In [98]:

```
pip install numpy
```

```
Defaulting to user installation because normal site-packages is not writea
ble
Requirement already satisfied: numpy in c:\programdata\anaconda3\lib\site-
packages (1.24.3)
Note: you may need to restart the kernel to use updated packages.
```

In [99]:

```
import numpy as np
```

In [100]:

```
a=np.array([[2,5],[4,8]])
a
```

Out[100]:

```
array([[2, 5],
       [4, 8]])
```

In [101]:

```
b = np.array([[1,4,8],[4,8,9],[7,1,2]])
b
```

Out[101]:

```
array([[1, 4, 8],
       [4, 8, 9],
       [7, 1, 2]])
```

In [102]:

```
c=np.array([[5,8,5,6],[1,8,7,6],[4,5,2,7],[4,5,4,9]])
c
```

Out[102]:

```
array([[5, 8, 5, 6],
       [1, 8, 7, 6],
       [4, 5, 2, 7],
       [4, 5, 4, 9]])
```

In [103]:

```
d=np.array([[1,2,9,4,8],[2,6,1,8,3],[9,5,6,7,8],[3,9,9,6,7],[3,8,7,6,7]])
d
```

Out[103]:

```
array([[1, 2, 9, 4, 8],
       [2, 6, 1, 8, 3],
       [9, 5, 6, 7, 8],
       [3, 9, 9, 6, 7],
       [3, 8, 7, 6, 7]])
```

In [104]:

```
e=np.array([[8,3],[9,5]])
e
```

Out[104]:

```
array([[8, 3],
       [9, 5]])
```

In [105]:

```
from numpy import linalg as la
```

In [106]:

```
print(la.det(a))
```

```
-4.0
```

In [107]:

```
print(la.det(b))
```

```
-189.00000000000003
```

In [108]:

```
print(la.det(c))
```

```
-252.00000000000003
```

In [109]:

```
print(la.det(d))
```

```
2937.000000000003
```

In [110]:

```
print(la.det(e))
```

```
13.000000000000005
```

In [111]:

```
print(la.inv(a))
```

```
[[-2.    1.25]
 [ 1.   -0.5 ]]
```

In [112]:

```
print(la.inv(b))
```

```
[[-0.03703704  0.          0.14814815]
 [-0.29100529  0.28571429 -0.12169312]
 [ 0.27513228 -0.14285714  0.04232804]]
```

In [113]:

```
print(la.inv(c))
```

```
[[ 0.35714286 -0.27777778 -0.33333333  0.20634921]
 [-0.07142857  0.16666667  0.5        -0.45238095]
 [ 0.21428571 -0.05555556 -0.66666667  0.41269841]
 [-0.21428571  0.05555556  0.16666667  0.08730159]]
```

In [115]:

```
print(la.inv(e))
```

```
[[ 0.38461538 -0.23076923]
 [-0.69230769  0.61538462]]
```

In [114]:

```
print(la.inv(d))
```

```
[[-0.08375894 -0.04800817  0.14913177  0.14300306 -0.19713994]
 [-0.14368403 -0.0742254  -0.05311542 -0.05549881  0.31222336]
 [ 0.07184202  0.0371127   0.02655771  0.5277494  -0.65611168]
 [ 0.10554988  0.23935989  0.01532176  0.20190671 -0.44262853]
 [ 0.03779367 -0.13687436 -0.04290092 -0.69867211  0.90602656]]
```

In [117]:

```
print(la.matrix_rank(a))
print(np.diag(a))
print(np.trace(a))
```

```
2
[2 8]
10
```

In [116]:

```
print(la.matrix_rank(b))
print(np.diag(b))
print(np.trace(b))
```

```
3
[1 8 2]
11
```

In [123]:

```
print(la.matrix_rank(c))
print(np.diag(c))
print(np.trace(c))
```

```
4
[5 8 2 9]
24
```

In [124]:

```
print(la.matrix_rank(d))
print(np.diag(d))
print(np.trace(d))
```

```
5
[1 6 6 6 7]
26
```

In [125]:

```
print(la.matrix_rank(e))
print(np.diag(e))
print(np.trace(e))
```

```
2
[8 5]
13
```

In [126]:

```
x,y=la.eig(a)
print("Roots:",x)
print("Vectors:",y)
```

```
Roots: [-0.38516481 10.38516481]
Vectors: [[-0.90256514 -0.51215158]
 [ 0.43055332 -0.85889508]]
```

