Problem Set 2

Problem 1

Question 1

The resulting representation is invariant to orientation because the filter bank contains numerous rotated variants of the filter. Thus, the texture should be able to be defined regardless of its direction.

Question 2

The clustering assignment will probably feature the circle divided into two halves along its center since k-means works using Euclidean distance from the mean points.

Question 3

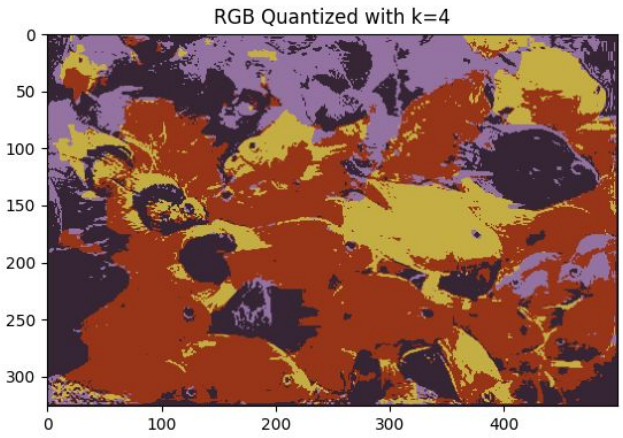
Mean shift would be most appropriate to recover the model parameter hypotheses because it converges points to the center of mass (i.e. point of most votes) in a continuous space. Graph cut would not work since it just sections features by breaking weak bounds while kmeans will not give points of max votes since it just finds the center of a cluster.

Question 4

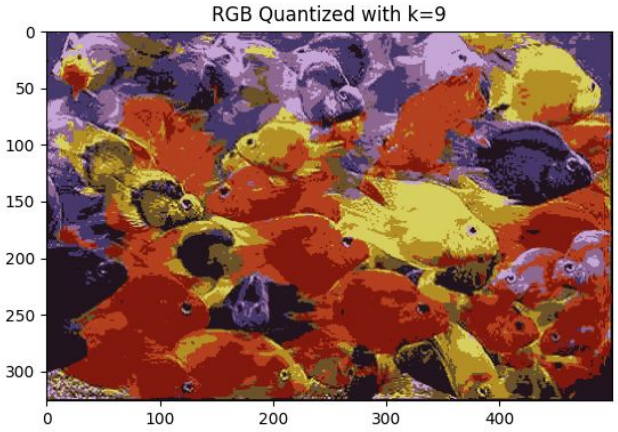
1. Find the center of mass of each blob ← variable
    a. Center of mass found by dividing the position of each pixel in blob by the total number of pixels in the blob and then adding them up
2. Define each blob by the average distance from center of mass to each pixel in the blob, storing this definition in a hashmap that maps average distance to blob. ← variable
3. Define a threshold for error possible between maps.
    a. Error defined as “sum square distance” between average distance of a blob
4. Cluster blobs that are below threshold of their distances.

