```python
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
df=pd.read_csv('/home/anudeep/Downloads/canada_per_capita_income.csv')
df.head()
df
```

	year	per capita income (US$)
0	1970	3399.299037
1	1971	3768.297935
2	1972	4251.175484
3	1973	4804.463248
4	1974	5576.514583
5	1975	5998.144346
6	1976	7062.131392
7	1977	7100.126170
8	1978	7247.967035
9	1979	7602.912681
10	1980	8355.968120
11	1981	9434.390652
12	1982	9619.438377
13	1983	10416.536590
14	1984	10790.328720
15	1985	11018.955850
16	1986	11482.891530
17	1987	12974.806620
18	1988	15080.283450
19	1989	16426.725480
20	1990	16838.673200
21	1991	17266.097690
22	1992	16412.083090
23	1993	15875.586730
24	1994	15755.820270
25	1995	16369.317250
26	1996	16699.826680
27	1997	17310.757750
28	1998	16622.671870
29	1999	17581.024140
30	2000	18987.382410
31	2001	18601.397240
32	2002	19232.175560
33	2003	22739.426280
34	2004	25719.147150
35	2005	29198.055690
36	2006	32738.262900
37	2007	36144.481220
38	2008	37446.486090
39	2009	32755.176820
40	2010	38420.522890
41	2011	42334.711210
42	2012	42665.255970
43	2013	42676.468370
44	2014	41039.893600
45	2015	35175.188980
46	2016	34229.193630

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 47 entries, 0 to 46
Data columns (total 2 columns):
year                      47 non-null int64
per capita income (US$)   47 non-null float64
dtypes: float64(1), int64(1)
memory usage: 880.0 bytes
```
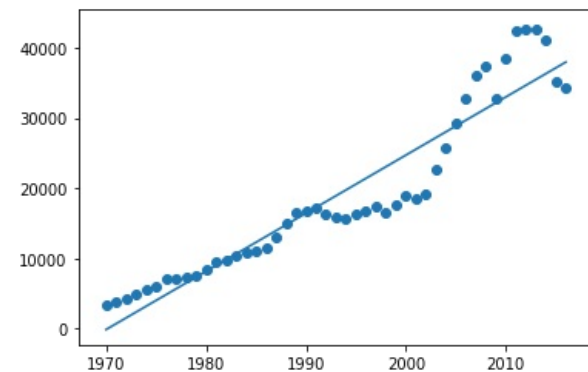
```
X=df['year'].values
Y=df['per capita income (US$)'].values
```

```
x_mean=np.mean(X)
y_mean=np.mean(Y)
n=len(X)
N=0
Z=0
for i in range(n):
    N+=(X[i]-x_mean)*(Y[i]-y_mean)
    Z+=(X[i]-x_mean)**2
M=(N/Z)
C=y_mean-(M*x_mean)
print(M,C)
min_X=np.min(X)
max_X=np.max(X)
x=np.linspace(min_X,max_X,100)
y=M*x+C
plt.plot(x,y,label='Regression line')
plt.scatter(X,Y,label='Scatter plot')
plt.show()
```

```
828.4650752227104 -1632210.7578554575
```

```
ss_t=0
ss_r=0
for i in range(n):
    y_pred=M*X[i]+C
    ss_t+=(Y[i]-y_mean)**2
    ss_r+=(Y[i]-y_pred)**2
r2=1-(ss_r/ss_t)
print(r2)
```

```
0.890916917957032
```

```
#89% accuracy
```

```
#prediction
```

```
x=int(input('enter x'))
y=M*x+C
print('predicted value is: ')
print(y)
```

```
enter x1990
predicted value is:
16434.74183773622
```

```
def gradient_descent(X,Y):
    m_curr=c_curr=0
    iterations=100
    n=len(X)
    learning_rate=0.0001

    for i in range(iterations):
        y_predicted=m_curr*X+c_curr
        cost=(1/n)*sum([val**2 for val in (Y-y_predicted)])
        md=-(2/n)*sum(X*(Y-y_predicted))
        cd=-(2/n)*sum(Y-y_predicted)
        m_curr=m_curr-learning_rate*md
        c_curr=c_curr-learning_rate*cd
        print("m {},c {},cost {},iteration {}".format(m_curr,c_curr,cost,i))
```

