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Spring 2025 IEE/CSE/DSE 506: Computing for Data-Driven Optimization

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Lectures: M W 1:30 PM – 2:45 PM, COORL1-74

Office Hours: TBA

Course Description: This course will be practical with theoretical details, in which students will learn a variety of optimization problem classes and get hands-on experience on how to model and solve them using computing resources. Optimization, equipped with ever-growing computing powers and volumes of data, finds many real-world applications and creates various research topics both in industry and academia. This course will discuss selectively a number of optimization problem classes and algorithms, their implementations, and their applications. This course will also cover basic usage of a high-level language (e.g., Julia) and how to leverage them in solving data-driven optimization problems.

Recommended Preparation: Students are expected to have a good background in linear algebra, calculus, and basic analysis. The course content will be presented in an abstract fashion. Moreover, students should be familiar with a programming language (C++, Matlab, Java, Python) or should have the motivation to learn.

Course Web Page: The Canvas site for this course will serve as a major course web page where students can find course materials, announcements, and assignments. Students are expected to check this web page frequently and stay up-to-date with course announcements and assignments.

Required Course Software:

- The course will use Julia and Jupyter notebooks to implement and/or visualize concepts learned in the classroom. A detailed installation guide will be posted on Canvas in the first week of the semester.
- Some homework assignments may task students with encoding concepts and algorithms covered in class. Julia is the recommended programming language for the course.

Course Learning Outcomes: At the end of the course, students will be able to

- Comprehend key ideas, analytics, and computational aspects of various optimization classes;
- Design, analyze, and implement algorithms for solving optimization problems.

Additional reading:

- Nonlinear Programming, 2nd Edition. 2004. D. P. Bertsekas. Athena Scientific.
- Numerical optimization. 2nd edition. J. Nocedal and S. Wright. Springer Science & Business Media.

- A First Course in Linear Optimization. J. Lee. https://github.com/jon77lee/JLee_LinearOptimizationBook/blob/master/JLee.4.0.pdf.
- Convex Optimization. S. Boyd and L. Vandenberghe. 2004. Cambridge University Press. https://web.stanford.edu/~boyd/cvxbook/bv_cvxbook.pdf.
- Integer programming. L. Wolsey. John Wiley & Sons.

Topics to be covered. The course will introduce students to key ideas/concepts of a variety of optimization problems and algorithms, discuss their various applications, and learn how to implement them. The tentative schedule is as follows:

- Syllabus and intro to optimization
- Continuous optimization
    1. Problem classes: unconstrained and constrained optimization, convex and linear optimization
    2. Algorithms: gradient-based methods, simplex methods, interior-point methods, ADMM
- Discrete optimization
    1. Problem classes: mixed-integer linear optimization
    2. Algorithms: branch-and-cut, Benders decomposition, column generation

The specific number of classes for each topic will depend on the pace of the course.

Grading and Timeline: Grades will be weighted as follows:

Homework Assignments 30%; Midterm 30% (March 5; tentative); Take-Home Final 40%. Final grades for the course will be decided according to the following scale:

A+: [100, ∞) A: [95, 100) A–: [90, 95)
B+: [85, 90) B: [80, 85) B–: [75, 80)
C+: [70, 75) C: [65, 70)
D: [55, 65) E: [0.0, 55)

Exam Rules:

- There will be no make up exams. In the event of a university-approved absence on an exam day, the final exam grade will be used as a substitute for the missed exam. Notify the instructor ahead of time, whenever possible.
- The final will be in a take-home mode, in which students will be asked to encode algorithms. The final exam is planned to be available from May 1 at 8 am until May 6 at 7:59 am; each student will choose the day they wish to complete the exam within this period.

Syllabus Changes: Any information in this syllabus may be subject to change with reasonable advance notice.

Course Policies:

- **Class Attendance and Participation**: Attendance and participation in class activities is an essential part of the learning process, and students are expected to attend class. Some absences are, however, unavoidable. Excused absences for classes will be given without penalty to the grade in the case of (1) a university-sanctioned event [ACD 304-02]; (2) religious holidays [ACD 304-04; a list can be found here https://eoss.asu.edu/cora/holidays]; (3) work performed in the line-of-duty according [SSM 201-18]; and (4) illness, quarantine or self-isolation related to illness as documented by a health professional.

  Anticipated absences for university-sanctioned events, religious holidays, or line-of-duty activity should be communicated to the instructor by email at least 7 days before the expected absence.

  Absences for illness, quarantine or self-isolation related to illness should be documented by a health professional and communicated to the instructor as soon as possible by email.

  Excused absences do not relieve students from responsibility for any part of the course work required during the period of absence. Faculty will provide accommodations that may include participation in classes remotely.

  If there is a disagreement as to whether an absence should be accommodated, the instructor and student should contact the academic unit chair immediately for resolution.

