Assignment 2
Machine Learning in Robotics

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1 Learning data set using Gaussian mixture model

In this exercise the parameters of a GMM of size 4 are learned using the Expectation-Maximization algorithm. The learned priors π_k, means μ_k and convariances Σ_k are presented in equations 1, 2 and 3 respectively.

$$\pi_1 = 0.2400, \pi_2 = 0.2011, \pi_3 = 0.2972, \pi_4 = 0.2617 \tag{1}$$

$$\mu_1 = \begin{bmatrix} -0.0432 \\ 0.0446 \end{bmatrix}, \mu_2 = \begin{bmatrix} -0.0147 \\ -0.0796 \end{bmatrix}, \mu_3 = \begin{bmatrix} -0.0194 \\ -0.0166 \end{bmatrix}, \mu_4 = \begin{bmatrix} 0.0262 \\ 0.0617 \end{bmatrix} \tag{2}$$

$$\begin{gathered} \Sigma_1 = 10^{-3} * \begin{bmatrix} 0.1748 & 0.2615 \\ 0.2615 & 0.3975 \end{bmatrix}, \Sigma_2 = 10^{-3} * \begin{bmatrix} 0.3944 & 0.2166 \\ 0.2166 & 0.1276 \end{bmatrix}, \\ \Sigma_3 = 10^{-3} * \begin{bmatrix} 0.7437 & -0.5917 \\ -0.5917 & 0.6103 \end{bmatrix}, \Sigma_4 = 10^{-3} * \begin{bmatrix} 0.0011 & -0.0004 \\ -0.0004 & 0.0002 \end{bmatrix} \end{gathered} \tag{3}$$

The density values for inputs in range [-0.1, 0.1] are shown from different angles in figures 1-3. It is clear that the mixture model consists of four separate Gaussian distributions that together follow the pattern of the input data. As they cover roughly equally sized input spaces, it makes sense that the priors are very similar.

2 Human gesture recognition using hidden Markov model

In this exercise a set of gestures are classified based on 10 observation sequences. This is done using the forward procedure.

The gesture is determined from the log-likelihood of the observation sequence. As all the sequences got a log-likelihood less than -115, they are **all classified as gesture 2**.

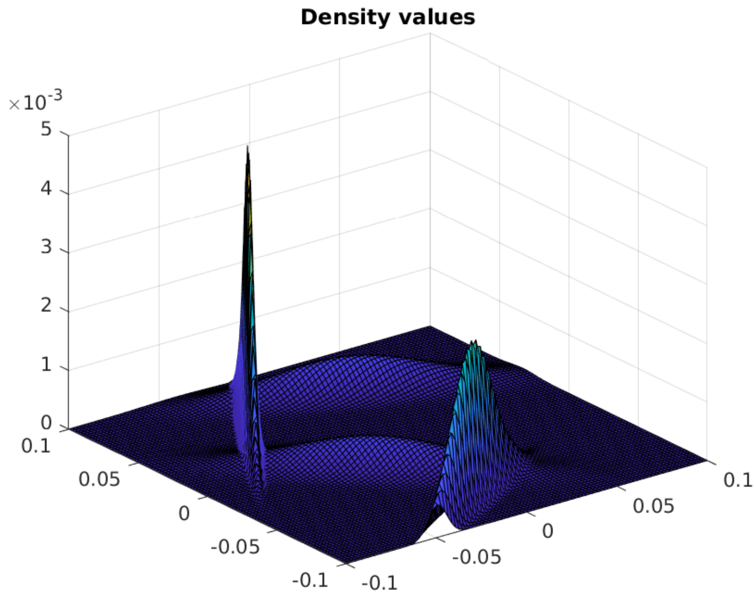

Figure 1: GMM density values

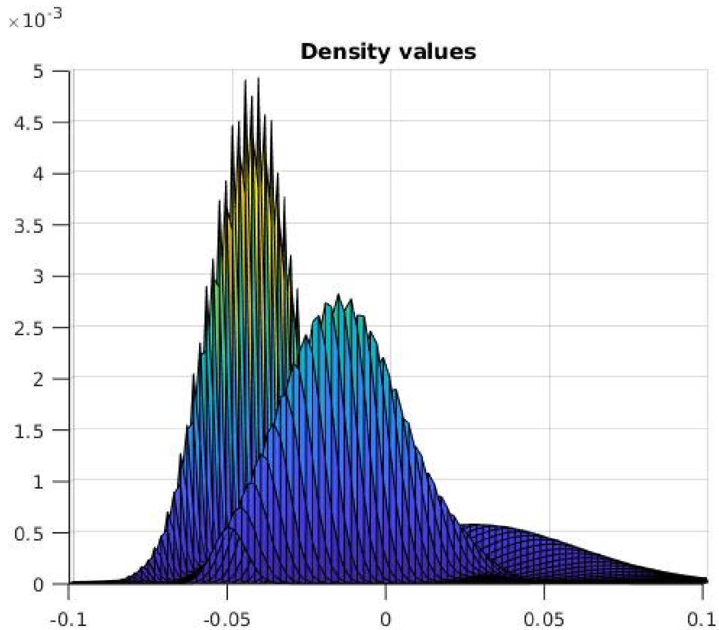

Figure 2: GMM density values side view

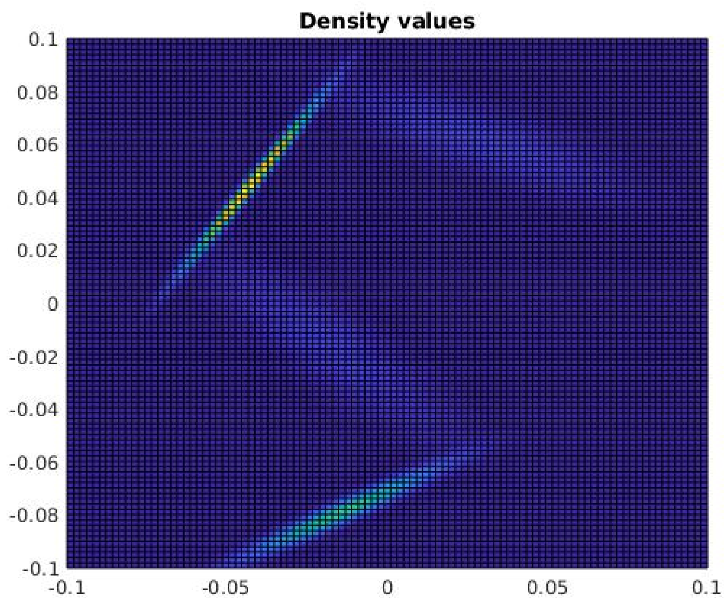

Figure 3: GMM density values top view