

Assignment 5: Mixture models

CS 6601

Due November 20 by 9:35 AM

Abstract

You will implement and evaluate several algorithms, including the Gaussian mixture model, to perform basic image segmentation.

1 The Challenge

Automatic image processing is a key component to many AI systems including facial recognition and video compression. One basic method for processing is segmentation, by which we segment an image into a fixed number of components to simplify its representation. For example, we can train a mixture of Gaussian distributions to represent an image and segment according to the simplified representation, as seen in Figure 1 with the original on the left and the segmented version on the right, which can be represented by 3 Gaussian distributions.



Figure 1: Original image (left) and segmented (right, 3 components)

2 Your Assignment

Your assignment is to implement several methods of image segmentation, with increasing complexity.

- In Part 1, you'll implement k-means clustering to segment a color image.
- In Part 2, you'll build a Gaussian mixture model to be trained with expectation-maximization.
- In Part 3 of the assignment, you'll experiment with varying the details of the Gaussian mixture model's implementation.

- In Part 4 of the assignment, you'll implement and test a new metric called the Bayesian information criterion which guarantees a more robust image segmentation.

You will complete this assignment in `mixture_model_notebook.ipynb`, following the instructions therein. We have provided a subset of the tests you will want and are working to finish the rest of the tests as soon as possible.

We will provide the following additional files:

File	Description
<code>doge_color.png</code>	color image to test k-means clustering
<code>k2</code> - <code>k6_doge_color.png</code>	pre-segmented images for comparison
<code>party_spock.png</code>	grayscale image to test your Gaussian mixture models
<code>em.pdf</code>	explanation of k-means, mixture models and expectation maximization

3 Grading

Each section of the assignment is associated with a number of points, as follows (out of 100 points total):

- Part 1: k-means clustering (20 points)
- Part 2: Gaussian mixture model (40 points)
- Part 3: improvements to model performance (20 points)
- Part 4: Bayesian information criterion (20 points)

4 Submission

This assignment is due on T-Square Friday November 20th by 9:35 AM. The deliverables for the assignment are:

- A filled out version of the iPython notebook provided. (`mixture_model_notebook.ipynb`)

Please submit this in iPython notebook format - it makes grading much easier.

5 Resources

The attached chapter (`em.pdf`) gives a good explanation of implementing and training mixture models, particularly 424-427 (k-means) and 435-439 (mixture models and EM).

As always, TAs will hold office hours Monday, Tuesday, Thursday and Friday from 2:00 to 4:00 PM outside TSRB 241.