Instructor: Prof. Prakash Ishwar (e-mail: pi@bu.edu)
Times: all times are Boston times.
Lectures: Mon + Wed, 4:30-6:15 pm (remote instruction, zoom in real-time + recording)
Instructor's office hours: (tentative) Mon + Wed 7:00-8:30 pm (zoom in real-time only)

Description:
Classical and contemporary theories of machine learning. Topics/emphasis may change based on instructor preference in different years. A project involving computer implementation of a learning or inference algorithm accompanied by or in support of theoretical analysis is required.

Prerequisites:
EC414 or EC503 or equivalent experience with machine learning. Good foundation in probability, linear algebra, multivariate calculus, and programming. Interest and appreciation of analytical work (e.g., theorems and proofs).

Syllabus:
- Statistical Decision Theory: optimum predictors and their properties.
- Frequentist and Bayesian learning with generative and discriminative probabilistic models of parametric or nonparametric kinds.
- Asymptotic consistency and limitations of ML learners.
- Universally consistent learners: generalized linear and k nearest-neighbor predictors.
- No free lunch theorem: non-existence of universal rate of convergence, error-decomposition, bias-complexity tradeoff.
- Structural Risk Minimization, nonuniform learnability, model-selection.
- Convex learning problems.
- Regularization and stability.
- Margin bounds; Analysis of some popular learning algorithms.
- Selected Topics (as time permits or via projects): emerging perspectives on over- and under-fitting, generalization, and the role of over-paramerization, success of stochastic subgradient descent algorithms, insights into why deep neural networks seem to generalize well, adversarial learning.
Grading:

45% Homeworks  
4–5 sets of predominantly analytical exercises. 
Due: 10:55pm of due date (upload pdf to Gradescope).

50% Project  
Project involving reading, analyzing, and presenting a recent paper related to statistical learning theory or its applications (more information will follow later in the semester).  
Project Presentation: April 26–30.  
Project Final report: Monday, May 3.

5% Class-participation  
For constructive and proactive engagement during lectures, office hours, and on Piazza.

Outcomes: As an outcome of successfully completing this course, students will:

- be able to understand and use classical and contemporary theoretical results and algorithms in machine learning;
- be able to read, understand, analyze, and implement classical and contemporary research articles related to the theoretical foundations of machine learning;
- be able to understand the pros and cons of different machine learning algorithms and their practical implications;
- be able to communicate theoretical results in written or oral forms.

Web site: http://learn.bu.edu will contain lecture slides, notes, links, and other useful information related to the course.

References: This course has no textbook. You will need to rely on lectures, office hours, and course materials that will be uploaded regularly to the course web site. Below is a list of reference books which we will consult.

  https://www.cs.huji.ac.il/~shais/UnderstandingMachineLearning/
  https://cs.nyu.edu/~mohri/mlbook/
  https://www.szit.bme.hu/~gyorfi/pbook.pdf
  https://web.stanford.edu/~ Hastie/Papers/ESLII.pdf
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Academic integrity, plagiarism: You may discuss homework problems among yourselves and with the instructor (during office hours), but any significant collaboration should be acknowledged in your solution. You must always create your own solution without copying it from your collaborator(s). In project reports, you may paraphrase relevant ideas from references, but not quote sentences verbatim from them.

The BU student handbook defines academic misconduct as follows: “Academic misconduct occurs when a student intentionally misrepresents his or her academic accomplishments or impedes other students’ chances of being judged fairly for their academic work. Knowingly allowing others to represent your work as theirs is as serious an offense as submitting another’s work as your own.” Please see the student handbook for procedures that will follow should academic misconduct be discovered.

Inclusion: I consider the classroom (physical or online) to be a place of learning where all individuals are expected to contribute to provide a respectful, welcoming and inclusive environment for every member of the class irrespective of their identity.

Disability accommodations: If you are a student with a documented disability or believe you might have a disability that requires accommodations, requests for accommodations must be made in a timely fashion to Disability & Access Services, 25 Buick St, Suite 300, Boston, MA 02215; 617-353-3658 (Voice/TTY). Students seeking academic accommodations must submit appropriate medical documentation and comply with the established policies and procedures [http://www.bu.edu/disability/accommodations/](http://www.bu.edu/disability/accommodations/)

COVID 19 BU expectations regarding safety: Masks are required and face coverings must be worn over the mouth and nose at all times when in public spaces on campus, including (physical) classrooms. Students should be prepared to show proof that they are compliant with health attestations and testing in order to attend class.

All students are expected to follow all university guidelines with respect to daily symptom checks, testing, social distancing, and mask wearing when they leave their dorm or home. For a detailed description of official BU policies regarding COVID, please visit: