Course Name and Number: DATA 604 – Simulation and Modeling
Techniques **Credits:** *3 cr.*
Prerequisite(s): DATA 606 – Statistics and Probability for Data Analytics

Course Description:
This course teaches students the basics of simulation, systems modeling, and related software applications. The objective is to introduce students to the theory, statistical aspects, and implementation of computational methods for stochastic simulation and event-driven systems modeling. Students will be exposed to topics such as random sampling, Monte Carlo integration, variance reduction, Markov methods, queuing theory, discrete-event systems simulation, input/output data analysis, and simulation-based optimization. Students will develop a contextual understanding of simulation and modeling techniques by implementing the covered methods.

Course Learning Objectives:
At the end of this course, students will be able to:
- Create a simulation model for a complex system.
- Show the advantages and limitations of the simulation model.

Program Learning Outcomes/Competencies addressed by the course:
- Business Understanding. Apply frameworks and processes to build data-analytic solutions from an understanding of business goals.
- Data Programming. Use industry standard statistical tools and simulation packages.
- Foundational Math and Statistics. Emphasis on probability, statistics, and computational methods.
- Data Understanding. Collect, describe, model, explore and verify data.
- Prescriptive Modeling. Selecting prescriptive modeling techniques, generating test designs, building and assessing models.
- Model Implementation and Deployment. Students will learn to implement simulation models for the various prescriptive modeling techniques covered in the course.
- Presentation. Students will deliver presentations of their project results.

How is this course relevant for IS and data analytics professionals?
Simulation and modeling techniques are essential skills in today's data-driven business environment where there is inherent uncertainty embedded in real-world decision-making processes. The material covered in this course lies at the heart of prescriptive data analytics, which suggests decision options on how to take advantage of a future opportunity or mitigate a future risk, while showing the implication of each decision option.

How does this course work?
The course is conducted entirely online via Blackboard. Each week, the student will complete assigned readings from the required textbook(s) and/or supplemental handout(s), study lecture slides, watch lecture videos, complete quizzes and homework assignments, and participate in the discussion board. There is also a final group project and presentation. Students are expected to complete all deliverables by their assigned due dates.

Assignments and Grading:

Bi-Weekly Homework Assignments - There will be 7 bi-weekly homework assignments (8% each, or 80 points each) used to re-enforce course concepts and provide implementation experience. I will review the assignments and release the solutions within 48 hours after the deadline.	**56%**	**560 points**
Weekly Quizzes - There will be 14 weekly quizzes (1% each, or 10 points each) used to test major points from the lesson. There are 5 questions per quiz, and the quiz is timed for 2 hours (so please allow sufficient time to take each quiz without interruption). I will review the quizzes and release the solutions within 48 hours after the deadline.	**14%**	**140 points**
Weekly Discussion Forum Participation - There will be 10 weekly discussion forum assignments (1% each, or 10 points each) on Blackboard. Each assignment is two-fold: one forum is used to discuss a weekly analytics-related video while the other is for peer question and answer. Questions, tips, and posts helping others count as participation. Postings that are rude or otherwise inappropriate will not receive any credit.	**10%**	**100 points**
Final Group Project Report - Students will form a group of 2-3 students and conduct a final course project using simulation and modeling technique(s) covered in class to solve a real-world problem. A project report must be turned-in.	**15%**	**150 points**
Final Group Project Presentation - Student groups will present the final course project.	**5%**	**50 points**
TOTAL	**100%**	**1000 points**

Grading Scale: Your grade will be based on your final weighted average score and the letter grade will be assigned according to the following table.

