MATH/305
NDSY

DYNAMIC MODELS in SOCIAL SCIENCES
2006 WINTER

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Topics: Mathematical

Goal: he first goal is to teach WHY mathematical and computational methods are important in understanding social phenomena, and HOW different social phenonemena an be described by proper mathematical models. Specifically, applications of the theory of dynamic systems will be presented.

The course needs some mathematical skill and background, but teaches and uses the basic mathematical notions of dynamical system theory. Students of science majors (with some mathematical interest and skill) are expected to take the class. Social scientists with some interest to modeling are welcome.

Course Structure:

Ten topics will be discussed. We shall spend one week on each topic. During the term it will be possible to attend demonstrations and make reports on readings. In addition, small groups will be formed to work on specific projects. They should collect data, and run simulations.

General Reading:

Epstein JM: Nonlinear Dynamics, Mathematical Biology, and Social Science. Santa Fe Inst. Studies in the Science of Complexity, 1997

Exam: There will be a sixty minutes long writtem midterm and a final oral examination. Written and oral report on a group project is a prerequirement of making the final examination.

Extra-class activities in connection with modeling and simulation of social systems (e.g. writing of simulation programs, participation in class discussion, active participation in the demonstrations of simulation softwares organized by the Center for Complex Systems Studies) will also be considered in assigning your final grade.

1. FROM MATHEMATICAL BIOLOGY TO SOCIODYNAMICS

Elements of dynamic system theory.
Basic model frameworks: the population dynamics of cooperation and competition; models of epidemics.

2-3. MODELS OF COMBAT AND ARMS RACE DYNAMICS

Lanchester equation, and its variations. An adaptive combat model.
Richardson model, and its variations.

Readings:

A new framework of combat risk managament usin the MANA model
www.esc.auckland.ac.nz/Organisations/ORSNZ/conf36/papers/Lauren.pdf

Andy Ilachinski
Towards a Science of Experimental Complexity:. An Artificial-Life Approach to
Modeling Warfare.
www.cna.org/isaac/isaac_einstein_paper.pdf

4. THE PROPAGATION OF IDEAS AND OPINIONS

The use of epidemic models for modeling the propagation of revolutionary ideas. Temporal and spatiotemporal models.

5. MODELS OF DRUG PROPAGATION AND CONTROL

Interactions between pushers, non-yet-addicted and police. The effect of legalization and law enforcement.

Jonathan P. Caulkins, Gustav Feichtinger, Alessandra Gragnani, Gernot Tragler:
High and Low Frequency Oscillations in Drug Epidemics
2005-5, May 2005
to be downloaded:
http://www.heinz.cmu.edu/wpapers/detail.jsp?id=6247

6. DYNAMICAL APPROACH TO PSCYHOLOGY

Dynamics of attidue change. Dynamic of opinion formation.

Sprott, JC: Dynamical Models of Love. Nonlinear Dynamics, Psychology, and Life Sciences
8(303-314)2004
http://sprott.physics.wisc.edu/pubs/paper277.htm

Sprott, JC: Dynamical Models of Happiness, Nonlinear Dynamics, Psychology, and Life Sciences
9, 23-36 (2005)

from http://sprott.physics.wisc.edu/pubs/paper281.htm

J.A. Hoyst, K. Kacperski and F. Schweitzer:
Social impact models of opinion dynamics
Annual Review of Comput. Phys. 9, 253-273(2001)
to be downloaded from:
http://www.if.pw.edu.pl/~jholyst/econom.htm

7. SOCIAL NETWORKS: STATISTICAL ANALYSISIS AND DEVELOPMENTAL MODELS

Social network analysis: searching and finding for the patters of people's interaction.
Regular, random and "small world" graphs
Formal models od network formation. More realistic models.

Readings:

Péter Érdi: Complex (not only neural) network
http://www.kzoo.edu/physics/ccss/material.html

M. E. J. Newman: The structure and function of complex networks
http://aps.arxiv.org/abs/cond-mat/0303516/

8.-9. DYNAMICAL MODELS IN ECONOMICS and POLITICAL SCIENCE

Chaos and chaos control in economic systems.
Econophysics.
Feedback in political science
Differential eqautionws versus agent-based models

Readings:

J.A. Hoyst and K. Urbanowicz:
Chaos control in economical model by time-delayed feedback method
Physica A, 287, 587-598 (2000)
to be downloaded from:
http://www.if.pw.edu.pl/~jholyst/econom.htm

Z. Burda, J. Jurkiewicz, M.A. Nowa:
Is Econophysics a Solid Science?
http://arxiv.org/abs/cond-mat/0301096

Frank R. Baumgartner and Bryan D. Jones
Positive and Negative Feedback in Politics
to be downloaded from
http://polisci.la.psu.edu/faculty/Baumgartner/contents.htm

Robert Axelrod and Leigh Tesfatsion
On-Line Guide for Newcomers to Agent-Based Modeling in the Social Sciences
http://www.econ.iastate.edu/tesfatsi/abmread.htm

10. DYNAMICS OF SOCIAL SYSTEMS: WHERE WE ARE NOW?

Summary. Reports on the group projects. Preparation for the exam.