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15.066J Systems Optimization and Analysis: Simulation Module

Outline and Logistics, Cases and Examples

Outline and Logistics

Digital simulation deals with the design and analysis of computer models in order to gain knowledge about, and optimize real systems. In particular, digital simulation enables numerical experiments that do hold some actual predictive value, but would be too costly, time consuming, risky or just plain impossible to directly conduct on a real system. Simulation can be an extremely powerful tool and is becoming quite widespread (LFM second year internships seem to increasingly involve simulation models!), yet few in industry seem well trained in the design, implementation and interpretation of a useful simulation experiment. The simulation module in 15.066J is an application-oriented introduction to static and dynamic discrete-event simulation for executive decision-making. This module has two primary goals:

1. Develop the practical skills necessary to design, implement and analyze discrete-event simulation systems;

2. Cover the basic theory underlying discrete-event simulation methodologies, in order to enable a critical understanding of simulation output in managerial environments and build the foundations necessary to quickly adapt to future advances in simulation technology.

Because of its first objective, this module involves a sustained workload and many opportunities for hands-on practice. This year we will use two software packages for in-class examples, tutorials and homework assignments throughout the course: *Crystal Ball* (CB) for static (Monte-Carlo) simulations, and *Simul8* (S8) for dynamic discrete-event simulations (the exact meaning of these terms will be explained in the first lecture). While I have primarily selected these software packages among dozens of others because they are both relatively easy to learn, they also happen to be quite widespread and powerful. For support regarding the actual use and learning of these software packages, you should normally consult the following sources (in this order):

Order	Crystal Ball	Simul8
1	Help File (Software Help Menu)	Help File (Software Help Menu)
2	User Manual (available on class server)	User Manual (available on class server)
3	Online FAQ http://www.decisioneering.com/support/tech_home.html	Online Q&A Forum http://www.simul8.com/cafe/
4	Teaching Assistant	Teaching Assistant
5	Professor Gallien	Professor Gallien

However, if for some reason you find yourself stuck or struggling for more than 30 minutes and sources 1-3 do not yield any quick answer/fix, please do escalate to sources 4 and 5 at that point (again, the goal is to learn about simulation, not software interface). In addition, the module will contain in-class introduction/demos to both CB and S8, and I have assigned as a required reading for Class 4 the tutorial "Introduction to Simul8" which I have adapted from some of Simul8 Corporation's training material.

This module consists of 7 lectures and 3 tutorials. The schedule, list of topics covered, reading and homework assignments are listed below:

Week	Class	Date	Topic	Reading	Assignment
1	1	15-Jul	Introduction, Simulation Process and Stochastic Modeling	ClearPictures, Inc.	Questions 1 to 3 in ClearPictures, Inc.
	2	16-Jul	Monte-Carlo Theory and Examples (with Crystal Ball)		Proba/Stat Review 1 Checklist
	TUT1	17-Jul	Monte-Carlo Modeling and Crystal Ball Tutorial		Homework 1
2	3	21-Jul	Ontario Gateway Case Discussion		Ontario Gateway Case Write-Up
	4	22-Jul	Discrete-Event Framework and Examples (with Simul8)	Introduction to Simul8	Question 5 in ClearPictures, Inc.
	TUT2	24-Jul	Discrete-Event Modeling and Simul8 Tutorial		Homework 2
3	5	28-Jul	Discrete Event Case Discussion		Human Genome Case Write-Up
	6	29-Jul	Experimental Design and Simulation Analysis		Proba/Stat Review 2 Checklist
	7	30-Jul	Advanced Modeling Examples, Simulation-Based Optimization		
	TUT3	31-Jul	Experimental Design and Simulation Analysis Tutorial		Homework 3

All assignments may be prepared as part of your regular study group/team (and not beyond!), but you should individually be able to answer questions in class about every part of the work that has been done by your team. The three homework assignments, *Introduction to Simul8* document, *Ontario Gateway* and *Human Genome* cases will be posted on SloanSpace, and the readings/assignment *ClearPictures, Inc.* refers to a mini case described later in the present document. The two Proba/Stat Review Checklists consist of making sure on your own (or as part of your study group) that you are comfortable with a number of concepts covered earlier this summer in 15.064 *Engineering Probability and Statistics* before walking into class that day. More specifically before the corresponding classes you should have a good understanding of the following concepts:

Proba/Stat Review 1 Checklist:
        -definition of continuous and discrete random variables;
        -pdf, cdf;
        -law of large numbers; and
        -statistical estimators of mean and variance;

Proba/Stat Review 2 Checklist:
        -central limit theorem;
        -fractile of a distribution; and
        -construction of confidence intervals for the mean.

Don't skip this! Besides helping you and the class as a whole to make the most out of the simulation lecture that day, it is also a great opportunity to ensure that you have internalized these important concepts covered in 15.064, which should prove useful to you time and time again at MIT and beyond.

An important milestone in the module is the software implementation of the ClearPictures model on Class 4: this assignment represent the first time in the module that you will have the opportunity to implement a somewhat realistic discrete-event simulation model. It has been partly designed to help you become familiar with S8 before you will need to use this software package even more extensively (when preparing Homework 2 and the Human Genome Project case in particular), so I strongly urge you to prepare it thoroughly –even if you don't get the ClearPictures model 100% right for Class 4, it is very important that you try!

Finally, an anonymous feedback survey will be posted on the class web site at the end of the module for you to complete – this is a key point in helping me to continuously improve the quality of this module (and thus the learning experience of future LFM students), so I ask that you please fill it completely and honestly.