In [128]:

```
x,y=la.eig(b)
print("Roots:",x)
print("Vectors:",y)
```

```
Roots: [13.96875451 -5.45093405  2.48217954]
Vectors: [[ 0.46171342  0.68855829  0.1565132 ]
 [ 0.81988576  0.25057066 -0.87150048]
 [ 0.33853812 -0.68051585  0.46474782]]
```

In [129]:

```
x,y=la.eig(c)
print("Roots:",x)
print("Vectors:",y)
```

```
Roots: [21.44461875+0.j         2.05350893+1.8320818j  2.05350893-1.832081
8j
 -1.55163661+0.j       ]
Vectors: [[ 0.55719484+0.j          0.68398207+0.j          0.68398207-0.j
  -0.14103057+0.j        ]
 [ 0.4930443 +0.j         -0.09440333+0.53077973j -0.09440333-0.53077973j
   0.5489662 +0.j        ]
 [ 0.42654775+0.j          0.08253752-0.16805241j  0.08253752+0.16805241j
  -0.81737328+0.j        ]
 [ 0.51429393+0.j         -0.27880134-0.35881078j -0.27880134+0.35881078j
   0.1031863 +0.j        ]]
```

In [131]:

```
x,y=la.eig(d)
print("Roots:",x)
print("Vectors:",y)
```

```
Roots: [29.19405435+0.j        5.3024136 +0.j       -4.67429862+0.645236j
 -4.67429862-0.645236j  0.85212928+0.j      ]
Vectors: [[ 0.39448812+0.00000000e+00j -0.51436598+0.00000000e+00j
  -0.10187088+1.55039474e-01j -0.10187088-1.55039474e-01j
  -0.21945813+0.00000000e+00j]
 [ 0.29319626+0.00000000e+00j  0.60039019+0.00000000e+00j
   0.51570417+1.22509778e-02j  0.51570417-1.22509778e-02j
   0.23962214+0.00000000e+00j]
 [ 0.53068536+0.00000000e+00j -0.57849612+0.00000000e+00j
   0.47489343-1.07638408e-01j  0.47489343+1.07638408e-01j
  -0.54907128+0.00000000e+00j]
 [ 0.51090404+0.00000000e+00j  0.07940816+0.00000000e+00j
  -0.61131486+0.00000000e+00j -0.61131486-0.00000000e+00j
  -0.29709608+0.00000000e+00j]
 [ 0.46450531+0.00000000e+00j  0.1843796 +0.00000000e+00j
  -0.29777263-1.53414574e-04j -0.29777263+1.53414574e-04j
   0.71040412+0.00000000e+00j]]
```

In [132]:

```
x,y=la.eig(e)
print("Roots:",x)
print("Vectors:",y)
```

```
Roots: [11.90832691  1.09167309]
Vectors: [[ 0.60889368 -0.3983218 ]
 [ 0.79325185  0.91724574]]
```

In [133]:

```
print(la.eigvals(a))
print(la.eigvals(b))
print(la.eigvals(c))
print(la.eigvals(d))
print(la.eigvals(e))
```

```
[-0.38516481 10.38516481]
[13.96875451 -5.45093405  2.48217954]
[21.44461875+0.j         2.05350893+1.8320818j  2.05350893-1.8320818j
 -1.55163661+0.j       ]
[29.19405435+0.j        5.3024136 +0.j       -4.67429862+0.645236j
 -4.67429862-0.645236j  0.85212928+0.j      ]
[11.90832691  1.09167309]
```

In [134]:

```
pip install pandas
```

```
Defaulting to user installation because normal site-packages is not writea
ble
Requirement already satisfied: pandas in c:\programdata\anaconda3\lib\site
-packages (1.5.3)
Requirement already satisfied: python-dateutil>=2.8.1 in c:\programdata\an
aconda3\lib\site-packages (from pandas) (2.8.2)
Requirement already satisfied: pytz>=2020.1 in c:\programdata\anaconda3\li
b\site-packages (from pandas) (2022.7)
Requirement already satisfied: numpy>=1.21.0 in c:\programdata\anaconda3\l
ib\site-packages (from pandas) (1.24.3)
Requirement already satisfied: six>=1.5 in c:\programdata\anaconda3\lib\si
te-packages (from python-dateutil>=2.8.1->pandas) (1.16.0)
Note: you may need to restart the kernel to use updated packages.
```

