libSVM

LING572
Advanced Statistical Methods for NLP
February 18, 2020

Documentation

- http://www.csie.ntu.edu.tw/~cjlin/libsvm/

- The libSVM directory on Patas:

  /NLP_TOOLS/ml_tools/svm/libsvm/latest/
  - README
  - FAQ.html
  - svm-train, svm-predict, etc.

- More info:
  - A practical guide to support vector classification
  - LIBSVM : a library for support vector machines

Steps for using libSVM

- Define features in the input space (if using one of the pre-defined kernel functions)
- Scale the data before training/test
- Choose a kernel function
- Tune parameters using cross-validation

Main commands

- svm-scale: scaling the data
- svm-train: training
- svm-predict: decoding

Scaling the data

- To avoid features with larger variance dominating those with smaller variance.

- Scale each feature to the range [-1,+1] or [0,1].
  - [0,1] is faster than [-1,1]

svm-scale

- svm-scale -l -1 -u 1 -s range_file training_data > training_data.scale
- svm-scale -r range_file test_data > test_data.scale
- Scale feature values to [-1, 1] or [0,1]
- No need to scale the data for HW7.

svm-train

- svm-train [options] training_data model_file

- Options:

  -t [0-3]: kernel type

  -g gamma: used in polynomial, RBF, sigmoid

  -d degree: used in polynomial

  -r coef0: used in polynomial, sigmoid

- Type “svm-train” to see options

Kernel functions

-t kernel_type : set type of kernel function (default 2)

0: linear: u'*v

1: polynomial: (gamma*u'*v + coef0)^degree

2: RBF: exp(-gamma*|u-v|^2)

3: sigmoid: tanh(gamma*u'*v + coef0)

svm-predict

- svm-predict test_data model_file output_file
- svm-predict produces only the system prediction in output_file.
- You will implement your own decoder in Hw7.

The format of training/test data

- Sparse format: no need to include features with value zero.

- Mallet format:

  truelabel f1: v1 f2: v2 …..

- libSVM format:

  truelabel_idx feat_idx1:v1 feat_idx2:v2 ….

  (feat_idx, v) is sorted according to feat_idx in ascending order.

  Ex: 1 20:1 23:0.5 34:-1 …

When there are two classes

The format of the model file

svm_type c_svc

kernel_type rbf

gamma 0.5

nr_class 2

total_sv 535

rho 0.281122

label 0 1

nr_sv 272 263

SV

0.98836 0:1 1:1 2:1 3:1 4:1 5:1 …

…

This is weight for the support vector, which is equal to $\alpha_i y_i$.

This is a support vector with the format f1:v1 f2:v2 ...

Classifying an instance x

$$f(x) = \sum_i \alpha_i y_i K(x_i, x) - \rho$$

$$= \sum_i weight_i \; K(x_i, x) - \rho$$

where y_i (i.e., x_i's label) is +1 ("c_0") or -1 ("c_1").

if $f(x) > 0$

then label it with c_0

else label it with c_1

Notation differences

	In SVM paper	In libSVM
Model	x_i, y_i, α_i b	$weight_i$, x_i ρ
Prediction	$\sum_i \alpha_i y_i K(x_i, x) + b$	$\sum_i weight_i K(x_i, x) - \rho$
Representing y_i in training/test/output	+1 -1	0 1

System output of svm-predict

0 $\#\# \ c_0$

0

1 $\#\# \ c_1$

1

0

0

1

0

Additional slides

When there are C classes

Handling a multi-class task

- All-pair

- Build a classifier for every (c_m, c_n) pairs
  - There are C(C-1)/2 classifiers

- The classifiers are stored in a compact format.

The format of the model file (when there are C>2 classes)

svm_type c_svc

kernel_type rbf

gamma 0.5

nr_class 3

total_sv 2698

rho -0.0111642 -0.00216906 0.00951624

label 0 1 2

nr_sv 900 898 900

SV

0.98836 0.9975 0:1 1:1 2:1 3:1 4:1 5:1 …

…

The rho array

It contains C(C-1)/2 elements, one per classifier

0 vs. 1, 0 vs. 2, …, 0 vs. C-1,

1 vs. 2, 1 vs. 3, …, 1 vs. C-1

2 vs. 3, …, 2 vs. C-1

…

C-2 vs. C-1

The format of the SV line

Each line includes C-1 weights (i.e., y_i α_i) followed by the vector.

w1 w2 … w_{C-1} f1:v1 f2:v2 ….

Suppose the current vector belongs to the i-th class, the weights are ordered as follows:

0 vs. i 1 vs. i 2 vs i …. i-1 vs i

i vs. i+1 i vs i+2 i vs i+3 …. i vs C-1

Ex1: i=0

0 vs. 1, 0 vs. 2, 0 vs. 3, …., 0 vs. C-1

Ex2: i=4

0 vs 4, 1 vs 4, 2 vs. 4, 3 vs. 4, 4 vs. 5, 4 vs. 6, …, 4 vs. C-1

Classifying an instance x

win[m]=0 for every class m

For each classifier for (m,n)

$$f(x) = \sum_i \alpha_i y_i K(x_i, x) - \rho$$

$$= \sum_i weight_i \; K(x_i, x) - \rho$$

where x_i is a training instance with label c_m or c_n.

if $f(x) > 0$

then $win[m]{+}{+}$

else $win[n]{+}{+}$

sysLabel = arg max_m $win[m]$

To classify x with a m-vs-n classifier (m < n):

ρ is stored at what position?

For each x_i belonging to c_m
    ## 0 vs. m, 1 vs. m, ..., m-1 vs. m,
    ## m vs. m+1, m vs. m+2, ..., m vs. n, ...
    the weight for m-vs-n is stored at position n-1

For each x_i belonging to c_n
    ## 0 vs. n, 1 vs. n, 2 vs. n, ..., m vs. n, ...
    the weight for m-vs-n is stored at position m