0. Various researchers have demonstrated that the RA model generates opinion dynamics in which the influence of the extremists on the moderates leads, over time, to the distribution of opinion values in the population converging to attractor states that can be qualitatively characterized as one of either uni-polar and bi-polar extremes, or reversion to the center ("central convergence"). However, a major weakness of the RA model is that it pre-supposes the existence of extremist individuals, and hence says nothing to answer the question of "where do extremists come from?" In this paper, we introduce the Relative Disagreement (RD) model, in which extremist individual arise spontaneously and can then exert influence over moderates, forming large groups of polar extremists, via an entirely internal, self-organization process. We demonstrate that the RD model can readily exhibit the uni-polar, bi-polar, and central-convergence attractors that characterize the dynamics of the RA model, and hence this is the first paper to describe an opinion dynamic model in which extremist positions can spontaneously arise and spread in a population via a self-organizing process where opinion-influencing interactions between any two individuals are characterized not only by the extent to which they agree, but also by the extent to which they disagree.

MODELING THE EMERGENCE OF A NEW LANGUAGE: NAMING GAME WITH HYBRIDIZATION

Lorenzo Pucci[1], Pietro Gravino[2], Vito D. P. Servedio[2]
1. Federico II University, Naples, Italy
2. Sapienza University of Rome, Italy

In recent times, the research field of language dynamics has focused on the investigation of language evolution, dividing the work in three evolutive steps, according to the level of complexity: lexicon, categories and grammar. The Naming Game is a simple model capable of accounting for the emergence of a lexicon, intended as the set of words through which objects are named. We introduce a stochastic modification of the Naming Game model with the aim of characterizing the emergence of a new language as the result of the interaction of agents. We fix the initial phase by splitting the population in two sets speaking either language A or B. Whenever the result of the interaction of two interacting individuals results in an agent able to speak both A and B, we introduce a finite probability that this state turns into a new idiom C, so to mimic a sort of hybridization process. We study the system in the space of parameters defining the interaction, and show that the proposed model displays a rich variety of behaviors, despite the simple mean field topology of interactions.

TALKS

TRUST-BASED SCENARIOS - PREDICTING FUTURE AGENT BEHAVIOR IN OPEN SELF-ORGANIZING SYSTEMS

Gerrit Anders, Florian Siefert, Jan-Philipp Steghöfer, Wolfgang Reif
University of Augsburg, Germany

Agents in open self-organizing systems have to cope with a variety of uncertainties. In order to increase their utility and to ensure stable operation of the overall system, they have to capture and adapt to these uncertainties at runtime. This can be achieved by formulating an expectancy of the behavior of others and the environment. Trust has been proposed as a concept for this purpose. In this paper, we present trust-based scenarios as an enhancement of current trust models. Trust-based scenarios represent stochastic models that allow agents to take different possible developments of the environment's or other agents' behavior into account. We demonstrate that trust-based scenarios significantly improve the agents' capability to predict future behavior with a distributed power management application.

ADDRESSING PHASE TRANSITIONS IN WIRELESS NETWORKING OPTIMIZATION

Maria Michalopoulou, Petri Mähönen
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The general aim of this paper is to introduce the notion of phase transitions into wireless networking optimization. It is particularly interesting that threshold phenomena, similar to phase transitions in physical systems, can been found to occur in many optimization problems. Nevertheless, although the theory of phase transitions from statistical physics has been employed in optimization theory, phase transitions in the context of optimization of wireless networks have not yet been considered. In wireless networking optimization, given one or more optimization objectives we often need to define mathematically an optimization task, so that a set of requirements is not violated. However, especially recent trends in wireless communications, such as self-organized networks, femto-cellular systems, and cognitive radios, calls for optimization approaches that can be implemented in a distributed and decentralized fashion. Thus we are interested to find utility-based approaches that can be practically employed in a self-organizing network. We argue that phase transitions can be identified and taken appropriatelly into account in order to eliminate the emergence of undesirable solutions that lie near the point where the phase transition occurs. As an example we present a simple power control problem for a macrocell-femtocell network scenario. We formulate a distributed framework of the problem where we model a phase transition effect by means of a dummy variable in order to exclude solutions lying in the one side of the phase transition.

