1. Aim:- Write a python program to find the best fit straight line and draw the scatter plot.

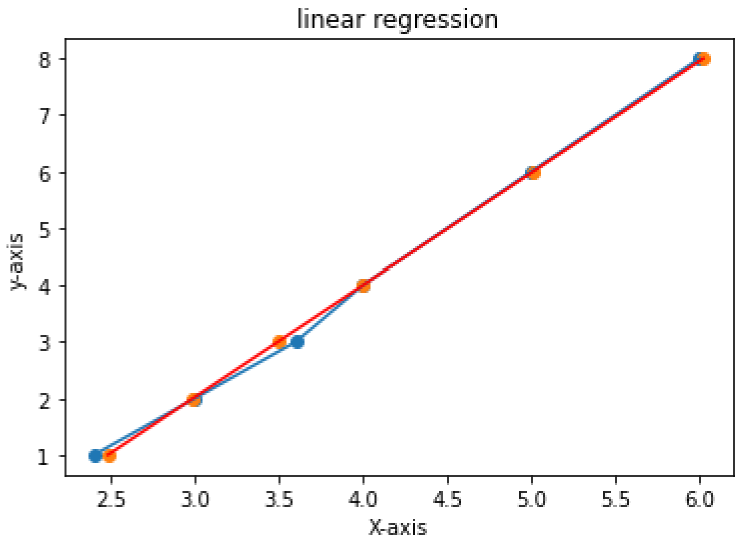
Source code:-

```
import numpy as np
import matplotlib.pyplot as plt
def mean(x):
    len=0
    sum=0
    for i in x:
        len+=1
        sum+=i
    return sum/len
x=np.array(list(map(float, input("Enter x values : ").split(",
"))))
y=np.array(list(map(float, input("Enter y values : ").split(",
"))))
x_bar=mean(x)
y_bar=mean(y)
num=0
den=0
length=len(x)
for i in range(length):
    num+=((x[i]-x_bar)*(y[i]-y_bar))
    den+=(x[i]-x_bar)**2
slope=num/den
slope=slope.round(4)
print(f"slope={slope}")
y_intercept=y_bar-(slope*x_bar)
y_intercept=y_intercept.round(4)
print(f"y_intercept={y_intercept}")
print(f"the required line is y={slope}x+{y_intercept}")
y1=[]
for i in range(len(x)):
  y1.append(slope*x[i] + y_intercept)
plt.scatter(y,x)
plt.scatter(y1,x)
plt.xlabel("X-axis")
plt.ylabel("y-axis")
plt.title("linear regression")
plt.plot(y,x)
plt.plot(y1,x,'r')
plt.show()
sse=0
```

```
sst=0
ssr=0
for i in range(length):
    sse=sse+(y[i]-(slope*x[i]+y_intercept))**2
    sst+=(y_bar-y[i])**2
    ssr+=((slope*x[i]+y_intercept)-y_bar)**2
print("y = ",y)
for i in range(length):
    print(slope*x[i]+y_intercept)
sse=sse.round(4)
ssr=ssr.round(4)
r_square=1-(sse/sst)
r_square=r_square.round(4)
print(f"cost function of the line is {sse}")
print(f"The regression is {ssr}")
print(f"total error is {sst}")
print(f"The Goodness of fit model {r_square}")
```

<u>Output 1</u>:-

Enter x values : 1,2,3,4,6,8
Enter y values : 2.4,3,3.6,4,5,6
slope=0.5059
y_intercept=1.9764
the required line is y=0.5059x+1.9764

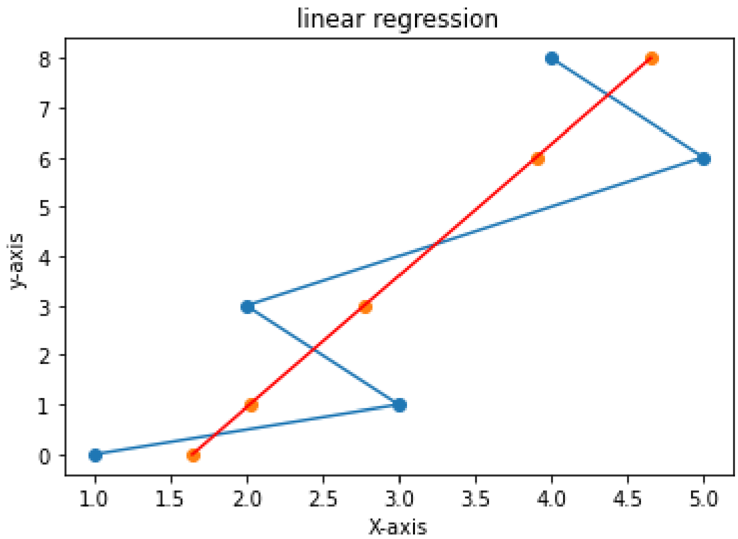


y = [2.4 3. 3.6 4. 5. 6.]
2.4823
2.9882
3.4941
4.0

5.0118
6.0236
cost function of the line is 0.0188
The regression is 8.7018
total error is 8.72
The Goodness of fit model 0.9978

Output 2:-

Enter x values : 0,1,3,6,8
Enter y values : 1,3,2,5,4
slope=0.3761
y_intercept=1.646
the required line is y=0.3761x+1.646



y = [1. 3. 2. 5. 4.]
1.646
2.0221
2.7742999999999998
3.9025999999999996
4.6548
cost function of the line is 3.6062
The regression is 6.3936
total error is 10.0
The Goodness of fit model 0.6394

