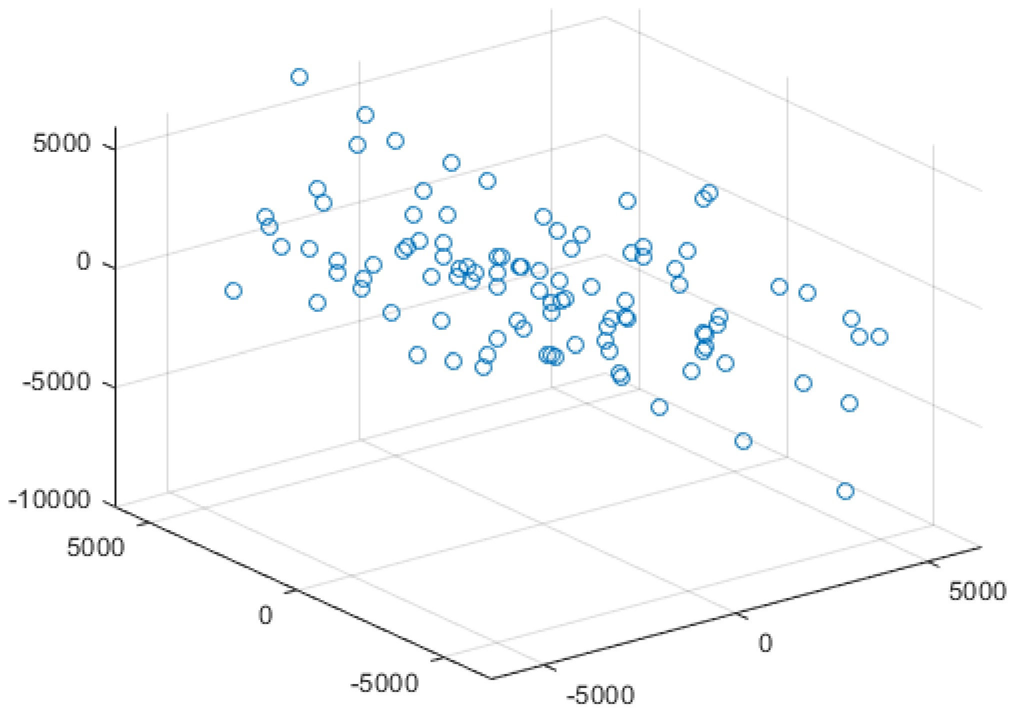
PROBLEM 1:

DATA 1

```
Y=X';
data(:,1)=Y(:,1)-mean(Y(:,1));
data(:,2)=Y(:,2)-mean(Y(:,2));
data(:,3)=Y(:,3)-mean(Y(:,3));
scatter plot of the Data
scatter3(X(1,:),X(2,:),X(3,:));
hold on;
```

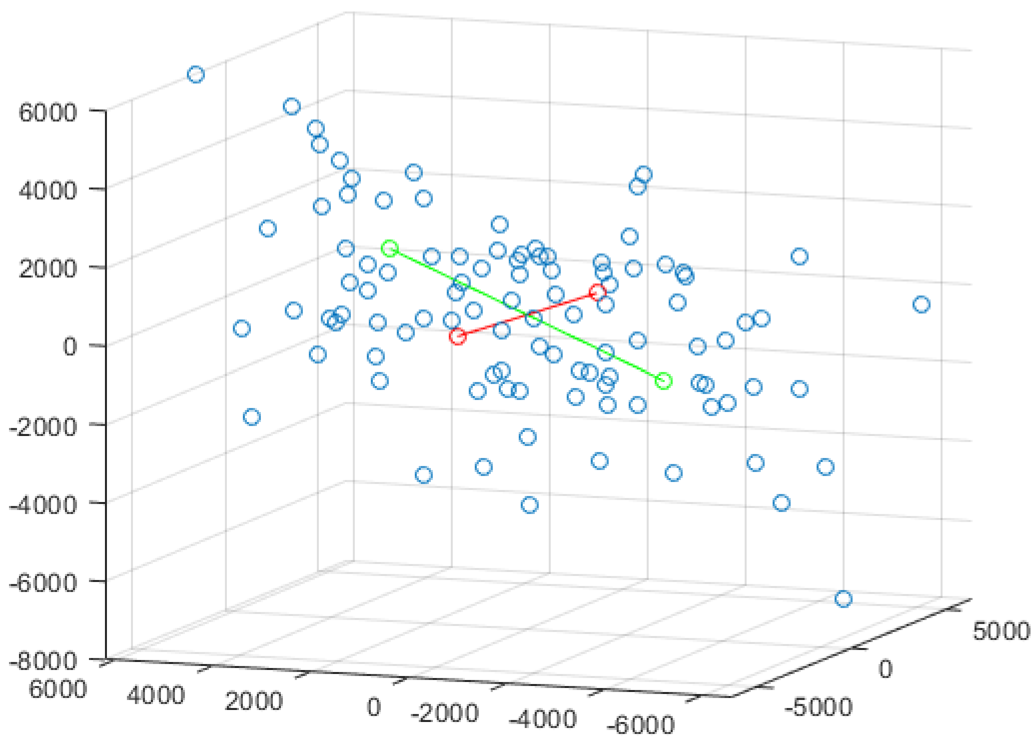



```
PCA of the data upto 2 componets
pca(data,"NumComponents",2)
```

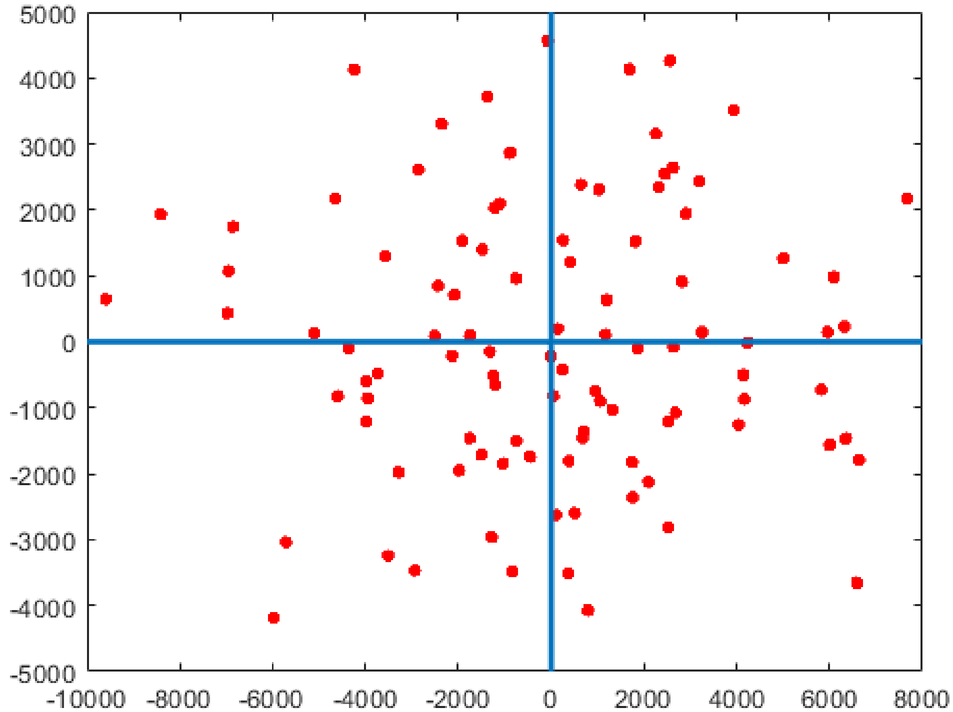
```
    0.6277    0.3682
   -0.5458    0.8364
   -0.5550   -0.4061
```

```
Var=cov(data);
[U,S,V]=svd(Var);
center=mean(Y);
```

