Homework 1 - due Wed. Feb. 5th
High-Dimensional Approximation, Probability, and Statistical Learning

Instructor: Mauro Maggioni
Office: 302D Whitehead Hall
Web page: https://mauromaggioni.duckdns.org
E-mail: mauro.maggioni *at* youknowwhat.edu

Homework Policies

Homework is due at the beginning of class, stapled, written legibly, on one side of each page only. Otherwise, it will be returned ungraded.
All answers should be fully motivated - the logical arguments and motivation matter at least as much as answering correctly. The lowest homework score will be dropped. No late homework will be accepted. JHU policies apply with no exceptions to cases of incapacitating short-term illness, or for officially recognized religious holiday. You may, and are encouraged to, discuss issues raised by the class or the homework problems with your fellow students and both offer and receive advice. However all submitted homework must be written up individually without consulting anyone else's written solution.

The submission of homework that require numerical work on a computer should include the following: printout of the code used to solve the problems, of its inputs and of its outputs. The code should be written clearly, and should be commented at least in such a way that the input/outputs of the code is clear. The specific outputs requested by the exercise should be discussed in your writeup, critically and as needed in order to answer specific questions in the problems.

Assignment

Review your linear algebra and probability. Review any concepts mentioned/reviewed in class with which you are not completely familiar, by going back to your linear algebra and probability textbooks as needed.

Topics in Linear Algebra: vector spaces, vectors and matrices, operations between them, linear operators, key subspaces associated with linear operators (kernel, range; rank); transposition and inversion; norms, inner products; orthogonal matrices; projections; positive definite matrices; eigenvalues and eigenvectors. (These is a non-exhaustive list; some of these topics, especially linear operators, will be reviewed in class)

Topics in Probability: expectation, variance, covariance; basic probability distributions (Bernoulli, uniform, Gaussian); law of large numbers, central limit theorem, Markov's and Chebychev's inequalities.

Exercises

The exercises below are from the *Foundations of Data Science* lecture notes/book by Kannan et al.; please note that there are different versions of these notes available on the web: the ones I am referring to are the ones linked at on the section of my webpage on this course (linked at just above where you downloaded the homework).

Exercise 1 (20 pts). Exercise 2.1 on page 32.

Exercise 2 (30 pts). Exercise 2.2 on page 32. Then do the same for points draw uniformly from the unit sphere. Compare and contrast the results.

Exercise 3 (20 pts). Exercise 2.9 on page 33.

Exercise 4 (30 pts). Exercise 2.29 on page 33.