```
gradient_descent(X,Y)
```

```
m 7572.054148241133,c 3.784027412680851,cost 499723531.6384421,iteration 0
m -6000450.073102908,c -3010.6534854690376,cost 227179221022271.7,iteration 1
m 4761045481.073882,c 2388773.13181146,cost 1.4302236871356121e+20,iteration 2
m -3777636293996.353,c -1895364429.5948365,cost 9.004085128997914e+25,iteration 3
m 2997353429007840.5,c 1503870841434.0215,cost 5.668592244664234e+31,iteration 4
m -2.378240486687522e+18,c -1193241506735255.5,cost 3.5687066010496103e+37,iteration 5
m 1.8870073037706232e+21,c 9.467736551352124e+17,cost 2.246707163734162e+43,iteration 6
m -1.4972399067359474e+24,c -7.512145269825662e+20,cost 1.414432074099283e+49,iteration 7
m 1.1879802128180646e+27,c 5.960487625408714e+23,cost 8.904667793535029e+54,iteration 8
m -9.425990983128064e+29,c -4.7293298327649223e+26,cost 5.606003283241023e+60,iteration 9
m 7.479022382304491e+32,c 3.752471621908049e+29,cost 3.529303230663583e+66,iteration 10
m -5.934206376298587e+35,c -2.977386600458987e+32,cost 2.2219004635992973e+72,iteration 11
m 4.708477059758734e+38,c 2.3623978704694782e+35,cost 1.39881482193145e+78,iteration 12
m -3.7359260558953544e+41,c -1.8744370306289364e+38,cost 8.806348160553726e+83,iteration 13
m 2.9642585740521793e+44,c 1.4872660637366653e+41,cost 5.54410538900398e+89,iteration 14
m -2.351981479926803e+47,c -1.180066499006675e+44,cost 3.4903349270318095e+95,iteration 15
m 1.8661721788853969e+50,c 9.363199874131169e+46,cost 2.197367663143714e+101,iteration 16
m -1.4807083435683572e+53,c -7.429200977803037e+49,cost 1.3833700054498132e+107,iteration 17
m 1.1748632969238956e+56,c 5.894675742325863e+52,cost 8.709114109926962e+112,iteration 18
m -9.321915233708304e+58,c -4.6771116047314703e+55,cost 5.482890931632282e+118,iteration 19
m 7.396443811970744e+61,c 3.711039235973719e+58,cost 3.4517968864261057e+124,iteration 20
m -5.868684673919465e+64,c -2.944512206423412e+61,cost 2.1731057381427474e+130,iteration 21
m 4.656489074676074e+67,c 2.336313787720318e+64,cost 1.3680957207300718e+136,iteration 22
m -3.6946763554935526e+70,c -1.8537406986409205e+67,cost 8.612953655350315e+141,iteration 23
m 2.931529131267793e+73,c 1.470844625349229e+70,cost 5.422352365054203e+147,iteration 24
m -2.3260124082840524e+76,c -1.1670369612669181e+73,cost 3.413684358157977e+153,iteration 25
m 1.8455671020917257e+79,c 9.259817423881485e+75,cost 2.14911169776329e+159,iteration 26
m -1.4643593113228553e+82,c -7.347172503477222e+78,cost 1.3529900848698406e+165,iteration 27
m 1.1618912096057571e+85,c 5.829590511863924e+81,cost 8.517854942864522e+170,iteration 28
m -9.218988621990533e+87,c -4.6254699368947865e+84,cost 5.36248222651693e+176,iteration 29
m 7.31477702126939e+90,c 3.670064319882515e+87,cost 3.3759926439929915e+182,iteration 30
m -5.803886420171965e+93,c -2.912000790370961e+90,cost 2.12538258419509e+188,iteration 31
m 4.605075107595133e+96,c 2.310517708690332e+93,cost 1.338051235756537e+194,iteration 32
m -3.653882107838352e+99,c -1.8332728822822717e+96,cost 8.423806249394085e+199,iteration 33
m 2.8991610660077444e+102,c 1.4546045019566615e+99,cost 5.30327313566656e+205,iteration 34
m -2.3003300704815743e+105,c -1.154151287329631e+102,cost 3.33871709757161e+211,iteration 35
m 1.8251895333460681e+108,c 9.157576456368834e+104,cost 2.1019154722861438e+217,iteration 36
m -1.4481907946100218e+111,c -7.26604973497635e+107,cost 1.3232773318378224e+223,iteration 37
m 1.1490623517593629e+114,c 5.7652239107905196e+110,cost 8.330795981302181e+228,iteration 38
m -9.117198459932956e+116,c -4.5743984632468125e+113,cost 5.2447177936383136e+234,iteration 39
m 7.234011942914266e+119,c 3.6295418225457215e+116,cost 3.301853123836401e+240,iteration 40
m -5.739803627200091e+122,c -2.8798483445314448e+119,cost 2.0787074691820935e+246,iteration 41
m 4.55422882057713e+125,c 2.2850064534270935e+122,cost 1.3086665518946102e+252,iteration 42
m -3.613538284112507e+128,c -1.8130310584299072e+125,cost 8.23881267296155e+257,iteration 43
m 2.867150388173082e+131,c 1.4385436915950272e+128,cost 5.186808982156843e+263,iteration 44
m -2.2749313005881283e+134,c -1.141407888742934e+131,cost 3.265396178465637e+269,iteration 45
m 1.8050369606504125e+137,c 9.056464368072626e+133,cost 2.0557557139696394e+275,iteration 46
m -1.4322008002930733e+140,c -7.185822672077341e+136,cost 1.294217094816539e+281,iteration 47
m 1.1363751419367098e+143,c 5.701568004460646e+139,cost 8.14784498534099e+286,iteration 48
m -9.016532199587003e+145,c -4.5238908880688657e+142,cost 5.129539562646326e+292,iteration 49
m 7.154138620775733e+148,c 3.589466748645488e+145,cost 3.229341767313053e+298,iteration 50
```

