

CENG 371
Scientific Computing
Homework 4
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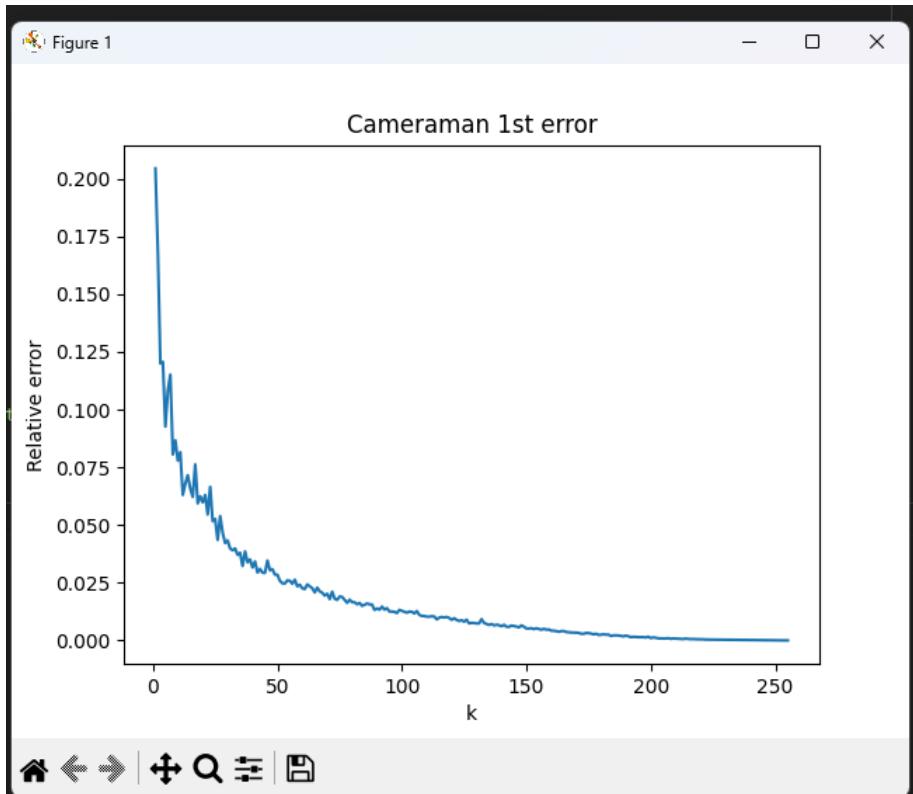
1)

Function is implemented as **approximate_svd(A,k)** with parameter p =5, returns u_k, sigma_k,v_k respectively.

2)

a) Cameraman:

