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Hidden Markov Processes

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ABSTRACT

Hidden Markov processes (HMP's) are discrete-time finite-state homogeneous Markov chains observed through time-invariant memoryless channels. The hookup of Markov chains with memoryless channels provides a rich family of parametric models that was found useful in many applications. In the past two decades the theory of HMP's was substantially advanced. In this paper an overview of HMP's from the statistical and information theoretic viewpoints is presented. In particular, statistical properties of HMP's and ergodic theorems for the sample entropy and relative entropy densities of HMP's are presented. Asymptotic optimality of the maximum likelihood parameter estimator, which was only recently proved, is reviewed. Algorithms estimating the state, parameter, and order, are described. Similarly, algorithms for universal coding and classification of HMP's as well as for universal decoding of finite-state channels, which are hidden Markov channels, are described.

Index Terms: hidden Markov models; entropy ergodic theorems; mixture processes; identifiability; maximum likelihood estimation; Baum-Petrie algorithm; EM-algorithm; forward-backward algorithm; Viterbi algorithm; Ziv's inequality; order estimation; recursive estimation; Kalman filter; Wonham filter; Lempel-Ziv algorithm; finite-state channels; unifilar sources; universal coding; universal classification; universal channel decoding.

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