```
m -5.676428395344639e+151,c -2.8480509053859104e+148,cost 2.033057377323834e+304,iteration 51
m 4.5039439456627514e+154,c 2.2597768770891682e+151,cost inf,iteration 52
m -3.573639911023758e+157,c -1.7930127318194594e+154,cost inf,iteration 53
m 2.8354931517209784e+160,c 1.422660214404797e+157,cost inf,iteration 54
m -2.2498129676286557e+163,c -1.1288051945936203e+160,cost inf,iteration 55
m 1.7851068997426174e+166,c 8.956468694632273e+162,cost inf,iteration 56
m -1.4163873572421622e+169,c -7.106481424973179e+165,cost inf,iteration 57
m 1.123828016151129e+172,c 5.63861494583857e+168,cost inf,iteration 58
m -8.916977431550502e+174,c -4.473940985155551e+171,cost inf,iteration 59
m 7.075147208653354e+177,c 3.549834158019072e+174,cost inf,iteration 60
m -5.613752912169389e+180,c -2.81660455317804e+177,cost inf,iteration 61
m 4.454214284099477e+183,c 2.234825869558451e+180,cost inf,iteration 62
m -3.5341820701917553e+186,c -1.7732154347376664e+183,cost inf,iteration 63
m 2.804185454178283e+189,c 1.406952112386783e+186,cost inf,iteration 64
m -2.224971975198327e+192,c -1.1163416513134993e+189,cost inf,iteration 65
m 1.7653968937901792e+195,c 8.8575771093107e+191,cost inf,iteration 66
m -1.400748516091402e+198,c -7.028016213053767e+194,cost inf,iteration 67
m 1.1114194276844943e+201,c 5.5763569745305176e+197,cost inf,iteration 68
m -8.81852188343797e+203,c -4.424542597047258e+200,cost inf,iteration 69
m 6.997027969062133e+206,c 3.510639165049847e+203,cost inf,iteration 70
m -5.551769451498026e+209,c -2.78550541143095e+206,cost inf,iteration 71
m 4.405033705577431e+212,c 2.210150355056766e+209,cost inf,iteration 72
m -3.495159897541746e+215,c -1.7536367267181783e+212,cost inf,iteration 73
m 2.7732234361604463e+218,c 1.3914174491607671e+215,cost inf,iteration 74
m -2.200405261080819e+221,c -1.1040157224878828e+218,cost inf,iteration 75
m 1.7459045130873548e+224,c 8.759777421474709e+220,cost inf,iteration 76
m -1.3852823489985447e+227,c -6.950417363700206e+223,cost inf,iteration 77
m 1.099147846896545e+230,c 5.51478641582797e+226,cost inf,iteration 78
m -8.721153418367705e+232,c -4.375689634271082e+229,cost inf,iteration 79
m 6.91977127203212e+235,c 3.471876938065023e+232,cost inf,iteration 80
m -5.490470372461707e+238,c -2.754749646469326e+235,cost inf,iteration 81
m 4.356396147473683e+241,c 2.1857472917666963e+238,cost inf,iteration 82
m -3.4565685827049637e+244,c -1.734274194240702e+241,cost inf,iteration 83
m 2.742603280895767e+247,c 1.376054309726797e+244,cost inf,iteration 84
m -2.176109796870838e+250,c -1.0918258886661876e+247,cost inf,iteration 85
m 1.7266273547556563e+253,c 8.663057575092276e+249,cost inf,iteration 86
m -1.3699869494073445e+256,c -6.8736753110924686e+252,cost inf,iteration 87
m 1.0870117610363273e+259,c 5.453895679761645e+255,cost inf,iteration 88
m -8.62486003346568e+261,c -4.327376074590174e+258,cost inf,iteration 89
m 6.8433675939213315e+264,c 3.4335426987400445e+261,cost inf,iteration 90
m -5.429848118557181e+267,c -2.724333466946842e+264,cost inf,iteration 91
m 4.308295614104912e+270,c 2.1616136714566397e+267,cost inf,iteration 92
m -3.418403368425664e+273,c -1.7151254504334958e+270,cost inf,iteration 93
m 2.712321213754895e+276,c 1.360860800229126e+273,cost inf,iteration 94
m -2.1520825876008103e+279,c -1.0797706471746323e+276,cost inf,iteration 95
m 1.7075630424476448e+282,c 8.567405647246376e+278,cost inf,iteration 96
m -1.3548604318125287e+285,c -6.797780595030196e+281,cost inf,iteration 97
m 1.0750096740557173e+288,c 5.393677260165828e+284,cost inf,iteration 98
m -8.529629858385927e+290,c -4.279595962261376e+287,cost inf,iteration 99

/home/anudeep/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:9: RuntimeWarning: overflo
w encountered in double_scalars
  if __name__ == '__main__':
```

In [ ]: