Homework Assignment 1
Perceptron and Logistic Regression

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1. When defining a perceptron, we have augmented an input vector $\mathbf{x}$ with an extra 1:
$$M(\mathbf{x}) = \text{sign}(\mathbf{w}^\top \tilde{\mathbf{x}}),$$
where $\tilde{\mathbf{x}} = [\mathbf{x}; 1]$. Why is this necessary? Provide an example in which this extra 1 is necessary.

2. We used the following distance function for perceptron in the lecture:
$$D(M^*(\mathbf{x}), M, \mathbf{x}) = -(M^*(\mathbf{x}) - M(\mathbf{x})) \left(\mathbf{w}^\top \tilde{\mathbf{x}} \right).$$
This distance function has a problem of a trivial solution. What is the trivial solution? Propose a solution to this.

3. The distance function of logistic regression was defined as
$$D(y^*, \mathbf{w}, \mathbf{x}) = -(y^* \log M(\mathbf{x}) + (1 - y^*) \log(1 - M(\mathbf{x}))).$$
Derive its gradient with respect to the weight vector $\mathbf{w}$ step-by-step.

4. (Programming Assignment) Complete the implementation of perceptron and logistic regression using Python and scikit-learn. The completed notebooks must be submitted together with the answers to the questions above.

Perceptron https://github.com/nyu-dl/Intro_to_ML_Lecture_Note/blob/master/notebook/Perceptron1.ipynb

Logistic Regression https://github.com/nyu-dl/Intro_to_ML_Lecture_Note/blob/master/notebook/Logistic%20Regression%201.ipynb