CSE 40317/60317 Online Algorithms for Computational Finance

Spring 2007

Description : Decision making under incomplete information, particularly under uncertainty about the future, is a common activity in finance. A traditional approach to this is to model the uncertainty using probability distributions and then optimize for the average-case performance of a utility function. In this course, we study a non-traditional approach in which we disregard probability models and optimize the worst-case performance. This "computer science-based" approach is often preferred because of the inherent unpredictability of financial markets.

Course Goals : At the end of the course students will be able to meet the following goals (some goals are only for CSE 60317) :

1. Understand the basic ideas and terminology used in online algorithms and competitive analysis, and place online algorithms in the context of the general area of decision making in the absence of complete information.
2. Design simple deterministic or randomized online algorithms and determine their competitive ratios.
3. Become familiar with the decision making problems in finance, including those related to derivatives, pricing futures, capital assets pricing, and stock options.
4. Study the known online algorithms for problems in computational finance, such as one-way trading, portfolio selection, and two-way trading. For CSE 60317, design and analyze algorithms that are extensions to these known algorithms.
5. Understand the relation between online algorithms and game theory. For CSE 60317, use Yao's technique to obtain lower bounds for online algorithms.
6. Research into a specific problem: learn the known techniques for solving it, develop new online algorithms for it, evaluate their performance both empirically and analytically, and conclude with recommendations for choosing between techniques.

Contact hours : Currently, MWF 10:40-11:30 am, in DeBartolo 334. We may chose a more convenient time in class.

Instructor : Amitabh Chaudhary. Room: Fitzpatrick 352. Email: achaudha at cse nd edu. Office hours: MWF 1:00-2:00 pm or by appointment.

Prerequisites : Introductory courses in probability, computer programming, and algorithms. These may be waived by the instructor on a case-to-case basis.

Textbooks : For reference, not required: (1) Online Computation and Competitive Analysis by Allan Borodin and Ran El-Yaniv, Cambridge University Press; (2) Options, Futures, and Other Derivatives by John C. Hull, Prentice Hall. Handouts will be provided in class. Students are encouraged to take notes in class.

Grading Policy : Homework assignments 50%, semester project 50%. The objective of grading is more to encourage students to appreciate this advanced topic, and less to score their work. Hence, 70% of the grade in assignments will be for effort and the rest for correctness.

Homework assignments : Short homework assignments designed to help students understand the material better will be assigned each class. Students are permitted, even encouraged, to work on these together, but must write their answers on their own. Any help taken from external sources (peers, books, Web) should be indicated. The assignments will be graded, but 70% of the grade will be for earnest effort and the rest for correctness. Homework assignments will constitute 50% of the final grade.

Semester Project : Students will work in groups on a semester project. Each group will present the results of their research as a report and a class presentation in four stages describing: (1) the problem, (2) the known techniques, online or otherwise, for solving the problem and/or related problems, (3) the online algorithm(s) designed to solve the problem, and (4) an evaluation of the approaches described earlier and a conclusion. The project will constitute 50% of the final grade. Two examples of project-types are developing algorithms for a problem in finance that has not been studied before as an online problem, and extending known online algorithms for financial problems to incorporate a generalization or a more realistic modeling.

Topics : A tentative list of topics follows:

Topic	Hours
Introduction to competitive analysis, deterministic online algorithms, and randomized online algorithms	5
Overview of financial products, financial markets, forward/futures prices, stock options, random walk models, and financial times series	8
Online algorithms for online search, replacement problems, portfolio selection, leasing problems, two-way trading, and other problems in finance	15
Game theoretical foundations, competitive analysis and zero-sum games, and Yao's Principle	6
Other approaches to decision making	3
Topics from recent research papers	5