

# ml\_exp2

January 8, 2025

## 1 Experiment 2

### 1.1 4 Jan

### 1.2 Simple Linear Regression

```
[67]: # importing the necessary libraries
import pandas as pd
import numpy as np
from sklearn.metrics import mean_squared_error
from sklearn import preprocessing
from sklearn.linear_model import LinearRegression
from sklearn.model_selection import train_test_split
import matplotlib.pyplot as plt

# reading the dataset
data = pd.read_csv(r'D:\study material\VIT_Data_Science\Winter_Sem\Data Mining_
↳ and Machine Learning Lab\Class_notes\ML_exp2\Training_set_heights200.csv')
data
```

```
[67]:      Height    Weight
0    127.8296   67.63371
1    123.4114   65.95421
2    134.4043   66.14316
3    155.9981   73.45251
4    136.1354   69.30943
..      ...      ...
194   135.2500   68.41222
195   109.5143   66.49607
196   139.6043   67.84894
197   134.3672   67.27839
198   130.3869   68.48742
```

[199 rows x 2 columns]

```
[68]: # Use MinMaxScaler() to scale the data to 0 to 1 range.
MM = preprocessing.MinMaxScaler()
x = MM.fit_transform(data)
```

```
print(x)
```

```
[ [0.55738247 0.53872437]
  [0.49548119 0.40985671]
  [0.64949743 0.4243548 ]
  [0.95203779 0.98519959]
  [0.67375104 0.66730199]
  [0.43738377 0.34466862]
  [0.34908247 0.50992308]
  [0.60113031 0.68675989]
  [0.73623936 0.75590033]
  [0.37092206 0.46972895]
  [0.46437503 0.39039343]
  [0.60406131 0.59593869]
  [0.79874449 0.71333218]
  [0.47575998 0.35674282]
  [0.49263425 0.55948975]
  [0.62913734 0.59716023]
  [1.          0.60338839]
  [0.54525776 0.3960699 ]
  [0.64237588 0.57734553]
  [0.73658121 0.8075786 ]
  [0.54945671 0.68787861]
  [0.75975041 0.65702327]
  [0.55166617 0.80390401]
  [0.73663586 0.72803437]
  [0.34895497 0.56025398]
  [0.64312404 0.59457137]
  [0.57725078 0.4842585 ]
  [0.41982578 0.39622106]
  [0.60528863 0.44350885]
  [0.60712822 0.32756095]
  [0.81467165 0.79411713]
  [0.38697672 0.18244576]
  [0.46978589 0.62691681]
  [0.76756548 0.43440256]
  [0.48096068 0.57167827]
  [0.39468531 0.6278859 ]
  [0.51695651 0.31010646]
  [0.6818239  0.85938194]
  [0.41629793 0.45115651]
  [0.57152048 0.43224569]
  [0.5441103  0.65371621]
  [0.55414043 0.50407627]
  [0.36149018 0.30173141]
  [0.19914889 0.44000997]
  [0.53127246 0.77748288]
  [0.31121343 0.13784965]
```

[0.3777606 0.45147647]  
[0.62251737 0.48554449]  
[0.42977745 0.59573229]  
[0.40259564 0.58968675]  
[0.60114012 0.69297577]  
[0.38313784 0.52247147]  
[0.57182031 0.66102473]  
[0.7974219 0.55225873]  
[0.38641349 0.62757822]  
[0.36282118 0.44235867]  
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[0.53808858 0.5218699 ]  
[0.4484787 0.592825 ]  
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[0.550635 0.2803261 ]  
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[0. 0. ]  
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[0.6831549 0.505284 ]  
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[0.57991558 0.56227043]  
[0.47242267 0.47237153]  
[0.67335454 0.76526136]  
[0.61626448 0.55572155]

