**GAUSSIAN MIXTURE MODEL**

Gaussian mixture model (GMM) is a parametric probability density function and the representation for it is a weighted sum of all the Gaussian component densities.

The formula of Gaussian mixture model is given as following:

Where x is the given feature, multi-dimensional input; distance, duration, and number of counts, stands for the mean value for each Gaussian distribution, is the covariance matrix, , are the mixtures weights, and are the component Gaussian densities. [1]

**BAYESIAN GAUSSIAN MIXTURE MODEL**

A Bayesian approach to Gaussian mixture model (GMM) automatically penalize the overcomplex model and allow the GMM to optimize the selection of the number of components in the model as well as the partition data sets. [2]

The expression of a distribution model with using Bayesian inference can be expressed as following:

In terms of Bayesian perspective denotes the posterior probability that a data point being a passenger where x denotes a data point observed at time t, B denotes the passenger class, denotes the k-th Gaussian. [3]

in the scope of probabilistic view, data points in different clusters generally have different probability distribution. [4] The reason that we chose mixture density-based clustering as comparison to FCM is that GMM is very good at forming smooth approximation to arbitrary shaped of probability density. [1] GMM is also very good at scaling with the dimensionally of data. [2]

The GMM model uses EM-like algorithm to maximize the likelihood for the model parameters. However, this causes issue like overfitting and the problem become more severe when involving high-dimensional data. Whereas, Bayesian approach is able to avoid overfitting by eliminating parameters using integration. [5]

[1] Gaussian Mixture Models <https://s3.amazonaws.com/academia.edu.documents/32964244/0802_Reynolds_Biometrics-GMM.pdf?AWSAccessKeyId=AKIAIWOWYYGZ2Y53UL3A&Expires=1551089478&Signature=hx6hgb%2Fm28cW6rTwEUGzBYdMqnE%3D&response-content-disposition=inline%3B%20filename%3DGaussian_Mixture_Models.pdf>

[2] Bayesian Approaches to Gaussian Mixture Modeling

<https://pdfs.semanticscholar.org/fdff/2ba3ce0df37af58c3ff7aae7f79be2d0833e.pdf>

[3] A BAYESIAN FRAMEWORK FOR GAUSSIAN MIXTURE BACKGROUND MODELING

<http://www.jonathanjhull.com/content/pubs/lee_icip2003.pdf>

[4] Survey of Clustering Algorithms

<http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.334.9507&rep=rep1&type=pdf>

[5] A Variational Bayesian Framework for Graphial Models

<http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.36.2841&rep=rep1&type=pdf>