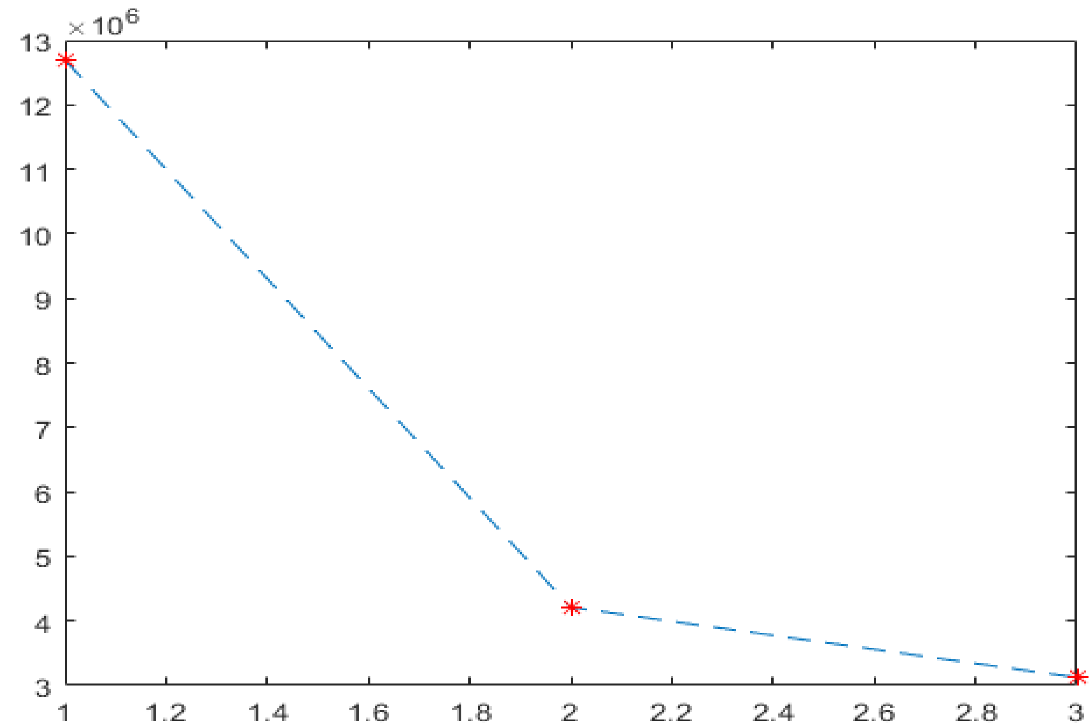
```
top two principal directions of variability overlaid onthe scatter plot of the data.
PD_1=[center'+sqrt(S(1,1))*U(:,1) , center'-sqrt(S(1,1))*U(:,1)];
PD_2=[center'+sqrt(S(2,2))*U(:,2) , center'-sqrt(S(2,2))*U(:,2)];
h1=plot3(PD_1(1,:),PD_1(2,:),PD_1(3,:),'-o','Color','g');
h2=plot3(PD_2(1,:),PD_2(2,:),PD_2(3,:),'-o','Color','r');
hold off;
view([-69 11])
```



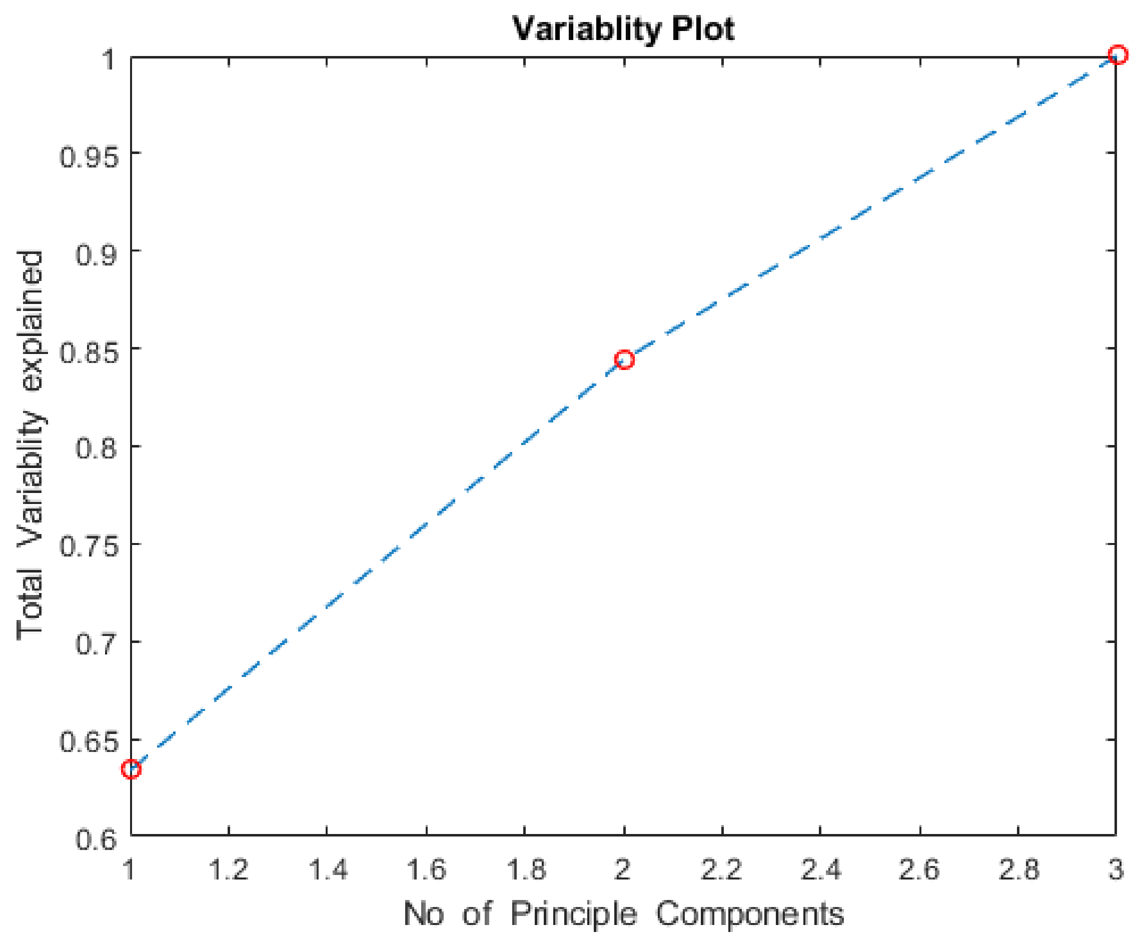

```
U1 = U(:,1:2);
Z=U1'*X;
Projection the original data to the first two principal dimensions
plot(Z(1,:), Z(2,:), '.', 'markersize', 15,"Color","r")
xL = xlim;
yL = ylim;
line([0 0], yL,"linewidth",2);
line(xL, [0 0],"linewidth",2);
```




```
singular value plot
plot(diag(S),"LineStyle","--","Marker","*","MarkerEdgeColor","r")
```

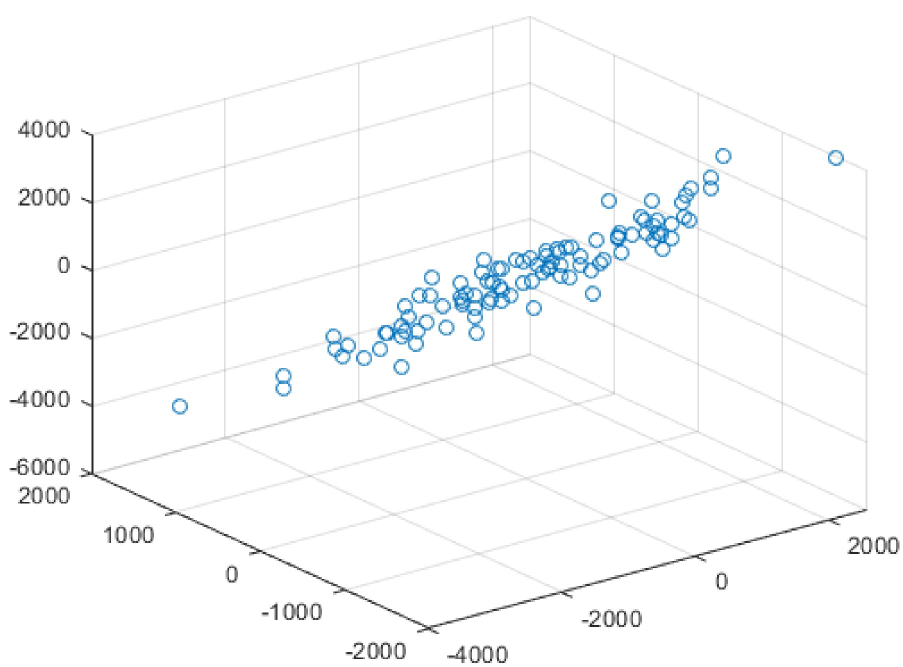



```
Splot=cumsum(diag(S))/sum(diag(S));
cumulative  total variance plot
plot(Splot,"Marker","o","MarkerEdgeColor","r","LineWidth",1,"LineStyle","--")
title("Variablity Plot")
xlabel("No  of  Principle  Components")
ylabel("Total  Variablity  explained")
```



