# Answers to questions in Lab 3: Image segmentation

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**Instructions**: Complete the lab according to the instructions in the notes and respond to the questions stated below. Keep the answers short and focus on what is essential. Illustrate with figures only when explicitly requested.

Good luck!

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**Question 1**: How did you initialize the clustering process and why do you believe this was a good method of doing it?

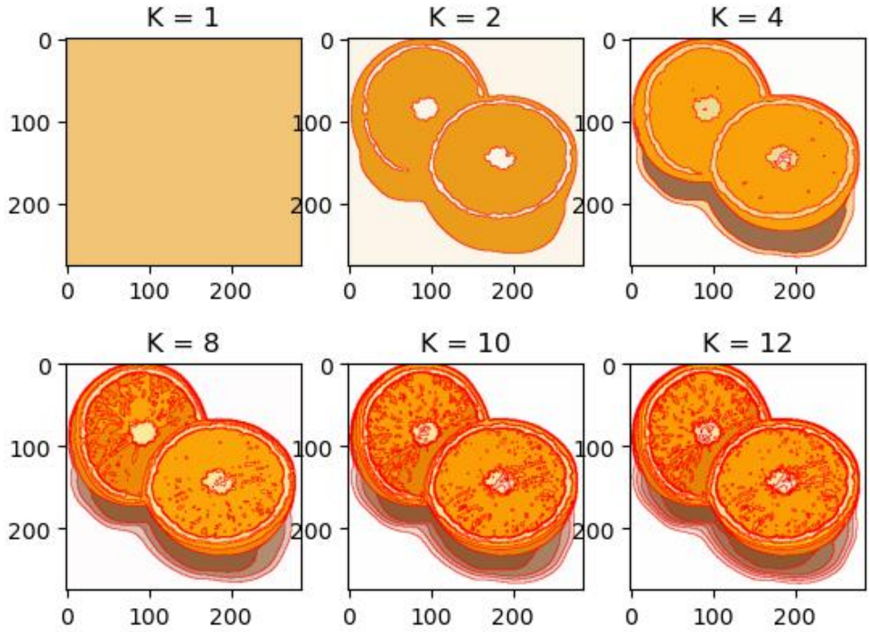
I picked each cluster randomly and made sure that they were not the same. Thereafter I kept each pixel to the closest cluster.

**Question 2**: How many iterations L do you typically need to reach convergence, that is the point where no additional iterations will affect the end results?

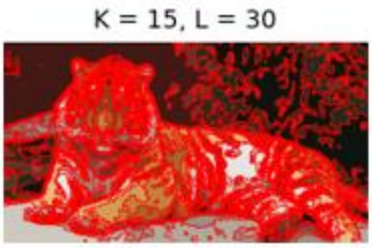
It is dependent on the total amount of clusters set. I found that in my case it was roughly 15-20 for k value of 8.

**Question 3**: What is the minimum value for K that you can use and still get no superpixel that covers parts from both halves of the orange? Illustrate with a figure.

Answers:
No value of K gave me that. Most likely because the oranges are connected to each other.

