OR 750 - 001
Simulation-Based Optimization
Fall 2014

Class time: 7:20pm-10:00pm, Thursday Room: Research Hall 202
Instructor: Prof. Jie Xu Email: jxu13@gmu.edu
Office: Engineering Building Room 2218 Phone: (703) 993-4620
Office Hours: Monday 2:30-4:30pm or by appointment

Course Description:
This course provides a comprehensive and in-depth treatment of simulation-based optimization, its applications in a variety of contexts, and its position in today's cloud/high-performance computing paradigm and big data environment. Simulation-based optimization is a widely applicable approach for decision making in highly nonlinear and uncertain environments. It searches a solution space and evaluates candidate solutions via computer simulations. Simulation models can be discrete-event, agent-based, or Monte Carlo. Working directly with simulation gives the decision maker flexibility but also poses new theoretical and computational challenges.

Lectures will first cover the mathematics required for simulation-based optimization. We will then discuss the following categories of simulation-based optimization algorithms: stochastic gradient based, sample average approximation/sample path based, metamodel based, and direct stochastic search. Decision variables can be continuous, integer-valued, or binary. Problems with both stochastic constraints and multiple objectives will also be discussed. We will also touch on emerging topics such as multi-fidelity simulation-based optimization and simulation-based optimization in parallel/cloud computing environments.

This course will also review the applications of simulation-based optimization in various areas. Examples include military operations & planning, health care, aviation, complex system/project management, financial portfolio optimization, manufacturing, and logistics/supply chain.

Because this is a doctoral-level class, in addition to regular lectures, this course will include extensive literature review and a term-project. The term-project will give the student the opportunity to carry out a small-scale project on the application and/or theory of simulation-based optimization, which may lead to a peer-reviewed journal publication and part of the student's thesis. The amount of overlap with OR735 is minimum as this course focuses on optimization algorithms instead of efficient use of simulation budget. Students who have taken OR635/735 may use this course as an opportunity to deepen their work on the term projects for these courses.

Students are expected to check BlackBoard daily to read course announcements.

Prerequisites:
OR541 and OR635, or equivalent courses with instructor permission.

Grading (all dates are tentative and subject to change):
Homework 15%; Literature review presentation 20%; Term paper proposal 5%; Term paper presentation 10%, Term Paper 45%; Class Participation 5%.

There will be three homework assignments (due 10/02, 11/06, 12/04), each with 5 points. There will be both theoretical exercises and programming exercises. For programming exercises, students can choose to code in C/C++, Java, Matlab, or R. Late homework submissions are allowed. However, the penalty for late homework and term project is 30% for the first day and then 5% per day. **No exemption.** Homework problems should be worked out independently but discussions are allowed.

Each student will choose a focus area and work with the instructor to identify 5-10 papers to read. On 10/30, we will have a literature review presentation.

Students will be asked to individually write a term paper. The topic should focus on the theory and algorithmic research side of simulation-based optimization. Application-based term papers will only be approved if it is supported by real data sets and has significant potential for important real-world applications. The instructor will provide a short list of potential term paper topics. Students are also highly encouraged to identify topics of their own interests.

The term paper proposal will be due on 10/02. It should be within two pages and briefly describes the problem to be studied, background/literature, the planned approach, and expected outcomes. Term paper presentations will be on 12/04. Term papers will be due on 12/12. Term papers should be between 8-12 pages and live up to the standard of a winter simulation conference proceedings paper (http://wintersim.org/). Ideally, it should build the foundation for a journal quality research paper.

Textbooks
There is no required textbook. This class will be based on research papers.