ENSAI (Non)-homogeneous hidden Markov chains 2019-2020, Smart Data Master

Projects details

The review of the HMM course part will focus on a project. Four projects are proposed to you. Each group of 2 or 3 students will work on one of the proposed projects. Two groups can work independently on the same project. Each group should submit a mini report of no more than 10 pages containing the results of the project. Codes R/Python/-Matlab can be rendered separately from reports but this is not mandatory. Below you will find the description and objective of each project. The detailed statement is also provided. The project should be sent by email to the following address : salima.el-kolei@ensai.fr by November 28, 8pm at the latest.

The number of stars corresponds to the degree of difficulty of the project.

Project 1 ($**$) : Extended Kalman Filter (state space models with continuous state space)

The purpose of this project is to apply the Extended Kalman filter (EKF) for the target tracking in the presence of two sensors. The EKF is well-described in Chapter 1.

Project 2 ($**$) : Auxiliary Particle Filter (state space models with continuous state space)

The purpose of this project is to discover a new filtering method : the Auxiliary Particle filter. This filter is an extension of the Bootstrap filter and allows observations to be taken into account in the sampling step. This modification reduces the variance of particle weights and thus significantly improves the estimation of the hidden Markov chain. This filter is well-described in Chapter 1 p.28 (Algo 8).

Project 3 ($*$) : Markov Switching models on real data (state space models with finite state space)

The objective of this project is to discover a new model of HMM, Markov Switching model, that is widely used in practice and in particular widely used in finance. There are several reasons why regime switching models have become popular in financial modeling. First, the idea of regime changes is natural and intuitive. When applied to financial series, regimes identified by econometric methods often correspond to different periods in regulation, policy, and other secular changes. The estimation of this model is made

by algorithms presented in class, that is forward-backward method and vitterbi method. Hence, the aim of this project is to discover this model and to apply the different algorithms to estimate it on real data.

Project 4 $(* * *)$ **: Non-Homogeneous Hidden Markov model (state space models with finite state space)**

The aim of this project is to study HMM models with finite state space when the Markov chain is non-homogeneous. In particular, the Markov chain is modelled by Berstein polynomials whose parameters depend on time. As the chain is non-homogeneous we cannot use the packages already existing under R so the objective of this project is to implement Forward and Vitterbi algorithms in this context.