Quality of Performance	Letter Grade	Range %	GPA/ Quality Pts.
Excellent - work is of exceptional quality	A	93 - 100	4
	A-	90 - 92.9	3.7
Good - work is above average	B+	87 - 89.9	3.3
Satisfactory	B	83 - 86.9	3
Below Average	B-	80 - 82.9	2.7
Poor	C+	77 - 79.9	2.3
	C	70 - 76.9	2
Failure	F	< 70	0

Discussion Board Etiquette: The purpose of the discussion board in general is to allow students to freely exchange ideas. It is imperative to remain respectful of all viewpoints and positions and, when necessary, agree to respectfully disagree. While active and frequent participation is encouraged, cluttering a discussion board with

inappropriate, irrelevant, or insignificant material will not earn additional points and may result in receiving less than full credit. Frequency is not unimportant, but content of the message is paramount. *Please remember to cite all sources (when relevant) in order to avoid plagiarism.*

Attendance: This course will not meet at a particular time each week, with the exception of the bi-weekly course meetups ("live" sync sessions). All course goals, session learning objectives, and assessments are supported through classroom elements that can be accessed at any time. To measure class participation (or attendance), your participation in threaded discussion boards is required, graded, and paramount to your success in this class. If you are unable to attend a scheduled synchronous meeting, you will need to make alternative arrangements with the instructor.

Late Policy: Unless otherwise noted, all work is due on the assigned day by 11:59 PM (Eastern Time). This includes homework assignments, projects, and participation in the discussions. *Late work is not accepted, unless pre-coordinated with the instructor.*

Required Textbooks:
- *Statistical Computing with R* (2008), by Maria L. Rizzo. ISBN 1-58488-545-9 **(SCR)**
- *Discrete-Event Systems Simulation, 5th Edition* (2010), by Jerry Banks, John S. Carlson, Barry L. Nelson, and David M. Nicol. ISBN 078-0-13-606212-7 **(DES)**
- *Simulation Modeling with SIMIO: A Workbook* (2012), by Jeffrey A. Joines and Stephen D. Roberts. ISBN 978-1-938207-76-1 **(SIM)**

Recommended Textbooks:
- *Simulation, 5th Edition* (2013), by Sheldon M. Ross. ISBN 978-0-12-415825-2

Relevant Software, Hardware, or Other Tools:
The primary software environment is the R statistical programming language, which can be downloaded for *free* from http://www.r-project.org. RStudio is the recommended interface for the R statistical programming language software, which can also be downloaded for *free* at http://www.rstudio.org. In addition, students are also allowed to implement solutions in alternative software, chosen from Python and/or Matlab.

The secondary software environment is Simio. The *free* training and evaluation version can be downloaded from http://www.simio.com/academics/student-resources.php. Also, for $25 you can obtain a personal copy of Simio that is the academic equivalent of the Simio Design Edition. I will help arrange this for those interested.

My Contact Information:

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Office hours are conducted by appointment via GoToMeeting, Skype or phone. You are encouraged to ask questions on the "Ask Your Instructor" forum on the course discussion board where other students will be able to benefit from your inquiries. For the most part, you can expect me to respond to questions by email within 24 to 48 hours. If you do not hear back from me within 48 hours of sending an email, please resend your message. I will be checking in on the course regularly, just about every day and likely several times each day. You can expect me to grade and return assignments within 10 days. Please do not hesitate to ask if you have questions or concerns.

Meetup Information:

Please join my meeting from your computer, tablet or smartphone. We will be using Blackboard Collaborate. The link is on the left-hand menu.

Course Outline:

Unit	Meetup	Topic	Reading	Activity
Week #1 08/25-9/4	8/31 8:00	Course Introduction; Introduction to Simulation	SCR – Ch. 1 DES – Ch. 1	- Week #1 Quiz Due - Discussion #1 Due - HW #1 Assigned
Week #2 9/5-9/11 (		Spreadsheet Simulation; General Principles	DES – Ch. 2-3	- Week #2 Quiz Due - Discussion #2 Due - HW #1 Due
Week #3 9/12-9/18	9/14 8:00	Review of Probability and Statistics	SCR – Ch. 2 DES – Ch. 5	- Week #3 Quiz Due - Discussion #3 Due - HW #2 Assigned
Week #4 9/19-9/25		Random Number Generation	DES – Ch. 7 Supplemental Handout	- Week #4 Quiz Due - Discussion #4 Due - HW #2 Due
Week #5 9/26-10/2	9/28 8:00	Random Variate Generation	SCR – Ch. 3 DES – Ch. 8 Supplemental Handout	- Week #5 Quiz Due - Discussion #5 Due - HW #3 Assigned
Week #6 10/3-10/9		Monte Carlo Integration	SCR – Ch. 5 (pp. 119-126) Supplemental Handouts	- Week #6 Quiz Due - Discussion #6 Due - HW #3 Due
Week #7 10/10-10/16		Variance Reduction Methods	SCR – Ch. 5 (pp. 126-152) Supplemental Handout	- Week #7 Quiz Due - Discussion #7 Due - HW #4 Assigned - Project Proposal Due
Week #8 10/17-10/23		Monte Carlo Methods in Inference; Bootstrap and Jackknife	SCR – Ch. 6-7	- Week #8 Quiz Due - Discussion #8 Due - HW #4 Due
Week #9 10/24-10/30	10/26 8:00	Markov Chains; Markov Chain Monte Carlo	SCR – Ch. 9 Supplemental Handouts	- Week #9 Quiz Due - Discussion #9 Due - HW #5 Assigned
Week #10 10/31-11/6		Queueing Models	DES – Ch. 6	- Week #10 Quiz Due - Discussion #10 Due - HW #5 Due

Unit	Meetup	Topic	Reading	Activity
Week #11 11/7-11/13	11/9 8:00	Simulation Software; Introduction to Simio	DES – Ch. 4 SIM – Ch. 1-2 Supplemental Handout	- Week #11 Quiz Due - HW #6 Assigned
Week #12 11/14-11/20		Simulation Input Analysis	DES – Ch. 9 SIM – Ch. 3	- Week #12 Quiz Due - HW #6 Due
Week #13 11/21-11/17		Simulation Model Verification and Validation	DES – Ch. 10 SIM – Ch. 4	- Week #13 Quiz Due - HW #7 Assigned
Week #14 11/28-12/4	11/29 8:00	Simulation Output Analysis	DES – Ch. 11 SIM – Ch. 5, 10	- Week #14 Quiz Due - HW #7 Due
Week #15 12/5-12/11		Comparing Systems; Simulation Optimization	DES – Ch. 12 SIM – Ch. 11, 16	- Project Presentations Due
Final Week 12/12+				- Project Report Due

ACCESSIBILITY AND ACCOMMODATIONS
The CUNY School of Professional Studies is firmly committed to making higher education accessible to students with disabilities by removing architectural barriers and providing programs and support services necessary for them to benefit from the instruction and resources of the University. Early planning is essential for many of the resources and accommodations provided. Please see: http://sps.cuny.edu/student_services/disabilityservices.html

ONLINE ETIQUETTE AND ANTI-HARASSMENT POLICY
The University strictly prohibits the use of University online resources or facilities, including Blackboard, for the purpose of harassment of any individual or for the posting of any material that is scandalous, libelous, offensive or otherwise against the University's policies. Please see:
http://media.sps.cuny.edu/filestore/8/4/9_d018dae29d76f89/849_3c7d075b32c268e.pdf

ACADEMIC INTEGRITY
Academic dishonesty is unacceptable and will not be tolerated. Cheating, forgery, plagiarism and collusion in dishonest acts undermine the educational mission of the City University of New York and the students' personal and intellectual growth. Please see:
http://media.sps.cuny.edu/filestore/8/3/9_dea303d5822ab91/839_1753cee9c9d90e9.pdf

STUDENT SUPPORT SERVICES
If you need any additional help, please visit Student Support Services:
http://sps.cuny.edu/student_resources/