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UNIVERSIDADE ESTADUAL PAULISTA
"JÚLIO DE MESQUITA FILHO"

WORKSHOP on Sociophysics:

Social Phenomena from a Physics Perspective

ONLINE **(October 18-22, 2021)**

LIST OF ABSTRACTS – TALKS

Analyzing mass media influence using natural language processing and time series analysis

Pablo Balenzuela
Universidad de Buenos Aires

A key question of collective social behavior is related to the influence of mass media on public opinion. Different approaches have been developed to address this issue quantitatively, ranging from field experiments to mathematical models. In this work we propose a combination of tools involving natural language processing and time series analysis. We compare selected features of mass media news articles with measurable manifestation of public opinion. We apply our analysis to news articles belonging to the 2016 US presidential campaign. We compare variations in polls (as a proxy of public opinion) with changes in the connotation of the news (sentiment) or in the agenda (topics) of a selected group of media outlets. Our results suggest that the sentiment content by itself is not enough to understand the differences in polls, but the combination of topics coverage and sentiment content provides an useful insight of the context in which public opinion varies. The methodology employed in this work is far general and can be easily extended to other topics of interest.

Group dominance or group hierarchies emerging from interplay between gossip and group prejudice

Guillaume Deffuant
Lisc

We consider a simple model of agents that have an opinion about themselves, about the group they belong to and about the other agents and their group. During random pair interactions, the agents modify their opinions about themselves, about their group, about the other agent and about her group and possibly about some other agents and their group (if there is gossip in the model). We assume that in the discussions, the agents do not tell directly their opinions about the agents and themselves, but a weighted average of this opinion and their group opinion. This aims at modelling socially expected behaviours that take into account the group status of an agent when talking about her (even when the agent talks about herself). Starting from neutral opinions about groups and agents, we observe the emergence of a stable single dominant group or a group hierarchy when gossip is activated in the model, depending on the value of the group prejudice parameter. We perform a set of experiments on the model that suggest some explanations for the emergence of these patterns.

Echo chambers in Twitter debates on political debates in Brazil

Silvio da Costa Ferreira Jr.
UFV

Echo chambers represent the communication interaction where individuals present strong ties with other individuals having the same leaning about a given subject. In this talk I will present a methodology to identify and quantify echo chambers in polarized debates on Twitter using spreading models. We illustrate the methodology in the debate on the impeachment of the former Brazilian president Dilma Rousseff. We identify a strong polarization, in which contents with pro-impeachment leaning spread much more efficiently than those with anti-impeachment messages. We will present recently published results [1] as well as our recentest analysis of other political debates on Twitter.

[1] Cota et al., Quantifying echo chamber effects in information spreading over political communication networks, EPJ Data Science 8, 35 (2019).

Wisdom of crowds: much ado about nothing

Jose Fernando Fontanari
IFSC/USP

The puzzling idea that the combination of independent estimates of the magnitude of a quantity results in a very accurate prediction, which is superior to any or, at least, to most of the individual estimates is known as the wisdom of crowds. In this talk we use the Federal Reserve Bank of Philadelphia's Survey of Professional Forecasters database to confront the statistical and psychophysical explanations of this phenomenon. Overall we find that the data do not support any of the proposed explanations of the wisdom of crowds. In particular, we find a positive correlation between the variance (or diversity) of the estimates and the crowd error in disagreement with some interpretations of the diversity prediction theorem. In addition, contra the predictions of the psychophysical augmented quincunx model, we find that the skew of the estimates offers no information about the crowd error. More importantly, we find that the crowd beats all individuals in less than 2% of the forecasts and beats most individuals in less than 70% of the forecasts, which means that there is a sporting chance that an individual selected at random will perform better than the crowd. These results contrast starkly with the performance of non-natural crowds composed of unbiased forecasters which beat most individuals in practically all forecasts. The moderate statistical advantage of a real-world crowd over its members does not justify the ado about its wisdom, which is most likely a product of the selective attention fallacy.

What was right with my failed prediction of a 2020 second Trump victory?

Serge Galam
SciPol

In 2016, contrary to the predictions of pundits and polls, using the Galam model of opinion dynamics, against all odds, I predicted Trump's victory. The model uncovered Trump winning. However, four year later, Trump ‘‘shocking’’ outings were not shocking any longer having lost their emotional reactions. paradoxical martingale as his capacity to activate frozen prejudices at his advantage in many voters by provoking their real indignation against him. During the 2020 campaign, with Trump losing his asymmetric advantage, the two candidates clashed with the same triggers which I identified as the prejudice of fear and inflexible partisanship. Depending on the State, these two triggers could either offset or reinforce each other. As a result, tiny differences would make the outcome. Based on my rough estimates, I assumed small advantages in the proportions of inflexibles and prejudices in favor of Trump in enough Swing States to secure his victory. My prediction failed. However, with Biden's victory so close, my error was not with the model but with the fact that I gave Trump slight advantages in terms of prejudices and inflexibles, when they had to be given to Biden. These results confirm the robustness of the model and the need to progress on the evaluation of the parameters. In my talk, I will first demonstrate that, while clear, Biden's victory was tight. Then I will show the robustness of the model with the error originating from attributing slight advantages given to Trump when iit was Biden who had them.

