

## SEMINARIO DI GEOMETRIA E STATISTICA

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Politecnico di Torino,  
Dipartimento di Scienze Matematiche,  
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### Emergent behaviour detected via manifold learning

The aim of this seminar is to illustrate the potentialities of a differential geometric approach (modern manifold learning methods) for analyzing and modelling complexity of systems. Models of complex adaptive systems and manifold learning constructions are introduced by means of a suitable common mathematical formalism. In particular a unified view on the discretization process of linear differential operators on smooth manifolds will be presented.

The leading paradigm for the comprehension of emergent phenomena ascribes them to the existence of opposite tendencies in the local dynamics of subsystems or single agents. Complex behaviour in a system arises when local phenomena cannot be extended to a global scale. Differential geometry offers specific tools able to detect local and global obstructions for the extendibility of certain point-wise constructions to local and global ones.

A strong boost to this research has been determined by a project developed jointly by the Polytechnic University of Turin and Tetra Pak, in which a relevant motivating example based on large amount of in-service industrial data appeared. The mechanical performance behavior of an industrial plant has been efficiently modelled as an emergent phenomenon in a complex adaptive system, which is strongly characterized by the interrelations between its different levels of organization.