

Latin American School and Workshop on Data Analysis and Mathematical Modeling of Social Science

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Latin American School and Workshop on
Data Analysis
and
Mathematical Modeling of Social Science

SoFiA

SocioFísica Argentina



November, 7-11 of 2016

Buenos Aires

Argentina

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Organizers

- **Pablo Balenzuela**
Universidad de Buenos Aires and CONICET, Buenos Aires, Argentina.
- **Daniel Parisi**
Instituto Tecnológico de Buenos Aires and CONICET, Buenos Aires, Argentina.
- **Viktoriya Semeshenko**
Instituto Interdisciplinario de Economía Política and CONICET, Buenos Aires, Argentina.
- **Juan Pablo Pinasco**
Universidad de Buenos Aires and CONICET, Buenos Aires, Argentina.
- **Federico Vázquez**
Instituto de Física de Líquidos y Sistemas Biológicos-CONICET, La Plata, Argentina.
- **Fabiana Laguna**
Centro Atómico Bariloche, CONICET y Un. Nac. de Río Negro, Bariloche, Argentina.
- **Damián Zanette**
Centro Atómico Bariloche, CONICET e Instituto Balseiro, Bariloche, Argentina.
- **Lucas Barberis**
Intituto de Física Enrique Gaviola-CONICET, Córdoba, Argentina.



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Argentina

Courses

Monday - Course 1

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Mathematical Modeling of Social Dynamics

by Prof. Maxi San Miguel

IFISC, Universitat de les Illes Balears, Spain.

Lecture 1: Axelrod model of cultural dissemination

I will address the question of the cultural globalization-polarization transition and the role of social network structure, cultural drift and social network dynamics in the cultural dynamics. I will also discuss the function of mass media in these processes.

Lecture 2: Game theory

I will review, from a physics perspective, the basic concepts of game theory used in models of collective social phenomena.

Contact: Maxi San Miguel, maxi@ifisc.uib-csic.es

Wednesday - Course 2

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Course 2: Testing theories of cooperation and polarization by means of social experiments and agent-based models

by Prof. Andreas Flache

University of Groningen, Groningen, The Netherlands

Lecture 1: Sociological Theories and Agent-based Computational Models of Diversity and Polarization in Society

I will discuss why explaining opinion diversity and polarization is a puzzle for many classical sociological theories of social influence, then discuss how proposed theoretical solutions have been analyzed with agent-based computational models, what are the strong and weak aspects of various approaches, and what are remaining puzzles for future work.

Lecture 2: Testing theories of cooperation and polarization in the Lab

Building on lecture 1, I will discuss general principles and problems of testing theories about human social behavior in the lab, focusing in particular on the themes of cooperation and polarization. A number of examples will be discussed in more detail, partially building on my own research.

Contact: Andreas Flache, a.flache@rug.nl

Thursday - Course 3

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Course 3: Quantitative methods in finances

by Prof. Frédéric Abergel

École Centrale Paris, Paris, France.

Lecture 1: High frequency financial data-especially limit order book

Lecture 2: Mathematical modelling of limit order books

Lecture 3: Optimal trading and trading strategies.

What is a limit order book?

It is a device that the vast majority of organized electronic markets (all equity, futures and other listed derivatives markets) use to store in their central computer the list of all the interests of market participants. It is essentially a file in a computer that contains all the orders sent to the market, with their characteristics such as the sign of the order (buy or sell), the price, the quantity, a timestamp giving the time the order was recorded by the market, and a host of various market-dependent information. In other words, the limit order book contains, at any given point in time, on a given market, the list of all the transactions that one could possibly perform on this market. Its evolution over time describes the way the market moves under the influence of its participants. In fact, the study of limit order books can provide deep insight into the understanding of the financial market, which is an excellent example of an evolving “complex system” where the different participants collectively interact to find the best price of an asset. A market in which buyers and sellers meet via a limit order book is called an order-driven market. Essentially, three types of orders can be submitted: Limit order: an order to specify a price at which one is willing to buy or sell a certain number of shares, with their corresponding price and quantity, at any point in time; Market order: an order to immediately buy or sell a certain quantity, at the best available opposite quote; Cancellation order: an order to cancel an existing limit order.

Why study limit order books?

It is clear that the study of the empirical properties, as well as the mathematical modelling and numerical simulation, of limit order books, is of paramount importance for the researcher keen on gaining a deep understanding of financial markets. In classical financial econometrics, the data consist in time series of prices of one or several assets, and models are based on the statistical properties of the various quantities one can build from these time series: returns, volatility, correlation. However, in order-driven markets, the price dynamics is controlled by the interplay between the incoming order flow and the order book. The study of the limit order book therefore reveals, as a by-product, the price dynamics. One of the main motivations for the study of limit order books is to understand the extent to which the mechanisms of the order book have an impact on the price dynamics at the microstructure level, and whether this impact remains visible at lower frequencies. Furthermore, the genuine scientific curiosity for this area of research is very definitely enhanced by the rapid growth of algorithmic trading

and high frequency trading. Market making strategies, optimal execution strategies, statistical arbitrage strategies, being executed at the individual order level, all require a perfect understanding of the limit order book.

How to model limit order books?

There are several steps to take when modelling limit order books. Probably, the first one is to select a mechanistic description of the way incoming orders are stored and market orders are executed. This prerequisite is achieved, at least in a stylized form, in all the mathematical models of limit order books, and plays an important role in the simulation of limit order books, for which realistic matching engines must be developed in order to study trading strategies. The second step, at a more conceptual and scientifically more fundamental stage, consists in choosing a mechanism for the arrival of orders, that is, for the submission of an order of a particular type at a specific date and time. In the approach proposed by econophysicists, agents are described statistically. In the simplest form along this line of research, the agents are supposed to act randomly. This approach is sometimes referred to as zero-intelligence order book modeling, in the sense that the arrival times and placements of orders of various types are random and independent, the focus being primarily on the "mechanistic" aspects of the continuous double auction rather than the strategic interactions between agents. Zero-intelligence models of the order book already capture some salient features of real markets, and exhibit interesting, non-trivial mathematical properties. It is however necessary to depart from this overly simplified approach and study models where agents do interact, at least in a statistical way. Some advanced limit order book models will be studied and presented.

Contact: Frédéric Abergel, frederic.abergel@orange.fr

Fridat - Course 4

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Course 4: From Individual Mobility to Transportation Networks

by Prof. Marta González

Human Mobility and Networks Lab, Civil and Environmental Engineering, Massachusetts Institute of Technology, Cambridge, USA.

Lectures 1 & 2: A review of human mobility: basic mechanisms and urban effects

We will review up to date findings in human mobility. In the first part we cover the mechanisms to model individual spatial-temporal trajectories that compare with travel diaries. Next we review its implications for modeling trips in the streets and the potential of smart commute apps given realistic congestion scenarios in various cities. We close with future directions and open questions in the area.

Contact: Marta González, martag@mit.edu

Monday 7

15:45hs - Invited 1

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The breakdown of trust

Dr. Mariano Sigman

Laboratorio de Neurociencia Integrativa (LNI), Universidad Torcuato Di Tella, Argentina.

I will present empirical studies that show that people can adjust conveniently their beliefs about others to justify non-altruistic behavior. Then I will discuss models in networks that may help us understand how this cognitive mechanisms may be at the seed of transitions between societies that are more or less driven by altruistic behavior.

Contact: Mariano Sigman, msigman@utdt.edu

16:35hs - Contributed 1

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Google matrix analysis of economics and social networks

Ermann L¹, Shepelyansky D L³

¹ *Departamento de Física Teórica, GIyA, CAC - CNEA*

² *CONICET*

³ *Laboratoire de Physique Theorique, IRSAMC, CNRS and Universit e de Toulouse, UPS, F-31062 Toulouse, France*

In the past decade modern societies have developed enormous communication and social networks. Their classification and information retrieval processing has become a formidable task for the society. Because of the rapid growth of the World Wide Web, and social and communication networks, new mathematical methods have been invented to characterize the properties of these networks in a more detailed and precise way. Various search engines extensively use such methods. It is highly important to develop new tools to classify and rank a massive amount of network information in a way that is adapted to internal network structures and characteristics.

We describe the Google matrix analysis of directed complex networks demonstrating its efficiency using various examples including the World Wide Web, Wikipedia, world trade, and Ulam networks. The analytical and numerical matrix methods used in this analysis originate from the fields of Markov chains, quantum chaos, and random matrix theory.

Contact: Giuliano Delle Chiaie, giulidellec@hotmail.com

17:00hs - Contributed 2

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Efficiency and Performance of Fragmentation of Networks

Gonçalves S¹, Requião da Cunha B^{1 2}

¹ *Instituto de Física, UFRGS, Porto Alegre, RS, Brasil*

² *Policia Federal do Brasil*

Optimization of procedures for efficiently breaking complex networks is attracting much attention from two practical points of view: attacking and preventing attacks or failures. In this contribution we present a novel procedure to break complex networks guided by the identification of modular structures. Our module-based method [1] first identifies communities in which the network can be represented, then it deletes the nodes or edges that connect different modules by decreasing order in the betweenness centrality ranking list. We illustrate the method by applying it to various well known examples of social, infrastructure, and biological networks. We show that the proposed method always outperforms vertex attacks which are based on the ranking of node degree or centrality, with a huge gain in efficiency for some examples. Remarkably, for the US power grid, our method breaks the original network of 4941 nodes in many fragments smaller than 210 nodes with less than 3% of nodes removed. Performance is addressed too by considering the processing time [2] to find the list of nodes, so the module based method is tested against the high adaptive methods which are based in sequential updates of the node list. Finally, the present method is applied for two examples of real criminal networks.

[1] Fast Fragmentation of Networks using Module-Based Attacks, Bruno Requião da Cunha, Juan Carlos Gonzalez Avella, and Sebastián Gonçalves. PLoS ONE 10(11): e0142824 (2015).

[2] Performance of attack strategies on modular networks, Bruno Requião da Cunha and Sebastián Gonçalves (arXiv:1608.02619).

Contact: Sebastián Gonçalves, sebastiangoncalves@gmail.com

Tuesday 8

14:00hs - Invited 2

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The complexity of social integration in a diverse society: can we connect theoretical models and big data?