Growing inequality and wealth redistribution

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2Instituto Nacional de Ciencia e Tecnologia de Sistemas Complexos (INCT-SC), Centro Brasileiro de Pesquisas Físicas (CBPF), Rio de Janeiro, Brazil.
3Departamento de Economia e Relações Internacionais, Universidade Federal de Santa Catarina, Florianópolis, SC, Brazil

Social and economic inequality is a scourge of the 21th Century. Wealth is more and more concentrated in a few hands while a vast majority of the society shares a very limited amount of resources. This situation has been predicted and denounced by economists and econophysicists. The former ones have widely used models of market dynamics considering the idea that a given wealth distribution is the result of wealth exchanges among economic agents. A simple analogy compares the trade in a society with the energy exchange between molecules during collisions in a physical system,. However, while in physical systems the equipartition of energy is valid, in most exchange models for economic markets the system converges to a very unequal ``condensed" state, where one or a few agents concentrate all the wealth of the society and the wide majority of agents shares zero or a very tiny fraction of the wealth. Here we discuss two ways of avoiding the "condensed" state. On one hand we consider mechanism to favor the poorer agents in exchanges, so increasing the probability that wealth goes from the richer to the poorer agent. On the other hand, we study regulatory politics, i.e. different types of taxes and their effects on the wealth distribution. One particular point of interest is to compare a financial assistant to zero income and very poor people, like "bolsa família" (family fellowship) in Brazil, with universal allocation, and even a once in the life allotment. We compare different redistribution processes and conclude that a meaningful reduction of the inequality can be obtained with very simple taxation and regulations.

Keywords
Wealth distribution
Inequalities
Regulations
Gini coefficient
Wealth condensation

The destructive effect of human stupidity: a revision of Cipolla's fundamental laws

Marcelo Kuperman
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In this work, we present an evolutionary game inspired by the original ideas of Carlo Cipolla about The Basic Laws of Human Stupidity. The game expands the classical scheme of two archetypical strategies, collaborators and defectors, by including two additional strategies. One of these strategies is associated with a stupid player that, according to Cipolla, is the most dangerous individual as it undermines the global wealth of the population. By considering a spatial evolutionary game and imitation dynamics that go beyond the paradigm of a rational player we explore the impact of Cipolla's ideas and analyze the extent of the damage that stupid players inflict on the population. We also show that the probability of behaving stupidly acts as a parameter that induces a phase transition in the steady distribution of strategies among the population

Optimal risk in a wealth exchange model: Agent dynamics from a microscopic perspective

Fabiana Laguna
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When studying certain macroeconomic aspects of different societies around the world, recurrent patterns appear. In particular, empirical data shows that wealth distributions commonly exhibit power law tails in the region of highest wealth. Such phenomenon has been found in repeated occasions in the past century, and their causes are still a case of study for the econophysics community.

In order to have a deeper understanding of social behavior that leads to unequal wealth distributions, a wide variety of simple models based on ensembles of economic agents have been proposed. These models are based on stochastic processes of wealth flow between entities, where their temporal evolution is determined by certain trading rules. The macroscopic aspects concerning these models have already been deeply studied. In particular, the Yard-Sale model, also known as the fair rule, has become quite popular, as it has shown promising results when replicating empirical data. However, the microscopic behavior has not been studied in the same detailed manner.

We recently conducted a microscopic approach that allowed us to study and classify the individual strategies carried out by the agents undergoing transactions [1]. We analyze the role of their interaction parameter, the risk propensity, and find a critical risk such that agents with risk above that value always end up losing everything when the system approaches equilibrium. Moreover, we find that the wealth of the agents is maximum for a range of risk values that depend on particular characteristics of the model, such as the social protection factor. Our findings allow determining a region of parameters for which the strategies of the economic agents are successful.

[1] J. Neñer and M.F. Laguna, Physica A 566 (2021) 125625.