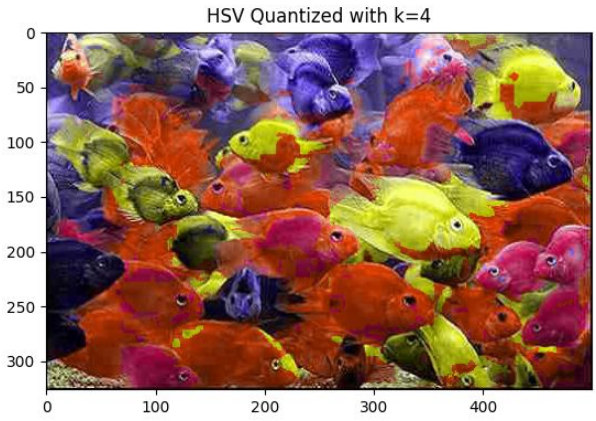
Problem 2B

Question 1

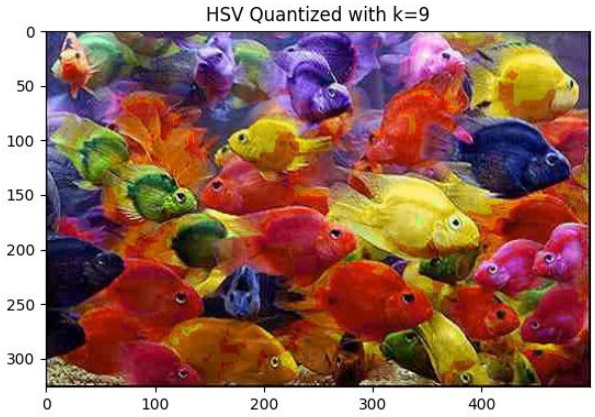


a)



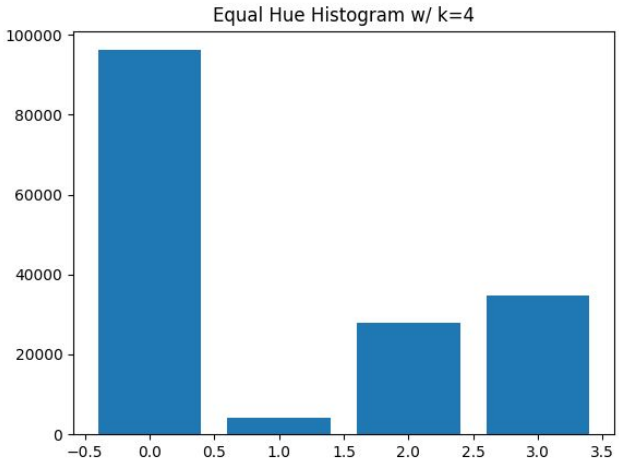


b)

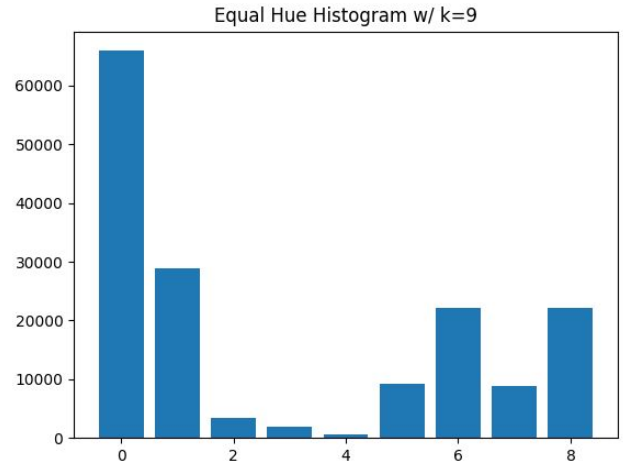


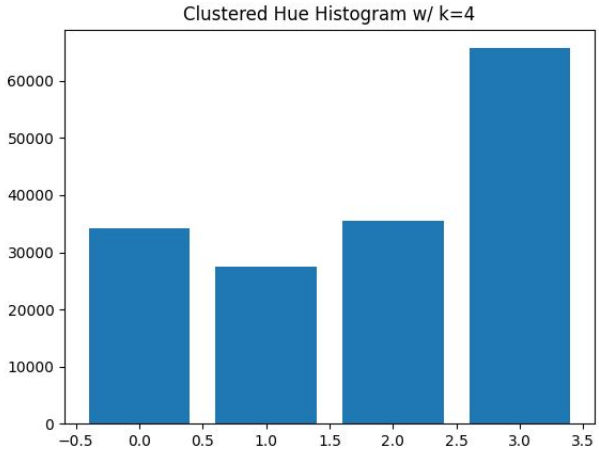
c) RGB Quantized k=4 SSD error: 563902032
RGB Quantized k=9 SSD error: 283848066