[0.27701375 0.41043602]  
[0.72466106 0.37385203]  
[0.59573206 0.62964915]  
[0.53088717 0.5247419 ]  
[0.72613217 0.73205732]  
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[0.68607049 0.35128657]  
[0.66060357 0.60216915]  
[0.68635911 0.6226138 ]  
[0.8947866 0.60925361]  
[0.52100415 0.6457087 ]  
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[0.61539863 0.42737258]  
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[0.68537277 0.66672498]  
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[0.6193622 0.85449732]  
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[0.24052616 0.51517984]  
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[0.38917637 0.67365138]  
[0.67733213 0.90727437]  
[0.47368082 0.63159425]  
[0.79361664 0.77769235]  
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[0.33686669 0.56829833]  
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[0.53542658 0.56710441]  
[0.23474682 0.4668347 ]  
[0.72931816 0.85877424]  
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[0.36953642 0.31285569]

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[0.39510282 0.3802628 ]  
[0.52689417 0.50628072]  
[0.46152949 0.81846272]  
[0.65871215 0.51378949]  
[0.65752686 0.7219405 ]  
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[0.40551544 0.59552665]  
[0.60759757 0.3739019 ]  
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[0.63077797 0.52330245]  
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[0.4342356 0.29095087]  
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[0.39843592 0.59676968]  
[0.74898753 0.95526731]  
[0.32187123 0.57119794]  
[0.38659003 0.38854962]  
[0.40950423 0.44987666]  
[0.31715389 0.62665362]  
[0.44446048 0.59272372]

```

[0.67521654 0.58838388]
[0.76691119 0.78852276]
[0.63220004 0.51865723]
[0.2677598  0.44720569]
[0.66134613 0.59845927]
[0.30077559 0.4514335 ]
[0.72235213 0.55523892]
[0.64897764 0.51146074]
[0.59321157 0.60422935]]

```

```

[69]: X = x[:,0]
      Y = x[:,1]

```

```

[70]: X

```

```

[70]: array([0.55738247, 0.49548119, 0.64949743, 0.95203779, 0.67375104,
            0.43738377, 0.34908247, 0.60113031, 0.73623936, 0.37092206,
            0.46437503, 0.60406131, 0.79874449, 0.47575998, 0.49263425,
            0.62913734, 1.          , 0.54525776, 0.64237588, 0.73658121,
            0.54945671, 0.75975041, 0.55166617, 0.73663586, 0.34895497,
            0.64312404, 0.57725078, 0.41982578, 0.60528863, 0.60712822,
            0.81467165, 0.38697672, 0.46978589, 0.76756548, 0.48096068,
            0.39468531, 0.51695651, 0.6818239 , 0.41629793, 0.57152048,
            0.5441103 , 0.55414043, 0.36149018, 0.19914889, 0.53127246,
            0.31121343, 0.3777606 , 0.62251737, 0.42977745, 0.40259564,
            0.60114012, 0.38313784, 0.57182031, 0.7974219 , 0.38641349,
            0.36282118, 0.54223289, 0.36788458, 0.64084173, 0.39221245,
            0.66611951, 0.89011129, 0.7975606 , 0.50349941, 0.46568782,
            0.53536633, 0.63261335, 0.44809201, 0.38473223, 0.53808858,
            0.4484787 , 0.62883892, 0.75883833, 0.63049356, 0.550635 ,
            0.65980076, 0.31397631, 0.44047729, 0.58080945, 0.47613826,
            0.          , 0.54415093, 0.77229123, 0.54361433, 0.38972418,
            0.47704474, 0.28104738, 0.44034979, 0.6831549 , 0.70493846,
            0.57991558, 0.47242267, 0.67335454, 0.61626448, 0.27701375,
            0.72466106, 0.59573206, 0.53088717, 0.72613217, 0.34704674,
            0.68607049, 0.66060357, 0.68635911, 0.8947866 , 0.52100415,
            0.52001781, 0.72733988, 0.60303294, 0.45703772, 0.75531048,
            0.40692349, 0.4647365 , 0.61539863, 0.77414482, 0.68537277,
            0.47600236, 0.45393579, 0.6193622 , 0.38492978, 0.24052616,
            0.55340768, 0.38917637, 0.67733213, 0.47368082, 0.79361664,
            0.3958804 , 0.79301559, 0.55608229, 0.58324308, 0.30578436,
            0.52490048, 0.58641506, 0.67078922, 0.39729406, 0.32919733,
            0.33686669, 0.70884039, 0.53542658, 0.23474682, 0.72931816,
            0.39198408, 0.36953642, 0.40916518, 0.75263587, 0.55753798,
            0.7036621 , 0.43406607, 0.43950916, 0.83074312, 0.60431771,
            0.6699738 , 0.51615931, 0.60648513, 0.73573638, 0.6947416 ,
            0.49305176, 0.43626713, 0.48065245, 0.84112771, 0.51315686,