Majority-vote and Biswas-Chatterjee-Sen model on Complex Networks

Francisco WS Lima
UFPI

Through the Monte Carlo simulations and finite-size scaling analysis, we study the phase transition into two types of opinion-forming models: the Majority-vote and Biswas-Chatterjee-Sen model on complex networks. Here, we obtained the exponents ratio β/ν, γ/ν, and $1/\nu$ for both models and different complex networks. In the end, we verified the existence of a universality class for these models.

Thermodynamics applied to game theory: study of the risk associated with cooperation in the Public Goods Games

Alexandre Martinez
USP-RP

The emergence of cooperation dilemmas is a phenomenon that we still do not fully understand. We observe many examples of these dilemmas in nature. Potential games are a feasible alternative to study realistic behavior in players. This formalism establishes a connection between the Game Theory and concepts of Thermodynamics. Inspired by the recent studies of this formalism, we have studied the Public Goods game using Statistical Mechanics tools. We introduce an operatorial notation, describing the players's payoff in terms of eigenvalues and eigenvectors equations. We study the Public Good Game, describing it through a "Hamiltonian". The analysis between the individual and the collective payoff operators, in the simplest scenario of the game, reveals that the dilemma emerges when we choose which operator describe the game. We created the "risk of cooperation" operator and identified that it is necessary to describe the correct Nash equilibrium. We also study the mechanism of punishment in the Public Goods Game. We observed the emergence of phase transitions, and that these transitions divide the cooperative regime from desertion regime.

How network theory and contact tracing can help to stop the Covid-19 pandemic

Hernán Makse
City College - CUNY

The spread of COVID-19 has become a worldwide problem with devastating consequences. To slow down the spread of the pandemic, mass quarantines have been implemented globally, provoking massive social and economic disruptions. Here, we implement a large-scale contact tracing protocol to find the optimal quarantine to dismantle the chain of transmission with minimal disruptions to society. We track billions of anonymized GPS human-mobility datapoints from a compilation of hundreds of mobile apps deployed in the State of Ceara, Brazil to monitor the evolution of the contact network of disease transmission. Our analysis indicates that superspreading k-core structures are responsible for the spreading of the disease despite the massive quarantines applied. Once the k-cores are identified, the optimal strategy to break the chain of transmission is to quarantine a minimal number of 'weak links' with high betweenness centrality connecting the large k-cores. Our results demonstrate the effectiveness of a contact tracing strategy to halt the pandemic with targeted quarantines and minimal disruptions.

Coevolution dynamics of opinion and social network

Maxi San Miguel
IFISC-UIB-CSIC

Modeling opinion dynamics of a set of interacting agents requires specifying the social network of interactions and the state (opinion) of the agents, represented as nodes of the network. The links of the network can also have a state, representing for instance attractive or repulsive interactions. In addition, the network might not be fixed, but adaptive with a time dependent topology in which agents can choose and change their neighbors. We introduce such a general dynamical model for binary opinions including the coupled dynamics of the states of the nodes, the states of the links and the topology of the network. We find a transition from a dynamical state of coexisting opinions to a consensus state showing network fragmentation at the transition line. Our results contribute to the description of processes of emergence of social fragmentation and polarization.

How does homophily and heterophily shape the topology of preferred-degree networks?

Mauro Mobilia
University of Leeds

We investigate the long-time properties of a dynamic, out-of-equilibrium, network of individuals holding one of two opinions ("zealots") in a population consisting of two communities of different sizes. Here, while the agents' opinions are fixed, they have a preferred degree which leads them to endlessly create and delete links. The topology of the evolving network is thus shaped by homophily/heterophily, which is a form of social interaction by which individuals tend to establish links with others having similar/dissimilar opinions. Using Monte Carlo simulations and a detailed mean-field analysis, we study in detail how the sizes of the communities and the degree of homophily/heterophily affects the network structure. In particular, we show that when the network is subject to enough heterophily, an intriguing "overwhelming transition" occurs: individuals of the smaller community are overwhelmed by links from agents of the larger group, and their mean degree greatly exceeds the preferred degree. This and related phenomena are characterized by obtaining the network's total and joint degree distributions, as well as the fraction of links across both communities and that of agents having less edges than the preferred degree. We also introduce a novel measure of polarization that quantifies the division between the two communities with different opinions, and using our mean-field theory, we discuss when it displays distinct advantages over the commonly used average edge homogeneity.

Joint work with Xiang Li (University of Leeds, UK), Alastair Rucklidge (University of Leeds, UK), and R.K.P. Zia (Virginia Tech, USA).

TBA

Yamir Moreno
University of Zaragoza

Investigating the role of talent and luck in getting success

Andrea Rapisarda
University of Catania

I'll review recent results on the role of talent and luck in getting success by means of a schematic agent-based model. In general the role of luck is found to be very relevant in order to get success, while talent is necessary but not sufficient [1]. An analytical solution in a simplified version of the model will be also presented [2]. Finally, results of a new agent-based model of a tournament-style sport competition will be discussed and compared with empirical data [3].

