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# Machine Learning for Computer Vision
# Winter term 2016

November 15, 2016
K-Means, Expectation-Maximization, Mixture Models

## Exercise 1: Expectation-Maximization for GMM

In the standard EM algorithm, we first define the responsibilities $\gamma$ as

$$\gamma_{nk} = p(z_{nk} = 1|x_n) = \frac{\pi_k \mathcal{N}(x_n|\mu_k, \Sigma_k)}{\sum_{j=1}^{K} \pi_j \mathcal{N}(x_n|\mu_j, \Sigma_j)} \quad , z_{nk} \in \{0, 1\}, \sum_{k=1}^{K} z_{nk} = 1$$

a) Find the optimal means, covariances and mixing coefficients that *maximize the data likelihood*. How can you interpret the results?

b) Define the complete-data-log-likelihood. What is the difference to the standard log-likelihood?

## Exercise 2: K-Means Compression and EM for GMM (Programming)

Implement following exercises in your preferred programming language.

a) Implement K-Means and use it to compress the *mona-lisa.jpg* image found on the website, by using only $2, 3, \ldots, 10$ colors.

b) Implement the Expectation-Maximization algorithm (EM) for Gaussian Mixture Models (GMM) to cluster the *old faithful* dataset.

The next exercise class will take place on **November 25th, 2016**.

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

`https://vision.in.tum.de/teaching/ws2016/mlcv16`