

Linear Programming and Network Optimization

ESI6417 – Section 8076

Class Periods: Tuesdays and Thursdays, 9:35 AM - 11:30 AM

Academic Term: Spring 2020

Location: CBD 0224

Instructor

Hongcheng Liu

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352-294-7728

<http://www.ise.ufl.edu/liu/>

Office hours: Tentatively, Wednesdays 2:30–4:00 pm or by appointment.

Office location: Weil 478

Teaching Assistants

No teaching assistant.

Course Description

Credit number: 3

Main Contents: Classical models, algorithms and results in Linear Programming and Network Optimization, including

- Formulation and solution techniques for network flow and linear programming problems.
- Algorithms for network optimization and basic complexity analyses.
- The simplex method, theory, and computation. Duality theory, sensitivity analysis.

Prerequisites/Co-Requisites

- Matrix theory
- An ability to prove basic mathematical statements
- An ability to write simple codes. Matlab is required. Python 3 is preferred.

Course Objectives

At the end of the class, students are anticipated to be able to (1) determine when and how problems can be formulated as linear programming or network optimization problems, (2) know classical results characterizing solutions to linear programming and network optimization problems, (3) understand basic algorithms for linear programming, (4) solve linear programming numerically and implement the simplex method, (5) undertake basic convergence and complexity analyses for linear optimization algorithms, (6) understand duality and conduct sensitivity analysis in linear

programming, and (7) formulate mathematical statements concerning linear optimization precisely and to prove them rigorously.

Materials and Supply Fees

Not applicable.

Textbooks and Software

Required textbook: Introduction to Linear Optimization, *Bertsimas and Tsitsiklis, Athena Scientific*, 1997 (ISBN#: 978-1-886529-19-9).

Recommended textbook: Linear and Nonlinear Programming, *David Luenberger, Yinyu Ye*, 2016 ISBN#: 978-3319188416

Materials and Supply Fees

Not applicable.

Course Schedule

Weeks 1. Chapter 1: Linear programming, history, basics, & terminology; the first model and its graphical representation

Weeks 2-3. Chapter 2: Linear programming models and implementation with CVX and GAMS

Weeks 4-5. Chapter 3: The geometry of linear programming

Weeks 6-8. Chapter 4: The simplex method

Weeks 9-10. Chapter 5: Variations of the simplex method

Weeks 11-12. Chapter 6: Duality and sensitivity analysis

Weeks 13-15. Chapter 7: Network flow models

Optional. Chapter 8: Complexity analysis, interior point and ellipsoid methods (optional, if time allows)

This list of topics and the associated schedule are tentative. Some topics may be added or dropped depending on the interest of students and the pace of the class. I encourage you to communicate with me about other topics of your interest. I will do the best I can to accommodate relevant requests.

Attendance Policy, Class Expectations, and Make-Up Policy

Attendance is required. Excused absences are allowed but must be requested promptly. Repeated unexcused absences may result in a penalty of up to 10% of the class grade. One make-up exam can be arranged for students who are unable to attend the midterm or the final exam because of a valid reason (UF-imposed curriculum requirement, exam conflicts, participation in a university required activity, religious holiday, physical illness or injury that prevents your attendance or significantly impairs your performance, life and death circumstances, physical impairment, or a family/medical emergency, or jury duty). However, the student must provide advanced notice of the situation to the instructor. Absence for an exam without advanced notice to the instructor (and without a valid reason for which such notice could not be given) will result in an F for the exam and will not be given a make-up exam. Maximally one make-up exam is allowed for each of the midterm and final exams.

Evaluation of Grades

Class grades will be based on: take-home project (15%), midterm (35%), in-class presentation(s) (10%), and final exam (40%). 30% of the grading on the project will be based on peer evaluation within the project team.

- A take home project will be assigned. The project will require GAMS modeling programming and MATLAB/Python implementations. This project will be done in group of two to four students. Groups will be assigned by the instructor.
- Students are required to take an in-class midterm exam. The exam will be closed-book but each student is allowed to bring in one sheet of 8.5×11.0 inches paper of handwritten notes. The exact date of the midterm will be communicated later.
- Students are required to take a final exam. The exam will be closed-book but each student is allowed to bring in one sheet of 8.5×11.0 inches paper of handwritten notes. The final exam is cumulative and will cover materials in both the lectures and the practice problems.

