ISE 580: Performance Analysis with Simulation

Spring 2024

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.

Class Schedule

Section	Time	Days	Location
31532	4:00-5:50 pm	Tue, Thu (TTh)	GFS 207

Course Instructor

Dr. Hamid Chabok
Email address: chabok@usc.edu
Office: SHS 365
Office hours: Monday 11:30 am – 1 pm (or by appointment)

Teaching Assistant

Citina Liang
Email address: citinal@usc.edu
Office: GER
Office hours: Tuesday and Thursday 4-5 pm

Course Learning 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

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.

Course Materials

Textbook

A textbook is not required.

Recommended Readings

- Kelton, Sadowski, Simulation with ARENA, 6ed., McGraw-Hill, 2014
- Law A., Simulation Modeling & Analysis, 5th Edition, McGraw-Hill, ISBN 9780073401324

Technological Proficiency and Hardware/Software Required

The student version of ARENA (**last version, 16.2 is required**), is the main computational tool. The R language and the RStudio IDE will be used for more general statistical analysis.

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1. Grading

Your final course grade will be based upon four major components:

Grade Component	Weight
Homework and Take-home assignments	25%
In-class group activities (ICA)	10%
Midterm	30%
Final Exam	35%

2. Grading scale

Letter Grade	Quality Grade	Percentage	Letter Grade	Quality Grade	Percentage
A	4.0	≥ 93%	C	2.0	≥ 73%
A-	3.7	≥ 90%	C-	1.7	≥ 70%
B+	3.3	≥ 87%	D+	1.3	≥ 67%

B	3.0	≥ 83%	D	1.0	≥ 63%
B-	2.7	≥ 80%	D-	0.7	≥ 60%
C+	2.3	≥ 77%	F	0.0	< 60%

3. Minimum Requirements for Passing the Course

In order to receive a passing grade in the course (D or above), you must have completed at least 70% of homework assignments during the semester. Failure to complete at least 70% of homework assignments will result in a zero for your final homework score.

You must also pass the midterm and final exams in order to pass the class.

Each semester a few students fail to complete the laboratory experiments and consequently fail the entire course. Please don't let this happen to you.

4. Homework Assignments

Homework will be submitted via Blackboard. We expect that it will take you, in total, approximately 4 - 6 hours to complete each of these homework assignments. The counsel to do your own homework does not mean that you cannot work with other students in the class. On the contrary, we recommend students work together, where feasible, in deciding how to solve problems. Of course, working together does not mean simply copying solutions from each other. That action is a violation of academic integrity standards. There is, however, a large difference between simply copying and learning by cooperating. Take advantage of this opportunity.

We also understand that many solutions can be found online. However, the more important point is that, apart from being an academic integrity violation, copying pre-existing solutions denies you an essential learning experience and this will typically result in a poor performance on midterm and the final exam.

Homework will be due by **11:59pm on Sunday**. Solutions to the homework assignments will be posted on Blackboard immediately after the deadline. As such, **late work will NOT be accepted.** Homework assignments will be graded within one week of their due date.

We recognize that from time-to-time students find it impossible to complete a specific homework assignment owing to illness or other outside commitments. In order to address this issue, we have set the final homework total equal to the point total of **4 out of 5 homework assignments**. This is better than dropping the two lowest homework grades, as it allows you to use all 5 assignments to build up to the maximum homework score. This is intended to cover things like, but not limited to, illness, intercollegiate competitions (both academic and non-academic), intramural competitions, conflicts with other courses scheduling required activities outside of their declared times, and family emergencies. The only exceptions are (i) Religious observances when documented on the web site of the Office of Religious Life, in which case any affected student must inform his/her instructor of the situation no later than the day before the religious observance. (ii) Extended and well-documented medical issues. Warning: You should view the fact that the equivalent of two homework will be dropped as a safety-net, and not as an excuse to goof-off on early homework. A student who misses an early homework for inadequate reasons, and then misses later homework for completely legitimate reasons will receive little sympathy.

5. Exams

There will be a **Midterm Examination** (02/22, during the class) and a **Final Examination** (05/02, 4:30-6:30 p.m.). **The Final Exam will be comprehensive of the entire semester**.

We recommend that you write all exam answers in pen, not pencil, because if, after reviewing your graded answers, you wish to request a reconsideration of their grading, only solutions written entirely in pen will be considered. Prior to turning in the exam, no student may leave the exam room unless personally accompanied by a proctor. There are no scheduled make-up examinations for either midterm or the Final Exam.

Students with special examination requirements as documented by the Office of Disability must present their documentation to their instructor as soon after the start of classes as is possible, and certainly no later than seven calendar days prior to the midterm, or as soon as the accommodation is granted.