References

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[2] D. Challet, A. Pluchino, A. E. Biondo, A. Rapisarda Advances in Complex Systems 23 (2020) 2050004
[3] P. Sobkowicz, R. H. Frank, A. E. Biondo, A. Pluchino , A. Rapisarda, Physica A 557 (2020) 124899

The Physics of Cities

Fabiano Ribeiro
UFLA

What are the similarities between cities and biological organisms? If there are similarities, are they mere analogies, or are they the result of similar physical processes? It will be shown in this presentation that larger animals (such as whales) are more efficient at processing energy. Likewise, larger cities (such as São Paulo) are more efficient in terms of infrastructure and wealth production. That is because the same physical laws of scale govern both animals and cities.

The Network Structure of Inter-Industry Labor Mobility in Argentina

Viktoriya Semeshenko
IIEP

Labor mobility involves different types of processes that characterize the structure and functioning of the labor market. More specifically, the analysis of employment flows enables us to extract information of short-term as well as long-term structural aspects of the productive system. The administrative records that provide support to these transitions naturally give rise to a bipartite network of interactions between workers and firms from which a unimodal projection of interactions between firms can be extracted. In particular, by observing employment flows under the light of employers' economic activity, valuable information from the exchange of skills and abilities among different sectors of activity can be extracted. Neffke and co-authors (Neffke and Henning 2013, Neffke et al 2017) developed a methodological framework based on a skills exchange process, which allows us to get information about the latent productive structure induced by intersectoral labor mobility. The authors applied this analysis to the labor markets of Germany and Sweden, and found remarkable similarities in their network structures. In this talk I will present the results of the analysis applied to the labor market of Argentina. We are interested to what extent and in what way the emerging structure will differ in the case of a developing country. We characterized the topology of the labor network of Argentina and the derived industry space, and compared these results with data available from Germany. In the case of Argentina, we obtained a network with a core-periphery structure that consists of a large interconnected heterogeneous and non-specific core, which contrasts with the core structure observed in Germany. The network presents the small world property, which means that the system is integrated and workers can easily move within it. Finally, I will talk about the temporal evolution of the system.

Cracking urban mobility

José Soares-Andrade Jr
UFC

Assessing the resilience of a road network is instrumental to improve existing infrastructures and design new ones. Here, we apply the optimal path crack model (OPC) to investigate the mobility of road networks and propose a new proxy for resilience of urban mobility. In contrast to static approaches, the OPC accounts for the dynamics of rerouting as a response to traffic jams. Precisely, one simulates a sequence of failures (cracks) at the most vulnerable segments of the optimal origin-destination paths that are capable to collapse the system. Our results with synthetic and real road networks reveal that their levels of disorder, fractions of unidirectional segments and spatial correlations can drastically affect the vulnerability to traffic congestion. By applying the OPC to downtown Boston and Manhattan, we found that Boston is significantly more vulnerable than Manhattan. This is compatible with the fact that Boston heads the list of American metropolitan areas with the highest average time waste in traffic. Moreover, our analysis discloses that the origin of this difference comes from the intrinsic spatial correlations of each road network. Finally, we argue that, due to their global influence, the most important cracks identified with OPC can be used to pinpoint potential small rerouting and structural changes in road networks that are capable to substantially improve urban mobility.

"Private Truths, Public Lies" within agent-based modeling

Katarzyna Sznajd-Weron
Wroclaw University of Science and Technology

The title of this work is inspired by the Timur Kuran's book entitled "Private Truths, Public Lies. The Social Consequences of Preference Falsification". During my presentation I will talk about the idea and real-life examples of Preference Falsification (PF). Furthermore, I will propose a simple binary agent-based model, which allows to describe PF by introducing two levels of the opinion: the public and the private one. Finally, I will discuss how PF can help in explaining social and political dynamics.

The biased voter model

Raul Toral
IFISC-UIB-CSIC

We study the voter model dynamics in the presence of confidence and bias. We assume two types of voters: Unbiased voters whose confidence is indifferent to the state of the voter, and biased voters whose confidence is biased towards a common fixed preferred state. We study the problem analytically on the complete graph using mean field theory and on an Erdos-Renyi random network topology using the pair approximation, where we assume that the network topology is independent of the type of voters. We verify our analytical results through numerical simulations. We find that for the case of a random initial setup, and for sufficiently large number of voters N, the time to consensus increases proportionally to $\log(N)/\gamma v$, with γ the fraction of biased voters and v a parameter measuring the bias of the voters. Finally, we study this model on a biased-dependent topology and analyze how the persuasiveness of the biased group, measured by the time needed to reach consensus in the preferred opinion, depends on how well its members are connected among each other, compared to how well the members of the unbiased group are connected among themselves.