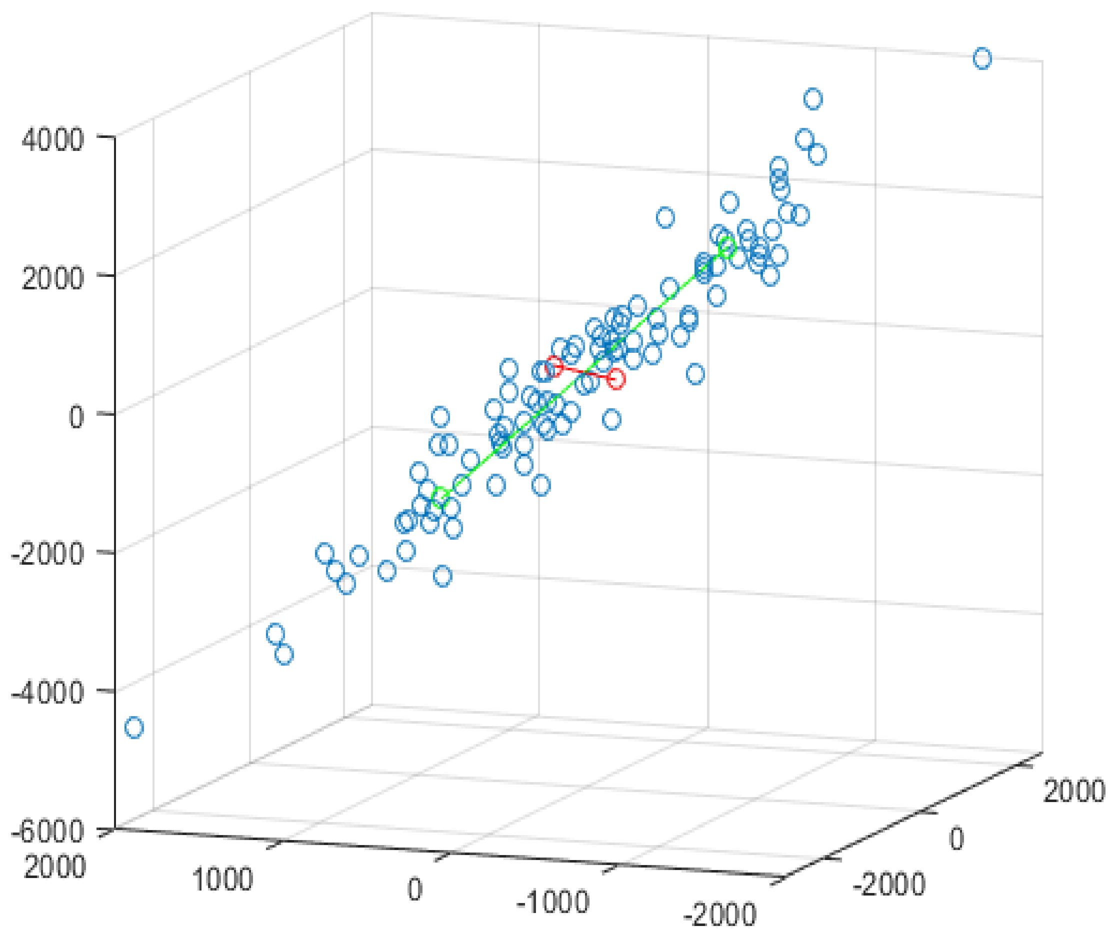
All 3 principal components are needed to obtain a total of 95% variability.

DATA 2

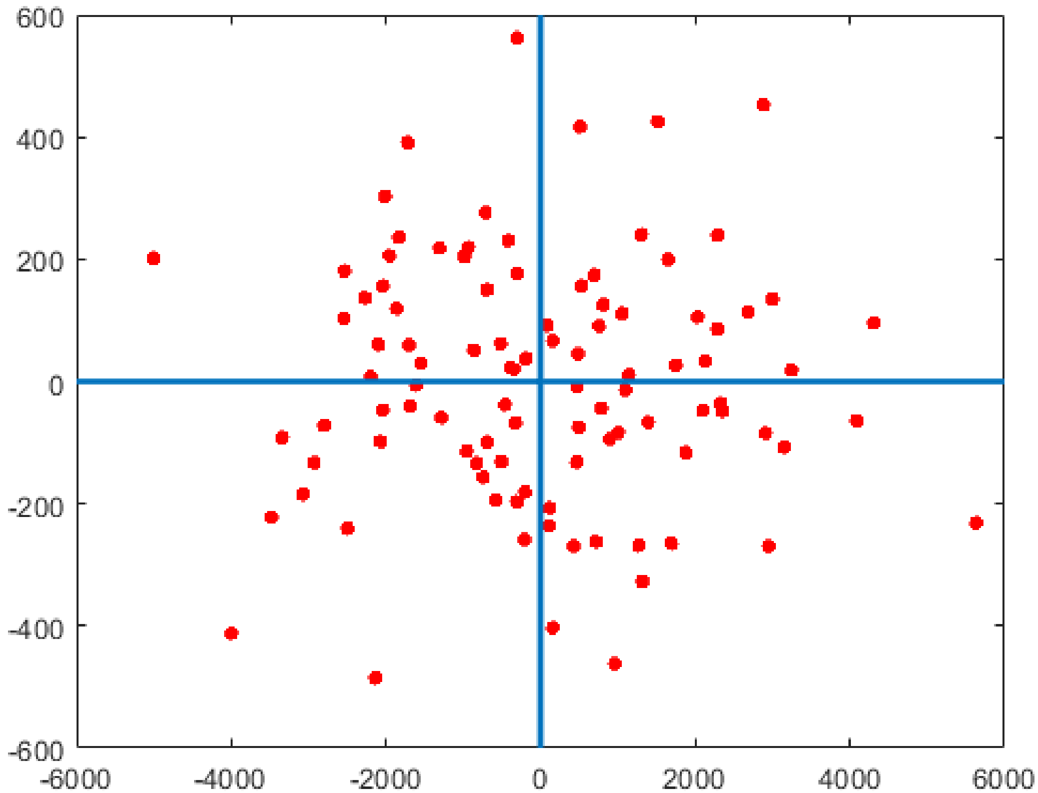


```
PCA of the data up to 2 components
    0.4990   -0.1959
   -0.2950    0.8775
    0.8148    0.4377
```

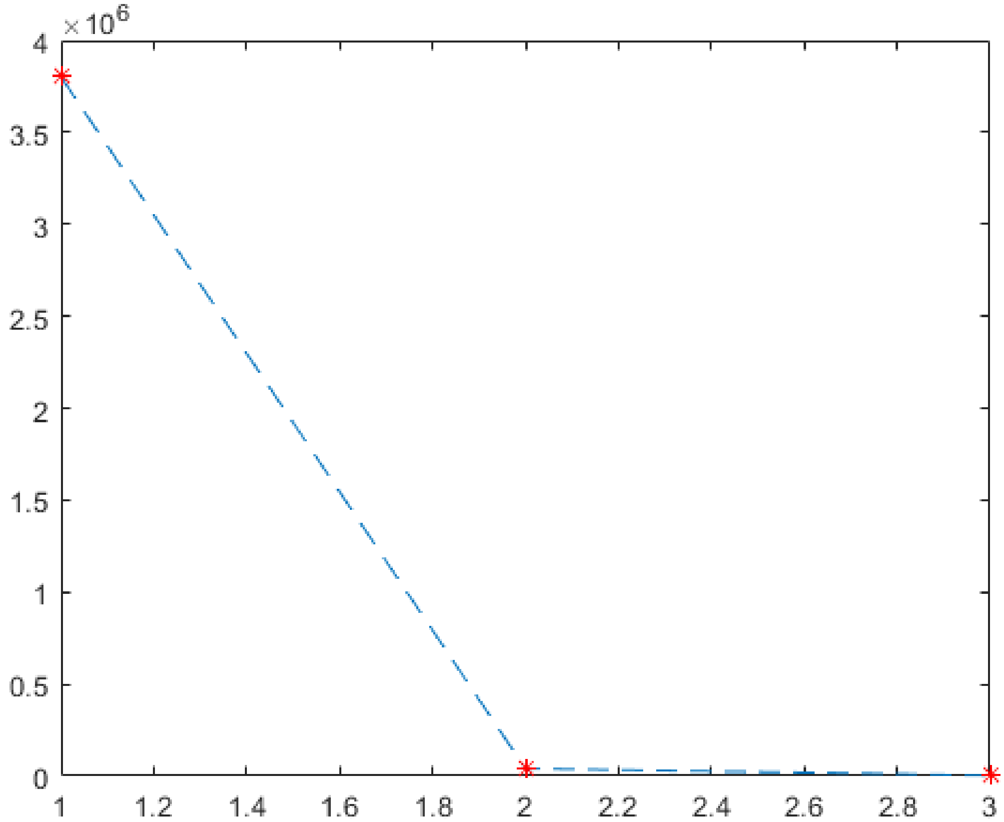
```
top two principal directions of variability overlaid on the scatter plot of the data.
```



