***HMM Classification***

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# 1 Introduction

This readme describes the HMM Classification toolbox. It presents the inputs, the main functions, and the outputs. The user should keep in mind that this HMM classification is for time series of monthly river discharges only.

The root functions of the toolbox are the following .M files:

* **HMM:** This is the main routine that performs the Hidden Markov Model classification on monthly inflow time series of river discharges. The main goals are to 1) calculate the HMM parameters (i.e., ) and 2) determine the sequence of hidden climate states.
* **EMHMM**: This function implements the Expectation-Maximization (EM) algorithm as described in Sections 2.1 of the paper. We use EM algorithm to fit a HMM to the time series of monthly river discharges (i.e., determine the optimal model parameters).
* **Alfabeta:** Performs the Viterbi algorithm (Viterbi, 1967). Viterbi algorithm computes the most likely sequence of states, given the HMM parameters and the observations. To precise, this function computes the logarithms of the forward and backward probabilities which are required for Viterbi algorithm (Please refer to Zucchini et al., (2017) Equations (4.1) and (4.2) on p. 60).

# Inputs

The main inputs are given in the following table:

|  |  |  |
| --- | --- | --- |
| Field | Meaning | Size |
| data | Time series of monthly river discharges |  |
| m | The number of climate states |  |
| mu | The vector of initial means for each climate state |  |
| sigma | The vector of initial standard deviations for each climate state |  |
| trpro | The transition probability matrix |  |
| delta | The vector of inital distribution of hidden climate states |  |

**\*** n is the total number of months in historical inflow records.

# Outputs

The main outputs of the HMM function are the optimum parameters of HMM (i.e., ) and the unfolded sequence of hidden climate states.

# References

Zucchini, W., MacDonald, I. L., & Langrock, R. (2017). Hidden Markov models for time series: an introduction using R. CRC press.

Viterbi, A. (1967). Error bounds for convolutional codes and an asymptotically optimum decoding algorithm. IEEE transactions on Information Theory, 13(2), 260-269.