d) HSV Quantized k=4 SSD error: 90368497
HSV Quantized k=9 SSD error: 28032166

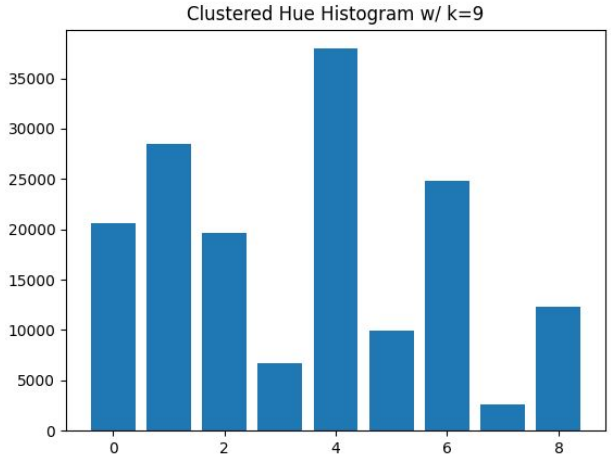

Equal Hue Histogram w/ k=4
100000
80000
60000
40000
20000
0
−0.5
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5

e)


Equal Hue Histogram w/ k=9
60000
50000
40000
30000
20000
10000
0
0
2
4
6
8


Clustered Hue Histogram w/ k=4
60000
50000
40000
30000
20000
10000
0
−0.5
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5

f)


Clustered Hue Histogram w/ k=9
35000
30000
25000
20000
15000
10000
5000
0
0
2
4
6
8

Question 2

Part (a) is the result of quantizing the image to RGB values. When k is set to 4, only 4 colors remain in the image and not a lot of detail whereas when k=9, there are 9 total colors and more detail from the original image. In contrast, part (b) is quantized to Hue values, leaving saturation and value untouched. Thus, while k=9 has more detail than k=4, since brightness and saturation are adjusted the same amount in both, there is not a huge difference. Overall, there is a lot more detail in the HSV quantized images. This further explains why the error for the RGB quantized image is a magnitude higher than the HSV quantized image, regardless of k. If the seed is changed, the images could be different since kmeans only finds the local maximum, so, depending on where the points start, the means could converge in different places and hence different colors. Parts (e) and (f) show that though there may be more of a certain hue, having it too spread out may cause it to not get noticed during clustering. However, again, clustering could differ based on the seed for kmeans. So even the histograms for clustering might be different.