Prof. Andreas Flache

University of Groningen, Groningen, The Netherlands

There is increasing societal and scholarly interest in understanding how social integration can be maintained in a diverse society, and what are possible pitfalls and risks of diversity. I will discuss how big data might help to better understand what underlies possible dynamics of segregation and polarization in a diverse society, but also what are the limitations of the use of big data. It will be argued that big data can only seriously foster our understanding of social integration dynamics when integrated with theory driven computational modelling and small-scale empirical research as well as “old” types of data such as surveys.

Contact: Andreas Flache, a.flache@rug.nl

14:50hs - Contributed 3

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Adoption of innovations with contrarians and repentants

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² *Instituto de Investigaciones Físicas De Mar De Plata, CONICET-UNMdP*

³ *Grupo de Física Estadística e Interdisciplinaria, Centro Atómico Bariloche - CONICET*

⁴ *Instituto de Física, UFRGS, Porto Alegre, RS, Brasil*

⁵ *Laboratoire d'Informatique de Grenoble*

The dynamics of adoption of innovations is an important subject in many fields like technological development, industrial processes, social behavior, fashion, marketing, etc. The number of adopters of a new technology generally increases following a kind of logistic function. However, and for different reasons, new adopters may have second thoughts and may change their decisions; we call these agents repentant. On the other hand, some people may resist adopting new products, the stronger the greater the number of adopters; we call these agents contrarian.

In this work we investigate a simple model for the adoption of an innovation which depends mainly on three elements: the appeal of the novelty, the inertia or resistance to adopt it, and social interaction with

other agents. Social interactions are taken into account in two ways: by imitation and by differentiation, i.e., some agents will be inclined to adopt an innovation if many people do the same, but others, the contrarians, will act in the opposite direction, trying to differentiate from the herd. Finally, we also include the possibility of regretting and abandoning the innovation. Both analytic calculations and numerical simulations have been performed and we have determined the conditions for the establishment of the new technology.

We find a balance between the advertising and the number of anti-herding agents that may block the adoption of a new product. Moreover, the fact that agents can reverse their decisions may generate a rich landscape of temporal evolution, including cycles of adoption.

Contact: José Roberto Iglesias, roberto.iglesias@ufrgs.br

15:45hs - Invited 3

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What can we learn from simple models of social interaction?

Prof. Maxi San Miguel

IFISC, Universitat de les Illes Balears, Spain.

I will use the voter model as a paradigmatic example to illustrate how understanding of general concepts in social phenomena can be obtained from simple models. I will also explain how the voter model can be used to explain real data of electoral processes and community structure of online games.

Contact: Maxi San Miguel, maxi@ifisc.uib-csic.es

16:35hs - Invited 4

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Pedestrian dynamics: experiments, models and applications.

Dr. Daniel R. Parisi

Instituto Tecnológico de Buenos Aires, Buenos Aires, Argentina.

In this talk we are going to introduce the main features of pedestrian and crowd physics, presenting the main “macroscopic” observables and some “microscopic” mechanisms of navigation. In order to describe the real system, empirical observation and controlled experiments will be shown, considering two kind of agent behaviors: cooperative and competitive. Also, we are going to discuss pedestrian models that allow computer simulation and that reproduce the observed data. Finally, the validated models are used to build simulation softwares that can handle virtual crowds in complex facilities and that can be used for different applications such as: efficient design of buildings, transport terminals and safe evacuation systems, among others.

Contact: Daniel Parisi, dparisi@itba.edu.ar

17:25hs - Contributed 4

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Large Text authorship recognition using the dynamics of co-occurrence networks

Akimushkin C¹, Amancio D², Novais de Oliveira Jr O¹

¹ *Instituto de Física de São Carlos - Universidade de São Paulo*

² *Institute of Mathematical and Computer Sciences, University of Sao Paulo*

Human languages have been described as evolving complex systems. While language as a whole has been successfully mapped into complex networks, there is still the open question of whether different authors create networks with different properties. We explore how the dynamics of networks depend on authorship by creating series of networks for various texts. From these we obtain a set of series for different network measures. It was found that the series are stationary therefore allowing to describe texts in terms of series moments. The moments are used as attributes for supervised learning algorithms reaching up to 85 % success score for a collection of 8 authors and 10 texts per author. This finding shows that authorship is characterized by changes in the structure of texts revealing new connections between human creations and complexity.

Contact: Camilo Akimushkin, camilo.akimushkin@gmail.com

Wednesday 9

14:00hs - Invited 5

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Hawkes-process driven limit order books

Prof. Frédéric Abergel

École Centrale Paris, Paris, France.

The limit order book is the at the core of every modern, electronic financial market. In this talk, I will present some results pertaining to their statistical properties and mathematical modelling. Questions such as ergodicity, dependencies, relation between time scales will be addressed, and recent results on optimal trading and market making will be evoked.

Contact:Frédéric Abergel, frederic.abergel@orange.fr

14:50hs - Contributed 5

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Multidimensional Middle Class

Edo M^{1 2}, Sosa Escudero W^{1 2}, Svarc M^{3 2}

¹ *Departamento de Economía, Universidad de San Andrés*

² *Consejo Nacional de Investigaciones Científicas y Técnicas*

³ *Departamento de Matemática, Universidad de San Andrés*

Middle class studies have gained relevance in the economic literature. Nevertheless, a profound lack of agreement on conceptual and methodological issues for its identification remains. Furthermore, it has mostly relied on only one dimension: income. In this paper we present a new multidimensional approach for identifying the middle class based on multivariate quantiles. We also propose a variable selection procedure for multivariate quantiles, the main idea is to aid to understand which are the quantiles main features. We provide an empirical application for the case of Argentina in the 2004-2014 period, characterizing its performance and main features.

Contact: Marcela Svarc, msvarc@udesa.edu.ar

15:45hs - Invited 6

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Macroeconomics and complex-system analysis

Dr. Daniel Heymann

Instituto Interdisciplinario de Economía Política, Universidad de Buenos Aires, Argentina.

Modern economies are characterized by highly intricate interactions between large numbers of agents. The image of an evolving complex system fits naturally such scenarios, with the specificity that the individuals who populate the system engage in information- processing tasks analogous to those of the analysts. Macroeconomics has been historically motivated by the challenge of understanding large- scale social disruptions –recessions, financial crises, hyperinflations–that put into question the self-coordinating capabilities of economies. Agent- based models (ABMs) seem certainly adapted to that study. However, while there have been relevant movements in that direction, the incorporation of complex-system concepts and techniques to the usual practice of macroeconomic analysis has been slow. The presentation will discuss this state of affairs. Two elementary models, prototypes of large bodies of literature, will be used to illustrate the existence of widely different representations of pertinent macro questions (e.g. the effects of changes in savings propensities) and to sketch the analytical roots of those discrepancies, which more general, encompassing models could address. Some factual evidence will be presented to indicate features of macro crises (changes in trends, mistaken forecasts, sudden transitions) that ask for theoretical representations. Finally, looking ahead, some reflections will be presented about the potential for the development of macro ABMs and about issues and tradeoffs deserving attention.

Contact: Daniel Heymann, dheyman@econ.uba.ar

16:35hs - Contributed 6

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Multifractal Cross-Correlation Analysis of Colombian Stock Market

Dominguez Monterroza A R^{1 2}¹ *Departamento Ciencias Básicas, Politécnico Grancolombiano, Bogotá, Colombia.*² *Departamento de Matemáticas, Escuela Colombiana de Ingeniería Julio Garavito, Bogotá, Colombia.*

Multifractality is one of important concepts introduced in the dynamical complex system of many fields such as earthquakes, biology and finance. Studying correlations between financial series and markets have a great interest. The method *Multifractal Fractal Detrended Fluctuation Analysis MF DFA* [1] is a generalization of *Detrended Fluctuation Analysis DFA* [2] and it has been shown to reliably extract more than one scaling exponent from a time series. In this work we applied MF DFA and its extension named *Multifractal Detrended Cross Correlations MDCC* [3] for two non-stationary series to order to analyze the cross-correlations of the Colombia stock series. The generalized hurst exponent $h(q)$ is estimated for the main Colombia stock series varying parameter $q = [-10, 10]$. One can note that at all series, the slopes ($h(q)$) decrease as the moment is increased from negative to positive values.

We investigated the cross-correlations of the Colombia market using a multifractal cross-correlation method. We found the existence of multifractal cross-correlations among the main series of the Colombia stock markets. This approximation may be usefull to manage portfolios in order to have a better understanding of risks and to ensure the best optimization.

[1] J.W Kantelhardt, et al. (2002), *Physica A* 316:87,114.[2] Peng C-K, et al. (1994), *Phys. Rev. E* 49:1685,1689.

[3] Wei-Xing Zhou, *Phys. Rev. E* 77: 066211

Contact: Andy-Rafael Dominguez Monterroza, ardominguezm@gmail.com

17:00hs - Contributed 7

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Study of the time series of the Consumer Price Index in Argentina

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² *Departamento de Física de la Materia Condensada, CAC, CNEA-CONICET*

³ *Dpto. de Economía, Facultad de Ciencias Económicas, Universidad de Buenos Aires*

The time series of the Consumer Price Index (CPI) in Argentina are studied. The theoretical formalism outlined in Refs. [1-3] is applied. There are branches of high- and hyper-inflation. The determination of a critical times for the hyperinflation is discussed.

[1] M. A. Szybisz and L. Szybisz, *Phys. Rev. E* 80, 026116 (2009). [2] M. A. Szybisz and L. Szybisz, *Physica A* (2016), <http://dx.doi.org/10.1016/j.physa.2016.07.052> [3] M. A. Szybisz and L. Szybisz, *Physica A* (2016), <http://dx.doi.org/10.1016/j.physa.2016.07.014>

Contact: Leszek Szybisz, szybisz@tandar.cnea.gov.ar

Thursday 10

14:00hs - Invited 7

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Big data to tackle Urban Mobility Challenges

Prof. Marta C. González

Human Mobility and Networks Lab, Civil and Environmental Engineering, Massachusetts Institute of Technology, Cambridge, USA.

