Prescriptive Analytics

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Course Description

Prescriptive analytics is the process of using selected variables extracted from data sets, along with optimization and simulation models, to find the best set of actions in a process called data-driven decision making.

This course shows this process by describing step-by-step how to build the simulation models to generate the scenarios that result from different decisions to find the best set of actions. The students use state-of-the-art tools to implement these models on a variety of business applications.

Two types of simulation models are to be used. Monte Carlo simulation models are useful to represent a system at a fixed time instant while system simulation models represent systems that evolve in time (with changes occurring at different time instants). Both can be used to improve operations and to identify what decisions lead to optimal results.

Learning Objectives and Outcomes

- Identify the different types of simulation models
- Build Simulation Models with the ARENA simulation software
- Perform goodness of fit tests to choose the best probability distribution for the input variables
- Analyze the output of a simulation model
- Construct Confidence Intervals to compare the performance of two or more system configurations
- Experiment with the system configuration using ARENA OptQuest optimizer to find the optimal configuration

Prerequisite(s): None.

Recommended Preparation: An undergraduate course in Statistics and basic knowledge of a programming language.

Course Notes

The course material is available online.

Technological Proficiency and Hardware/Software Required

The student version of ARENA, is the main computational tool. It is a MS Windows based Software. Students using MacOS should use a virtual machine to have access to ARENA. The R language and the RStudio IDE will be used for additional statistical analysis.

Required Textbook

- Kelton, Sadowski, *Simulation with ARENA*, 6ed., McGraw-Hill, 2014

Supplementary Materials (References)

- Lantz B., *Machine Learning with R*, Packt Pub., 2015
  ISBN 978-1-78439-390-8

Description and Assessment of Assignments

- **Midterm** take home exercises on ARENA
- **Final Examination** a comprehensive exam scheduled by USC.
- **Homework** are assigned every other week. Homework is based on the material of the previous and current week.

Grading Policy

Assignment	Points	% of Grade
Homework	100 each	30
Midterm	100	30
Final	100	40
TOTAL		100

Grading Scale (Course final grades will be determined using the following scale)

A	95-100	B-	80-82	D+	67-69
A-	90-94	C+	77-79	D	63-66
B+	87-89	C	73-76	D-	60-62
B	83-86	C-	70-72	F	59 and below

Assignment Submission Policy
Assignments should be typewritten and clean. They should be submitted as pdf files by the due date. Email submissions and late submissions are not allowed. No make-up exams are considered.

Timeline and Rules for submission
Assignments are to be returned the week after submission. Solutions will be released soon after the homework submission date.

Course Schedule: A Weekly Breakdown

	Date	Topics/Daily Activities	Homework	References
1	**Jan 11**	**Introduction to Simulation.** Types of Simulation Models. The Flaw of Averages. **Introduction to R,** RStudio**,** and rmarkdown. Introductory example with R	HW1 R Exercises	1overview 2Rbase ppt,r 3intro calendars.r 4RStudio.ppt
2	**Jan 18**	**Monte Carlo simulation.** Random variables Triangular, Gamma, Weibull, Lognormal. Examples on Marketing, Manufacturing, and Finance.	HW1 due HW2 Simulation with R	intro3.ppt montecarlo.ppt overbooking.r inventory2.r
3	**Jan 25**	**Simulation with ARENA.** Category Overview Report. Statistics on Queues, Resources, Time in System. Case Study: Serial and parallel Service.	HW3 ARENA Modeling	K 3.5 arena1.ppt
4	**Feb 1**	**Simulation with ARENA.** Exercises 5.2, 4.31, 4.10, 4.4	HW3 due	arena2.ppt
5	**Feb 8**	**Simulation with ARENA.** Resource Schedules Exercise 4.18 Fast Food Restaurant. Exercise 4.15.	HW4 ARENA Modeling	schedules.ppt
6	**Feb 15**	**Comparing Two Systems.** ARENA Output Analyzer. Two-Sample *t* test, Paired *t* test. Exer. 4.18	HW4 due	comparison.ppt K 6.4 p288
7	**Feb 22**	**MIDTERM EXAM**		
8	**Mar 1**	**Input Probability Distributions.** Fitting data with the ARENA Input Analyzer. Goodness of Fit test. Empirical cdf. Examples.	HW5 Input Analyzer	ia.ppt mixture.r K 4.6
9	**Mar 8**	**Applications on Discrete Event Simulation** Queues (Capacity and Entity Priority). Example: Car Wash Service.	HW5 due	queues.ppt
10	**Mar 15**	**Spring Break**		
11	**Mar 22**	**Applications on Discrete Event Simulation** Sets (Counters). Emergency Room. Sets (Resources). Exercises.	HW6 ARENA Modeling	set.ppt hospital.doe assembly.doe
12	**Mar 29**	**Statistical Concepts on Simulation Models** Conf. Interval, half-width and precision. Exercises 5.17, 5.13, 6.6. Sharing Resources.	HW6 due	models12.ppt inventory.ppt
13	**Apr 5**	**Systems Optimization.** ARENA OptQuest Toolbox. Exercises 4.22, 6.16		opt.ppt inventory1.doe K 6.6
14	**Apr 12**	**Generating Random Observations** The Inverse Transform Method. Mixtures and the Composition Method.	HW7 ARENA OptQuest	random.ppt newproduct2.doe K 12.2
15	**Apr 19**	**Modeling Detailed Operations** Model 5-2. Simulating a Call Center	HW7 due	callcenter.pdf K 5
16	**Apr 26**	**REVIEW**		
	May 9	**Final Exam**		