ECE 8540
Analysis of Tracking Systems

Assignment 7
Particle Filter

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1 Introduction

This report considers the problem of modeling a system described by Hidden Markov Model(HMM). A Markov model is a stochastic model used to model randomly changing systems. A Markov process is a random process where the future state is independent of the past states given the present state. A Hidden Markov Model is a statistical Markov model in which the system being modeled is assumed to be a Markov process with unobserved (i.e. hidden) states. The aim is to discover the hidden state sequence that most likely describes a given observation sequence.

One solution to this problem is to use the Viterbi algorithm, which finds the single best state sequence for an observation sequence. For example, in speech-to-text (speech recognition), the acoustic signal is treated as the observed sequence of events, and a string of text is considered to be the "hidden cause" of the acoustic signal. The Viterbi algorithm finds the most likely string of text given the acoustic signal.

The problem considered for this report is a simple HMM which comprises of two states, H(High GC content) and L(Low GC content). State H characterizes coding DNA while state L characterizes non-coding DNA. The model is used to predict the region of coding DNA from a given sequence.

2 Methods

This section describes the implementation of the Viterbi algorithm to find the hidden state probabilities for the given problem.

The HMM in consideration is shown in Figure 1. The model consists of two states, labeled H and L in the example, which can be given numerical values of 0 and 1. The prior probabilities are 0.5, 0.5. The state transition probabilities are 0.5, 0.5 for state 0 and 0.4, 0.6 for state 1. Each state observes a discrete value that takes on one of four values A, C, G, T that can be given numerical values 0, 1, 2, 3. The emission probabilities of these values are 0.2, 0.3, 0.3, 0.2 for state 0 and 0.3, 0.2, 0.2, 0.3 for state 1.

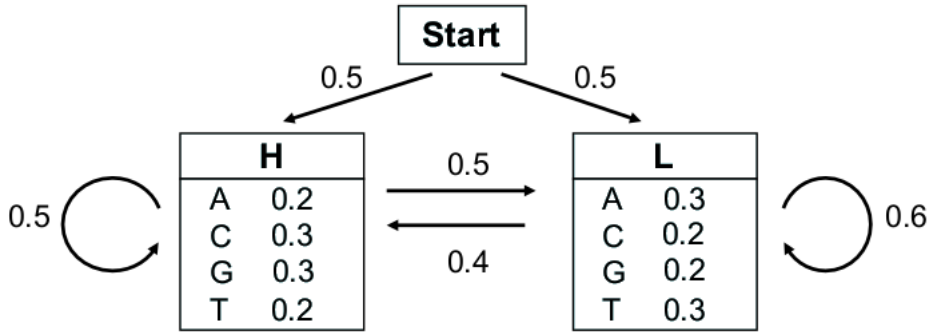

Figure 1: The Hidden Markov Model with H and T States

The Viterbi calculations are done using sums of log_2 probabilities.

There are several paths that lead to the desired sequence of states, but not all of them have the same probabilities. The Viterbi algorithm is a dynamical programming algorithm that computes the most probable path.

The probability of the most probable path ending in state k with observation " i " is:

$$p_l(i,x) = e_l(i) \cdot \max_k(p_k(j,x-1) \cdot p_{kl}) \tag{1}$$

3 Results

4 Conclusion

References

Appendix

MATLAB Code