```

```
0.78865692, 0.53834917, 0.25847784, 0.50237716, 0.39510282,  
0.52689417, 0.46152949, 0.65871215, 0.65752686, 0.54538245,  
0.33311327, 0.40551544, 0.60759757, 0.49741324, 0.63077797,  
0.64412439, 0.45195471, 0.6839605 , 0.39480299, 0.56536426,  
0.47251654, 0.4342356 , 0.55904972, 0.39843592, 0.74898753,  
0.32187123, 0.38659003, 0.40950423, 0.31715389, 0.44446048,  
0.67521654, 0.76691119, 0.63220004, 0.2677598 , 0.66134613,  
0.30077559, 0.72235213, 0.64897764, 0.59321157])
```

```
[71]: Y
```

```
[71]: array([0.53872437, 0.40985671, 0.4243548 , 0.98519959, 0.66730199,  
0.34466862, 0.50992308, 0.68675989, 0.75590033, 0.46972895,  
0.39039343, 0.59593869, 0.71333218, 0.35674282, 0.55948975,  
0.59716023, 0.60338839, 0.3960699 , 0.57734553, 0.8075786 ,  
0.68787861, 0.65702327, 0.80390401, 0.72803437, 0.56025398,  
0.59457137, 0.4842585 , 0.39622106, 0.44350885, 0.32756095,  
0.79411713, 0.18244576, 0.62691681, 0.43440256, 0.57167827,  
0.6278859 , 0.31010646, 0.85938194, 0.45115651, 0.43224569,  
0.65371621, 0.50407627, 0.30173141, 0.44000997, 0.77748288,  
0.13784965, 0.45147647, 0.48554449, 0.59573229, 0.58968675,  
0.69297577, 0.52247147, 0.66102473, 0.55225873, 0.62757822,  
0.44235867, 0.69027642, 0.5681817 , 0.90035641, 0.5202839 ,  
0.50415377, 0.85937734, 0.80953905, 0.60002686, 0.36238246,  
0.71725231, 0.68251137, 0.45112198, 0.57993133, 0.5218699 ,  
0.592825 , 0.54575358, 0.54421362, 0.54392818, 0.2803261 ,  
0.72754868, 0.40024016, 0.49177879, 0.52236021, 0.60867814,  
0. , 0.37853254, 0.50281867, 0.5088128 , 0.50728895,  
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0.56227043, 0.47237153, 0.76526136, 0.55572155, 0.41043602,  
0.37385203, 0.62964915, 0.5247419 , 0.73205732, 0.67304598,  
0.35128657, 0.60216915, 0.6226138 , 0.60925361, 0.6457087 ,  
0.56767144, 0.60678214, 0.41956993, 0.46135083, 0.64531277,  
0.30806545, 0.3748779 , 0.42737258, 0.56487771, 0.66672498,  
0.26702346, 0.43280351, 0.85449732, 0.40747578, 0.51517984,  
0.52906409, 0.67365138, 0.90727437, 0.63159425, 0.77769235,  
0.4929282 , 0.71106942, 0.52900577, 0.56610922, 0.19056914,  
0.5796973 , 0.75784006, 0.71414552, 0.60616907, 0.57090253,  
0.56829833, 0.69083271, 0.56710441, 0.4668347 , 0.85877424,  
0.36931193, 0.31285569, 0.51888205, 0.67739119, 0.53927222,  
0.75737201, 0.42328365, 0.31518137, 0.52240471, 0.97508354,  
0.66517197, 0.65844354, 1. , 0.61801001, 0.66066717,  
0.53802613, 0.32083866, 0.57391495, 0.79509697, 0.58910591,  
0.64808271, 0.65186166, 0.54579425, 0.46030884, 0.3802628 ,  
0.50628072, 0.81846272, 0.51378949, 0.7219405 , 0.58564002,  
0.27899944, 0.59552665, 0.3739019 , 0.4323815 , 0.52330245,  
0.59980664, 0.62875832, 0.45083731, 0.67601696, 0.73624753,
```

```
0.4645543 , 0.29095087, 0.56246303, 0.59676968, 0.95526731,
0.57119794, 0.38854962, 0.44987666, 0.62665362, 0.59272372,
0.58838388, 0.78852276, 0.51865723, 0.44720569, 0.59845927,
0.4514335 , 0.55523892, 0.51146074, 0.60422935])
```

```
[72]: # splitting the data into train and test

x_train,x_test,y_train,y_test = train_test_split(X,Y,test_size = 0.
↪3,random_state= 0)
```

```
[73]: # Creating linear regression model and fitting the data
reg = LinearRegression()
reg.fit(x_train.reshape(-1,1),y_train)
```

```
[73]: LinearRegression()
```