2. Aim:- Write a python program to fit a second degree parabola of the form y=a+bx+cx^2 and draw the scatter plot.

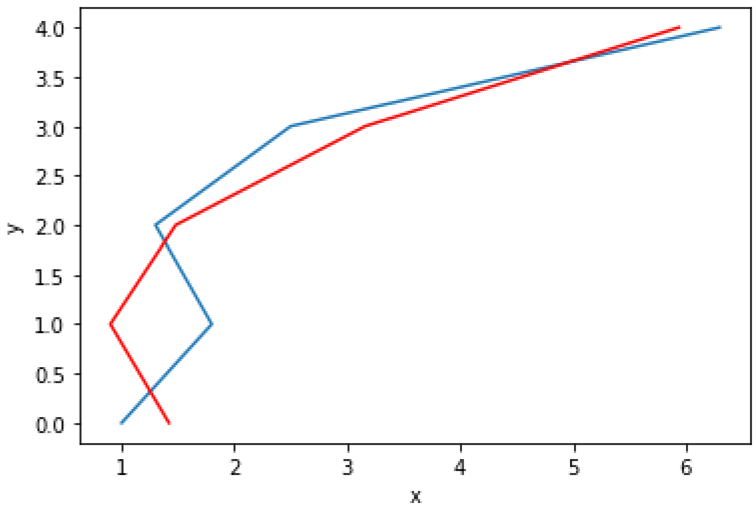
<u>Source code</u>:-

```
import numpy as np
import matplotlib.pyplot as plt

x=list(map(float, input().split(",")))
y=list(map(float, input().split(",")))

def mean(x):
    len=0
    sum=0
    for i in x:
        len+=1
        sum+=i
    return sum/len

xy=[]
x2y=[]
x2=[]
x3=[]
x4=[]
for i in range(len(x)):
  xy.append(x[i]*y[i])
  x2y.append(x[i]*x[i]*y[i])
  x2.append(x[i]*x[i])
  x3.append(x2[i]*x[i])
  x4.append(x2[i]*x2[i])

#print(x,y,xy,x2y,x2,x3,x4)
print("Equations to be solved are : ")
print("{} = {}a + {}b + {}c".format(sum(y),len(x),sum(x),sum(x
2)))
print("{} = {}a + {}b + {}c".format(sum(xy),sum(x),sum(x2),sum
(x3)))
print("{} = {}a + {}b + {}c".format(sum(x2y),sum(x2),sum(x3),s
um(x4)))

def getMinor(m,i,j):
  return [p[:j]+p[j+1:] for p in m[:i]+m[i+1:]]
def getDeterminant(a):
  if len(a)==1:
    return a[0][0]
  if len(a)==2:
    return a[0][0]*a[1][1]-a[0][1]*a[1][0]
  det=0
  for c in range(len(a)):
```

```
    det+=(-1)**c*a[0][c]*getDeterminant(getMinor(a,0,c))
  return det

d=[[len(x),sum(x),sum(x2)],[sum(x),sum(x2),sum(x3)],[sum(x2),s
um(x3),sum(x4)]]
d1=[[sum(y),sum(xy),sum(x2y)],[sum(x),sum(x2),sum(x3)],[sum(x2
),sum(x3),sum(x4)]]
d2=[[len(x),sum(x),sum(x2)],[sum(y),sum(xy),sum(x2y)],[sum(x2)
,sum(x3),sum(x4)]]
d3=[[len(x),sum(x),sum(x2)],[sum(x),sum(x2),sum(x3)],[sum(y),s
um(xy),sum(x2y)]]

a=getDeterminant(d1)/getDeterminant(d)
b=getDeterminant(d2)/getDeterminant(d)
c=getDeterminant(d3)/getDeterminant(d)
print()

print('a = {},b = {},c = {}'.format(a,b,c))

print('final equation is :')
print('y = {} + {}x + {}x^2'.format(a,b,c))
print()
y1=[]
for i in range(len(y)):
  y1.append(a + b*x[i] + c*x[i]*x[i])

plt.xlabel('x')
plt.ylabel('y')
plt.plot(y,x)
plt.plot(y1,x,'r')
plt.show()
```

Output 1:-

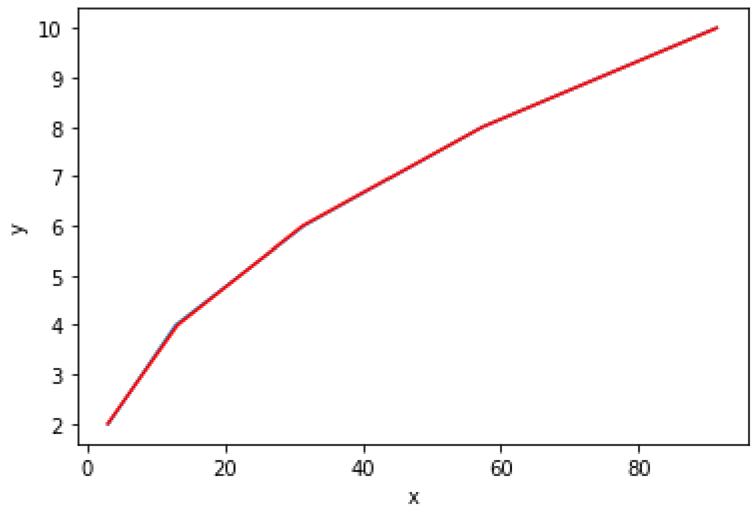
```
0,1,2,3,4
1,1.8,1.3,2.5,6.3
Equations to be solved are :
12.899999999999999 = 5a + 10.0b + 30.0c
37.1 = 10.0a + 30.0b + 100.0c
130.3 = 30.0a + 100.0b + 354.0c

a = 1.4200000000000026,b = -1.0700000000000116,c = 0.5500000000000025
final equation is :
y = 1.4200000000000026 + -1.0700000000000116x + 0.5500000000000025x^2
```



Output 2:-

2,4,6,8,10
3.07,12.85,31.47,57.38,91.29
Equations to be solved are :
196.06 = 5a + 30.0b + 220.0c
1618.3000000000002 = 30.0a + 220.0b + 1800.0c
14152.12 = 220.0a + 1800.0b + 15664.0c

a = 0.6959999999996008,b = -0.8550714285710326,c = 0.9919642857143065
final equation is :
y = 0.6959999999996008 + -0.8550714285710326x + 0.9919642857143065x^2



3. Aim:- Write a python program to find Karl Pearson's correlation coefficient.

Source code:-

```
import numpy as np
import statistics as st
import math
x_input=list(map(int,input("enter x values:").split()))
y_input=list(map(int,input("enter y values:").split()))
x=np.array(x_input)
y=np.array(y_input)
print(x)
print(y)
xsum=sum(x)
ysum=sum(y)
xy=x*y
xysum=sum(xy)
xsquare=x**2
ysquare=y**2
xsquaresum=sum(xsquare)
ysquaresum=sum(ysquare)
xbar=st.mean(x_input)
ybar=st.mean(y_input)
cov_xy=(xysum/np.size(x))-(xbar*ybar)
sigma_x=math.sqrt((xsquaresum/np.size(x))-(xbar**2))
sigma_y=math.sqrt((ysquaresum/np.size(y))-(ybar**2))
r=round(cov_xy/(sigma_x*sigma_y),4)
r=round(cov_xy/(sigma_x*sigma_y),4)
print('the correlation coefficient  of given data is:',r)
r_builtin=np.corrcoef(x, y)
print('the correlation coefficient  of given data by builtin f
unction is:',round(r_builtin[1,0],4))
```

Output 1:-

enter x values:3 7 4 2 0 4 1 2

enter y values:11 18 9 4 7 6 3 8

[3 7 4 2 0 4 1 2]

[11 18 9 4 7 6 3 8]

the correlation coefficient of given data is: 0.7867

the correlation coefficient of given data by builtin function is: 0.7867

Output 2:-

```
enter x values:35 39 45 53 63 75 89 105 117
enter y values:181 151 126 106 91 81 76 68 65
[ 35  39  45  53  63  75  89 105 117]
[181 151 126 106  91  81  76  68  65]
the correlation coefficient  of given data is: -0.8834
the correlation coefficient  of given data by builtin function is: -0.8834
```

4. Aim:- Write a python program to find the Spearman's correlation coefficient between x and y variables.

Source code:-

```
import numpy as np
cf=[]
def find_rank(l):
    r={}
    s=list(set(l))
    w=l.copy()
    s.sort(reverse=True)
    w.sort(reverse=True)
    a=1
    for i in s:
        m=l.count(i)
        if m==1:
            r[i]=a
            a+=1
        else:
            q=0
            for j in range(m):
                q+=a
                a+=1
            r[i]=q/m
            cf.append(m*(m**2-1)/12)
    return r
x=list(map(int, input().split(",")))
y=list(map(int, input().split(",")))
x_rank=find_rank(x)
y_rank=find_rank(y)
n=len(x)
d=[]
for i in range(n):
    d.append(x_rank[x[i]]-y_rank[y[i]])

d_2=[i*i for i in d]
if len(cf)!=0:
    sum_d_2=sum(d_2)+sum(cf)
else:
    sum_d_2=sum(d_2)
print(d)
print(d_2)
print(x_rank)
print(cf)
print(sum_d_2)
num=6*sum_d_2
den=n*(n**2 - 1)
print(num)
```

```
print(den)
rankcorelation=1 - num/den
print("Rank corelation is {:.5f}".format(rankcorelation))
```

