USC Viterbi
School of Engineering

ISE 580 Performance Analysis with Simulation
Spring 2022- W 3:30 p.m.
3 Units
Location: ZHS 352

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Course Description

Simulation is a widely used statistical method for decision making. It consists of building a probability model representing a system. The model contains relationships that describe how to compute the outputs given the values of the inputs. Some of these inputs are controllable by the decision maker and others are probabilistic in nature. The system outputs depend on the decisions made by the analyst, who may experiment with the model to find the best set of decisions. Those that lead to optimal results. The inputs are modeled by random variables whose distribution may be estimated by the data available. Simulation models are tools to predict how a system operates given some choices. It can be very powerful to designing a new system or to improve an existing one.

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 separated time instants). Both can be used to improve operations and to identify what decisions lead to optimal results.

In this course we review the fundamentals of simulation models and use state-of-the-art tools to implement these models on a variety of applications.

Prerequisite(s): None.

Recommended Preparation Expected to have knowledge of Engineering Statistics at the level of ISE 225 and working knowledge of a programming language.

Learning Objectives and Outcomes

At the end of this course students are able to

- Identify the different types of simulation models
- Build Simulation Models with ARENA
- Perform goodness of fit tests
- Analyze the output of a simulation model
- Construct Confidence Intervals to compare the performance of two or more system configurations
- Optimize a system configuration with ARENA

Course Notes
The course material is available on Blackboard.

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 follow the VDI Tutorial pdf file on Blackboard to have access to ARENA. The R language and the RStudio IDE will be used for more general 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** in-class based on the schedule and 2 hours length.
- **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. It may be graded by an in-class quiz.

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.

ISE 580 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**		

Statement on Academic Conduct and Support Systems

Academic Conduct:

Plagiarism – presenting someone else's ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Part B, Section 11, "Behavior Violating University Standards" policy.usc.edu/scampus-part-b. Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct, policy.usc.edu/scientific-misconduct.

Support Systems:

Counseling and Mental Health - (213) 740-9355 – 24/7 on call
studenthealth.usc.edu/counseling
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

National Suicide Prevention Lifeline - 1 (800) 273-8255 – 24/7 on call
suicidepreventionlifeline.org
Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

Relationship and Sexual Violence Prevention and Services (RSVP) - (213) 740-9355(WELL), press "0" after hours – 24/7 on call
studenthealth.usc.edu/sexual-assault
Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office of Equity and Diversity (OED)- (213) 740-5086 | Title IX – (213) 821-8298
equity.usc.edu, titleix.usc.edu
Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants. The university prohibits discrimination or harassment based on the following *protected characteristics*: race, color, national origin, ancestry, religion, sex, gender, gender identity, gender expression, sexual orientation, age, physical disability, medical condition, mental disability, marital status, pregnancy, veteran status, genetic information, and any other characteristic which may be specified in applicable laws and governmental regulations. The university also prohibits sexual assault, non-consensual sexual contact, sexual misconduct, intimate partner violence, stalking, malicious dissuasion, retaliation, and violation of interim measures.

Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298
usc-advocate.symplicity.com/care_report
Avenue to report incidents of bias, hate crimes, and microaggressions to the Office of Equity and Diversity |Title IX for appropriate investigation, supportive measures, and response.

The Office of Disability Services and Programs - (213) 740-0776
dsp.usc.edu
Support and accommodations for students with disabilities. Services include assistance in providing readers/notetakers/interpreters, special accommodations for test taking needs, assistance with architectural barriers, assistive technology, and support for individual needs.

USC Support and Advocacy - (213) 821-4710
uscsa.usc.edu
Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity at USC - (213) 740-2101
diversity.usc.edu
Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call
dps.usc.edu, emergency.usc.edu
Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

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dps.usc.edu
Non-emergency assistance or information.