Report problem 1

Perform SVD for a matrix (or matrices)

(i) Prepare a $M \times N$ matrix A. ($M, N > 100$ is better)

It is encouraged to prepare a matrix related to your research field.

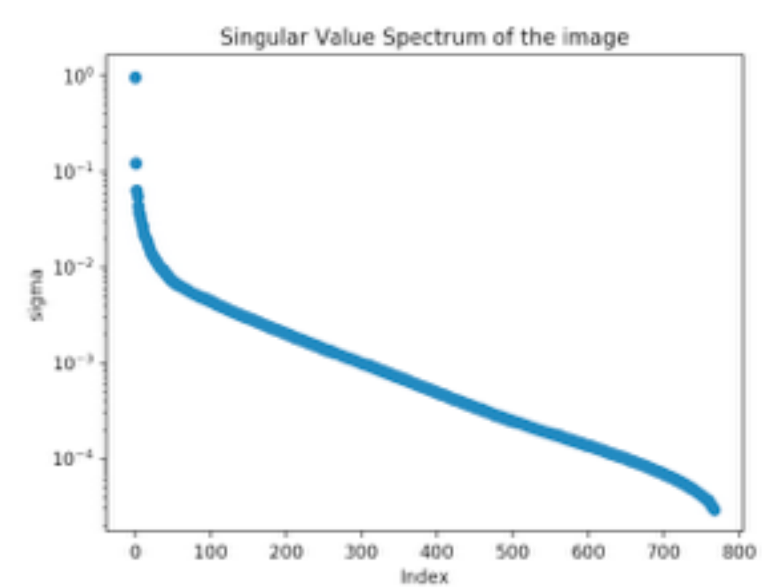
If it is difficult, prepare a picture. (It should be different from the examples in the lecture.)

(In the report, please include the explanation (meaning) of the matrix.)

(ii) Perform SVD and plot the singular values.

You can use any libraries. (LAPACK, numpy or scipy in python, matlab, ...)

Please normalize the singular values as $\tilde{\sigma_i} = \sigma_i / \sqrt{\sum_j \sigma_j^2}$



Report problem 1 (cont.)

Perform SVD for a matrix (or matrices)

(iii) Perform low rank approximations of the matrix with ranks r_1,r_2, ...

- Calculate the distances between the original and approximate matrices.
  Please use Frobenius norm $\|A - \tilde{A}\|_F$ as the distance.
  It is better to show a normalized distance: $\|A - \tilde{A}\|_F / \|A\|_F$
- Try at least two ranks (r_1 and r_2).

(iv) Discuss characteristics of the low rank approximations (for your matrix) based on the singular value spectrum.

- Please include "explanation" of the relation between the distance and singular values.
  (You can find the relation in the lecture slides.)

Report problem 1 (cont.)

Sample python code for Image SVD: Report_SVD.zip

(Run with python2.7 or python3. You need PIL, numpy, matplotlib)

It works at least on ECCS.

Usage of sample python code for Image SVD:

python image_svd.py -c chi -f filename

[Example of output]

```
Input file: sample.jpg
Array shape: (768, 1024)
Low rank approximation with chi=10
Normalized distance:0.10087303978176487
```

(In addition, the singular value spectrum and the approximated image appear.)

You can see help message: *python image_svd.py -h*

```
usage: image_svd.py [-h] [-c chi] [-f filename]

Low rank approximation of an image

optional arguments:
  -h, --help            show this help message and exit
  -c chi, --chi chi     rank of the approximated matrix. (default: chi = 10)
  -f filename, --file filename
                        filename of the image. (default: sample.jpg)
```