Support Vector Machine

COMP 4211 - Tutorial 08

Chun-Kit Yeung

Hong Kong University of Science and Technology

2018-04-13

Objective

In this tutorial, we will review the linear SVM and implement it using scikit-learn.

Agenda

1. Review of linear SVM.
2. Use SVM from scikit-learn.

Recap Quiz

- What is the central idea/objective about SVM?
- How to formulate the objective of SVM mathematically?
- What techniques are used to optimize the objective function in SVM?
- What is introduced if the training data is not linearly separable?
- More questions available on `https://www.analyticsvidhya.com/blog/2017/10/svm-skilltest/`

Recap

What if Training Data not Linearly Separable?

separate the training set with a minimal number of errors

introduce positive slack variables ξ_i's ($\xi_i \geq 0$)

$$\begin{cases} \mathbf{w}'\mathbf{x}_i + b \geq 1 - \xi_i & y_i = 1 \\ \mathbf{w}'\mathbf{x}_i + b \leq -1 + \xi_i & y_i = -1 \end{cases}$$

penalize $\sum_i \xi_i$ in the objective function

$$\min \quad \frac{1}{2}\|\mathbf{w}\|^2 + C\sum_i \xi_i$$

$$\text{s.t.} \quad y_i(\mathbf{w}'\mathbf{x}_i + b) \geq 1 - \xi_i, \xi_i \geq 0$$

- soft margin hyperplane

$$\text{(dual)} \quad \max \quad \sum_{i=1}^{N} \alpha_i - \frac{1}{2}\sum_{i,j=1}^{N} \alpha_i \alpha_j y_i y_j \mathbf{x}_i' \mathbf{x}_j$$

$$\text{s.t.} \quad C \geq \alpha_i \geq 0, \quad i = 1, \ldots, N$$

$$\sum_{i=1}^{N} \alpha_i y_i = 0$$

- still a QP problem → every solution is a global solution

COMP4211 Support Vector Machines (I)

Let's code

To better understand today tutorial, the following .ipynb is covered:

- T08_Linear_SVM.ipynb

SVM in Scikit-learn

`sklearn.svm.SVC`[1] is SVM classifier provided by scikit-learn, and SVC stands for support vector classifier.

```
from sklearn.svm import SVC
clf = SVC(kernel='linear', C=1.0)
clf.fit(X, y)
```

C is the penalty parameter of the error incurred by the slack variables, and `kernel='linear'` indicates the use of linear SVM.

Question: What does a large value of C imply?

[1] More detail can be found on `http://scikit-learn.org/stable/modules/generated/sklearn.svm.SVC.html`.