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Q1

```
clear
close all
clc
```

A: Covariance Matrix

```
X = [2.5 2.4
     0.5 0.7
     2.2 2.9
     1.9 2.2
     3.1 3
     2.3 2.7
     2 1.6
     1 1.1
     1.5 1.6
     1.1 0.9];

S = covarianceMat(X)

S =

    0.6166    0.6154
    0.6154    0.7166
```

B: Covariance matrix Eigen values and vectors

```
[eigVect, eigVals] = eig(S)

eigVect =

   -0.7352    0.6779
    0.6779    0.7352
```

```
eigVals =  
  
    0.0491    0  
    0    1.2840
```

C: Sorting Eigen Vectors by Eigen Values descending

```
eigVectOrg = eigVect;  
d = diag(eigVals);  
[~, ind] = sort(d, 'descend');  
eigVect = eigVect(:,ind)
```

```
eigVect =  
  
    0.6779   -0.7352  
    0.7352    0.6779
```

D: Mapped Data using Covariance Eigen vectors

```
mappedX = (X * eigVectOrg)
```

```
mappedX =  
  
   -0.2111    3.4591  
    0.1069    0.8536  
    0.3484    3.6233  
    0.0945    2.9054  
   -0.2454    4.3069  
    0.1393    3.5441  
   -0.3858    2.5320  
    0.0105    1.4866  
   -0.0182    2.1931  
   -0.1986    1.4073
```

E: Show the new Data is linear independent

The covariance matrix is diagonal

```
mappedS = covarianceMat(mappedX)
```

```
mappedS =
```

```
0.0491    0.0000
0.0000    1.2840
```

F: Show original Data as linear combination of new Data and Eigen Vectors

```
fprintf("\t\t a * eig1 + b * eig2 = (X1 X2)\n")
n = size(X,1);
for i=1:n
    fprintf("%6.3f * (%5.3f %5.3f) + %5.3f * (%5.3f %5.3f) = (%.1f\n", ...
        mappedX(i,1), eigVectOrg(1,:), mappedX(i,2), eigVectOrg(2,:),
        X(i,:));
end

a * eig1 + b * eig2 = (X1 X2)
-0.211 * (-0.735 0.678) + 3.459 * (0.678 0.735) = (2.5 2.4)
0.107 * (-0.735 0.678) + 0.854 * (0.678 0.735) = (0.5 0.7)
0.348 * (-0.735 0.678) + 3.623 * (0.678 0.735) = (2.2 2.9)
0.094 * (-0.735 0.678) + 2.905 * (0.678 0.735) = (1.9 2.2)
-0.245 * (-0.735 0.678) + 4.307 * (0.678 0.735) = (3.1 3.0)
0.139 * (-0.735 0.678) + 3.544 * (0.678 0.735) = (2.3 2.7)
-0.386 * (-0.735 0.678) + 2.532 * (0.678 0.735) = (2.0 1.6)
0.010 * (-0.735 0.678) + 1.487 * (0.678 0.735) = (1.0 1.1)
-0.018 * (-0.735 0.678) + 2.193 * (0.678 0.735) = (1.5 1.6)
-0.199 * (-0.735 0.678) + 1.407 * (0.678 0.735) = (1.1 0.9)
```

G: Map data to one feature data.

```
singleMappedX = X * eigVect(:,1)
```

```
singleMappedX =
```

```
3.4591
0.8536
3.6233
2.9054
4.3069
3.5441
2.5320
1.4866
2.1931
1.4073
```

The Feature Reduction Error is:

```
err = min(diag(eigVals))
```

`err =`

`0.0491`

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