OREM 8384: Fall 2024

Stochastic Programming

Tuesdays and Thursdays: 2:00-3:20 pm   Caruth Hall 0161

Instructor(s)	:	Prof. Harsha Gangammanavar
email	:	harsha@smu.edu
Office hours	:	Caruth Hall 331
		By appointment only

Description: *Stochastic programming (SP) is a systematic framework for modeling optimization problems involving uncertain data and finding optimal decisions. With its roots in mathematical programming, SP draws upon tools and methods developed in many disciplines, including mathematics, computer science, and statistics. Over the years, SP has gained significant attention as the work-horse for problems arising in various application areas, such as finance, infrastructure systems, healthcare systems, industrial engineering, agriculture, and telecommunication networks. This course will provide an overview of the different modeling approaches and solution methods cutting across the different themes of SP (two- and multistage risk-neutral, risk-averse, chance-constrained, and distributionally robust optimization). The course project will involve a study of recent developments in the field and computer implementation of solution methods in SP.*
Pre-requisites: *OREM 8370: Stochastic Models (or equivalent) and OREM 8371: Linear Programming (or equivalent).*

Course Material:

1. References:

    (a) Alexander Shapiro, Darinka Dentcheva and Andrzej Ruszczyński, *Lectures on Stochastic Programming: Modeling and Theory*, MOS-SIAM Series on Optimization, third edition, 2021, ISBN: 978-1-611973-42-6. (Available online for registered SMU students.)

    (b) Stein W. Wallace and William T. Ziemba, *Applications of Stochastic Programming*, MOS-SIAM Series on Optimization, 2005, ISBN: 978-0-89871-555-2. (Available online for registered SMU students.)

    (c) John R. Birge and François Louveaux, *Introduction to Stochastic Programming*, Springer New York, tenth edition, 2011, ISBN: 978-1-4614-0236-7 (Online: 978-1-4614-0237-4). (Available online for registered SMU students.)

    (d) A. Ruszczynski, and A. Shapiro, *Stochastic Programming*, Volume 10, 1st Edition, Handbooks in Operations Research and Management Science, 2003, ISBN: 9780444508546 (Available online for registered SMU students.).

2. Additional notes will be posted on Canvas.

Course Requirement and Grading:

- **Assignments:** There will be seven problem sets which will be spread evenly throughout the duration of the semester. Each of these assignments will wither be a (a) textbook-type problem set, and/or (b) presentation of archived journal articles. You may consult/collaborate with one other student on these problem sets, however, you are completely responsible for your final submission. If you have collaborated on your assignment, then you are required to declare the name of your collaborator, and the nature of collaboration during submission. Students **must submit all the assignments**.

- **Examination:** There will be a single take home examination at the end of semester. The class notes and the recommended books can be used as reference to complete the examination. This will be an individual examination, and collaborations with anyone (classmates or otherwise) is strictly prohibited.

  Scheduling conflicts: Legitimate conflicts that prevent you from taking your exam on scheduled dates and special requests should be notified within the first two weeks of the course. Any requests after that time will be handled on case-by-case basis.

- **Project**: The course involves a semester-long project component. There are two paths to choose for the course project. Students are encouraged to work on an implementation-based project requiring computer programming skills in C, C++, Java, Julia, or Python - this is the first path. The students will write a report on the models and techniques adopted in completing their project and the computational results obtained. Interested students can adopt a more research-oriented project, for which I am willing to work with you. Research-oriented projects that meet my publication standards may lead to journal article submissions. The second path involves reading research articles (two or three) on recent developments in SP. These papers must be chosen from a list that I will compile and share and must not overlap with other students (in case of conflict, we will adopt randomized assignment). You must indicate your path within the first two weeks of classes.

- **Grade distribution:**

  1. Problem sets/assignments: 40%
  2. Project: 30%
  3. Final Exam: 30%

Tentative Syllabus:

Part I: Stochastic programming models   (4 weeks)

  (a) Two-stage stochastic programs with fixed recourse
  (b) Probabilistic/chance constrained programs
  (c) Stochastic integer programs
  (d) Multistage stochastic programs
  (e) Risk-averse and distributionally robust formulations

  Assessment: Two problem sets and a presentation on application

Part II: Optimality, duality and bounds in stochastic programs   (2 weeks)

  (a) Expected value of perfect information
  (b) Value of stochastic information
  (c) Jensen's inequality; Edmunson-Madansky inequality
  (d) Optimality conditions (basic and multistage)
  (e) Duality (basic and multistage).

  Assessment: One problem set

Part III: Computational solution methods   (4 weeks)

  (a) L-shaped method (single and multicut)
  (b) Regularized decomposition

    (c) Trust-region methods

    (d) Nested methods for multistage stochastic programs

    (e) Progressive hedging.

Assessment: Two problem sets

Part IV: Monte-Carlo sampling methods   (2 weeks)

    (a) Sample average approximation

    (b) Stochastic decomposition

    (c) Variance reduction

    (d) Statistical optimality.

