Traffic Sign detection

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HOG+SVM

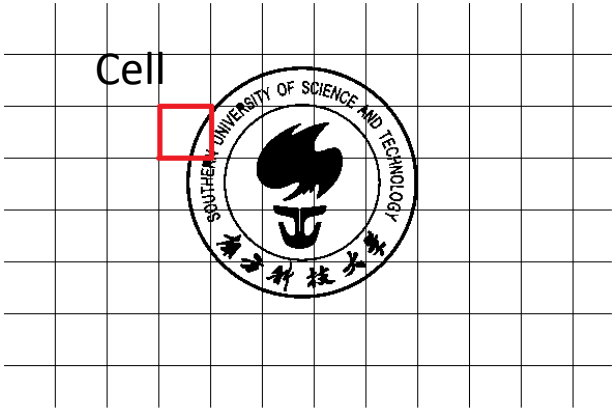
HOG: Extract features

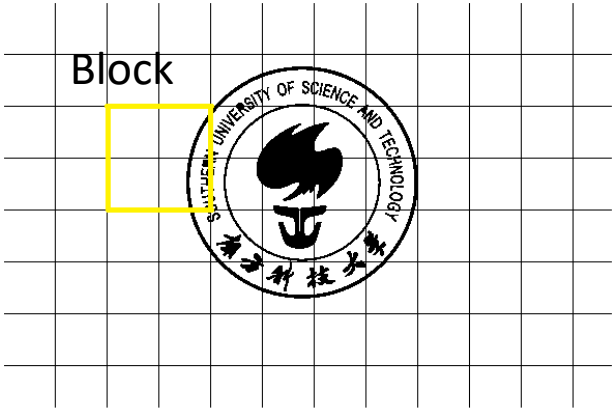
SVM: Classifier(Optimize here)

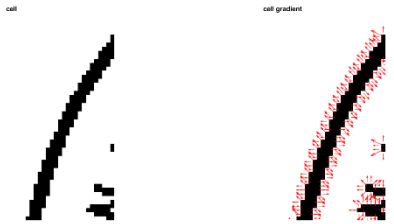
HOG

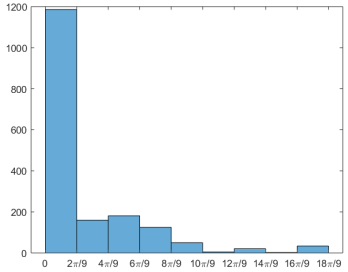
HOG: (Histogram of Oriented Gradient)

Divide image into small connected areas, which we call cell. A gradient or edge direction histogram of each pixel in the cell is then acquired. These histograms can be combined to form a feature descriptor.

