Computational Optimization Methods

Overview

The course covers typical computational optimization methods widely used in many computing domains, such as data mining, machine learning and bioinformatics. The theoretical foundation of each optimization method is rigorously studied, followed by typical real-world applications in one or more domains. An active, problem-solving based teach and learning format will be applied to help students to develop various skills including research, teaching, reading, communication, algorithms, programing, team work, collaboration, leadership, planning, project management, and presentation.

Instructor

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

Location and Time

Engineering Building West 240; 2014 Fall Semester, Wed & Fri, 11:00 – 12:15

Course Website

http://www.cs.missouri.edu/~chengji/com2014/

Topics

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

2. Incremental improvement algorithms (e.g., 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 network flow problem

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

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

Assignments

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

Projects

There is one group project for each of the first five topics. Under the instructor's guidance, students work in a group to design and implement one optimization method for each of these five topics and apply it to solve one computing problem. Each group may have up to five students.

Problem Solving Based Active Teaching and Learning Format

A new *problem-solving* active 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 1/4 to 1/3 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 a topic by working on a group software development project. In the discussion class for 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 during discussions and present it on the white board in the classroom. After the class students 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. A faculty then leads students to discuss the feasibility, strength and weakness of the plan. After the presentation, students revise the plan and submit a revised plan to be graded. Then students start to implement the plan cooperatively in background. After the plan of a topic has been implemented according to the schedule, 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 server by students. The implementation and results will be assessed and discussed by faculty and students in a discussion class. After the discussion class, students may be required to incorporate discussion comments into implementation and analysis. At the end of the semester, students turn in a formal report in a paper style describing all the projects and present it to the entire class. All the students are required to work on the group homework assignments (i.e. project plan, report, implementation, and final report and 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 (group, 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