

Contents

Introduction	1
1 Hidden Markov models and related models	5
1.1 Finite mixture models	5
1.2 Hidden Markov models	8
1.3 Switching regression models	12
1.4 Other related models	13
1.5 Notation and standing assumptions	15
2 Testing in HMMs under nonstandard conditions	17
2.1 Likelihood inference for HMMs	20
2.1.1 MLE and LRT under standard conditions for HMMs	21
2.1.2 MLE and LRT under nonstandard conditions for HMMs	24
2.2 Examples	27
2.3 Simulations and empirical illustration	34
2.3.1 Some notes on numerical evaluation	34
2.3.2 Quality of asymptotic approximation for the MLE and LRT	36
2.3.3 Series of epileptic seizure counts	43
2.4 Proofs	45
3 Testing for the number of states	51
3.1 Testing for the number of components in a finite mixture model	54
3.1.1 Testing for homogeneity in a finite mixture model	55
3.1.2 Testing for two components in a finite mixture model	58
3.2 Testing for the number of states in an HMM	64
3.2.1 The LRT under independence assumption	66
3.2.2 Testing for homogeneity in an HMM	68
3.2.3 Testing for two states in an HMM	69

3.2.4	Simulation experiments	71
3.2.5	Empirical illustrations: Series of the S&P 500	79
3.3	Testing for the number of components in a switching regression model	82
3.3.1	Testing for homogeneity in a switching regression model	84
3.3.2	Testing for two components in a switching regression model	85
3.3.3	Simulation experiments	90
3.3.4	Empirical illustration: Application to dental health trial	93
3.4	Proofs	97
4	Modeling HMMs with flexible state-dependent distributions	103
4.1	An HMM with flexible sdfs: a parametric approach	104
4.2	An HMM with flexible sdfs: a semiparametric approach	106
4.2.1	Semiparametric mixtures	107
4.2.2	Semiparametric HMMs	107
4.3	Simulation experiments	112
4.4	Proofs	118
	Bibliography	120