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Sarah

Mixture Models K-Means Algorithms Gaussian Process Models +3

What is the difference between K-means and the mixture model of Gaussian?

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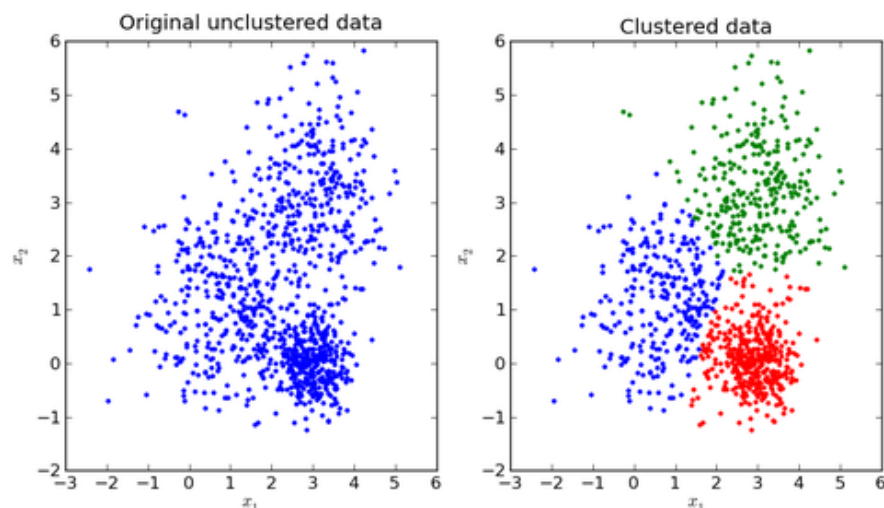
**Sourav Chatterjee**, Engineering PhD, now Data Scientist

Written Dec 24, 2014

I'll try to give a more intuitive answer.

What does k-means algorithm do?

Here's a picture from the internet to help understand k-means.



Now, the figure to the left shows some unclustered data. K-means/Mixture of Gaussians tries to break them into clusters.

Let's say we are aiming to break them into three clusters, as above. K means will start with the assumption that a given data point belongs to one cluster.

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belongs to the green cluster. However, remember, in each iteration, we are absolutely certain as to which cluster the point belongs to. This is the "hard assignment".

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What if we are uncertain? What if we think, well, I can't be sure, but there is 70% chance it belongs to the red cluster, but also 10% chance its in green, 20% chance it might be blue. That's a **soft assignment**. The Mixture of Gaussian model helps us to express this uncertainty. It starts with some prior belief about how certain we are about each point's cluster assignments. As it goes on, it revises those beliefs. But it incorporates the degree of uncertainty we have about our assignment.

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Kanwal Prakash Singh, Data Scientist,Software Engineer,Musician,Bug Fixer,Private Eye,Insanely Curi...

Updated Sep 19, 2015

K-means define hard clusters, the samples are to be associated to the groups (subpopulations).

Mixture models would let you determine these subpopulations, without associating each sample with a cluster. These subpopulations are defined by distributions with unknown parameters , for learning these parameters Expectation-Maximisation is to be used. Also there are weights for each of these distributions which are probabilities and hence sum to 1. With each sample there is a corresponding latent random variable each distributed according to a K -dimensional categorical distributions, K is the number of subpopulations

One can think of mixture models as generalising k-means clustering to incorporate information about the covariance structure of the data as well as the centers of the latent Gaussians.

[Mixture model](#)

[2.1. Gaussian mixture models](#)

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**Sanjay Doraiswamy**

Written Dec 24, 2014

K-means is a "simple" methodology used for clustering. Although the "basic" k-means has hard assignments, where each data point only belongs to one cluster, it's easy to extend it to soft assignments by (for example) assigning a probability according to the relative distance from the centroid of each cluster. K-means works by:

1. choosing k , the number of clusters
2. seeding k random points throughout the space
3. assigning each data point x to the cluster with the nearest centroid (according to your metric)
4. calculate the centroid of each cluster
5. repeat steps 3-4 till convergence

The algorithm is guaranteed to converge to a local optimum. You need to run it many times to (hopefully) find a global optimum.

In GMM, you now take a more Bayesian approach. Assume there are k components (clusters), and each component $z_k \sim \mathcal{N}(\mu_k, \Sigma_k)$. Each data point x is generated from one of these components with a certain probability ($\Sigma_k = 1$ for each x). The EM algorithm uncovers these probabilities. You still need to choose a k ahead of time.

Finally, using variational inference, you can choose a sparse Dirichlet prior over the components which will force the EM algorithm to choose the right k .

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**Vasily Konovalov**Written Dec 24, 2014 · Upvoted by Luis Argerich, [Data Science Professor at the University of Buenos Aires \(UBA\)](#)

K-means is a special case of Mixture of Gaussian, and Mixture of Gaussian is a special case of Expectation-Maximization.

It can be easily shown that in case of hard clustering Mixture of Gaussian is K-means

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