TALKS

ON THE LOCAL APPROXIMATIONS OF NODE CENTRALITY IN INTERNET ROUTER-LEVEL TOPOLOGIES

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In many networks with distributed operation and self-organization features, acquiring their global topological information is impractical, if feasible at all. Internet protocols drawing on node centrality indices may instead approximate them with their egocentric counterparts, computed out over the nodes' ego-networks. Surprisingly, however, in router-level topologies the approximative power of localized ego-centered measurements has not been systematically evaluated. More importantly, it is unclear how to practically interpret any positive correlation found between the two centrality metric variants. The paper addresses both issues using different datasets of ISP network topologies. We first assess how well the egocentric metrics approximate the original socio-centric ones, determined under perfect network-wide information. To this end we use two measures: their rank-correlation and the overlap in the top-k node lists the two centrality metrics induce. Overall, the rank-correlation is high, in the order of 0.8-0.9, and, intuitively, becomes higher as we relax the ego-network definition to include the ego's r-hop neighborhood. On the other hand, the top-k node overlap is low, suggesting that the high rank-correlation is mainly due to nodes of lower rank. We then let the node centrality metrics drive elementary network operations, such as local search strategies. Our results suggest that, even under high rank-correlation, the locally-determined metrics can hardly be effective aliases for the global ones. The implication for protocol designers is that rank-correlation is a poor indicator for the approximability of centrality metrics.

MODELLING CRITICAL NODE ATTACKS IN MANETs

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MANETs (mobile ad hoc networks) operate in self-organized and decentralized way. Attacks against nodes that are highly relied to relay traffic between other node pairs could result in a wide range of service outage. A comprehensive model that could enhance the understanding of network behaviour under attacks is important to the design and construction of resilient self-organizing networks. Previously, we modelled MANETs as an aggregation of time-varying graphs into a static weighted graph, where the weights represent link availability of pairwise nodes. Centrality metrics were used to measure node significance but might not always be optimal. In this paper, we define a new metric called criticality that can capture node significance more accurately than centrality metrics. We demonstrate that attacks based on criticality have greater impact on network performance than centrality-based attacks in real-time MANETs.

TALKS

EVOLUTION AS A TOOL TO DESIGN SELF-ORGANIZING SYSTEMS

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Self-organizing Systems exhibit numerous advantages such as robustness, adaptivity and scalability, and thus provide a solution for the increasing complexity we face within technical systems. While they are attractive solutions, due to their nature, designing self-organizing systems is not a straightforward task. Artificial evolution has been proposed as a possible way to build self-organizing systems, but there are still many open questions on how an engineer should apply this method for this purpose. In this paper we propose a system architecture for evolving self-organizing systems, that marks the major cornerstones and decisions the designer has to face, thus providing a practical set of guidelines.

SELF-ORGANIZATION PROMOTES THE EVOLUTION OF COOPERATION WITH CULTURAL PROPAGATION

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In this paper three computational models for the study of the evolution of cooperation under cultural propagation are studied: Kin Selection, Direct Reciprocity and Indirect Reciprocity. Two analyzes are reported, one comparing their behavior between them and a second one identifying the impact that different parameters have in the model dynamics. The results of these analyzes illustrate how game transitions may occur depending of some parameters within the models and also explain how agents adapt to these transitions by individually choosing their attachment to a cooperative attitude. These parameters regulate how cooperation can self-organize under different circumstances. The emergence of the evolution of cooperation as a result of the agent's adapting processes is also discussed.

NOT ALL PATHS LEAD TO ROME: ANALYSING THE NETWORK OF SISTER CITIES

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This work analyses the practice of sister city pairing. We investigate structural properties of the resulting city and country networks and present rankings of the most central nodes in these networks. We identify different country clusters and find that the practice of sister city pairing is not influenced by geographical proximity but results in highly assortative networks.

