

Image Segmentaion (Total 125Points)

Session # 5 (2018-2019)

Lab Objective

- Learn how to apply image segmentation
- Use clustering techniques to differentiate between image objects

Problem Statement

We intend to perform image segmentation. Image segmentation means that we can group similar pixels together and give these grouped pixels the same label. The grouping problem is a clustering problem. We want to study the use of K-means and Normalized - Cut methods on the Berkeley Segmentation Benchmark. Below we will show the needed steps to achieve the goal of the assignment.

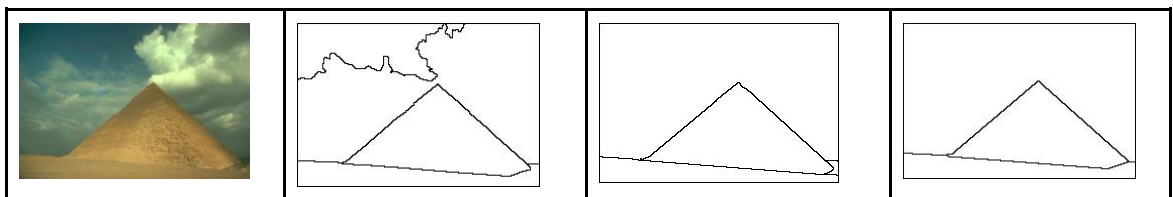
Lab Session

1. Download the dataset and understand the format (5 Points)

- a. We will use Berkeley Segmentation Benchmark
- b. The data is available at the following link.
http://www.eecs.berkeley.edu/Research/Projects/CS/vision/grouping/BSR/BSR_bsds500.tgz.
- c. The dataset has 500 images. The test set is 200 images only. We will report our results on the test set only.

2. Visualize the image and the ground truth segmentation (5 points)

- a. Write your own function that reads an image and display an image with its associated ground truth segmentation(s).



3. Segmentation using K-means (35 Points)(your implementation)

Every image pixel is a feature vector of 3-dimension $\{R,G,B\}$. We will use this feature representation to do the segmentation.

- a. We will change the K of the K-means algorithm between $\{3,5,7,9,11\}$ clusters. You will produce different segmentations and save them as colored images. Every color represents a certain group (cluster) of pixels.
- b. We will evaluate the result segmentation using **F-measure**, **Conditional Entropy**. for image I with M available ground-truth segmentations. For a clustering of K-clusters you will report your measures M times and the average of the M trials as well. Report average per dataset as well.
- c. Display good results and bad results for every configuration in a,b. Discuss

4. Normalized-Cut Segmentation(40 Points)(your implementation)

- Use RBF kernel with $\gamma = \{1, 10\}$ to generate the similarity graph of the pixels. **(Be careful of the graph size, you might need to resize the image first if you don't have 4GB of RAM).**
- Use Similarity graph as the 5-NN graph. Where $\text{Sim}(x_i, x_j) = 1$ iff x_j is one of the nearest three points to x_i (or vice versa). x_i is the (R_i, G_i, B_i) coordinates for a pixel x_i .
- In every of the above cases set the number of clusters $= \{3, 5, 7, 9, 11\}$. You will produce different segmentations and save them as colored images. Every color represents a certain group (cluster) of pixels.
- We will evaluate the result segmentation using **F-measure, Conditional Entropy**. for image I with M available ground-truth segmentations. For a clustering of K -clusters you will report your measures M times and the average of the M trials as well. Report average per dataset as well.
- Display good results and bad results for every configuration in a,b. Discuss.

5. Big Picture (15 Points)

- Select a set of five images and display their corresponding ground truth against your segmentation results using K-means at $K=5$. Comment on the results.
- Select the same five images and display their corresponding ground truth against your segmentation results using Normalized-cut for the 5-NN graph, at $K=5$. Comment on the results.
- Select the same five images and contrast your segmentation results using Normalized-cut for the 5-NN graph, at $K=5$ versus using K-means at $K=5$. Comment on the results.

6. BONUS (20 Points)

- In the previous parts, we used the color features RGB. We didn't encode the spatial layout of the pixels. We want to modify that for 5-NN graph in the Normalized cut algorithm. We will construct the 5-NN graph only from the 24 pixels surrounding the pixel x_i .
 - Contrast the results you obtained in 5.b to the results you obtained by considering the spatial layout.
- In the previous parts, we used the color features RGB. We didn't encode the layout of the pixels. We want to modify that for K-means clustering to encode the spatial layout of the pixels
 - Suggest a way to modify the feature vector to include spatial layout.
 - Contrast the results you obtained in 5.a to the results you obtained by considering the spatial layout.

Notes

- **Submit a report and the codes used. Report should detail and illustrate every step in the assignment. Report will worth (25 points).**
- You should work in groups of two. Each student should answer any questions in the lab session.
- You should deliver well documented code as well as a report showing all your work and conclusions.
- Copied assignments will be penalized; so not delivering the assignment would be much better.
- You should write your code in python.

GOOD LUCK