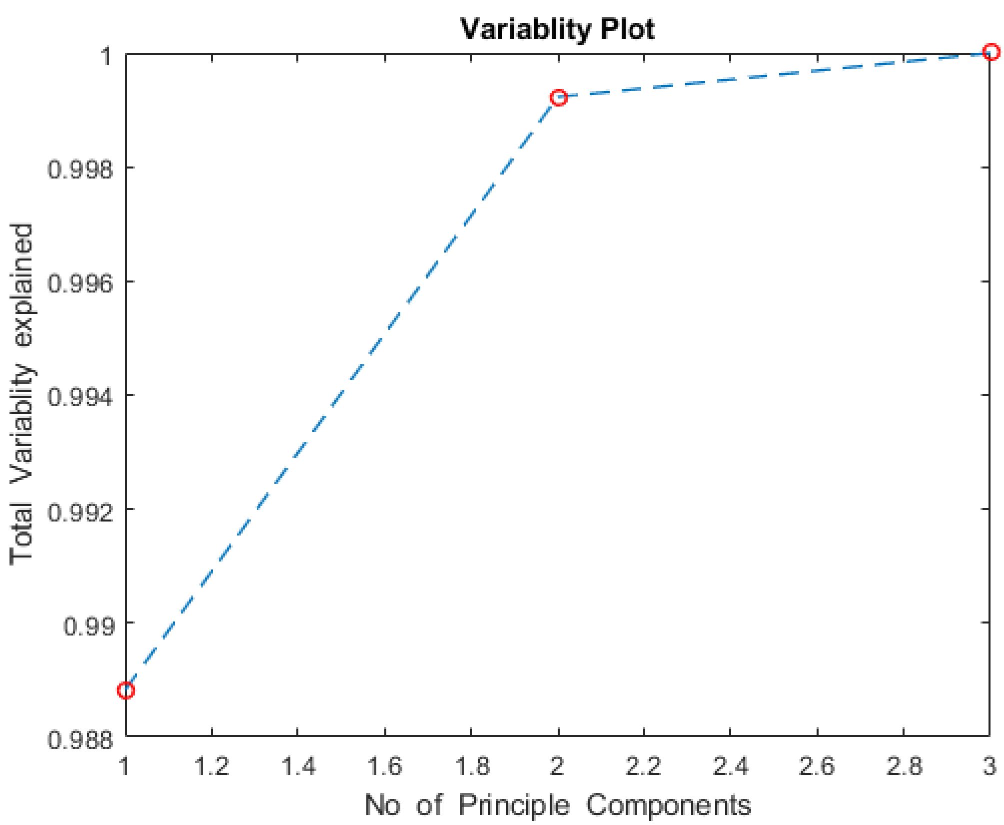
Projection the original data to the first two principal dimensions



```
singular value plot
```




```
cumulative total variance plot
```



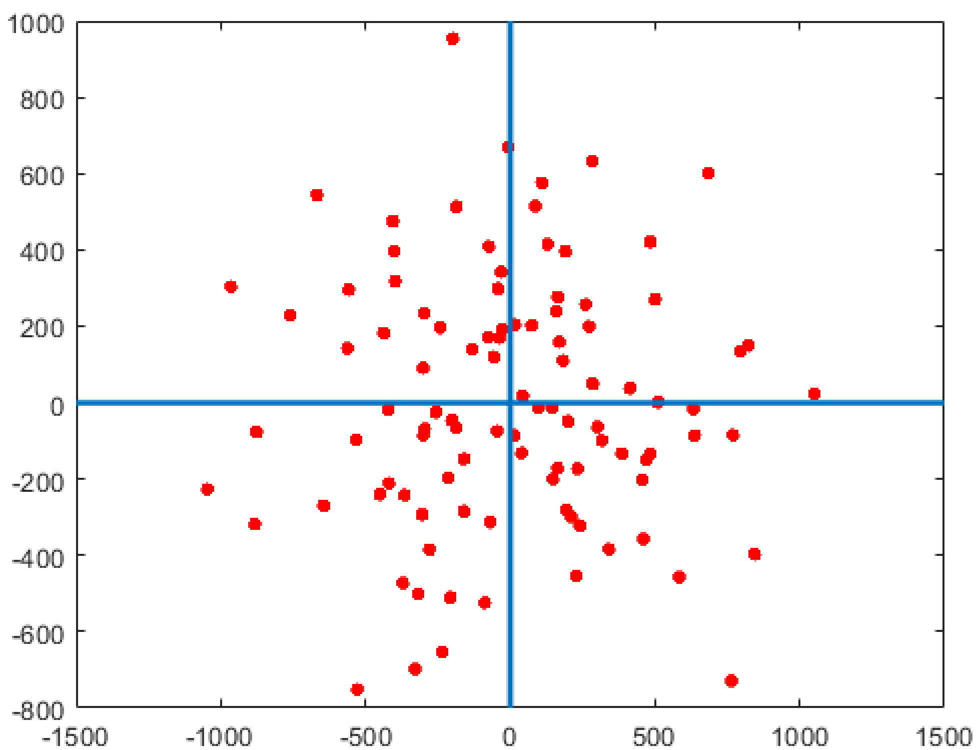

```
Only 2 principal components are needed to obtain a total of 95% variability.
```

Data 3

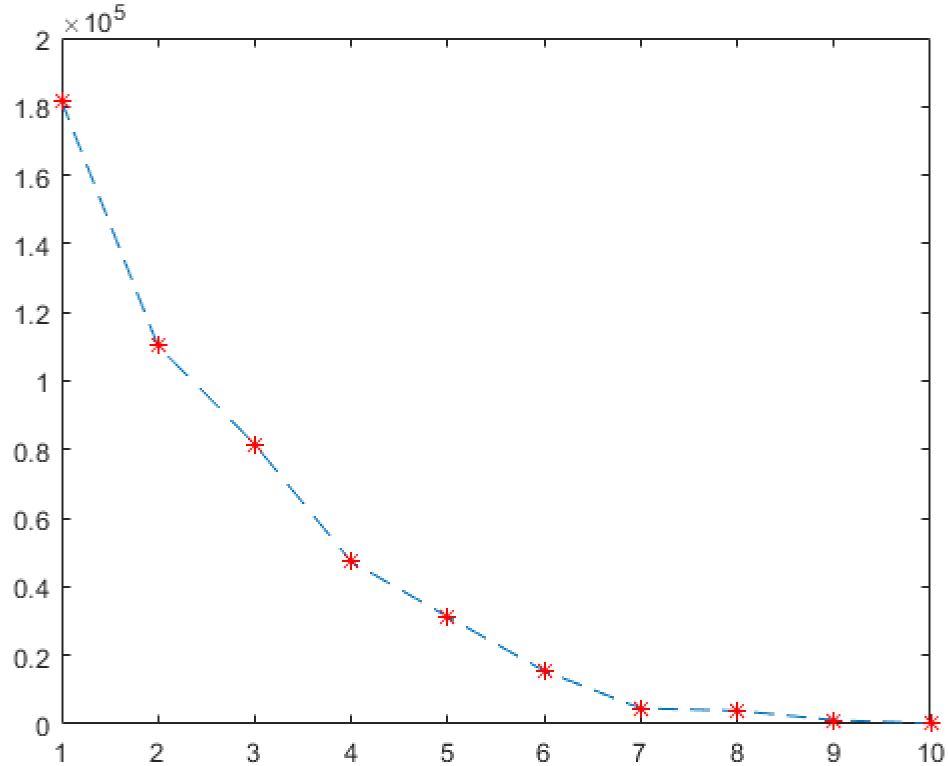
PCA of the data up to 2 components

```
    0.0975    0.3257
   -0.2693   -0.2891
    0.4379    0.0955
    0.0726   -0.1795
    0.1976    0.5454
    0.6304   -0.0079
   -0.1281   -0.0883
   -0.0183   -0.4561
   -0.3631    0.3832
    0.3686   -0.3299
```

