Geometric Science of Information 2023

Palais du Grand-Large
Saint-Malo, France

DISCOVER OUR KEYNOTE SPEAKERS

ALEAE GEOMETRIA

Inria
Ecole Normale
Supérieure

Francis BACH

Information Theory with Kernel Methods

Estimating and computing entropies of probability distributions are key computational tasks throughout data science. In many situations, theunderlying distributions are only known through the expectation of some feature vectors, which has led to a series of works within kernelmethods. In this talk, I will explore the particular situation where the feature vector is a rank-one positive definite matrix, and show how the associated expectations (a covariance matrix) can be used with information divergences from quantum information theory to draw direct linkswith the classical notions of Shannon entropies.

Polytechnic University of Catalonia

Eva MIRANDA

From Alan Turing to Contact geometry: towards a "Fluid computer"

Is hydrodynamics capable of performing computations? (Moore 1991). Can a mechanical system (including a fluid flow) simulate a universal Turing machine? (Tao, 2016). Etnyre and Ghrist unveiled a mirror between contact geometry and fluid dynamics reflecting Reeb vector fields as Beltrami vector fields. With the aid of this mirror, we can answer in the positive the questions raised by Moore and Tao. This is a recent result that mixes up techniques from Alan Turing with modern Geometry (contact geometry) to construct a "Fluid computer" in dimension 3. This construction shows, in particular, the existence of undecidable fluid paths. I will also explain applications of this mirror to the detection of escape trajectories in Celestial mechanics (for which I'll need to extend the mirror to a singular set up). This mirror allows us to construct a tunnel connecting problems in Celestial mechanics and Fluid Dynamics.

MPI-MiS, Leipzig, Germany

Bernd STURMFELS

Algebraic Statistics and Gibbs Manifolds

Gibbs manifolds are images of affine spaces of symmetric matrices under the exponential map. They arise in applications such as optimization, statistics and quantum physics, where they extend the ubiquitous role of toric geometry. The Gibbs variety is the zero locus of all polynomials that vanish on the Gibbs manifold. This lecture gives an introduction to these objects from the perspective of Algebraic Statistics

Institut Denis Poisson,
UMR CNRS
Université d'Orléans &
Université de Tours,
France

Diarra FALL

Statistics Methods for Medical Image Processing and Reconstruction

In this talk we will see how statistical methods, from the simplest to the most advanced ones, can be used to address various problems in medical image processing and reconstruction for different imaging modalities. Image reconstruction allows to obtain the images in question, while image processing (on the already reconstructed images) aims at extracting some information of interest. We will review several statistical methods (mainely Bayesian) to address various problems of this type.

Hervé SABOURIN

Transverse Poisson Structures to adjoint orbits in a complex semi-simple Lie algebra

Poitiers University

The notion of transverse Poisson structure has been introduced by Arthur Weinstein stating in his famous splitting theorem that any Poisson Manifold M is, in the neighbourhood of each point m, the product of a symplectic manifold, the symplectic leaf S at m, and a submanifold N which can be endowed with a structure of Poisson manifold of rank 0 at m. N is called a transverse slice at M of S. When M is the dual of a complex Lie algebra g equipped with its standard Lie-Poisson structure, we know that the symplectic leaf through x is the coadjoint G. x of the adjoint Lie group G of g. Moreover, there is a natural way to describe the transverse slice to the coadjoint orbit and, using a canonical system of linear coordinates (q1, qk), it follows that the coefficients of the transverse Poisson structure are rational in (q1, qk)

Nanyang
Technological
University,
Singapore

Juan-Pablo ORTEGA

Learning of Dynamic Processes

The last decade has seen the emergence of learning techniques that use the computational power of dynamical systems for information processing. Some of those paradigms are based on architectures that are partially randomly generated and require a relatively cheap training effort, which makes them ideal in many applications. The need for a mathematical understanding of the working principles underlying this approach, collectively known as Reservoir Computing, has led to the construction of new techniques that put together well known results in systems theory and dynamics with others coming from approximation and statistical learning theory. This combination has allowed in recent times to elevate Reservoir Computing to the realm of provable machine learning paradigms and, as we will see in this talk, it also hints at various connections with kernel maps, structure preserving algorithms, and physics inspired learning.

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