Homework VII

Deadline: 2017-12-13

1. (5 pts) Let $\boldsymbol{A} = \underbrace{\begin{pmatrix}\boldsymbol{u}_1 & \boldsymbol{u}_2 & \boldsymbol{u}_3 & \boldsymbol{u}_4 & \boldsymbol{u}_5\end{pmatrix}}_{\boldsymbol{U}} \begin{pmatrix}-5 & & & & \\ & 1 & & & \\ & & -3 & & \\ & & & 2 & \\ & & & & 6\end{pmatrix} \underbrace{\begin{pmatrix}\boldsymbol{v}_1 & \boldsymbol{v}_2 & \boldsymbol{v}_3 & \boldsymbol{v}_4 & \boldsymbol{v}_5\end{pmatrix}^T}_{\boldsymbol{V}}$, where $\boldsymbol{U}$ and $\boldsymbol{V}$ are 5×5 orthogonal matrices. Give the best rank three approximation of $\boldsymbol{A}$.

2. (10 pts) Take a picture of your favorite and plot its singular values. (For a RGB color image, you can first transform it into grayscale by `rgb2gray()`, and then apply `double()/255` to scale the image). Find the best rank r approximations of your image for r starting from 1 up to a certain value. Report the approximation error for different r by making an *approximation error vs. r* plot. What do you observe as r increases?

3. (15 pts) Repeat the "eigenfaces" experiment presented in 10CaseStudiesD.pdf:

   - Download the data set from the link: http://www.cl.cam.ac.uk/research/dtg/attarchive/facedatabase.html
   - Read one face from each person. For example, the following sample codes can read the first face (i.e., 1.pgm) in the s5 folder and form it into a vector: `path = 'your local folder/oral_faces/s'; I = imread([path num2str(5) '/1.pgm']); I = double(I)/255; I = I(:);`
   - Compute the mean of all the faces and form the data matrix.
   - Compute the SVD of the data matrix and find the principal components.
   - Compute projections of all the faces that are used to compute the principal components.
   - Choose another 50 faces randomly from the remaining faces (i.e., faces that are not used in computing the principal components) and do face recognization by comparing the projection of the target face with that of the faces used in computing the principal components, and recognizing the target face as the closest one from the known faces. Report the successful rate for recognization.