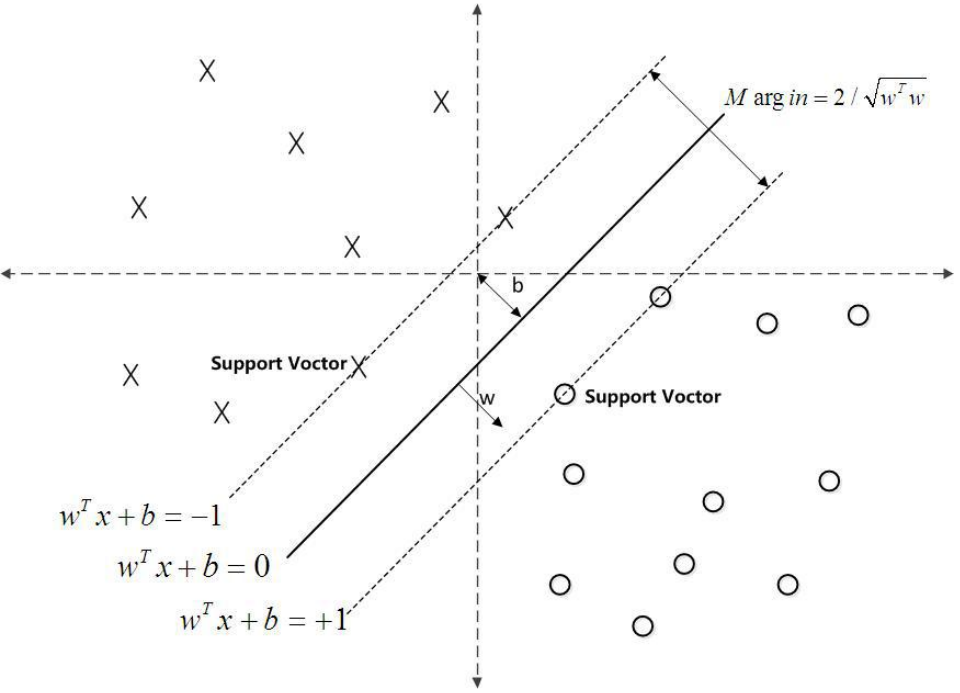








SVM



$$min_{w,b}\ L(w,b,\alpha) = \frac{1}{2}||w||^2 - \sum_{i=1}^{m} \alpha_i [y_i(w^T x_i + b) - 1]$$

$$\frac{\partial L}{\partial w} = 0 \rightarrow w = \sum_{i=1}^{m} \alpha_i y_i x_i$$

$$\frac{\partial L}{\partial b} = 0 \rightarrow \sum_{i=1}^{m} \alpha_i y_i = 0$$

$$max_{\alpha}\ \sum \alpha_i - \frac{1}{2}\sum\sum \alpha_i \alpha_j y_i y_j x_i^T x_j$$

$$s.t\ \sum \alpha_i y_i = 0,\ \alpha_i \geq 0$$

$$min\ \frac{1}{2}||w||^2$$

$$s.t\quad y_i(w^T \times x_i + b) \geq 1$$

So we need to get the α_i, then w will be solved.

HOG+SVM

HOG: Extract features

Each image: $\{x_1, x_2, \dots, x_i\}$, donate the image to be 1 or -1;

……

Samples: we get a matrix

$$\begin{bmatrix} x_{11}, x_{12}, \dots, x_{1l}, 1 \\ x_{21}, x_{22}, \dots, x_{2l}, -1 \\ \dots \\ x_{n1}, x_{n2}, \dots, x_{nl}, -1 \; or \; 1 \end{bmatrix}$$

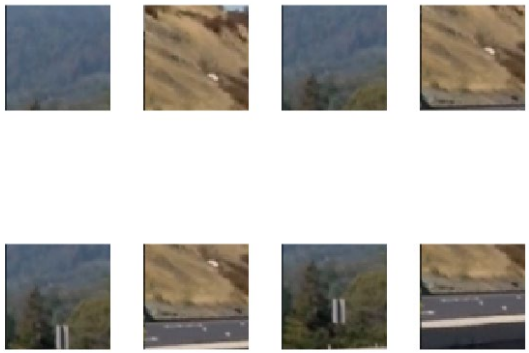
SVM: Classifier

Put the multidimensional matrix into SVM, we get the *support vector, alpha* and *rho.*

Classifier = [*alpha* support vector, rho*]

Project-train

Positive samples(1980): Mark as +1



Negative samples(1980): Mark as -1

Use HOG extract features:

For these 8 images, resize these images to 64×64, each cell have 9 feature, each block have 4 cell. If the sliding window moves every 8 pixels, then we get 7×7 windows. The number of the features is 9×4×7×7=1764.

pos feature

$$\begin{bmatrix} x_{1,1}, x_{1,2}, \dots, x_{1,1764}, 1 \\ x_{2,1}, x_{2,2}, \dots, x_{2,1764}, 1 \\ \dots \\ x_{8,1}, x_{8,2}, \dots, x_{8,1764}, 1 \end{bmatrix}$$

neg feature

$$\begin{bmatrix} x_{1,1}, x_{1,2}, \dots, x_{1,1764}, -1 \\ x_{2,1}, x_{2,2}, \dots, x_{2,1764}, -1 \\ \dots \\ x_{8,1}, x_{8,2}, \dots, x_{8,1764}, -1 \end{bmatrix}$$

