SYLLABUS SPRING 2023

The University of Iowa
The College of Liberal Arts and Sciences
Department of Mathematics
Optimization Techniques: MATH:4820

Lecture meets 10:30-11:20 MWF 210 MLH

Course is cross-listed with CS:4720
Website address: http://icon.uiowa.edu

Some of the policies relating to this course (such as the drop deadline) are governed by its administrative home, the College of Liberal Arts and Sciences, 120 Schaeffer Hall.

Instructor: Bruce Ayati
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Description of Course:

This course will consist of nine modules:

1) Weeks 1-2: Statement of the Optimization Problem and Bracketing Methods
   a. Material from Chapters 1 & 3 of Kochenderfer & Wheeler
   b. Scheduled dates for lectures are Jan. 18 to Jan. 27
2) Weeks 3 -4: Local Descent Methods (Line Search and Trust Region Methods)
   a. Material from Chapter 4 of Kochenderfer & Wheeler
   b. Scheduled dates for lectures are Jan. 30 to Feb. 10
3) Week 5: Conjugate Gradient Method
   a. Material from Chapter 5 of Kochenderfer & Wheeler
   b. Scheduled dates for lectures are Feb. 13 to Feb. 17
4) Weeks 6-7: Newton-type Methods
   a. Material from Chapter 6 of Kochenderfer & Wheeler
   b. Scheduled dates for lectures are Feb. 20 to Mar. 3
5) Week 8: Simulated Annealing (a stochastic gradient descent method)
   a. Material from Chapter 8 of Kochenderfer & Wheeler
   b. Scheduled dates for lectures are Mar. 6 to March 10
6) Week 10: Population Methods (genetic algorithms)
   a. Material from Chapter 9 of Kochenderfer & Wheeler
   b. Schedule dates for lectures are Mar. 27 to Mar. 31
7) Weeks 11-12: Simplex Method (linear constrained optimization)
   a. Material from Chapters 10 & 11 of Kochenderfer & Wheeler
   b. Scheduled dates for lectures are Apr. 3 to Apr. 14
8) Week 13: Multiobjective Optimization (Pareto optimality)
   a. Material from Chapter 12 of Kochenderfer & Wheeler
   b. Scheduled dates for lectures are Apr. 17 to Apr. 21
9) Week 14: Discrete Optimization
   a. Material from Chapter 19 of Kochenderfer & Wheeler
   b. Scheduled dates for lectures are Apr. 24-28

We will have two exam prep weeks

• Week 9: Midterm review and midterm exam
  o Exam review on Mar. 20 and Mar. 22, unless some or all of this time is needed to catch up with lecture material
  o Midterm exam on Mar. 24
• Week 15: Final Exam Review
  o Review days on May 1, 3, 5, unless some or all of this time is needed to catch up with lecture material

This course will be mathematical with computer applications and demonstrations using Julia, which will be taught as needed during the semester.

The material from Kochenderfer & Wheeler may be augmented from outside sources. I will provide the relevant notes.

This schedule of dates may need to be adjusted due to varying lengths of lectures, instructor absences due to illness, etc. You will be kept apprised of any changes to the schedule.

**Objectives and Goals of the Course:**
The aim of this course is to teach students how to derive, analyze and (to a lesser degree) implement numerical methods for solving mathematical problems. This course plan may be modified during the semester. Such modifications will be announced in advance during class periods; the student is responsible for keeping abreast of such changes.

**Texts:**
Required texts or materials: *Algorithms for Optimization* by Mykel J. Kochenderfer and Tim A. Wheeler, MIT Press. The URL [https://algorithmsbook.com/optimization/](https://algorithmsbook.com/optimization/) seems to provide a free pdf copy, shared under a under a Creative Commons CC-BY-NC-ND license.

**Grading System and the Use of +/−:**
Letter grades with +/- will be used. Percentage brackets for these letter grades will be based on the specific point distribution of student scores in the class.