REGULATING VEHICULAR FLOW THROUGH DENSITY ESTIMATIONS AND COMMUNICATIONS TECHNOLOGY

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Understanding and regulating traffic flow is very much in the interest of governments, transport/environmental/economic agencies, major car companies and citizens. Time, cost, and frustration spent in traffic jams in many cities around the world leads to poor productivity and environmental damage. Improving the flow of vehicles in cities is an important priority of most councils. A one-dimensional stream or 2-dimensional grid of vehicles constitutes a self-organizing system. Individual drivers take local decisions, constrained by regulations, physical limitations (other vehicles and roadside obstacles) sensibility and an objective function to reach their destination, often minimizing the journey time. Therefore, the study of traffic flow through simulation, modeling or measurements, on a microscopic, macroscopic or mixture of levels thereof, is central to the problem of traffic flow. Observing the density of vehicles in space-time is the key issue. Using non-linear differential equations is one method to analyze and model the behavior of the vehicular self-organizing system. Treating the system as a traveling wave permits complex real-world scenarios to be modeled and phase transitions to be observed, in particular shockwaves in which flows which have been shown to lead to (rapid) queue building. Shockwaves are also interesting for both the analytic and numerical computations, as somewhat specialized methods are needed to deal with multi-valued functions. Once we have a vehicular density estimate, we propose a communications strategy assist in how to deal with queue building. Regulating the vehicular network via communications technology is the second major contribution in this paper. The first is using non-linear differential equations to show how the behavior of the vehicles changes under a selected number of common road situations.

TOWARDS A DISTRIBUTED APPROACH TO MALWARE DETECTION IN CLOUD COMPUTING

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Cloud computing is an increasingly popular platform for both industry and consumers. The cloud presents a number of unique security issues, such as a high level of distribution or system homogeneity, which require special consideration. In this paper we introduce a resilience architecture consisting of a collection of self-organizing resilience managers distributed within the infrastructure of a cloud. More specifically we illustrate the applicability of our proposed architecture under the scenario of malware detection. We describe our multi-layered solution at the hypervisor level of the cloud nodes and consider how malware detection can be distributed to each node, removing the need for wholly centralized detection systems.

DEMAND RESPONSE BY DECENTRALIZED DEVICE CONTROL BASED ON VOLTAGE LEVEL

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The amount of alternative energy sources like photovoltaic systems or wind power will rise significantly in the future. Renewable energy sources, however, typically rely on the weather and thus lead to variable energy production which is hard to manage [1]. In this work, we concentrate on the question how to handle power under-supply, i.e. the situation where demanded power exceeds possible production capabilities. Based on the Color Power architecture described in [2], we propose a decentralized control mechanism to temporarily turn off devices in dependence on their criticality. While in [2] all modeled devices consume an equal amount of energy, we introduce different device classes and allow a wider range of consumption data, targeting towards typical domestic application. Following [3], we organize devices into households and take connection resistivity effects into account.

ON COORDINATED TRANSMISSION IN UAV NETWORKS BY LEVERAGING CONCEPTS OF SELF-ORGANIZATION

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In Search and Rescue (SAR) missions, the integration of heterogeneous search agents with particular cognitive, mobility, and sensory skills may significantly fasten the successful completion of the mission. In this setting, the project SWARMIX integrates human rescuers, dogs, and Unmanned Aerial Vehicles (UAVs) by developing appropriate interfaces, context sensing, and coordination methods relying on ad-hoc wireless communication. Hereby, UAVs scan areas using high-resolution cameras and provide a multi-hop wireless network. As ad-hoc wireless communication protocols have been mainly developed for static and nomadic settings, they are impaired by mobility-related dynamics, such as, changing link quality and intermittent connectivity. We discuss promising concepts of self-adaptation and self-organization for coordinated networking within a fleet of UAVs.