- **Academic Integrity**: Students in this class must adhere to ASU's academic integrity policy, which can be found at https://provost.asu.edu/academic-integrity/policy. Students are responsible for reviewing this policy and understanding each of the areas in which academic dishonesty can occur. In addition, all engineering students are expected to adhere to both the ASU Academic Integrity Honor Code and the Fulton Schools of Engineering Honor Code. All academic integrity violations will be reported to the Fulton Schools of Engineering Academic Integrity Office (AIO). The AIO maintains record of all violations and has access to academic integrity violations committed in all other ASU college/schools. "Each student must act with honesty and integrity, and must respect the rights of others in carrying out all academic assignments." Failure to meet these standards may result in recommended sanctions such as reduction in assignment grade, reduction in course grade, suspension or expulsion from the university, or other sanctions consistent with the university policy and the Student Code of Conduct. This course

will follow the ethical standards of ASU at large. Plagiarism, cheating, and dishonesty will not be tolerated.

- **Grade Corrections**: A student may submit a written request for a homework or exam grade to be reviewed within one week after the grade is posted in Canvas. Note that Obligation 14 in the Student Academic Integrity Policy reads "Attempts to influence or change any Academic Evaluation, assignment or academic record for reasons having no relevance to academic achievement." In other words, asking an instructor to change your grade because you need a higher grade to keep a scholarship, maintain athletic eligibility, get off academic probation, or for any reason not relevant to your academic achievement in this class is a violation of the Academic Integrity Policy.

- **Harassment and Sexual Discrimination**: Arizona State University is committed to providing an environment free of discrimination, harassment, or retaliation for the entire university community, including all students, faculty members, staff employees, and guests. ASU expressly prohibits discrimination, harassment, and retaliation by employees, students, contractors, or agents of the university based on any protected status: race, color, religion, sex, national origin, age, disability, veteran status, sexual orientation, gender identity, and genetic information. Title IX is a federal law that provides that no person be excluded on the basis of sex from participation in, be denied benefits of, or be subjected to discrimination under any education program or activity. Both Title IX and university policy make clear that sexual violence and harassment based on sex is prohibited. An individual who believes they have been subjected to sexual violence or harassed on the basis of sex can seek support, including counseling and academic support, from the university. If you or someone you know has been harassed on the basis of sex or sexually assaulted, you can find information and resources at https://sexualviolenceprevention.asu.edu/faqs.

- **Mandated sexual harassment reporter:** As a mandated reporter, I am obligated to report any information I become aware of regarding alleged acts of sexual discrimination, including sexual violence and dating violence. ASU Counseling Services, https://eoss.asu.edu/counseling is available if you wish to discuss any concerns confidentially and privately. ASU online students may access 360 Life Services, https://goto.asuonline.asu.edu/success/online-resources.html.

- **Counseling Services:** ASU provides confidential and private counseling services for students experiencing emotional concerns, problems in adjusting, and other factors that affect their ability to achieve their academic and personal goals. You can find information and resources at https://eoss.asu.edu/counseling.

- **SCAI Advising Services**: Information about academic advising is available at https://scai.engineering.asu.edu/scai-advising-appointments/.

- **Disability Accommodations**: Suitable accommodations will be made for students having disabilities. Students needing accommodations must register with the ASU Disabilities Resource Center and provide documentation of that registration to the instructor. Students should communicate the need for an accommodation in sufficient time for it to be properly arranged. See ACD 304-087 Classroom and Testing Accommodations for Students with Disabilities.

- **Threatening or Disruptive Behavior**: Students, faculty, staff, and other individuals do not have an unqualified right of access to university grounds, property, or services (see SSM 104-028). Interfering with the peaceful conduct of university-related business or activities or remaining on campus grounds after a request to leave may be considered a crime. All incidents and allegations of violent or threatening conduct by an ASU student (whether on-or off-campus) must be reported to the ASU Police Department (ASU PD) and the Office of the Dean of Students.

- **Copyrighted Course Material**: Students must refrain from uploading to any course shell, discussion board, or website used by the course instructor or other course forum, material that is not the student's original work, unless the student first complies with all applicable copyright laws; faculty members reserve the right to delete materials on the grounds of suspected copyright infringement. The contents of this course, including lectures and other instructional materials, are copyrighted materials. Students may not share outside the class, including uploading, selling or distributing course content or notes taken during the conduct of the course. Any recording of class sessions is authorized only for the use of students enrolled in this course during their enrollment in this course. Recordings and excerpts of recordings may not be distributed to others (see ACD 304–069, "Commercial Note Taking Services" and ABOR Policy 5-308 F.1410 for more information).

- **Classroom Etiquette**: In order to assure an environment that promotes learning for everyone present, cell phones must be turned off during class to avoid causing distractions. The use of recording devices is not permitted during class. Any violent or threatening conduct by an ASU student in this class will be reported to the ASU Police Department and the Office of the Dean of Students.