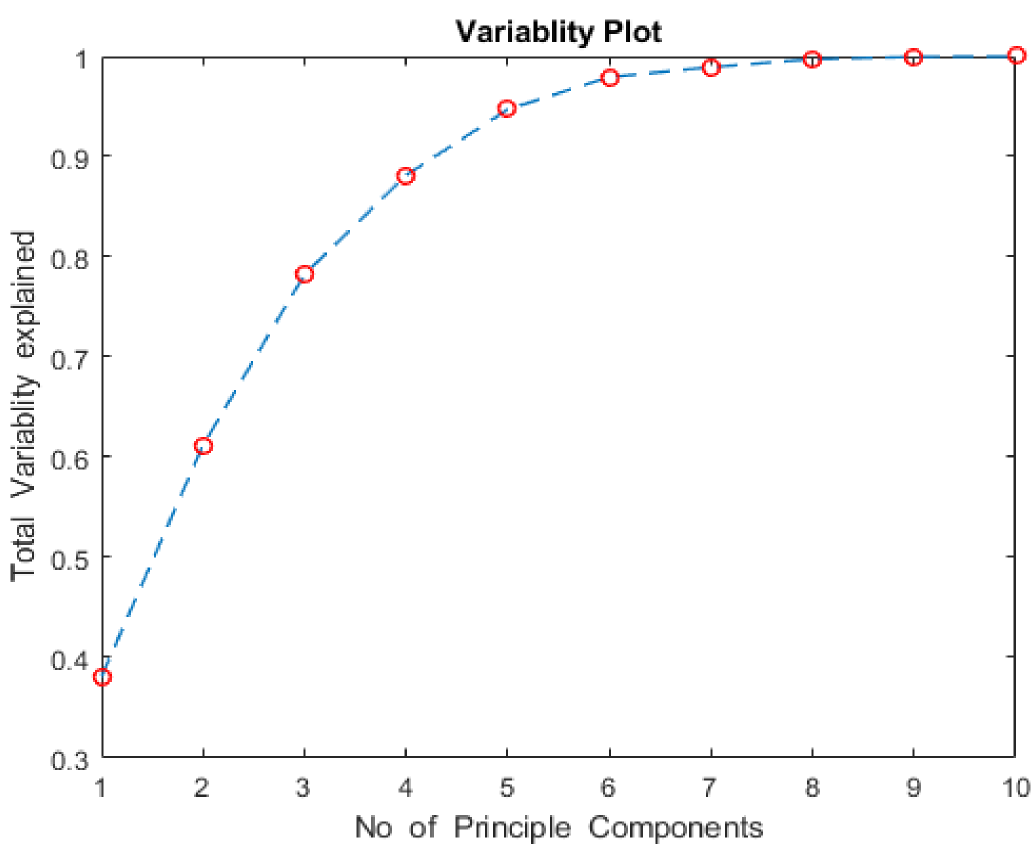
Projection the original data to the first two principal dimensions



singular value plot



cumulative total variance plot



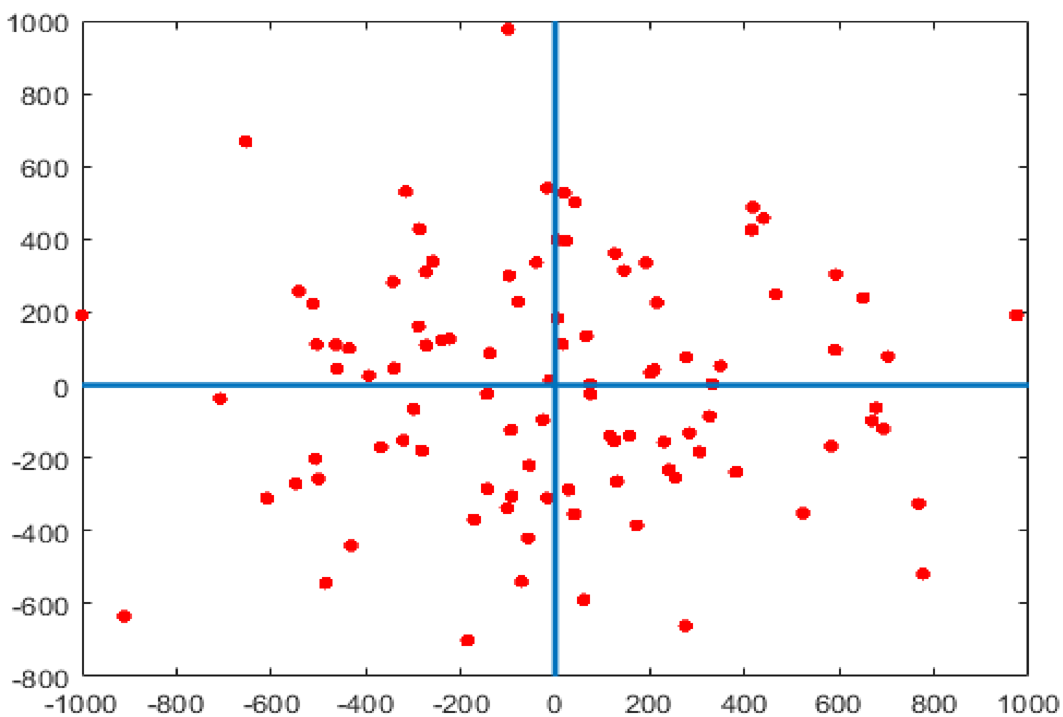
Only 5 principal components are needed to obtain a total of 95% variability.

Data 4

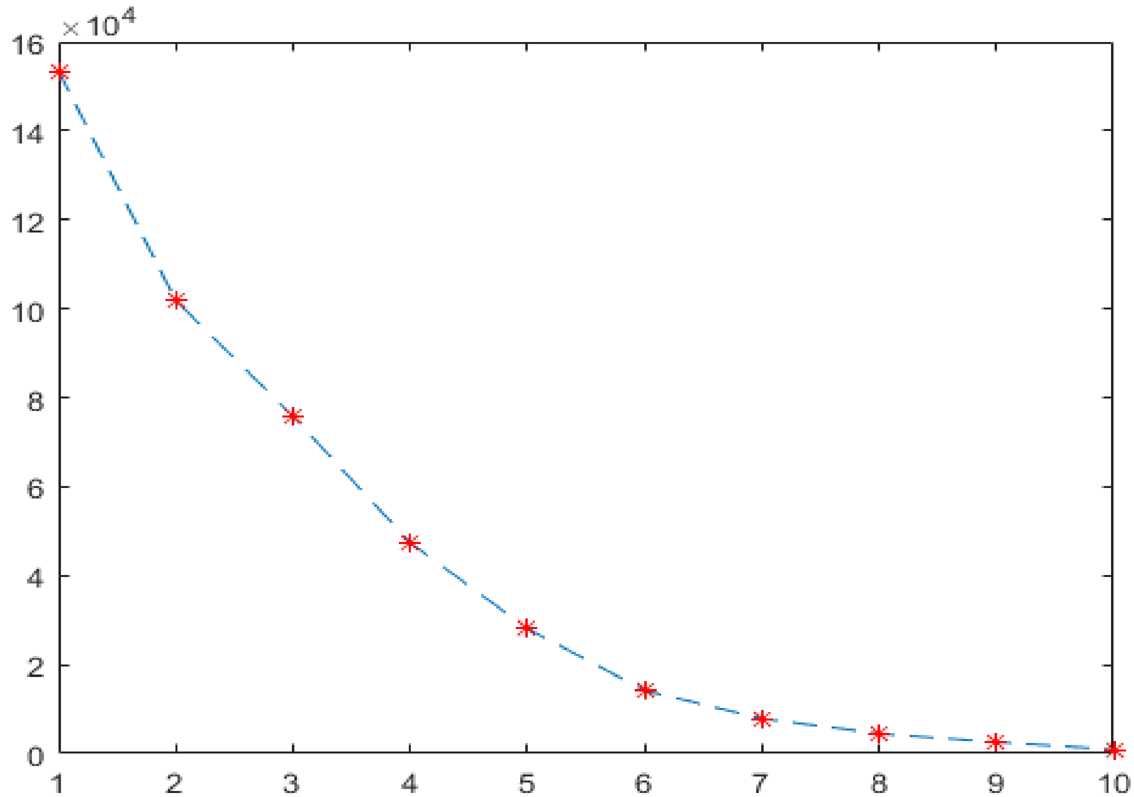
PCA of the data upto 2 componets

```
   -0.2367   -0.4419
   -0.3196   -0.3424
    0.0863   -0.1074
   -0.1825    0.1362
   -0.1673    0.4473
    0.1898   -0.0366
    0.6393    0.0806
   -0.2737   -0.3267
   -0.4995    0.4284
    0.0630   -0.3990
```

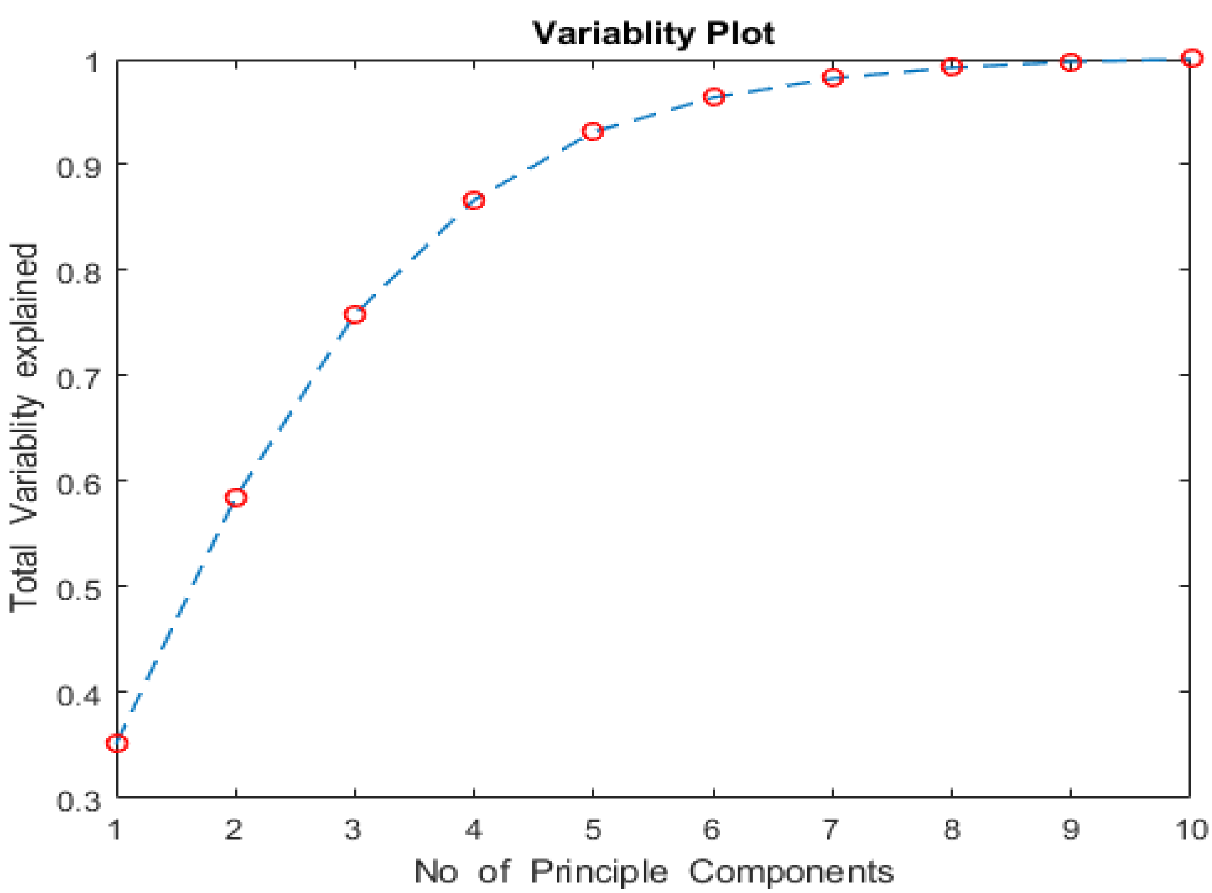
Projection the original data to the first two principal dimensions



singular value plot



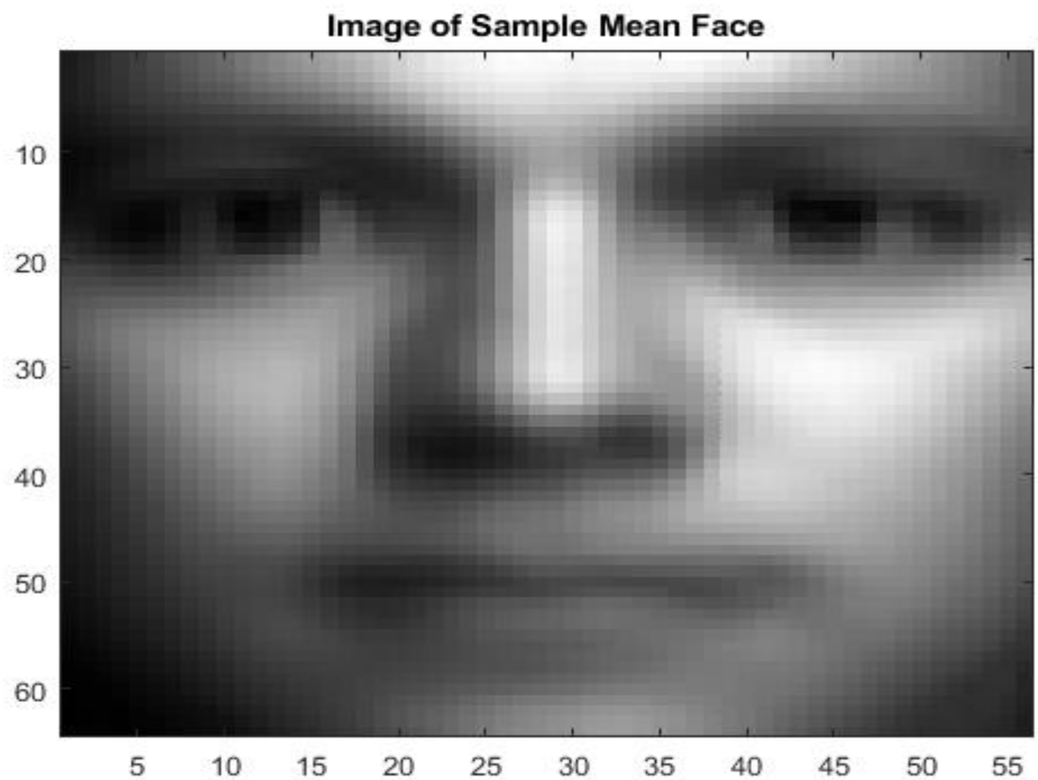
cumulative total variance plot



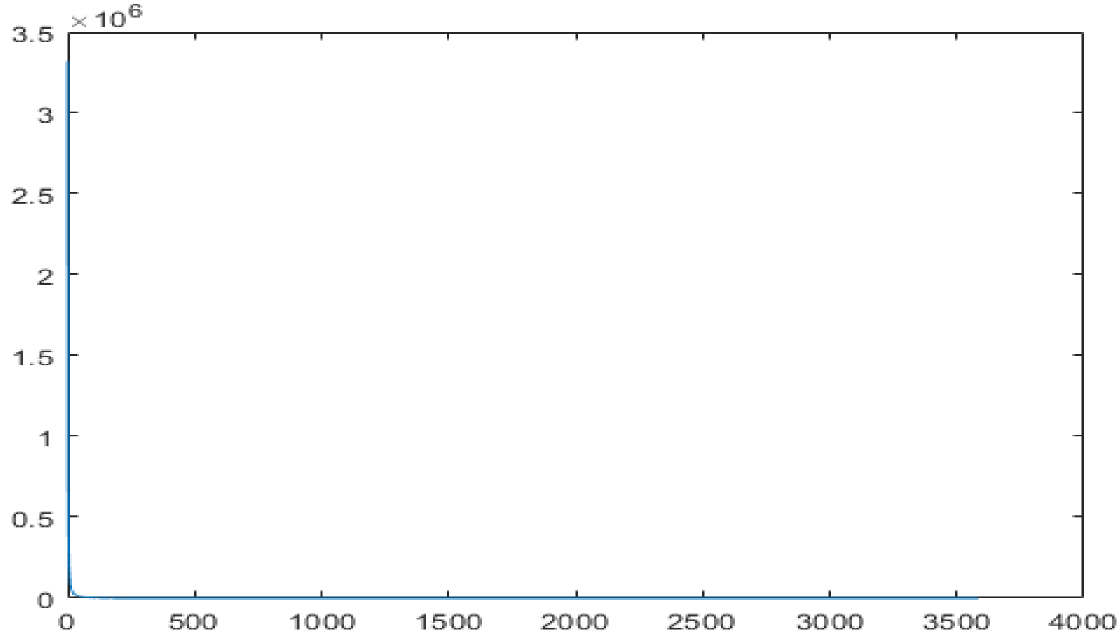
1st 6 principal components are needed to obtain a total of 95% variability.

