Contents

Solution to Project 3

This project examines the use of singular value decomposition to compress an image, reconstructing it from a sequence of columns of U, columns of V, and the first k singular values.

```
clear
clc
clf
```

Part 1: Loading the image

We read in the appropriate image file and display it:

```
img = imread('nd.jpeg');
figure(1)
image(img)
axis image %We keep the original aspect ratio
title('Original Color Image')
axis 'off' %We turn off the axis too!
```

Part 2: Converting to Gray Scale

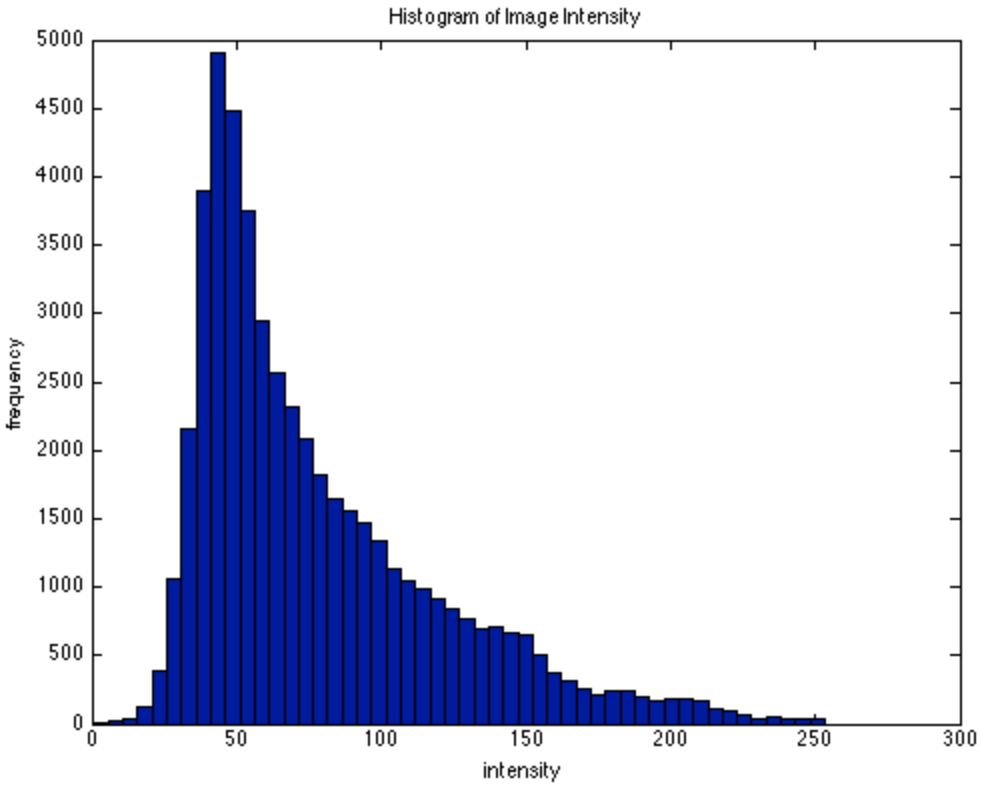
We convert to gray scale using the RGB planes:

```
img=double(img); %It is now a matrix we can do math on!
xn = 0.2126*img(:,:,1) + 0.7152*img(:,:,2) + 0.0722*img(:,:,3);
figure(2)
imagesc(xn)
axis image
colormap('gray') %We use the gray-scale colormap
title('Gray Scaled Image')
axis 'off'
```

Part 3: Constructing the histogram

We want to construct a histogram of luminance values. In image processing the histogram is often "equalized" so that the contrast and brightness brings out the features of the image. Here we just plot it up:

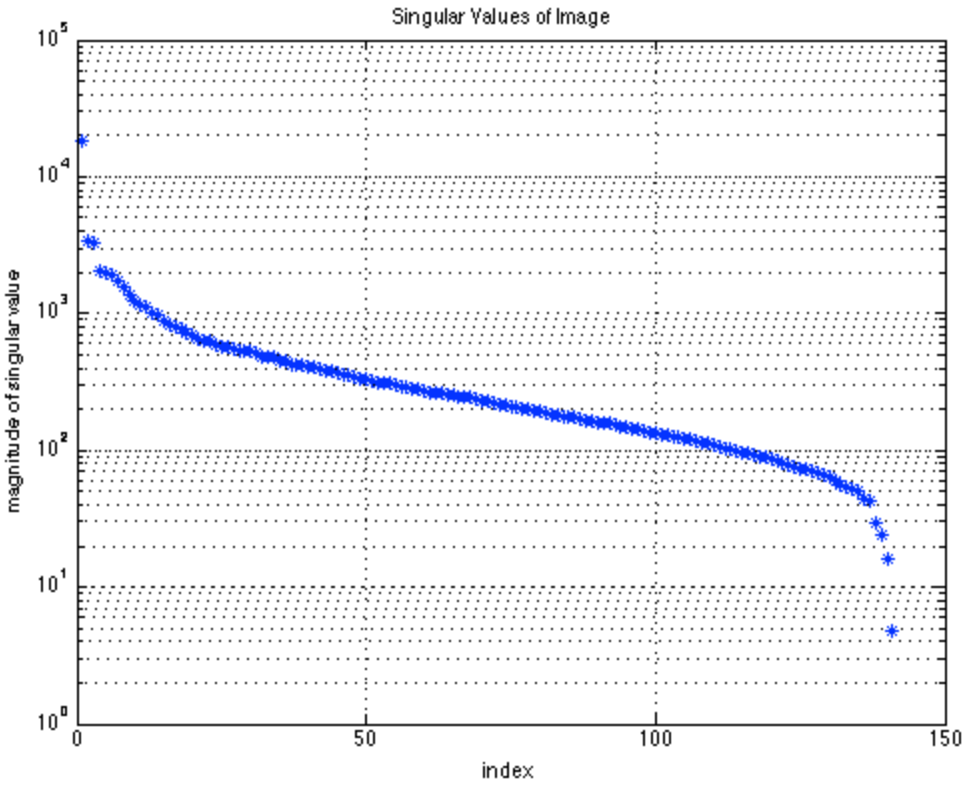
```
figure(3)
hist(reshape(xn,1,[]),50) %We turn xn into a vector and use 50 bins
xlabel('intensity')
ylabel('frequency')
title('Histogram of Image Intensity')
```



Part 4: Doing SVD

The image can be compressed by doing singular value decomposition. Here we do this and plot up the magnitude of the singular values. Note that the singular values fall off very rapidly!

```
[u s v] = svd(xn);
sv=diag(s);
figure(4)
semilogy(abs(sv),'*')
xlabel('index')
ylabel('magnitude of singular value')
title('Singular Values of Image')
grid on
```



Part 5: Reconstructing the image

We can reconstruct the image using different numbers of singular values and the corresponding columns of U and V. We can do this using loops, or in a very compact way with matrix multiplication.

```
k=[1 2 5 10 20 50 100 length(sv)]; %The number of singular values we want to use
for p=1:length(k)
    kt=k(p); %The number we use this time!
    xt=u(:,1:kt)*diag(sv(1:kt))*v(:,1:kt)'; %Reconstruction with just kt values
    figure(5)
    subplot(4,2,p), imagesc(xt)
    axis image
    colormap('gray')
    title(['Image with ',num2str(kt),' singular values'])
    axis 'off'
end
```

Image with 1 singular values

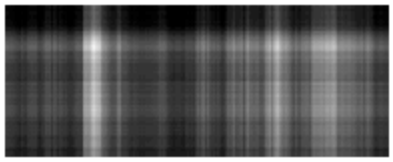


Image with 2 singular values

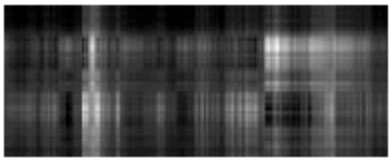


Image with 5 singular values

Image with 10 singular values

Image with 20 singular values

Image with 50 singular values

Image with 100 singular values

Image with 141 singular values

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