Labs
Machine Learning Course
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Problem Set 11, Nov 30, 2017
(Theory Questions, PyTorch Introduction)

Goals. The goal of this exercise is to

- familiarize yourself with the theory related to SVD.
- introduce you to the PyTorch platform.

1 Theory Questions

Problem 1 (How to compute U and S efficiently):

In class, we saw that solving the eigenvector/value problem for the matrix $\boldsymbol{X}\boldsymbol{X}^\top$ gives us a way to compute $\boldsymbol{U}$ and $\boldsymbol{S}$. But in some instances $D \gg N$. In those cases, is there a way to accomplish this computation more efficiently?

Problem 2 (Positive semi-definite):

Show that if $\boldsymbol{X}$ is a $N \times N$ symmetric matrix then the SVD has the form $\boldsymbol{U}\boldsymbol{S}\boldsymbol{U}^\top$, where $\boldsymbol{U}$ is a $N \times N$ unitary matrix and $\boldsymbol{S}$ is a $N \times N$ diagonal matrix with non-necessarily positive entries. Show that if $\boldsymbol{X}$ is positive semi-definite, then all entries of $\boldsymbol{S}$ are non-negative.

2 PyTorch Getting Started

Tutorials. Installation instructions:

pytorch.org

We recommend using the following online tutorial:

pytorch.org/tutorials/beginner/pytorch_with_examples.html

Setup, data, and sample code. Obtain the folder `labs/ex11` of the course github repository

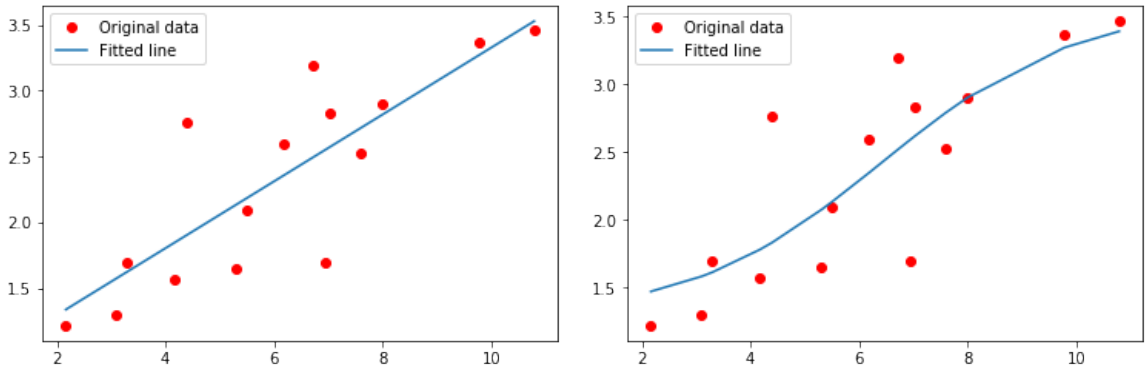
github.com/epfml/ML_course

Exercise 1: Torch Familiarize yourself with the basics of pytorch through the tutorial.

Exercise 2: Basic Linear Regression

- Implement prediction and loss computation for linear regression in the `MyLinearRegression` class.
- Implement the gradient descent steps in the `train` function.
- **HINT:** don't forget to clear the gradients computed at previous steps.

Your output should be similar to that of Fig. 1, left.



(a) Prediction with linear regression

(b) Prediction with MLP

Figure 1: Predictions made by various trained models.

Exercise 3: NN package

- Re-Implement Linear Regression using the routines from the `nn` package for defining parameters and loss in the `NNLinearRegression` class. Does the result that you obtain differ from the previous one? If so, why?
- Combine two linear layers and a non-linearity (sigmoid or ReLU) layer to build a Multi-Layer Perceptron (MLP) with one hidden layer, in the `MLP` class. Find the optimal hyper-parameters for training it.

Your prediction using the MLP should be non-linear, and for a hidden size of 2 might look like Fig. 1, right.