PROBLEM 2:

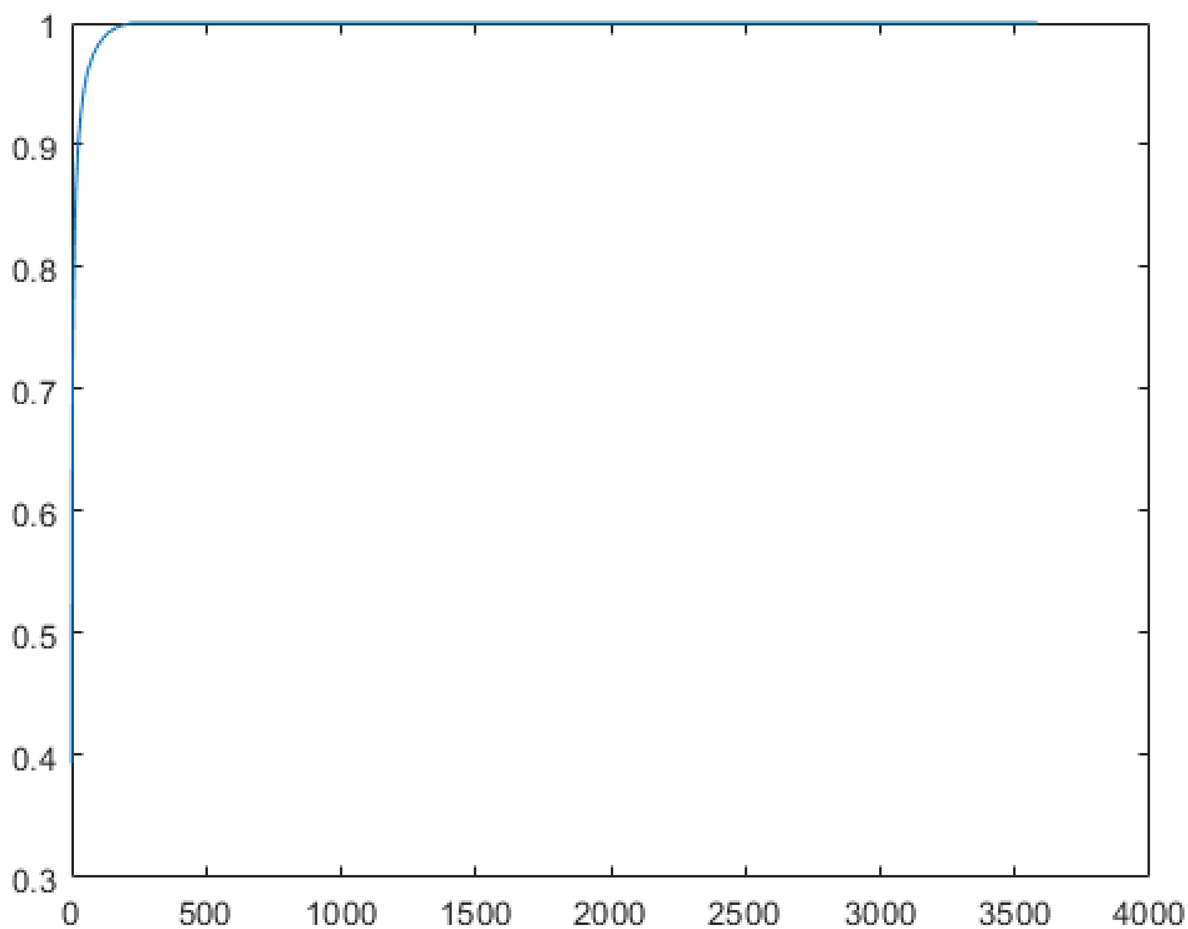
```
Y=X';
for i=1:1:3584
  data(:,i)=Y(:,i)-mean(Y(:,i));
end

M=mean(Y);
I=reshape(M,64,56);
%Image of Sample mean face
imagesc(I)
title('Image of Sample Mean Face');
colormap(gray)
```




```
var=cov(data);
[U,S,V]=svd(var);
plot(diag(S));
```

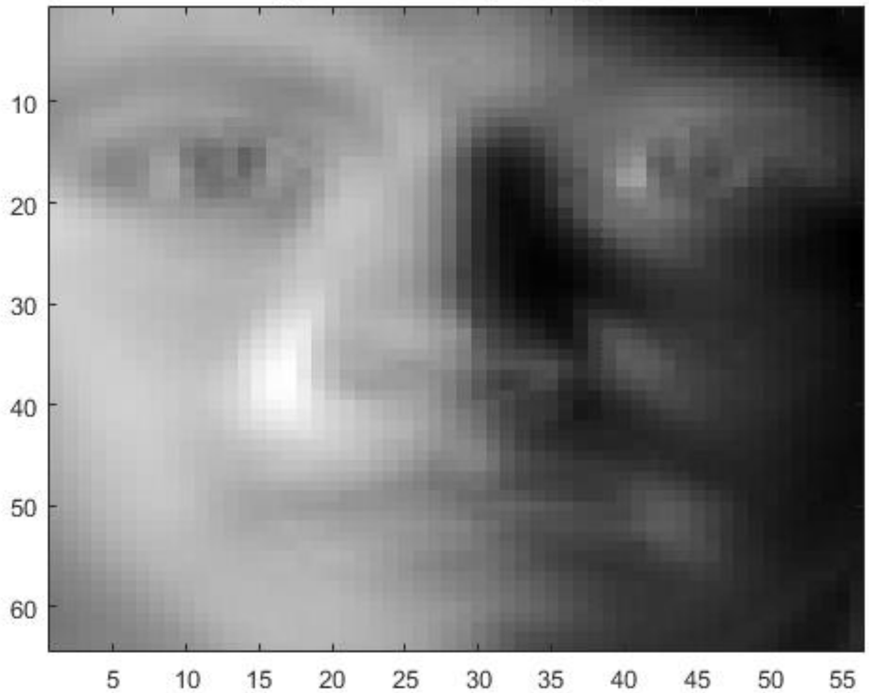



```
Splot=cumsum(diag(S))/sum(diag(S));
plot(Splot)
```



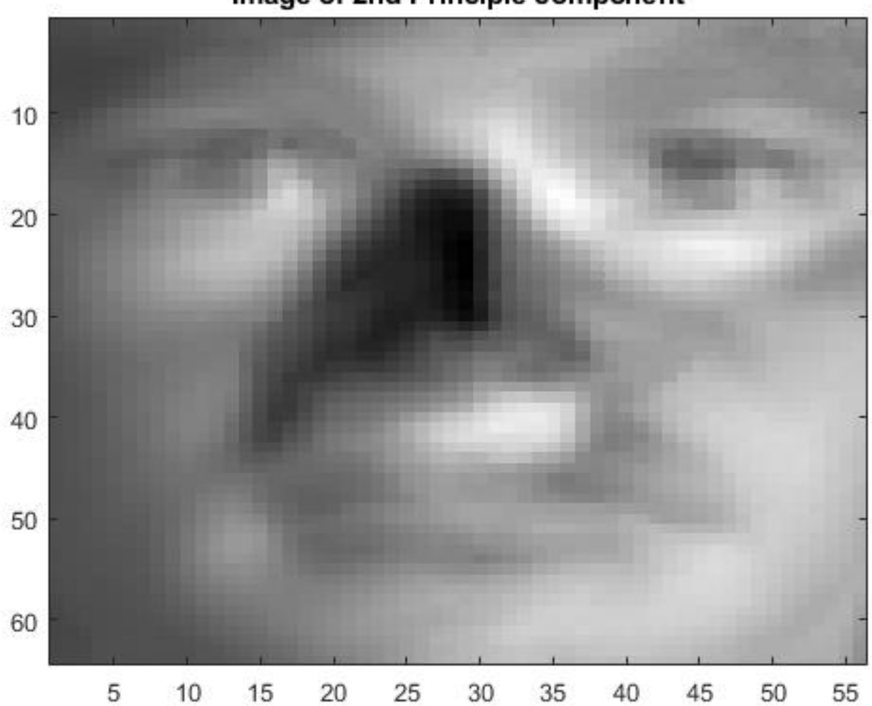
```
C=pca(var,"NumComponents",3);
I1=reshape(C(:,1),64,56);
imagesc(I1)
title('Image of 1st Principle Eigen vector');
colormap(gray)
```

