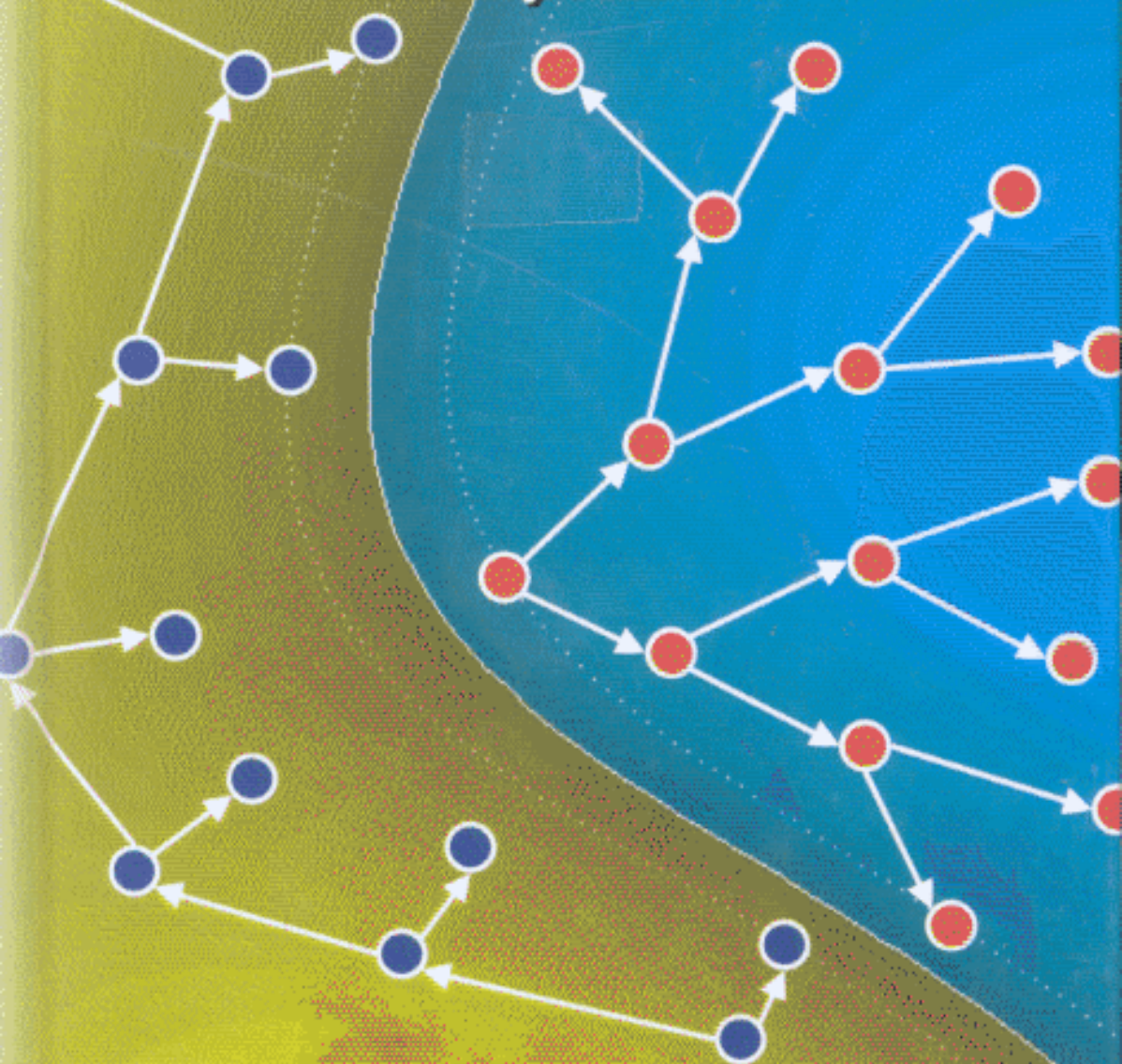


Machine Learning

Discriminative and Generative

Tony Jebara



Kluwer Academic Publishers

Contents

List of Figures	ix
List of Tables	xi
Preface	xiii
Acknowledgments	xvii
1. INTRODUCTION	1
1 Machine Learning Roots	2
2 Generative Learning	5
2.1 Generative Models in AI	8
2.2 Generative Models in Perception	8
2.3 Generative Models in Tracking and Dynamics	9
3 Why a Probability of Everything?	9
4 Discriminative Learning	10
5 Objective	12
6 Scope and Organization	14
7 Online Support	15
2. GENERATIVE VERSUS DISCRIMINATIVE LEARNING	17
1 Two Schools of Thought	18
1.1 Generative Probabilistic Models	19
1.2 Discriminative Classifiers and Regressors	21
2 Generative Learning	22
2.1 Bayesian Inference	23
2.2 Maximum Likelihood	24
2.3 The Exponential Family	25
2.4 Maximum Entropy	28
2.5 Expectation Maximization and Mixtures	32

2.6	Graphical Models	36
3	Conditional Learning	42
3.1	Conditional Bayesian Inference	43
3.2	Maximum Conditional Likelihood	46
3.3	Logistic Regression	47
4	Discriminative Learning	48
4.1	Empirical Risk Minimization	48
4.2	Structural Risk Minimization	49
4.3	VC Dimension and Large Margins	50
4.4	Support Vector Machines	52
4.5	Kernel Methods	55
5	Averaged Classifiers	57
6	Joint Generative-Discriminative Learning	58
3.	MAXIMUM ENTROPY DISCRIMINATION	61
1	Regularization Theory and Support Vector Machines	62
1.1	Solvability	64
1.2	Support Vector Machines and Kernels	65
2	A Distribution over Solutions	66
3	Augmented Distributions	69
4	Information and Geometry Interpretations	72
5	Computing the Partition Function	74
6	Margin Priors	75
7	Bias Priors	78
7.1	Gaussian Bias Priors	78