Output 1:-

81,78,73,73,69,68,62,58
10,12,18,18,18,22,20,24
[-7, -5, -1.5, -1.5, 0.0, 4, 4, 7]
[49, 25, 2.25, 2.25, 0.0, 16, 16, 49]
{81: 1, 78: 2, 73: 3.5, 69: 5, 68: 6, 62: 7, 58: 8}
[0.5, 2.0]
162.0
972.0
504
Rank corelation is -0.92857

Output 2:-

68,64,75,50,64,80,75,40,55,64
62,58,68,45,81,60,68,48,50,70
[-1, -1.0, -1.0, -1, 5.0, -5, -1.0, 1, 0, 4.0]
[1, 1.0, 1.0, 1, 25.0, 25, 1.0, 1, 0, 16.0]
{80: 1, 75: 2.5, 68: 4, 64: 6.0, 55: 8, 50: 9, 40: 10}
[0.5, 2.0, 0.5]
75.0
450.0
990
Rank corelation is 0.54545

5. Aim:- Write a python program to classify the data based on one-way Anova.

Source code:-

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
%matplotlib inline
import scipy.stats as s
print("ANOVA ONE WAY CLASSIFICATION")
deg=float(input("Enter the degrees of freedom:"))
tn=int(input("Enter the no.of Treatments: "))
f_list=[]
d=[]
for i in range(tn):
  l=[float(j) for j in input().split()]
  d.append(len(l))
  f_list.append(l)
#print(f_list)
ti=[]
for i in f_list:
  ti.append(sum(i))
#print(ti)
ti_sum=sum(ti)
#print(ti_sum)
ti2_ni=[]
for i in range(len(ti)):
  ti2_ni.append((ti[i]**2)/d[i])
#print(ti2_ni)
#print(sum(ti2_ni))
rss=0.0
for i in f_list:
  for j in range(len(i)):
    rss+=(i[j]**2)
cf=(ti_sum**2)/sum(d)
sst=rss-cf
sstr=sum(ti2_ni)-cf
sse=sst-sstr
print("The row sum of squares: ",rss)
print("The correction factor:",cf)
print("sum of squares due to total:",sst)
print("sum of squares due to treatments:",sstr)
print("sum of squares due to error:",sse)
#print("sst:{},sstr:{},sse:{}".format(sst,sstr,sse));
#Constructing a dataframe
df=pd.DataFrame()
df["source of variation"]=["treatments","errors","total"]
df["sum of squares"]=[sstr,sse,sst]
```

```
x=(tn-1)
y=sum(d)-tn
z=sum(d)-1
df["Degrees of freedom"]=[x,y,z]
x1=sstr/x
y1=sse/y
df["Mean sum of Squares"]=[x1,y1,"*"]
f=x1/y1
df["Variance ratio"]=["*",f,"*"]
print(df)
if f<1:
  f=1/f
  tv=s.f.ppf(1-deg,y,x)
else:
  tv=s.f.ppf(1-deg,x,y)
print("f is :",f)
print("The table value is:",tv)
#Inference or decision
if f>=tv:
  print("Reject the Null Hypothesis")
else:
  print("Accept the NUll Hypothesis")
```

Output 1:-

```
ANOVA ONE WAY CLASSIFICATION
Enter the degrees of freedom:0.05
Enter the no.of Treatments: 3
13 10 8 11 8
13 11 14 14
4 1 3 4 2 4
The row sum of squares:  1262.0
The correction factor: 960.0
sum of squares due to total: 302.0
sum of squares due to treatments: 270.0
sum of squares due to error: 32.0
  source of variation  sum of squares  Degrees of freedom Mean sum of Squares  \
0          treatments           270.0                   2               135.0
1              errors            32.0                  12            2.666667
2               total           302.0                  14                   *

  Variance ratio
0              *
1         50.625
2              *
f is : 50.625
The table value is: 3.8852938346523933
Reject the Null Hypothesis
```

Output 2:-

```
ANOVA ONE WAY CLASSIFICATION
Enter the degrees of freedom:0.05
Enter the no.of Treatments: 3
90 82 79 98 83 91
105 89 93 104 89 95 86
83 89 80 94
The row sum of squares:  138638.0
The correction factor: 137700.0
sum of squares due to total: 938.0
sum of squares due to treatments: 234.4523809523671
sum of squares due to error: 703.5476190476329
  source of variation  sum of squares  Degrees of freedom Mean sum of Squares  \
0          treatments      234.452381                   2           117.22619
1              errors      703.547619                  14           50.253401
2               total      938.000000                  16                   *

  Variance ratio
0              *
1       2.332702
2              *
f is : 2.3327016142676427
The table value is: 3.738891832440735
Accept the NUll Hypothesis
```

6. Aim:- Write a python program to classify the data based on two-way Anova.

Source code:-

```
import scipy.stats as stats
print("Enter level of significance")
alpha=float(input())
print("Enter number of treatments")
t=int(input())
print("Enter number of blocks")
b=int(input())
l=[]
ti=[]
ti2ni=[]
for i in range(t):
    p=list(map(int,input().split()))
    ti.append(sum(p))
    ti2ni.append(sum(p)**2)
    l.append(p)
sti2=sum(ti2ni)
blocks=[]
squared_blocks=[]
for i in range(b):
  s=0
  for k in range(t):
    s+=l[k][i]
  blocks.append(s)
  squared_blocks.append(s**2)
G=sum(blocks)
sbi2=sum(squared_blocks)
m=[]
for i in l:
  m.extend(i)
rss=0
for i in m:
  rss+=i**2
cf=(G**2) / len(m)
st2=rss-cf
str2=(sti2/b) - cf
sb2=(sbi2/t) - cf
se2=st2 - str2 - sb2
dft=t-1
dfb=b-1
dfe=dft*dfb
mst2=str2/dft
msb2=sb2/dfb
mse2=se2/dfe
ftr=mst2/mse2
```

```
fb=msb2/mse2
print("rss : {} ,cf : {} ,st2 : {} ,str2 : {} ,sb2 : {} ,se2 :
 {} ,ftr : {} ,fb : {}".format(rss,cf,st2,str2,sb2,se2,ftr,fb)
)
if ftr<1.0:
  ftr=(1.0/ftr)
  t_ftr=stats.f.ppf(1-alpha,dfe,dft)
  print("table value for treatments")
  print(t_ftr)
  if ftr>t_ftr:
    print("we reject treatments")
  else:
    print("we accept treatments")
else:
  t_ftr=stats.f.ppf(1-alpha,dft,dfe)
  print("table value for treatments")
  print(t_ftr)
  if ftr>t_ftr:
    print("we reject treatments")
  else:
    print("we accept treatments")
if fb<1.0:
  fb=(1.0/fb)
  t_fb=stats.f.ppf(1-alpha,dfe,dfb)
  print("Table value for blocks")
  print(t_fb)
  if fb>t_fb:
    print("we reject blocks")
  else:
    print("we accept blocks")
else:
  print("Table value for blocks")
  t_fb=stats.f.ppf(1-alpha,dfb,dfe)
  print(t_fb)
  if fb>t_fb:
    print("we reject blocks")
  else:
    print("we accept blocks")
```

Output 1:-

Enter level of significance
0.05
Enter number of treatments
3
Enter number of blocks
4
13 7 9 3
6 6 3 1
11 5 15 5
rss : 786 ,cf : 588.0 ,st2 : 198.0 ,str2 : 56.0 ,sb2 : 90.0 ,se2 : 52.0 ,ftr : 3.230769230769231 ,fb : 3.4615384615384617
table value for treatments
5.143252849784718
we accept treatments
Table value for blocks
4.757062663089414
we accept blocks

Output 2:-

Enter level of significance
0.01
Enter number of treatments
4
Enter number of blocks
3
45 43 51
47 46 52
48 50 55
42 37 49
rss : 26867 ,cf : 26602.083333333332 ,st2 : 264.9166666666679 ,str2 : 110.91666666666788 ,sb2 : 135.16666666666788 ,se2 : 18.83333333333212 ,ftr : 11.77876106194779 ,fb : 21.530973451329015
table value for treatments
9.779538240923273
we reject treatments
Table value for blocks
10.92476650083833
we reject blocks

7. Aim:- Write a python program to fit a multiple regression model for any given data.

Source code:-

