Computational Optimization Methods

Overview

The course covers typical computational optimization methods widely used in many computing domains, such as bioinformatics, data mining and machine learning. The theoretical foundation of each optimization method is rigorously studied, followed by typical real-world applications in one or more domains.

Instructor

Prof. Jianlin Cheng (http://www.cs.missouri.edu/~chengji)

Location and Time

Engineering Building West 240; 2013 Fall Semester, Wed & Fri, 11:00 – 12:15

Course Website

http://www.cs.missouri.edu/~chengji/com/

Topics

1. Markov chain Monte Carlo methods (MCMC) and their applications in sequence motif search

2. Incremental improvement algorithms (hill climbing, simulated annealing, genetic algorithm, gradient descent) and their applications to travel sales person problem

3. Dynamic programming and its applications in graph theory and sequence alignment

4. Linear programming, integer programming and its application to filtering protein contact map

5. Quadratic programming, Lagrange theory of constrained optimization and its applications in kernel methods

6. Contrastive divergence optimization and its application in deep learning networks

Assignments

There is one reading assignment for each topic. Students are required to read one paper regarding each topic and write a half-page overview of the method and application described in the paper.

Projects

There is one group project for each topic and six projects in total. Under the instructor's guidance, students work in a group to design and implement one optimization method

for each topic and apply it to solve one computing problem. Each group may have up to six students.

Problem Solving Based Teaching and Learning Format

A new problem-solving teaching format including three teaching components (lecture, student presentation, and discussion) will be used in the class. The class consists of two alternated phases.

Phase I: theory phase. An introduction lecture for each topic will be given by the faculty. The lecture will survey problems, methods, algorithms and data structures in each topic. Before or after a lecture, each student is required to read one classic paper and write a review summary as homework for the topic. Overall, the theory phase accounts for 1/3 to 1/4 class time.

Phase II: practice phase. Under the direction of the faculty, students will apply the techniques learned in the first phase to develop and apply a computational optimization method of each topic by working on a group software development project. In each topic, the faculty first introduces main problems to be solved and then engages students in discussions to come up with tasks and solutions to the problems. Students are rotated to write a discussion memo / notes during discussions. Students then write a presentation document including the tasks, solutions and implementation plan and turn it in as homework assignment. In the following class, students present the implementation plan in the first half of a class. A faculty then leads students to discuss the feasibility, strength and weakness of the plan in the second half of the class. After the presentation, students revise the plan and post a revised plan to the project server. Then students start to implement the plan. At the end of each step, a formal progress report (e.g. a Word/PDF document) including results and assessment is turned in and the corresponding programs and results are posted at the project web site by students. The implementation and results will be assessed and discussed by faculty and students. At the end of the semester, students turn in a formal project report in a paper style and present the project to all the instructors of the class. All the students are required to do the group homework assignments (i.e. reports, implementation, and final presentation). Students are rotated to be the leader of each group assignment. The leader gives presentations with the help of other students. The final report and presentation should be done by all the students. Overall, the practice phase accounts for 2/3 to 3/4 class time.

Evaluation and Grading

Students are graded based on class discussion (individual, 15%), literature reading and review (individual, 10%), topic plan presentation (individual, 20%), topic implementation and report (group, 45%), and a final presentation and report (group, 10%). A grade scale for graduate courses (A+, A, A-, B+, B, B-, C+, C, C-, and F) is applied.

Intellectual Pluralism

The University community welcomes intellectual diversity and respects student rights. Students who have questions concerning the quality of instruction in this class may address concerns to either the Departmental Chair or Institute Director or Director of the Office of Students Rights and Responsibilities (http://osrr.missouri.edu/). All students will have the opportunity to submit an anonymous evaluation of the instructor(s) at the end of the course.

Attendance Policy

Attendance is essential to understanding the course material and is required. As in the workplace, if you cannot attend a class session due to illness or emergency please call or e-mail before the class to inform the instructor of your absence.

Academic Integrity

Academic integrity is fundamental to the activities and principles of a university. All members of the academic community must be confident that each person's work has been responsibly and honorably acquired, developed, and presented. Any effort to gain an advantage not given to all students is dishonest whether or not the effort is successful. The academic community regards breaches of the academic integrity rules as extremely serious matters. Sanctions for such a breach may include academic sanctions from the instructor, including failing the course for any violation, to disciplinary sanctions ranging from probation to expulsion. When in doubt about plagiarism, paraphrasing, quoting, collaboration, or any other form of cheating, consult the course instructor.

ADA

If you need accommodations because of a disability, if you have emergency medical information to share with me, or if you need special arrangements in case the building must be evacuated, please inform me immediately. Please see me privately after class, or at my office.

Office location: _____ Office hours: _____

To request academic accommodations (for example, a note taker), students must also register with the Office of Disability Services, (http://disabilityservices.missouri.edu), S5 Memorial Union, 882-4696. It is the campus office responsible for reviewing documentation provided by students requesting academic accommodations, and for accommodations planning in cooperation with students and instructors, as needed and consistent with course requirements. For other MU resources for students with disabilities, click on "Disability Resources" on the MU homepage