Principle Component Analysis

Matlab Code for PCA

- Use matlab function ‘princomp’ to calculate principle components of given data
  - princomp is a matlab function provided by toolbox ‘stat’
  - add path matlab7\toolbox\stat before calling princomp

Uniform sample

- Use ‘rand’ to create a uniform sample within [-1 1]x[-1 1] and plot all data

```
X=rand(5000,2)*2-1;
plot(X(:,1),X(:,2),'.');
```

De-mean

- De-mean

```
X=X-repmat(mean(X),size(X,1),1);
plot(X(:,1),X(:,2),'.');
```

- Create a matrix that contains ten I_3 in one row, where

$$I_3 = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 3 \end{pmatrix}$$

Lines

- Connect [-2,0] and [2,0]

```
hold on;
plot([-2 2],[0 0],'k');
```

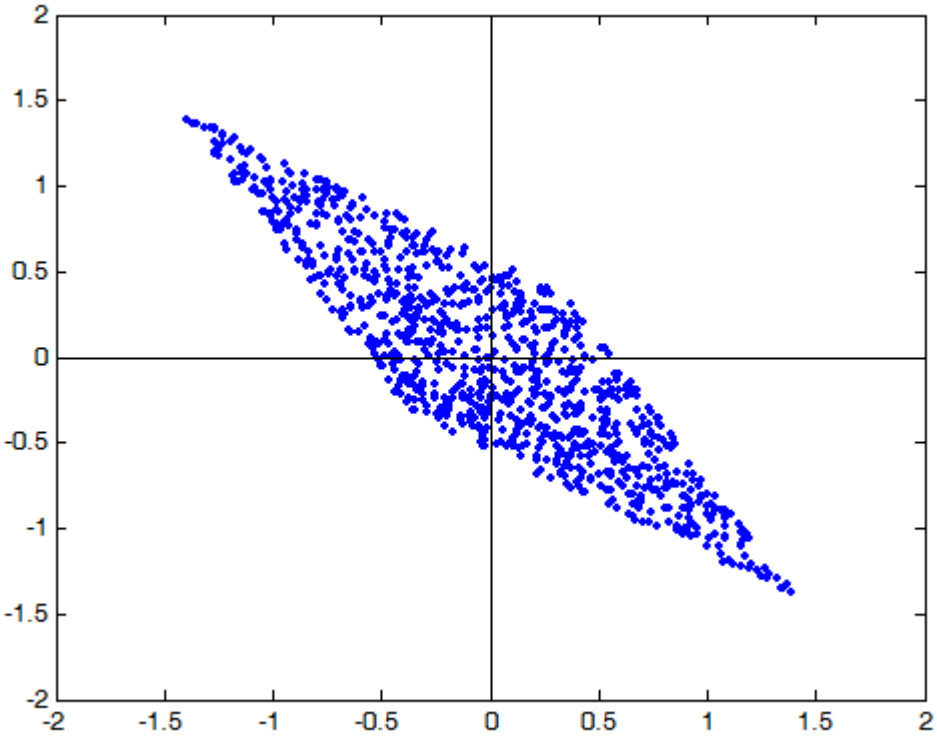
- Add another line to connect [0 -2] and [0 2];

```
plot([0 0],[-2 2], 'k');
```

Data generation

data_gen.m

X=data_gen(1000,1);



