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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 1.6
    1.5 1.6
    1.1 0.9];

S = covarianceMat(X)
```

```
S =

    0.6166    0.5704
    0.5704    0.6516
```

B: Covariance matrix Eigen values and vectors

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

```
eigVect =

   -0.7179    0.6962
    0.6962    0.7179
```

```
eigVals =

    0.0633         0
         0    1.2048
```

C: Sorting Eigen Vectors by Eigen Values descending

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

```
eigVect =

    0.6962   -0.7179
    0.7179    0.6962
```

D: Mapped Data using Covariance Eigen vectors

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

```
mappedX =

   -0.1238    3.4633
    0.1284    0.8506
    0.4396    3.6134
    0.1677    2.9020
   -0.1368    4.3118
    0.2286    3.5395
   -0.3218    2.5409
    0.3960    1.8448
    0.0371    2.1929
   -0.1631    1.4119
```

E: Show the new Data is linear independent

The covariance matrix is diagonal

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

```
mappedS =

    0.0633   -0.0000
   -0.0000    1.2048
```

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

```
fprintf("\t\ta * 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
 %.1f)\n", ...
        mappedX(i,1), eigVectOrg(:,1),mappedX(i,2), eigVectOrg(:,2),
 X(i,:));
end
```

```
  a * eig1 + b * eig2 = (X1 X2)
-0.124 * (-0.718 0.696) + 3.463 * (0.696 0.718) = (2.5 2.4)
 0.128 * (-0.718 0.696) + 0.851 * (0.696 0.718) = (0.5 0.7)
 0.440 * (-0.718 0.696) + 3.613 * (0.696 0.718) = (2.2 2.9)
 0.168 * (-0.718 0.696) + 2.902 * (0.696 0.718) = (1.9 2.2)
-0.137 * (-0.718 0.696) + 4.312 * (0.696 0.718) = (3.1 3.0)
 0.229 * (-0.718 0.696) + 3.539 * (0.696 0.718) = (2.3 2.7)
-0.322 * (-0.718 0.696) + 2.541 * (0.696 0.718) = (2.0 1.6)
 0.396 * (-0.718 0.696) + 1.845 * (0.696 0.718) = (1.0 1.6)
 0.037 * (-0.718 0.696) + 2.193 * (0.696 0.718) = (1.5 1.6)
-0.163 * (-0.718 0.696) + 1.412 * (0.696 0.718) = (1.1 0.9)
```

G: Map data to one feature data.

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

```
singleMappedX =

    3.4633
    0.8506
    3.6134
    2.9020
    4.3118
    3.5395
    2.5409
    1.8448
    2.1929
    1.4119
```

The Feature Reduction Error is:

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

```
err =

    0.0633
```

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