CENTRO DE MATEMÁTICA UNIVERSIDADE DO PORTO

Dynamical Systems in Porto

Dynamics of singularities and networks – Part I

Day	Speaker	Talk
02/11 14h30 50' + 50' **FC1.006**	**Sofia Castro** FEP, CMUP	**Heteroclinic dynamics** In ordinary differential equations, a saddle-sink connection is generically not robust. However, when either symmetry or extinction hyperplanes are present these give rise to flow-invariant spaces, a saddle-sink connection may be robust. A sequence of connections between consecutive equilibria is called a heteroclinic cycle. A heteroclinic network is a connected union of heteroclinic cycles. When a cycle is part of a heteroclinic network it cannot be asymptotically stable. It can nevertheless exhibit some stability that may make the cycle visible in experiments and simulations. I shall describe several intermediate notions of stability and ways to determine them. This mini-course will be more pedagogical than a standard scientific seminar.
03/11 14h30 1h30 **FC1.031**	**Manuela Aguiar** FEP, CMUP	**Coupled Cell Networks: basic definitions and results** In this course we will introduce the basic definitions of the coupled cell networks formalism. In particular, we will define different kinds of networks, in what concerns their topology and the existence or not of weights on the connections, and the coupled systems that are admissible by them. One of the key aspects of this formalism is the capacity of deducing dynamical properties of the admissible systems of a network based only on the topology of the network. One of those properties is the existence of subspaces of the phase space that are flow invariant by all the admissible systems. This is an important property that is observed in many models in different real world areas and that can impact greatly the dynamics, as we will see. We will also see how it iis possible to get the lattice of the synchrony subspaces of a given network.
06/11 12h00(*) 1h **FC1.005**	**Liliana Garrido da Silva** CMUP	**Stability of cycles and networks** The stability of heteroclinic trajectories within a heteroclinic cycle or network can be quantified by means of the local stability index. We derive explicit expressions for the local stability indices for a general class of robust heteroclinic cycles called quasi-simple heteroclinic cycles. A heteroclinic cycle is quasi-simple if its heteroclinic connections are one-dimensional and contained in flow-invariant spaces of equal dimensions. We ensure that the dynamics between two connected equilibria is encoded in a transition matrix whose entries only depends on the eigenvalues of the linearisation at the outgoing equilibrium. The local stability index is calculated by taking the rows of the (products of) suitable transition matrices. We illustrate our method with quasi-simple cycles arising in models from game theory, population dynamics and neuroscience. Part of this course is based on joint work with Sofia Castro (FEP, CMUP).
07/11 14h30 45'+45' **FC1.031**	**Ana Paula Dias** FCUP, CMUP	**Network constraints on bifurcations of coupled cell systems** We address some interesting network questions that have been posed in the last years. One concerns when two distinct networks are equivalent from the point of view of the sets of network admissible dynamical systems; the answer to this question effects the possibility of networks classification and we illustrate all that with small excitatory-inhibitory networks. In the second part of this talk, we intend to illustrate the application of Liapunov-Schmidt reduction to the study of steady-state bifurcations in network admissible dynamical systems. Finally, we present the class of Hopf-steady-state networks aiming to illustrate how network constrains on bifurcations of network admissible dynamical systems. Part of the talk is based on joint works with Aguiar (Porto), Mokhtari (Vrije Universiteit Amsterdam, Holland) and Stewart (Warwick, UK).
09/11 14h30 50' + 50' **FC1.006**	**Santiago Ibanez** University of Oviedo	**Singularities: unfolding and coupling** When two or more dynamical systems interact, new behaviors emerge. For example, synchronization (or desynchronization) phenomena may occur. Also, as Alan Turing observed, oscillations can occur where behavior was previously stationary, or even chaotic dynamics where evolution was previously predictable. These are some of the topics we will address in the context of couplings. Our tool will be the study of singularities (local bifurcations) that occur in coupled systems. We will see how the study of their unfoldings (the atlas of dynamics that arise around the singularity) sometimes allows us to determine properties of synchronisation/desynchronization or the existence of chaotic dynamics. We will first approach singularities and their unfoldings from a very general perspective and then focus on three particularly interesting cases: Hopf-Zero and Hopf-Hopf singularities, and nilpotent singularities. Moreover, our dynamics will be governed by families of vector fields, i.e., we will refer to singularities of vector fields (points at which the vector fields are zero) and to couplings of systems of differential equations.
10/11 14h30 1h30 **FC1.031**	**Alexandre Rodrigues** ISEG, CMUP	**Chaos in homoclinic bifurcations** Proving the existence of a homo- or heteroclinic connection in a given vector field is not an easy task. Santiago Ibanez showed how certain types of non-hyperbolic singularities (nilpotent singularities) generically unfold fields with homo- and heteroclinic connections. In this talk, we describe some global bifurcations (homo and heteroclinic) in autonomous differential equations, and their impact on the geometry of the associated dynamics. Special emphasis will be given to the emergence of chaos.

(*) Unusual time

Site: https://sites.google.com/view/oporto2023dynsys/dynamics-of-singularities-and-networks

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