```
import scipy.stats as stats
def transportMatrix(a):
  res = [[a[j][i] for j in range(len(a))] for i in range(len(a[0]))]
  return res
import numpy as np
no_ind=int(input("Enter no of independent variables"))
indep=[]
for i in range(no_ind):
  print(f"Enter the values for independent variable {i+1}")
  li=[float(x) for x in input().split()]
  indep.append(li)
print("Enter the values of output")
y=[float(x) for x in input().split()]
alpha=float(input("Enter level of significance"))
x_trans=[]
x_trans.append(np.ones(len(indep[0])))
for i in range(len(indep)):
  x_trans.append(indep[i])
s1=np.dot(x_trans,transportMatrix(x_trans))
s2=np.linalg.inv(s1)
s3=np.dot(x_trans,y)
s4=np.dot(s2,s3)
s4=s4.round(4)
y_equ=[x.round(4) for x in s4]
y_equ=str(s4[0])
for i in range(1,no_ind+1):
    y_equ+='+'+str(s4[i])+'x'+str(i)
print()
print(f"The required multi linear regression is y={y_equ}")
print()

y_fit=[float(0) for i in range(len(indep[0]))]
for i in range(len(indep[0])):
    y_fit[i]=s4[0]
    k=0
    for j in range(1,no_ind+1):
        y_fit[i]+=s4[j]*indep[k][i]
        k+=1
y_fit=[x.round(4) for x in y_fit]
print("Fitted values are")
print(y_fit)
print()
sse=0
```

```
for i in range(len(y_fit)):
    sse+=(y[i]-(y_fit[i]))**2
sse=sse.round(4)
print(f"The sum of squares due to error is {sse}")
y_mean=np.mean(y).round(4)
sst=0
for i in range(len(y_fit)):
    sst+=(y[i]-y_mean)**2
sst=sst.round(4)
print(f"The sum of squares due to total is {sst}")
ssr=sst-sse
print(f"The sum of squares due to total is {ssr}")
print()
r_square=(ssr/sst).round(4)
print(f"The R^2 value is {r_square}")
print()
print("By using R^2 test")
if(r_square>=0.90):
    print("We accept the model")
else:
    print("We reject the model")
print()
m_ssr=(ssr/no_ind).round(4)
m_sse=(sse/(len(y_fit)-no_ind-1))
f_cal=(m_ssr/m_sse).round(4)
dfe=len(y_fit)-no_ind-1
print(f"The calucalted value of F is {f_cal}")
f_tab=stats.f.ppf(1-alpha,no_ind,dfe).round(4)
print(f"The table value of F is {f_tab}")
print()
print("By using ANOVA test")
if(f_cal>f_tab):
    print("We accept the model")
else:
    print("We reject the model")
print()
param_value=[]
for i in range(no_ind+1):
    temp=(s4[i]/((m_sse*s2[i][i])**0.5)).round(4)
    param_value.append(temp)
print("t values parameters are :")
print(param_value)
t_table=stats.t.ppf(1-alpha/2,len(y_fit)-no_ind-1)
print(f"The table value of t : {t_table}")
i=0
for a in param_value:
    if(abs(a))>t_table:
        print("Beta"+str(i)+" is contributing to the model")
```

```
    else:
        print("Beta"+str(i)+" is not contributing to the model
")
    i+=1
```

Output 1:-

Enter no of independent variables2
Enter the values for independent variable 1
9 8 7 14 12 10 7 4 6 5 7 6
Enter the values for independent variable 2
62 58 64 60 63 57 55 56 59 61 57 60
Enter the values of output
100 110 105 94 95 99 104 108 105 98 105 110
Enter level of significance.05

The required multi linear regression is y=133.4605+-1.2485x1+-0.351x2

Fitted values are
[100.462, 103.1145, 102.257, 94.9215, 96.3655, 100.9685, 105.416, 108.8105, 105.2605, 105.807, 104.714, 104.9095]

The sum of squares due to error is 151.4104
The sum of squares due to total is 330.25
The sum of squares due to total is 178.8396

The R^2 value is 0.5415

By using R^2 test
We reject the model

The calucalted value of F is 5.3152
The table value of F is 4.2565

By using ANOVA test
We accept the model

t values parameters are :
[5.0882, -2.8079, -0.7711]
The table value of t : 2.2621571627409915
Beta0 is contributing to the model
Beta1 is contributing to the model
Beta2 is not contributing to the model

Output 2:-

Enter no of independent variables2
Enter the values for independent variable 1
-5 -4 -1 2 2 3 3
Enter the values for independent variable 2
5 4 1 -3 -2 -2 -3
Enter the values of output
11 11 8 2 5 5 4
Enter level of significance0.05

The required multi linear regression is y=6.5714+1.0x1+2.0x2

Fitted values are
[11.5714, 10.5714, 7.5714, 2.5714, 4.5714, 5.5714, 3.5714]

The sum of squares due to error is 1.7143
The sum of squares due to total is 73.7143
The sum of squares due to total is 72.0

The R^2 value is 0.9767

By using R^2 test
We accept the model

The calucalted value of F is 83.9993
The table value of F is 6.9443

By using ANOVA test
We accept the model

t values parameters are :
[26.5579, 2.1523, 4.3046]
The table value of t : 2.7764451051977987
Beta0 is contributing to the model
Beta1 is not contributing to the model
Beta2 is contributing to the model

8. Aim:- Write a python program to fit a multivariate regression model for any given data.

<u>Source code</u>:-

```
import numpy as np
q=int(input('Enter no. of dependent variables:'))
yt=[]
for i in range(q):
  print('Enter y'+str(i+1),'data')
  yt.append([float(j) for j in input().split()])

n=len(yt[0])
p=int(input('Enter no. of independent variables:'))
xt=[]
xt.append([1]*n)
for i in range(p):
  print('Enter x'+str(i+1),'data')
  xt.append([float(j) for j in input().split()])

p=p+1
g=float(input('Enter level of  significance: '))

def transpose(m):
    return [[m[j][i] for j in range(len(m))] for i in range(le
n(m[0]))]

def getMinor(m,i,j):
  return [p[:j]+p[j+1:] for p in m[:i]+m[i+1:]]

def getDeterminant(a):
  if len(a)==1:
    return a[0][0]
  if len(a)==2:
    return a[0][0]*a[1][1]-a[0][1]*a[1][0]
  det=0
  for c in range(len(a)):
    det+=(-1)**c*a[0][c]*getDeterminant(getMinor(a,0,c))
  return det

def coFactor(m):
  return [[(-
1)**(i+j)*getDeterminant(getMinor(m,i,j))for j in range(len(m)
)] for i in range(len(m))]

def Inverse(m):
  det=getDeterminant(m)
  if det==0: print('det=0,Inverse not posssible');exit()
```

