ALGORITHMS FOR IMAGING SPECTROSCOPY

HOMEWORK 3, SPRING 2017

DUE DATES:
PROBLEM(4), READING MONDAY, FEB 6.
PROBLEMS (1)-(3), PCA EXPERIMENTS, WEDNESDAY, FEB 8.

Name: _____

(1) MyPCA 2D Data

(a) Generate a data set $\mathbf{X}$ of samples from a two-dimensional Gaussian with mean vector $\boldsymbol{\mu}$ and covariance matrix $\mathbf{C}$ for different choices of $\boldsymbol{\mu}$ and $\mathbf{C}$ and numbers of samples (in the range of about 100-2000). Note: if $\mathbf{A}$ is a square matrix, then the matrix $\mathbf{A}\mathbf{A}^t$ can be used as a covariance matrix. For each $\mathbf{X}$, set `NumComps = 2` and run `MyPCA` with arguments $\mathbf{X}$ and `NumComps`.

(b) For each run of `MyPCA`, reconstruct the covariance matrix used to define the transformation of $\mathbf{X}$ to $\mathbf{Y}$ using the values of the output variables. Do not use the covariance matrix $\mathbf{C}$ that was used to generate the data sample.

(c) For each run of `MyPCA`, display the plots using the function `See2DimPCA`. Resize the figure window so that the plots are square (each axis is the same size on the screen).

(2) MyPCA 3D Data

(a) Load the 3D data set from the file X3D.mat..

(b) Display the data in 3D using the `MATLAB` function `scatter3`. Use the rotate button on the figure window to look at the data from different perspectives.

(c) Run `MyPCA` on the data with `NumComps = 2`. Plot the result using the `MATLAB` function `scatter`. What do you observe?

(3) MyPCA Real Data

(a) Load the hyperspectral image and corresponding wavelengths from the files `SanBarIm88x400.mat` and `SanBarWvs.mat` using the `MATLAB load` command (run `doc load` for instructions on load.

(b) Use the wavelengths in `SanBarWvs` to determine band indices that correspond to Red, Green, and Blue. Make a color image representation of the hyperspectral image using the command `SanBarRGB = SanBarIm88x400(:, :, [RedInd, GreenInd, BlueInd])` where `[RedInd, GreenInd, Bl` are the indices of the Red, Green, and Blue bands you selected. Display the `SanBarRGB` image using the `MATLAB imagesc` function. Is there a unique set of indices `[RedInd, GreenInd, BlueInd]`? Why or why not?

(c) Use the `MATLAB reshape` function and the transpose to transform the image data array into an array `SanBarVecs` in the format required by `MyPCA`. Call the reformatted array and run `MyPCA` on `SanBarVecs` with `NumComps = 178`. Plot the eigenvalues. What do you observe?

(d) Run `MyPCA` on `SanBarVecs` with `NumComps = 3`. Plot $\mathbf{Y}$ using the `MATLAB` function `scatter3`. What do you observe?

(4) **Reading.** Do your best to read the paper

Green, Berman, Switzer, and Craig, "A Transformation for Ordering Multispectral Data in Terms of Image Quality with Implications for Noise Removal", IEEE Transactions on Geoscience and Remote Sensing, Vol. 26, No. 1, pp. 65-74, January 1988.

You can get it through the UF Libraries using the IEEE Xplore electronic database.