IE 690: Applied Probability for Machine Learning
Spring 2020

1 Description:

The broad goal of this course is to study recent developments in the application of probabilistic tools and methods to the analysis of statistical machine learning algorithms. The intended audience of this course are Ph.D. students who work on theoretical questions surrounding statistical machine learning (or intend to do so).

A solid background in stochastic processes (especially Markov processes) and real analysis is necessary. Ideal preparation includes measure theory and graduate level probability.

The course will be driven by paper readings carefully chosen and assigned to each student. There is no required textbook, but "Applied Stochastic Analysis," by Weinan, Li and Vanden-Eijnden is a useful resource for the basic analytical tools needed. Here is a tentative list of topics that will be covered in this course. It should be noted that there is significant freedom in choosing topics, depending on the class interest.

Week 1-5   Stochastic analysis of "phase-space" algorithms: we will study the asymptotics and transient behavior of algorithms like stochastic gradient descent (SGD), Langevin Markov chain Monte Carlo (MCMC), stochastic Langevin gradient descent (SGLD) etc. by passing to a continuum limit. Particular focus on weak convergence to steady state behavior, large deviations principles and metastability analyses.

Week 6-11   Stochastic analysis of "measure-space" algorithms: we will study variational approximations for Bayesian computation and distributionally robust optimization (DRO). Particular focus on connections to gradient flow theory on Wasserstein spaces, connections with the analysis of phase-space algorithms.

Week 12-14   Applications of the analytical tools to reinforcement learning algorithms and/or inference of dynamical systems from time series (time permitting).

Evaluation will be by class participation (10%), paper presentations (40%) and a final paper presentation (50%). The final paper is expected to be of publishable quality. Group work is encouraged. The final term paper will be due at the end of the semester on 05/09/2020. You are expected to make a brief presentation of your project to the class in the last week of classes.

Class Details

Time: T-Tr 1:30-2:45PM (subject to change)
Location: GRIS134 (subject to change)
Instructor: Harsha Honnappa
email: honnappa@purdue.edu
Office: GRIS 266 Office hours: TBA/By appointment

Academic Dishonesty

Purdue prohibits "dishonesty in connection with any University activity. Cheating, plagiarism, or knowingly furnishing false information to the University are examples of dishonesty." [Part 5, Section III-B-2-a, University Regulations] Furthermore, the University Senate has stipulated that "the commitment of acts of cheating, lying, and deceit in any of their diverse forms (such as the use of substitutes for taking examinations, the use of illegal cribs, plagiarism, and copying during examinations) is dishonest and must not be tolerated. Moreover, knowingly to aid and abet, directly or indirectly, other parties in committing dishonest acts is in itself dishonest." [University Senate Document 72-18, December 15, 1972].
Please see Purdue's student guide for academic integrity:
(http://www.purdue.edu/odos/aboutodos/academicintegrity.php)

Students with Disability

Purdue University is required to respond to the needs of the students with disabilities as outlined in both the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990 through the provision of auxiliary aids and services that allow a student with a disability to fully access and participate in the programs, services, and activities at Purdue University.

If you have a disability that requires special academic accommodation, please make an appointment to speak with me within the first three (3) weeks of the semester in order to discuss any adjustments. It is important that we talk about this at the beginning of the semester. It is the student's responsibility to notify the Disability Resource Center (http://www.purdue.edu/drc) of an impairment/condition that may require accommodations and/or classroom modifications.