CCS2018: The Conference on Complex Systems 2018
Thessaloniki, Greece. September 23 - 28
http://ccs2018.web.auth.gr

Satellite : September 26, 2018
QUESTIONS AND PERSPECTIVES
IN UNDERSTANDING COMPLEXITY
VIA NONLINEARITY AND INFORMATION THEORY

Invited Speakers

Alberto Robledo (Universidad Nacional Autónoma de México, Mexico)

Alessandro Pluchino (Catania University, Italy)

Alvaro Diaz Ruelas (Universidad Nacional Autónoma de México, Mexico)

Andrea Rapisarda (Catania University, Italy)

Constantino Tsallis (Centro Brasileiro de Pesquisas Fisicas, Brazil)

Evaldo Curado (Centro Brasileiro de Pesquisas Fisicas, Brazil)

Fulvio Baldovin (Padova University, Italy)

G.Cigdem Yalcin (Istanbul University, Turkey)

Hildegard Meyer - Ortmanns (Jacobs University, Germany)

Satellite Organizers:
G.Cigdem Yalcin (gcyalcin@istanbul.edu.tr)
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(Universidad Nacional Autonoma de Mexico)

Deadline for abstract submission: June 30, 2018
http://complexityscience.net/satellite-ccs18/

Satellite of the CCS2018
"Questions and Perspectives in Understanding Complexity via Nonlinearity and Information Theory"

26 September 2018

09:10- 09:20 *Opening*

09:20 - 10:00 *"Nonlinear dynamical systems: Does strong chaos exclude q-statistics?"*
Constantino Tsallis (Centro Brasileiro de Pesquisas Fisicas, Brazil)

10:00 - 10:30 *"The role of talent and luck in getting success"*
Andrea Rapisarda (Catania University, Italy)

10:30 - 11:00 *Coffee break*

11:00 - 11:30 *"On the impact of a fundamental trade-off between costs and precision on the fate of dynamical systems"*
M.Voit and **Hildegard Meyer-Ortmanns** (Jacobs University, Germany)

11:30 - 12:00 *"From the nonlinear Fokker-Planck equation to the Vlasov description and back: Confined interacting particles with drag"*
A. R. Plastino[1], **E. M. F. Curado[2,3]**, F. D. Nobre[2,3] and C. Tsallis[2,3]
([1] UNNOBA-Conicet, Junin, Argentina, [2] CBPF, Rio de Janeiro, Brazil
[3] INCT-SC, Rio de Janeiro, Brazil)

12:00 - 12:30 *"Nonequilibrium statistical mechanics and the logistic map"*
Fulvio Baldovin (Padova University, Italy)

13:00 - 14:30 Lunch

15:00 - 15:30 *"Success in science: exploring the role of talent, luck and interdisciplinarity"*
Alessandro Pluchino, A. E. Biondo, A. Rapisarda, G. Burgio, A. Pulvirenti, T. Giorgino (Catania University, Italy)

15:30 - 16:00 *"Generalized statistical mechanics of high energy scattering processes"*
G.Cigdem Yalcin[1] and Christian Beck[2]
([1] Istanbul University, Turkey, [2] Queen Mary University of London,UK)

1**6:00 - 16:30** *Coffee break*

16:30 - 17:00 *"Critical phenomena at the onset of chaos"*
Alvaro Diaz Ruelas and Alberto Robledo (Universidad Nacional Autónoma de México, Mexico)

17:00 - 17:40 *"Self-organized criticality and a constrained thermal system analogue of the onset of chaos"*
Alberto Robledo (Universidad Nacional Autónoma de México, Mexico)

17:40 - 17:50 *Closing remarks*

Self-Organized Criticality and a Constrained Thermal System Analogue of the Onset of Chaos

Alberto Robledo

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We construct a self-contained statistical-mechanical model for self-organization that emulates the hierarchical properties of the nonlinear dynamics towards the attractors that define the period or band doubling route to or out of chaos. The aforementioned dynamics translates into a sequential partitioning of an otherwise conventional thermal system into isolated compartments that privileges progressively lower entropies, while a new set of configurations emerges due to the multiplicities of the secluded portions. The initial canonical balance between numbers of configurations and Boltzmann-Gibbs (BG) statistical weights is drastically altered and ultimately eliminated by the sequential procedure that mirrors the actions of the attractor. However the emerging set of group configurations implies a different and novel entropy growth process that eventually upsets the original loss and has the capability of marginally locking the system into a self-organized state with characteristics of criticality, therefore reminiscent in spirit to the so-called self-organized criticality.

Success in Science: Exploring the Role of Talent, Luck and Interdisciplinarity

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The debate on the benefits of specialized and interdisciplinary research has a long tradition but still remains largely controversial [1, 2]. Recently, this topic has received an increasing attention, also due the highly competitive environment where scientists have to compete for comparative funding and publication of papers in top-ranked academic journals [3]. In this context, it has been shown that the commonly adopted meritocratic strategies, which pursuit excellence and drive out variety, seem destined to be loosing and inefficient, in large part also because chance and luck seem to play an important role in determining the success of a scientific research as well as of a scientific career [4].

