

Master M2 MVA 2018/2019 - Graphical models - HWK 3

- These exercises are due on or before December 5th 2018.
- They should be submitted on the Moodle.
- **They can be done in groups of two students.**
- The write-up can be in English or in French, can be typed or scanned (except for the figures).
- **Please follow precisely the formatting described in Section 2.**
- Please submit your answers as a pdf file that you will name `MVA_DM3_<your_name>.pdf` if you worked alone or `MVA_DM3_<name1>_<name2>.pdf` with both of your names if you work as a group of two. Indicate your name(s) as well in the documents. Please submit your code as a separate zipped folder and name it `MVA_DM3_<your_name>.zip` if you worked alone or `MVA_DM3_<name1>_<name2>.zip` with both of your names if you worked as a group of two. Note that your files should weight no more than 16Mb.

1 Implementation - HMM

We consider the same training data from homework 2, on the folder “EMGaussienne.dat”, but this time considering the temporal structure, i.e., data are of the form $u_t = (x_t, y_t)$ with $u_t = (x_t, y_t) \in \mathbb{R}^2$, for $t = 1, \dots, T$.

The goal of this exercise is to implement HMM inference and EM algorithm for learning the parameters of the model. It is recommended to use the code from the previous homework.

We consider the following HMM model with a linear chain (q_t) with $K=4$ states of the transition matrix $a \in \mathbb{R}^{4 \times 4}$, and Gaussian “emission probabilities” : $u_t | q_t = i \sim \mathcal{N}(\mu_i, \Sigma_i)$.

1. Implement the α and β recursions seen on the course and on the notes to estimate $p(q_t | u_1, \dots, u_T)$ and $p(q_t, q_{t+1} | u_1, \dots, u_T)$.
2. Compute the estimation equations of EM.
3. Implement the EM algorithm for the learning (you can initialize the means and covariances with the ones found on the previous homework).
4. Implement the inference algorithm to estimate the sequence of more likely states, i.e, $\arg \max_q p(q_1, \dots, q_T | y_1, \dots, y_T)$, and represent the obtained result with the data (for the parameters learned by EM).
5. Comment the different obtained results with the ones of the previous homework. In particular, compare the log-likelihoods on the training data and the test data (inside “EMGaussienne.test”).

2 Formatting

In order to reduce the correction time of these homeworks, please follow the following formatting precisely :

— Page 1

Exercise 1.2	
Exercise 1.4	
EM - GMM	EM - HMM
Exercise 1.5	