Simple Linear Iterative Clustering (SLIC)

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Overview

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- Superpixels
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Image Segmentation

The process of partitioning a digital image into multiple segments that share similar attributes (like color) to simplify the representation

The goal is for the regions to represent meaningful areas of the image thus, making it more useful for the analysis and interpretations.

Superpixels

When we group pixels based on color, texture, or other low level primitives, we call these perceptual groups **superpixels**

Also known as color based segmentation

Advantages:

- Computational Efficiency
- Perceptual Meaningfulness

Superpixels Example

Simple Linear Iterative Clustering (SLIC)

SLIC generates compact, nearly uniform superpixels by clustering pixels based on their color similarity and proximity in the image plane.

Adaptation of K-means algorithm

A 5 dimensional [labxy] space is used for clustering.

CIELAB color space is considered as perpetually uniform for small color distances.

Definitions

Input: K i.e., a desired number of approximately equally-sized superpixels

Each superpixel will have approximately N/K pixels.

For each equally sized superpixels, there would be a superpixel center Ck = [lk, ak, bk, xk, yk] with k = [1, K]

The centers of superpixels are separated by a distance of S = √(N/K)

The pixels associated with a cluster lie within 2S x 2S area around the superpixel center in the xy plane

Distance Measure

If spatial pixel distances exceed this perceptual color distance limit, then they begin to outweigh pixel color similarities

$dlab = \sqrt{(lk - li)^2 + (ak - ai)^2 + (bk - bi)^2}$

$dxy = \sqrt{(xk - xi)^2 + (yk - yi)^2}$

$Ds = \sqrt{}(dlab/m)^2 + (dxy/S)^2$

where Ds is the sum of the lab distance and the xy plane distance normalized by the grid interval S. A variable m is introduced in Ds allowing us to control the compactness of superpixel.

Algorithm

First get initial K cluster centers

Then each pixel in the image is associated with the nearest cluster center whose search area overlaps this pixel.

Once all the pixels are associated with the nearest cluster center, a new center is computed by averaging over the cluster members

