Problem Set 13

Computer Vision 2021
University of Bern

1 Segmentation

1. Lets derive the Mean shift iteration.
2. The Normalized-Cut segmentation algorithm computes the eigenvalues and eigenvectors of the normalized affinity matrix, $D^{-1/2}AD^{1/2}$. Describe the meaning of the two eigenvectors corresponding to the two smallest eigenvalues.
3. Define an affinity measure, $A(i, j)$, which measures the similarity of pixels i and j and depends on the similarity of their intensities, $f(i)$ and $f(j)$, and inversely on their distance apart, $d(i, j)$. Briefly explain your definition.
4. To minimise the computational burden of NCut, which requires computing a very large affinity matrix, suppose we first divide an input image into small sub-images, say each of size 50×50. Using these sub-images, describe the main steps of a procedure to use NCut in a two-stage fashion (first with the sub-images, and second with the results of the first stage) to segment an image.
5. Consider an image that is empty except for two sets of points. One is a set of points distributed roughly uniformly on a circle of radius r centered at point C1, which is near the center of the image. The other set of points is distributed on a circle of radius $2r$, which is centred at point $C2$, which is located inside the other circle. Assume the points in each set are distributed densely enough so that the distances between points on the same circle are smaller than the distances between points on different circles.

   (a) Describe what segmentation the k-means clustering algorithm would produce for this example, and briefly explain why.

(b) Describe what segmentation the normalized-cut algorithm would produce for this example, and briefly explain why.