CS571 Project Report

Nameet Hitendrakumar Dalal ,T21253

Image segmentation using K-mean and GMM

1.Summary

In this project, segmentation of image is done using k-means clustering and Gaussian Mixture Modelling (GMM). Both the algorithms are applied to the input image separately and their output foreground and background images are obtained.

2 Introduction

Our target is to design and implement an algorithm to segment any input images into foreground and background. K-means algorithm is an unsupervised clustering algorithm that classifies the input data points into multiple classes based on their inherent distance from each other. The algorithm assumes that the data features form a vector space and tries to find natural clustering in them. The objective of the project is to implement the probabilistic clustering model-Gaussian Mixture Model which is based on expectation maximization algorithm and using it for satellite image clustering. The model uses Gaussian mixture models to model the original image, and transforms segmentation problem into the maximum likelihood parameter estimation by expectation-maximization (EM) algorithm and use it to classify the pixels of the image, This segmentation can be useful for recognizing of objects, detecting of edges etc. by the machine.

3 Solution

While using k-means clustering methode which is a distance-based model. However, the similar type of data sets are clubbed together in a group such that data points of different groups have different characteristics. These groups are clusters.
Using GMM, we use gaussian distribution and each of these distributions represent a cluster. GMM groups data points belonging to same distribution. Basically, using gaussian function, we get probability of each of these data points to belong to these distributions.

3.1 Assumptions:

For k mean clustering:

In k-means clustering, the assumption used is that all variables have same variance i.e. the clusters are spherical and clusters are of similar size and have roughly equal number of observations.
With init='k-means++ , max_iter=300, n_init=10, random_state=42.

For GMM:

In GMM, each cluster is modelled by a gaussian distribution with a certain mean and covariance.
With n_components=2, covariance_type='full' and ‘tied’.

3.2 Algorithm used

For k mean cluster:

1. Randomly select initial clusters=2 as per assumption.
2. Data points which are closer to respective cluster are assigned to that cluster.
3. It will calculate the mean of these clusters atomatically.
4. And it will also Calculate distance of each point from each center of cluster.
5. On the basis of distance, points are reassigned to nearest cluster.
6. Calculate the new formed cluster centers.

This process is repeated until center of cluster do not change or the maximum number of iterations are executed as I assumed max.iteration=300.
In this project I have Implemented conventional k-means clustering algorithm for gray-scale image also.

For GMM cluster:

Gaussian Mixture Models are probabilistic models and use the soft clustering approach for distributing the points in different clusters.
GMM works on Expectation-Maximization Algorithum(EM). expectation-maximization (EM) algorithm and use it to classify the pixels of the image, This segmentation can be useful for recognizing of objects, detecting of edges etc. by the machine.

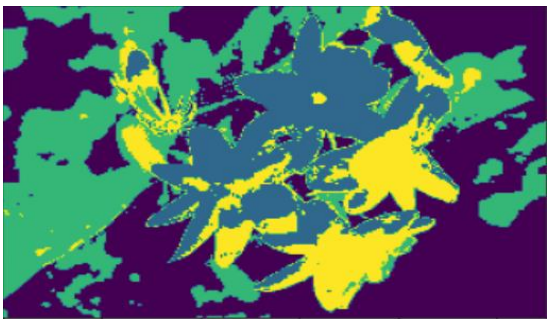
1. k number of component clusters are assigned i.e. k Gaussian distributions with their mean, covariance and density.
2. E step: we find probability that data points belong to different cluster, if probability is high, it is more closer to cluster.
3. Again density is calculated.
4. Mean and covariance are updated based on value assigned to the distribution.
5. Based on the update values, new probabilities of each point and values are updated iteratively.

This process is repeated until center of cluster do not change or the maximum number of iterations are executed.

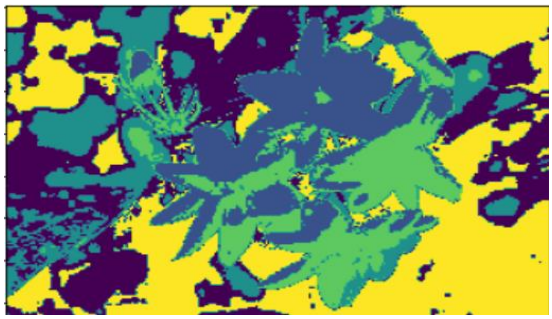
4 Results and analysis

1.original image

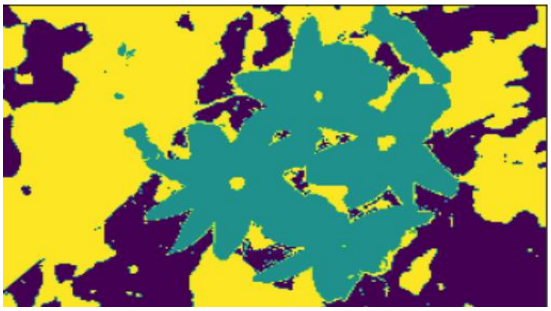
2. K-means cluster for n=4



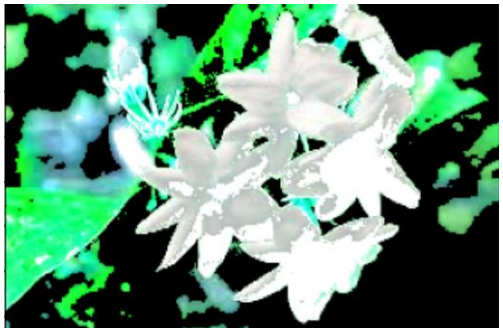
3.K-means cluster for n=5



4.GMM cluster for n=3



5.K-means foreground image



6.GMM foreground image

7.K-means background image

8.GMM background image

5 Conclusion

1. k-means is a distance-based model, while GMM is a distribution-based model.
2.foreground, background of the image is a difficult task, I learnt to isolate the desired area of input image that can be used for further operations.

6 Project GitHub page

https://github.com/imnameet/Image_Foreground_Background_mask-Segmentation_using_GMM

7 References

Bishop, C. (2006). *Pattern Recognition and Machine Learning*. Springer.

https://ai.stanford.edu/~syyeung/cvweb/tutorial3.html

https://opencv24-python-tutorials.readthedocs.io