# CSCI 5525: Advanced Machine Learning (Spring 2023)

# Homework 0

**(Due Tue, Jan. 24, 11:59 PM central)**

1. Have you read through the class syllabus, noted the important dates, and the class policies?

2. (i) Which of the following courses have you taken? If you haven't taken any, describe what background you have in machine learning.
   - CSci 5512 - Artificial Intelligence II
   - CSci 5521 - Machine Learning Fundamentals
   - CSci 5523 - Introduction to Data Mining
   - CSci 5527 - Deep Learning: Models, Computation, and Applications
   - CSci 5561 - Computer Vision

   (ii) Have you taken any course on Probability/Statistics? If yes, please write down the course department and course name.

   (iii) Have you taken any course on Linear Algebra? If yes, please write down the course department and course name.

   (iv) Have you taken any course on Optimization? If yes, please write down the course department and course name.

3. Let $X \in \mathbb{R}^{n \times p}$ and $y \in \mathbb{R}^n$ be given. The goal is to find a $w^* \in \mathbb{R}^p$ which solves the following problem:
$$w^* = \operatorname*{argmin}_{w \in \mathbb{R}^p} \frac{1}{2}\|y - Xw\|^2 + \frac{\lambda}{2}\|w\|^2 \ ,$$
where $\lambda > 0$ is a constant. Give a closed form expression for $w^*$ in terms of $X, y$ and $\lambda$. (Consult the *Matrix Cookbook* if you want to look up expressions for derivatives in matrix/vector form.) Is the expression valid when $n < p$? Briefly explain your answer.

4. Using Python, write the **one line** code to compute the answer to Question 3 above. You may use numpy (assume it has been imported as `import numpy as np`).

5. Let $A$ be a $n \times n$ positive definite matrix. The solutions to the following problems
$$\max_{w \in \mathbb{R}^n : w^\top w = 1} w^\top A w \quad \text{and} \quad \min_{w \in \mathbb{R}^n : w^\top w = 1} w^\top A w \tag{1}$$
have well known names—do you know what the solutions to these problems are called? (You can refer back to your Linear Algebra course if needed.)