- Reshaping x\_train to be a 2D array of shape (n\_samples, 1).The 'reshape(-1, 1)' automatically determines the number of rows (samples) while setting the number of columns (features) to 1, as a single feature.

```
[74]: m = reg.intercept_
n = reg.coef_
print(m,n)
```

```
0.31424682064854753 [0.41532209]
```

### 1.3 Gradient descent algorithm

```
[79]: def gd(xt,yt,mb,nb,L):
    Dm=0
    Dn=0
    for i in range(len(xt)):
        Dm=Dm+(2/len(xt))*((mb*xt[i]+nb-yt[i])*xt[i])
        Dn=Dn+(2/len(xt))*((mb*xt[i]+nb-yt[i]))
    mb=mb-L*Dm
    nb=nb-L*Dn
    return mb,nb

m=0
n=0
L=0.5
epochs=900
for i in range(epochs):
    m,n=gd(x_train,y_train,m,n,L)
    print(m,n)
```

```
0.29400567314907805 0.5355308520634722
0.21307802410916096 0.37888432999762056
0.24027552379120423 0.4220026638218827
0.23621075007809111 0.4075118082936667
```



0.241105510028543 0.40967752386753253  
0.24335463465579932 0.40706959078116406  
0.2463078195764101 0.40587125488927905  
0.24899945871098447 0.4042977949560878  
0.2517091279093877 0.402863686884052  
0.25435708546861596 0.4014199723756466  
0.2569672571085028 0.40000913789144  
0.2595336400543951 0.3986184357835392  
0.26205885291274117 0.39725106433639273  
0.2645430121874199 0.395905628353818  
0.26698694223822983 0.3945820657624297  
0.2693912492636815 0.3932799373424877  
0.271756588732365 0.39199892011080817  
0.27408358843631564 0.3907386648330589  
0.27637287091243196 0.3894988370210041  
0.27862504718730985 0.38827910498635015  
0.2808407187933404 0.38707914317350456  
0.2830204773946792 0.38589863108539685  
0.2851649050995302 0.3847372534827622  
0.2872745745710778 0.38359470021775693  
0.289350049193262 0.38247066617485304  
0.29139188321752196 0.3813648511825136  
0.2934006219118773 0.38027695993500743  
0.29537680170623265 0.37920670191297834  
0.29732095033571887 0.37815379130602683  
0.29923358698159847 0.3771179469363378  
0.301115222409919 0.3760988921836058  
0.3029663591079105 0.3750963549111606  
0.30478749141817374 0.3741100673932943  
0.3065791056706941 0.3731397662437656  
0.3083416803127144 0.37218519234546327  
0.31007568603650393 0.37124609078120896  
0.31178158590505545 0.3703222107656822  
0.31345983547574574 0.36941330557844904  
0.3151108829219909 0.36851913249807505  
0.31673516915293065 0.36763945273730775  
0.318333127931172 0.3667740313793085  
0.3199051859886249 0.3659226373149185  
0.3214517631404601 0.3650850431809416  
0.32297327239722 0.3642610252994273  
0.3244701200751126 0.3634503636179379  
0.32594270590451707 0.36265284165078415  
0.32739142313673125 0.36186824642121285  
0.32881665864898874 0.3610963684045321  
0.3302187930477736 0.3603370014721577  
0.33159820077046054 0.3595899428365674  
0.332955250185308 0.35885499299714674  
0.3342903036898299 0.35813195568691236

