ENE 3031
Computer Simulation

Week 1: Course Overview

Chuljin Park

Assistant Professor

Industrial Engineering

Hanyang University

Instructor

- Chuljin Park (박철진)
- Assistant professor
- Email: parkcj@hanyang.ac.kr
- Office: Engineering Center 706-2
- Phone: 02-2220-0476
- Homepage: https://sites.google.com/site/stochsim/
- Research Interests
  - Decision making under uncertainty
  - Stochastic simulation modeling and analysis
  - Stochastic Process and statistical quality control
  - Simulation optimization
  - Environmental management (Air quality and water quality)
  - Sensor network design

Course Information

- Title: Computer Simulation

    (컴퓨터 시뮬레이션)

- Course schedule
    - Tuesday (16:30 – 18:30) at H027 (제2공학관) #404
    - Wednesday (16:00 – 18:00) at H027 #208

    (50min lecture + 5 min break + another 50min lecture)

- **Office Hour: TBA**

    Other times available by appointment

Grading Policy

- Midterm (25%)
- Final (35%)
- Attendance (10%)
- Homework (10%)
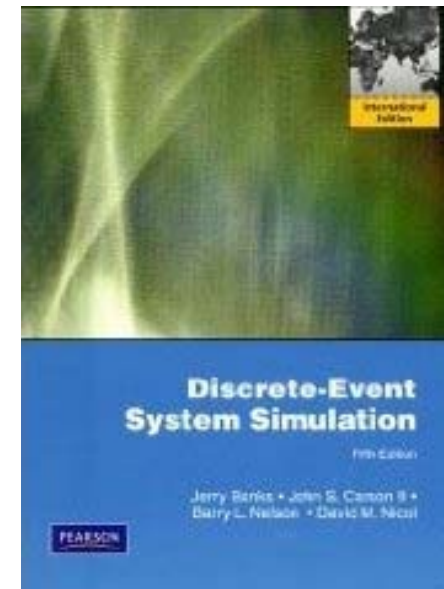- Project (20%)
  Total: 100%

Grading Policy

- Final Grade: Calculate your total scores (out of 100%) and the curve is as follows.

Grade	Score
A+	95 ~ 100
A0	90 ~ 94
B+	85 ~ 89
B0	80 ~ 84
C+	75 ~ 79
C0	70 ~ 74
D+	65 ~ 69
D0	60 ~ 64
F	0 ~ 59

Book and Resource

- Reference book
  - Discrete Event System Simulation (Paperback/5th Ed.)
  - ISBN: 9780138150372

- HY-IN
  - Readings & resources
  - Additional readings
  - Examples

Simulation Language: SIMIO

- We will model with Simio, a comprehensive discrete-event simulation package with extensive modeling, animation, and statistical analysis capabilities.

- Download SIMIO at
  http://www.simio.com/academics/student-resources.htm.

Tentative Schedule I

Week	Topics	Comment
Week1 (9/2, 9/3)	Introduction; Prob. and stat. review	
Week2 (9/9, 9/10)	Prob. and stat. review	Chuseok holiday
Week3 (9/16, 9/17)	Queueing system	HW1 due
Week4 (9/23, 9/24)	Hand and spreadsheet simulation	HW2 due
Week5 (9/30, 10/1)	Random number generation	HW3 due
Week6 (10/7, 10/8)	General Principles and Simulation Language	HW4 due
Week7 (10/14, 10/15)	Intro to SIMIO and SIMIO Lab 1	HW5 due
Week8 (10/21, 10/22)	Midterm (Tuesday 4:30 – 6:30)	In-class/closed book

Tentative Schedule II

Week	Topics	Comment
Week9 (10/28, 10/29)	SIMIO Lab 2 & 3	HW 6due
Week10 (11/4, 11/5)	SIMIO Lab 4 Input Modeling	Project report 1
Week11 (11/11, 11/12)	Input Modeling	INFORMS (conference)
Week12 (11/18, 11/19)	Verification and Validation	HW7 due
Week13 (11/25, 11/26)	Output Analysis for a single model	HW8 due
Week14 (12/2, 12/3)	Comparison of alternative system designs	HW9 due
Week15 (12/9, 12/10)	Final presentations (project)	Final presentation files (with SIMIO file)
Week16 (12/16, 12/17)	Final (Tuesday 4:30 – 6:30)	In-class/closed book

Advertisement I

- SOQ연구실에서 컴퓨터 시뮬레이션/시뮬레이션 최적화/통계적 품질관리/환경관리에 관심과 열정이 있는 (3, 4 학년) 학부인턴을 모집합니다. 관심 있는 학생들은 박철진 교수 에게 연락 바랍니다 (parkcj@hanyang.ac.kr).

