Homework 4: Due December 20

Reading: Read section 3.3 and 3.4 of course notes.

1. Prove Theorem 3.13.

   Hint: Adapt the proof of Theorem 3.12.

2. Reformulate and prove Theorem 3.8 for linear models $\mathbb{R}^D \to \mathbb{R}^N$ and the quadratic loss $\ell(y, \hat{y}) = \|y - \hat{y}\|^2$.

3. Prove Proposition 3.14.

4. From the `RDatasets` package in `Julia` load the `pressure` data set. This data set contains the variables `temperature` and `pressure`, which give the values of pressure of mercury depending on temperature.

   The Antoine equation is a simple model for this dependency: $\log(\texttt{pressure}) = a - \frac{b}{\texttt{temperature}}$.

   Set up and solve a regression problem to estimate a and b.

5. (**Hand in**) Let $w_1, \ldots, w_n \in \mathbb{R}$. Prove that the median of the w_i minimizes the aggregated distances $d(v) = \sum_{i=1}^{n} |w_i - v|$. Recall this is used in finding the linear constant when working with Dual SVM.

6. Exercise 3.8 of the course notes. The `MNIST` database inside `MLDatasets.jl` consists of handwritten digits from 0 to 9. Adapting the `classification` notebook (Notebook 5) and restricting the dataset to pictures of 0s and 1s only, set up a support vector machine to distinguish 0s from 1s.

   Note: when loading the `MNIST` database for the first time, digit "y" when prompted to download the database.