K-Means Algorithms Gaussian Process Models Cluster Analysis +1

What are the advantages to using a Gaussian Mixture Model clustering algorithm?

2 Answers

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Answered Sep 9, 2016

The question asks about advantages but does not specify advantages compared to what method. I'm going to assume it is advantages compared to the most popular clustering algorithm: k-means.

- GMM is *a lot* more **flexible** in terms of **cluster covariance**
  k-means is actually a special case of GMM in which each cluster's covariance along all dimensions approaches 0. This implies that a point will get assigned only to the cluster closest to it. With GMM, each cluster can have unconstrained covariance structure. Think of rotated and/or elongated distribution of points in a cluster, instead of spherical as in kmeans. As a result, cluster assignment is much more flexible in GMM than in k-means. Image below is from scikit-learn documentation on GMM .

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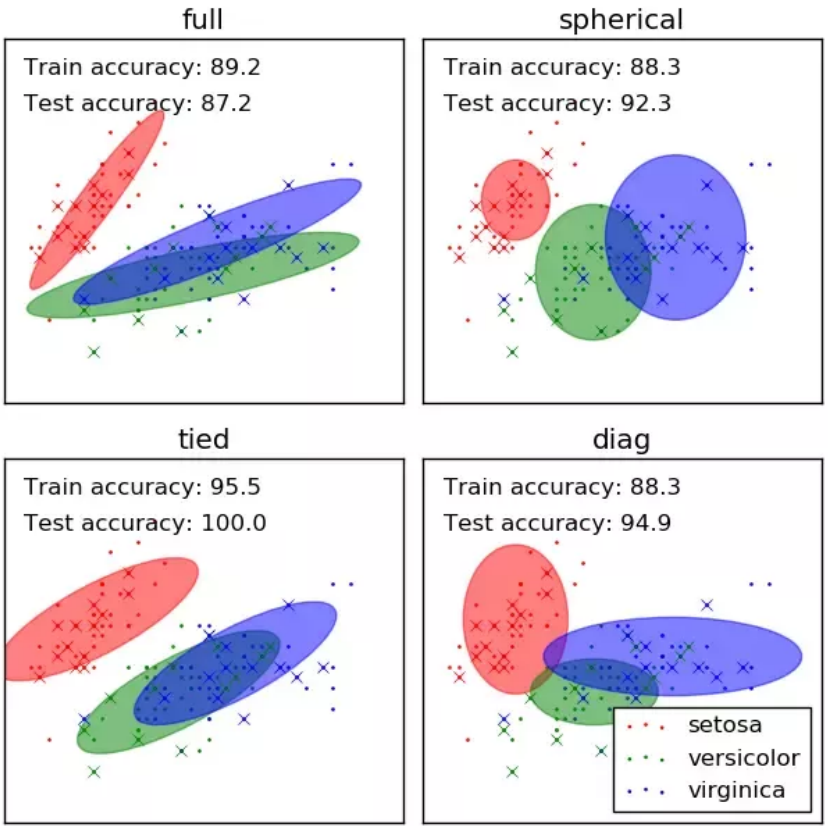

- GMM model accommodates **mixed membership**
  Another implication of its covariance structure is that GMM allows for mixed membership of points to clusters. In kmeans, a point belongs to one and only one cluster, whereas in GMM *a point belongs to each cluster to a different degree*. The degree is based on the probability of the point being generated from each cluster's (multivariate) normal distribution, with cluster center as the distribution's mean and cluster covariance as its covariance. Depending on the task, mixed membership may be more appropriate (e.g. news articles can belong to multiple topic clusters) or not (e.g. organisms can belong to only one species).

You can read more about GMM in Coursera's Machine Learning Course on Clustering and Retrieval .

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There are several reasons to use this model. However it depends on the case where you will use it.

First, if you think that your model is having some hidden, not observable parameters, then you should use GMM. This is because, this algorithm is assigning a probability to each point to belong to certain cluster, instead of assigning a flag that the point belongs to certain cluster as in the classical k-Means. Then, GMM is producing non-convex clusters, which can be controlled with the variance of the distribution. In fact, k-Means is a special case of GMM, such that the probability of a one point to belong to a certain cluster is 1, and all other probabilities are 0, and the variance is 1, which a reason why k-Means produces only spherical clusters.

However, the algorithms for optimizing the loss function for GMM are not so trivial, since it is not a convex function. The most popular algorithm is the Expectation Maximization algorithm.

Hope this helps, you can read a lot of stuff on the Internet, because it is a mature and well-known algorithm.