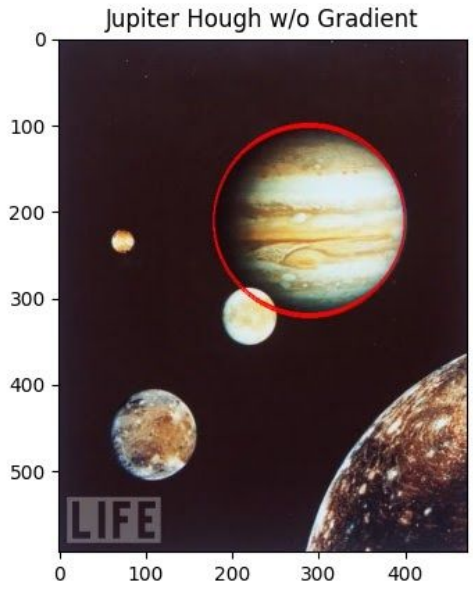
Problem 2.2

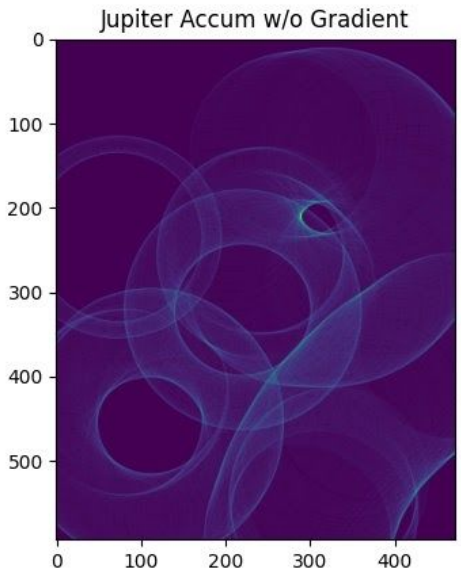
Question 1

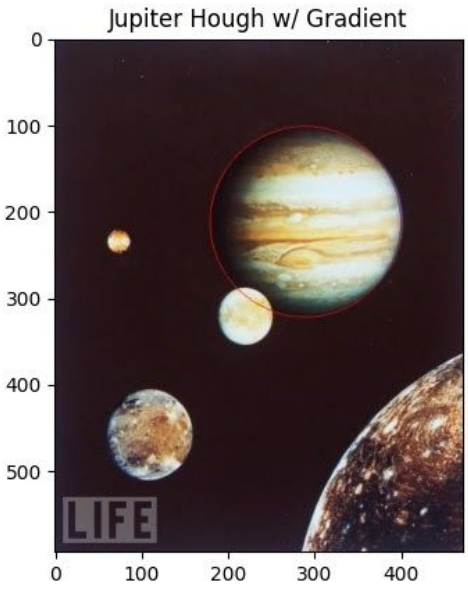
The function takes the grayscale of an image and uses the canny detector to find edges. Then it loops over the image and essentially maps possible circles that have a center at a point if they are likely. If `use_gradient` is enabled, the function uses the gradient instead of all possible circles. Then, the function returns all of the points that have “votes” above a certain threshold to be likely centers for circles in the image.

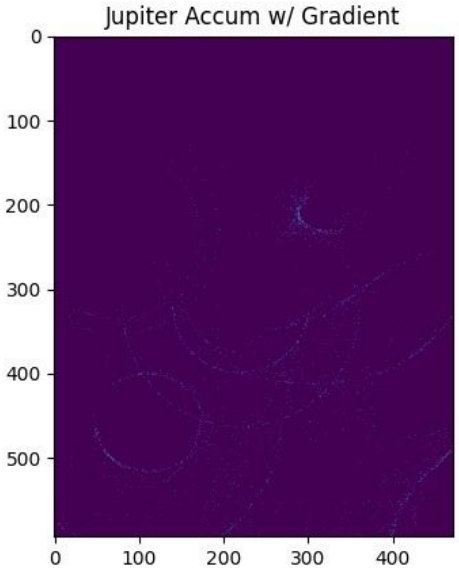
Question 2

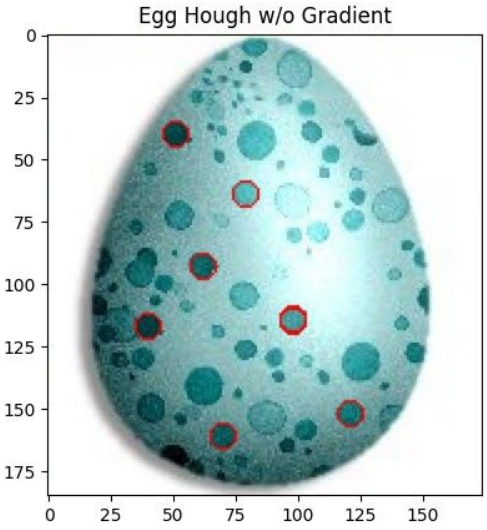
Jupiter with radius 110 and Egg with radius 5:

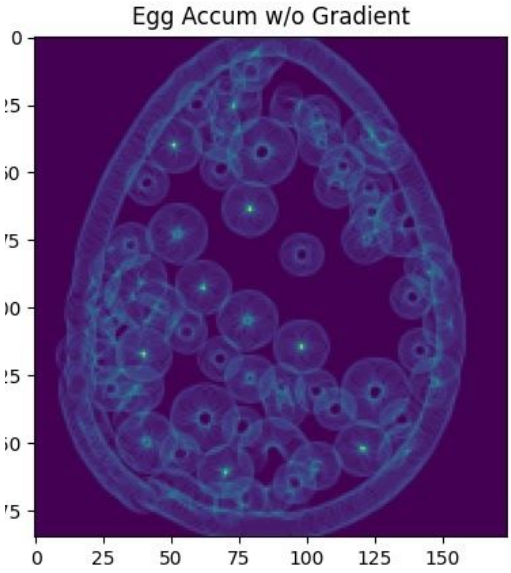


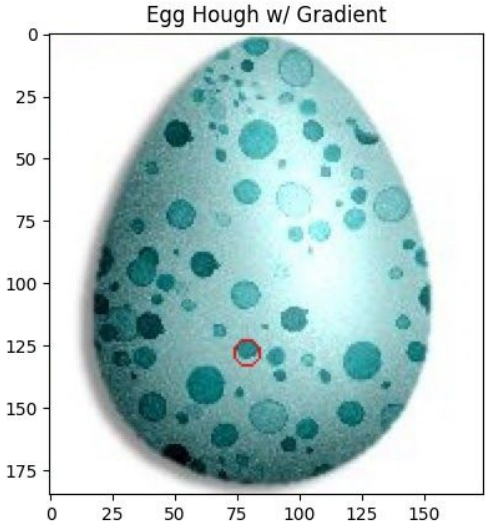


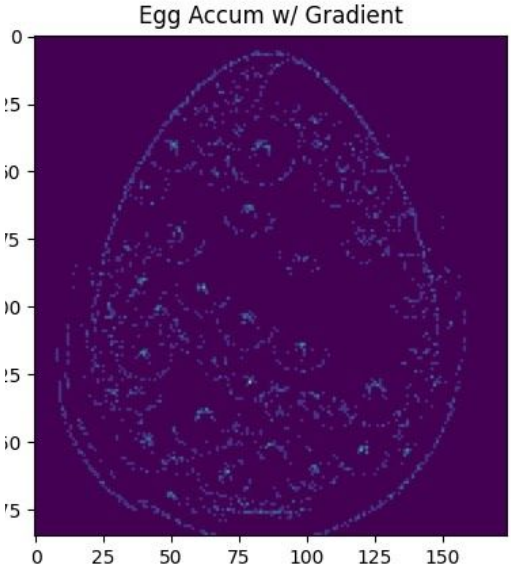




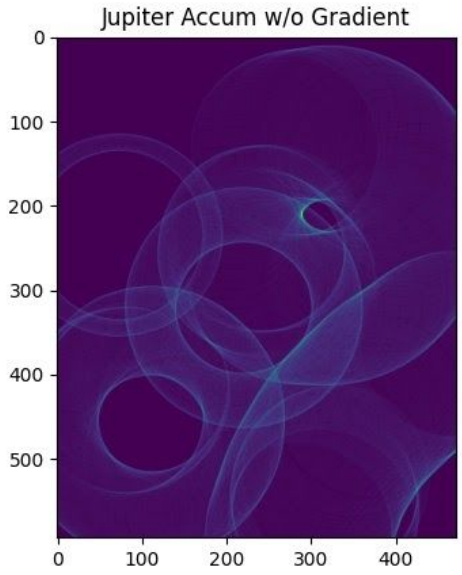

Egg Hough w/o Gradient
0
25
50
75
100
125
150
175
0
25
50
75
100
125
150


Egg Accum w/o Gradient
0
25
50
75
100
125
150


Egg Hough w/ Gradient
0
25
50
75
100
125
150
175
0
25
50
75
100
125
150

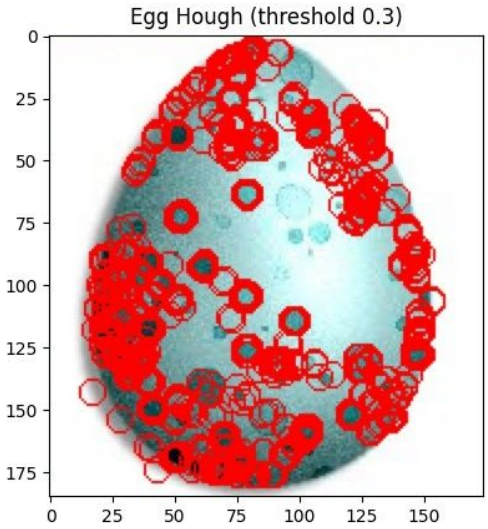

Egg Accum w/ Gradient
0
25
50
75
100
125
150

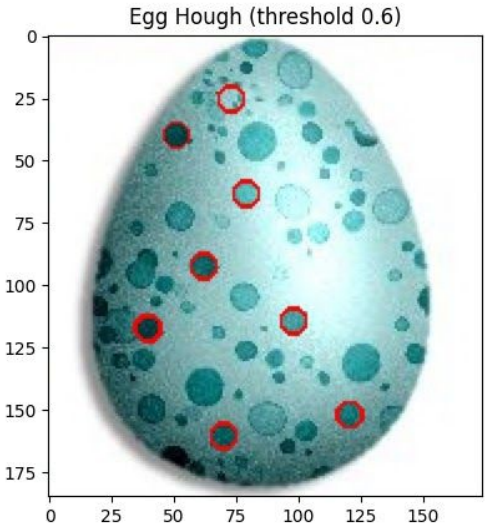
Question 3

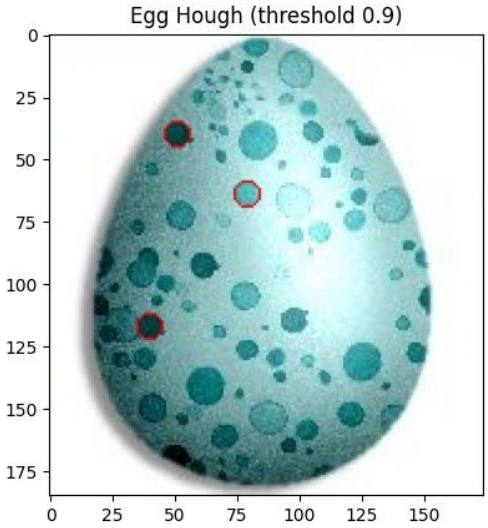


