ISCTE University Institute of Lisbon
Department of Information Science and Technology

updated September 2015

Doctoral Program in Complexity Sciences 2015-1016

Advanced Topics in Complexity Sciences I

Goal

Students will develop competences regarding the study of complex systems and the modelling techniques proposed by mathematics, physics, and biology. This discipline proposes discussing the state of the art in these domains, concerning the study of complex systems observed in nature.

Program

1. Mathematics: differential equations; order vs. chaos; non-linearity and feedback; linear and non-linear dynamics; determinism vs. previsibility; Rössler's attractor; the butterfly effect; strange attractors; Lorenz equations; bifurcation diagrams; fractal structures; Cantor, Koch, Sierpinski, Mandelbrot.

2. Network Theory: essential concepts; relational structures; complex simplices; hypergraphs; poliedral connectivity; q-transmition; incidence matrices; system time and events; applying hypernetworks.

3. Physics: statistical mechanics; order, disorder, equilibrium point and fractal geometry; patterns and auto-organised structures; reaction-diffusion; stationary patterns through the Turing mechanism; Ockham's razor; sand piles; percolation.

4. Biology: auto-organization; evolutionary biological systems; positive and negative feedback; stigmergy; epidemiology and pandemic propagation.

Assessment

Continuous Assessment:

- Exercises (90%) - Exercises regarding the subjects presented in class.
- Participation in class (10%).