NUS-PKU

Joint Summer Programme on Mathematical Modeling 9 July - 3 August 2007

NUS PROGRAMME OUTLINE

NUS-PKU Joint Summer Programme on Mathematical Modeling 2007

NUS PROGRAMME SCHEDULE

Date	9.00am – 11.00am	2.00pm – 4.00pm
Monday 23 July	**Modeling Sudoku with integer programs** Karthik Balkrishnan Natarajan S14, #01-19	**Finance (I)** Dai Min S14, #03-10
Tuesday 24 July	**Finance (II)** Dai Min S14, #03-10	**Introduction to hybrid systems (I)** Lin Hai S14, #03-10
Wednesday 25 July*	**Introduction to hybrid systems (II)** Lin Hai S14, #03-10	**Mathematical models in biology (I)** Bao Weizhu S14, #03-10
Thursday 26 July	**Mathematical models in biology (II)** Bao Weizhu S14, #03-10	**Game theory (I)** Zhao Gongyun S14, #03-10
Friday 27 July	**Game theory (II)** Zhao Gongyun S14, #03-10	**Gambling (I)** Teo Chung Piaw S14, #03-10
Monday 30 July	**Gambling (II)** Teo Chung Piaw S14, #03-10	**Mathematical modeling on 3D visual perception: depth from X (I)** Ji Hui S14, #03-10
Tuesday 31 July	**Mathematical modeling on 3D visual perception: depth from X (II)** Ji Hui S14, #03-10	**Mathematical model of the behaviors of stock prices (I)** Xiang Cheng S14, #03-10
Wednesday 1 August*	**Mathematical model of the behaviors of stock prices (II)** Xiang Cheng S14, #01-19	**(Title not available)** Jin Hanqing S14, #03-10
Thursday 2 August	**(Title not available)** Jin Hanqing S14, #03-10	**Supply chain management (I)** Mabel Chou S14, #03-10
Friday 3 August	**Supply chain management (II)** Mabel Chou S14, #03-10	**Experiences at MCM 2007** Hou Yu S14, #03-10 Cancelled

*Students and staff to proceed to S14, #03-11 for afternoon tea from 4pm-5pm on every Wednesday.

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(The outline is arranged in order of speaker's name)

MATHEMATICAL MODELS IN BIOLOGY

Bao Weizhu
Department of Mathematics
www.math.nus.edu.sg/~bao/index.html

1. Population models for single species
   - 1.1 Continuous models: exponential growth models, logistic model, etc.
   - 1.2 Discrete models
   - 1.3 Population model with age distribution
   - 1.4 Equilibrium and bifurcation
   - 1.5 Numerical methods for ODEs

2. Models for interacting populations
   - 2.1 Lotka-Volterra systems
   - 2.2 Realistic Predator-Prey models
   - 2.3 Complexity and stability

3. Reaction kinetics
   - 3.1 Enzyme kinetics
   - 3.2 Cooperative phenomena
   - 3.3 Multiple steady states

4. Biological oscillators and switches

SUPPLY CHAIN MANAGEMENT

Mabel Chou
Department of Decision Sciences
www.bschool.nus.edu.sg/staff_profile/cv.asp?ID=207

We will introduce mathematical modeling tools to handle supply chain management problems in a stochastic environment. In particular, we will focus on coordination in supply chains, one of the most important topics in supply chain management. Our objective is to provide the students a basic understanding of this topic and how to use mathematical modeling tools to analyze related issues. We will start with an introduction on supply chain management, followed by a basic newsboy model and discussions on interactions between stages in a supply chain, double marginalization and contracts for supply chain coordination.

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FINANCE

Dai Min
Department of Mathematics
www.math.nus.edu.sg/~matdm/

Option pricing modeling: including (a) concepts of options and futures (b) no-arbitrage argument (c) binomial model (d) Black-Scholes model.

Optimal investment: including (a) single period mean-variance analysis (b) the continuous time model.

EXPERIENCES AT MCM 2007

Hou Xuan
Department of Statistics and Applied Probability

Cancelled

Hou Xuan is a member of the team which participated in MCM 2007 (The Mathematical Contest in Modeling), where teams of undergraduates use mathematical modeling to present their solutions to real world problems. His team was one of the nine winning teams that solved "Problem B: The Airplane Seating Problem". He will share his experiences with the students.

