Stochastic Filtering (SS2016) Exercise Sheet 11

Lecture and Exercises: JProf. Dr. Philipp Harms
Due date: July 13, 2016

11.1. Viterbi algorithm: discussion

Read Section 3.3 in [2] to find answers to the following questions:

a) What does the Viterbi algorithm compute?

b) What is the difference to the Baum-Welch algorithm?

c) What could be plausible applications of the Viterbi algorithm?

d) How does the Viterbi algorithm work.

11.2. Viterbi algorithm: implementation

Present an implementation of the Viterbi algorithm for an example of your own choice. You may implement the algorithm yourself, find an implementation online, or use a ready-made implementation in R, Matlab, Mathematica, etc. Here are some ideas:

a) The Viterbi algorithm is used to code and decode mobile phone, radio, and TV signals, computer storage, and modem data. An overview of the specific challenges is given in [1]. A simple example is [2, Problem 3.5].

b) In molecular biology, DNA sequence alignment and FRET [2] can be solved using the Viterbi algorithm. It takes only minor steps to modify your implementation of Exercise 4.4 accordingly.

c) Annual average temperatures can be estimated from sequence of tree ring sizes. For example, one could use a HMM with two hidden temperature levels (hot and cold) and three tree observed ring sizes (small, medium, and large).

d) Empirical transition probabilities of characters or words in sample text can be used to define a HMM. Then the Viterbi algorithm can be used to fill gaps in damaged documents, improve results from text or speech recognition, etc.

References

[1] Herbert Dawid, Olaf Joeressen, and Heinrich Meyr. “Viterbi Decoders: High Performance Algorithms and Architectures”. In: *Digital Signal Processing for Multimedia Systems*. CRC Press, 1999. URL: http://www.eecs.berkeley.edu/newton/Classes/EE290sp99/lectures/ee290aSp996_1/vit_chap17.pdf.

[2] Ramon van Handel. *Hidden Markov Models*. Lecture Notes. Princeton University, 2008.