Introduzione alla trattazione numerica di sistemi dinamici aleatori

Programma

Il corso proposto intende costruire i prerequisiti e permettere degli approfondimenti del mini-corso "*The effects of noise on nonlinear dynamical systems*" che il prof. Peter Kloeden dell'Università di Francoforte terrà presso il nostro Dipartimento dal 13 al 17 aprile 2004 per la Scuola organizzata nell'ambito del progetto INDAM "Il rumore semplifica o complica la dinamica di sistemi non lineari?". In tale corso affronterà argomenti quali la stabilità, la stabilizzazione e la presenza di biforcazioni e attrattori stocastici in sistemi dinamici nonlineari in presenza di rumore così come la trattazione numerica di tali sistemi in base alle linee seguenti:

Noise can enter into nonlinear dynamical systems. Often it appears additively as background noise to account for small forces or interactions that have been neglected in the modelling process or it may appear multiplicatively, that is, coupled with the state of the system, which often arises when parameters are randomized. Then the evolution of transition probabilities of the resulting systems is governed by partial differential equations such as the Fokker-Planck equations, while the pathwise dynamics of the systems is governed by random or stochastic differential equations. In the latter case, the dynamics is intrinsically nonautonomous, even though the original system may have been autonomous. Completely new concepts and methods are often required in order to formulate and investigate the dynamics of such noisy dynamical systems.

In this series of lectures, I will discuss topics such as stability, stabilization and bifurcation in noisy nonlinear dynamical systems as well as random attractors and numerical methods for stochastic differential equations. I will assume that students have a basic familiarity (from an applied mathematical or engineering perspective) with stochastic calculus, stochastic differential equations and Fokker-Planck equations, all of which I will briefly review in my first lecture. Then I will consider linear stochastic differential equations in some detail, especially stability concepts and useful tools such as Lyapunov functions and Lyapunov exponents, because these are essential for a stability and bifurcation analysis of nonlinear systems through linearization about a stationar solution.

Suitable references for background reading are the books of Arnold (1974) and Gard (1988), as well as the first half of the book Kloeden & Platen. More advanced topics will be taken from Arnold (1998) as well as Crauel & Gundlach (1997) and suitable research papers.

(http://www.dm.unito.it/personalpages/sacerdote/doesnoise.htm)

Si pensa quindi di integrare le sue lezioni con prerequisiti riguardanti elementi di base del calcolo stocastico e del trattamento numerico delle equazioni differenziali stocastiche e problemi connessi e di offrire la possibilità al termine del corso di approfondire alcuni argomenti specifici a livello seminariale.

Prerequisiti

Si assume che gli studenti possiedano conoscenze di base relativamente al calcolo stocastico, alle equazioni differenziali stocastiche e alle equazioni di Fokker-Planck.

Testi consigliati

L. Arnold (1974), Stochastic differential equations. Wiley, New York.

L. Arnold (1998), Random dynamical systems, Springer, Heidelberg.

H. Crauel and V. M. Gundlach (1999), Stochastic dynamics, Springer, Heidelberg.

P. E. Kloeden and E. Platen (1992) , The numerical Solution of stochastic differential equations, Springer, Heidelberg.