ISE 580

Performance Analysis with Simulation

Spring 2023

***** Please make sure to see your instructor ASAP if you were not present on the first day of class or enrolled late for the course*****

Units: 3 **Day/time**: Thursday 3:00-6:20 pm **Location**: KAP 145

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.

Course Instructor

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Office: SHS 365
Office hours: Mondays 10:30am - 12:00pm
and by appointment

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

Required Textbook

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

Supplementary Materials (References)

- Law A., Simulation Modeling & Analysis, 5th Edition, McGraw-Hill, ISBN 9780073401324

Technological Proficiency and Hardware/Software Required

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

Administrativia

1. **Grading**

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

Grade Component	Weight
Homework	25%
In-class activities (ICA)	5%
Midterm	30%
Final Exam	40%

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 Wednesday**. 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 6 out of 7 homework assignments. This is better than dropping the two lowest homework grades, as it allows you to use all 7 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 (Feb 23 at 3 pm) and a Final Examination (Tuesday, May 9 at 2-4 pm). **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 9	First day of classes
January 16	Martin Luther King's Birthday
January 27	Last day to add
January 27	Last day to drop without a mark of "W" and receive a refund
February 20	President's Day
February 23	Midterm Exam
February 24	Last day to withdraw without a "W" on transcript or change pass/no pass to letter grade
March 12-19	Spring Recess
March 31	Last day to drop class with mark of "W"
April 28	Last day of classes
Tuesday, May 9 at 2-4 pm	**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)**
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	-