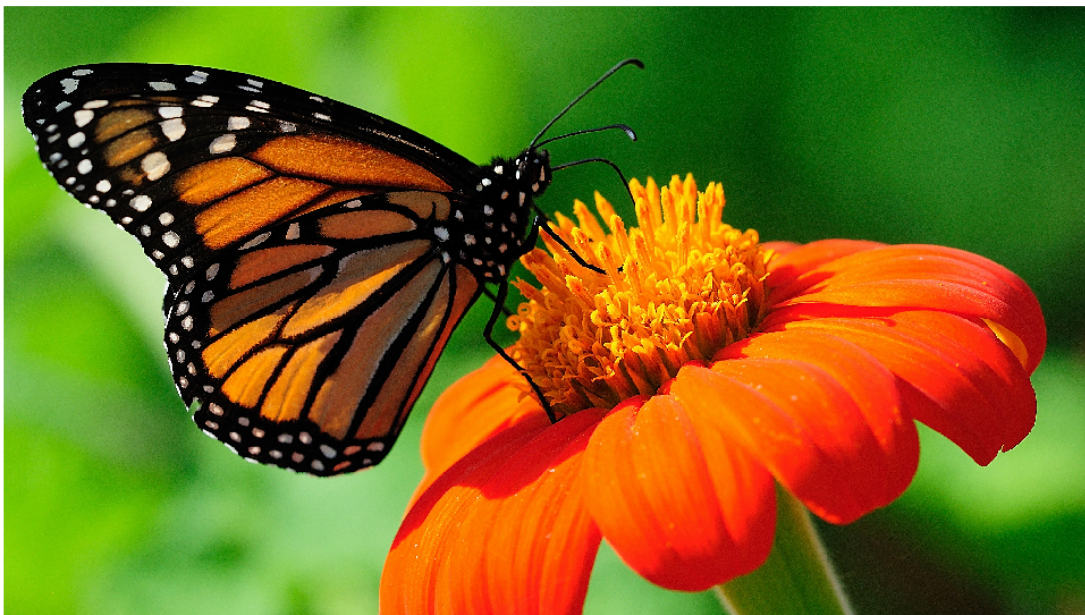# Homework 1

Problem 3

```matlab
clc
close all
clear all

A = imread('butterfly.jpg');
imshow(A);
```

