MATLAB Exploration #5 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 14: MATLAB #5 *SVD exploration.* Download the file `buzz.jpg` from Sal's 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.

Answer the questions below as comments in your MATLAB document:

Q1: Why is it important that the image file is converted to grayscale?

Q2: What is the practical effect of having a low r-value?

Q3: Compute the `Approx` matrix for $r = 6$ and then compute the rank of the matrix `Approx`. Do this for several more r-values, adding code and comments to your MATLAB document. What do you notice?

Q4: State a small r-value that still results in a clear image, explain in a sentence or two why such a clear image can be obtained from a low rank image matrix.

Q5: Write the entire sentence as a comment and fill in the blanks:
If $r = 6$ then the rows of the matrix `Approx` are linear combinations of the rows of [ ] for values of i between [ ].

* (*optional*) Can the process be modified to deal with color images?
* (*optional*)HARD How is each row of the image being calculated when $r = 1$? When $r = 2$?
* (*optional*)ADVANCED Describe in words how each row of the image is being calculated for arbitrary r. *Hint: each row is a linear combination of the vectors* $v_1, \ldots, v_r$.

Your grade will be determined by how well you annotate the code above with appropriate comments and your answers to the first three questions above.