

MACHINE LEARNING (IMC-4302C)

LAB 5: MODEL SELECTION, CROSS VALIDATION AND REGULARIZATION

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School Year
2017-2018

6/3/2018

About Lab 5

- **Outline:**

- Split data to train and test set with predefined function in sklearn library or by hand with random permutation.
- Select polynomial model with best performance on cross validation set. Then, estimate the generalized performance on test set.
- Implement regularized cost and gradient function and visualize the effect of regularization on classification problem.

Regularization

- **Cost function:** $J_{Reg}(\theta) = J(\theta) + \frac{\lambda}{2} \times \sum_{j=1}^{n-1} \theta_j^2$

Where:

$$J(\theta) = \frac{-1}{m} \sum_{i=1}^m [y \times \log(h_{\theta}(x)) + (1 - y) \times \log(1 - h_{\theta}(x))]$$

$$h_{\theta}(x_i) = \text{sigmoid}(\theta^{\top} x_i) = \frac{1}{1 + e^{-\theta^{\top} x_i}}$$

Regularization

• **Cost function gradient:** $\nabla J_{Reg}(\theta) = \begin{bmatrix} \frac{\partial J(\theta)}{\partial \theta_0} \\ \frac{\partial J(\theta)}{\partial \theta_1} \\ \vdots \\ \frac{\partial J(\theta)}{\partial \theta_{n-1}} \end{bmatrix} + \lambda \begin{bmatrix} 0 \\ \theta_1 \\ \vdots \\ \theta_{n-1} \end{bmatrix}$

Where:

$$\frac{\partial J(\theta)}{\partial \theta_j} = \frac{1}{m} \sum_{i=1}^m (h_{\theta}(x_i) - y_i) x_j \quad j = 0 \dots n - 1$$

$$h_{\theta}(x_i) = \text{sigmoid}(\theta^{\top} x_i) = \frac{1}{1 + e^{-\theta^{\top} x_i}}$$