Warning: Image is too big to fit on screen; displaying at 25%


```matlab
Ar = A(:,:,1);
Ag = A(:,:,2);
Ab = A(:,:,3);
[Ur,Sr,Vr] = svd(double(Ar));
[Ug,Sg,Vg] = svd(double(Ag));
[Ub,Sb,Vb] = svd(double(Ab));

eig_Ar = diag(Sr);
eig_Ag = diag(Sg);
eig_Ab = diag(Sb);

ep1_var = zeros(1,length(eig_Ar));
for i = 1:length(eig_Ar)
    ep1_var(i) = sum(eig_Ar(1:i).^2 + eig_Ag(1:i).^2 + eig_Ab(1:i).^2);
```
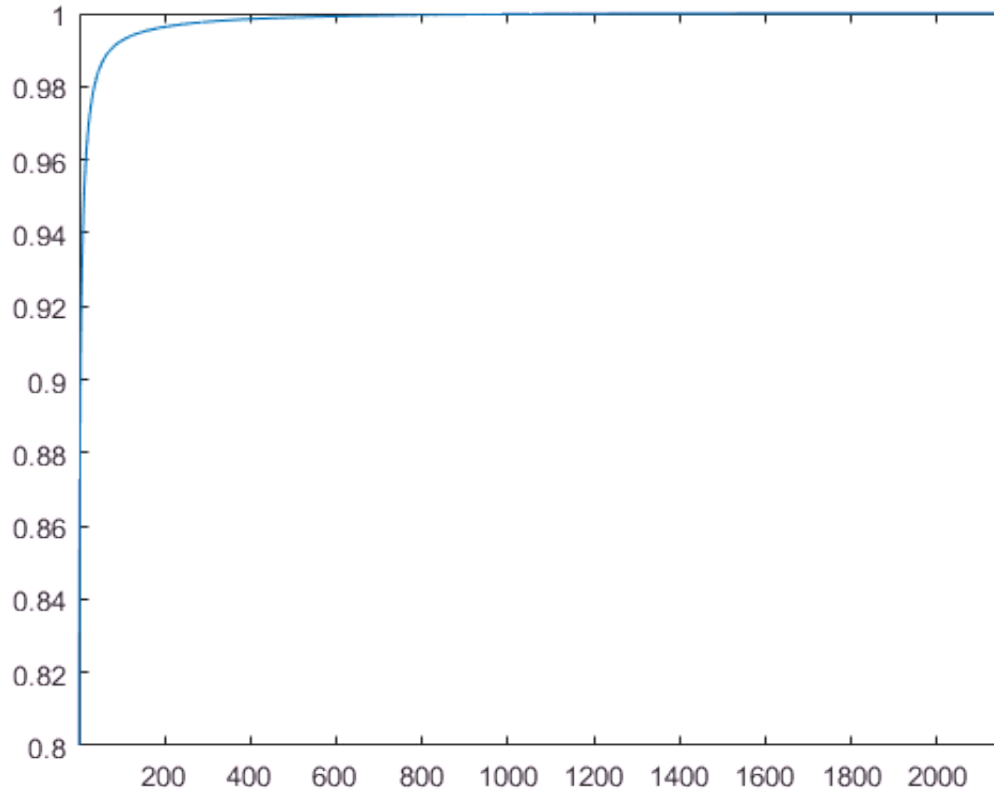
```
        ep1_var(i) = ep1_var(i)/sum(eig_Ar.^2+eig_Ag.^2+eig_Ab.^2);
end

figure;
plot(ep1_var)
axis([1 length(eig_Ar) .8 1])
```



```
ep1_var(4)
```

```
ans = 0.8924
```

```
ep1_var(5)
```

```
ans = 0.9073
```

As we can see, at least 5 elements are required to have at least 90% of the image.

```
vec_red = [4,8,16,32,64,128];
figure;
for i=1:length(vec_red)
    ind = vec_red(i);
    Ar_reduced = Ur(:,1:ind)*Sr(1:ind,1:ind)*Vr(:,1:ind)';
    Ag_reduced = Ug(:,1:ind)*Sg(1:ind,1:ind)*Vg(:,1:ind)';
    Ab_reduced = Ub(:,1:ind)*Sb(1:ind,1:ind)*Vb(:,1:ind)';
```

```
    A_reduced = A;
    A_reduced(:,:,1)=Ar_reduced;
    A_reduced(:,:,2)=Ag_reduced;
    A_reduced(:,:,3)=Ab_reduced;
    subplot(3,2,i);
    imshow(A_reduced);
    title([num2str(vec_red(i)) ' components']);

end
```

4 components

8 components

16 components

32 components

64 components

128 components

Visually we can see that although we have nearly 90% of the image at 4 elements it is extremely blurry. I would therefore use the 64 or 128 component image compressions.

