MATLAB Exploration #2/#3/#4 for MATH 1554

For each MATLAB assignment, follow the step-by-step formatting guidelines we provided. You will be graded on completeness, following directions, proper usage of comments, and overall readability of your code and published .pdf submission. We recommend `format bank`

For Week 15: MATLAB #2 - This exploration has **two parts**. (See following page for the SVD exploration)

Part 1: *Basis of eigenvectors.* Suppose A is a 3×3 matrix with the following eigenvectors and eigenvalues.

$$\vec{v}_1 = \begin{bmatrix} 1 \\ 0 \\ -1 \end{bmatrix}, \text{ with eigenvalue } \lambda = 1,$$

$$\vec{v}_2 = \begin{bmatrix} 2 \\ 2 \\ 0 \end{bmatrix}, \text{ with eigenvalue } \lambda = 0.5,$$

$$\vec{v}_3 = \begin{bmatrix} 1 \\ 1 \\ 2 \end{bmatrix}, \text{ with eigenvalue } \lambda = 0.5,$$

(a) Write $\vec{x}$ in the coordinates of the basis $\{\vec{v}_1, \vec{v}_2, \vec{v}_3\}$.

$$\vec{x} = \begin{bmatrix} 7 \\ 5 \\ 4 \end{bmatrix}$$

(b) Find $A^k\vec{x}$ (in the standard coordinates) and the coordinates of $A^k\vec{x}$ in the basis $\{\vec{v}_1, \vec{v}_2, \vec{v}_3\}$ for $k = 1, 2, 3, 4, 5$.

(c) Find $\lim_{k\to\infty} A^k\vec{x}$ in both the standard coordinates and the coordinates in the basis $\{v_1, v_2, v_3\}$. Use comments in your MATLAB code to explain why the limit is what it is.

Part 2: *SVD exploration.* Download the file `buzz.jpg` from my website and place a copy in your MATLAB directory, and then copy the following code into MATLAB.

```
clc
RGB=imread('buzz.jpg');
gray=rgb2gray(RGB);
A=im2double(gray);
```

```
[U,S,V]=svd(A);
sz=size(A);
Approx=zeros(sz);
r=50
for i=1:r
    u=U(:,i);
    s=S(i,i);
    v=V(:,i);
    Approx=Approx+s*u*v';
end
Approx;
subplot(1,2,1),imshow(A),title('original');
subplot(1,2,2),imshow(Approx),title(['low rank r=',num2str(r)]);
```

Run the code in MATLAB. Add comments to the code to indicate what the code-lines are doing to create the image file (not every line needs a comment - google any commands you are not sure about from the command name - hint: `v'` is the MATLAB command for v^T). Next, make some changes to the r-value in order to determine what changing the r-value does to the image file. Make a comment in your code about what you discover.

Try finding some other images on the internet, and repeat the above. Some questions you may want to think about:

* Why is it important that the image file is converted to grayscale?
* What is the practical effect of having a low r-value?
* (*hard?*) Can the process be modified to deal with color images?

Your grade on Part 2 will be determined by how well you annotate the code above with appropriate comments.