Urban mobility models are important in a wide range of application areas. Current mainstream models require socio-demographic information from costly manual surveys, which are in small sample sizes and updated in low frequency. In this study, we propose a novel individual mobility modeling framework, TimeGeo, that extracts all required features from ubiquitous, passive, and sparse digital traces in the information age. Combining demographic data, road network information and billions of mobile phone records, we infer travel demand profiles and estimate travel times across five different cities. We demonstrate that the percentage of time lost in congestion is a function of the proportion of vehicular travel demand to road infrastructure capacity, and is closely tied to spatial density and selfish choices of drivers. In this context we explore the feasibility of smart routing applications.

Contact: Marta González, martag@mit.edu

14:50hs - Contributed 8

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Conurbano bonaerense's Atlas

Hopp M^{1, 2}, Martnelli V²

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² *Universidad Nacional de Avellaneda*

The Conurbano bonaerense's Atlas -the region around Argentina's capital city, Ciudad Autónoma de Buenos Aires- is an interactive web that systematizes and shares information about diverse dimensions of the territory, with special focus on popular economy. This tool maps and shows the socio-demographic, economic, productive characteristics, as well as the urban-environmental features of Buenos Aires's suburbs and its popular neighborhoods (slums, settlements, informal boroughs).

This Atlas displays the current picture of the Conurbano bonaerense, based on primary information and open data that was formerly disperse. The data gathered was provide by governmental agencies from the Province of Buenos Aires, township's administrations, and state universities located in the urban and sub-urban area.

This project combines official socio-economic public data with specific habitat, life conditions and production in popular economy research. The Atlas is a tool for the analysis of transformations in the social, economic and territorial structures of the Conurbano bonaerense during the last decade. It also aims to be helpful for the design and implementation of public policies assessing problems linked with work and life conditions in the popular neighborhoods.

The research conducted by the "Equipo de Estudios de Condiciones de Vida en el Conurbano Bonaerense" has provided the basis for the development of the Atlas. This research group aims to display the productive circuits of the popular economy, and contribute to the institutionalization of the Provincial Public Registry of Slums and Precarious Settlements, that was command by the Law on the Fair Access to Habitat (statute 14.449 of the Province of Buenos Aires).

In sum, the Conurbano bonaerense's Atlas -developed by this social science research group- aims at analyzing and displaying great amounts of data through interdisciplinary techniques and methodologies. This tool will produce information on four dimensions of social life: habitat, production, work and consumption by means of surveying popular neighborhoods within the Province of Buenos Aires.

Contact: Malena Hopp, malenahopp@yahoo.com.ar

15:45hs - Invited 8

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Inference of Socio-economic Attributes in a Communication Graph

Dr. Jorge Brea

Grandata Lab

Our understanding of the structure and dynamics of social systems has greatly increased in recent years due to the availability of large datasets, collecting the social interactions of millions of individuals. One of the most promising directions of study is the analysis of mobile phone datasets. As mobile phones have become ubiquitous devices that we carry and use during the whole day, they also capture an important part of our daily activities, recording our communications, messages, physical location and online activities. These advancements give us the opportunity to study the structure and temporal evolution of large social communication networks, and to find general patterns in human behavior.

Here we study a coupled dataset combining mobile phone records and banking information of millions of individuals in Mexico. The banking information gives us insight into economic aspects such as income, wealth and purchases (i.e. credit card transactions). We show the existence of unbalances in the distribution of wealth and spending, and describe how it relates to the social structure. In particular, we highlight the presence of a marked homophily in the communication graph respect to wealth, revealing the stratification of society and the existence of "rich clubs" in the social fabric. We take advantage of this homophily to generate inferences of socio-economic status for users in the graph for which we lack that information (namely, individuals that are not clients of the bank), and show the experimental results obtained.

Contact: Jorge Brea, jorge@grandata.com

16:35hs - Contributed 9

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Epidemiological models with human mobility based on dengue time series from Northern Argentina

Laneri K F¹, Kaufman B²¹ *Grupo de Física Estadística e Interdisciplinaria, Centro Atómico Bariloche - CONICET*² *Instituto Balseiro - Universidad Nacional de Cuyo*

The space-time patterns of dengue cases from Northern Argentina seem to be closely related with human mobility. Tourism and/or temporal work associated with regional economies generates a flux of immigration from dengue endemic countries that should be considered in epidemiological mathematical models together with intercity mobility. Besides mosquito population that produce dengue transmission changes with climate and water accumulation. I will present a dynamical metapopulation model for dengue inspired on observed cases in several cities from Salta and Misiones provinces. The model takes into account climate forcing and human mobility at the provincial scale and is used to test the effect of different hypothesis about the sources of imported cases from endemic bordering countries.

Contact: Karina Laneri, karinalaneri@gmail.com

17:00hs - Contributed 10

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Where does everybody go? Active particles under position-dependent interactions

Barberis L¹, Peruani F²¹ *Instituto de Física Enrique Gaviola de Córdoba, CONICET-UNC*² *Lab. J.A. Dieudonné, Université de Nice Sophia-Antipolis, Francia*

Navigation in animals and humans strongly depends on their interaction with their environment. For animals capable of vision, and depending on the conformation of their sensory organs (eyes), side viewing angle and cognitive horizon limit the interaction to a 'cone of vision' (CV).

I present a system of active particles interacting through an attractive short-range social force, which solely depends on the position and is restricted to a CV. Since CV breaks Newton's third law, this system can display various patterns of complex self-organization at a macroscopic scale that correspond to social patterns observed in nature.

Depending on the values of the parameters we can observe: (a) The formation of polar lines whose heading particles act as effective leaders, similarly to what is observed in sheep. (b) Phase separation into droplets with different structures, some of them similar to schools of fish and other swarms. (c) Nematic structure formation with long range order, similar to pedestrian traffic lines or ant columns.

Combining computer simulations and nonlinear field equations I show that position-based active particle models belong to a new class of active systems. In particular, they are very different from other well-known systems such as those that consider velocity alignment (Vicsek models).

These results are of importance for the study, interpretation, modeling and/or design of collective patterns of active particle systems both live and synthetic.

[1] Accepted for publication in *Phys. Rev. Lett.* October 21, 2016. **Contact:** Lucas Barberis, Ibarbe-

ri@famaf.unc.edu.ar

Friday 11

14:00hs - Invited 9

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Of Bitcoins and blockchains: A testbed for emergence in complex socio-technical systems

Dr. Claudio Tessone

Department of Business Administration & Network Science, University of Zurich, Switzerland.

Nowadays, most facets of human behaviour are pervaded by technical systems that facilitate our communication, information and economic exchanges. In the last years, aiming at a more resilient and scalable growth, these systems have transitioned towards decentralised concepts. Blockchain based systems have disrupted the way of thinking distributed systems: This mechanism allows for securely diffusing information across a network, without the need of central authorities to enforce consensus. As a primary example, the digital currency Bitcoin is indeed implemented on top of a blockchain, and its value is solely assigned by a (largely speculative) market. This talk is divided in three parts: First, by recourse of a large-scale analysis of different social and economic signals, those that affect the pricing of Bitcoin in exchange markets will be described. Bitcoin has followed a technocratic approach in its immutable design. It is the only isolated economy where all the transactions can be traced back with full detail. Interestingly, its fixed incentive scheme has created the emergence of large levels of centralisation and economic flow, drastically different from its original purpose. This is the subject of the second part of the presentation. Finally, these socio-technical systems are underlain by decentralised peer-to-peer networks. While in the last years the number of its applications has increased enormously, little is known about their suitability in stressed working conditions. In the final part of this presentation we will introduce a parsimonious modelling approach to these systems, identifying a transition from consensus to congestion in them.

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Rumor Propagation with Heterogeneous Transmission in Social Networks

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Propagation models have been developed to predict and control disease or rumor spreading in com-

plex networks. Most of the models consider identical propagation force for all individuals. However, this homogeneous assumption is a property rarely found in social and technological networks. For example, diseases, as measles, mumps or chickenpox are most commonly developed during childhood and the transmission among children is far more likely to occur than among adults. Moreover, subjects do not propagate information in social networks with the same capacity — some people, as celebrities and political leaders, are more influential than others. For a more accurate modeling of information propagation in real-world networks, models with heterogeneous transmission must be taken into account.

This paper presents a rumor model with heterogeneous transmission behavior correlated with the network structure. We analyze the heterogeneous propagation behavior in social networks motivated by the following questions: (i) How does heterogeneous transmission influence the spread and prevalence of information? (ii) Can the spread of information be controlled or improved? (iii) Which topological properties are most related to propagation? (iv) Can the existence of influential spreaders be quantified?. Six centrality measures, namely degree, betweenness, closeness, k -core, PageRank and eigenvector were evaluated in artificial and real-world networks, so that the questions could be answered.

As results, the impact on the rumor spreading according to network topology and propagation probabilities proportional to such centrality measures was addressed. Probabilities correlated to PageRank, degree and betweenness centrality improved the rumor propagation in scale-free networks in comparison with the homogeneous case. However, propagation behaviors correlated to closeness or k -core insignificantly improved the results. The Markov chain approach modeling was also considered and a good agreement between theoretical results and Monte Carlo (MC) simulations was found. Finally, we showed rumor spreading can be controlled through the adjustment of the transmission probability of the most central nodes.

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15:45hs - Contributed 12

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Statistics of dynamic networks

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The study of random graphs and networks had an explosive development in the last couple of decades. Meanwhile, techniques for the statistical analysis of sequences of networks were less developed. In this talk we focus on networks sequences with a fixed number of labeled nodes and study some statistical problems in a nonparametric framework. We introduce natural notions of center and a depth function for networks that evolve in time. We develop several statistical techniques including testing, supervised and unsupervised classification, and some notions of principal component sets in the space of networks. Some examples and asymptotic results are given, as well as two real data examples.

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Posters

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1. Acuerdos de Pesca: La problemática en torno a su ejecución como instrumento para la gobernanza de recursos pesqueros en el resguardo indígena Ticoya

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La investigación que se aborda corresponde a la tesis de maestría, titulada: Acuerdos de Pesca, impactos en el sistema de gobernanza del recurso pesquero en el resguardo Ticoya.