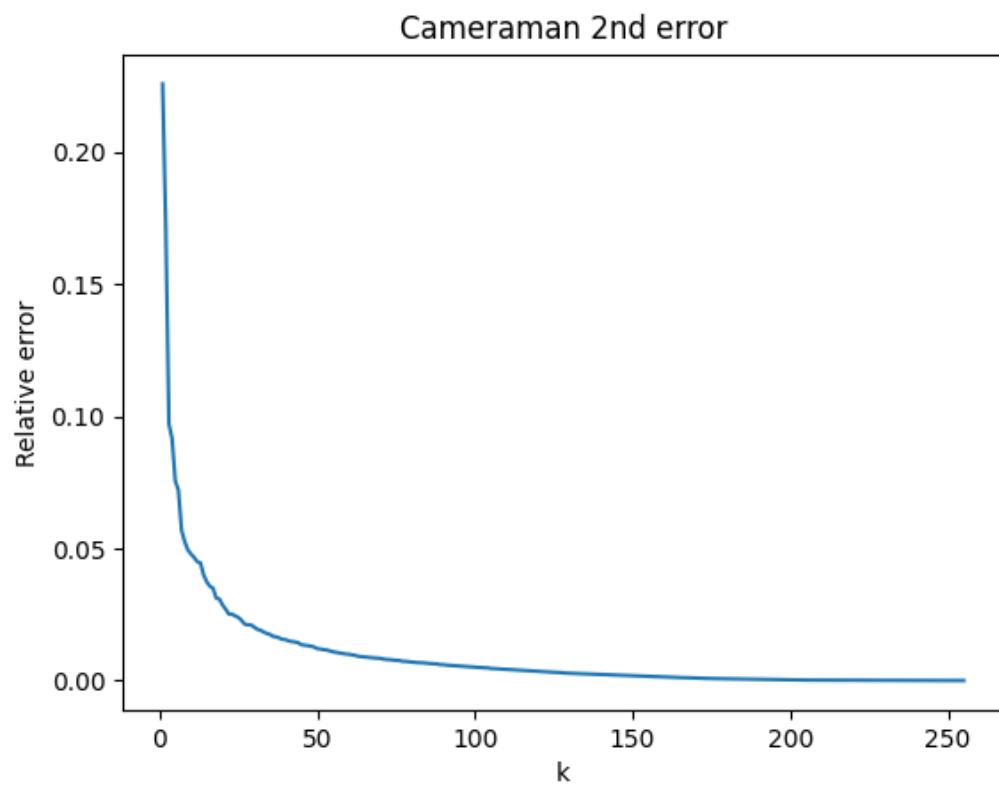
1st error:



2nd error:

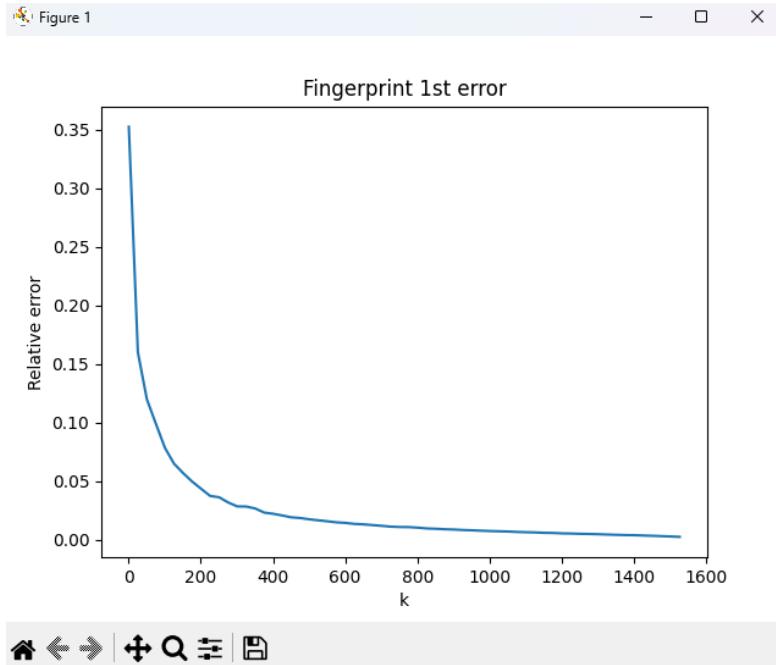
Figure 1

— □ ×

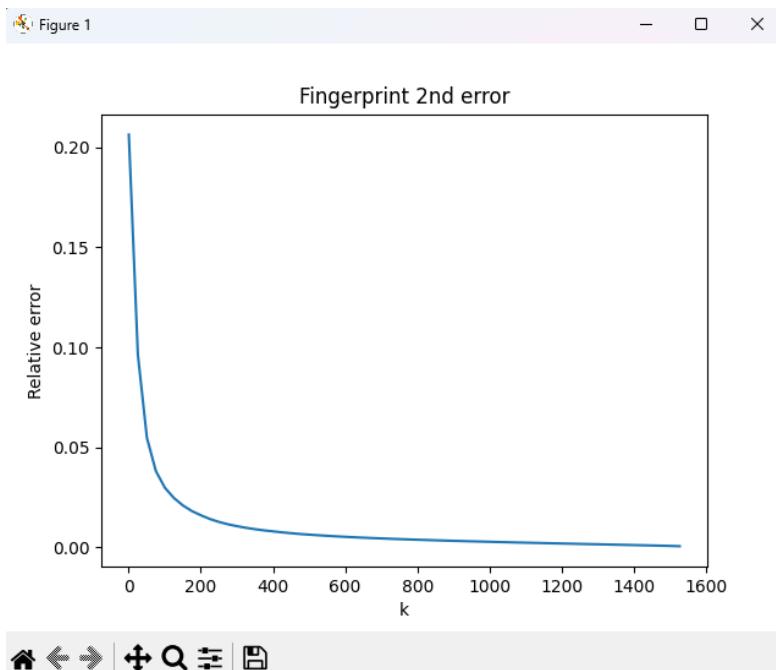


Fingerprint:

1st error:



2nd error:

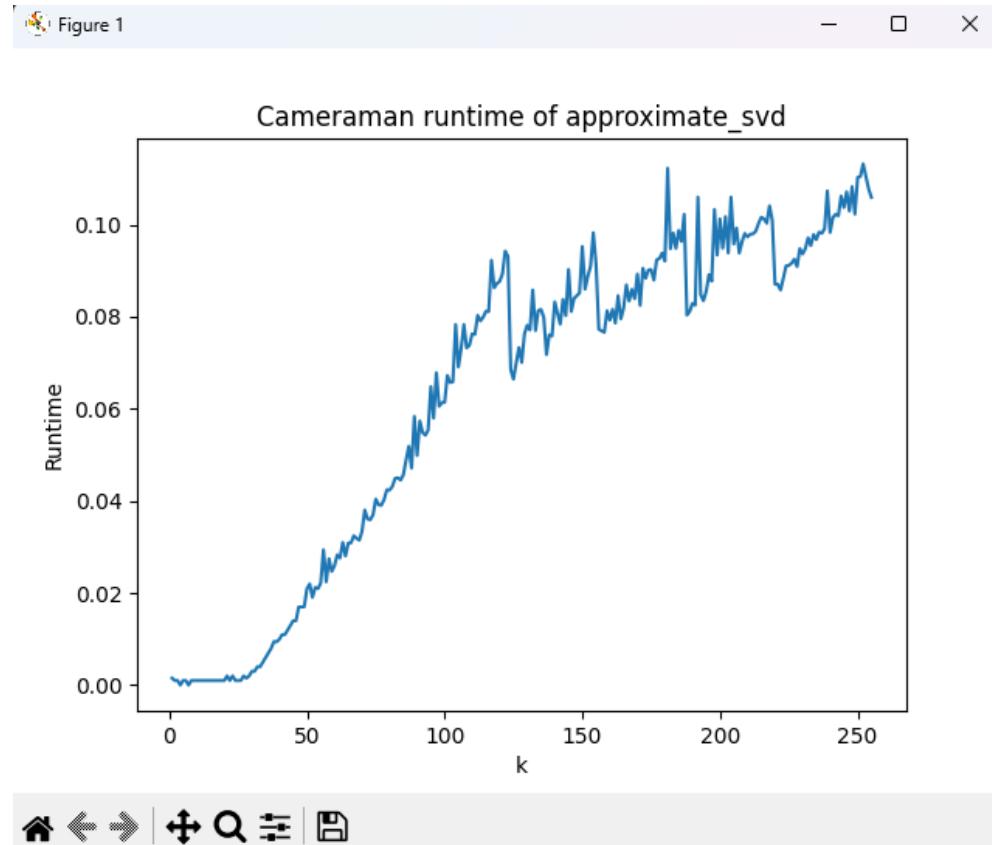


In both cameraman and fingerprint, as k increases, relative error decreases as expected. Svds relative error curve has more steep decline