In this study, with the help of an agent based model built on the basis of real information extracted from the American Physical Society (APS) Data Set, we explore the role of talent, luck and interdisciplinarity for achieving success in scientific careers. On one hand, the results of the numerical simulations show that some degree of interdisciplinary attitude is helpful for reaching high citations scores, in perfect agreement with the analysis of the APS data set. In particular, both the real and the simulated distributions of citations for various interdisciplinarity levels seem to be well fitted by q-exponential functions. On the other hand, in agreement with the certified influence of randomness and serendipity in real scientific research, our simulations also show that the most talented researchers not necessarily are also the most successful ones.

References

[1] J. Aldrich (2014) "Interdisciplinarity". Oxford Univ Press, Oxford and New York.

[2] J. Jacobs (2014) "In Defense of Disciplines: Interdisciplinarity and Specialization in the Research University". University of Chicago Press, Chicago IL.

[3] Special issue on Interdisciplinarity (2015). Nature 525 (7569).

[4] A. Pluchino, A. E. Biondo, A. Rapisarda (2018) "Talent vs Luck: the role of randomness in success and failure". Advances in Complex Systems - Vol.21, No.03n04, 1850014.

Critical Phenomena at the Onset of Chaos

Alvaro Diaz-Ruelas, Alberto Robledo

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We determine the (Frobenius-Perron) invariant density of all attractors associated with the quadratic iterated map, and, through this, their entropy and related first and second derivative properties. We show that the infinite family of stationary dynamical states, arranged according to the monotonic increase of the value of de map control parameter from $\mu = 0$ to $\mu = 2$, possesses features akin to those of an isotherm of equilibrium thermodynamic states where the role of temperature is taken by μ. Disregarding windows of periodicity and focusing on the main period-doubling cascade and its mirror chaotic-band splitting cascade we obtain the familiar picture of two phases separated by a critical point. The periodic and the chaotic attractors represent the low and high temperature phases, respectively, while the critical point is located at the onset of chaos at μ_∞, the accumulation point of the cascades.

The Role of Talent and Luck in Getting Success

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The largely dominant meritocratic paradigm of highly competitive Western cultures is rooted on the belief that success is due mainly, if not exclusively, to personal qualities such as talent, intelligence, skills, efforts or risk taking. Sometimes, we are willing to admit that a certain degree of luck could also play a role in achieving significant material success. But, as a matter of fact, it is rather common to underestimate the importance of external forces in individual successful stories. It is very well known that intelligence or talent exhibit a Gaussian distribution among the population, whereas the distribution of wealth - considered a proxy of success follows typically a power law (Pareto law). Such a discrepancy between a Normal distribution of inputs, with a typical scale, and the scale invariant distribution of outputs, suggests that some hidden ingredient is at work behind the scenes. In this paper, with the help of a very simple agent-based model, we suggest that such an ingredient is just randomness. In particular, we show that, if it is true that some degree of talent is necessary to be successful in life, almost never the most talented people reach the highest peaks of success, being overtaken by mediocre but sensibly luckier individuals. As to our knowledge, this counterintuitive result although implicitly suggested between the lines in a vast literature is quantified here for the first time. It sheds new light on the effectiveness of assessing merit on the basis of the reached level of success and underlines the risks of distributing excessive honors or resources to people who, at the end of the day, could have been simply luckier than others. With the help of this model, several policy hypotheses are also addressed and compared to show the most efficient strategies for public funding of research in order to improve meritocracy, diversity and innovation.

References

A. Pluchino, A. E. Biondo, A. Rapisarda, arXiv:1802.07068 [physics.soc-ph]

Nonlinear Dynamical Systems: Does Strong Chaos Exclude q-Statistics?

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There is a common belief concerning classical Hamiltonian systems, namely that strong chaos necessarily leads to Boltzmann-Gibbs stationary states. The full scenario might be more subtle than that when the relevant phase space is not fully occupied.

Indeed, for the d-dimensional long-range XY and Fermi-Pasta-Ulam models (and possibly the long-range Heisenberg model as well), a region appears to exist where strong chaos is exhibited and nevertheless the system shows one-body q-statistical distributions (q>1) for both velocities and energies, which excludes Boltzmann-Gibbs statistics. This apparent paradox might be related to the nature of the occupancy of phase-space, as recently suggested by numerical studies on the standard and web maps [U. Tirnakli and E.P. Borges, Scientific Reports/Nature 6, 23644 (2016); G. Ruiz, U. Tirnakli, E.P. Borges and C. Tsallis, J. Stat. Mech. 063403 (2017); G. Ruiz, U. Tirnakli, E.P. Borges and C. Tsallis, Phys. Rev. E 96, 042158 (2017)].