Keep iterating until convergence or max # of iterations is reached

Results

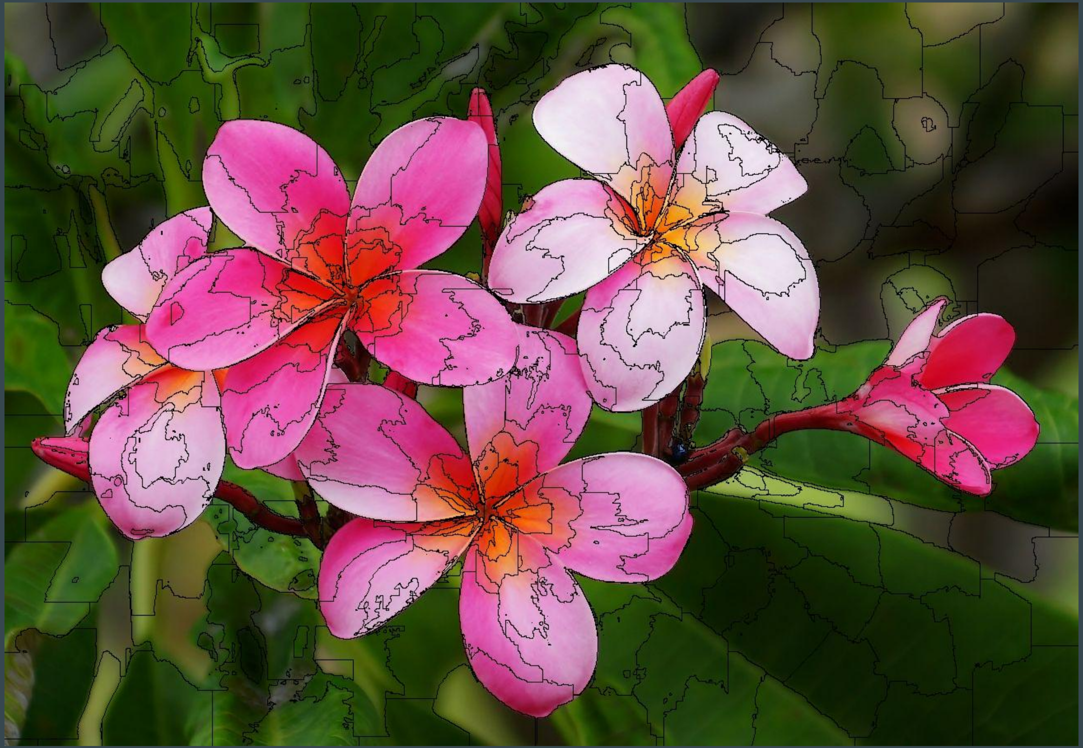
K = 64, 256, 1024

My Results

K = 64

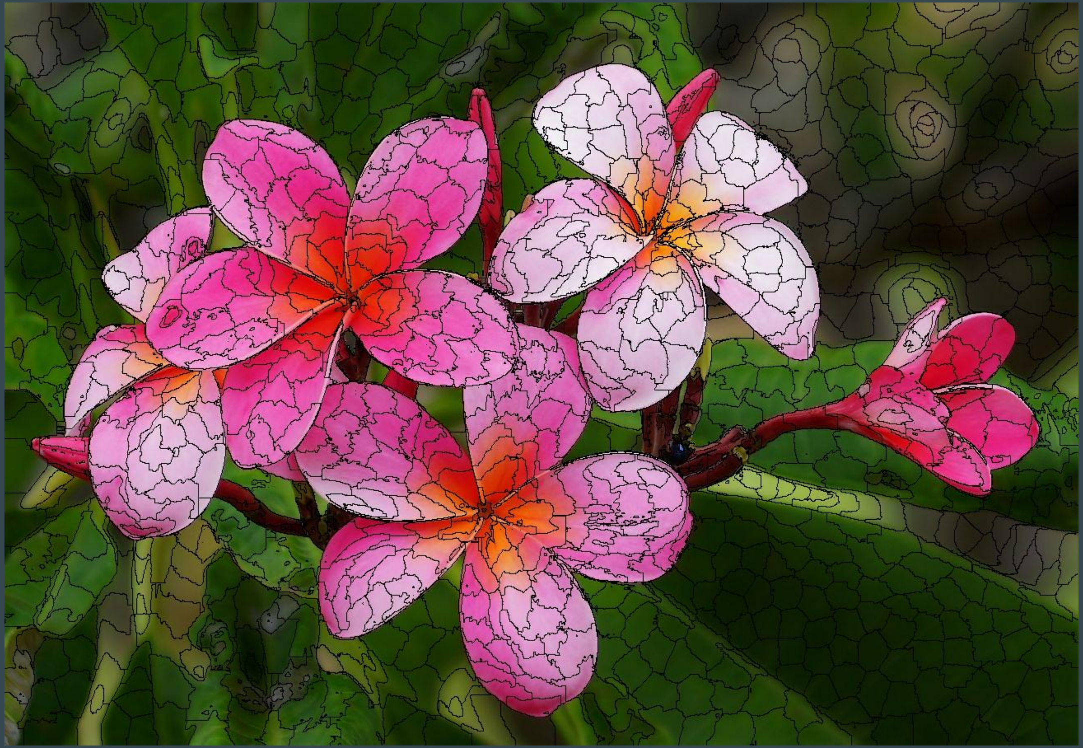
My Results

K = 256



My Results

K = 1024

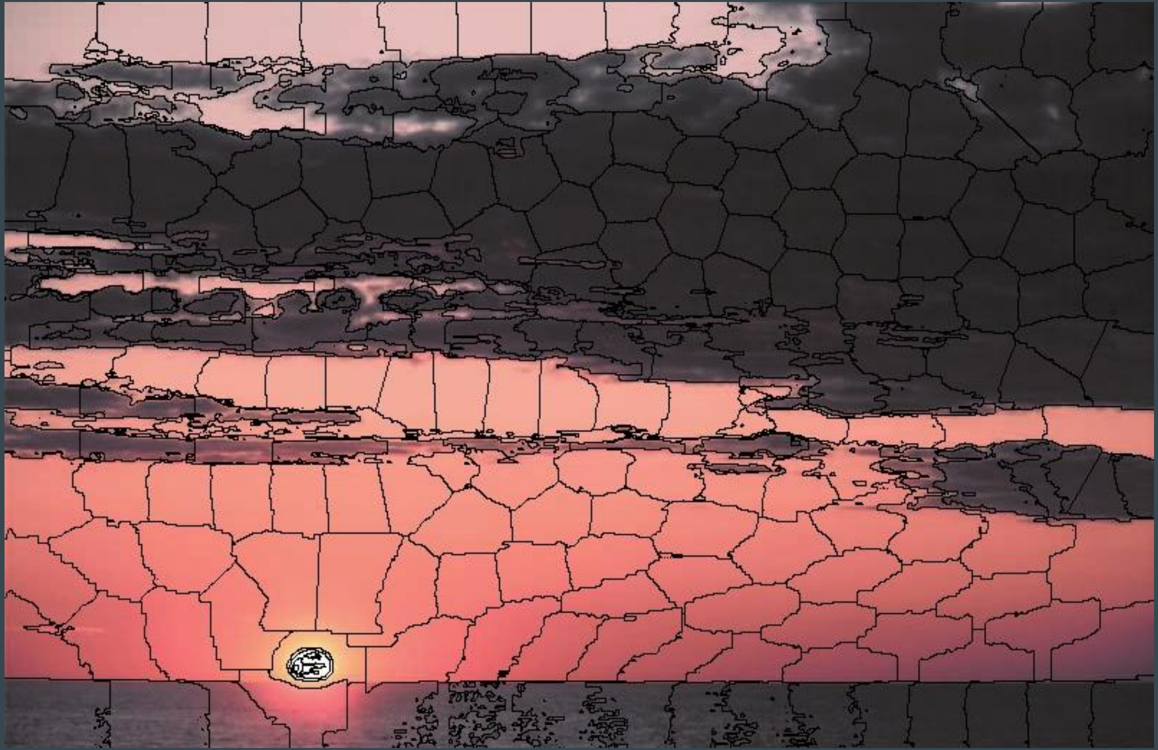


My Results

K = 64

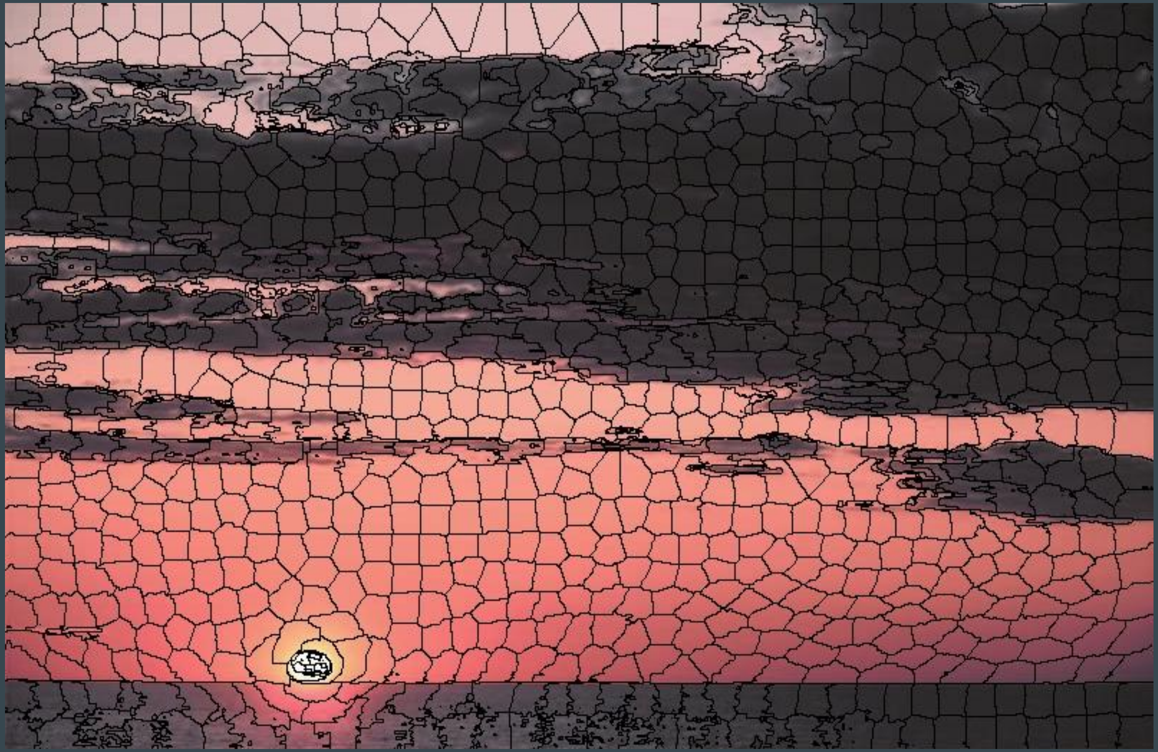
My Results

K = 256



My Results

K = 1024



Limitations

- Require prior knowledge of the image, the expected number of clusters k. Otherwise, over segmentation might happen
- Strongly affected by the outliers

Sources

- Achanta, Radhakrishna, et al. “SLIC Superpixels Compared to State-of-the-Art Superpixel Methods.” IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 34, no. 11, 2012, pp. c3–c3., doi:10.1109/tpami.2012.202.
- Mallick, Satya. “Home.” Learn OpenCV, 5 Nov. 2018, www.learnopencv.com/image-segmentation/
- Körting, Thales Sehn, director. YouTube. YouTube, YouTube, 1 Sept. 2018, www.youtube.com/watch?v=-hmUbB-Y8R0
- Rambhia, Jay. “SLIC Based Superpixel Segmentation.” 25 Aug. 2013, jayrambhia.com/blog/superpixels-slic.
- Rosebrock , Adrian. “Segmentation: A SLIC Superpixel Tutorial Using Python.” PyImageSearch, 2 Aug. 2018, www.pyimagesearch.com/2014/07/28/a-slic-superpixel-tutorial-using-python/
- Achanta et al. “PSMM/SLIC-Superpixels.” GitHub, PAMI'12, Vol. 34, Num. 11, Pp. 2274-2282, 13 May 2013, github.com/PSMM/SLIC-Superpixels.

Thank You