En la investigación, se expone la problemática de gobernanza en torno al uso de los recursos pesqueros del resguardo indígena Ticoya del municipio de Puerto Narino-Amazonas, Colombia.

En primer lugar, se presenta la forma en que los acuerdos de pesca fueron creados mediante la participación comunitaria y el apoyo de entes gubernamentales y no gubernamentales, evidenciando algunas fallas que se identificaron en el proceso de formulación, y las cuales representan grandes debilidades en su ejecución hasta la actualidad.

En segundo lugar, tiene por objetivo establecer las relaciones de poder en torno a la gobernanza de los bienes comunes, que para este caso serán los recursos pesqueros, los cuales son gobernados mediante acuerdos de pesca, siendo estos una herramienta para el uso adecuado de los recursos pesqueros del sistema de humedales de Tarapoto, principal complejo lagunar del resguardo, donde los bosquesinos realizan pesca para el autoconsumo, venta e intercambio.

Dichos acuerdos fueron formulados por las comunidades indígenas del resguardo y por entidades gubernamentales y no gubernamentales, creando así una red de gobernanza en torno a la pesca, la cual se aborda en esta investigación, a partir de las relaciones de poder y la toma de decisiones respecto al uso de recursos naturales, generando a lo largo del proceso de ejecución de los acuerdos de pesca, una elevada dependencia institucional por parte de las autoridades del resguardo, hacia las instituciones que han apoyado el proceso de ejecución de los acuerdos de pesca, restando la autonomía de las comunidades indígenas y sus autoridades, en el manejo de sus recursos naturales, como es el recurso pesquero que aborda esta investigación.

Finalmente, se busca que la problemática de gobernanza que se presenta actualmente en torno al manejo del recurso pesquero y la cual ha ido aumentando de manera progresiva mediante la ejecución de los acuerdos de pesca apoyados en un débil modelo de co-manejo, que combina el apoyo de instituciones externas hacia el resguardo, como es el caso de las ONGs, se exponga mediante información organizada y datos claros, evidenciando cual ha sido el papel de las instituciones que han participado en el proceso

del manejo del recurso pesquero, y la forma en que las decisiones de grupos sociales externos a las comunidades del resguardo pueden afectar directamente un sistema de gobernanza, como lo es el de la pesca para en las comunidades indígenas.

2. A multiscale model for the dynamics of crowd evacuation from bounded domains.

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A mathematical model of the evacuation of a crowd from bounded domains is derived by a hybrid approach with kinetic and macro features. Interactions at the micro-scale, which modify the velocity direction, are modeled by using tools of game theory and are transferred to the dynamics of collective behaviors. The velocity modulus is assumed to depend on the local density. The modeling approach considers dynamics caused by interactions of pedestrians not only with all the other pedestrians, but also with the geometry of the domain, such as walls and exits. Interactions with the boundary of the domain are non-local and described by games. Numerical simulations are developed to study evacuation time depending on the size of the exit zone, on the initial distribution of the crowd and on a parameter which weighs the unconscious attraction of the stream and the search for less crowded walking directions.

3. An Entropical Characterization for Complex Systems Becoming out of Control

Gaudio M¹

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General properties of N -dimensional multi-component systems exhibiting self-similar hierarchical structure are presented. The entire system is partitioned into *cells*, which have an associated generalized entropy $S(D)$ that is shown to be a universal function of the fractal dimension D of the configurations, exhibiting self-similarity properties which are independent of the dimensionality N . This opens the doors to a classification of the system components based on entropical reasons and according to their degree of uncontrollability. This is a quantitative classification criterium, which – being independent of any observer's bias – could potentially be applied to Economics, Sociology, etc.

The simplicity and generality of the ideas involved here seem to point out that at least for a non-negligible fraction of the complex systems observed, a proportional to $S(D)$ components distribution defines a kind of *ideal worst possible scenario*, that can be associated to an ultimate state resulting from a hypothetical evolution in the absence of control.

References:

- 1) S. Encarnação, M. Gaudio, F.C. Santos, J.A. Tenedório, J.M. Pacheco, Fractal cartography of urban areas, *Scientific Reports* 2, 527, Nature Publishing Group (2012).
- 2) M. Gaudio, An entropical characterization for complex systems becoming out of control, *Physica A*, 440, 185-199, Elsevier (2015).

4. Can studying economics make people more selfish? Evidence from experimental economics

Mena A S¹

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Many studies indicate that economists behave more selfishly than other people. There is less agreement about the causes of this differentiated pattern. Some people say that this is caused by indoctrination, which means: studying economics discourage pro-social behavior. Others say that selfish people self-select into economics. Based in developments in Behavioral Economics, Game Theory, and Behavioral Psychology, this study provides experimental evidence from 150 students in favor of indoctrination hypothesis. It also reproduces Rubinstein's (2006) "maximizations profit bias" experiments and find the same results as him: Economist trend to behave as profit maximizers more usually than others. Finally it dismisses, through a moral judgment test, the hypothesis that selfishness in economists can be explained by the disability of economists to distinguish between "right" and "wrong" behavior.

5. Contagio, indecisión y polarización en un modelo de opinión de auto-posicionamiento ideológico.

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La evolución de la opinión pública utilizando herramientas y conceptos tomados de Física Estadística es un área emergente que consituye un nuevo campo interdisciplinar denominado sociofísica. En el presente trabajo, un modelo de Física Estadística fue desarrollado para estudiar la evolución del auto-posicionamiento ideológico de un conjunto de agentes. El modelo consiste en una serie de componentes L , cada uno de los cuales representa la ideología de un agente, con números enteros en la escala del 0 al 10, donde 0 es la extrema izquierda y 10 es la extrema derecha. El mecanismo propuesto se basa en el "modelo del votante", en el que un agente puede adoptar la opinión del otro si la diferencia de sus opiniones se encuentra dentro de un cierto rango. En el modelo también se tuvo en cuenta la existencia de agentes "indecisos" (es decir, Los agentes que no tienen una opinión definida). La posibilidad de radicalización de la opinión de un agente de la interacción con otro también se puso en práctica. Se plantearon las ecuaciones matemáticas asociadas al modelo, para algunos casos particulares. Los resultados de las simulaciones son comparados con los datos estadísticos extraídos de la encuestadora Latinobarómetro, con datos para los casos de Argentina, Chile, Brasil y Uruguay en la última década. Entre otros resultados, el efecto de tener en cuenta la posibilidad de existencia de agentes indecisos es la formación de un solo pico en la mitad de el espectro ideológico (que corresponde a una posición ideológica de centro), lo cual se encuentra de acuerdo con los casos reales estudiados.

6. Dinámica del interés social en un tema en función de su novedad.

Sibona G^{1 2}, Barberis L¹

¹ *Instituto de Física Enrique Gaviola (CONICET-UNC)*

² *Facultad de Matemática Astronomía y Física - Universidad Nacional de Córdoba*

El interés de una comunidad en un dado tema puede ser impulsado por la aparición de información no habitual sobre el mismo. En este trabajo se modela este fenómeno a partir de un esquema de agentes móviles que poseen distintos niveles de interés en el tema en cuestión. Este nivel de interés puede ser incrementado debido a la interacción con otros agentes y disminuido por un mecanismo de olvido en caso de no interacción. Utilizando una tasa de transmisión de información modelada como una función de lo novedoso/original que sea el tema, hemos reproducido curvas cualitativas de frecuencia de tweets sobre el "Domino's Pizza case".

7. Dynamics news of mass media.

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² *Instituto de Física de Buenos Aires, Facultad de Ciencias Exactas y Naturales CONICET- Universidad de Buenos Aires*

The aim of our research is the modelling of Mass Media's influence on a society. In order to do that, we study the dynamics of the news present in newspapers and news websites of Buenos Aires. We describe this dynamics by analyzing, for example, the average time of a given event on Media, its distinction between spontaneous or anticipated event and the weight given to the event by the Media. We will present the main findings of this research, accompanied with the description of the techniques used for the corresponding analysis.

8. Economic growth and human capital accumulation: a discrete time analysis

BRIDA J G¹, Yapor M^{1 2}, Lorenzo P¹

¹ *Universidad de la República- Uruguay*

² *Universidad de La Republica*

This paper reformulates the classical Razin model of economic growth and human capital accumulation by representing time as a discrete variable. In addition, the model is developed in a more general framework of the Ramsey neoclassical model of optimal economic growth. The study examines the optimal trajectories in human and physical capital and consumption showing the existence of a unique steady state which stability is analyzed. The paper compares the results with the original study of Razin. Keywords: economic dynamics; human capital; economic growth; discrete time. JEL classification: C62; O41. AMS (MOS) subject classification: 91B55; 91B62.

9. El proyecto como investigación social en la era de la técnica: una posibilidad de invención colectiva

Gómez Gutiérrez M L¹

¹ *Universidad de Guadalajara*

El presente proyecto busca adentrarse en el debate histórico entre lo virtual-actual (actualidad entendida como aquella realidad cambiante en un continuum de espacio-tiempo) y sus conexiones multi-dimensionales, que desde siempre ha tenido lugar.

Para ello, sirviéndose del reconocimiento contemporáneo que en el estado de la técnica se evidencia por primera vez dicha dislocación de realidades múltiples, en la presente convocatoria se pretenderá implementar dichas posibilidades técnicas en el producto resultante de la experimentación -es decir, la extensión de la infografía del cartel mediante realidad aumentada-, que como coexistencia dimensional permita expandir los contenidos de un objeto físico como un multiverso de sus posibles.

En 1994, del equipo de Paul Milgram, conformado también por los japoneses Haruo Takemura, Akira Utsumi y Fumio Kishino presentaría la concepción de -virtuality continuum-, refiriéndose a la coexistencia dimensional de aquellas realidades paralelas que fueran creadas por el hombre y que desde un lenguaje tecnológico podían legitimarse como posibilidades de telepresencia, y de carácter remoto. El equipo logra un esquema de configuración muy simple, que trataría de explicar la noción de realidad mixta, mostrando una taxonomía que busca clasificar las relaciones entre la realidad aumentada y las -otras- dimensiones de realidad tecnológica; dimensiones que, por el momento sin mucho detenimiento, pueden diferenciarse como entorno virtual, virtualidad aumentada, realidad aumentada y entorno real; capas que iban superándose a sí mismas (aunque con la posibilidad de sumarse, restarse, multiplicarse o dividirse entre ellas) según su posibilidad mimética hacia la realidad -real-, pudiendo estratificarse para su enriquecimiento informacional.