The complex traffic in cities under route optimization ... an example of transport over complex networks

Juan Alejandro Valdivia
Universidad de Chile

Urban traffic has become a topic of strategic scientific interest, not only because of its social and economic impact, but also because of its complex behavior. There has been many strategies to study city traffic, ranging from statistical and cellular automaton, to hydrodynamical and mean field models. Previous analysis have shown that even the traffic in a single lane with a sequence of traffic lights displays quite complex behavior due to finite breaking and accelerating capacities of the cars and their interactions [1,2]. Here we will study, through simulations, the stochastic dynamics of cars traveling in a city defined as a complex network of streets and intersections where we have the traffic lights. Cars travel between two randomly chosen points in the city and can chose, with and without adaptation, different routes depending on different optimization parameters. In particular we will analyze the complex dynamics of car trajectories, the fundamental diagrams, and the existence of particular but different asymptotic states of the system for different car densities or injection rates.

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Mixing innovative and imitative dynamics in evolutionary games: the role of update rules

Marco Antonio Amaral
Universidade Federal do Sul da Bahia

In this work, we use the framework of evolutionary game theory for studying a heterogeneous population that has two types of updating rule: imitative and innovative. More specifically, an imitative agent changes its strategy copying its neighbors, according to the classical replicator dynamics. On the other hand, innovative agents use the Logit rule, allowing them to change to the opposite strategy, without the need of a copying source. Previous works have shown that innovative strategy updating rules can lead to drastically different outcomes than imitative ones. In this work we shed some light on the behavior of a population provided with a mixture of updating rules. Notably, we analyze the influence of this heterogeneity in the dynamics leading to cooperation. The proposed model is studied by means of analytical and computational approaches. Remarkably, results indicate that the mixing of updating rules can be beneficial to cooperation in the well-mixed case, but have non trivial effects in the square lattice. Specifically, near the phase transition from cooperation to defection, homogeneous populations perform better than heterogeneous ones in supporting cooperation.

Socio-economic urban scaling properties: influence of regional geographic heterogeneities in Brazil

Roberto Fernandes Silva Andrade
Federal University of Bahia

The recent efforts dedicated to understanding important features and consequences of city growth have profited from the scaling approach to urban indicators. This kind of analysis can be conveniently used to investigate the impact of geo-economic transformations, like fast urbanization and industrial development, which occurred in continental size countries (e.g., India, China, and Brazil) during the past half-century. Profiting from high quality data, this work explores how scaling relationships among urban indicators are influenced by strong regional heterogeneities in Brazil. It is based on economic, infrastructure and violence related data sets for the time interval 2002-2016. Results indicate that regional specificities related to infrastructure, economic development, and geography have a larger influence on the absolute value of the urban indexes. Regional scaling similarities and differences among Brazilian regions were also uncovered. Interesting enough, the results indicate that the richest and poorest Brazilian regions share similar scaling behavior, despite all huge different local influences. By contrast, the results for the two richest regions, with similar average values of urban indexes and the same kind of local influences have rather different scaling properties. Thus, scaling analysis suggests that distinct political solutions might be necessary to improve life's quality, even for two regions with similar average values of urban indicators.

de Castro CP, dos Santos GF, de Freitas AD, dos Santos MI, Andrade RFS, Barreto ML - (2020) Socio-economic urban scaling properties: Influence of regional geographic heterogeneities in Brazil. PLoS ONE 15(12): e0242778. https://doi.org/10.1371/journal.pone.0242778

Entropy and hierarchical clustering: analysing built environments in different spatial cultures

Edgardo Brigatti
Universidade Federal do Rio de Janeiro

In this work we apply a general method for estimating the Shannon entropy of a 2D sequence to the analysis of the spatial configurations of the urban fabric of different cultures and regions of the world. Findings suggest that this methodology is able to identify similarities between cities, generating accurate results for recognition and classification of the urban morphologies. This approach allows the introduction of a classification scheme that opens up new questions about the idea that urban form can embody characteristics related to different cultural identities, historical processes and geographical regions.

Infectious disease dynamics in metapopulations with heterogeneous transmission and recurrent mobility

Wesley Cota
Universidade Federal de Viçosa

The spread of infectious diseases across different regions is affected by the interplay of human mobility and contact patterns, and epidemic models should be refined to incorporate these two elements. In this work, we propose a theoretical framework that incorporates both the heterogeneity of human contacts and mobility patterns in the form of a set of Markovian equations. We perform extensive stochastic simulations and compare them with analytical expressions of the epidemic threshold. This critical value depends on the demographic distribution, mobility flows, and heterogeneity of contact patterns, shedding light on the microscopic mechanisms responsible for the epidemic detriment driven by recurrent mobility patterns reported in the literature.