A full Bibliography is available at http://tsallis.cat.cbpf.br/biblio.htm

From the Nonlinear Fokker-Planck Equation to the Vlasov Description and Back: Confined Interacting Particles with Drag

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Nonlinear Fokker-Planck equations endowed with power-law diffusion terms have proven to be valuable tools for the study of diverse complex systems in physics, biology, and other fields. The nonlinearity appearing in these evolution equations can be interpreted as providing an effective description of a system of particles interacting via short-range forces while performing overdamped motion under the effect of an external confining potential. This point of view has been recently applied to the study of thermodynamical features of interacting vortices in type-II superconductors. In this talk we explore an embedding of the nonlinear Fokker-Planck equation within a Vlasov equation, thus incorporating inertial effects to the particle dynamics. Exact time-dependent solutions of the q-Gaussian form (with compact support) are obtained for the Vlasov equation in the case of quadratic confining potentials [1].

References

[1] A. R. Plastino, E. M. F. Curado, F. D. Nobre and C. Tsallis, Phys. Rev. E 97, 022120 (2018).

Nonequilibrium Statistical Mechanics and the Logistic Map

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We discuss how general results in nonequilibrium statistical mechanics generalize to the non-local dynamics described by logistic map iterates. Specifically, after a general discussion of the thermodynamics of conductive processes, we address whether aspects of the classic Onsager's picture of regression to equilibrium are reproduced by the fully chaotic logistic map dynamics. We then try to generalize fluctuation theorems (e.g., the Jarzynski equality) to the logistic map.

Generalized Statistical Mechanics of High Energy Scattering Processes

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Very recently we have applied q-generalized statistical mechanics methods to high energy scattering processes, which lie at the root of the production process of cosmic rays.

It is known that the Boltzmann-Gibbs formalism has severe restrictions: It is not valid for nonequilibrium systems, it is not valid for systems with long-range interactions (such as gravity), and it is not valid for systems with a very small volume and fluctuating temperature (as probed in scattering processes of cosmic ray particles at very high energies). For these types of complex systems it is useful to generalize the formalism to a more general setting, based on the maximization of more general entropy measures which contain the Shannon entropy as a special case.

In this talk we present how to apply these techniques borrowed from generalized statistical mechanics to analyse the AMS-02 (the Alpha Magnetic Spectrometer) data sets. To conclude, we have shown that the different energy dependences of the spectral indices of positron and electron cosmic rays are well explained by a q-generalized Hagedorn theory.

Also we compare our ongoing analysis for DAMPE (DArk Matter Particle Explore) and CALET (The CALorimetric Electron Telescope), showing that they may be good candidates to keep investigating high energy scattering processes by using generalized statistical mechanics.

On the Impact of a Fundamental Trade-off between Costs and Precision on the Fate of Dynamical Systems

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In biological systems, information transfer is realized in the transcription and translation machinery, in molecular motors or pumps and enzymatic reactions. For these biomolecular processes a thermodynamic uncertainty relation has been derived. It states that a more precise output (such as the number of product molecules generated by an enzymatic reaction) requires a higher thermodynamic cost independent of the time used to produce the output. Applied to molecular motors which provide an example for a driven system that moves with time t along a coordinate x, the uncertainty relation implies an upper bound on its thermodynamic efficiency: the higher the precision, that is, the smaller the dispersion or uncertainty in x, the higher the entropy production, and the smaller the efficiency. Another example for information transfer and transformation is realized in cellular sensing. Living cells measure low chemical concentrations with high but limited precision. The fundamental sensing limit results from different resource classes, one of which is energy. In particular it has been shown why cellular sensing systems can never reach the Landauer limit on the optimal trade-off between accuracy and energetic costs. In view of all these inherent error-prone processes, nature has invented correction mechanisms like kinetic proofreading, that is a mechanism for error correction in biochemical reactions. However, also there, in conformational proofreading, there is a trade-off between product production and its efficiency. Theoretically the proofreading can achieve infinite specificity the longer the reaction runs, but at the costs of large amounts of the (correct) product as well.

In this contribution we abstract from the concrete realizations and consider a minimalist model for analyzing the influence of a fundamental trade-off between costs and precision on the dynamical performance of a system. An essential characteristics of the dynamics is a cyclic process that should run at low entropy, here chosen to be an error-prone copying process of an ordered bitstring. Without repair, the bitstring gets either randomized, going along with a complete loss of the original structure, or the finite accessible energy reservoir gets depleted before the string is randomized. When the copying process is combined with a repair process with constant probability of the success of repair, it is possible to sustain the cyclic performance without exceeding a desired tolerable error threshold. This is possible in spite of the fact that energy for repair is taken from the same finite reservoir from which the copying process is sustained, so repair is performed on the price of the subsequent copying accuracy. The conditions for this to happen are derived from the bifurcation diagram of a discrete map that describes the time evolution of errors. When these conditions are violated, the fate of the system is a lack of energy supply for its essential performance, since all energy gets absorbed by repair. This fate seems unavoidable when also repair succumbs the trade-off and gets less effective in the course of time, unless energy would be invested in the repair of repair. We truncate the iteration at the point where the costs for repair of repair should be taken into account in view of a complete description. Our conjecture is that a decaying success of repair over time amounts to an effective description of such an iterated procedure.