Course Description:

This course is a PhD level seminar course on advanced research topics. We will focus on two main areas of research (a) commonly used optimization techniques and computational tools in statistics and machine learning; (b) popular statistical machine learning methodologies for high-dimensional data. Students are expected to be able to replicate and understand the discussed research work with further implementation on real data and through simulation studies.

For topic (a) commonly used optimization techniques and computational tools in statistics and machine learning. We will start by introducing theories and algorithms of convex optimization, with emphasis on ADMM type algorithm. For non-convex optimization, we will discuss DC-algorithm and its application. Moreover, we will also survey integer optimization and discuss its application and potential in solving statistics and machine learning problems.

For topic (b) popular statistical machine learning methodologies for high-dimensional data, we will discuss feature selection, Gaussian graphical models, dimension reduction, classification, clustering, modal regression, subgrouping and longitudinal data analysis. We will explore how the optimization technique and computational tools introduced in (a) is applied to these problems, including how to apply them through parallel computing for large scale data.
Tentative Schedule

Week 1 (Jan 9th): Convex optimization and ADMM

Week 2 (Jan 16th): MLK Day

Week 3 (Jan 23rd): DC algorithm, integer optimization and their applications.

Week 4 (Jan 30th): Feature selection and its inference

Week 5 (Feb 6th): Gaussian graphical models and its inference

Week 6 (Feb 13th): Dimension reduction and classification

Week 7 (Feb 20th): Clustering, modal regression and others.

Evaluation

Reading assignment and Presentation:
Each of you will do a presentation and lead a paper discussion for each class

Computing assignment:
There are one computing assignment in replicating some current research. You are welcome to exploring different analysis. Please run your idea before you proceed.

Each of you will lead a paper discussion and/or computing assignment.

Final Project/Proposal
You are expected to write a 5 page research proposal of possible future research topics to explore after conducting a comprehensive literature search and examining relevant recent journal articles and working papers. A sample proposal will be provided. Alternatively, you are more than welcome to directly working on a research project.