

Contents

Abstract / Resumen / Resum	iii
Acknowledgments	v
Contents	vii
List of Figures	xi
List of Tables	xiii
Notation	xv
Abbreviations and Acronyms	xvii
1 Introduction	1
1.1 Goals of the Thesis	3
1.2 Organization of the Thesis	4
2 Classification Problems and Dimensionality Reduction	5
2.1 Statistical Pattern Classification	5
2.1.1 Review of Related Work	6
2.2 Dimensionality Reduction in Classification	8
2.2.1 Review of Related Work	9
3 Learning Projections and Prototypes for Classification	11
3.1 Estimation of the 1-NN Error Probability	12
3.2 Optimization Approximations	14
3.3 The LDPP Algorithm	17
3.4 Discussion	18
3.5 Using LDPP only for Dimensionality Reduction	19
3.6 Orthonormality Constraint	20
3.7 Algorithm Convergence and the Sigmoid Slope	21
3.8 Distances Analyzed	21
3.8.1 Euclidean Distance	21
3.8.2 Cosine Distance	23

3.9	Normalization and Learning Factors	24
3.10	Experiments	26
3.10.1	Data Visualization	27
3.10.2	UCI and Statlog Corpora	30
3.10.3	High-Dimensional Data Sets	33
3.11	Conclusions	38
4	Modeling Variability Using Tangent Vectors	41
4.1	Overview of the Tangent Vectors	41
4.1.1	Tangent Distance	43
4.1.2	Estimation of Tangent Vectors	45
4.2	Principal Component Analysis	47
4.2.1	Tangent Vectors in PCA	48
4.3	Linear Discriminant Analysis	49
4.3.1	Tangent Vectors in LDA	50
4.4	Spectral Regression Discriminant Analysis	51
4.4.1	Tangent Vectors in SRDA	53
4.5	LDPP Using the Tangent Distances	54
4.6	Experiments	56
4.6.1	Gender Recognition	57
4.6.2	Emotion Recognition	58
4.6.3	Face Identification	59
4.6.4	LDPP Using the Tangent Distances	61
4.7	Conclusions	64
5	Regression Problems and Dimensionality Reduction	65
5.1	Regression Analysis	65
5.1.1	Review of Related Work	66
5.2	Dimensionality Reduction in Regression	67
5.2.1	Review of Related Work	67
5.3	Learning Projections and Prototypes for Regression	68
5.3.1	Normalization and the LDPPR Parameters	72
5.4	Experiments	73
5.4.1	StatLib and UCI Data Sets	74
5.4.2	High-Dimensional Data Sets	76
5.5	Conclusions	78
6	Ranking Problems and Score Fusion	81
6.1	Review of Related Work	82
6.2	Score Fusion by Maximizing the AUC	83
6.2.1	Score Normalization	83
6.2.2	Score Fusion Model	84
6.2.3	AUC Maximization	84
6.2.4	Notes on the Implementation of the Algorithm	86
6.2.5	Extensions of the Algorithm	87
6.3	Biometric Score Fusion	87

6.4	Estimation of Quality by Fusion	90
6.4.1	Proposed Quality Features	91
6.4.2	Quality Fusion Methods for Frame Selection	91
6.4.3	Experimental Results	92
6.5	Conclusions	95
7	General Conclusions	97
7.1	Directions for Future Research	99
7.2	Scientific Publications	100
A	Mathematical Derivations	103
A.1	Chapter 3	103
A.1.1	Gradients of the Goal Function in LDPP	103
A.1.2	Gradients of the Euclidean Distance in LDPP	103
A.1.3	Gradients of the Cosine Distance in LDPP	104
A.1.4	Dependence of the LDPP Parameters on the Distance	105
A.1.5	Normalization Compensation	106
A.2	Chapter 4	106
A.2.1	The Single Sided Tangent Distance	106
A.2.2	Principal Component Analysis	107
A.2.3	Linear Discriminant Analysis	108
A.2.4	Between Scatter Matrix Accounting for Tangent Vectors	108
A.2.5	Covariance Matrix Accounting for Tangent Vectors	109
A.2.6	Gradients of the Tangent Distance in LDPP	110
A.3	Chapter 5	111
A.3.1	Gradients of the Goal Function in LDPPR	111
A.4	Chapter 6	112
A.4.1	Gradients of the Goal Function in SFMA	112
A.4.2	Constraints in SFMA	113
Bibliography		115