

```
In [50]: import numpy as np
import pandas as pd
from numpy import *
```

```
In [54]: #Câu 1:
```

```
data = np.loadtxt("bostonh.dat")
print(data)
```

```
[[6.3200e-03 1.8000e+01 2.3100e+00 ... 3.9690e+02 4.9800e+00 2.4000e+01]
 [2.7310e-02 0.0000e+00 7.0700e+00 ... 3.9690e+02 9.1400e+00 2.1600e+01]
 [2.7290e-02 0.0000e+00 7.0700e+00 ... 3.9283e+02 4.0300e+00 3.4700e+01]
 ...
 [6.0760e-02 0.0000e+00 1.1930e+01 ... 3.9690e+02 5.6400e+00 2.3900e+01]
 [1.0959e-01 0.0000e+00 1.1930e+01 ... 3.9345e+02 6.4800e+00 2.2000e+01]
 [4.7410e-02 0.0000e+00 1.1930e+01 ... 3.9690e+02 7.8800e+00 1.1900e+01]]
```

```
In [73]: #Câu 2:
```

```
X = np.append(np.ones((len(data),1)),data[:,13],axis =1)
print(X)
print("-----")
Y = data.transpose()[-1].reshape(len(data),1)
print(Y)
```

```
[19.1]
[20.6]
[15.2]
[ 7. ]
[ 8.1]
[13.6]
[20.1]
[21.8]
[24.5]
[22.1]
```

```
In [75]: #Câu 3:
x_T = X.transpose()
print(x_T)
#Tính vecto B
beta = linalg.inv(x_T.dot(X)).dot(x_T).dot(Y)
print(beta)

[[ 1.0000e+00  1.0000e+00  1.0000e+00 ...  1.0000e+00  1.0000e+00  1.0000e+00]
 [ 6.3200e-03  2.7310e-02  2.7290e-02 ...  6.0760e-02  1.0959e-01  4.7410e-02]
 [ 1.8000e+01  0.0000e+00  0.0000e+00 ...  0.0000e+00  0.0000e+00  0.0000e+00]
 ...
 [ 1.5300e+01  1.7800e+01  1.7800e+01 ...  2.1000e+01  2.1000e+01  2.1000e+01]
 [ 3.9690e+02  3.9690e+02  3.9283e+02 ...  3.9690e+02  3.9345e+02  3.9690e+02]
 [ 4.9800e+00  9.1400e+00  4.0300e+00 ...  5.6400e+00  6.4800e+00  7.8800e+00]]
[[ 3.64594884e+01]
 [-1.08011358e-01]
 [ 4.64204584e-02]
 [ 2.05586264e-02]
 [ 2.68673382e+00]
 [-1.77666112e+01]
 [ 3.80986521e+00]
 [ 6.92224640e-04]
 [-1.47556685e+00]
 [ 3.06049479e-01]
 [-1.23345939e-02]
 [-9.52747232e-01]
 [ 9.31168327e-03]
 [-5.24758378e-01]]
```

```
In [77]: #Câu 4:
#Tính C:
C = linalg.inv(x_T.dot(X))
print(C)

[[ 1.15665067e+00 -4.79507297e-04 -7.27912374e-05  7.81007312e-04
```

```
In [77]: #Câu 4:
#Tính C:
```

```
C = linalg.inv(x_T.dot(X))
print(C)
```

```
[[ 1.15665067e+00 -4.79507297e-04 -7.27912374e-05  7.81007312e-04
-5.30636011e-03 -4.72633728e-01 -6.72009691e-02  2.52574657e-04
-1.60858766e-02  4.27955175e-03 -9.32179147e-05 -1.77832398e-02
-1.77463251e-04 -3.44062107e-03]
[-4.79507297e-04  4.79667291e-05 -1.74622146e-06  3.33058300e-06
 6.29163676e-05  3.32353579e-04  1.60589501e-05 -6.44104667e-08
 3.40052584e-05 -2.58500572e-05  6.50408184e-08  3.99960618e-06
 4.60269987e-07 -1.13029256e-05]
[-7.27912374e-05 -1.74622146e-06  8.36861245e-06  3.98676259e-06
-7.75453928e-06  8.33368670e-05 -3.96939822e-05  9.71684642e-07
-4.89624081e-05  4.27993705e-06 -5.11685476e-07  2.48176992e-05
-1.86831132e-08 -1.64268535e-06]
[ 7.81007312e-04  3.33058300e-06  3.98676259e-06  1.67943163e-04
-2.42364262e-04 -2.75364026e-03  1.04925166e-04 -3.97527513e-08
 1.14987074e-04  5.04398943e-05 -4.49769287e-06 -4.64149258e-05
 2.43976935e-07 -1.05525682e-05]
[-5.30636011e-03  6.29163676e-05 -7.75453928e-06 -2.42364262e-04
 3.29658256e-02 -4.90317797e-03 -4.98480956e-04 -2.56627859e-05
 1.20331081e-04 -2.73145702e-04  1.74383419e-05  4.68840845e-04
-5.27318555e-06  1.15327313e-04]
[-4.72633728e-01  3.32353579e-04  8.33368670e-05 -2.75364026e-03
-4.90317797e-03  6.47949909e-01  6.62608200e-03 -5.94124576e-04
 9.53889054e-03 -1.59989671e-03 -4.75854409e-05  7.31483621e-03
 3.41113655e-05 -5.91605940e-04]
[-6.72009691e-02  1.60589501e-05 -3.96939822e-05  1.04925166e-04
-4.98480956e-04  6.62608200e-03  7.75657890e-03 -5.06941561e-05
 4.94416767e-04 -1.94649180e-04  5.18444533e-06  3.87223280e-04
 5.2211421e-06  5.03507223e-04]
[ 2.52574657e-04 -6.44104667e-08  9.71684642e-07 -3.97527513e-08
-2.56627859e-05 -5.94124576e-04 -5.06941561e-05  7.74933231e-06
 3.40849783e-05  2.95027780e-06 -6.60690922e-08 -6.00107894e-06]
```

In [82]: #Tính y mũ:

```
y_mu = X.dot(beta)
print(y_mu)
```

```
[[ 30.00384338]
 [ 25.02556238]
 [ 30.56759672]
 [ 28.60703649]
 [ 27.94352423]
 [ 25.25628446]
 [ 23.00180827]
 [ 19.53598843]
 [ 11.52363685]
 [ 18.92026211]
 [ 18.99949651]
 [ 21.58679568]
 [ 20.90652153]
 [ 19.55290281]
 [ 19.28348205]
 [ 19.29748321]
 [ 20.52750979]
 [ 16.91140135]
 [ 16.17801106]
 [ 18.40613603]]
```

In [84]: #Tính e mũ:

```
e = Y - y_mu
print(e)
```

```
[[ -6.00384338e+00]
 [ -3.42556238e+00]
 [  4.13240328e+00]
 [  4.79296351e+00]
 [  8.25647577e+00]
 [  3.44371554e+00]]
```



```
In [86]: #Tính sigma bình:
sigma = (transpose(e).dot(e)) / (len(X) - (13+1))
print(sigma)

[[22.51785483]]
```

```
In [90]: #Tính SE_beta:

SE_beta = sigma*np.diag(c)
print(SE_beta)

[[2.60452918e+01 1.08010784e-03 1.88443200e-04 3.78171976e-03
 7.42319676e-01 1.45904420e+01 1.74661518e-01 1.74498340e-04
 3.97821912e-02 4.40185014e-03 1.41416344e-05 1.71156401e-02
 7.21440767e-06 2.57203944e-03]]
```

```
In [95]: #Câu 5: Xây dựng KTC cho beta:

import scipy.stats as scipy
t = (1 - 0.99)/2
t_value = scipy.t.ppf(t,len(X) - (13+1))
VT = beta - t_value * SE_beta
VP = beta + t_value * SE_beta
print(VT,VP)

3.91273634e+00 3.82124777e+00 3.80990178e+00 3.85412384e+00
3.80988386e+00 3.81651614e+00]
[ 6.73501416e+01 3.48523110e-03 1.17951216e-03 1.04712183e-02
 1.92022616e+00 3.77295163e+01 4.52342262e-01 1.14345272e-03
 1.03563357e-01 1.20747879e-02 7.28792911e-04 4.49508546e-02
 7.10880081e-04 7.34315569e-03]
[ 6.58738825e+01 -1.47277384e+00 -1.47507956e+00 -1.46578785e+00
 4.43967086e-01 3.62532572e+01 -1.02391681e+00 -1.47511562e+00
 -1.37269571e+00 -1.46418428e+00 -1.47553028e+00 -1.43130822e+00
 -1.47554819e+00 -1.46891591e+00]
[ 6.76554988e+01 3.08842485e-01 3.06536767e-01 3.15828473e-01
 2.22552241e+00 3.80248726e+01 7.57609517e-01 2.06500707e-01
 2.22552241e+00 3.80248726e+01 7.57609517e-01 2.06500707e-01
```