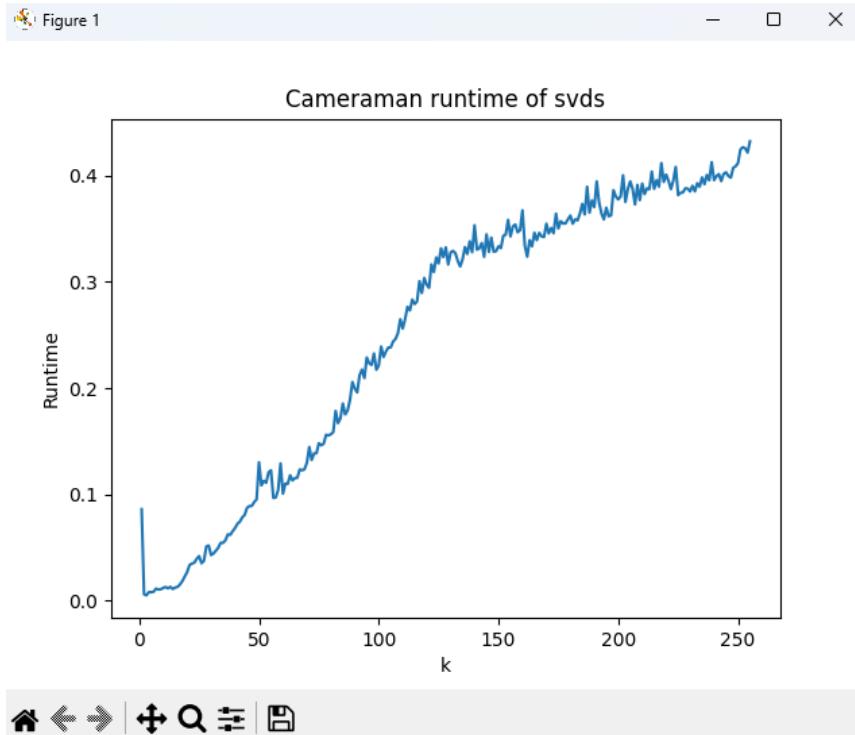
than approximate_svd, so lower k values in svds are closer to 0 than approximate_svd.

b) Cameraman:

Cameraman runtime of approximate_svd:

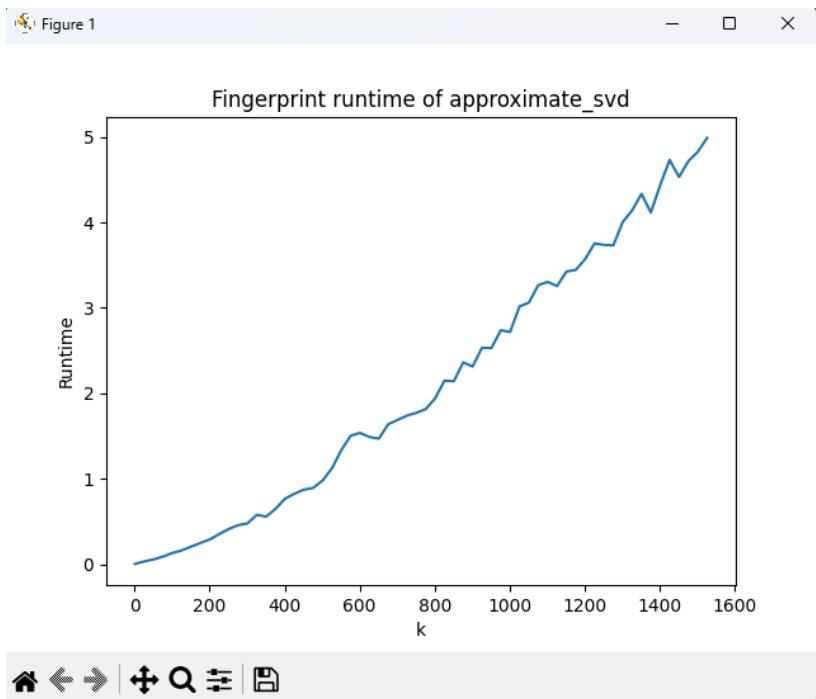


Cameraman runtime of svds:

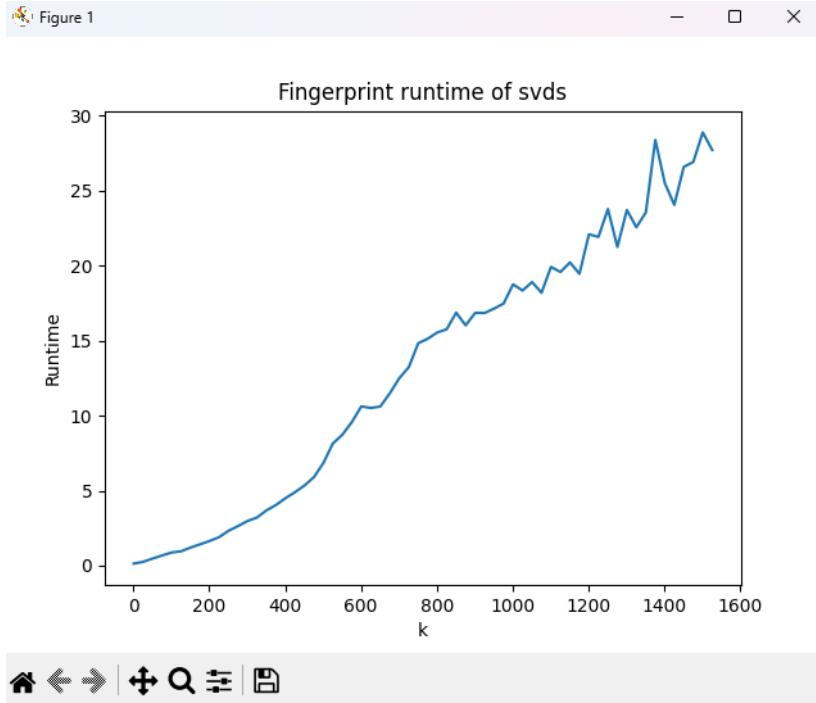


Fingerprint:

Fingerprint runtime of approximate_svd:



Fingerprint runtime of svds:



For runtime comparison, fingerprint runtimes are bigger than cameraman runtimes as expected since fingerprint's matrix is way larger than cameraman's. Additionally, approximate_svd is faster than svds in both images.

c)

Setting k=25 for both images;

Cameraman approximate_svd:



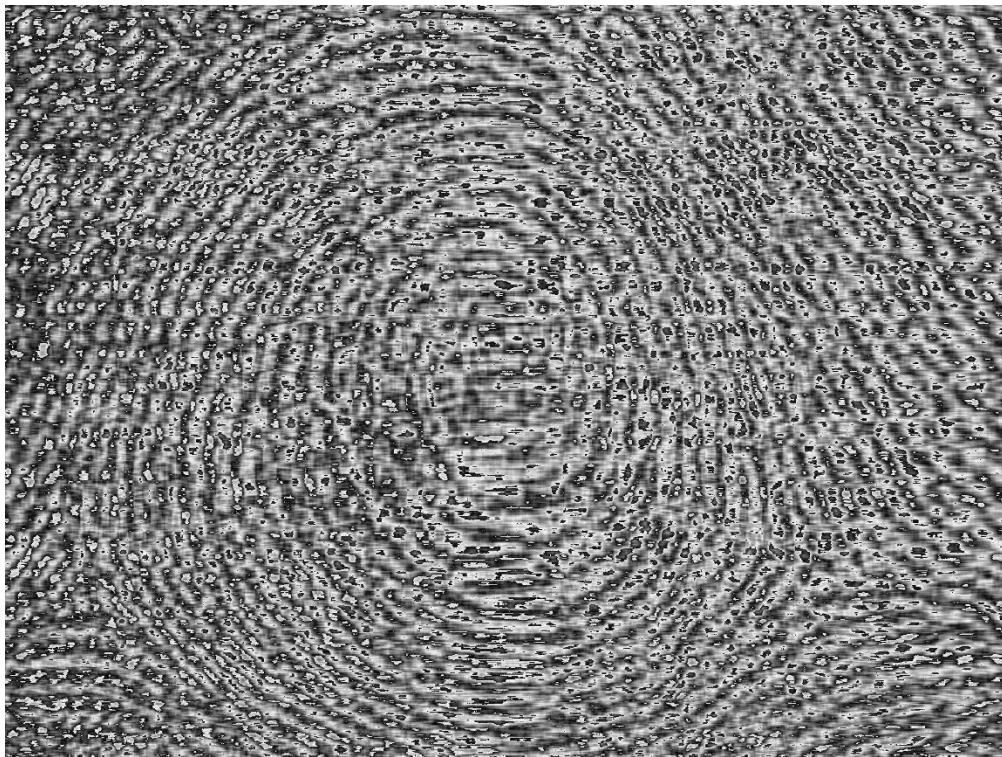
Cameraman svd:



Cameraman svds:



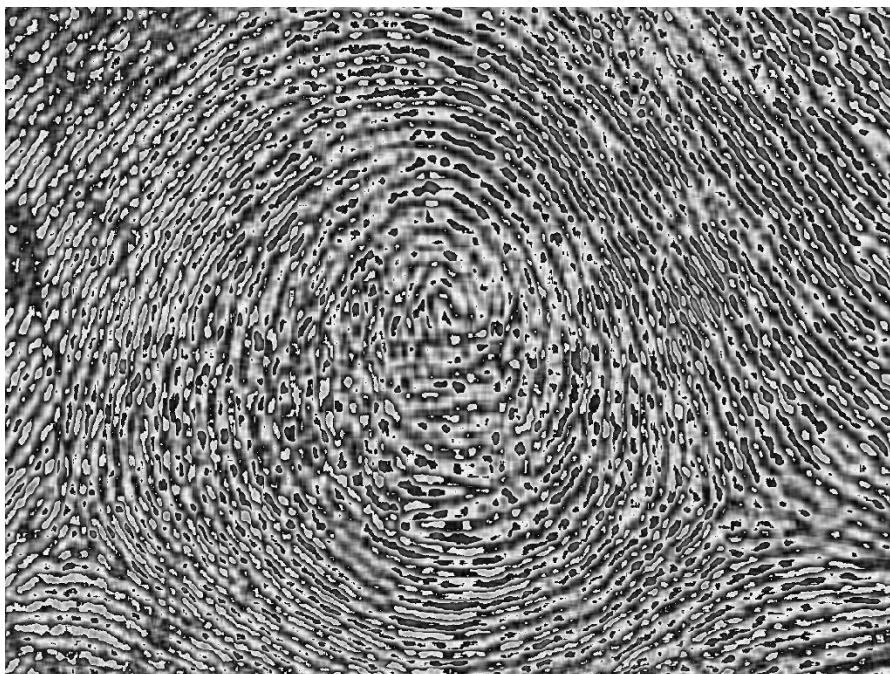
Fingerprint approximate_svd:



Fingerprint svd:



Fingerprint svds:



In both images, we get the same result in svd and svds. Even recompiled image sizes are the same. However approximate_svd

results are different from svd and svds. Svd and svds images are closer to original images than the images recompiled from approximate_svd.

If we select k close to the rank of the matrix, we get the image almost the same as the original image.

d)

Since approximate_svd runs faster than both svd and svds, for large image files, it can be used to approximate. Even though svd and svds give better results than approximate_svd, we may encounter really large matrices and using approximate_svd with appropriate k value will be better if time is an issue. It is particularly useful when the matrix is too large to fit in memory, or when only a small number of the singular values and vectors are needed. In contrast, the standard svd and svds algorithms compute the full svd of a matrix, which can be computationally expensive for large matrices.