```
  adj=transpose(coFactor(m))
  return [[adj[i][j]/det for j in range(len(adj[0]))] for i in range(len(adj))]

def Multiply(a,b):
    r1,c1,r2,c2=len(a),len(a[0]),len(b),len(b[0])
    if c1!=r2: print('Multiplication not possible');exit()
    mm=[]
    for i in range(0,r1):
        c=[]
        for j in range(0,c2):
            p=0
            for k in range(0,c1):
                p=p+(a[i][k]*b[k][j])
            c.append(p)
        mm.append(c)
    return mm

x=transpose(xt)
y=transpose(yt)
xtxi=Inverse(Multiply(xt,x))
xty=Multiply(xt,y)
b=Multiply(xtxi,xty)

yt=np.array(yt)
xt=np.array(xt)

for i in range(q):
  print('\nFOR THE EQUATION y'+str(i+1),':')
  ye='y'+str(i+1)+' = '
  ye=ye+str('%.3f'%b[0][i])+' + '
  y1=np.array(b[0][i]*xt[0])
  f=0
  for j in range(1,p):
      ye=ye+str('(%.3f)'%b[j][i])+'x'+str(j);y1=y1+(b[j][i]*xt[j])
      if j!=p-1:ye=ye+' + '

  print('Model fit equation is ',ye)
  sse=np.sum((yt[i]-y1)**2)
  sst=np.sum((yt[i]-np.mean(yt[i]))**2)
  ssr=sst-sse
  print('\nUsing Coefficient of Determination Method: ')
  r2=ssr/sst
  print('R^2 = %.5f'%(r2))
  if(r2>0.90):print('Model fits good (R^2>0.90)')
  else:print('Model does not fit good (R^2<=0.90)')
  print('\nUSing ANOVA Test:')
```

```
mssr=ssr/(p-1)
msse=sse/(n-p)
f=mssr/msse
import scipy.stats as s
if f>=1: ft=s.f.ppf(1-g,p-1,n-p)
else: f=1/f;ft=s.f.ppf(1-g,n-p,p-1)
print('Calculated value of f is %.5f'%(f))
print('Table value of f is %.5f'%(ft))
if f>ft: print('Model fits good')
else: print('Model does not fit good')

print('\nTest of Individual Parameters:')
cjj=[xtxi[j][j] for j in range(len(xtxi))]
tt=s.t.ppf(1-g/2,n-p)
print('Table value of t is %.5f'%(tt))
for j in range(p):
    e=np.sqrt(msse*cjj[j])
    t=b[j][i]/e
    q='b['+str(j)+']'
    print('t(cal) for',q,'is %.5f'%(t))
    if abs(t)>tt: print(q,'is contributing to the model')
    else: print(q,'is not contributing to the model')
```

Output 1:-

Enter no. of dependent variables:2
Enter y1 data
10 12 11 9 9 10 11 12 11 10 11 12
Enter y2 data
100 110 105 94 95 99 104 108 105 98 103 110
Enter no. of independent variables:3
Enter x1 data
9 8 7 14 12 10 7 4 6 5 7 6
Enter x2 data
62 58 64 60 63 57 55 56 59 61 57 60
Enter x3 data
1 1.3 1.2 0.8 0.8 0.9 1 1.2 1.1 1.0 1.2 1.2
Enter level of significance: 0.05

FOR THE EQUATION y1 :
Model fit equation is y1 = 10.897 + (-0.045)x1 + (-0.088)x2 + (5.035)x3

Using Coefficient of Determination Method:
R^2 = 0.92380
Model fits good (R^2>0.90)

USing ANOVA Test:
Calculated value of f is 32.32738
Table value of f is 4.06618

Model fits good

Test of Individual Parameters:
Table value of t is 2.30600
t(cal) for b[0] is 4.23735
b[0] is contributing to the model
t(cal) for b[1] is -0.82835
b[1] is not contributing to the model
t(cal) for b[2] is -2.27524
b[2] is not contributing to the model
t(cal) for b[3] is 5.46181
b[3] is contributing to the model

FOR THE EQUATION y2 :
Model fit equation is y2 = 91.097 + (-0.064)x1 + (-0.294)x2 + (27.835)x3

Using Coefficient of Determination Method:
R^2 = 0.86551
Model does not fit good (R^2<=0.90)

USing ANOVA Test:
Calculated value of f is 17.16130
Table value of f is 4.06618
Model fits good

Test of Individual Parameters:
Table value of t is 2.30600
t(cal) for b[0] is 5.26478
b[0] is contributing to the model
t(cal) for b[1] is -0.17534
b[1] is not contributing to the model
t(cal) for b[2] is -1.13500
b[2] is not contributing to the model
t(cal) for b[3] is 4.48725
b[3] is contributing to the model

9. Aim:- Write a python program to classify the treatments based on MANOVA Test.

Source code:-

```
import numpy as np
import scipy.stats as s

k = int(input("Enter no.of treatments : "))
p = int(input("Enter no.of observations in each subgroup : "))
T = []
n = []
alp = float(input('Enter level of significance : '))
for i in range(k):
    n.append(int(input("Enter no.of sub groups in treatment :"
)))
    t = []
    for j in range(n[i]):
        a = list(map(int, input("Enter rowwise: ").split()))
        a = np.matrix(a).reshape(p,1)
        t.append(a)
    T.append(t)
print()
for i in range(k):
    print()
    print("Treatment ",i+1)
    print(T[i])
print()
yi_ = []
y__ = 0
for i in range(k):
    yi_.append(sum(T[i])/n[i])
    y__ += sum(T[i])

y__ = y__/sum(n)
print("yi_ = ",yi_)
print()
print("y__ = ",y__)
print()

# For y1
ssey1 = 0
ssty1 = 0
for i in range(k):
    for j in range(n[i]):
        ssey1 = ssey1 + (float(T[i][j][0])-
float(yi_[i][0]))**2
        ssty1 = ssty1 + (float(T[i][j][0])-float(y__[0]))**2
```

```
ssry1 = ssty1-ssey1
print("ssey1 = ",ssey1)
print("ssty1 = ",ssty1)
print("ssrt1 = ",ssry1)
print()

# For y2
ssey2 = 0
ssty2 = 0
for i in range(k):
    for j in range(n[i]):
        ssey2 = ssey2 + (float(T[i][j][1])-
float(yi_[i][1]))**2
        ssty2 = ssty2 + (float(T[i][j][1])-float(y__[1]))**2

ssry2 = ssty2-ssey2
print("ssey2 = ",ssey2)
print("ssty2 = ",ssty2)
print("ssry2 = ",ssry2)
print()

# For y1 and y2
ssey12 = 0
ssty12 = 0
for i in range(k):
    for j in range(n[i]):
        ssey12 = ssey12 + float((T[i][j][0]*T[i][j][1]) -
 (yi_[i][0]*yi_[i][1]))
        ssty12 = ssty12 + float((T[i][j][0]*T[i][j][1]) -
 (y__[0]*y__[1]))

ssry12 = ssty12-ssey12
print("ssey12 = ",ssey12)
print("ssty12 = ",ssty12)
print("ssry12 = ",ssry12)
print()