With 64 Component Compression

```
ind = 64;


Ar_red = Ur(:,1:ind)*Sr(1:ind,1:ind)*Vr(:,1:ind)';
Ag_red = Ug(:,1:ind)*Sg(1:ind,1:ind)*Vg(:,1:ind)';
Ab_red = Ub(:,1:ind)*Sb(1:ind,1:ind)*Vb(:,1:ind)';
A_red = A;
A_red(:,:,1)=Ar_red;
A_red(:,:,2)=Ag_red;
A_red(:,:,3)=Ab_red;
```
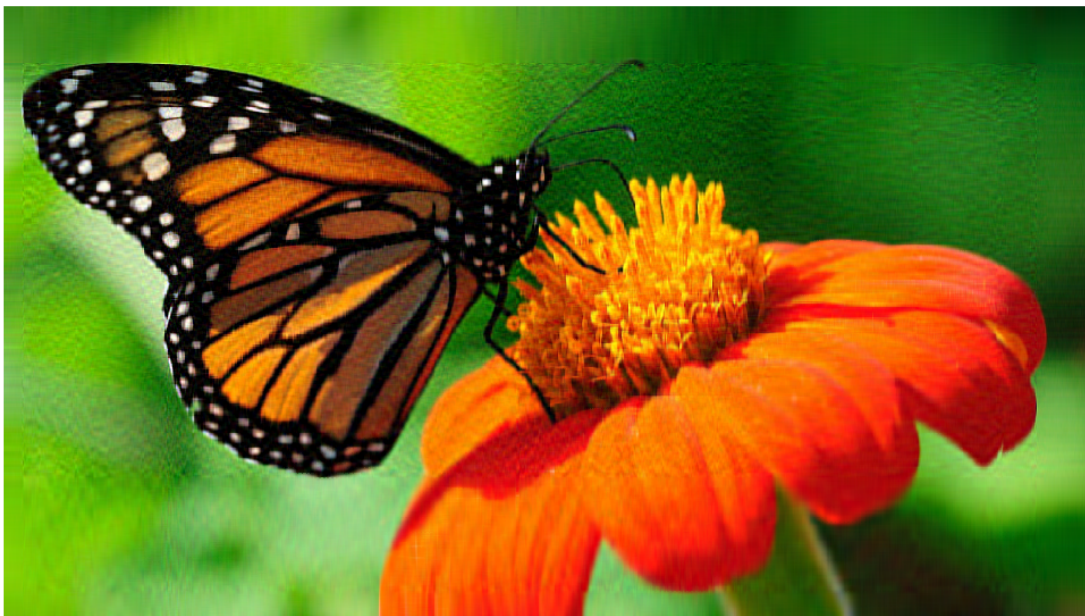
```
figure;
imshow(A);
```

```
imshow(A_red);
```

```
err_r = norm(double(Ar) - Ar_red)/norm(double(Ar));
err_g = norm(double(Ag) - Ag_red)/norm(double(Ag));
err_b = norm(double(Ab) - Ab_red)/norm(double(Ab));
err_avg = (err_r+err_g+err_b)/3*100;
```

```
size_diff = (2160*3840*3 - (2160 + 3840 + 64)*64*3)*100/(2160*3840*3);
```

```
fprintf('Reduced matrix represents a savings of %0.4f percent with a %0.4f percent reduction i
```

```
 Reduced matrix represents a savings of 95.3210 percent with a 2.1338 percent reduction in accuracy
```

With 128 Component Compression

```
ind = 128;


Ar_red2 = Ur(:,1:ind)*Sr(1:ind,1:ind)*Vr(:,1:ind)';
Ag_red2 = Ug(:,1:ind)*Sg(1:ind,1:ind)*Vg(:,1:ind)';
Ab_red2 = Ub(:,1:ind)*Sb(1:ind,1:ind)*Vb(:,1:ind)';
A_red2 = A;
A_red2(:,:,1)=Ar_red;
A_red2(:,:,2)=Ag_red;
A_red2(:,:,3)=Ab_red;


figure;
imshow(A);
```

```
 Warning: Image is too big to fit on screen; displaying at 25%
```



```
imshow(A_red);
```

```
err_r2 = norm(double(Ar) - Ar_red2)/norm(double(Ar));
err_g2 = norm(double(Ag) - Ag_red2)/norm(double(Ag));
err_b2 = norm(double(Ab) - Ab_red2)/norm(double(Ab));
err_avg2 = (err_r2+err_g2+err_b2)/3*100;

size_diff = (2160*3840*3 - (2160 + 3840 + 128)*128*3)*100/(2160*3840*3);
```

```
fprintf('Reduced matrix represents a savings of %0.4f percent with a %0.4f percent reduction i
```

Reduced matrix represents a savings of 90.5432 percent with a 1.1205 percent reduction in accuracy