0.3356037178075734 0.35742063782009986  
0.33689584328332783 0.3567208494406002  
0.3381670251767903 0.35603240367123234  
0.3394176029547135 0.3553551166638384  
0.3406479105815594 0.3546888075501868  
0.341858276608684 0.35403329839367204  
0.34304902426207623 0.3533884141417971  
0.344220471528675 0.3527539825794259  
0.345372931241287 0.35212983428279354  
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```

**1.3.1** Change the learning rate to be a bigger value and check whether your algorithm is converging to a valid values for the parameters m and n.

```

[76]: def gd(xt,yt,mb,nb,L):
        Dm=0
        Dn=0
        for i in range(len(xt)):
            Dm=Dm+(2/len(xt))*((mb*xt[i]+nb-yt[i])*xt[i])
            Dn=Dn+(2/len(xt))*((mb*xt[i]+nb-yt[i]))
        mb=mb-L*Dm
        nb=nb-L*Dn
        return mb,nb
m=0
n=0

```

```

L=.7
epochs=900
for i in range(epochs):
    m,n=gd(x_train,y_train,m,n,L)
    print(m,n)

```

```

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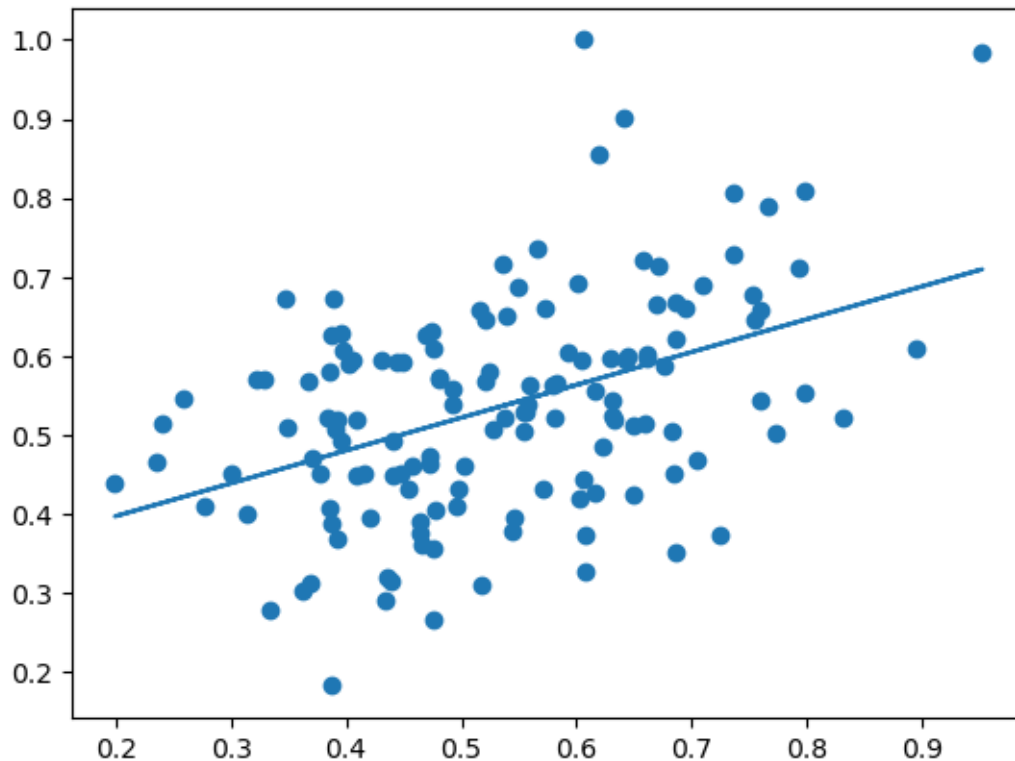
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0.4153220877304917 0.3142468207632502  
0.4153220877352977 0.31424682076064736  
0.4153220877399947 0.31424682075810356

