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Machine Learning for Robotics and Computer Vision
Summer term 2013

Homework Assignment 4
Topic: Mixture Models and EM
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For the following exercises, download the file 'ClassCode3.tgz' available at the course's website.

Exercise 1: K-Means

In *mixturemodels/clustering.cc* you find a basic example that opens a dataset file which contains randomly sampled points from two gaussian distributions. Run the example with *./clustering ../data/twoGauss.dat*

a) Extend the code and implement the K-Means algorithm to cluster the dataset. Access to the values of the dataset is provided by *data.GetInput()*.

b) Restart your algorithm 100 times with randomized initial values of the cluster centers. Evaluate the clustering performance by comparing the result with the true labels stored in *data.GetOutput()*. Plot a histogram of the clustering performance.

Exercise 2: Expectation Maximization

Modify the K-Means algorithm to implement the Expectation Maximization (EM) for Gaussian mixture models (GMM) using a fixed symmetric covariance (supplied as a parameter) and apply it to the same dataset.

a) Evaluate the algorithm for different initializations of cluster centers and covariance. How do the EM errors compare to Kmeans on average? Does EM converge faster? Is it more reliable in finding the true means?

b) Update the EM algorithm to also estimate the sigma of a symmetric covariance. Then update the algorithm to estimate the full covariance for each Gaussian. Does the full covariance EM algorithm show an increased perfomance at finding the models?

Exercise 3: Gaussian Processes for Classification

In *mixturemodels/gp-classification.cc* you find an implementation of Gaussian Processes for classification.

a) Evaluate the algorithm for different training fractions and values of the hyperparameters (In the config file: *TRAIN_FRAC, SIGMA_F_SQR, LENGTH_SCALE, SIGMA_N_SQR*).

b) Change *DO_OPTIMIZATION* in the config file to *1* to estimate the optimal values for the hyperparamters. Evaluate the method using different initial values of the hyperparameters.

For downloads of slides and of homework assignments and for further information on the course see

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