Columbia University – Fall 2013

Machine Learning Homework #1

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1 Problem 1

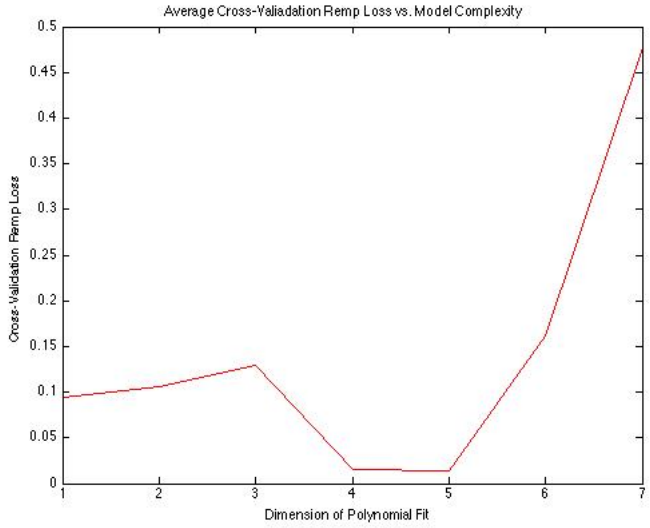
In this problem we investigate fitting a polynomial model and regression to a dataset consiting of 10 data points. Our d-dimensional polynomail function, f, is described below,

$$f(x;\boldsymbol{\theta}) = \boldsymbol{\theta}_0 + \boldsymbol{\theta}_1 x_1 + \boldsymbol{\theta}_2 x_2 + ... + \boldsymbol{\theta}_d x_d \tag{1.1}$$

where $\boldsymbol{\theta}$ is the learned parameters of our model, and x is a given data point. We choose to use squared error for our empirical loss function to gauge how well our model fits the data present. The equation for empirical loss can be seen below, where x represents the given data points, y represents the output, which our function f is attempting to solve for.

$$R_{emp}(\boldsymbol{\theta}) = \frac{1}{N}\sum_{i=1}^{n}(y_i - f(x_i;\boldsymbol{\theta}))^2 \tag{1.2}$$

We perform cross-validation to find the adequate dimensionality of an appropriate model. The cross-validation performed is completed 1000 times for each model complexity with train/test split of 9 points for training and 1 point for testing. The results of the cross-validation can be seen in Figure 1., and we can see that a model of 4 or 5 dimesions is suitable for this dataset. Models with lower than 4-dimensions have a hard time describing the variation in the data, where as models with many more than 4-dimensions tend to overfit.



1.1 Heading on level 2 (subsection)

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$$A = \begin{bmatrix} A_{11} & A_{21} \\ A_{21} & A_{22} \end{bmatrix} \tag{1.3}$$

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1.1.1 Heading on level 3 (subsubsection)

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2 Lists

2.1 Example of list (3*itemize)

- First item in a list
  - First item in a list
    - First item in a list
    - Second item in a list
  - Second item in a list
- Second item in a list

2.2 Example of list (enumerate)

1. First item in a list
2. Second item in a list
3. Third item in a list