B = np.matrix([[ssry1, ssry12],[ssry12, ssry2]])
W = np.matrix([[ssey1, ssey12],[ssey12, ssey2]])
T = np.matrix([[ssty1, ssty12],[ssty12, ssty2]])
print("B = ",B)
print()
print("W = ",W)
print()
print("T = ",T)
print()

def determinent(matrix):
```

```
    no_rows=len(matrix)
    for row in matrix:
        if len(row)!=no_rows:
            print("not a square matrix")
            return None
    if len(matrix)==2:
        simple_det=(matrix[0][0]*matrix[1][1])-
(matrix[1][0]*matrix[0][1])
        return simple_det
    else:
        #cofactor expression
        answer=0
        no_columns=no_rows
        for j in range(no_columns):
            cofactor=((-
1) ** (0+j) * matrix[0][j]) * (determinent(smallermatrix(matri
x,0,j)))
            answer+=cofactor
        return answer

det_w = determinent(np.array(W))
det_t = determinent(np.array(T))
LAMBDA = float(det_w/det_t)
print("LAMBDA*=",LAMBDA)

F = ((sum(n)-k-1)/(k-1))*((1-(LAMBDA)**.5)/(LAMBDA**.5))
alp = .05
cou = 0
if F<1:
    cou=1
    F=1/F
print("F cal=",F)
if cou==1:
    Ft=s.f.ppf(1-alp,p*(sum(n)-k-1),p*(k-1))
else:
    Ft=s.f.ppf(1-alp,p*(k-1),p*(sum(n)-k-1))
print("F t.v=",Ft)
if F>Ft:
    print("We reject Ho")
    print("There is no homoginity among the table")
    print("We reject the model")
else:
    print("We accept Ho")
    print("There is homoginity among the table")
    print("We accept the model")
```

Output 1:-

```
Enter no.of treatments : 3
Enter no.of observations in each subgroup : 2
Enter level of significance : 0.05
Enter no.of sub groups in treatment :4
Enter rowwise: 2 3
Enter rowwise: 3 4
Enter rowwise: 5 4
Enter rowwise: 2 5
Enter no.of sub groups in treatment :3
Enter rowwise: 4 8
Enter rowwise: 5 6
Enter rowwise: 6 7
Enter no.of sub groups in treatment :5
Enter rowwise: 7 6
Enter rowwise: 8 7
Enter rowwise: 10 8
Enter rowwise: 9 5
Enter rowwise: 7 6


Treatment  1
[matrix([[2],
        [3]]), matrix([[3],
        [4]]), matrix([[5],
        [4]]), matrix([[2],
        [5]])]

Treatment  2
[matrix([[4],
        [8]]), matrix([[5],
        [6]]), matrix([[6],
        [7]])]

Treatment  3
[matrix([[7],
        [6]]), matrix([[8],
        [7]]), matrix([[10],
        [ 8]]), matrix([[9],
        [5]]), matrix([[7],
        [6]])]

yi_ =  [matrix([[3.],
        [4.]]), matrix([[5.],
        [7.]]), matrix([[8.2],
        [6.4]])]

y__ =  [[5.66666667]
 [5.75      ]]
```

```
ssey1 =  14.799999999999997
ssty1 =  76.66666666666667
ssrt1 =  61.866666666666674

ssey2 =  9.2
ssty2 =  28.25
ssry2 =  19.05

ssey12 =  1.6000000000000156
ssty12 =  25.999999999999943
ssry12 =  24.399999999999928

B =  [[61.86666667 24.4       ]
 [24.4        19.05      ]]

W =  [[14.8  1.6]
 [ 1.6  9.2]]

T =  [[76.66666667 26.        ]
 [26.         28.25      ]]

LAMBDA*= 0.08967446023045059
F cal= 9.357513005519227
F t.v= 3.0069172799243438
We reject Ho
There is no homoginity among the table
We reject the model
```

Output 2:-

```
Enter no.of treatments : 3
Enter no.of observations in each subgroup : 2
Enter level of significance : 0.05
Enter no.of sub groups in treatment :3
Enter rowwise: 9 3
Enter rowwise: 6 2
Enter rowwise: 9 7
Enter no.of sub groups in treatment :2
Enter rowwise: 0 4
Enter rowwise: 2 0
Enter no.of sub groups in treatment :3
Enter rowwise: 3 8
Enter rowwise: 1 9
Enter rowwise: 2 7


Treatment  1
[matrix([[9],
        [3]]), matrix([[6],
        [2]]), matrix([[9],
```

```
        [7]])]

Treatment  2
[matrix([[0],
        [4]]), matrix([[2],
        [0]])]

Treatment  3
[matrix([[3],
        [8]]), matrix([[1],
        [9]]), matrix([[2],
        [7]])]

yi_ =  [matrix([[8.],
        [4.]]), matrix([[1.],
        [2.]]), matrix([[2.],
        [8.]])]

y__ =  [[4.]
 [5.]]

ssey1 =  10.0
ssty1 =  88.0
ssrt1 =  78.0

ssey2 =  24.0
ssty2 =  72.0
ssry2 =  48.0

ssey12 =  1.0
ssty12 =  -11.0
ssry12 =  -12.0

B =  [[ 78. -12.]
 [-12.  48.]]

W =  [[10.  1.]
 [ 1. 24.]]

T =  [[ 88. -11.]
 [-11.  72.]]

LAMBDA*= 0.03845534995977474
F cal= 8.198859563778374
F t.v= 3.837853354555897
We reject Ho
There is no homoginity among the table
We reject the model
```

10. Aim:- Write a python program to classify the given observations using Linear Discriminant Analysis.

Source code:-

```
import numpy as np
import math
#l1=[2.95,2.53,3.57,3.16,2.58,2.16,3.27]
#l2=[6.63,7.79,5.65,5.47,4.46,6.22,3.52]
k=[[2.81,5.46]]
l1=[1300,1260,1220,1180,1060,1140,1100,1020,980,940]
l2=[2.7,3.7,2.9,2.5,3.9,2.1,3.5,3.3,2.3,3.1]
x=[]
for i in range(len(l1)):
  x.append([l1[i],l2[i]])
print("x=",x)
x1=[]
x2=[]
#y=[1,1,1,1,0,0,0]
y=[1,1,1,1,1,0,0,0,0,0]
for i in range(len(y)):
  if(y[i]==y[0]):
    x1.append([l1[i],l2[i]])
  else:
    x2.append([l1[i],l2[i]])
print("x1=",x1)
print("x2=",x2)
mu=[]
sum1=0
sum2=0
for i in range(len(l1)):
  sum1=sum1+l1[i]
  sum2=sum2+l2[i]
mu.append([(sum1/len(l1)),(sum2/len(l2))])
print("Mean of x=",mu)
mu1=[]
sum3=0
sum4=0
for i in range(len(x1)):
  sum3=sum3+x1[i][0]
  sum4=sum4+x1[i][1]
mu1.append([(sum3/len(x1)),(sum4/len(x1))])
print("Mean of x1=",mu1)
mu2=[]
sum5=0
sum6=0
for i in range(len(x2)):
  sum5=sum5+x2[i][0]
  sum6=sum6+x2[i][1]
```

