

# Homework 9, due November 10th, 11:59pm

November 2, 2023

In this homework, you are required to include in your report the code that you implemented. If you use some code from the web or package, also mention in your report the origin of the code.

1. Load the image `scene256.jpg` from Canvas as a  $164 \times 256 \times 3$  array. Normalize the image by dividing it by 256. We will cluster the  $164 * 256 = 41984$  pixels using spectral clustering.

Construct an affinity matrix  $A$  between the pixels, with

$$A(i, j) = \exp(-\|I(i) - I(j)\|^2 / \sigma^2)$$

if pixels  $i$  and  $j$  are neighbors (left, right, top or down), otherwise zero. Here  $I(i) = (R(i), G(i), B(i))$  is the RGB triplet of values of pixel  $i$  of the image  $I$  and a value of  $\sigma = 0.03$  works fine.

Implement the spectral clustering algorithm discussed in the Clustering section using the affinity matrix  $A$ .

Use sparse matrices and sparse SVD (e.g. `scipy.sparse.linalg.svds`) for speed.

- a) Display the obtained clustering with 10 clusters as an  $164 \times 256$  label image. (4 points)
- b) Construct a  $164 \times 256$  color image where for each cluster you compute the means of the R, G, and B values of the pixels of that cluster and place that mean at all locations of the pixels from this cluster. (2 points)
- c) Repeat points a) and b) with 20 clusters. (3 points)