**Assignments and Percentage of Final Grade:**
There will be 9 homework assignments that will consist of theoretical problems and computer problems. Homework in total will be worth 45% of the grade for the course (i.e., each assignment will be worth 5%).
Exams and Percentage of Final Grade:
Midterm: **20%** (covers Modules 1-4)
Final exam: **35%** (comprehensive)

**A Word about the Date and Time of the Final Exam:**
The date and time of every final examination is announced by the Registrar generally by the fifth week of classes. **No exams of any kind are allowed during the last week of classes.** All students should plan on being at the UI through the final examination period. Once the Registrar has announced the date, time, and location of each final exam, the complete schedule will be published on the Registrar’s web site and will be shared with instructors and students. It is the student’s responsibility to know the date, time, and place of the final exam.

**Course Policies:**
Course attendance: *There is no formal attendance requirement. However, not attending lectures will put you at a significant disadvantage.*
Participation in class discussions: *You may be called upon from time to time during the course.*
Timely completion of assignments: *Late assignments will only be accepted with a documented excuse.*

**Student Collaboration:**
The homework assignments for this course are designed to help you master your knowledge related to the topics covered during lecture. As such, you may work on the homework problems with others or use online resources, but must write up the solutions yourself, including your own computer code when applicable.

**Other Expectations of Student Performance:**
*You are expected to engage in civil behavior at all times during this course. Failure to do so may result in being asked to leave the lecture.*

**Calendar of Course Assignments and Exams:** *(these are subject to change if events require)*
- Jan. 27: Module 1 Homework assigned
- Feb. 3: Module 1 Homework due
- Feb. 10: Module 2 Homework assigned
- Feb. 17: Module 2 Homework due, Module 3 Homework assigned
- Feb. 24: Module 3 Homework due
- Mar. 3: Module 4 Homework assigned
- Mar. 10: Module 4 Homework due, Module 5 Homework assigned
- **Mar. 24: Midterm Examination**
- Mar. 31: Module 5 Homework due, Module 6 Homework assigned
- Apr. 7: Module 6 Homework due
- Apr. 14: Module 7 Homework assigned
- Apr. 21: Module 7 Homework due, Module 8 Homework assigned
- Apr. 28: Module 8 Homework due, Module 9 Homework assigned
- May 5: Module 9 Homework due
- **May 8-12: Finals Week (specific day and time of final TBA by Registrar)**
Date and Time of the Final Exam
The final examination date and time will be announced by the Registrar generally by the fifth week of classes and it will be announced on the course ICON site once it is known. Do not plan your end of the semester travel plans until the final exam schedule is made public. It is your responsibility to know the date, time, and place of the final exam. According to Registrar's final exam policy, students have a maximum of two weeks after the announced final exam schedule to request a change if an exam conflict exists or if a student has more than two exams in one day (see the policy here).

Academic Honesty and Misconduct
All students in CLAS courses are expected to abide by the CLAS Code of Academic Honesty. Undergraduate academic misconduct must be reported by instructors to CLAS according to these procedures. Graduate academic misconduct must be reported to the Graduate College according to Section F of the Graduate College Manual.

Student Complaints
Students with a complaint about a grade or a related matter should first discuss the situation with the instructor and/or the course supervisor (if applicable), and finally with the Director or Chair of the school, department, or program offering the course.

Undergraduate students should contact CLAS Undergraduate Programs for support when the matter is not resolved at the previous level. Graduate students should contact the CLAS Associate Dean for Graduate Education and Outreach and Engagement when additional support is needed.

Drop Deadline for this Course
You may drop an individual course before the deadline; after this deadline you will need collegiate approval. You can look up the drop deadline for this course here. When you drop a course, a “W” will appear on your transcript. The mark of “W” is a neutral mark that does not affect your GPA. Directions for adding or dropping a course and other registration changes can be found on the Registrar's website. Undergraduate students can find policies on dropping and withdrawing here. Graduate students should adhere to the academic deadlines and policies set by the Graduate College.

University Policies
Accommodations for Students with Disabilities
Basic Needs and Support for Students
Classroom Expectations
Exam Make-up Owing to Absence
Free Speech and Expression
Mental Health
Military Service Obligations
Non-discrimination
Religious Holy Days
Sexual Harassment/Misconduct and Supportive Measures
Sharing of Class Recordings