Some Useful Dates

January 8	First day of classes
January 15	Martin Luther King's Birthday
January 26	Last day to add
January 26	Last day to drop without a mark of "W" and receive a refund
February 19	Presidents' Day, university holiday
February 22	Midterm Exam
February 23	Last day to withdraw without a "W" on transcript or change pass/no pass to letter grade
March 11-15	Spring Recess
April 5	Last day to drop class with mark of "W"
April 26	Last day of classes
May 2	Final Exam. This is one of the Exceptions in the Schedule of Classes. Don't make travel plans based upon a different exam date! If you have any issues or conflicts, see us **immediately**.

Course Schedule

You should read through the relevant chapters prior to coming to the lectures each week, and review them again after each lecture before attempting the homework problems.

Week	**Topic**	**Chapter(s)** (Based on Kelton)
1	Introduction to Simulation Modeling Fundamental Simulation Concepts	1, 2, Notes
2	A Review of Statistics and Probability Distributions Introduction to R	App. B Notes
3	Monte Carlo simulation	Notes
4	Simulation with ARENA	2, 3
5	Modeling Basic Operations and Inputs with Arena	4, 5
6	Comparing Two Systems with ARENA	6
7	Midterm Exam	-

8	Input Probability Distributions	4
9	Applications on Discrete Systems Simulation	11
10	Applications on Discrete Event Simulation	11
11	Statistical Concepts on Simulation Models	12
12	Systems Optimization	6
13	Generating Random Observations	12
14	Modeling Detailed Operations	5
15	Review	-

Academic Integrity

The University of Southern California is foremost a learning community committed to fostering successful scholars and researchers dedicated to the pursuit of knowledge and the transmission of ideas. Academic misconduct is in contrast to the university's mission to educate students through a broad array of first-rank academic, professional, and extracurricular programs and includes any act of dishonesty in the submission of academic work (either in draft or final form).

This course will follow the expectations for academic integrity as stated in the USC Student Handbook. All students are expected to submit assignments that are original work and prepared specifically for the course/section in this academic term. You may not submit work written by others or "recycle" work prepared for other courses without obtaining written permission from the instructor(s). Students suspected of engaging in academic misconduct will be reported to the Office of Academic Integrity.

Other violations of academic misconduct include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

The impact of academic dishonesty is far-reaching and is considered a serious offense against the university and could result in outcomes such as failure on the assignment, failure in the course, suspension, or even expulsion from the university.

For more information about academic integrity see the student handbook or the Office of Academic Integrity's website, and university policies on Research and Scholarship Misconduct.

Students and Disability Accommodations:

USC welcomes students with disabilities into all of the University's educational programs. The Office of Student Accessibility Services (OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each course. The LOA must be given to each

course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at osas.usc.edu. You may contact OSAS at (213) 740-0776 or via email at osasfrontdesk@usc.edu.

Support Systems:

Counseling and Mental Health - (213) 740-9355 – 24/7 on call

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

988 Suicide and Crisis Lifeline - 988 for both calls and text messages – 24/7 on call

The 988 Suicide and Crisis Lifeline (formerly known as the National Suicide Prevention Lifeline) provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week, across the United States. The Lifeline is comprised of a national network of over 200 local crisis centers, combining custom local care and resources with national standards and best practices. The new, shorter phone number makes it easier for people to remember and access mental health crisis services (though the previous 1 (800) 273-8255 number will continue to function indefinitely) and represents a continued commitment to those in crisis.

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-9355(WELL) – 24/7 on call

Free and confidential therapy services, workshops, and training for situations related to gender- and power-based harm (including sexual assault, intimate partner violence, and stalking).

Office for Equity, Equal Opportunity, and Title IX (EEO-TIX) - (213) 740-5086

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.

Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298

Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title for appropriate investigation, supportive measures, and response.

The Office of Student Accessibility Services (OSAS) - (213) 740-0776

OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

USC Campus Support and Intervention - (213) 740-0411

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity, Equity and Inclusion - (213) 740-2101

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

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.

USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-1200 – 24/7 on call

Non-emergency assistance or information.

Office of the Ombuds - (213) 821-9556 (UPC) / (323-442-0382 (HSC)

A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

Occupational Therapy Faculty Practice - (323) 442-2850 or otfp@med.usc.edu

Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.

Course Content Distribution and Synchronous Session Recordings Policies

USC has policies that prohibit recording and distribution of any synchronous and asynchronous course content outside of the learning environment.

Recording a university class without the express permission of the instructor and announcement to the class, or unless conducted pursuant to an Office of Student Accessibility Services (OSAS) accommodation. Recording can inhibit free discussion in the future, and thus infringe on the academic freedom of other students as well as the instructor. (Living our Unifying Values: The USC Student Handbook, page 13).

Distribution or use of notes, recordings, exams, or other intellectual property, based on university classes or lectures without the express permission of the instructor for purposes other than individual or group study. This includes but is not limited to providing materials for distribution by services publishing course materials. This restriction on unauthorized use also applies to all information, which had been distributed to students or in any way had been displayed for use in relationship to the class, whether obtained in class, via email, on the internet, or via any other media. (Living our Unifying Values: The USC Student Handbook, page 13).