In [135]:

```
import pandas as pd
```

In [136]:

```
i1={
    'branch':pd.Series([40,80,20,10,60]),
    'courses':pd.Series([3,4,2,5,1]) }
print(i1)
```

```
{'branch': 0    40
1    80
2    20
3    10
4    60
dtype: int64, 'courses': 0    3
1    4
2    2
3    5
4    1
dtype: int64}
```

In [138]:

```
i2={
    'age':pd.Series([10,20,30,40,50]),
    'Weight':pd.Series([35,56,45,78,67]) }
print(i2)
```

```
{'age': 0    10
1    20
2    30
3    40
4    50
dtype: int64, 'Weight': 0    35
1    56
2    45
3    78
4    67
dtype: int64}
```

In [139]:

```
i3={
    'cities code':pd.Series([10,20,30,40,50]),
    'population':pd.Series([35,16,45,78,67]) }
print(i3)
```

```
{'cities code': 0    10
1    20
2    30
3    40
4    50
dtype: int64, 'population': 0    35
1    16
2    45
3    78
4    67
dtype: int64}
```

In [140]:

```
i4={
    'city code':pd.Series([10,20,30,40,50]),
    'vacanies':pd.Series([35,56,45,78,67]) }
print(i4)
```

```
{'city code': 0    10
1    20
2    30
3    40
4    50
dtype: int64, 'vacanies': 0    35
1    56
2    45
3    78
4    67
dtype: int64}
```

In [141]:

```
i5={
    'cars no':pd.Series([10,20,30,40,50]),
    'distance':pd.Series([35,56,45,78,67]) }
print(i5)
```

```
{'cars no': 0    10
1    20
2    30
3    40
4    50
dtype: int64, 'distance': 0    35
1    56
2    45
3    78
4    67
dtype: int64}
```

In [142]:

```
j=pd.DataFrame(i1)
j
```

Out[142]:

	branch	courses
0	40	3
1	80	4
2	20	2
3	10	5
4	60	1

In [143]:

```
k=pd.DataFrame(i2)
k
```

Out[143]:

	age	Weight
0	10	35
1	20	56
2	30	45
3	40	78
4	50	67

In [144]:

```
m=pd.DataFrame(i3)
m
```

Out[144]:

	cities code	population
0	10	35
1	20	16
2	30	45
3	40	78
4	50	67

In [145]:

```
n=pd.DataFrame(i4)
n
```

Out[145]:

	city code	vacanies
0	10	35
1	20	56
2	30	45
3	40	78
4	50	67

In [146]:

```
o=pd.DataFrame(i5)
o
```

Out[146]:

	cars no	distance
0	10	35
1	20	56
2	30	45
3	40	78
4	50	67

In [147]:

```
print(j.mean())
print(j.median())
print(j.mode())
```

```
branch     42.0
courses     3.0
dtype: float64
branch     40.0
courses     3.0
dtype: float64
   branch  courses
0      10        1
1      20        2
2      40        3
3      60        4
4      80        5
```

In [148]:

```
print(k.mean())
print(k.median())
print(k.mode())
```

```
age       30.0
Weight    56.2
dtype: float64
age       30.0
Weight    56.0
dtype: float64
   age  Weight
0   10      35
1   20      45
2   30      56
3   40      67
4   50      78
```

In [150]:

```
print(m.mean())
print(m.median())
print(m.mode())
```

```
cities code    30.0
population     48.2
dtype: float64
cities code    30.0
population     45.0
dtype: float64
   cities code  population
0           10          16
1           20          35
2           30          45
3           40          67
4           50          78
```

In [151]:

```
print(n.mean())
print(n.median())
print(n.mode())
```

```
city code    30.0
vacanies     56.2
dtype: float64
city code    30.0
vacanies     56.0
dtype: float64
   city code  vacanies
0         10        35
1         20        45
2         30        56
3         40        67
4         50        78
```

In [152]:

```
print(o.mean())
print(o.median())
print(o.mode())
```

```
cars no     30.0
distance    56.2
dtype: float64
cars no     30.0
distance    56.0
dtype: float64
   cars no  distance
0       10        35
1       20        45
2       30        56
3       40        67
4       50        78
```

In [153]:

```
print(j.sum())
print(j.cumsum())
print(j.count())
print(j.max())
print(j.min())
```

```
branch     210
courses     15
dtype: int64
   branch  courses
0      40        3
1     120        7
2     140        9
3     150       14
4     210       15
branch     5
courses    5
dtype: int64
branch     80
courses     5
dtype: int64
branch     10
courses     1
dtype: int64
```

