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?

Answers:

For the initial cluster centers the best method seems to be selecting K random pixel values from the image itself. The alternative would be generating K random colors with no direct connection to the image in use. If the colors used in the image are biased and some colors are not really represented in the image, this has the drawback of potentially generating dead segments, where no pixels are assigned to the segment. For example, in the oranges image, if we do absolutely random initialization and one of the centers is initialized to blue color, it’s likely it will get no pixels assigned, it won’t be shifted anywhere after the means are calculated, so it will remain an empty class.

Ideally, some method could be devised to first look for K most distinct values in the color space the images uses.

In general it seems, the best approach seems to be sampling randomly from the image, so we avoid empty classes while not needing complex initialization.

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**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?

Answers:

Depends on the complexity of each individual image and the chosen number of clusters K. Blurring the image also seems to make the convergence faster, as it starts to merge neighboring color values together, resulting in less color variety throughout the image.

It seems that as the means are recalculated, which are floating point values, there are pixels that just keep moving back on forth between the clusters practically forever (at least for the duration tests were run for this purpose), but those are minimal changes and don’t really affect the practically usable result, so we can look at some error criterion and say that convergence has been reached when no significant change in the results is no longer produced.

For the converge criterion the maximum absolute difference between two subsequent sets of center points was chosen, i.e. if no color channel value in any of the cluster centers hasn’t changed by more than 0.5 (colors are integers 0-255, so the decimal change doesn’t change the resulting integer anymore), we say that there’s no significant change anymore and it has converged.

Using *default* seed and the **orange.jpg** image, this yielded the following results

K = 2 converged at L = 2

K = 3 converged at L = 4

K = 4 converged at L = 4

K = 5 converged at L = 7

K = 6 converged at L = 7

K = 7 converged at L = 15

K = 8 converged at L = 17

K = 9 converged at L = 20

K = 10 converged at L = 20

On more complex images with higher color variety the convergence would obviously be slower.

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**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:

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

Answers:

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**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:

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**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:

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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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**Question 9**: Why does Normalized Cut prefer cuts of approximately equal size? Does this happen in practice?

Answers:

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

Answers:

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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:

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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:

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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:

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