Course Outline for COMP 599 – MATH 597
Statistical Learning Theory
Fall 2020

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Introduction

This course will be co-taught by Prof. Adam Oberman of the Department of Mathematics aqnd Statistics and Prof. Prakash Panangaden of the School of Computer Science. The lectures will be split between the two instructors; in the detailed schedule below we have shown which lecture is taught by which instructor. Lectures will be taught via Zoom and will be recorded and made available to the students.

In this course we will cover the basic statistical theory underlying machine learning. The course will overlap with many courses taught in the Univerity but will have a more theoretical and mathematical flavour. We will explain the theory behind several algorithms that you may have seen in other courses. There will be no implementation assignments.

Prerequisites

We expect a certain level of mathematical maturity, as is only natural for a course cross-listed between Mathematics & Statistics and Computer Science. People in Honours mathematics or joint honours mathematics and computer science typically have the appropriate level of mathematical maturity. The core material that you need is linear algebra, calculus and probability.

Grading

Grades will be based on a few 7 or 8 assignments **and** a term paper. There will be no exams or tests. The assignments will account for 75% of your

total grade and the term paper will account for 25% of your total grade. The term-paper will be an in-depth exploration of a theoretical topic *of your choice* related to statistical machine learning. We will put up a list of possible topics later in the term. All assignments will have to be written using LaTex and submitted as pdf files.

Textbook

We will not be following any book precisely but the following two books are recommended:

- *Foundations of Machine Learning* by Mehryar Mohri, Afshin Rostamizadeh and Ameet Talwalkar.
- *Understanding Machine Learning: From Theory to Algorithms* by Shai Ben-David and Shai Shalev-Shwartz.

Academic Integrity

McGill University values academic integrity and treats it seriously. Please see the website

`http://www.mcgill.ca/integrity`

for more details. In the present class we expect that the work that you turn in is your own. You can discuss ideas and approaches with your friends but you cannot blindly copy their solutions. If we find that someone has handed in a correct solution that they cannot satisfactorily explain to me, we will treat it as a case of cheating and prosecute accordingly.

Lecture schedule

Week 0	Lecture 1	Sept 2	Introduction	Adam
Week 1	No Lecture	Sept 7	LABOUR DAY	
	Lecture 1	Sept 9	Concentration inequalities	Adam
Week 2	Lecture 1	Sept 14	The PAC model, the agnostic setting	Prakash
	Lecture 2	Sept 16	VC dimension	Prakash
Week 3	Lecture 1	Sept 21	Sample bounds from VC dimension	Prakash
	Lecture 2	Sept 23	Rademacher complexity	Prakash
Week 4	Lecture 1	Sept 28	Convexity theory	Adam
	Lecture 2	Sept 30	Convex optimization	Adam
Week 5	Lecture 1	Oct 5	SGD theory	Adam
	Lecture 2	Oct 7	SGD numerics	Adam
Week 6	No Lecture	Oct 12	THANKSGIVING	
	Lecture 2	Oct 14	Online learning, regret bounds	Prakash
Week 7	Lecture 1	Oct 19	Online convex optimization	Prakash
	Lecture 2	Oct 21	Support vector machines (SVM)	Adam
Week 8	Lecture 1	Oct 26	Learning bounds for SVM	Adam
	Lecture 2	Oct 28	Regression and Learning bounds	Adam
Week 9	Lecture 1	Nov 2	Multi-class classification	Adam
	Lecture 2	Nov 4	Uncertainty for classification	Adam
Week 10	Lecture 1	Nov 9	RHKS basics	Prakash
	Lecture 2	Nov 11	RHKS learning bounds	Prakash
Week 11	Lecture 1	Nov 16	Metrics between probability distributions	Prakash
	Lecture 2	Nov 18	KR duality	Prakash
Week 12	Lecture 1	Nov 23	Maximum entropy models	Prakash
	Lecture 2	Nov 25	Generative adversarial models	Prakash
Week 13	Lecture 1	Nov 30	Density estimation	Adam
	Lecture 2	Dec 2	Learning bounds kernel density estimators	Adam
	Lecture 3	Dec 3	Farewell	