1 Course Information

Lecturer: CHEUNG, Yun Kuen (You may call me Marco.)
Tutor: RAY CHAUDHURY, Bhaskar
Lecture Time: Every Monday, 4pm—6pm (Starting from 23 October, 2017.)
Tutorial Time: Alternating Tuesday, 2pm—4pm (Starting from 7 November, 2017.)
Classroom: For both lectures and tutorials, Room 021 in Building E1.4
Credits: 5
Prerequisite: The followings are required from enrolled students:
(A) Basic knowledge in algorithms and data structure, and their analyses
(B) Calculus, including the concepts of limit, convergence, derivative and integration
(C) Basic Linear Algebra, including how to solve linear systems

The followings will be useful in some parts of this course, but NOT required:
(1) Basics of probability theory (what are discrete/continuous distributions, expected values and variances)
(2) Linear programming and its duality
(3) Basic max-flow algorithm, e.g., Ford-Fulkerson

AGT, AMD and CE are rather new research topics, there are plenty of research opportunities. For ambitious students (Immersion Lab? Master Thesis?) who want to develop rigorous theoretical training related to these topics, I can suggest extra materials for reading and thinking.

2 Course Objective

Games and markets appear wherever agents (which can refer to humans, animals, computers, bacteria or even molecules) interact to compete for selfish benefits. In this course, you will learn the mathematical formulations of different games/markets and algorithms for computing a solution/equilibrium. We will also discuss computational complexity of computational problems about games and markets.

Here is a list of canonical questions to ask:

• In a scenario where agents compete for selfish benefits, how to formulate it as a game/market? E.g., what are the strategies and interests of different agents?
• Does a game/market have an equilibrium? How do we determine?
• If “yes”, is there an algorithm to compute it?
• If “yes”, is the algorithm polynomial-time, or the computation of equilibrium is inherently hard?
• “Equilibrium” seems a good word, but don’t be fooled — not every equilibrium is good/efficient (e.g., Prisoner Dilemma). How good is an equilibrium, or what is the efficiency of the equilibrium?
• In many scenarios, the agents involved can only access rather limited information of the game/market, and some information is probabilistic (e.g., statistics of other agents preferences, games that involve throwing dice, games which are heavily affected by weather condition).
  – What information can different agents access?
– How the information facilitate the agents to play game better?
– When the accessible information is limited, can agents follow simple and local dynamic that leads to equilibrium?

After getting a good understanding of games and markets, we will discuss a prominent application, the design of auctions, or what we call the mechanism design. Examples include eBay, Google ad auction, spectrum auction. In the simplest setting, there is an auctioneer selling a number of items, and there are many agents who are interested in those items. Mechanism design concerns

• the design of (preferably short and simple) communication protocols between auctioneer and agents;
• design of efficient (polynomial-time, or even stricter time requirement due to practical constraints) algorithms to decide the allocation of items which achieve good efficiency;
• design of truthful mechanism which motivates agents to tell their true valuations on the items, i.e., not to be strategic on reporting their preferences.

3 Exercises, Examination and Grade Structure

Exercise Sheets. I will assign an exercise sheet in alternating weeks; the first exercise sheet will be assigned right after the first lecture. While discussion with your course-mates is encouraged, each student should write independently her/his own solution. Plagiarism is strictly prohibited.

Each exercise sheet will have two types of questions, those without star marks called standard exercises, and those with star marks called extra bonus. Your score in all exercises is the number of points you earn in both standard exercises and extra bonus, but the base score is the number of points assigned to standard exercises ONLY.

Your exercise score will make up 30% of the total grade of the course. Let me make this more precise.

YOUR TOTAL GRADE IN THIS COURSE FROM EXERCISE

\[
= \min \left\{ 30, \frac{\text{YOUR POINTS EARNED IN ALL EXERCISES (STANDARD & BONUS)}}{\text{THE TOTAL POINTS ASSIGNED TO ALL STANDARD EXERCISES}} \right\}
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Oral Examination. The remaining 70% of the total grade of this course is from the examination. There is only one oral examination by the end of all lectures. In January 2018, we will make appointments with individual registered students to determine the time slot. The oral exam will take 30–60 minutes for each student.