Assessment: One problem set

Part V: Stochastic Integer Programming   (2 weeks)

    (a) Set Convexification

    (b) Value Function Convexification.

Assessment: One problem set

University policies:

- **Disability Accommodations:** Students who need academic accommodations for a disability must first register with Disability Accommodations & Success Strategies (DASS). Students can call 214-768-1470 or visit smu.edu/DASS to begin the process. Once they are registered and approved, students then submit a DASS Accommodation Letter through the electronic portal, DASS Link, and then communicate directly with each of their instructors to make appropriate arrangements. Please note that accommodations are not retroactive, but rather require advance notice in order to implement.

- **Sexual Harassment:** All forms of sexual harassment, including sexual assault, dating violence, domestic violence and stalking, are violations of SMU's Title IX Sexual Harassment Policy and may also violate Texas law. Students who wish to file a complaint or to receive more information about the grievance process may contact Samantha Thomas, SMU's Title IX Coordinator, at accessequity@smu.edu or 214-768-3601. Please note that faculty and staff are mandatory reporters. If students notify faculty or staff of sexual harassment, they must report it to the Title IX Coordinator. For more information about sexual harassment, including resources available to assist students, please visit smu.edu/sexualharassment.

- **Pregnant and Parenting Students:** Under Title IX, students who are pregnant or parenting may request academic adjustments by contacting the Office of Student Advocacy and Support by calling 214-768-4564. Students seeking assistance must schedule an appointment with their professors as early as possible, present a letter from the Office of the Dean of Students, and make appropriate arrangements. Please note that academic adjustments are not retroactive and, when feasible, require advance notice to implement.

- **Religious Observance:** Religiously observant students wishing to be absent on holidays that require missing class should notify their professors in writing within the first two weeks of the semester and should discuss with them, in advance, acceptable ways of making up any work missed because of the absence. Click here for a list of holidays.

- **Medical-Related Absences:** To ensure academic continuity and avoid any course penalties, students should follow procedures described by the instructors in order to be provided with appropriate modifications to assignments, deadlines, and exams.

- **Excused Absences for University Extracurricular Activities:** Students participating in an officially sanctioned, scheduled university extracurricular activity should be given the opportunity to make up class assignments or other graded assignments that were missed as a result of their participation. It is the responsibility of the student to make arrangements for make-up work with the instructor prior to any missed scheduled examinations or other missed assignments. (See current Catalog under heading of "Academic Records/Excused Absences.")

- **Academic Dishonesty:** Students are expected to embrace and uphold the SMU Honor Code. Violations of the Honor Code will be acted upon in accordance with the policies and procedures outlined in the Mustang Student Handbook.

- **Generative AI Guidance:** The use of generative AI to complete the course assignment is not allowed. The student must complete all course requirements in their own words, all references should be appropriately cited, and source code versions must be time stamped. Any violation of these rules will be treated at the undergraduate level within the SMU Student Honor Code and at the graduate and professional level within the honor codes found in their respective school policies. If there is sufficient cause for concern, the Office of Student Conduct and Community Standards will submit an incident report for review.

- **Student Academic Success Programs:** Students needing assistance with writing assignments for SMU courses may schedule an appointment with the Writing Center through Canvas. Students who would like support for subject-specific tutoring or success strategies should contact SASP, Loyd All Sports Center, Suite 202; 214-768-3648; smu.edu/sasp. Tutor schedules are available at smu.edu/tutorschedule.

- **Caring Community Connections Program:** CCC is a resource for anyone in the SMU community to refer students of concern to the Office of the Dean of Students. The online referral form can be found at smu.edu/deanofstudentsccc. After a referral form is submitted, students will be contacted to discuss the concern, strategize options, and be connected to appropriate resources. Anyone who is unclear about what steps to take if they have concerns about students should contact the Office of the Dean of Students at 214-768-4564.

- **Mental Health Resources:Counseling Services & Teletherapy:** Throughout the academic year, students may encounter different stressors or go through life experiences which impact their mental health and academic performance. Students who are in distress or have concerns about their mental health can schedule a same-day or next-day appointment to speak with a counselor by calling Counseling Services. Counselors are available at any time, day or night for students in crisis at this number: 214-768-2277 (then select option 2) They will be connected with a counselor immediately. Students seeking ongoing counseling should call the same number (214-768-2277, then select option 1) during normal business hours to schedule an initial appointment. SMU Teletherapy provides another free option for on-demand counseling and video appointments with a medical professional.

- **"Campus Carry" law:** In accordance with Texas Senate Bill 11, also known as the 'campus carry' law, and following consultation with entire University community, SMU chooses to remain a weapons-free campus. Specifically, SMU prohibits possession of weapons (either openly or in a concealed manner) on campus. For more information, please see smu.edu/campuscarrylaw.