MATH170A HW5

Tyler Barbero
Instructor: Caroline Moosmueller

Due 16 November 2020

Problem 5

a) Explain line by line what the code does (you might need to google some of the commands).

4. reads image from file and stores data type (uint8) in array A.
5. converts truecolor image to grayscale by eliminating hue and saturation, retains luminance (intensity of light). I assume hue and saturation are 2/3 z-dimensions turning it into a 2d array of just luminance.
7. convert matrix A to double data type from uint8 unsigned integer 8bit.
11. returns size of B (x,y)
12. stores rank (scalar) of matrix b in var r.
13. does singular value decomp of matrix B and outputs u,v (orthog matrices, and s (singular value matrix).
17. stores numbers in a matrix "ranks" with r=rank(B)=480 as the last element.
18. stores length of matrix "ranks" in var "l"
20. starts for loop for i=1 to i=l, repeats code in loop l-times.
24. store the i-th element of ranks in var k.
26. matrix multiplication: U(all rows, 1 to k columns) * S(1 to k rows, 1 to k columns) * V(all rows, 1 to k columns) transposed. stores result in matrix approxB.
28. convert approxB data type from double to uint8 and store in approxA
32. designate figure 1.
33. create a 8 subplots in 2 rows and 4 columns (assigns a plot to one subplot in each iteration of loop).
34. for each subplot(2,4,i) plot the approxA matrix which changes based on i-th rank.
35. titles each subplot. sprintf will screen print the text and format a number into the first argument of sprintf which is a char array. Number is formatted into char array by %d.

b) Explain mathematically what the code does with the original image.

The image is a 480x640 uint8 matrix. The code will use more singular values of S as k = ranks(i) where with each iteration of the loop k (rank) will increase in value.

c) The approximation gets better as we increase k. Already for k= 100, the resulting approximation looks reasonable. What is the advantage to use/store the k= 100approximation instead of the original image? What is the disadvantage?

The advantage is that we don't need all of the of the data in A outside the values corresponding to the rank k=100. The disadvantage is that it will be an approximation and we won't have the full quality.

d) For a general image, by using the SVD, how can one determine a value for k that results in a reasonable approximation?

We can use the low-rank approximation. We approximate A with a rank-k matrix such that k ¡ r. We know that the singular values are descending meaning $\sigma_1 > \sigma_2 > ... > \sigma_k > ... > \sigma_r$. We can choose a σ_k that is very small and if we cut off $\sigma_{k+1}...\sigma_r$ it won't affect the result very much and we still get a good approximation.