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Project 4: K-means Clustering

In this project, I used the provided starter code to implement an algorithm that would apply a K-means clustering to a series of rgb values from an image, then return a new set of rgb values according to the clusters. The K-means cluster works on the following steps:

1. Create k clusters, assigning a distinct random rgb value from the image to be the center
2. Iterate through the rgb values of each pixel in the image. Assign each pixel to the cluster with the closest rgb value to its own color
3. Update all clusters color center to be the average of all pixels part of that cluster
4. Repeat from 2 until no pixel changes the cluster they are part of
5. Create a new rgb array using the cluster colors

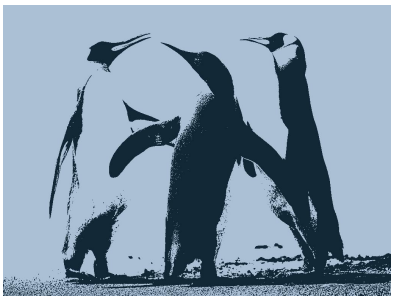
I used this function on the two test images Koala.jpg and Penguins.jpg with varying K values to find the average image compression, as well as how much variance there was in image compression due to the random nature of the clusters. Each K value was run 5 times for each image.

Koala.jpg (762.53 KB)

K	Image	Average Compression/Variance (KB)
2		Mean: 127.83 Variance: 0.167
5		Mean: 172.318 Variance: 0.49117

10		Mean: 159.784 Variance: 0.81233
15		Mean: 154.282 Variance: 1.05952
20		Mean: 152.076 Variance: 0.63463

Penguins.jpg (759.60 KB)

K	Image	Average Compression/Variance
2		Mean: 83.096 Variance: 0.00203

5		Mean: 104.408 Variance: 0.09817
10		Mean: 114.464 Variance: 0.96438
15		Mean: 113.274 Variance: 0.26298
20		Mean: 113.108 Variance: 0.24683

Generally, a low K value results in a much smaller file - not surprising, since storing only 2 different colors is fairly easy. The files did also seem to be more compressed with higher K values, though this could be either an issue of variance or something to do with the JPEG format I am not aware of. Either way, increasing K in this manner didn't increase compression by a significant amount, suggesting there is little difference between K =10 and K=20. The Koala image compressed notably worse than the Penguin, though this seems easily explainable by the context of the images. The Penguin image has few colors that are fairly distinct, being yellow, black, white, gray, and blue. The Koala image has orange, green, brown, pink, white, gray, and black. The Koala image also has blurs of colors along the koala's fur, with pixels not consistently being a single color in a row. Compare this to the penguin image, which often has

massive areas of white or black space. The Penguin image maintains most of its detail upon reaching a K of 10-15, so such values work fine. For the Koala, while the fuzziness of the image is lost by K=15, the colors are incredibly muted. Even trying up to a K value of 70, it was hard to fully keep the colors of the image.