Homework 2

MATH 591 Mathematics of Machine Learning
Fall 2019

due: 5pm Nov 4th, submit on MyCourses

Homework based on Lectures from Sept and Oct 1,Oct 3. Refer to corresponding chapters in Bishop, Pattern recognition and machine learning. We covered

- Chapter 3, Linear Regression: Section 3.1 (only).

- Chapter 6, Kernel Methods: Sections 1 and 3 (you should also read section 2).

- Chapter 7, Sparse Kernel Machines: Section 7.1.

- Mohri, Ch 5, Support Vector Machines, Sections 5.1, 5.2, 5.3.

- Mohri, Ch 6, Kernel Methods, Section 6.1, 6.2.

1. *Polynomial least squares* Bishop Chapter 1, Question 1.1.

2. *Projection Matrix.* Bishop Chapter 3, Question 3.2. (You can also refer to a linear algebra textbook, such as Strang, Introduction to Linear Algebra).

3. *Regularized Least Squares and Lagrange Multipliers* Bishop Chapter 3, Question 3.5.

4. *Dual Formulation of Kernels* Bishop Chapter 6, Question 6.1. (Refer also to the class notes).

5. *Rule for Constructing Kernels* Bishop Chapter 6, Question 6.6.

6. *Maximum margin hyperplanes* Consider the data set where the two classes correspond to
$$\{(0,0), (-1,1), (1,-1), (-1,-1)\}, \qquad \{(0,1), (1,0), (1,1)\}$$

   (a) Sketch the classes and the maximum margin hyperplane.

   (b) Write down the corresponding optimization problem $\min \|w\|^2$ subject to $y_i(w \cdot x_i + b) \geq 1$ for all i in this case. (You don't need to solve the problem.)

   (c) Confirm that the margin ρ satisfies $\rho^2 = 1/\|w\|_2^2$.