

Contents

1	Introduction	1
1.1	An Overview of Machine Learning	1
1.2	Challenges in Machine Learning	3
1.2.1	Solving Large-Scale SVMs	4
1.2.2	Feature Reduction with Support Vector Machines	5
1.2.3	Graph-Based Semi-supervised Learning Algorithms	6
1.2.4	Unsupervised Learning Based on Principle of Redundancy Reduction	7
2	Support Vector Machines in Classification and Regression – An Introduction	11
2.1	Basics of Learning from Data	12
2.2	Support Vector Machines in Classification and Regression	21
2.2.1	Linear Maximal Margin Classifier for Linearly Separable Data	21
2.2.2	Linear Soft Margin Classifier for Overlapping Classes	32
2.2.3	The Nonlinear SVMs Classifier	36
2.2.4	Regression by Support Vector Machines	48
2.3	Implementation Issues	57
3	Iterative Single Data Algorithm for Kernel Machines from Huge Data Sets: Theory and Performance	61
3.1	Introduction	61
3.2	Iterative Single Data Algorithm for Positive Definite Kernels without Bias Term b	63
3.2.1	Kernel AdaTron in Classification	64
3.2.2	SMO without Bias Term b in Classification	65
3.2.3	Kernel AdaTron in Regression	66
3.2.4	SMO without Bias Term b in Regression	67
3.2.5	The Coordinate Ascent Based Learning for Nonlinear Classification and Regression Tasks	68

3.2.6	Discussion on ISDA Without a Bias Term b	73
3.3	Iterative Single Data Algorithm with an Explicit Bias Term b .	73
3.3.1	Iterative Single Data Algorithm for SVMs Classification with a Bias Term b	74
3.4	Performance of the Iterative Single Data Algorithm and Comparisons	80
3.5	Implementation Issues	83
3.5.1	Working-set Selection and Shrinking of ISDA for Classification	83
3.5.2	Computation of the Kernel Matrix and Caching of ISDA for Classification	89
3.5.3	Implementation Details of ISDA for Regression	92
3.6	Conclusions	94
4	Feature Reduction with Support Vector Machines and Application in DNA Microarray Analysis	97
4.1	Introduction	97
4.2	Basics of Microarray Technology	99
4.3	Some Prior Work	101
4.3.1	Recursive Feature Elimination with Support Vector Machines	101
4.3.2	Selection Bias and How to Avoid It	102
4.4	Influence of the Penalty Parameter C in RFE-SVMs	103
4.5	Gene Selection for the Colon Cancer and the Lymphoma Data Sets	104
4.5.1	Results for Various C Parameters	104
4.5.2	Simulation Results with Different Preprocessing Procedures	107
4.6	Comparison between RFE-SVMs and the Nearest Shrunk Centroid Method	112
4.6.1	Basic Concept of Nearest Shrunk Centroid Method . .	112
4.6.2	Results on the Colon Cancer Data Set and the Lymphoma Data Set	115
4.7	Comparison of Genes' Ranking with Different Algorithms	120
4.8	Conclusions	122
5	Semi-supervised Learning and Applications	125
5.1	Introduction	125
5.2	Gaussian Random Fields Model and Consistency Method	127
5.2.1	Gaussian Random Fields Model	127
5.2.2	Global Consistency Model	130
5.2.3	Random Walks on Graph	133
5.3	An Investigation of the Effect of Unbalanced labeled Data on CM and GRFM Algorithms	136
5.3.1	Background and Test Settings	136

5.3.2	Results on the <i>Rec</i> Data Set	139
5.3.3	Possible Theoretical Explanations on the Effect of Unbalanced Labeled Data	139
5.4	Classifier Output Normalization: A Novel Decision Rule for Semi-supervised Learning Algorithm	142
5.5	Performance Comparison of Semi-supervised Learning Algorithms	145
5.5.1	Low Density Separation: Integration of Graph-Based Distances and ∇ TSM	146
5.5.2	Combining Graph-Based Distance with Manifold Approaches	149
5.5.3	Test Data Sets	150
5.5.4	Performance Comparison Between the LDS and the Manifold Approaches	152
5.5.5	Normalizatioin Steps and the Effect of σ	154
5.6	Implementation of the Manifold Approaches	154
5.6.1	Variants of the Manifold Approaches Implemented in the Software Package SemiL	155
5.6.2	Implementation Details of SemiL	157
5.6.3	Conjugate Gradient Method with Box Constraints	162
5.6.4	Simulation Results on the <i>MNIST</i> Data Set	166
5.7	An Overview of Text Classification	167
5.8	Conclusions	171
6	Unsupervised Learning by Principal and Independent Component Analysis	175
6.1	Principal Component Analysis	180
6.2	Independent Component Analysis	197
6.3	Concluding Remarks	208
A	Support Vector Machines	209
A.1	L2 Soft Margin Classifier	210
A.2	L2 Soft Regressor	211
A.3	Geometry and the Margin	213
B	Matlab Code for ISDA Classification	217
C	Matlab Code for ISDA Regression	223
D	Matlab Code for Conjugate Gradient Method with Box Constraints	229
E	Uncorrelatedness and Independence	233

**F Independent Component Analysis by Empirical
Estimation of Score Functions i.e., Probability Density
Functions 237**

G SemiL User Guide 241

 G.1 Installation 241

 G.2 Input Data Format 243

 G.2.1 Raw Data Format: 243

 G.3 Getting Started 244

 G.3.1 Design Stage..... 245

References 247

Index 257