CS 282r: Adaptive methods in Machine Learning Syllabus

Ron Kupfer and Prof. Yaron Singer Fall 2021

1 Overview

This course is focused on adaptive methods in machine learning.
The standard paradigm in machine learning assumes there is a training set of labeled examples and the goal is to learn a prediction rule that can be used on new examples. This course covers methods where the goal is to perform an adaptive search over existing models to identify a strategy that performs well. The course covers the two paradigms of pure exploration and regret minimization. These two paradigms belong to the more general framework of reinforcement learning. We will study some high-level concepts of reinforcement learning and cover additional models as time permits (e.g., Markov decision processes, Monte Carlo tree search).
The course is a seminar and includes presentation of research papers by students. Students will be primarily evaluated through their presentations, assignments, and a final project.

2 Basic Information

Course staff:

- **Professor Yaron Singer**
  Email: yaron@seas.harvard.edu
- **Ron Kupfer**
  Email: rkupfer@seas.harvard.edu

Location and schedule: We will meet on **Friday 9:45am – 12:30pm**, in SEC 2.118 Classroom.

Course homepage: Most information about the course can be found on the course Canvas site:

`https://canvas.harvard.edu/courses/94986`

3 Prerequisites

To enjoy and succeed in this course, you will need to be comfortable with machine learning (obviously) at the level of CS 181, statistics at the level of STAT 110, algorithms at the level of CS 124, and theory of computation (CS 121), as well as basic proficiency in some programming language.

4 Course Format

The course is a seminar and includes presentation of research papers by students. Students will be primarily evaluated through their presentations, assignments, and a final project.

5 Learning Objectives

Doing research. This course is targeted toward graduate students. As such, many of you already have research experience and a unique research style. In this course we'll be learning from each on how to take a hint of an interesting question and forge it into a clear, interesting story.

6 Logistics

Presentations. You will need to pair up and present a paper or two together in class. You will also need to scribe your own lecture and make it available to the rest of the class.

Final project. The final project is a research project.

Grading. The grading for the course consists of three differently-weighted pieces:

- 10%: class participation;
- 40%: paper presentation;
- 10% first project milestone
- 20%: second project milestone
- 20%: final project and poster presentation.

7 Schedule

- **September 3rd** Introduction to Adaptive Learning
- **September 10th** Best arm identification
  - Median Elimination [EMM] (without MDP)
  - A lower bound for learning an ϵ, δ best arm [MT]
- **September 17th**
  - From (ϵ, δ)-best arm to optimal best arm [JN],[KKS]
  - top k best arms [KS], [KTAK], [JJ]

- **September 24th** Bandits at scale
  - Finding a best arm in parallel [JSXC], [AAAK]
  - Finding a best arm with limited memory [AW][JHTX]
- **October 1st** Regret minimization
  - UCB and Thompson Sampling [S Chapters 1,3], [RVKOW]
  - First milestone presentation
- **October 8th** Complex output models
  - Linear bandits [S Chapter 7], [SLM]
  - Dueling bandits [YBKJ],[YJ]
- **October 15th** Contextual bandits
  - Contextual bandits [S Chapter 8]
  - Contextual bandits' applications [TRSA], [TM]
- **October 22nd** Adversarial bandits
  - Adversarial bandits and regret minimization [S Chapter 6], [LS part 3]
  - Adversarial bandits and best-arm identification [ABGMV],[ABM]
- **October 29th** Second milestone presentation
- **November 5th** Strategic Behavior
  - Competing bandits [MSW]
  - Bandits and agents [S Chapter 11]
- **November 12th** Reinforcement learning
  - Finite Markov Decision Processes (MDP) [LS chapter 38] [EMM]
  - Monte Carlo tree search [KS], [H]
- **November 19th** Final project presentation and sad goodbyes

8 Important dates

- **September 7:** partner up, choose papers to present
- **October 1:** milestone 1: project proposal due (one page)
- **October 29:** milestone 2: initial results and presentation
- **November 19:** Final project presentations

9 Action items

- Find a partner(s) to work on your final project and presentation and inform us by September 7th at 11:59pm EST. using this form - `https://forms.gle/tKr49aNXHbLytUvE7`.