```
[80]: plt.scatter(x_train,y_train)
      y_pred = m*x_train + n
      plt.plot(x_train,y_pred)
      plt.show()
```



**1.3.2** use the testing data and predict the mean square error for the testing set using this model.

```
[81]: ytestpred = m * x_test + n
testingerror = mean_squared_error(y_test, ytestpred)
print("Testing Mean Squared Error:", testingerror)
```

Testing Mean Squared Error: 0.027629530250748133

## 2 Reverse fitting (predicting X using Y)

**2.0.1** Now create a linear regression model using gradient descent technique to predict height in terms of weight. Choose suitable value of learning rate and also modify your program so that your training terminates when the parameter values are the same for 3 decimal places in consecutive iterations in the gradient descent function you are writing

```
[36]: x_train2,x_test2,y_train2,y_test2 = train_test_split(x[:,1],x[:,0],test_size=0.
↪3,random_state=0)
reg = LinearRegression()
reg.fit(x_train2.reshape(-1,1),y_train2)
m = reg.intercept_
```

```
n = reg.coef_  
print(m,n)
```

0.28916508772067234 [0.45494285]

```
[38]: def gd(xt, yt, mb, nb, L):  
    Dm = 0  
    Dn = 0  
    for i in range(len(xt)):  
        Dm = Dm + (2 / len(xt)) * ((mb * xt[i] + nb - yt[i]) * xt[i])  
        Dn = Dn + (2 / len(xt)) * (mb * xt[i] + nb - yt[i])  
    mb = mb - L * Dm  
    nb = nb - L * Dn  
    return mb, nb  
  