In-class presentation:

- “Flipped” classroom sessions will be held. For each of the sessions, the instructor will select one practice problem for one student group (assigned by the instructor) to explain to the class. One student (assigned by the instructor) from the group will make a short presentation and address questions, if any, from both the instructor and students.

Extra credit:

- A second type of “Flipped” classroom sessions will be held. For each of the sessions, the instructor will select one mathematical proof for one student group (assigned by the instructor) to explain to the class. One student (assigned by the instructor) from the group will make a short presentation and address questions, if any, from both the instructor and students. Maximally, two additional points to the final grades can be earned for completing one session. Each student can only be offered two additional points maximally as extra credit from participating in the those sessions. The list of the proofs will be provided by the instructor one week before each session. The following are the criteria for the extra credit.
 - 0.5 points:** The selected student from the group understand 80% or more of the assigned proof. The group is able to complete the whole explanation with efforts made to satisfy the time limit and to answer all the questions raised by the instructor.
 - 1 point:** The selected student from the group can fully understand the proof, but some part of the explanation is unclear or the presentation does not satisfy the time limit, despite that efforts are made to meet the time requirement. The students can answer correctly most of the questions raised by the instructor.
 - 1.5 points:** The selected student from the group can explain the assigned mathematical proof successfully within the given time limit. The students refer to notes/references for less than three times. The students can answer correctly all the questions raised by the instructor.
 - 2 points:** The selected student from the group can successfully explain the assigned mathematical proof within the given time limit. No notes/references are used. The students can answer all the questions raised by the instructor.
- Students using Python 3 instead of Matlab for the project will be rewarded by **0.5 points** added to the final grade.

Grading Policy

The grading scale for the class is: A (90-100), A- (80-90), B+ (70-80), B (60-70), B- (50-60), C+ (40-50), C (30-40), C- (20-30), D+ (10-20), F [0-10]. Curving might occur in any assignment/exam if the average result is too low. More information on UF grading policy may be found at: <http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#grades>.

In order to graduate, graduate students must have an overall GPA and an upper-division GPA of 3.0 or better (B or better). Note: a B- average is equivalent to a GPA of 2.67, and therefore, it does not satisfy this graduation requirement. For more information on grades and grading policies, please visit: <http://gradschool.ufl.edu/catalog/current-catalog/catalog-general-regulations.html#grades>.

Students Requiring Accommodations

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting <https://disability.ufl.edu/students/get-started/>. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation

Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at <https://gatorevals.aa.ufl.edu/>. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at <https://gatorevals.aa.ufl.edu/>

University Honesty Policy

UF students are bound by The Honor Pledge which states, We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: On my honor, I have neither given nor received unauthorized aid in doing this assignment. The Honor Code (<http://sccr.dso.ufl.edu/students/student-conduct-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see the following link:

<http://registrar.ufl.edu/catalog0910/policies/regulationferpa.html>.

Campus Resources

- *Health and Wellness*

U Matter, We Care: If you or a friend is in distress, please contact umatter@ufl.edu or 352-392-1575 so that a team member can reach out to the student.

Counseling and Wellness Center: <http://www.counseling.ufl.edu/cwc>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Assault Recovery Services (SARS): Student Health Care Center, 392-1161.

University Police Department: 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

- *Academic Resources*

E-learning technical support: 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. <http://lss.at.ufl.edu/help.shtml>.

Career Resource Center: Reitz Union, 392-1601.

Career assistance and counseling. <http://www.crc.ufl.edu/>.

Library Support: <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center: Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. <http://teachingcenter.ufl.edu/>.

Writing Studio: 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers. <http://writing.ufl.edu/writing-studio/>.

Student Complaints Campus: http://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf.

On-Line Students Complaints: <http://www.distance.ufl.edu/student-complaint-process>.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination.

It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Robin Bielling, Director of Human Resources, 352-392-0903, rbielling@eng.ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@ufl.edu

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the Office of Title IX Compliance, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu