Course Change Request

New Course Proposal

Date Submitted: 03/13/24 2:41 pm

Viewing: CSI 745 : Robust Optimization for Decision Making

Last edit: 03/13/24 2:41 pm

Changes proposed by: blaisten

Programs referencing this course

SC-PHD-CSI: Computational Sciences and Informatics, PhD

In Workflow

1. **CDS Chair**
2. **SC Curriculum Committee**
3. SC Assistant Dean
4. Assoc Provost-Graduate
5. Registrar-Courses
6. Banner

Approval Path

1. 03/13/24 3:39 pm Jason Kinser (jkinser): Approved for CDS Chair

Are you completing this form on someone else's behalf?

Yes

Requestor:

Name	Extension	Email
Estela Blaisten	31988	blaisten@gmu.edu

Effective Term: Fall 2024

Subject Code: CSI - Computational Science & Informatics **Course Number:** 745

Bundled Courses:

Is this course replacing another course? No

Equivalent Courses:

Catalog Title: Robust Optimization for Decision Making

Banner Title: Robust Optimization

Will section titles vary by semester? No

Credits: 3

Schedule Type: Lecture

Hours of Lecture or Seminar per week: 3

Repeatable: May only be taken once for credit (NR)
GRADUATE ONLY

Default Grade Mode: Graduate Regular

Recommended Prerequisite(s):
CSI 690 or equivalent or permission from the instructor

Recommended Corequisite(s):

Required Prerequisite(s) / Corequisite(s) (Updates only):

Registrar's Office Use Only - Required Prerequisite(s)/Corequisite(s):

And/Or	(	Course/Test Code	Min Grade/Score	Academic Level	)	Concurrency?

Registration Restrictions (Updates only):

Registrar's Office Use Only - Registration Restrictions:

Field(s) of Study:

Class(es):

Level(s):

Degree(s):

School(s):

Catalog Description:
This course aims to cover modern robust optimization tools for data-driven decision-making under uncertainty. The course includes theory, applications, and computations. Application domains include analysis and optimization of stochastic networks, transportation, machine learning, finance, and energy. The course utilizes Python and IBM ILOG CPLEX Optimizer for computations.

Justification:

What: The course aims to empower students with data-driven decision-making skills, ensuring they are well-prepared for the challenges and opportunities presented by the dynamic field of data analytics.

Why: Most decision-making tasks involve uncertainty that is directly impacted by the limitation and/or imperfection of the data at hand. Classical decision models rely on strong data/distributional assumptions about uncertain events. This course focuses on robust optimization (RO), a more recent approach to optimization for tackling uncertainty and data limitations. This new approach enjoys enhanced computational tractability and strong modeling capacity.

Does this course cover material which crosses into another department? No

Learning Outcomes:

Upon completion of the course, students will have acquired a comprehensive skill set essential for tackling real-world data-driven decision-making problems. Students will learn different ways of modeling data uncertainty and will develop fundamental skills of robust optimization and data-driven decision-making under uncertainty. Students will be able of analyzing a variety of scenarios requiring optimization approaches that are immune to data uncertainty and produce robust solutions. Aditionally, students will become proficient in computationally tractable solutions/algorithms and practice implementations of these methods using IBM ILOG CPLEX Optimizer. Altogether, students will be exposed to the effects of uncertainty on application problems and become proficient in modeling uncertain phenomena utilizing robust optimization for solving challenges in these domains.

Will this course be scheduled as a cross-level cross listed section? No

Attach Syllabus

CSI745-Syllabus_March7-2024.pdf

Additional Attachments

Staffing:

Instructor: Dr. Hoda Bidkhori, Assistant Professor, Department of Computational and Data Sciences

Relationship to Existing Programs:

None

Relationship to Existing Courses:

None

Additional Comments:

The course will be added to the catalog in the Areas of Emphasis Courses of the Computational Sciences and Informatics, PhD program (banner code SC-PHD-CSI).

Reviewer Comments

Key: 18614

CSI 745: Robust Optimization for Decision Making

Department: Computational and Data Sciences
Instructor: Dr. Hoda Bidkhori, Assistant Professor (hbidkhor@gmu.edu)
Time, Location, Website, Office hours: TBD

Required Prerequisite: Working knowledge of Python
Suggested Prerequisites: CSI 690 or permission from the instructor

Course Description

This course aims to cover modern tools for data-driven decision-making under uncertainty. Most decision-making tasks involve uncertainty directly impacted by the limitation of the data. This course covers modern, robust optimization, including theory, applications, and computations. It offers formulations and their connection to probability, information, and risk theory for conic optimization (linear, second-order, and semidefinite cones) as well as integer optimization. It also covers the recent developments in data-driven distributionally robust optimization. Application domains include analysis and optimization of stochastic networks, optimal mechanism design, transportation, machine learning, finance, and energy. In this course, the students will learn to perform computations with IBM ILOG CPLEX Optimizer

Course Learning Outcomes:

By the end of the course, students will

- have acquired proficiency on modeling uncertainty sets utilizing the available data and information.
- have competence for preforming analyses based on robust optimization and data-driven decision-making under uncertainty.
- have the knowledge of how to apply these techniques and perform the related computations on various application domains.

