1. Let X and Y be two random variables. We observed the following for X and Y:

$X = \{7, -5, 6, 4\}$ and $Y = \{11, -13, 9, 1\}$. Compute by hand

- The mean for X and Y
- The variance of X and Y
- The sample covariance between X and Y
- Form covariance matrix between X and Y
- Are X and Y positively or negatively correlated?
- Form the correlation matrix
- What's the correlation coefficient between X and Y?
- What are the covariance and correlation matrix if $Y = \{-11, 13, -9, -1\}$?
- Then confirm your computation by using a software

In [83]:
```
import numpy as np
```

In [84]:
```
#Computing Mean of X
Calc_Mean_X = np.array([7,-5,6,4])
np.mean(Calc_Mean_X)
```

Out[84]: 3.0

In [85]:
```
#Computing Mean of Y
Calc_Mean_Y = np.array([11,-13,9,1])
np.mean(Calc_Mean_Y)
```

Out[85]: 2.0

In [86]:
```
#Computing Mean of the SAMPLE
Calc_Mean = np.array(([7,-5,6,4],[11,-13,9,1]))
np.mean(Calc_Mean)
```

Out[86]: 2.5

Computing Variance of the Sample (DOF = 0 and 1)

In [87]:
```
# Computing Variance of SAMPLE with DOF = 0

Calc_Var_dof_0 = np.array(([7,-5,6,4],[11,-13,9,1]))
np.var(Calc_Var_dof_0,ddof=0)
```

Out[87]: 56.0

In [88]:
```
# Computing Variance of SAMPLE with DOF = 1

Calc_Var_dof_1 = np.array(([7,-5,6,4],[11,-13,9,1]))
np.var(Calc_Var_dof_1,ddof=1)
```

Out[88]: 64.0

Computing Individual Variance (DOF = 0 and 1)

In [89]:
```
# Computing Variance of X with DOF = 0

Calc_Var_X_dof_0 = np.array([7,-5,6,4])
np.var(Calc_Var_X_dof_0,ddof=0)
```

Out[89]: 22.5

In [90]:
```
# Computing Variance of Y with DOF = 0

Calc_Var_Y_dof_0 = np.array([11,-13,9,1])
np.var(Calc_Var_Y_dof_0,ddof=0)
```

Out[90]: 89.0

In [91]:
```
# Computing Variance of X with DOF = 1

Calc_Var_X_dof_1 = np.array([7,-5,6,4])
np.var(Calc_Var_X_dof_0,ddof=1)
```

Out[91]: 30.0

In [92]:
```
# Computing Variance of Y with DOF = 1

Calc_Var_Y_dof_1 = np.array([11,-13,9,1])
np.var(Calc_Var_Y_dof_0,ddof=1)
```

Out[92]: 118.66666666666667

Computing Covariance (DOF = 1)

In [93]:
```
a2 = [7,-5,6,4]
b2 = [11,-13,9,1]
Covariance = np.cov(a2, b2, ddof=1)[0][1]
print(Covariance)
```

```
58.6666666667
```

covariance matrix

In [94]:
```
Calc_Co_Var_Matrix = np.array(([7,-5,6,4],[11,-13,9,1]))
np.cov(Calc_Co_Var_Matrix)
```

Out[94]:
```
array([[  30.        ,   58.66666667],
       [  58.66666667,  118.66666667]])
```

X and Y are positively correlated

correlation matrix and coefficient

In [95]:
```
Calc_Correlation_Matrix = np.array(([7,-5,6,4],[11,-13,9,1]))
np.corrcoef(Calc_Correlation_Matrix)

# The correlation coefficient between X and Y is 0.98
```

Out[95]:
```
array([[ 1.        ,  0.98325557],
       [ 0.98325557,  1.        ]])
```

What are the covariance and correlation matrix if Y={−11,13,−9,−1} ?

DOF = 1

In [96]:
```
# Computing Variance of SAMPLE with DOF = 1 using the New value of Y

a4 = [7,-5,6,4]
b4 = [-11,13,-9,-1]
Covariance = np.cov(a4, b4, ddof=1)[0][1]
print(Covariance)
```

```
-58.6666666667
```

correlation matrix and coefficient

In [97]:
```

Calc_Correlation_Matrix_Y = np.array(([7,-5,6,4],[-11,13,-9,-1]))
np.corrcoef(Calc_Correlation_Matrix_Y)

# we can observe that the it is now Negative 0.98 when the value of Y is
```

Out[97]:
```
array([[ 1.        , -0.98325557],
       [-0.98325557,  1.        ]])
```