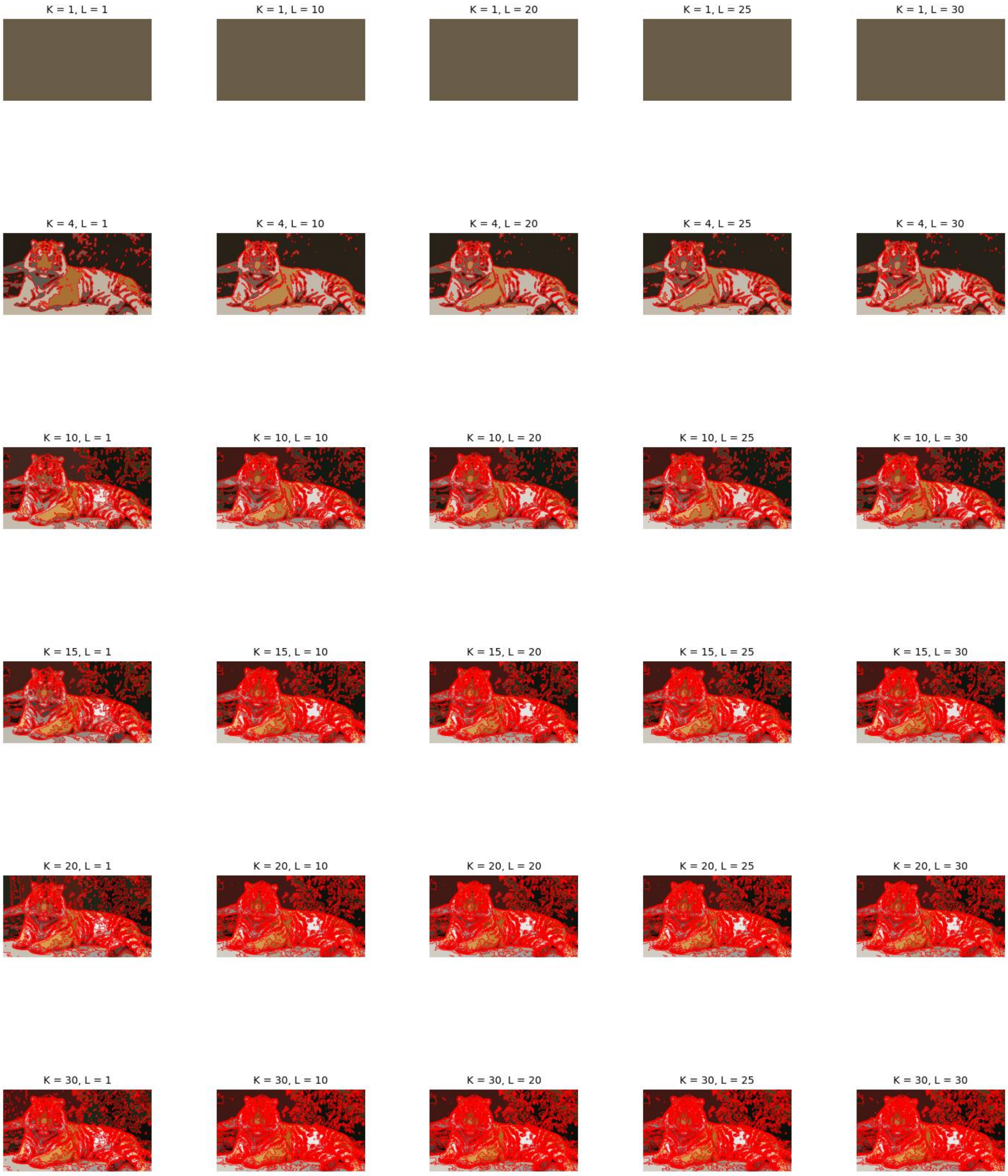


**Question 4**: What needs to be changed in the parameters to get suitable superpixels for the tiger images as well?



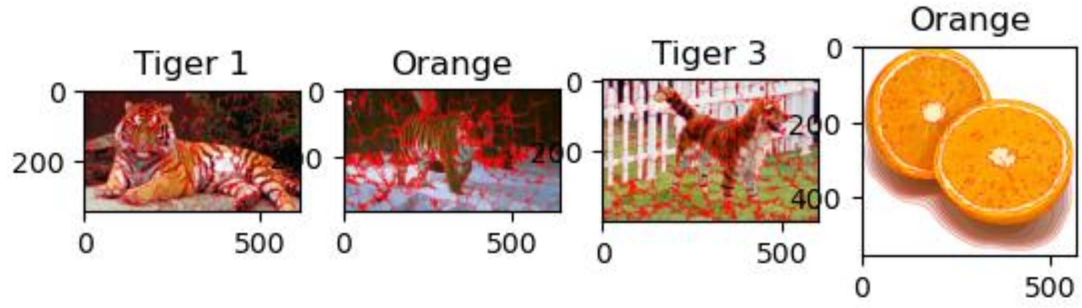

The K and L values needs to be changed

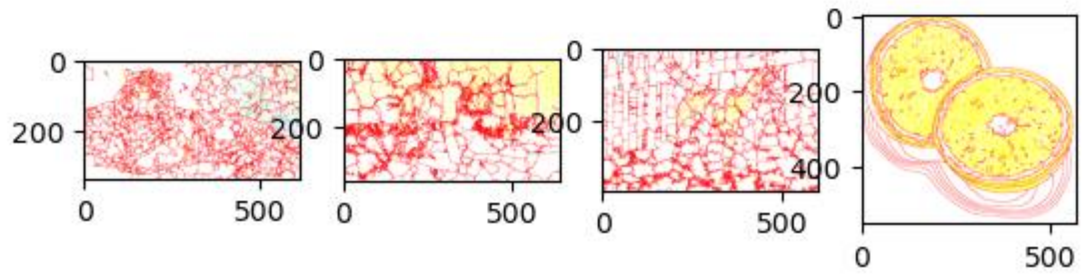
Answers:



**Question 5**: How do the results change depending on the bandwidths? What settings did you prefer for the different images? Illustrate with an example image with the parameter that you think are suitable for that image.

