**Expected Value Vector and Correlation Matrix**

The expected value of random vector  is **column vector**



The correlation of a random vector  is  matrix and it is denoted as



* As I mentioned early, the **format of the vector is column vector** and its transpose is row vector.
* If the size of the vector  is  then the size of the  is = matrix.
* **For an example** the size of vector is 3, and then the size of correlation matrix is 3x3 matrixes.

Let , then



And the **correlation matrix** is



* **Covariance** of a random vector  is an  matrix and it is written in vector form as









**Ex 5.12** Find the **expected value**, the **correlation matrix**, and the **covariance matrix ** of the **2 dimensional random vector  with pdf**













* **Autocorrelation or Autocovariance**: Dealing with one random vector
* **Cross-correlation or Cross-covariance**: Dealing with a pair of random vectors

**Cross correlation**

* The **cross correlation** of random vectors,  with  components and  with  components is an  matrix.



**Cross covariance**

* The cross covariance of a pair of random vectors  with  components and  with  components is an  matrix.



**Ex)**

*  dimensional random vector has: 
*  dimensional random vector has  where  has matrix and  has  vector,

**Find **.







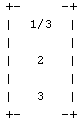
**Ex 5.13** Given random variable  and let , where



**Find **







**A = sym([1 0; 6 3; 3 6]);**

**Rx = sym([1/6 1/4; 1/4 1/2]);**

**Ey = sym([1/3; 2; 3]);**

**b = sym([0; -2; -2]);**

**Ex = sym([1/3; 2/3]);**

muy = A\*Ex +b

Ry = A\*Rx\*A' + A\*Ex\*b' + b\*(A\*Ex)' + b\*b'

Cx = Rx-Ex\*Ex'

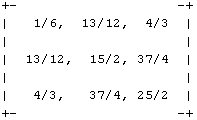
Cy = A\*Cx\*A'

muy =

1/3

2

3

Ry =

[ 1/6, 13/12, 4/3]

[ 13/12, 15/2, 37/4]

[ 4/3, 37/4, 25/2]

Cx =

[ 1/18, 1/36]

[ 1/36, 1/18]

Cy =

[ 1/18, 5/12, 1/3]

[ 5/12, 7/2, 13/4]

[ 1/3, 13/4, 7/2]

muy =

1/3

2

3

The vectors  and , **find cross-correlation and cross-covariance**, .









**Ex 5.14** All the values in Ex5.13 applies here.

Find  and correlation coefficient 





[ 1/6, 13/12, 4/3]

[ 1/4, 5/3, 29/12]





[ 1/6, 1/4]

[ 13/12, 5/3]

[ 4/3, 29/12]



=

[ 1/18, 5/12, 1/3]

[ 1/36, 1/3, 5/12]





[ 1/18, 1/36]

[ 5/12, 1/3]

[ 1/3, 5/12]

Cy =

[ 1/18, 5/12, 1/3]

[ 5/12, 7/2, 13/4]

[ 1/3, 13/4, 7/2]





=

[ 1/18, 5/12, 1/3]

[ 1/36, 1/3, 5/12]



**Quiz 5.6** The 3 dimensional random vectors  has PDF



**Find the expected value**  and the **correlation and covariance matrices**, 

From the previous lecture notes, the marginal density functions were found and they are rewritten here