[Wesley Cota et al 2021 New J. Phys. 23 073019]

Invasion Dynamics: Deception favours slow invasion

Kishore Dutta
Handique Girls' College Guwahati

We shall be presenting here a computational model for the invasion of empires and its consequences due to the interplay of internal conflict, defensive maneuvers and deceptive foreign invasions. The model outcomes will be discussed to some extent in the light of their resemblance to historical events.

Why are the borders of Palestine/Israel and Wallonia/Flanders so different?: Entropic Analysis of a Schelling model with hierarchically structured initial conditions.

Marcos Gaudiano
FAMAF-UNC, CIEM-CONICET

Despite the ubiquity of hierarchical structures found in every complex system, random initial conditions are prestablished in several Sociophysics models. In this talk, we firstly show the remarkable differences that arise between both assumptions applied to the case of the renowned segregation Schelling model for minorities. It is found that, under a simple quasi non parametric Schelling model with structured initial conditions, the segregation phenomenon shows a local or short-range behaviour, developing at the borders of the minority-majority agent pattern and leaving the macroscopic agent structure mostly unaltered. Besides, it is found that the highest uncontrollability regime pointed out in [1], perfectly corresponds to where system segregation blows up. In addition, recurrent peace/segregation cycles are also more likely to occur there.

[1] M. Gaudiano, An entropical characterization for complex systems becoming out of control, Physica A, 440,185-199, Elsevier (2015).

Urban Scaling of COVID-19 across countries

Sebastian Goncalves
Instituto de Física - Universidade Federal do Rio Grande do Sul

Urban scaling is a very active topic that shows non-trivial relationships between a city's population size and some socioeconomic characteristics. Generally, it aims to find the empirical laws that make larger cities more efficient, more inno- vative, and with greater economic complexity. However, such well-being comes at a price: large urban areas show not only those desirable metrics being compara- tive larger, but they experience faster spread of diseases. We present an analysis of the transmission rate of COVID-19 as a function of population size at the metropolitan area level for the US, Brazil, and four other countries. Contrary to the usual hypothesis in epidemics modeling, we observe that the disease trans- missibility scales with the logarithm of the local's population size. The analysis, made possible by the large amount of available data on simultaneous epidemics of the same type, is probably universal for any disease transmitted between hu- mans. We present a theory of contact rate scaling that explains the results, which can help to better manage resources to fight the ongoing epidemic.

A continuous-opinion model inspired by the physics of granular gases

Nagi Khalil
Universidad Rey Juan Carlos

A continuous-opinion model with a dynamics similar to a mono-dimensional granular gas is proposed and studied. Agents interact as in the Deffuant model, with a parameter α controlling the persuasibility of the individuals. The interaction coincides with the collision rule of two grains moving on a line, provided opinions and velocities are identified, with α being the so-called coefficient of normal restitution. Starting from the master equation of the probability density of all opinions, general conditions are given for the system to reach consensus. The case when the interaction frequency is proportional to the β-power of the relative opinions is studied in more detail. It is shown that the mean-field approximation to the master equation leads to the Boltzmann kinetic equation for the opinion distribution. In this case, the system always approaches consensus, which can be seen as the approach to zero of the opinion temperature, a measure of the width of the opinion distribution. Moreover, the long-time behaviour of the system is characterized by a scaling solution to the Boltzmann equation in which all time dependence occurs through the temperature. The case $\beta = 0$ is related to the Deffuant model and is analytically soluble. The scaling distribution is unimodal and independent of α. For $\beta > 0$ the distribution of opinions is unimodal below a critical value of $|\alpha|$, being multimodal with two maxima above it. This means that agents may approach consensus while being polarized. Near the critical points and for $|\alpha| \geq 0.4$, the distribution of opinions is well approximated by the sum of two Gaussian distributions. Monte Carlo simulations are in agreement with the theoretical results.

