Electrical & Computer ENGINEERING **lecture series**

Four Lectures:
February 27, February 29,
March 3, and March 5
3:30-5:00 p.m.
Hamerschlag D210

Four-Part Lecture Series on Systems Biology

Professor Carlo Cosentino, Ph.D.
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Carlo Cosentino received a M.Sc. degree in Computer Engineering in 2001 and a Ph.D. degree in Computer and Automation Engineering in 2005, both from University of Naples "Federico II", Italy. He is currently Assistant Professor of Systems and Control Theory at the University of Magna Græcia, Catanzaro, Italy. His research interests are focused on finite-time stability of linear systems, stability of quadratic systems, modeling and reconstruction of biological networks.

Outline of the lectures:

- Introduction to Systems Biology
  - Biology in a nutshell
  - Getting experimental data
  - Modeling biochemical reactions
    - Deterministic models
    - Stochastic models
- Biological Networks
  - Types of biological networks
  - Dynamical models of biological networks
  - Inference of biological networks
- Analysis and Simulation of Biological Systems
  - A case-study: The cell cycle
  - Modeling the cell cycle
  - Analysis of biological models
  - Software tools

Systems biology is concerned with the study of biological functions and mechanisms, underpinning inter- and intra-cellular dynamical networks, by means of signal- and system-oriented approaches. The application of mathematical and engineering concepts to biology is not a novelty, indeed the first works in this area can be traced back to several centuries ago (e.g. population models, dynamics of infectious diseases). Nonetheless, only recently the need for a more systematic view of biological processes, as opposed to the reductionist approach that has played a dominant role in the past centuries, has yielded to the widespread and interdisciplinar research field that is now referred to as systems biology.

This renewed interest is largely based on the revolution of experimental techniques and methodologies brougth by biotechnologies (the so-called omics). New high-throughput methods allow measurement of the expression levels of all genes of a cell at the same time and with suitable time resolution. Fluorescence labeling and sophisticated microscopy techniques enable us to directly observe the spatio-temporal dynamics of specific molecules within a single cell.

The potential benefits of systematic approaches encompass a deeper understanding of biological processes, thanks to the use of formal models and reverse-engineering methodologies, and the possibility to predict the response of complex systems to exogenous and endogenous perturbations (harmful compounds, drugs, genetic mutations) by means of in silico experiments, thus helping in overcoming the limits of classical in vitro/in vivo experimentation.

This series of lectures will provide an overview of some of the main topics in systems biology, starting with a brief review of basic biological notions and biochemical reaction modeling. The core of the course will consist of an overview of different types of models used for describing biological networks and some of the methods that exploit such models to infer biological knowledge from experimental observations. Finally, some analysis methodologies and simulation tools will be presented and illustrated through a relevant case-study, namely the model of cell division cycle.

LECTURE SERIES HOST: Bruno Sinopoli

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