Guerra80

Celebrating the eightieth birthday of Francesco Guerra interpolating maxima of rugged lanscapes

Book of abstracts

Recurrent neural networks that generalize from examples and improve by sleeping

Elena Agliari,

Dipartimento di Matematica, Sapienza Università di Roma

Abstract: We consider the Hopfield model of neural networks and, inspired by biological information-processing, we revise its Hebbian kernel to allow for on-line learning and off-line "sleeping". We then investigate the reconstruction capabilities of the network as the control parameters (quality and quantity of the training data, fast and slow noises) are tuned. In particular, we show that sleeping enhances the machine effectiveness by lifting its capacity to its upper bound and by lowering the necessary training-set size up to a factor 90%. These results are proved analytically for structureless datasets by Guerra's interpolation technique and checked numerically for examples of structured ones.

Universality of information processing by shallow neural networks

Adriano Barra,

Dipartimento di Matematica & Fisica, Università del Salento

Abstract: In this talk, at first, I will show a formal equivalence among archetypical models in biologically inspired neural networks (e.g. the Hopfield model for Hebbian learning) and artificial neural networks typically involved in Machine Learning (e.g. the restricted Boltzmann machine): thresholds for learning, storing and retrieving information and, ultimately, phase diagrams will be shown to be the same for both these models (analytically, via Guerra's interpolation technique, in the random setting, numerically on structured datasets). At the end, I will show how this duality suggests an interpretation of information processing by deep architectures connecting one-to-one their multiple layers with the steps of replica symmetry breaking.

Disordered systems beyond the Permutation Symmetry Paradigm

Pierluigi Contucci,

Dipartimento di Matematica, Università di Bologna

Abstract: In this talk I will review some results obtained for the mean-field spin-glass models when disorder is not permutation invariant or, more generally, not identically distributed. Cases include the convex and non-convex multi-species, with emphasis on deep Boltzmann machines in the Nishimori line and the multi-bath SK model.

Stochastic Mechanics and Lévy Processes

Nicola Cufaro Petroni,

Dipartimento di Matematica, Università di Bari

Abstract: The stochastic mechanics (SM) - both in its original Nelson formulation and in its variational version by Guerra and Morato - is a stochastic model for the Schrödinger equation based on the Gaussian Brownian motion. The study of the transverse beam distribution in particle accelerators suggests however that non-Gaussian, Lévy infinitely divisible (i.d.) distributions, may play a role in the applications of the SM beyond its initial implementation in quantum mechanics. We therefore explore the possible extension of the background noise of the SM to the entire family of the i.d. Lévy processes.

A Levy-Schrödinger (LS) equation is introduced where the usual kinetic energy operator -the Laplacian- is replaced with a selfadjoint pseudodifferential operator whose symbol is the logarithmic characteristic of an i.d. law. The Lévy-Khintchin formula shows how to write down this operator in an integro-differential form. When the underlying Lévy process is stable we recover the fractional Schrödinger equation, but there are physically relevant models -such as a form of the relativistic Schrödinger equation- that are in the domain of the non stable self-decomposable LS equations. We finally analyze the time-dependent solutions of the LS wave equation in the free case, and we compare them with the corresponding Lévy processes showing the characteristic multimodality of these LS wave packets: a feature at variance with the typical diffusive unimodality of both the Lévy process densities and the usual Schrödinger wave functions.

Statistical ensembles in fluid dynamics

Giovanni Gallavotti,

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Abstract: Existence-uniqueness theorems may be too strict requirements for many body problems in Physics: Statistical Mechanics flourishes studying systems for which no existence-uniqueness is available for most infinite systems to which ideally it should apply in studying thermodynamics.

Here an analogy is proposed between the theory of the *thermodynamic limit* and the problem of fluids and turbolence discussing pro-and-con for a statistical interpretation of *viscosity and reversibility* of fluid motion, also with attention to recent computer simulations.

The relation between Parisi scheme and multi-thermalized dynamics in finite dimensions

Silvio Franz,

LPTMS, Université Paris-Sud

Abstract: The method of Random Perturbation was invented by Francesco and collaborators about 25 years ago. Since then, it has become an essential tool in the Mathematical Physics of Spin Glasses in equilibrium. This method was also used to related Equilibrium and Slow Off-equilibrum Dynamics ina generalized Linear Response Theory.

In this talk I will summarize the relation between equilibrium and slow out of equilibrium dynamics, such as we understand them today. If we assume that a finite-dimensional system is stable with respect to a familiy of weak random perturbation (stochastic stability) than its dynamics have a “multithermalization” structure if and only if the Boltzmann-Gibbs distribution obeys an Ultrametric Parisi distribution.

TBA

Luciano Maiani

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Factorizing large matrices with neural networks

Marc Mézard,

Department of Computing Sciences, Bocconi University

Abstract: The factorization of large matrices into product of two terms is an important mathematical problem encountered in many tasks, ranging frmo dictionary learning to machine learning. This talk will descibe a new approach to matrix factorization that maps it to neural network models of associative memory: each pattern found in the associative memory corresponds to one factor of the matrix decomposition. A detailed theoretical analysis of this new approach shows that matrix factorization in the extensive rank regime is possible when the rank is below a certain threshold.

TBA

Giorgio Parisi

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Pseudo-Spin Glasses, Materials, Community and Friendship

David Sherrington,

Rudolf Peierls Centre for Theoretical Physics, University of Oxford

Abstract: I shall describe some examples of pseudo-spin glasses from material situations involving atomic displacements and induction, as well as other puzzles and conceptual issues that have arisen in my mind and those of some others. My approach will be that of a physical theoretical modeller rather than that of a rigorous mathematical physicist.

I shall also celebrate the European network community that we initiated formally more than thirty years ago and which continues to flourish, not only in its wide-randing and fruitiful scientific success but also in the friendship it engendered and which endure, a shining example for our wider human society.

Energy storage and coherent states

Giuseppe Vitiello

Dipartimento di Fisica "E.R. Caianiello", Università di Salerno

Abstract: The analysis of free energy and energy storage in coherent states resulting from the spontaneous breakdown of symmetry in quantum field theory is presented. The relation between temperature and the coherent domain linear size and its consistency with the minimization of free energy is discussed also in relation to the Le Chatelier principle.