- Looking for undergraduate interns who are interested in computer simulation/ simulation optimization/ statistical quality control/environmental management. If you are interested in, please contact Prof. Park (parkcj@hanyang.ac.kr).

Advertisement II

2014 한국 경영과학회 주최 대학생 경영과학상 경연대회

국문: 대학생 경영과학상

(English Title: The Undergraduate Operations Research Prize)

- 주제: 재난안전 또는 환경 및 에너지 문제를 해결하는 경영과학 응용 & 경영과학 전 분야

  (Topics: Disaster, safety, environmental, or energy problems & any problem in management science)

- 제출마감: 2014년 9월 29일 월 오후 9시

  (Due date: September/29/2014)

- 관심 있는 학생은 박철진 교수 (parkcj@hanyang.ac.kr)로 문의하세요.

  (If you are interested in, please contact Prof. Park (parkcj@hanyang.ac.kr).)

Intro to Simulation

- **Models** are high-level representations of the operations of a real-world process or system.

- Our concern will be with models that are

- How can we "solve" a model?

Simulation?

- **Simulation** is

- Simulation involves the generation of an artificial history to draw inferences concerning the operating characteristics of the real system that is represented.

Simulation is …

- One of the top three industrial engineering / operations research technologies

- Used by academics and practitioners on a wide array of theoretical and applied problems

- An indispensable methodology

When do we need simulation?

- We use simulation to:

Why do we simulate?

- Will the system accomplish its goals?
  - Current system won't accomplish its goals.
- Now what?
  - Need incremental improvement
  - Resolve disputes
  - Solve a problem, like a bottleneck
  - Sell an idea
  - Create a specification or plan of action

Advantages of Simulation

- Can study models

- Can study detailed relations that might be lost in the

- Can be used as a basis for experimental studies of systems

- Can be used to check

- Really nice demo method

- ...

Disadvantages

- Sometimes

- Simulations give   (and lots of misinterpretation of results is possible)

- To do a certain problem, better methods than simulation may exist.

- …

Origins: Mfg/Material Handling

- Simulation is the technique of choice
  - Calculates   of system components
  - Evaluates   through the system
  - Examines conflicting demand for resources
  - Examines contemplated changes before their introduction
  - Eliminates major design blunders

Typical Questions

- What will be the throughput?

- How can we change it?

- Where are the   ?

- Which is   ?

- What is the reliability of the system?

- What is   ?

Applications

- Manufacturing
  - Automobile Production Facility
  - Carpet Production Facility

- Service systems
  - Call Center Analysis
  - Fast Food Drive-Thru
  - Fast-Food Drive-Thru Call Center
  - Airport Security Line

Applications (con'd)

- Inventory and Supply Chain Analysis
- Financial Analysis
  - Portfolio Analysis
  - Options Pricing
- Traffic Simulation
- Airspace Simulation
- Service Sector
- Health Systems

Healthcare systems

- Patient Flow in a Hospital

- Hospital Room Allocation

- Optimization of Doctor / Nurse Scheduling

- Procurement of Supplies

- Propagation of Disease Spread

- Disease Surveillance

- Humanitarian Logistics

Simulation Examples

1. Let's make some Pi

2. Fun with calculus

3. Evil Random Numbers

Thanks to Dave.

Ex 1. Let's make some Pi

- Use Monte Carlo simulation to estimate π.

- Idea:
  - Area of a unit square is 1.
  - Area of an inscribed circle is π/4.
  - Probability that a dart thrown at the square will land in the circle is π/4.
  - Throw lots of darts. Proportion that will land in circle should approach π/4.

Ex 2. Fun with calculus

- Use simulation to integrate

$$f(x) = \sin(\pi x) \text{ over } [0,1].$$

- Idea:

  – Sample n rectangles.

  – Each is centered randomly on [0,1] and has width 1/n and height f(x).

  – Add up areas.

  – Make n really, really big.

Ex 3. Evil Random Numbers

- See what happens when you use a bad random number generator.

- Idea:
  - Simulate heights vs weights.
  - Should be a 2-D bell curve (normal distribution) with most observations in the middle and some on the outside.
  - Do observations "look" random?

Bigger Examples with SIMIO

1. Airport terminal

2. Theme park

3. Inventory system

4. Emergency department (hospital)

© SIMIO

Next topic

- Probability and statistics review