Homework 1 of CS492(F) Computational Learning Theory
Deadline: 6:00pm on 11 October 2023 (Wednesday)

Submit your solutions in KLMS. (Reminder: We adopt a very strict policy for handling dishonest behaviours. If a student is found to copy answers from fellow students or other sources in his or her homework submission, she or he will get F.)

The numbers in the questions refer to exercise questions in the textbook of the course, i.e. "Foundations of Machine Learning" (2nd Edition) by Mohri et al.

Question 1

Solve 2.7. (20 marks)

Question 2

Solve 2.10. (20 marks)

Question 3

Solve 2.12. (20 marks)

Question 4

Solve 3.11. In the question 3.11(c), replace the equality by the inequality as follows:

$$\hat{\mathfrak{R}}_S(\mathcal{H}') \leq \frac{\Lambda}{m} \cdot \mathop{\mathbb{E}}_{\sigma} \left[\left\| \sum_{i=1}^{m} \sigma_i \mathbf{x}_i \right\|_2 \right].$$

(20 marks)

Question 5

Solve 3.23.

Hint: I (Hongseok) couldn't figure out how to use the hint in the textbook and prove the bound there. Instead, I proved a different bound shown below:

$$\mathrm{VCDim}(\mathcal{C}_s) \leq \frac{esd}{(e-1)\log 2} \log\left(s \times \frac{e}{\log 2}\right).$$

My proof uses the following lemma: for all $x \geq e$ and all y,

$$\frac{x}{\log x} \leq y \implies x \leq \frac{e}{e-1} \times y \log y.$$

If you want to follow my path, you will have to show the above lemma and use it to derive my upper bound. (20 marks)