Image of 1st Principle component

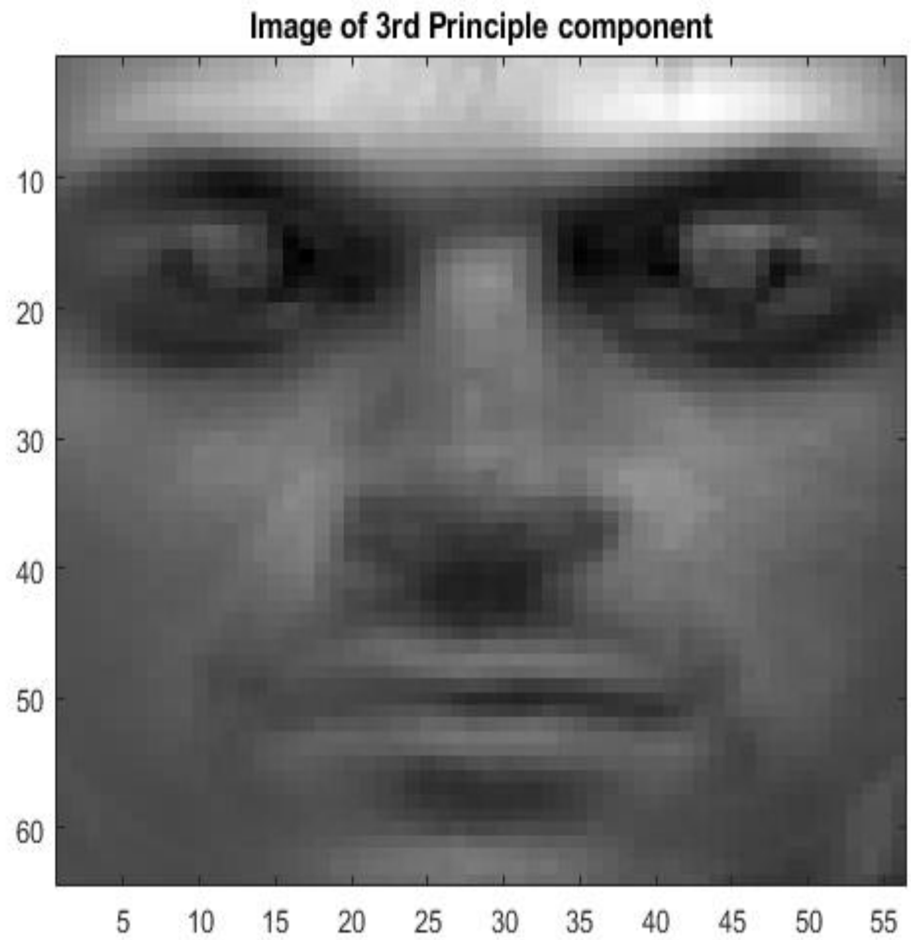



```
I2=reshape(C(:,2),64,56);
imagesc(I2)
title('Image of 2nd Principle Eigen vector');
colormap(gray)
```

Image of 2nd Principle component



```
I3=reshape(C(:,3),64,56);
imagesc(I3)
title('Image of 3rd Principle Eigen vector');
colormap(gray)
```



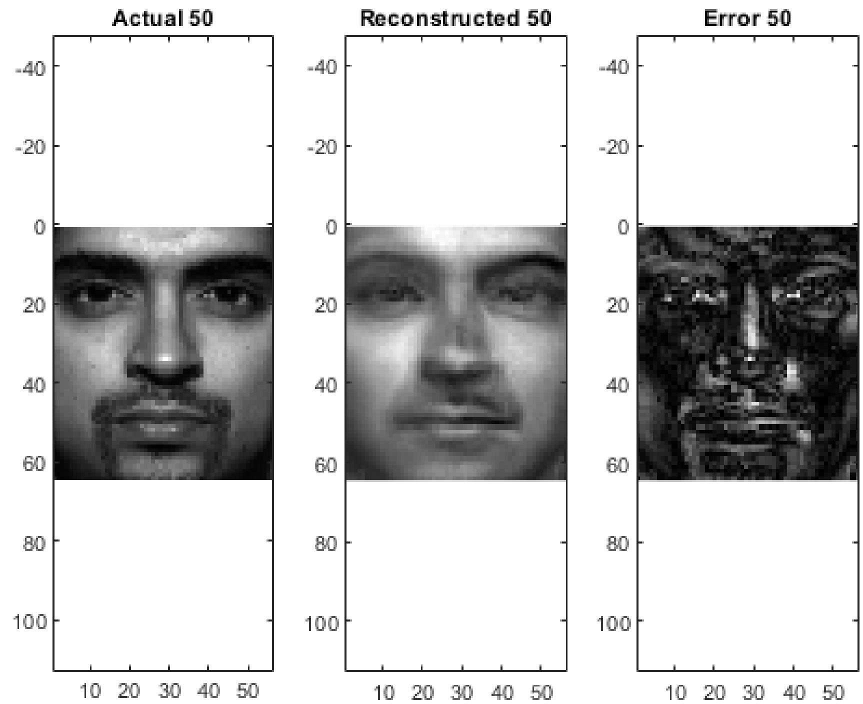
reconstruction of image 50

```
d = 20
```

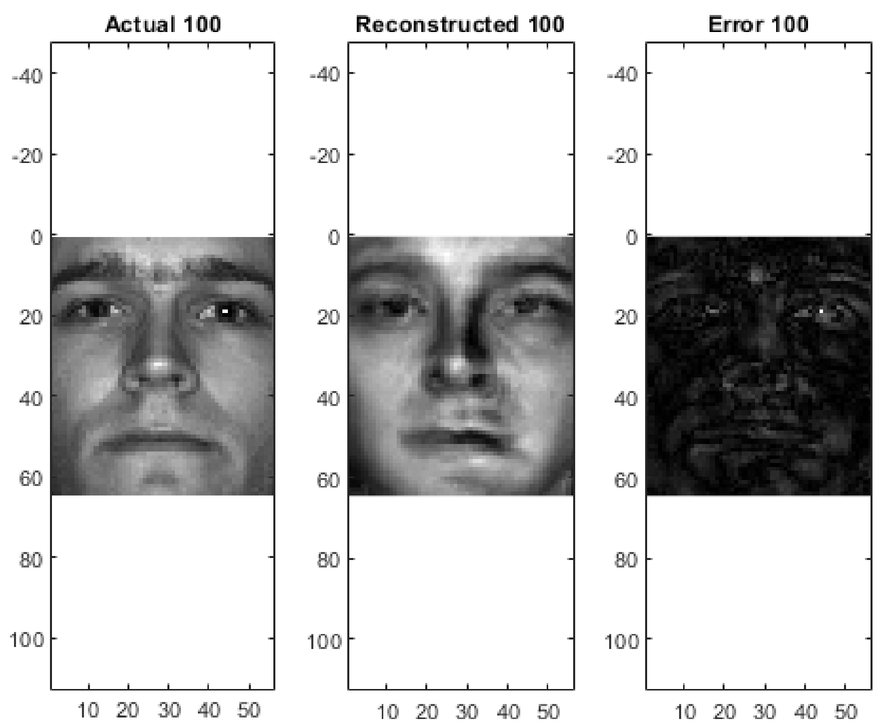
```
d = 20
```

```
P = 0;
for i = 1:1:d
    P = P + U(:,i)'*((U(:,i)')*X(:,50));
end
Diff = abs(X(:,50) - P');
Actual = reshape(X(:,50),64,56);
Reconstructed = reshape(P,64,56);
Error = reshape(Diff,64,56);


subplot(1,3,1)
imagesc(Actual);
colormap(gray)
axis equal;
title('Actual 50');
subplot(1,3,2)
imagesc(Reconstructed);
colormap(gray)
```

```
axis equal;
title('Reconstructed 50');
subplot(1,3,3)
imagesc(Error);
colormap(gray)
axis equal;
title('Error 50');
```




```
reconstruction of image 100
```



reconstruction of image 200