PCA

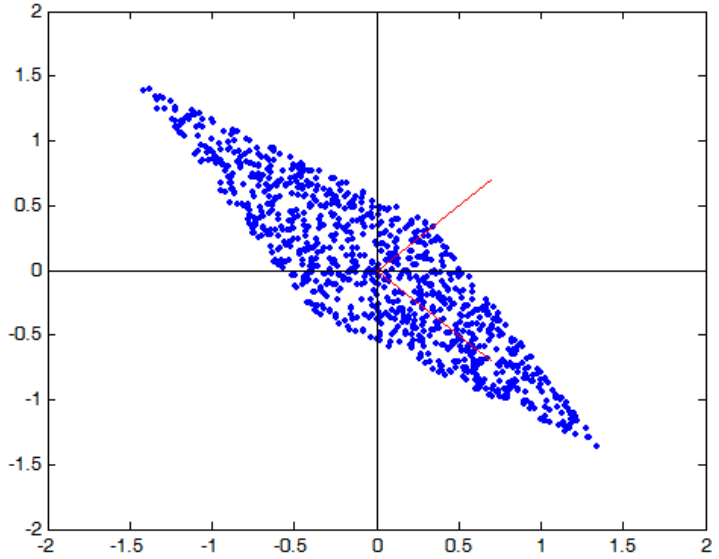
- Find principle components of data

```
C=princomp(X);
size(C)
C
```

PCs

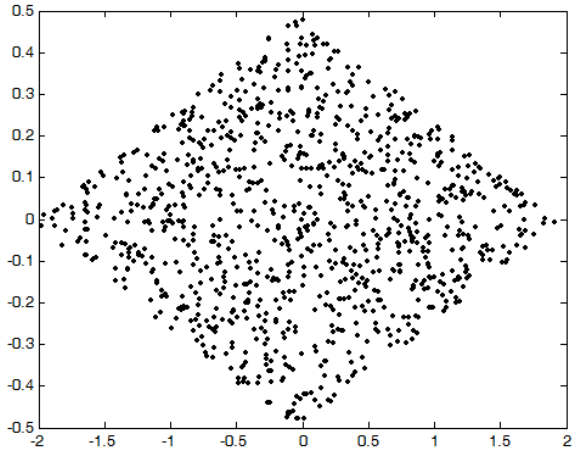
- Draw lines that represent two PCs (principle components)
- Connect (0,0) to C(:,1) and C(:,2)

```
hold on
plot([0 C(1,1)],[0 C(2,1)], 'r');
plot([0 C(1,2)],[0 C(2,2)], 'r');
```

