STATISTICAL LEARNING THEORY

SYLLABUS: CSC2532 WINTER 2021

University of Toronto

1. Instructors.

Murat A. Erdogdu
Email: csc2532prof@cs.toronto.edu
Office: online
Office Hours: Tue 10:00-11:00

2. Lectures. M 10:00-12:00, online

3. Teaching Assistants.

TBA
Email: csc2532ta@cs.toronto.edu

4. Course webpages. Course webpage contains all course information, additional readings, assignments, announcements, office hours, etc. Please check regularly!

- https://erdogdu.github.io/csc2532/
- q.utoronto.ca
- piazza.com/utoronto.ca/winter2021/csc2532h

Instructions to join online lectures and office hours will be sent through quercus every week. Lectures will be recorded and posted on quercus for your convenience. **Please do not distribute!**

5. Course Evaluation.

- 3 assignments: 50%
- Midterm exam: 30%
- Project: 20%

6. Submitting Course Work.

- TBA

7. Course Outline. This course covers several topics in classical machine learning theory. Topics are:

1/11: Introduction & Stein Paradox
1/18: Exponential Families
1/25: Asymptotic statistics (hw1 out)
2/01: Uniform convergence & Generalization
2/08: Epsilon-nets and covering (hw1 due & hw2 out)
2/15: Rademacher complexity I

2/22: Rademacher complexity II (hw2 due & hw3 out)
3/01: VC dimension
3/08: PAC-Bayes bounds & Stability (hw 3 due)
3/15: Midterm (during class time)
3/22: Chaining (project proposal due)
3/29: Small ball method
4/05: Kernel Methods

- (if time left) Sampling/Online Learning/Optimization/Double descent/...

8. Prerequisites. CSC2515 is a prerequisite. This class requires a good informal knowledge of probability theory, linear algebra, real analysis. Homework 0 is a good way to check your background.

9. Textbooks. There is no required course textbook. The following materials can be helpful.

- Understanding Machine Learning by Shai Shalev-Shwartz and Shai Ben-David
- High Dimensional Probability by Roman Vershynin
- High Dimensional Statistics by Martin Wainwright
- Information Theory, Inference, and Learning Algorithms by David MacKay
- Elements of Statistical Learning by Jerome Friedman, Trevor Hastie, and Robert Tibshirani

10. Assignments. There will be 3 assignments in this course.

10.1. *Collaboration policy.* After attempting the problems on an individual basis, you may discuss and work together on the homework assignments with up to two classmates. However, you must write your own code and write up your own solutions individually. Groups should bundle their solutions and submit together by explicitly stating the name of any collaborators at the top of their homework.

11. Exam. There will be a "in-class" midterm exam (tentatively) on Mar 15. Details will be announced on the course webpage. You can use an optional A4 cheat sheet - double-sided. You will need to scan and upload your solutions to a online submission platform. Instructions will be posted before the exam.

12. Project. Final project should give you experience on carrying out theoretical research.

12.1. *Objectives.* Your project goal is to read and write a comprehensive review of a theoretical machine learning paper, and understand the main building blocks.

12.2. *Collaboration policy.* You may work on the project alone or in a group of 2 (groups of 2 need to review 2 papers and the standards for a group project will be higher). We strongly encourage you to come to office hours to discuss your project ideas, progress, and difficulties with the course staff.

12.3. *Evaluation.* Evaluation will be based on two reports:

1. Proposal 2%: 1/2 page, to be submitted on 1/30: the papers to be reviewed, and a brief summary of what paper is about, why it is interesting.

2. Final report 18%: 3 pages, to be submitted on 4/06: comprehensive review of the papers, key ideas/tools used in proofs, potential future directions, open problems. More details about the expectations will be posted on course website.

13. Late policy. Ten percent of the value will be deducted for each late day. No credit will be given for assignments submitted after the solutions have been posted. Exceptions will be made for documented emergencies.

14. Grading concerns. Any requests to have graded work re-evaluated must be made within one week of the date the grade is released. Re-evaluation may result in a decrease in the grade.

15. Computing. In the assignments and project, you may need to write your own programs, debug them, and use them to conduct various experiments, plot curves, etc. You may use any programming language, but `Python`, and `R` might be preferable.

16. Missed exam/test.

- If a test is missed for a valid reason, you must submit documentation to the course instructor.
- If a test is missed for a valid medical reason, you must submit the University of Toronto Verification of Student Illness or Injury form to your instructor within one week of the test.
- The form will only be accepted as valid if the form is filled out according to the instructions on the form.
- Important: The form must indicate that the degree of incapacitation on academic functioning is moderate, serious, or severe in order to be considered a valid medical reason for missing the term test. If the form indicates that the degree of incapacitation on academic functioning is negligible or mild then this will not be considered a valid medical reason.
- If the midterm test is missed for a valid reason then the final project will be submitted separately from the group and will be evaluated on individual basis. Final project will be worth 70% of your final grade.
- Other reasons for missing a test will require prior approval by your instructor. If prior approval is not received for non-medical reasons then you will receive a term test grade of zero.