In [154]:

```
print(k.sum())
print(k.cumsum())
print(k.count())
print(k.max())
print(k.min())
```

```
age       150
Weight    281
dtype: int64
   age  Weight
0   10      35
1   30      91
2   60     136
3  100     214
4  150     281
age       5
Weight    5
dtype: int64
age       50
Weight    78
dtype: int64
age       10
Weight    35
dtype: int64
```

In [155]:

```
print(m.sum())
print(m.cumsum())
print(m.count())
print(m.max())
print(m.min())
```

```
cities code    150
population     241
dtype: int64
   cities code  population
0           10          35
1           30          51
2           60          96
3          100         174
4          150         241
cities code    5
population     5
dtype: int64
cities code    50
population     78
dtype: int64
cities code    10
population     16
dtype: int64
```

In [156]:

```
print(n.sum())
print(n.cumsum())
print(n.count())
print(n.max())
print(n.min())
```

```
city code    150
vacanies     281
dtype: int64
   city code  vacanies
0         10        35
1         30        91
2         60       136
3        100       214
4        150       281
city code    5
vacanies     5
dtype: int64
city code    50
vacanies     78
dtype: int64
city code    10
vacanies     35
dtype: int64
```

In [157]:

```
print(o.sum())
print(o.cumsum())
print(o.count())
print(o.max())
print(o.min())
```

```
cars no     150
distance    281
dtype: int64
   cars no  distance
0       10        35
1       30        91
2       60       136
3      100       214
4      150       281
cars no     5
distance    5
dtype: int64
cars no     50
distance    78
dtype: int64
cars no     10
distance    35
dtype: int64
```

In [89]:

```
print(m.describe())
print(n.describe())
print(o.describe())
print(p.describe())
print(q.describe())
```

```
          branch   courses
count   5.000000  5.000000
mean   42.000000  3.000000
std    28.635642  1.581139
min    10.000000  1.000000
25%    20.000000  2.000000
50%    40.000000  3.000000
75%    60.000000  4.000000
max    80.000000  5.000000
             age     Weight
count   5.000000   5.000000
mean   30.000000  56.200000
std    15.811388  17.079227
min    10.000000  35.000000
25%    20.000000  45.000000
50%    30.000000  56.000000
75%    40.000000  67.000000
max    50.000000  78.000000
       cities code  population
count     5.000000    5.000000
mean     30.000000   48.200000
std      15.811388   24.813303
min      10.000000   16.000000
25%      20.000000   35.000000
50%      30.000000   45.000000
75%      40.000000   67.000000
max      50.000000   78.000000
       city code   vacanies
count   5.000000   5.000000
mean   30.000000  56.200000
std    15.811388  17.079227
min    10.000000  35.000000
25%    20.000000  45.000000
50%    30.000000  56.000000
75%    40.000000  67.000000
max    50.000000  78.000000
         cars no   distance
count   5.000000   5.000000
mean   30.000000  56.200000
std    15.811388  17.079227
min    10.000000  35.000000
25%    20.000000  45.000000
50%    30.000000  56.000000
75%    40.000000  67.000000
max    50.000000  78.000000
```

In [158]:

```
from numpy import cov
covariance=cov(j,k)
print(covariance)
```

```
[[  684.5  1406.    333.     92.5  1091.5  -462.5  -666.   -277.5  -703.
   -314.5]
 [ 1406.   2888.    684.    190.   2242.   -950.  -1368.   -570.  -1444.
   -646. ]
 [  333.    684.    162.     45.    531.   -225.   -324.   -135.   -342.
   -153. ]
 [   92.5   190.     45.     12.5   147.5   -62.5   -90.    -37.5   -95.
    -42.5]
 [ 1091.5  2242.    531.    147.5  1740.5  -737.5 -1062.   -442.5 -1121.
   -501.5]
 [ -462.5  -950.   -225.    -62.5  -737.5   312.5   450.    187.5   475.
    212.5]
 [ -666.  -1368.   -324.    -90.  -1062.    450.    648.    270.    684.
    306. ]
 [ -277.5  -570.   -135.    -37.5  -442.5   187.5   270.    112.5   285.
    127.5]
 [ -703.  -1444.   -342.    -95.  -1121.    475.    684.    285.    722.
    323. ]
 [ -314.5  -646.   -153.    -42.5  -501.5   212.5   306.    127.5   323.
    144.5]]
```