MATHEMATICAL MODELING ON 3D VISUAL PERCEPTION: DEPTH FROM X

Ji Hui
Department of Mathematics
www.math.nus.edu.sg/~matjh

1. Image formation

2. Stereopsis
   - 2.1 Projective Geometry
   - 2.2 Epipolar Geometry

3. Interpretation of image motion field
   - 3.1 Optical flow
   - 3.2 3D motion perception from image derivatives.

4. Shape from shading and texture.

If we think about modern traffic or even the simple task of directing chopsticks with something to eat into our mouth, it is easy to see how important the three-dimensional (3D) perception of our 3D world is for human daily living. Our eyes only have 2D retina images and no special component for depth (the third dimension) perception. This requires an interpretation of our physiological cues from retina images that leads to useful depth perception.

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(The outline is arranged in order of speaker's name)

In this lecture, we will discuss various visual cues used for extracting reliable information about the three dimensions of our world and their corresponding mathematical models. In particular, we will focus on two most important visual cues: depth from stereopsis and depth from motion. Also, we will give a brief introduction on two other important cues: depth from shading and depth from texture.

(TITLE NOT AVAILABLE)

Jin Hanqing
Department of Mathematics
www.math.nus.edu.sg/~matjinh/

Outline not available.

MODELING SUDOKU WITH INTEGER PROGRAMS

Karthik Balkrishnan Natarajan
Department of Mathematics
www.math.nus.edu.sg/~matkbn

The purpose of this lecture is to introduce students to modeling ideas with tools of linear and integer programming. The focus will be on modeling Sudoku using these techniques. The students will also get a chance to try solving the model using the computer.

INTRODUCTION TO HYBRID SYSTEMS

Lin Hai
Department of Electrical and Computer Engineering
www.ece.nus.edu.sg/stfpage/elelh/

Traditionally, most of the research in systems and control has been concerned predominantly with dynamical systems that are described purely as either time-driven continuous variable dynamics (e.g. state space equations) or event-driven discrete logic dynamics (e.g. automata). Yet, there are numerous dynamical systems that are of heterogeneous nature. By heterogeneity, we mean that both continuous variable and discrete event dynamics are present and interacting with each other to generate complex dynamical behaviors. These are termed hybrid systems and have been used as mathematical models for automated highway systems, air traffic management systems, embedded automotive controllers, manufacturing systems, chemical processes, and, more recently, biomolecular networks. The wide applicability of hybrid systems has inspired a great deal of research from both control theory and theoretical computer science.

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In this mini course, we will go through a tutorial presentation of some representative hybrid system modeling frameworks with simple illustrations. The outline of the course can be described as follows:

1. Motivation for hybrid systems;
2. Short review for continuous variable dynamics and basics for discrete event systems;
3. Hybrid automata;
4. Piecewise linear systems;
5. Switched systems;
6. Examples.

GAMBLING

Teo Chung Piaw
Department of Decision Sciences
www.bschool.nus.edu.sg/staff_profile/cv.asp?ID=157

Basic probability, mean, variance, and overview of the case, particularly on the role of hot number management.

A set of data will be provided for students to do their analysis and to try out the performance of their proposal. (The problem is simple enough for the students to work on using only excel.) The students will then be formed into groups and work on the case at night.

Students do their presentation and discussion.

MATHEMATICAL MODEL OF THE BEHAVIORS OF STOCK PRICES

Xiang Cheng
Department of Electrical and Computer Engineering
www.ece.nus.edu.sg/staff/AcadStf.asp?Nm=X&RsrchG=

Part I: Introduction of the stock market.
Part II: Mathematical modeling of the stock market.

GAME THEORY

Zhao Gongyun
Department of Mathematics
www.math.nus.edu.sg/~matzgy/

Game theory studies multi-person decision making. We outline the game theory through the following examples:

- Prisoners' dilemma
- Infinitely repeated games
- Cournot model of duopoly
- Stackelberg model of duopoly
- Final-offer arbitration
- Auctions