Theoretical differences between extreme and polarized opinions

André Martins
Escola de Artes, Ciências e Humanidades

Understanding the problems that might arise from opinions, such as polarization in political debates or the consequences of extreme opinions involves both exploring how those questions happen and evolve in the real world as well as obtaining solid and useful theoretical models and definitions. As such, a better comprehension of how opinion dynamics models work and how they can represent those questions is a fundamental step. Opinion Dynamics models have, since their beginnings, tried to capture how human groups reach consensus or tend to a more polarized state, where disagreement prevails and even gets reinforced. Discrete models tend to do a decent job at describing situations where there are two or more clear choices. On the other hand, when we want to know how extreme an opinion is, some kind of continuous variable tends to work better. For situations where choices are made but we still want to model extreme views, it is common to either introduce inflexibles, agents that do not change their opinions, or to use a model with both discrete and continuous variables. In this talk, I will discuss why the term opinion is something we need to define in more solid terms. Taking inspiration from Bayesian methods, I will show how a probabilistic framework can help us better understand what an opinion means, from defining the variable of interest, to an internal probabilistic guess to what is actually observed by other agents. From that framework, I will show how different internal models on what agents expect from their observations might lead to very different measurements to their extremism, even when the evolution of polarization between the agents is not altered. Wishers, who try to find a single option to defend, and mixers, who try to find the best mixture of options can end with very different probability values in the problem of two choices. While it seems natural to conclude wishers tend to be extremist and mixers show no such a tendency, the effects their different models have on possible consensus reaching and moving out of a polarized state seem to be quite weak. In the most simple case, the actual effect is null. That suggests a problem with the definition of extreme opinions. Opinions might be called extreme because they are not central. That is the case, for example, when those opinions correspond to certainties associated to probability values close to 0 or 1. But difficulties in reaching consensus might also arise from a different type of strong opinions: opinions represented by very narrow probability distributions around a value that, in principle, should be considered non-extreme. That is also the case for wishers and two choices. In order to further explore the difference between strong, consensus-avoiding and actual extreme opinions, I will present and explore a opinion model where agents must choose between n options. Opinion models with three possible choices do exist and the one I will present is a generalization of a previous model for n = 3. I will discuss the differences between cases where the options are symmetrical and independent and the situation where those options are choices over a one-dimensional space. We will see the same general model apply to both cases, with differences only in the matrix, obtained from the model likelihoods, that defines how opinions change. In the case where options are independent, the definition of extremism is clear. When agents reinforce their opinions locally, extreme preferences emerge and are easy to interpret. However, the extremism definition that works well for the independent case is not so clear when choices are aligned. In that case, extremism could also be defined as belief in the options that are

situated in the end of the spatial range. Extreme opinions in favor of a specific choice become the equivalent of narrow probability distributions for continuous opinions or the wishers. In order to further explore the different meanings of those terms, the n options model, initially proposed as a wisher type of model, will also be implemented with agents who make mixer assumptions. The tendency to extremism in that case will also be measured. Those examples will highlight how, when making opinion models, it might be important to have a clear definition of extremism. They will also serve as an illustration of how simple changes in how the agents reason about the same choices might have important consequences on problems related to extremism.

Entropic analysis of an opinion formation model presenting a spontaneous third position emergence

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Characterization of complexity within the sociological interpretation has resulted in a large number of notions, which are relevant in different situations. From the statistical mechanics point of view, these notion resemble entropy. In a recent work, intriguing non-monotonous properties were observed in an opinion dynamics Sznajd model. These properties were found to be consequences of the hierarchical organization assumed for the system, though their nature remained unexplained. In the present work, we bring a unified entropic framework that provides a deeper understanding of those system features. By performing numerical simulations, the system tracks probabilistic dependence on the initial structures is quantified in terms of entropy. Several entropic regimes are unveiled. The myriad of possible system outputs is enhanced within a maximum unpredictability regime. A mutual structural weakness of the initial parties could be associated with this regime, fostering the emergence of a third position.

A machine learning approach for identification of the most influential spreaders in networks

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Epidemic processes are ubiquitous in our society. Diseases propagate from person to person and fake are widespread in social networks. To control these processes, it is fundamental to find the most influential spreaders in social networks. These nodes may trigger the propagation of a virus or fake news. To control the epidemic processes, we need to vaccinate these nodes or removed them from the network, such that the propagation is decreased. However, a current challenge is the identification of these spreaders. In this talk, we will show how we can identify the most influential spreaders by considering centrality measures and machine learning methods. We will consider models of disease and rumour spreading in social networks.

Social distancing in pedestrian dynamics and its effect on disease spreading

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Nonpharmaceutical measures such as social distancing can play an important role in controlling the spread of an epidemic. In this paper, we use a mathematical model combining human mobility and disease spreading. For the mobility dynamics, we design an agent-based model consisting of pedestrian dynamics with a novel type of force to resemble social distancing in crowded sites. For the spreading dynamics, we consider the compartmental susceptible-exposed-infective (SEI) dynamics plus an indirect transmission with the footprints of the infectious pedestrians being the contagion factor. We show that the increase in the intensity of social distancing has a significant effect on the exposure risk. By classifying the population into social distancing abiders and nonabiders, we conclude that the practice of social distancing, even by a minority of potentially infectious agents, results in a drastic change in the population exposure risk, but it reduces the effectiveness of the protocols when practiced by the rest of the population. Furthermore, we observe that for contagions for which the indirect transmission is more significant, the effectiveness of social distancing would be reduced. This study can help to provide a quantitative guideline for policy-making on exposure risk reduction.

