Numerical stability of dynamical systems described by delay differential equations

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Timetable: 12 hrs (6+6). Lectures on October/November 2012 (to be defined), Room 2BC/30, Torre Archimede.

Course requirements: basic course on Numerical Analysis.

Examination and grading: exercises and/or computer experiments or brief essay on an argument treated during the course.

SSD: MAT/08 Numerical Analysis

Course contents:

The study of the dynamical systems that are encountered in diverse natural evolutive phenomena is focused on the possibility of foreseeing the time behavior by varying either some control parameters or initial conditions. The stability of the solutions represents a key aspect and the numerical analysis, through the development of efficient and accurate algorithms, can furnish an important contribution in the comprehension and description of the dynamics over the long period (equilibria, cycles, chaos).

Object of this course are the dynamical systems described by differential equations with delay(s), characterized by a future evolution depending on the past history. Interesting applications can be found in control theory, where the delay can be used to stabilize the system, or in population models, where it acts, e.g., as gestation time.

The basic concepts of stability, asymptotic stability and the relevant conditions will be defined by generalizing the same concepts for linear and autonomous systems of ordinary differential equations. Then, the most recent numerical approaches for the study of the stability of equilibria and limit cycles in the retarded case will be presented, based on the discretization with pseudospectral methods of the solution operators or their infinitesimal generator. Eventually, example of applications will be given, relevant to the bifurcation analysis and the stability maps following the variation of the parameters.

With regards to nonautonomous problems, finally, the concepts of Lyapunov exponents and spetrum will be introduced, always starting from the ordinary case, passing then to the theory and numerical methods recently developed for delay differential equations.