Answers:



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**Question 6**: What kind of similarities and differences do you see between K-means and mean-shift segmentation?

Answers:
Both of them are clustering algorithms used in image segmentation but they differ in their approaches and assumptions. Below is a comparison of their similarities and differences.

****Similarities:****
- Both are clustering algorithms used in image segmentation
- Both are iterative algorithms that update their parameters (cluster centers in K-means and search window locations in mean-shift) to optimize a certain criterion.
- Seems to be robust to noise

****Difference:****
- ****Clusters:**** Tehires the number of clusters to be a specified parameter while mean-shift does not require the number of clusters to be specified, it relies on the a bandwidth parameter.
- ****Cluster view**** In K-means, the clusters are circular while in mean-shift, the clusters change shape based on the data.
- ****Computation**** K-means is quick and efficient while mean-shift is slower and computationally expensive.
- ****Initialization**** K-means requires the number of clusters to be specified and the initial cluster centers to be specified while mean-shift does not require the number of clusters to be specified and the initial cluster centers are chosen randomly.

**Question 7**: Does the ideal parameter setting vary depending on the images? If you look at the images, can you see a reason why the ideal settings might differ? Illustrate with an example image with the parameters you prefer for that image.

Answers:
I would assume that the ideal parameters differs from image to image. This is because the ideal parameters depend on the size of the image, the resolution of the image, the contrast of the image, the color variation in the image, the shape of the image and the blur of the image. That being said these are how the different parameters affect the segmentation process.

- **Color Bandwidth:** Used to define threshold for color similarit. If value was larger, a wider range of colors would be considered similar and the segments would be larger. If value was smaller, a smaller range of colors would be considered similar and the segments would be smaller.

- **Radius:** Maximum distance within two pixels are considered neighbours. If value was larger, a wider range of pixels would be considered neighbours and the segments would be larger. If value was smaller, a smaller range of pixels would be considered neighbours and the segments would be smaller.

- **Ncuts_thresh:** Used to define minimum cost considered before cutting into segments. A segment is not further divided if the normalized cost is below this threshold. If value was larger, a wider range of pixels would be considered similar and the segments would be larger. If value was smaller, a smaller range of pixels would be considered similar and the segments would be smaller.

- **Min_size:** Used to define minimum size of a segment. If value was larger, the segments would be larger. If value was smaller, the segments would be smaller.

- **Scale_factor:** Used to scale dow nimage before processing. Reduces the image size and thereby decrease processing time

- **Image sigma:** Used to define the standard deviation of the Gaussian smoothing filter applied to the image before processing. If value was larger, the image would be more blurred and the segments would be larger. If value was smaller, the image would be less blurred and the segments would be smaller.

Color_bandwidth = 20
Radius = 3
Ncuts_treshold = 0.1
Min_area  100
Max_depth = 15

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**Question 8**: Which parameter(s) was most effective for reducing the subdivision and still result in a satisfactory segmentation?

Answers:

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To reduce the subdivision keeping the same segmentatino, we can modify
- Ncuts_thresh
- Min_size
- Max_depth
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**Question 9**: Why does Normalized Cut prefer cuts of approximately equal size? Does this happen in practice?

Answers:
Normalized cut prefers aims to find a balance between segment sizes, consdering not only the cut itself but aslo the total connections within each segment. Does this by normalizing the cut by the total edge connections in each segment. This approach discourages cuts that isolate small groups of highly connected nodes or pixels as it would result in a high normalized cut value.