Si bien, la duda fundamental sobre los procesos tecnológicos de éste tiempo, ya no se posa sobre las capacidades en los motores de potencia tecnológica; puesto que aún desde su proceso de desarrollo ya de manera temprana permiten la comprobación mínima de la existencia tácita de coexistencia multidimensional para la condición humana; y no obstante este efecto de alguna manera permite la comprensión de una expansión y distensión del cuerpo humano para nuevas realidades. Es el caso de las disciplinas de humanidades, y como ya vaticinaba Descartes, ahora es posible observar el fin de manera más inmediata, que desde lenguajes más rudimentarios esperaban necesariamente la traducción del medio.

Puntualmente para la realización operativa del póster se tienen tres esqueletos de proyecto -siempre mostrando el referente de la línea de investigación que se ha manejado como la triada -arquitectura, tecnología, y procesos participativos-, sin embargo, se pretende analizar las dinámicas del workshop para decidir cuál será la manera más directa para dicha implementación infográfica.

10. El rol de la persuasión y el compromiso en formación de opiniones: dinámica lenta en redes cuadradas

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El proceso de formación de opiniones en una sociedad involucra diversos mecanismos sociales complejos. Uno de ellos es la persuasión que puede darse entre sujetos con la misma orientación y tiende a reforzar sus opiniones previas. Otro es el acuerdo por compromiso que tiende a moderar visiones encontradas. La competencia entre estos dos mecanismos fue explorada recientemente mediante un modelo de agentes interactuantes analizado en campo medio, es decir, donde cada agente puede interactuar con todos los demás [1]. En ese modelo las opiniones están representadas por un número entero k que

expresa el nivel de acuerdo que se tiene respecto a un determinado tema, desde totalmente a favor $k = M$ a totalmente en contra $k = -M$. Dos agentes interactuantes con la misma orientación (positiva o negativa) refuerzan sus opiniones hasta convertirse en extremistas de esa orientación, mientras que dos agentes con orientaciones contrarias acercan sus opiniones. El comportamiento del sistema depende de un parámetro de refuerzo r que mide la intensidad de la persuasión respecto del compromiso. En este trabajo estudiamos este modelo sobre una red cuadrada, la que simula una población con agentes que interactúan con sus primeros vecinos de la red. Analizamos la evolución temporal de las densidades de agentes en cada opinión, observando que relajan lentamente –como ley de potencias– hacia el estado final de consenso de opiniones. Por otro lado, encontramos que el tiempo de consenso en el sistema crece exponencialmente con r , a diferencia del comportamiento no-monótono observado en campo medio.

[1] C. E. La Rocca, L. A. Braunstein, and F. Vázquez, *Europhys. Lett.* 106, 40004 (2014).

11. Few inter-links suffice for optimal diffusion in regular multiplex networks

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The structure of a large variety of complex systems is often represented by networks with many connected layers. For example, an acquaintance network has both real and virtual layers of connectivity. Diffusion processes, like spreading of a rumour or a disease, can be quite different in networks with many layers than in single-layered networks. Here we investigate the role of the inter-layer connectivity in the diffusion rate for duplex networks (namely, multi-layer networks with two equally sized layers). The diffusion rate is determined by the smallest non-zero eigenvalue of the Laplacian matrix. We deal, numerically, with duplex networks formed by two regular nearest-neighbours layers. One advantage of the nearest-neighbours topologies is that they yield Fourier eigenvalues and eigenvectors since they are circulant graphs. This allows us to compare analytical and numerical Laplacian spectra for multiplex networks via perturbation theory. Our results show that, when randomly adding inter-links between one node and its symmetrical node in the second layer, few links are needed for the network to reach an optimal diffusion rate. This optimal value equals the diffusion rate of one isolated layer. We also find that the number of inter-links needed to achieve the optimal diffusion rate increases exponentially with the number of intra-layer neighbours. Moreover, we show that, for this class of duplex networks, there is a scaling law between observables related to the number of inter-links and the diffusion rate. These results can naturally be extended to multiplex networks.

12. Flocking dynamics with voter-like interactions: fast nematic consensus by spatial segregation

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We study the collective motion of self-propelled particles with voter-like interactions. Each particle moves at a constant speed on a two-dimensional space and, in a single step of the dynamics, it aligns its direction of motion with that of a randomly chosen neighboring particle. Directions are also perturbed by an external noise of amplitude η . We find that, in the absence of a noise $\eta = 0$, the system ultimately reaches full nematic (orientational) order. However, in the thermodynamic limit, a very small amount of noise $\eta > 0$ is enough to keep the system totally disordered. Besides, at zero noise the dynamics of ordering is much slower than in the standard Vicsek model, and is characterized by an order parameter φ that increases as $\varphi \sim t^{1/2}$ for short times, and approaches exponentially fast to 1 for long times. Also, at zero noise, the mean convergence time to complete order is non-monotonic with the density of particles, and for high densities the convergence is faster than in the case of all-to-all interactions. We show that the fast nematic consensus is a consequence of the segregation of the system into clusters of equally-oriented particles, breaking the balance of transitions between directional states observed in well mixed systems.

13. Inclusión social en la toma de decisiones.

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Uno de los principales problemas de las sociedades actuales es el impacto ambiental generado por las actividades económicas o desarrollos de gran escala (megadesarrollos) que por sus características resulta en consecuencias negativas para el ambiente, aunado a esto se presenta la falta de participación social en la toma de decisiones dirigidas en este sentido. Esta falta de participación se puede presentar por diversas cuestiones como son: el interés, la información, el conocimiento y las cuestiones legislativas-gubernamentales.

Actualmente en México se cuenta con recursos y procedimientos legales de carácter participativo y se transita a su mayor inclusión dentro de todos los procedimientos administrativos y de toma de decisiones. De igual forma, la política nacional de desarrollo social, desarrollo urbano y vivienda incluyen estrategias de participación e inclusión social. Ante todas estas iniciativas sorprende que en la práctica no se cuente con un nivel elevado de participación de la sociedad en general.

Tomando como ejemplo la ciudad de La Paz, ubicada en el estado de Baja California Sur ubicado en México, que por sus características territoriales y costeras se vuelve ideal para la instauración de megadesarrollos turísticos y que actualmente enfrenta graves problemas socio-ambientales, se presentan algunas de las cuestiones de participación expuestas.

Es por ello que se requiere identificar y analizar cada una de las variables que componen a cada concepto expuesto, como legislaciones, instituciones gubernamentales, manejo del lenguaje y aspectos que rodean a todos los involucrados que puedan resultar afectados de manera negativa por cuestiones de desarrollos o actividades en territorios determinados.

En esta investigación se planteará un modelo metodológico que pretende visualizar un esquema funcional del sistema social del de centro de población La Paz, para ello se utiliza un estudio prospectivo a través de un software de análisis estructural con el que es posible identificar cada uno de los conceptos y variables que le rodean para lograr encontrar el grado de interrelación entre unos y otros, siendo necesario el apoyo de especialistas en todo momento que se encargaran de asignar, mediante valores, el grado de

relación.

Al hacer uso de métodos matemáticos de asignación de valores a un determinado número de conceptos sociales clave y la postura objetiva de diversos especialistas es posible obtener determinados grados de relación con los que se pueden generar estrategias para erradicar la falta de participación en la toma de decisiones de interés para el desarrollo territorial-ambiental de un espacio determinado.

14. Inference of human-computation algorithms through video games

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Several government programs in Argentina have provided most students with a personal laptop computer. This unified digital platform enables educational interventions and research in a country-wide fashion. There are important results on how video games can improve children grades in primary school [1]. Implementing these interventions requires the development of many tools and methods. One such method constitutes the main aim of this proposal: the development of data-mining techniques to infer human-computation algorithms from the huge corpus of data that is being currently collected.

We aim to combine ideas from intelligent tutor systems developed at Carnegie Mellon University [2] with training cognitive bricks (such as executive functions) at initial levels of primary school using specific games. We will focus on 5 to 8 year-old children. By the creation of training games and their deployment country-wide, we propose to build a massive-scale repository of human-development cognitive data, together with the methods for their analysis.

Chocolate Fix is a video game which can be defined as a planification and reasoning task. The player –in our study students from the first grades of primary school– had to combine and validate some clues to fill a tray with certain pieces in an specific order. Our software log every action and movement of the player. With technics of data mining adapted to education [3] we aim to answer thre - Which are the tips and hits that can/must be showned to the player as a personlized tutor to help her getting a better performance? - Are there general strategies to solve some puzzles? Or every player has a different one? - Is it possible to caraterize this puzzle in order to have a difficulty value for each possible puzzle? (to validate the progresion of levels)

In the present work we will present some results which answer partially this research goals.

[1] Goldin, Andrea Paula, et al. "Far transfer to language and math of a short software-based gaming intervention." *Proceedings of the National Academy of Sciences* 111.17 (2014): 6443-6448.

[2] K.R. Koedinger and AT Corbett. *Cognitive tutors: Technology bringing learning science to the classroom*. The Cambridge handbook of the learning sciences, pages 61?78, 2006.

[3] R. Baker, A. Corbett, K. Koedinger, S. Evenson, I. Roll, A. Wagner, M. Naim, J. Raspat, D. Baker, and J. Beck. *Adapting to when students game an intelligent tutoring system*. In *Intelligent Tutoring Systems*, pages 392?401. Springer, 2006.

15. Influence maximization based on the least influential spreaders

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The emergence of social media increases the need for the recognition of social influence mainly motivated by online advertising, political and health campaigns, recommendation systems, epidemiological study, etc. In spreading processes, it is possible to define the most central or influential vertices according to the network topology and dynamic. On the other hand, the least influential spreaders have been disregarded. This work aims to maximize the mean of information propagation on the network by recognizing the non-influential individuals by making them better spreader. Experimental results confirm that selecting 0,5% of least influential spreaders in three social networks (google+, hamsterster and advogato) and rewiring one connection to some important vertex, increase the propagation over the entire network.