```
mu2.append([(sum5/len(x2)),(sum6/len(x2))])
print("Mean of x2=",mu2)
def transpose(x):
    xt=[[0 for i in range(len(x))] for j in range(len(x[0]))]
    for i in range(len(x)):
        for j in range(len(x[0])):
             xt[j][i]=x[i][j]
    return xt
def mul(x,y):
    res =  [[0 for i in range(len(y[0]))] for j in range(len(x
))]
    for i in range(len(x)):
        for j in range(len(y[0])):
            for k in range(len(y)):
                res[i][j]+=x[i][k]*y[k][j]
    return res
a=[]
for i in range(len(x)):
  a.append([x[i][0]-mu[0][0],x[i][1]-mu[0][1]])
print("x-mu=",a)
for i in range(len(a)):
  c=mul(transpose(a),a)
for i in range(len(c)):
  for j in range(len(a[0])):
    c[i][j]=c[i][j]/len(a)
print("c=",c)
cin=np.linalg.inv(c)
print("c inverse=",cin)
f1=0
f2=0
f1=mul(mul(mu1,cin),transpose(k))[0][0]-
((mul(mul(mu1,cin),transpose(mu1))[0][0])*0.5)+math.log(len(x1
)/len(x))
print("F1=",f1)
f2=mul(mul(mu2,cin),transpose(k))[0][0]-
((mul(mul(mu2,cin),transpose(mu2))[0][0])*0.5)+math.log(len(x2
)/len(x))
print("F2=",f2)

if(f1>f2):
  print('The new observation is kept into first category i.e,p
assed category')
else:
  print('The new observation is kept into second category')
```

Output 1:-

x= [[2.95, 6.63], [2.53, 7.79], [3.57, 5.65], [3.16, 5.47], [2.58, 4.46], [2.16, 6.22], [3.27, 3.52]]
x1= [[2.95, 6.63], [2.53, 7.79], [3.57, 5.65], [3.16, 5.47]]
x2= [[2.58, 4.46], [2.16, 6.22], [3.27, 3.52]]

Mean of x= [[2.888571428571429, 5.677142857142857]]
Mean of x1= [[3.0525, 6.385]]
Mean of x2= [[2.67, 4.733333333333333]]
x-mu= [[0.06142857142857139, 0.9528571428571428], [-0.358571428571429, 2.112857142857143], [0.681428571428571, -0.02714285714285669], [0.27142857142857135, -0.2071428571428573], [-0.3085714285714287, -1.217142857142857], [-0.7285714285714286, 0.5428571428571427], [0.38142857142857123, -2.157142857142857]]

c= [[0.2059836734693877, -0.23093265306122449], [-0.23093265306122449, 1.6921632653061225]]
c inverse= [[5.73171449 0.78221769]
 [0.78221769 0.69771022]]
F1= 43.82818099216788
F2= 43.86302017821443
The new observation is kept into second category

Output 2:-

x= [[1300, 2.7], [1260, 3.7], [1220, 2.9], [1180, 2.5], [1060, 3.9], [1140, 2.1], [1100, 3.5], [1020, 3.3], [980, 2.3], [940, 3.1]]
x1= [[1300, 2.7], [1260, 3.7], [1220, 2.9], [1180, 2.5], [1060, 3.9]]
x2= [[1140, 2.1], [1100, 3.5], [1020, 3.3], [980, 2.3], [940, 3.1]]

Mean of x= [[1120.0, 3.0000000000000004]]
Mean of x1= [[1204.0, 3.14]]
Mean of x2= [[1036.0, 2.86]]
x-mu= [[180.0, -0.30000000000000027], [140.0, 0.6999999999999997], [100.0, -0.10000000000000053], [60.0, -0.5000000000000004], [-60.0, 0.8999999999999995], [20.0, -0.9000000000000004], [-20.0, 0.49999999999999956], [-100.0, 0.2999999999999994], [-140.0, -0.7000000000000006], [-180.0, 0.09999999999999964]]

c= [[13200.0, -2.799999999999991], [-2.799999999999991, 0.32999999999999996]]
c inverse= [[7.58941713e-05 6.43950545e-04]
 [6.43950545e-04 3.03576685e+00]]
F1= -16.559987701607927
F2= -4.471300403992386
The new observation is kept into second category

11. Aim:- Write a python program to find Principle components for the given variables.

Source code:-

```
import numpy as np
import pandas as pd
import scipy.stats as st
import copy
xn=int(input('Enter number of components='))
x=[]
n=int(input("Enter no of observations="))
for i in range(xn):
    l=list(map(float,input().split()))
    x.append(l)
x_copy=np.transpose(x)
print("x=",x_copy)
def mu_cal(x):
  n=len(x)
  l=len(x[0])
  mu=[]
  for i in range(l):
    s=0
    for j in range(n):
      s+=x[j][i]
    s=s/n
    mu.append(s)
  return mu
mu_x=(mu_cal(x_copy))
print("Mean of x=",mu_x)
xsubm=np.subtract(x_copy,mu_x)
print("\nx-mu=",xsubm)
#calculating pooled variance c_inverse
pooled_matrix=(np.dot(np.transpose(xsubm),xsubm))/n
print("pooled matrix=",pooled_matrix)

# pooled_matrix_inv=np.linalg.inv(pooled_matrix)
# print("pooled matrix inverse is:",pooled_matrix_inv)
eig_value,eig_vector=np.linalg.eig(pooled_matrix)
eig_value=np.sort(eig_value)[::-1]
print("Eigen values=",eig_value)
df=pd.DataFrame()
df['pricipal components']=[i+1 for i in range(len(eig_value))]
df['variance explained']=[i for i in eig_value]
sum=0
```

```
tot_sum=np.sum(eig_value)
l=[]
for i in eig_value:
  sum+=i
  l.append((sum/tot_sum)*100)
df['cumulative tot var']=l
print(df)
thres_value=float(input("Enter The Threshold Value For Princip
al Component Analysis="))
l=0
#del df['cumulative tot var']
for i in df['cumulative tot var']:
  if i>=thres_value:
    break
  else:
    l+=1
df=df.loc[0:l]
print(df)
eig_values=list(df['variance explained'])
print("Eigen values taken for to retain the principal componen
ts[based on the thershold is fixed]=",eig_values)
co_related_coeff=[]
for m in eig_values:
  l=copy.copy(pooled_matrix)
  for i in range(len(l)):
    for j in range(len(l[0])):
      if i==j:
        l[i][j]-=m
  co_related_coeff.append(l)
co_related_coeff
def normalization(x):
  if len(x)==2:
    total=(x[0][0])**2+(x[0][1])**2
    total=total**0.5
   # print(total)
   # l=[]
    l=[-x[0][1]/total,x[0][0]/total]
   # l=list(-x[0][1]/total,x[0][0]/total)
    return l
  else:
    l=[]
    copy1=list(copy.copy(x[0]))
    copy2=list(copy.copy(x[1]))
    copy1.append(x[0][0])
```

```
    copy1.append(x[0][1])
    copy2.append(x[1][0])
    copy2.append(x[1][1])
    for i in range(1,len(copy1)-1):
      l.append(copy1[i]*copy2[i+1]-copy1[i+1]*copy2[i])
    sum=0
    for i in range(len(l)):
      sum+=l[i]**2
    sum=(sum**0.5)**-1
    l=[i*sum for i in l]
    return l
z=[normalization(i) for i in co_related_coeff]
print("The eigen vectors of z1 and z2 are:",z)
print("The Principal component equation are:")
for i in range(len(z)):
  print("\nZ",i+1,"=",end='')
  for j in range(len(z[0])):
    if j==len(z[0])-1:
      print(z[i][j],'X',j+1)
    else:
      print(z[i][j],"X",j+1,"+",end='')
corelated_data=[]
for i in z:
  l=[]
  for j in range(len(x_copy)):
    sum=0
    for k in range(len(x_copy[j])):
      sum+=x_copy[j][k]*i[k]
    l.append(sum)
  corelated_data.append(l)
corelated_data

corelated_data_df=pd.DataFrame()
for i in range(len(corelated_data)):
  corelated_data_df[f'Z{i+1}']=corelated_data[i]
corelated_data_df
```

Output 1:-

Enter number of components=2
Enter no of observations=4
2 1 0 -1
4 3 1 0.5
x= [[2.   4.]