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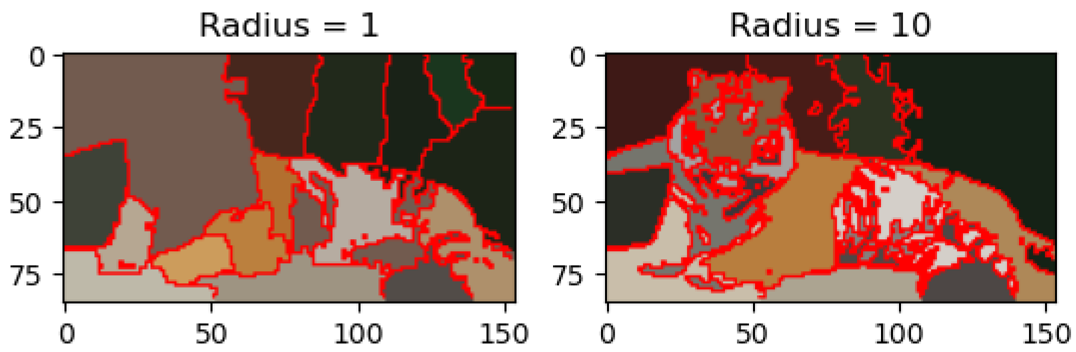
**Question 10**: Did you manage to increase *radius* and how did it affect the results?

Answers:




Did not really enhance the image that much but it definitely became more clear.

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**Question 11**: Does the ideal choice of *alpha* and *sigma* vary a lot between different images? Illustrate with an example image with the parameters you prefer.

Answers:

**Alpha** - The maximum cost of an edge: When increasing alpha, we increase the maximum cost of an edge making it more difficult to cut across similar pixels or smooth surfaces as they will have higher costs. Higher alpha will preserve edges during segmentation-

**Sigma** - How much the cost decays for decreasing similarity between neighbouring pixels. Used in edge weight calculation.

If we lower both parameters, the cuts will be more sensitive and the accuracy of the segmentation will decrease as we are ok with cutting similar pixels with high edge values or costs.

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**Question 12**: How much can you lower K until the results get considerably worse?

Answers:


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**Question 13**: Unlike the earlier method Graph Cut segmentation relies on some input from a user for defining a rectangle. Is the benefit you get of this worth the effort? Motivate!

Answers:

Depends on the picture which the algorithm is applied to. If the picture is simple and the object is easily distinguishable from the background, then the rectangle can be easily drawn and the algorithm can be applied. However, if the picture is complex and the object is not easily distinguishable from the background, then the rectangle can be difficult to draw and the algorithm may not be able to be applied.

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**Question 14**: What are the key differences and similarities between the segmentation methods (K-means, Mean-shift, Normalized Cut and energy-based segmentation with Graph Cuts) in this lab? Think carefully!!

Answers:

**Similarities:**
- All of the methods use clustering to group points. Mainly based on similarity of color and in some cases, spatial proximity.
- Mean-shift and Graph cut both use the Gaussian distribution to model the data.
- Both

****Differences:****
Energy based segmentation using graph cuts requires prior information about the expected ratio of background to foreground in order to produce more accurate results. Normalized cut does not require this information.
- Mean-shift and the graph based methods look at the spatial information into account while K-means, in this code, looks only at the color information.

K mean does not care to what is in the image or if it should be a part of the background ot not, it simply creates clusters based on the color similarity and spatial proximity of the pixels then assigns each pixel to the cluster that it is most similar to. <br>

Mean shift is similar to K mean in that it also creates clusters based on the color similarity and spatial proximity of the pixels but it does not require the number of clusters to be specified. Instead, it uses a bandwidth parameter to define the radius of the search window. The search window is centered around a pixel and the mean of the pixels within the search window is calculated. The center of the search window is then shifted to the mean and the process is repeated until convergence. <br>

Normalized cut is different from K mean and mean shift in that it does not use clustering to segment the image. Instead, it uses graph theory to segment the image. It first creates a graph where each pixel is a node and the edges are the similarity between the pixels. It then uses the graph to find the minimum cut which is the cut that minimizes the cost of the cut. The cost of the cut is the sum of the weights of the edges that are cut. The cut is done by removing the edges with the highest weights. The process is repeated until the cost of the cut is below a certain threshold. <br>

Energy-based segmentation using graph cuts is different from the other methods in that it requires prior information about the expected ratio of background to foreground. It then uses this information to create a graph where each pixel is a node and the edges are the similarity between the pixels. It then uses the graph to find the minimum cut which is the cut that minimizes the cost of the cut. The cost of the cut is the sum of the weights of the edges that are cut. The cut is done by removing the edges with the highest weights. The process is repeated until the cost of the cut is below a certain threshold. <br>