Textbooks and Other Instructional Material

- *Robust and Adaptive Optimization*. Dimitris Bertsimas, Dick den Hertog. *Dynamic Ideas LLC*, 2022.
- Several research papers will be introduced in the class.
- The lecture slides and relevant notes will be provided via the course website.

Grades

Attendance is mandatory. If the student is sick or cannot participate in a class for major issues, they need to contact the instructor. Homework and written midterm exam are individual work that will be graded on a 0-100 scale. An individual project is weighted 50% of the grade and will include a proposal, a written report in the style of a science journal publication, and a presentation. The final grade will be totaled as a weighted average according to the following weights, final marks and grades.

Average Homework Score	**30%**
Midterm Exam Score	**20%**
Final Project Score	**50%**

Final mark	Final grade
97.0 or more	A+
94.0 – 96.99..	A
90.0 – 93.99..	A-
87.0 – 89.99..	B+
84.0 – 86.99..	B
80.0 – 83.99..	B-
70.0 – 79.99..	C
Less than 70	F

Course outline (Tentative)

Week		Topic	
1		**Introduction** ● Welcome and Course Overview ● Background for Optimization	
2		**Probability Theory and Its Limitations** **Uncertainty Sets**	
3		**Robust Linear Optimization**	
4		**Robust Integer Optimization**	Assignment 1
5		**Robust Convex Optimization**	
6		**Adaptive Multistage Optimization**	Final project proposal due
7		**Affine/Robust Policies in Adaptive Optimization**	
8		**Robust Optimization without Objective Function**	Take-home Midterm
9		**Robust Optimization in Supply Chain and Energy**	
10		**Robust Optimization and Risk Preferences**	Assignment 2
11		**Robust Optimization in Portfolios and Options Pricing**	
12		**Robust Optimization in Machine learning and Statistics**	Assignment 3
13		**Data-Driven Distributionally Robust Optimization**	
14		**Project Presentation**	

General University Policies

The course abides to the Mason policies. The information faculty should add to the public syllabus is at: *https://stearnscenter.gmu.edu/knowledge-center/designing-your-syllabus* .
A set of policies follow as attachment to his document:

Mason Honor Code (quote from catalog.gmu.edu): "To promote a stronger sense of mutual responsibility, respect, trust, and fairness among all members of the George Mason University community and with the desire for greater academic and personal achievement, we, the student members of the university community, have set forth this honor code: Student members of the George Mason University community pledge not to cheat, plagiarize, steal, or lie in matters related to academic work."

Email policy: Mason's electronic mail provides any official information to students. Any class materials, assignments, questions, and instructor feedback should use the email Mason email. Students are responsible for maintaining their email account active, working correctly, and should check their content regularly (review details in catalog.gmu.edu).

Plagiarism policy for Internet materials: Copyright rules apply to users of the Internet who employ elements downloaded from Internet sources. Any information in the form of graphics, text, tables, or data accessed electronically and used in homework, presentations, exams, email, reports, must be cited giving credit to the pertaining sources. Even if credit is given, students must obtain permission from any copyrighted source to use any material not created by them. Inserting someone's else material in your work is stealing intellectual property. Including a link to the site URL is currently an appropriate citation.

Student privacy policy: Mason complies with FERPA by protecting the privacy of student records and judiciously evaluating requests for release of information from those records. It is not permitted for faculty to share class progress or grade information with parents/guardians under any circumstances. Student privacy policy: https://registrar.gmu.edu/students/privacy/

Academic integrity: This course embodies the value that we all have differing perspectives and ideas, and we each deserve the opportunity to share our thoughts. Therefore, we will conduct our discussions with respect for those differences. That means, we each have the freedom to express our ideas, but we should also do so keeping in mind that our colleagues deserve to hear differing thoughts in a respectful manner, i.e. we may disagree without being disagreeable. https://oai.gmu.edu/

Students with disabilities: Students with disabilities should contact the Office of Disability Services (ODS). Students requiring special accommodations should inform the instructor the first week of classes. Accommodations may be appropriate for situations that directly affect the student academic performance. ODS requires pertinent medical documentation of a physical, mental health, attention, or other health challenge. https://ds.gmu.edu/.