```
 [ 1.   3. ]
 [ 0.   1. ]
 [-1.   0.5]]
Mean of x= [0.5, 2.125]

x-mu= [[ 1.5    1.875]
 [ 0.5    0.875]
 [-0.5   -1.125]
 [-1.5   -1.625]]
pooled matrix= [[1.25     1.5625  ]
 [1.5625   2.046875]]
Eigen values= [3.26093826 0.03593674]
   pricipal components  variance explained  cumulative tot var
0                    1            3.260938           98.909976
1                    2            0.035937          100.000000

Enter The Threshold Value For Principal Component Analysis=99
   pricipal components  variance explained  cumulative tot var
0                    1            3.260938           98.909976
1                    2            0.035937          100.000000

Eigen values taken for to retain the principal components[based on the thershold is fixed]=
[3.2609382570250163, 0.03593674297498417]
The eigen vectors of z1 and z2 are: [[-0.6135581035026774, -0.789649576474399], [-
0.7896495764743992, 0.6135581035026774]]

The Principal component equation are:

Z 1 =-0.6135581035026774 X 1 +-0.789649576474399 X 2

Z 2 =-0.7896495764743992 X 1 +0.6135581035026774 X 2
```

	Z1	**Z2**
0	-4.385715	0.874933
1	-2.982507	1.051025
2	-0.789650	0.613558
3	0.218733	1.096429

Output 2:-

Enter number of components=3
Enter no of observations=5
90 90 60 60 30
60 90 60 60 30
90 30 60 90 30
x= [[90. 60. 90.]
 [90. 90. 30.]
 [60. 60. 60.]
 [60. 60. 90.]
 [30. 30. 30.]]
Mean of x= [66.0, 60.0, 60.0]

x-mu= [[24.   0. 30.]
 [24. 30. -30.]
 [-6.   0.   0.]
 [-6.   0. 30.]
 [-36. -30. -30.]]
pooled matrix= [[504. 360. 180.]
 [360. 360.   0.]
 [180.   0. 720.]]
Eigen values= [910.06995304 629.11038668 44.81966028]

	pricipal components	variance explained	cumulative tot var
0	1	910.069953	57.453911
1	2	629.110387	97.170476
2	3	44.819660	100.000000

Enter The Threshold Value For Principal Component Analysis=95

	pricipal components	variance explained	cumulative tot var
0	1	910.069953	57.453911
1	2	629.110387	97.170476

Eigen values taken for to retain the principal components[based on the thershold is fixed]= [910.0699530410365, 629.1103866763252]
The eigen vectors of z1 and z2 are: [[0.6558022549801461, 0.42919779654868706, 0.6210576895914801], [0.38599879538810006, 0.5163664177215531, -0.7644413990675454]]

The Principal component equation are:

Z 1 =0.6558022549801461 X 1 +0.42919779654868706 X 2 +0.6210576895914801 X 3

Z 2 =0.38599879538810006 X 1 +0.5163664177215531 X 2 +-0.7644413990675454 X 3

Z1 **Z2**

	Z1	Z2
0	140.669263	-3.077849
1	116.281735	58.279627
2	102.363464	8.275429
3	120.995195	-14.657813
4	51.181732	4.137714

12. Aim:- Write a python program to group the given variables using Factor Analysis.

Source code:-

```
import numpy as np
n=int(input("enter no of variables"))
x=[]
for i in range(n):
  p=[int(x) for x in input().split(" ")]
  x.append(p)
print(x)

mu=[]
for i in range(n):
  mu.append(np.mean(x[i],axis=0))
print(mu)
from math import sqrt
from statistics import mean
n1=len(x[0])
si=[]
x=np.array(x)
for i in range(n):
  k=sum((x[i]-mu[i])**2)
  si.append(round(sqrt(k/(n1-1)),4))
print(si)
a=[]
for i in range(n):
  a.append((x[i]-mu[i])/si[i])
print(a)
A=np.transpose(a)
#variance covariance matrix
VarCov=np.dot(np.transpose(A),A)/n1
print('\nVariance Covariance Matrix is :\n {}'.format(VarCov))

#calculating eigen values and vectors
eigenValues, eigenVectors = np.linalg.eig(VarCov)

idx = eigenValues.argsort()[::-1]
eigenValues = eigenValues[idx]
eigenVectors = eigenVectors[:,idx]

print('\nEigen Values are {}'.format(eigenValues))
print('\nEigen Vectors are {}'.format(eigenVectors))
```

```
#no of principal components to be retained
k=int(input("enter threshold limit :"))
s=sum(eigenValues)
t=[]
stoppoint=1
for i in range(len(eigenValues)):
    numerator=sum(eigenValues[0:i+1])
    z=(numerator/s)*100
    if z<=k:
        stoppoint=stoppoint+1
    t.append(z)
print('\nThreshold Table :\n{}'.format(t))


eigenValues=eigenValues[0:stoppoint]
eigenVectors=eigenVectors[:,0:stoppoint]

#retaining eigen values and vectors
print('\nRetained Eigen Values :\n{}'.format(eigenValues))
print('\nRetained Eigen Vectors: \n{}'.format(eigenVectors))
egv=np.transpose(eigenVectors)
f=[]

for i in range(len(egv)):
  o=[]
  for j in range(n):
    k=sqrt(eigenValues[i])*egv[i][j]
    o.append(k)
  f.append(o)
print(f)
h=[]
for i in range(len(f[0])):
  h.append(f[0][i]*2+f[1][i]*2)
print(h)
print(“Variance:”)
sumh=sum(h)
print(sumh)

pve=[]
for i in range(len(eigenValues)):
  pve.append((eigenValues[i]/sumh)*100)
print(pve)
```

Output 1:-

```
enter no of variables3
3 7 10 3 10
6 3 9 9 6
5 3 8 7 5
[[3, 7, 10, 3, 10], [6, 3, 9, 9, 6], [5, 3, 8, 7, 5]]
[6.6, 6.6, 5.6]
[3.5071, 2.51, 1.9494]
[array([-1.02648912,  0.11405435,  0.96946195, -1.02648912,  0.96946195]), array([-0.23904382, -1.43426295,  0.9561753 ,  0.9561753 , -0.23904382]), array([-0.30778701, -1.33374372,  1.23114805,  0.71816969, -0.30778701])]

Variance Covariance Matrix is :
 [[ 0.80001623 -0.04089598  0.06435815]
 [-0.04089598  0.7999873   0.78479557]
 [ 0.06435815  0.78479557  0.79996624]]

Eigen Values are [1.58512447 0.80666111 0.0081842 ]

Eigen Vectors are [[ 0.02122114 -0.99538368 -0.09360014]
 [ 0.70624057  0.0811911  -0.70330098]
 [ 0.70765382 -0.05117936  0.7047033 ]]
enter threshold limit :99

Threshold Table :
[66.04768471804098, 99.65898746868129, 100.0]

Retained Eigen Values :
[1.58512447 0.80666111]

Retained Eigen Vectors:
[[ 0.02122114 -0.99538368]
 [ 0.70624057  0.0811911 ]
 [ 0.70765382 -0.05117936]]
[[0.026717780654088277, 0.8891690658976457, 0.8909483734282817], [-0.8939970315309378, 0.07292122996398519, -0.04596639553844041]]
[-1.734558501753699, 1.9241805917232617, 1.6899639557796826]
Variance:
1.8795860457492453
[84.33370077691795, 42.916955545008435]
```