7.2	Non-Informative Bias Priors	78
8	Support Vector Machines	79
8.1	Single Axis SVM Optimization	80
8.2	Kernels	81
9	Generative Models	81
9.1	Exponential Family Models	82
9.2	Empirical Bayes Priors	84
9.3	Full Covariance Gaussians	86
9.4	Multinomials	91
10	Generalization Guarantees	93
10.1	VC Dimension	93
10.2	Sparsity	94
10.3	PAC-Bayes Bounds	95

4. EXTENSIONS TO MED	99
1 Multiclass Classification	100
2 Regression	102
2.1 SVM Regression	103
2.2 Generative Model Regression	105
3 Feature Selection and Structure Learning	105
3.1 Feature Selection in Classification	106
3.2 Feature Selection in Regression	110
3.3 Feature Selection in Generative Models	113
4 Kernel Selection	114
5 Meta-Learning	117
6 Transduction	120
6.1 Transductive Classification	121
6.2 Transductive Regression	125
7 Other Extensions	129
5. LATENT DISCRIMINATION	131
1 Mixture Models and Latent Variables	133
2 Iterative MED Projection	137
3 Bounding the Latent MED Constraints	138
4 Latent Decision Rules	143
5 Large Margin Mixtures of Gaussians	144
5.1 Parameter Distribution Update	145
5.2 Just a Support Vector Machine	148
5.3 Latent Distributions Update	149
5.4 Extension to Kernels	154
5.5 Extension to Non Gaussian Mixtures	155
6 Efficiency	155
6.1 Efficient Mixtures of Gaussians	160
7 Structured Latent Models	161
8 Factorization of Lagrange Multipliers	166
9 Mean Field for Intractable Models	168
6. CONCLUSION	171
1 A Generative and Discriminative Hybrid	172
2 Designing Models versus Designing Kernels	174
3 What's Next?	176

7. APPENDIX	179
1 Optimization in the MED Framework	179
1.1 Constrained Gradient Ascent	179
1.2 Axis-Parallel Optimization	181
1.3 Learning Axis Transitions	183
Index	199