In [159]:

```
from numpy import cov
covariance=cov(k,m)
print(covariance)
```

```
[[312.5 450.  187.5 475.  212.5 312.5 -50.  187.5 475.  212.5]
 [450.  648.  270.  684.  306.  450.  -72.  270.  684.  306. ]
 [187.5 270.  112.5 285.  127.5 187.5 -30.  112.5 285.  127.5]
 [475.  684.  285.  722.  323.  475.  -76.  285.  722.  323. ]
 [212.5 306.  127.5 323.  144.5 212.5 -34.  127.5 323.  144.5]
 [312.5 450.  187.5 475.  212.5 312.5 -50.  187.5 475.  212.5]
 [-50.  -72.  -30.  -76.  -34.  -50.    8.  -30.  -76.  -34. ]
 [187.5 270.  112.5 285.  127.5 187.5 -30.  112.5 285.  127.5]
 [475.  684.  285.  722.  323.  475.  -76.  285.  722.  323. ]
 [212.5 306.  127.5 323.  144.5 212.5 -34.  127.5 323.  144.5]]
```

In [160]:

```
from numpy import cov
covariance=cov(m,n)
print(covariance)
```

```
[[312.5 -50.  187.5 475.  212.5 312.5 450.  187.5 475.  212.5]
 [-50.    8.  -30.  -76.  -34.  -50.  -72.  -30.  -76.  -34. ]
 [187.5 -30.  112.5 285.  127.5 187.5 270.  112.5 285.  127.5]
 [475.  -76.  285.  722.  323.  475.  684.  285.  722.  323. ]
 [212.5 -34.  127.5 323.  144.5 212.5 306.  127.5 323.  144.5]
 [312.5 -50.  187.5 475.  212.5 312.5 450.  187.5 475.  212.5]
 [450.  -72.  270.  684.  306.  450.  648.  270.  684.  306. ]
 [187.5 -30.  112.5 285.  127.5 187.5 270.  112.5 285.  127.5]
 [475.  -76.  285.  722.  323.  475.  684.  285.  722.  323. ]
 [212.5 -34.  127.5 323.  144.5 212.5 306.  127.5 323.  144.5]]
```

In [161]:

```
from numpy import cov
covariance=cov(n,o)
print(covariance)
```

```
[[312.5 450.  187.5 475.  212.5 312.5 450.  187.5 475.  212.5]
 [450.  648.  270.  684.  306.  450.  648.  270.  684.  306. ]
 [187.5 270.  112.5 285.  127.5 187.5 270.  112.5 285.  127.5]
 [475.  684.  285.  722.  323.  475.  684.  285.  722.  323. ]
 [212.5 306.  127.5 323.  144.5 212.5 306.  127.5 323.  144.5]
 [312.5 450.  187.5 475.  212.5 312.5 450.  187.5 475.  212.5]
 [450.  648.  270.  684.  306.  450.  648.  270.  684.  306. ]
 [187.5 270.  112.5 285.  127.5 187.5 270.  112.5 285.  127.5]
 [475.  684.  285.  722.  323.  475.  684.  285.  722.  323. ]
 [212.5 306.  127.5 323.  144.5 212.5 306.  127.5 323.  144.5]]
```

In [95]:

```
pip install scipy
```

```
Defaulting to user installation because normal site-packages is not writea
ble
Requirement already satisfied: scipy in c:\programdata\anaconda3\lib\site-
packages (1.10.1)
Requirement already satisfied: numpy<1.27.0,>=1.19.5 in c:\programdata\ana
conda3\lib\site-packages (from scipy) (1.24.3)
Note: you may need to restart the kernel to use updated packages.
```

In [163]:

```
from scipy.stats import pearsonr
c=[1,2,3,4,5,6,7,8,9,10]
d=[11,13,15,16,24,56,34,25,39,90]
corr=pearsonr(c,d)
print(corr)
```

```
PearsonRResult(statistic=0.767143303518697, pvalue=0.009605641558179966)
```

In [164]:

```
from scipy.stats import spearmanr
c=[1,2,3,4,5,6,7,8,9,10]
d=[11,13,15,16,24,56,34,25,39,90]
corr=spearmanr(c,d)
print(corr)
```

```
SignificanceResult(statistic=0.9151515151515152, pvalue=0.0002044724061488
323)
```

In [ ]:

```

```