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Effects of the COVID-19 pandemic in higher education: a particular case from the perspective of complex systems

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The COVID-19 pandemic abruptly changed the classroom context, understood as the meeting space between teachers and students where a fundamental part of the construction of new knowledge takes place. This presented enormous challenges for all actors in the educational process, who had to overcome multiple difficulties and adapt to a new daily life in which the incorporation of new strategies and tools was essential. In this work we study the knowledge acquisition process in two different contexts: face-to-face (before the onset of the pandemic) and virtual (during confinement), for a particular case in higher education in Argentina. We develop an analytical model for the knowledge acquisition process, based on a series of surveys and information on academic performance. We analyze the significance of the model by means of Artificial Neural Networks and a Multiple Linear Regression Method. We show how the non-linear nature of the interaction between individuals (students and teachers) is evidenced in the observed changes in strategy.

Dynamics of the threshold q-voter opinion with independence in random networks

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Social systems are a rich field in terms of phenomenology and featurures in complex systems. Modeling in this area is a difficult task due to the subjective behavior of the human being. However, there are many social scenarios that can be described by mathematical models, such as opinion dynamics. The voter model is one of the most famous of this class, where a dual scenario of opinion is presented and agents can copy the opinion of one of their neighbors. In 2009, C. Castellano et al. proposed the q-voter model, in which unanimity among a group with q (lobby group) members formed from the neighbors of an agent could change its own opinion. Recently, a threshold has been introduced in this dynamic, in which a minimum number of opposing opinions among the lobby group is needed instead of unanimity. In this work, we use the threshold q-voter rule (conformist) with independent behavior (inconformist). In addition, we explore the difference in whether or not to allow repetition in the influence group, which is not relevant for the mean field case. We study this model in a random network using Monte Carlo numerical simulations. In addition, we use pair approximation theory. We investigate the emergence of macroscopic behaviors in these systems and also phase transitions.

The R Network evolution: characterization of a collaborative network of software

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We present the evolution of the R project's collaborative software network, based on the official site where R-users upload their package contributions (the Comprehensive R Archive Network, CRAN). R is a free open source programming language created in the late '90s from S, a statistical analysis-oriented software. Nowadays, R packages cover a wide range of topics, including statistics, economics, machine-learning, biology, ecology, physics, geography, and many others. A R package consists of functions designed to provide a specific tool and can take advantage of other available packages. CRAN has grown from a few packages in 2000 to more than 14000 interrelated packages today. This growth results from an ever-increasing collaboration between developers from different fields and the emergence of a community of R-users worldwide, developing packages and building other resources on R like books, tutorials, FAQ, etc. We study the evolution of two networks, in which the packages work as nodes and the links correspond to two types of relationships among them (dependencies and suggestions). Dependencies are directed relationships, similar to paper citations, where a package depends on another if it uses its functionalities to work. Suggestions indicate the existence of examples or tutorials using both packages. While both networks were sparse in their origin, the number of connections of each type surpasses the number of packages nowadays, making both networks mostly connected. We characterize each network's change in time using macroscopic measures accounting for the size of the biggest connected component (BCC), and the fraction of independent packages in each network. We analyze how relationships of both types are distributed among packages, finding long-tailed distributions. The process of package addition is characterized using preferential attachment (PA) notions, finding superlinear PA in dependencies and suggestions. The number of relationships (dependencies and suggestions) added by a new package is described with a unique time-independent distribution for both relationships, using the fraction of packages in each network's BCC as its only parameter. We associate the network increase in connectivity with external "R events" like book publications, journal creations, and interest in StackOverflow. Changes in the network connectivity can be related to changes in the CRAN guidelines for development and the availability of resources for learning R. This work provides a detailed characterization of an empirical network, useful for further modeling on software networks.

Competing local and global interactions in social dynamics: how important is the friendship network?

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Motivated by the empirical research on product ratings, we study a class of opinion formation models with competing global and local interactions. Models are investigated by means of the pair approximation and Monte Carlo simulations on Watts-Strogatz networks. We show that the agreement is the most difficult to achieve within the model with local conformity and global anticonformity. Moreover, the role of the network structure is the most significant in this case, and it becomes almost irrelevant in the opposite case, namely for the model with global conformity and local anticonformity.