16. Interacting social processes on interconnected networks

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We propose and study a model for the interplay between two different dynamical processes –one for opinion formation and the other for decision making– on two interconnected networks A and B . The opinion dynamics on network A corresponds to that of the M-model, where the state of each agent can take one of four possible values ($S = -2, -1, 1, 2$), describing its level of agreement on a given issue. The likelihood to become an extremist ($S = \pm 2$) or a moderate ($S = \pm 1$) is controlled by a reinforcement parameter $r \geq 0$. The decision making dynamics on network B is akin to that of the Abrams-Strogatz model, where agents can be either in favor ($S = +1$) or against ($S = -1$) the issue. The probability that an agent changes its state is proportional to the fraction of neighbors that hold the opposite state raised to a power β . Starting from a polarized case scenario in which all agents of network A hold positive orientations while all agents of network B have a negative orientation, we explore the conditions under which one of the dynamics prevails over the other, imposing its initial orientation. We find that, for a given value of β , the two-network system reaches a consensus in the positive state (initial state of network A) when the reinforcement overcomes a crossover value $r^*(\beta)$, while a negative consensus happens for $r < r^*(\beta)$. In the $r - \beta$ phase space, the system displays a transition at a critical threshold β_c , from a coexistence of both orientations for $\beta < \beta_c$ to a dominance of one orientation for $\beta > \beta_c$. We develop an analytical mean-field approach that gives an insight into these regimes and shows that both dynamics are equivalent along the crossover line (r^*, β^*) .

17. La dimensión izquierda-derecha y su poder de predicción en el voto

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En este trabajo analizamos cómo son percibidos los últimos candidatos presidenciales en la dimensión izquierda-derecha por los votantes, y su relación con el autopoicionamiento de los mismos. Estudiamos el poder predictivo de la variable izquierda-derecha en el voto, y la influencia de otra variables. Los datos fueron obtenidos a través de una encuesta en un panel de internet.

18. La economía internacional como sistema complejo: Efectos de la globalización en la red de flujos económicos

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La globalización económica es un proceso iniciado en la segunda mitad del siglo XX y que tiene como motor al sistema financiero. Numerosos estudios teóricos y modelos han analizado los efectos de la globalización financiera en el crecimiento de los países, la calidad de vida y la resiliencia a crisis internacionales [1-2].

En este trabajo se estudian los flujos económicos por sectores entre 68 países en el período 1995-2011 con un enfoque basado en redes complejas. Utilizando medidas de centralidad, analizamos la evolución de la red de flujos y, en particular, del sector financiero, para entender de qué modo los distintos países se han adaptado a la globalización económica en dicho período, y los efectos sobre parámetros como el nivel de consumo y el crecimiento económico en términos de PBI.

Para el desarrollo de este trabajo se utilizaron datos de matrices de input-output entre países (Inter-Country Input-Output tables) provistos por la OECD (Organisation for Economic Co-operation and Development).

[1] M A Kose, E Prasad, K Rogoff, S-J Wei, IMF Staff Papers (2009) doi: 10.3386/w12484

[2] E S Prasad, K Rogoff, S-J Wei, M A Kose, Globalization and Poverty (2007) 457-516

19. La persistencia de la memoria: un modelo de propagación de rumores

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La propagación de un concepto (una idea, un rumor, etc.) entre individuos que se mueven en un mismo entorno e interactúan socialmente depende, principalmente, de dos factores: la facilidad que tiene este concepto para pasar de un individuo a otro (el "boca en boca") y la posibilidad de que los individuos olviden el concepto. Modelamos el medio de transmisión del concepto con un sistema de agentes que se mueven libremente y con interacciones de a pares. El primer factor a estudiar, el boca en boca, posee una dinámica determinada por el tiempo de interacción de los agentes para describir

el proceso de transmisión oral. En cada encuentro, cada agente que quiere transmitir la información, aumenta la probabilidad de recordar del agente con que interactúa. El factor de olvido se modela con un campo externo que afecta a todos los agentes por igual. Por medio simulaciones numéricas y soluciones de las ecuaciones de la dinámica del sistema, mostramos que existe una transición para la dinámica de transmisión de la información, en el espacio de los parámetros tamaño del sistema - velocidad de los agentes. Esta transición separa una región de este espacio donde el concepto se olvida totalmente, de otra donde el concepto es recordado.

20. Lets talk about the Earth: Children learn about conceptual Earth models from their peers.

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Peer interactions play an important role in children's cognitive development. One example is peer tutoring, the transfer of knowledge among companions of equal status (Topping, 2015). Despite its importance and effectiveness, there is little to no quantitative evidence about how children engage in it and on whether it has an impact on both tutees and tutors. Here we present evidence that, by teaching each other, children may promote conceptual change about models of the Earth.

First, 46 second graders were interviewed to reveal which Earth models they held. Then, children were paired in dyads. Within each dyad, the child showing the more advanced model -the teacher- was told to explain the other -the student- that they should agree on one single drawing of the planet. Finally, all children were reassessed and scored in 44 knowledge dimensions.

Student subjects showed significant knowledge level gains mainly driven by dimensions relating to the position of objects on the planet, not seen in control (non-interacting) subjects. Students' adoption of their teachers' responses contributed to these gains. No significant changes were seen in teacher subjects either, though it cannot be ruled out that they could have been favored by the interaction as well if they had had lower initial scores.

These results suggest that children effectively enhance their understanding of the Earth by interaction with a more knowledgeable partner, without negative impact on the latter's knowledge levels.

21. Mass Media influence in an agent-based model of cultural dissemination.

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We study the Mass Media influence in the Axelrod model of cultural dissemination. We explore different scenarios where the Media compete with stubborn agents in order to impose a given point of view. We also study the role of the co-evolution of the network within the dynamics of the system. This

work is inspired by the recent outbreaks of measles in the United States, where one of the main causes was the presence of anti-vaccine movements who alert people about side effects of the MMR vaccine, despite the absence of scientific evidence and the massive pro-vaccine campaigns.

22. Mate Marote: estudiando la cognición humana mediante el entrenamiento cognitivo

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Mate Marote es un software educacional de entrenamiento cognitivo para niños de entre 4 y 8 años especialmente desarrollado por un grupo de científicos de distintas disciplinas con el objetivo de ayudar a comprender y mejorar los mecanismos por los cuales se logra el entrenamiento de capacidades mentales esenciales, que sientan las bases para el buen desarrollo de habilidades sociales y cognitivas en el futuro. En investigaciones previas (1) se demostró que el software, libre y de licencia CONICET, es una intervención lúdica y económica capaz de mejorar, con menos de 7 horas de juego en total, el rendimiento académico en niños pequeños en situación de vulnerabilidad social. De hecho, al día de hoy es el único entorno de estimulación de este estilo que ha demostrado mejorar y nivelar, de manera efectiva, el desempeño escolar. El software consiste en una serie de juegos que desafían distintos mecanismos cognitivos asociados al control del comportamiento, del pensamiento y de la acción, tales como el control inhibitorio, la planificación, la flexibilidad y la memoria de trabajo, entre otros. Habiendo comprobado que jugar con Mate Marote produce una mejora en los aspectos mencionados, se generan muchas preguntas disparadoras de líneas de trabajo en el área. Una de ellas, la que comenzaremos a responder en este trabajo, tiene que ver con el orden de complejidad en el que conviene entrenar las capacidades cognitivas para obtener el mayor efecto. ¿Es mejor comenzar por entrenar las funciones ejecutivas más básicas seguidas de aquellas que requieren una mayor asociación? ¿O conviene entrenar primero las más complejas e integradoras y seguir luego con aquellas más básicas? Para responder, trabajamos en entornos escolares controlados con más de 300 niños que viven en distintos contextos socio-económicos, provenientes de varias escuelas en distintos lugares del país.

23. Metodologías de las posibilidades del espacio público y su análisis prospectivo.

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El trabajo a presentar continuará las metodologías para el proyecto -Espacios de posibilidad- que fue resultado de un equipo de egresados del posgrado Maestría y Expresión Gráfica en la Proyección Arquitectónica y Urbana (MPEGPAU), las cuales estarán encaminadas a implementar aquellas soluciones propuestas y encontrar un modelo conveniente para el análisis prospectivo de las mismas, donde se busque no sólo la observación de los experimentos sociales, sino también el seguimiento oportuno de los

resultados, para asegurar la determinación de los casos de éxitos y que exista una metodología adecuada en las propuestas de evocación planteadas, y que sean factibles ante una posible implementación urbana. El proyecto de -Espacios de Posibilidad- tiene como objetivo fortalecer la participación social por medio de mecanismos evocativos, los cuales habiliten ámbitos de acción, cooperación y corresponsabilidad entre la gran diversidad de actores implicados en la conformación de las dinámicas que constituyen al espacio público y lo potencializan como plataforma abierta, accesible y sobre todo, como ámbito de posibilidades infinitas. Asimismo, generar procesos de apropiación dentro del espacio público que permitan crear nuevas maneras de habitar la ciudad a través de la participación social. También promover en los ciudadanos un sentido de pertenencia dentro de la ciudad que habitan para sustentar una crítica prospectiva de la misma. y por último fomentar la cohesión social a fin de crear comunidades que puedan autogestionarse para lograr objetivos en común. La alternativa gira en torno a las posibilidades que tiene un espacio de generar nuevos usos, se plantea la evocación como el instrumento idóneo para potencializar los procesos de participación ciudadana dentro de la ciudad, implicando directamente al habitante dentro de las dinámicas a las que los espacios públicos invitan. De esta manera se logra fortalecer significativamente la relación recursiva entre sujeto y objeto, instaurando así procesos constantes de estructuración por medio de la retroalimentación continua entre las partes. Por tanto, esta propuesta se conforma a partir de variadas intervenciones urbanas a fin de mostrar que es posible atender a una misma demanda desde variadas perspectivas. Suplantar el convocar, por el evocar. Así que se espera que estas acciones e intervenciones urbanas se dirijan a la creación de una mejor conciencia ciudadana hacia sus entornos y espacios, desde la creación de estos modelos de análisis, el desarrollo de las propuestas, y la interpretación de los resultados por parte de las personas que se involucren en las intervenciones, esperando tener una visión más enriquecedora de cómo integrar estas propuestas a un nivel mayor y con un impacto social más contundente.