Project-train

Mix these features and split it into 2 parts: train set and test set

train set

$$\begin{bmatrix} x_{1,1}, x_{1,2}, \dots, x_{1,1764}, +1 \\ x_{2,1}, x_{2,2}, \dots, x_{2,1764}, -1 \\ \dots \\ x_{8,1}, x_{8,2}, \dots, x_{8,1764}, -1 \end{bmatrix}$$

test set

$$\begin{bmatrix} x_{1,1}, x_{1,2}, \dots, x_{1,1764}, -1 \\ x_{2,1}, x_{2,2}, \dots, x_{2,1764}, +1 \\ \dots \\ x_{8,1}, x_{8,2}, \dots, x_{8,1764}, -1 \end{bmatrix}$$

$$max_{\alpha} \sum \alpha_i - \frac{1}{2} \sum\sum \alpha_i \alpha_j y_i y_j x_i^T x_j$$
$$s.t \ \sum \alpha_i y_i = 0, \alpha_i \geq 0$$

$$min_{\alpha} \frac{1}{2} \sum\sum \alpha_i \alpha_j y_i y_j x_i^T x_j - \sum \alpha_i$$
$$s.t \ \sum \alpha_i y_i = 0, \alpha_i \geq 0$$

Quadratic Problem: *quadprog* function. Then

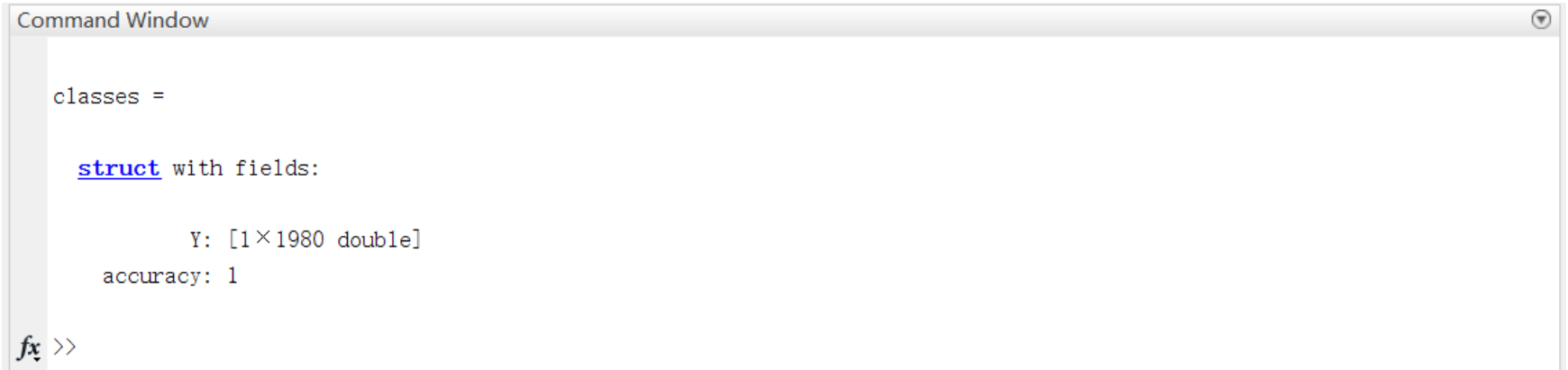
$$w = \sum_{i=1}^{m} \alpha_i \, y_i x_i$$
$$b = y_i - w^T \times x_i$$

y_i: Only the value of support vector can be used here. We donate the image to +1 or -1, but not all the true value of image equal to +1 or -1.

Project-test

Use the test set to get the accuracy of this model. The scale of this model is too small, so the accuracy is high.

My SVM



Matlab SVM

Project-predict

My SVM

Matlab SVM

Project-summary

1. The sliding window's size ?
In different images： 1023×728, 427×640
The signs have different pixel sizes, how to design the window's size.

2. Wrong detection.
Both My SVM and Matlab SVM have wrong detection.

My SVM

Matlab SVM

Reference

1. Zhao J D , Bai Z M , Chen H B . Research on Road Traffic Sign Recognition Based on Video Image[C]// International Conference on Intelligent Computation Technology & Automation. 2017.
2. Garrido M Á G, Sotelo M Á, Martíngorostiza E. Traffic sign detection in static images using Matlab[C]// Emerging Technologies & Factory Automation, Etfa 03 IEEE Conference. 2003.
3. 凸优化-对偶问题 http://www.hanlongfei.com/convex/2015/11/05/duality/

Gantt Chart

Student Name	卢博
Student ID	11849159

Task Name	Start	End	Duration (days)
Data collect	2018/11/20	2018/11/25	5
Data Process	2018/11/26	2018/12/2	6
Sample Training	2018/12/3	2018/12/9	6
Test Data	2018/12/10	2018/12/16	6
Fix bug	2018/12/17	2018/12/23	6
Report	2018/12/24	2018/12/27	3