Here we see a strong likeliness for there to be a circle of radius 110 at about position (310, 220). When running the algorithm, edges of the circle collectively gave that point as a likely center, which is why it's brighter than any other point in the graph.

Question 4

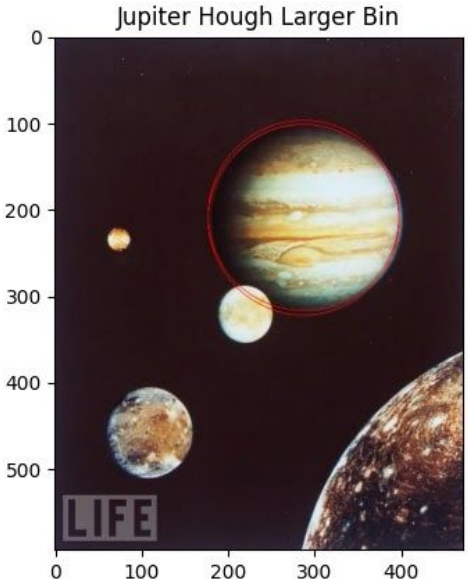


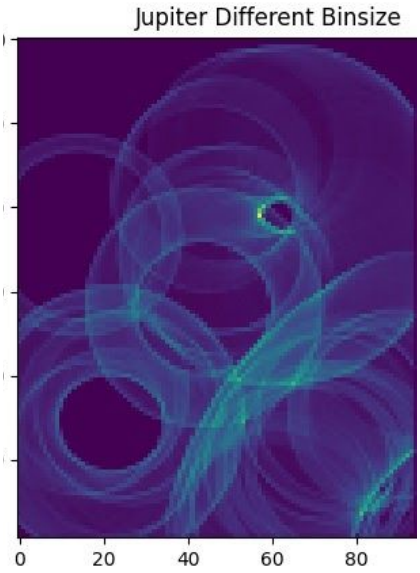




Here we see post-processing done on the accumulator array with 3 possible thresholding values. With a lower threshold, we see many false positives whereas with a high threshold, we miss some circles.

Question 5


Jupiter Hough Larger Bin
0
100
200
300
400
500
LIFE
0
100
200
300
400


Jupiter Different Binsize
0
20
40
60
80