24. Minority game theory in a new parameters region: mobility to transportation, social and economic studies.

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We study the effect the memory record and strategies in the evolution of a minority game. The problem is similar to that of drivers choosing a trajectory in a city with many roads. It is shown that while the memory increases the election becomes in a type of random walker. We also study the generalized minority game problem where instead of two choices we include three choices sell, buy and not do anything. This situation is similar to the problem of a participatory economy.

25. Modelo de distribución de riqueza usando teoría de juegos

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Resumen: En nuestro trabajo consideramos un modelo de agente dentro de una población donde intercambian dinero mediante un juego (por ejemplo, el piedra, papel o tijera). Observamos que la

distribución de riqueza sigue una función gamma con parámetros que dependen del juego elegido. Además proponemos una forma de evolución donde cada agente trata de jugar en forma óptima.

26. Modelo de transición orden desorden de opinión en una sociedad no homogénea.

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¿Que es lo que lleva a una sociedad a pasar de una situación social estable a un estado convulsionado o caótico? Los mejores ejemplos de esto son los procesos revolucionarios o las crisis económicas argentinas, en este trabajo presentamos un modelo simple en el cual observamos transiciones abruptas en la opinión media de un sistema dinámico. Consideramos una sociedad formada por agentes con distintos estados de opinión sobre una determinada cuestión. Los cuales pueden modificar su estado debido a dos procesos; una influencia externa(propaganda) y por la interacción entre agentes (persuasión), generada por la dinámica espacial del modelo. El cambio de los estados de opinión genera un salto entre las poblaciones estables al variar algunos parámetros del modelo.

27. Modelo de Vasicek aplicado a tasas Badlar

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Los modelos de tasas de interés han tenido una vasta aplicación en la práctica financiera. Algunas herramientas son usadas para: política monetaria, finanzas corporativas, riesgo crediticio, derivados financieros, entre otros. Hemos centrado nuestro estudio en los modelos de tasas a corto plazo con el fin de estimar la estructura a término de las tasas de interés (ETTI), esta estructura analiza la relación que existe entre el tiempo que resta hasta el vencimiento de obligaciones o bonos con el mismo grado de riesgo y sus rendimientos durante dicho plazo. Existe una gran cantidad de modelos para estimar la ETTI, nos hemos focalizado en el estudio del modelo de Vasicek (1977) que fue uno de los primeros modelos para tasas a corto plazo pero que aún sigue vigente dada su tratabilidad matemática y la capacidad de generar distintas formas de la estructura de tasas de interés como crecientes, decrecientes y con montes o valles. El modelo de Vasicek tiene una base conceptual sólida que permite interpretar la información que contienen las tasas de interés a través del tiempo. Hemos estimado los parámetros para la solución discretizada de la ecuación diferencial estocástica que plantea este modelo, analizamos las propiedades estadísticas de la solución y aplicamos el modelo a las tasas Badlar para bancos privados (tasa de referencia Argentina). Realizamos también un estudio de los residuos para corroborar el cumplimiento de las hipótesis del modelo. Por último obtuvimos la ETTI para las tasas Badlar y el precio de una opción europea sobre un bono cupón cero, tomando como hipótesis que las tasas a corto plazo siguen el modelo de Vasicek asumiendo un escenario libre de arbitraje.

[1] Brigo-Mercurio, Interest Rate Models- Theory and Practice, Springer 2000. [2] D. Duffie, Dynamic asset pricing, Princeton University 2001. [3] Base de datos Banco Central de la República Argentina. http://www.bcra.gov.ar/PublicacionesEstadisticas/Principales_variables_datos.asp

28. Movilidad cotidiana: efectos del entorno construido en la elección del modo de transporte en Montevideo.

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El objetivo del trabajo es analizar en qué medida la elección del modo de transporte de pasajeros en Montevideo se encuentra afectado por el entorno urbano construido y la estructura urbana de la zona de residencia del individuo y las características del mismo [Boarnet & Crane, 2001, Cervero, 2013, Brownstone y Golob, 2009]. El proyecto busca como objetivo general encontrar elementos que permitan apoyar la postura de que las políticas de planificación en transporte y de ordenamiento territorial deben realizarse de forma integrada. Se considera que la forma de la ciudad define el contexto de residencia de las personas, las zonas de destino y origen de los viajes y restringen las opciones de movilidad de los mismos [Camagni, Gibelli & Rigamonti, 2002]. Se plantea una metodología de análisis empírica, de carácter cuantitativo, mediante el uso de análisis multivariado: modelos multinomiales y de modelos multinivel, para identificar variables que afecten a la elección del modo de viaje [Kim & Wang, (2015)]. Asimismo se procura establecer la variabilidad que comprende al nivel de los individuos y la variabilidad a nivel de las localidades. El proyecto se encuentra en proceso y se presentan como resultado los avances de los modelos multinomiales, que a diferencia de los modelos multinivel, no toman en cuenta la variabilidad de la zona. Se encuentra como resultados que a medida que aumenta la densidad poblacional cae el uso del transporte público (ómnibus y taxi) y aumenta el uso de vehículos privados (autos, motos y motonetas). La disminución de las paradas de ómnibus, por zona, contribuye al aumento de los viajes no motorizados frente al transporte público, pero no son significativas en la elección de los demás modos. La longitud de líneas de transporte público, corregida por el tamaño del área, a medida que aumenta afecta negativamente el uso de vehículos privados y aumenta los viajes no motorizados (pie y bicicleta) y los viajes en transporte público. La tenencia de vehículos en el hogar incide negativamente en la elección de viaje en transporte público frente a viajar en vehículo privado. Los hombres eligen realizar sus viajes en autos o motos más que las mujeres. Y la diversidad de servicios y equipamientos en la zona de residencia lleva a aumentar los viajes no motorizados, en transporte público o en vehículo privado frente a los viajes en transporte escolar u transportes particulares de empresas. Se espera en los avances de la investigación encontrar información de cómo la variabilidad de la zona afecta la elección modal.

29. Mutual information network of archaeological sites using rock art

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The communicative function of rock art and its ability to store information have always been considered by archaeologists. Setting the specific meaning of rock art motifs aside (i.e. types of drawings), in

this work we propose that there is information contained in the spatial distribution of the motifs on different archaeological sites. To test this assertion we have studied sites in north-western Patagonia dating from the Last Holocene. Specifically, we have calculated mutual information to formalize correlations between the motives of rock art found in a set of archaeological sites in the region studied, detecting cases in which the presence of a particular motif can be associated with the presence of another one. We have identified clusters of interrelated motifs and then observed the geo-referenced network of archaeological sites associated with each cluster. We have interpreted the connections between the sites as cultural transmission paths. The obtained results have been compared with models of peopling proposed for Patagonia (Borrero 1994-1995). We have found a strong correlation between the sites of the middle and north part of the studied area, revealing a hypothetical population node in the region, well known and travelled by hunter-gatherers. A few connections with the northernmost and southernmost sites of the region allow us to hypothesize that these areas were in a phase of colonization and/or exploration.

30. Opinion Formation by Social Influence: From Experiments to Modeling

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Predicting different forms of collective behavior in human populations, as the outcome of individual attitudes and their mutual influence, is a question of major interest in social sciences. In particular, processes of opinion formation have been theoretically modeled on the basis of a formal similarity with the dynamics of certain physical systems, giving rise to an extensive collection of mathematical models amenable to numerical simulation or even to exact solution. Empirical ground for these models is however largely missing, which confine them to the level of mere metaphors of the real phenomena they aim at explaining. In this paper we present results of an experiment which quantifies the change in the opinions given by a subject on a set of specific matters under the influence of others. The setup is a variant of a recently proposed experiment, where the subject's confidence on his or her opinion was evaluated as well. In our realization, which records the quantitative answers of 85 subjects to 20 questions before and after an influence event, the focus is put on characterizing the change in answers and confidence induced by such influence. Similarities and differences with the previous version of the experiment are highlighted. We find that confidence changes are to a large extent independent of any other recorded quantity, while opinion changes are strongly modulated by the original confidence. On the other hand, opinion changes are not influenced by the initial difference with the reference opinion. The typical time scales on which opinion varies are moreover substantially longer than those of confidence change. Experimental results are then used to estimate parameters for a dynamical agent-based model of opinion formation in a large population. In the context of the model, we study the convergence to full consensus and the effect of opinion leaders on the collective distribution of opinions.

31. Panic evacuation dynamics with fallen pedestrians

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The evacuation process of pedestrians under panic can be studied through the "Social Force Model" (SFM) [1]. This model assumes that there exists a "desire force" resembling the pedestrians own willing to move in a certain direction and the own anxiety level to reach the target place. The higher the anxiety level, the greater the "desire force" intensity [2-6]. Thus, very high pressure levels can be achieved inside a crowd, raising to dangerous levels and causing unconsciousness of many individuals [7-9]. Fallen (unconscious) people modify the dynamics of the surrounding pedestrians, since the latter will decide to avoid the former, or to skip over them. We investigated both behavioural patterns by means of the SFM. We observed that, according to the individuals anxiety level, the evacuation dynamics can switch from a completely blocked situation (due to fallen people) to a free moving regime. The free moving regime allows the pedestrians to escape through an open path, but the evacuation time strongly depends on the path topology. If the path is narrow enough, the pedestrians may only evacuate intermittently (following a stop-and-go behavior). The evacuation process improves if the escaping pedestrians decide to skip over the fallen people.