m = 0  
n = 0  
L = 0.2  
while True:  
    mnew, nnew = gd(x_train2, y_train2, m, n, L)  
    if m != 0 and n != 0 and abs(mnew - m) <= 0.1**6 and abs(nnew - n) <= 0.  
↪1**6:  
        break  
    print(mnew, nnew)  
    m, n = mnew, nnew  
print(f"\nOptimized m: {m}, Optimized n: {n}")
```

0.11760226925963123 0.21312040735543564  
0.17516358225109518 0.31580079438421377  
0.20368720648392027 0.36507868300459634  
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0.454159624009537 0.28959081508516443  
0.4541642506468097 0.289588300239073  
0.45416884995372586 0.2895858002486178  
0.45417342209173067 0.289583315026044  
0.45417796722131565 0.28958084448411514  
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0.45425533851248473 0.2895387886933286

0.4542593997474279 0.2895365811762441  
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0.45426745038775196 0.2895322051856144  
0.454271440075727 0.2895300365584628  
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0.4542793488875396 0.289525737659867  
0.4542832682889929 0.2895236072375226  
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0.45432853374799215 0.2894990028313563  
0.4543321626058619 0.28949703033632546  
0.4543357700274328 0.2894950694931681  
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0.4543464649368962 0.2894892561886714  
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0.45439717880786684 0.289461690254133  
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0.45440679187594024 0.2894564649932694  
0.4544099584493444 0.2894547437766969  
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0.4544162355901386 0.28945133178607363  
0.4544193463778693 0.28944964089225494  
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0.4546051629457346 0.28934863879464573  
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0.45470897372498337 0.28929221160637597  
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0.4547130938872516 0.2892899720588676  
0.4547144510810382 0.2892892343452133  
0.4547158002576434 0.28928850098936276  
0.45471714146442616 0.28928777196557365  
0.4547184747484656 0.2892870472482557  
0.45471980015656277 0.28928632681196986  
0.4547211177352422 0.2892856106314273  
0.45472242753075365 0.28928489868148866



0.45472372958907364 0.2892841909371629  
0.45472502395590714 0.2892834873736069  
0.4547263106766891 0.28928278796612394  
0.4547275897965861 0.2892820926901635  
0.4547288613604979 0.28928140152131987  
0.45473012541305896 0.28928071443533165  
0.4547313819986402 0.28928003140808073  
0.4547326311613504 0.28927935241559133  
0.4547338729450377 0.28927867743402946  
0.4547351073932913 0.2892780064397019  
0.45473633454944296 0.28927733940905537  
0.45473755445656827 0.2892766763186756  
0.4547387671574886 0.28927601714528683  
0.4547399726947723 0.2892753618657507  
0.4547411711107361 0.28927471045706554  
0.4547423624474469 0.2892740628963656  
0.45474354674672324 0.2892734191609201  
0.45474472405013633 0.28927277922813255  
0.454745894399012 0.28927214307554006  
0.45474705783443187 0.2892715106808123  
0.454748214397235 0.28927088202175094  
0.45474936412801914 0.2892702570762888  
0.4547505070671422 0.2892696358224889  
0.4547516432547237 0.28926901823854395  
0.4547527727306463 0.28926840430277556  
0.45475389553455675 0.2892677939936333  
0.4547550117058679 0.2892671872896939  
0.4547561212837597 0.289266584169661  
0.4547572243071806 0.2892659846123637  
0.45475832081484896 0.2892653885967564  
0.4547594108452545 0.2892647961019176  
0.4547604944366596 0.2892642071070496  
0.4547615716271005 0.2892636215914774  
0.45476264245438885 0.2892630395346482  
0.4547637069561129 0.28926246091613067  
0.4547647651696388 0.289261885715614  
0.45476581713211217 0.28926131391290755  
0.454766862880459 0.2892607454879398  
0.45476790245138715 0.28926018042075785  
0.45476893588138784 0.2892596186915267  
0.4547699632067365 0.2892590602805285  
0.4547709844634945 0.2892585051681618  
0.45477199968751 0.2892579533349411  
0.4547730089144194 0.28925740476149586  
0.45477401217964875 0.28925685942857005

Optimized m: 0.45477401217964875, Optimized n: 0.28925685942857005

### 3 Multiple Regression

```
[40]: ## Loading the dataset
data = pd.read_csv(r"D:\study material\VIT_Data_Science\Winter_Sem\Data Mining_
and Machine Learning Lab\Class_notes\ML_exp2\Book1.csv")
data.head()
```

```
[40]:      price  area  bedrooms  bathrooms  stories  parking  furnishingstatus
0  13300000  7420         4          2         3         2      furnished
1  12250000  8960         4          4         4         3      furnished
2  12250000  9960         3          2         2         2  semi-furnished
3  12215000  7500         4          2         2         3      furnished
4  11410000  7420         4          1         2         2      furnished
```

#### 3.1 Drop the furnishingstatus column and then we will be left out with 5 features

```
[43]: data.drop('furnishingstatus',axis = 1,inplace = True)
```

```
[64]: data
```

```
[64]:      price  area  bedrooms  bathrooms  stories  parking
0  13300000  7420         4          2         3         2
1  12250000  8960         4          4         4         3
2  12250000  9960         3          2         2         2
3  12215000  7500         4          2         2         3
4  11410000  7420         4          1         2         2
..      ...  ...      ...      ...      ...      ...
244  4550000  5320         3          1         2         0
245  4550000  5360         3          1         2         2
246  4550000  3520         3          1         1         0
247  4550000  8400         4          1         4         3
248  4543000  4100         2          2         1         0
```

[249 rows x 6 columns]

##### 3.1.1 Use MinMaxScaler() to scale the data to 0 to 1 range.