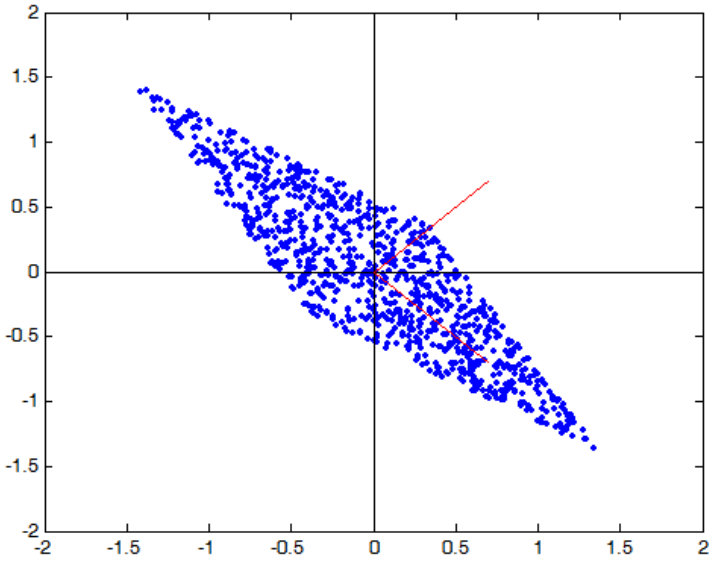


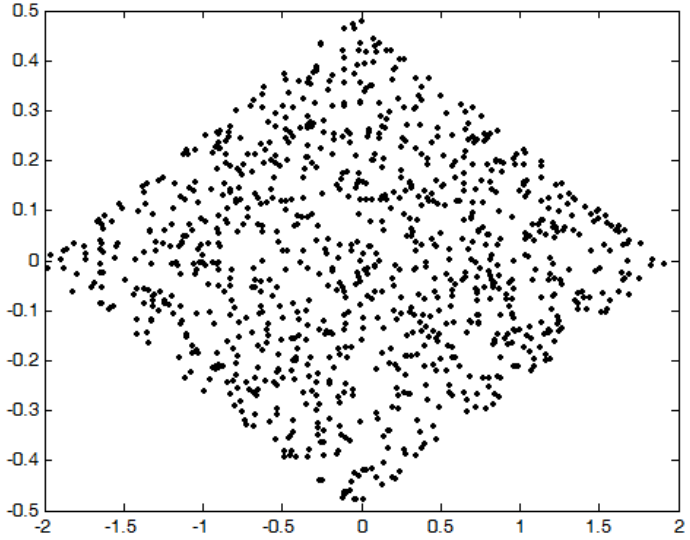
Projection on PCs

- X1= X*C(:,1);
  X2= X*C(:,2);
  XX=[X1 X2];
  plot(XX(:,1),XX(:,2),'.k');



PCA





Two statistically dependent components

Eigen Vectors

- Calculate eigen vectors of a covariance matrix

```
A=X'*X;
[D,V]=eig(A);
D
V
```

Eigen vectors

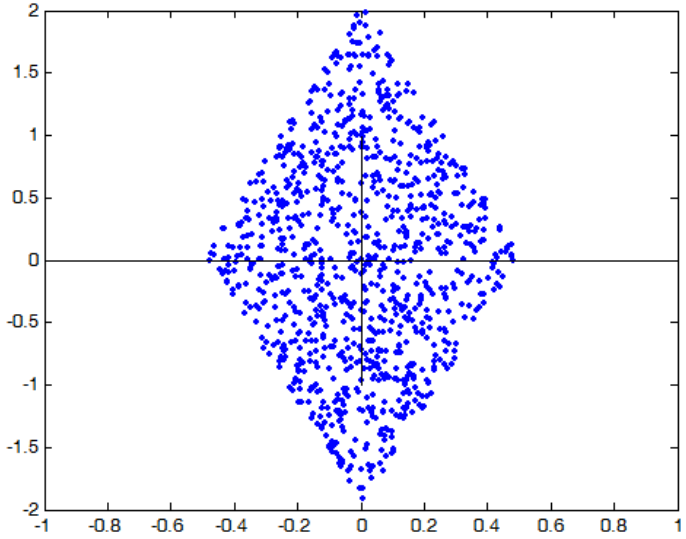
- Connects (0,0) and ends of two eigen vectors.

```
hold on;
plot([0 D(1,1)],[0 D(2,1)], 'g');
plot([0 D(1,2)],[0 D(2,2)], 'g');
```

Projection on Pcs

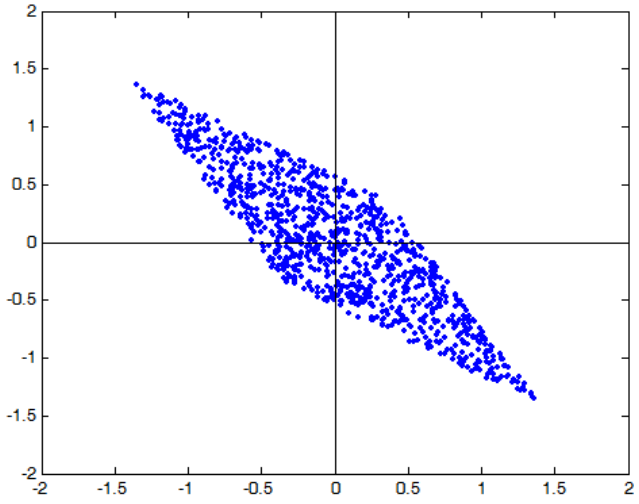
- Projections of data in X on two eigen vectors

```
Y=X*D;
 figure
 plot(Y(:,1),Y(:,2),'.');
 hold on
 plot([-1 1],[0 0], 'k');
 plot([0 0],[-1 1], 'k');
```



ICA

```
X=data_gen(1000,1);
W=JadeR(X');
Y=W*X';
plot(Y(1,:),Y(2,:), '. ')
```



Statistically independent components