- [1] D. Helbing, I. Farkas, and T. Vicsek, *Nature*, 2000
- [2] D. Parisi and C. O. Dorso, *Physica A* 354, 606 (2005)
- [3] D. Parisi and C. O. Dorso, *Physica A* 385, 343 (2007)
- [4] G. A. Frank and C. O. Dorso, *Physica A: Statistical Mechanics and its Applications* 390, 2135 (2011)
- [5] G. A. Frank and C. O. Dorso, *International Journal of Modern Physics C* 26, 1550005 (2015)
- [6] G. A. Frank and C. O. Dorso, *International Journal of Modern Physics C* 27, 1650091 (2016)
- [7] J. Fruin, in *Engineering for Crowd Safety*, edited by R. Smith and J. Dickie (Elsevier Science Publishers BV, 1993) pp. 1-10
- [8] R. S. Lee and R. L. Hughes, *Accident Analysis & Prevention* 38, 712 (2006)
- [9] J. Gill and K. Landi, *Am. J. Forensic Med. Pathol.* 25, 358 (2004)

32. Room evacuation through two contiguous exits

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The evacuation of pedestrians in panic situations may cause clogging around the available exits. The basic "Social Force Model" (SFM) achieves this phenomenon as the "faster is slower" effect. It states that the harder the pedestrians try to escape (because of their high anxiety level), the slower they are able get out of the room. However, increasing the number of available exits may not always improve the evacuation performance. We studied the situation when only two contiguous doors are available. We found that if the doors separation distance is not properly set, a worsening in the evacuation time may occur. The worst evacuation performance was obtained for a separation distance similar to two pedestrian's width (for approximately 200 pedestrians). For larger crowds, this separation distance exhibits similar evacuation times to the case of two independent exits. If the door separation is smaller

than two pedestrian's width, the evacuation process improves considerably and the delays become dominated by the very local dynamics on each door.

33. Study of the time series of the Consumer Price Index in Argentina

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The time series of the Consumer Price Index (CPI) in Argentina are studied. The theoretical formalism outlined in Refs. [1-3] is applied. There are branches of high- and hyper-inflation. The determination of a critical times for the hyperinflation is discussed.

[1] M. A. Szybisz and L. Szybisz, Phys. Rev. E 80, 026116 (2009).

[2] M. A. Szybisz and L. Szybisz, Physica A (2016), <http://dx.doi.org/10.1016/j.physa.2016.07.052>

[3] M. A. Szybisz and L. Szybisz, Physica A (2016), <http://dx.doi.org/10.1016/j.physa.2016.07.014>

34. Systemic risk analysis in banking networks with scale-free topology

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The risk of systemic breakdown in banking systems constitutes a main concern for central banks tasked with preserving financial stability. Systemic risk emerges when there is the probability for multiple banks to fail, inflicting costs on the financial system and on the economy as a whole. The structure of a banking-network, comprising the degree to which banks are connected to each other through bilateral exposures may play an important role in its susceptibility to systemic breakdown. Empirical analysis has shown that interbank networks often exhibit a scale-free topology, i.e. they are characterized by a few money center banks with many interconnections and a large number of small banks with few connections (Blavarg and Nimander (2002), Boss et al. (2004), van Lelyveld and Liedorp (2006), Degryse and Nguyen (2007)). In this work we develop a numerical study of systemic risk in such scale-free banking-systems. Networks are generated using a modified version of the Fitness-model adapted for static networks with given expected degree sequences. We analyze how the stability of the system evolves as the structure of the network is changed by modifying key parameters as the maximum degree, power-law-coefficient, and banking-exposure.

35. The heterogeneous impact of an 8.0 earthquake on housing quality. The case of Peruvian quake on 2007

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We study the effect of the 2007 Pisco Earthquake, a large though relatively frequent- natural disaster striking a top-performing developing region in Peru, which ought to have increased speed of

recovery. For identification, we exploit the exogeneity in location of the quake to define treatment and control groups within concentric circles, and use a diff-in-diff estimator using microdata from both national household surveys (2005-2015) and three unusually close censuses, in mid-2005, late-2007, and early-2013. Our findings show that, in the very short run, the main impacts are the destruction of physical infrastructure of housing (we do not find statistically significant results for different outcomes such as poverty, consumption, education or health). However, we find that the destructive power of the quake was particularly severe on bad-quality houses, traditionally associated with poorer households, and that the recovery pattern was anti-poor and unequal. Regarding the latter, in the medium run we observe an increase in good quality material houses accompanied with the persistence of low-quality material houses caused by the earthquake, meaning that only a the better-off group is recovering from the disaster, while the worse-off are lagging behind.

36. The Mankiw-Romer-Weil model with a decreasing population growth

Cayssials G

This paper studies an extension of the Mankiw-Romer-Weil growth model by departing from the standard assumption of constant population growth rate. More concretely, this rate is assumed to be decreasing over time and a general population growth law with this characteristic is introduced. In this setup, the model can be represented by a three dimensional dynamical system which admits a unique solution. It is shown that there is a unique nontrivial equilibrium which is a stable equilibrium. In addition, the speed of convergence to the steady state is characterized. Keywords: Mankiw, Romer and Weil economic growth model; decreasing population growth rate; JEL classification: C62; O41

37. The role of the shopaholics and impulsive people in the adoption of innovations

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When the full stock of a new product is quickly sold in a few days or weeks, one has the impression that new technologies develop and conquer the market in a very easy way. This may be true for some new technologies, like the cell phone, but not for others, the blue-ray for example. Novelty, usefulness, advertising, price, and fashion are the driving forces behind the adoption of a new product. But, what are the key factors that lead to adopt a new technology?

We have proposed and investigated a simple model for the adoption of an innovation which depends mainly on three elements: the appeal of the novelty, the inertia or resistance to adopt it, and the interaction with other agents. Initially we have studied the conditions for the new technology to be appealing, the effect of social interactions which lead to full adoption of the new technology, and the role of agents that resist adopting new products on the dynamics of adoption (the contrarians) [1]. Later

on we performed both analytic calculations and numerical simulations to determine the conditions for the establishment of the new technology in a society in which new adopters may have second thoughts and change their decisions (the repentants). The presence of repentants generates a rich landscape of temporal evolution, including cycles of adoption [2].

In this work we analyze a new variant of the model: What if a group of agents acts on the spur of the moment? We explore this situation by introducing a parameter in the system that sets the probability that a given agent, when selected, change its technology without assessing whether it is appropriate. We mainly consider the case of shopaholics, i.e., agents that have old technology and impulsively decide to change to a new technology. We also study a symmetric case (the agent impulsively changes its adoption status, whatever it is). We used several distributions of the agent's inertia, in order to model different types of societies.

We analyze the effect of the impulsive agents in the dynamics of adoption, and compare these results with the ones obtained in our previous studies. We find a sharp transition on the fraction of adopters as a function of the parameter which measures the impulsiveness.

[1] Why, when and how fast innovation spreads, S. Gonçalves, M.F. Laguna, J.R. Iglesias. *The European Physical Journal B* 85: 192 (2012).

[2] Adoption of innovations with contrarians and second thoughts, M.B. Gordon, S. Goncalves, M.F. Laguna, J.R. Iglesias. In preparation (2016).

38. The symmetric phase of the Minority Game

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The Minority Game (MG) was introduced in 1997 by Challet and Zhang in an attempt to capture the essential characteristics of a population competing for limited resources. As in the case of a traffic problem in which people have to decide between two routes, in the MG an individual achieves the best result when she manages to be in the minority group. In the model, there are N agents, that at each step of the game must choose one of two sides, 0 or 1. The only information available for the agents is the system state, which stores the best side choices for the last m steps and which is updated after each step of the game. The parameter m defines the information-processing capacity of the agents, who take decisions based on strategies. The Full Strategy Minority Game (FSMG) is an instance of the Minority Game (MG) which includes a single copy of every potential agent (a combination of strategies). In this work we present some results in which the FSMG can help us to understand some aspects of the MG in the symmetric phase.

We have explicitly been able solve the FSMG thanks to certain symmetries of this game. Then, by considering the MG as a statistical sample of the FSMG, we have computed approximated values of the key variable observed in the MG, which measures the waste of population resources, in accordance to computational results. Another property is the quasi-periodicity of the sequence of minority sides, which turn out to be periodic in the case of the FSMG. Moreover, we characterize these sequences as the eulerian paths on a De Bruijn graphs connecting states of the system.

On the other hand, although there are no explicit interactions among MG agents, it is known that they interact through the global magnitudes of the model and through their strategies. We have formalized the implicit interactions among MG agents as if they were links on a complex network. We have defined the link between two agents by quantifying the similarity between them, in terms of their strategies. We have analyzed the structure of the resulting network for different MG parameters, such as N and m . In the region of crowd-effects of the model, the resulting network structure is a small world network, whereas in the region where the behavior of the MG is the same as in a game of random decisions, MG network becomes a random network of Erdos-Renyi. We have explicitly calculated the degree distribution of the FSMG network and, on the basis of this analytical result, we have estimated the degree distribution of the MG network, which is in accordance with computational results.

39. Using solved cases and expert knowledge to prioritize the search of disappeared people

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During the last 32 years, the Argentine Forensic Anthropology Team (EAAF) has been using a multidisciplinary approach to recover and identify the remains of thousands of disappeared people during the last military dictatorship in Argentina (1976-1983).

The idea of this work is to learn from the already-resolved cases and from the expert knowledge of EAAF researchers to carry out new searches. We have mathematically systematized non-genetic variables and information obtained by already solved identifications in a particular event to generate a probabilistic ranking of candidates for the unidentified related cases of the same event, in a Bayesian framework. A particular event can be defined as a fact in which a set of people whose number is known were killed on a known day in a specific place. An example of an event is the Fatima's slaughter in the Province of Buenos Aires, where 30 people (20 men and 10 women) were killed on 20/8/1976 in that location. So far, 24 of the victims have been identified at different stages and 6 of them remain unidentified. The variables used are geographical and temporal (i.e. the place and date of individuals' kidnapping) among others. We have constructed a specific geo-referential frame to address geographical variables that is related to the historical process in Argentina. The results have been evaluated using reserved data through cross-validation. Measures of predictability and efficiency have allowed us to determine the adequate parameter of the model for a particular event. Once the ranking has been constructed, people are represented on a network where the connections are established among them based on the individuals' attributes while they were alive. Those candidates bearing low probability values but strongly connected to other candidates bearing high probability values improve their position on the ranking. Finally, the information related to every skeleton is used to construct a specific ranking for each one.

Prioritizing the searches helps the work of constructing new hypotheses of identity, which are later evaluated with genetic evidence. The importance of establishing a ranking lies in the fact that the EAAF has no blood samples of the family members of all of the still-unidentified missing people. For this reason, the rankings can prioritize which families to solicit blood samples from. The methodology has been applied to different events, generating specific rankings for several cases of unidentified remains.

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