```
[45]: MM = preprocessing.MinMaxScaler()
x = MM.fit_transform(data)
print(x)
```

```
[[1.00000000e+00  3.56776557e-01  5.00000000e-01  3.33333333e-01
  6.66666667e-01  6.66666667e-01]
 [8.80095923e-01  4.69597070e-01  5.00000000e-01  1.00000000e+00
  1.00000000e+00  1.00000000e+00]
 [8.80095923e-01  5.42857143e-01  2.50000000e-01  3.33333333e-01
  3.33333333e-01  6.66666667e-01]
```

```
...
[7.99360512e-04 7.10622711e-02 2.50000000e-01 0.00000000e+00
 0.00000000e+00 0.00000000e+00]
[7.99360512e-04 4.28571429e-01 5.00000000e-01 0.00000000e+00
 1.00000000e+00 1.00000000e+00]
[0.00000000e+00 1.13553114e-01 0.00000000e+00 3.33333333e-01
 0.00000000e+00 0.00000000e+00]]
```

```
[47]: X = x[:,1:]
      Y = x[:,0]
```

```
[50]: X.shape
```

```
[50]: (249, 5)
```

```
[51]: Y.shape
```

```
[51]: (249,)
```

### 3.2 Do the `train_test_split` of your data.

```
[53]: x_train,x_test,y_train,y_test = train_test_split(X,Y,test_size = 0.
      ↪3,random_state=0)
```

### 3.3 Write an appropriate gradient descent algorithm and determine the values of the parameters involved in the prediction function using the testing data and print them.

```
[58]: # Gradient Descent Function for Multiple Linear Regression
def gd(X, Y, m, n, L):
    Dm = np.zeros(X.shape[1]) # Gradient for each feature
    Dn = 0
    m_len = len(X)

    for i in range(m_len):
        prediction_error = np.dot(X[i], m) + n - Y[i]
        Dm += (2 / m_len) * prediction_error * X[i]
        Dn += (2 / m_len) * prediction_error
    m = m - L * Dm
    n = n - L * Dn
    return m, n

m = np.zeros(x_train.shape[1])
n = 0
L = 0.3
epochs = 1000

# Training the model using Gradient Descent
for epoch in range(epochs):
```

```

m, n = gd(x_train, y_train, m, n, L)

print(f"Optimized m: {m}")
print(f"Optimized n (intercept): {n}")

# Making predictions using the learned parameters on the test data
Y_pred = np.dot(x_test, m) + n

# Evaluating the model performance using Mean Squared Error
mse = mean_squared_error(y_test, Y_pred)
print(f"Mean Squared Error on test data: {mse}")

```

```

Optimized m: [0.31626449 0.06619415 0.31538426 0.13903004 0.15363781]
Optimized n (intercept): -0.05644518906539534
Mean Squared Error on test data: 0.01865133932323103

```

**3.4 Also use the in-build LinearRegression class and create an object of this class and fit the model and check for the values of the parameters of your model.**

```

[55]: model = LinearRegression()
model.fit(x_train,y_train)
print("optimized m:",model.coef_)
print("optimized n:",model.intercept_)

```

```

optimized m: [0.31626718 0.06619594 0.31538369 0.13903006 0.15363749]
optimized n: -0.056446303907598444

```

**3.4.1 Also print the testing error for the model you have created using the test set you have**

```

[57]: Y_pred = model.predict(x_test)

# Evaluating the model performance using Mean Squared Error
mse = mean_squared_error(y_test, Y_pred)
print(f"Mean Squared Error on test data: {mse}")

```

```

Mean Squared Error on test data: 0.018651360569613903

```