

▼ Libraries Used

```
import pandas as pd

import statistics

from sklearn.model_selection import train_test_split

from sklearn.linear_model import LinearRegression

from sklearn.metrics import mean_squared_error

from sklearn.metrics import r2_score

import seaborn as sns

from sklearn import linear_model
```

▼ PreProcessing

```
df = pd.read_csv("Real estate.csv")
df
```

X1 transaction date	X2 house age	X3 distance to the nearest MRT station	X4 number of convenience stores	X5 latitude	X6 longitude	Y house price of unit area
---------------------	--------------	--	---------------------------------	-------------	--------------	----------------------------

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 414 entries, 0 to 413
Data columns (total 7 columns):
 #   Column           Non-Null Count  Dtype  
--- 
 0   X1 transaction date    407 non-null   float64
 1   X2 house age          410 non-null   float64
 2   X3 distance to the nearest MRT station 406 non-null   float64
 3   X4 number of convenience stores 411 non-null   float64
 4   X5 latitude           410 non-null   float64
 5   X6 longitude          412 non-null   float64
 6   Y house price of unit area      412 non-null   float64
dtypes: float64(7)
memory usage: 22.8 KB
```

```
412 2013-000 2 1 101 21010 5 0 21 06671 121 51067 52 5
```

```
df.isnull().sum()
```

X1 transaction date	7
X2 house age	4
X3 distance to the nearest MRT station	8
X4 number of convenience stores	3
X5 latitude	4
X6 longitude	2
Y house price of unit area	2

dtype: int64

```
x1mean = df["X1 transaction date"].mean()
x1mean
```

```
2013.1509189189194
```

```
x2mean = df["X2 house age"].mean()
x2mean
```

```
17.623414634146343
```

```
x3mean = df["X3 distance to the nearest MRT station"].mean()
x3mean
```

```
1087.3476437192119
```

```
x4mean = df["X4 number of convenience stores"].mean()
```

```
x4mean
```

```
4.104622871046229
```

```
x5mean = df["X5 latitude"].mean()  
x5mean
```

```
24.9690411219512
```

```
x6mean = df["X6 longitude"].mean()  
x6mean
```

```
121.53331538834966
```

```
Ymedian = statistics.median(df["Y house price of unit area"])  
Ymedian
```

```
38.4
```

```
df["X1 transaction date"].fillna(x1mean, inplace = True)
```

```
df["X2 house age"].fillna(x2mean, inplace = True)
```

```
df["X3 distance to the nearest MRT station"].fillna(x3mean, inplace = True)
```

```
df["X4 number of convenience stores"].fillna(x4mean, inplace = True)
```

```
df["X5 latitude"].fillna(x5mean, inplace = True)
```

```
df["X6 longitude"].fillna(x6mean, inplace = True)
```

```
df["Y house price of unit area"].fillna(Ymedian, inplace = True)
```

▼ Splitting the data (70/30)

```
X = df[['X1 transaction date', 'X2 house age',  
        'X3 distance to the nearest MRT station',  
        'X4 number of convenience stores', 'X5 latitude', 'X6 longitude']]
```

```
Y = df["Y house price of unit area"]
```

```
X_train, X_test, Y_train, Y_test = train_test_split(X,Y,test_size=0.30)

X_train.shape, X_test.shape, Y_train.shape, Y_test.shape

((289, 6), (125, 6), (289,), (125,))
```

▼ 1. Linear Regression(Ordinary Least Squares)

```
reg1 = LinearRegression().fit(X_train,Y_train)

reg1.coef_

array([ 4.82768458e+00, -2.53497405e-01, -3.05460851e-03,  1.34421653e+00,
       2.76226332e+02,  8.29827101e+01])

reg1.intercept_

-26660.916355396304
```

▼ Training Error and Accuracy

```
Y1_pred_train = reg1.predict(X_train)
```

```
Y1_pred_train
```

```
array([48.10605557, 37.04941204, 43.14582214, 47.92112454, 44.95177784,
       48.57840423, 8.97685275, 47.19298577, 31.8462119 , 40.99154045,
       41.03850144, 45.33669462, 32.07913058, 42.67462012, 49.73106651,
       28.47654364, 37.61907878, 14.28000956, 46.05328572, 52.40675288,
       45.88483561, 23.24977577, 47.33111718, 39.97407609, 35.97596601,
       32.73170948, 46.02561798, 43.80549204, 29.84859185, 29.26832525,
       52.03185935, 35.45120232, 36.37106317, 36.63167436, 48.09551001,
       38.50474495, 47.95766825, 12.09082569, 43.62781699, 13.49913597,
       41.09136371, 42.31549764, 45.75528701, 38.65132947, 43.12022261,
       34.98574387, 44.514353 , 33.0192849 , 36.03120704, 31.04120528,
       45.19465114, 33.33229827, 28.22440157, 42.14477069, 24.75599578,
       46.11793537, 47.95869671, 49.14693425, 34.28552732, 49.10205863,
       46.04889138, 53.58832428, 42.15172752, 37.2748471 , 44.63383569,
       38.22528191, 46.85214607, 37.97032924, 25.69360594, 40.26619403,
       38.92552232, 24.92264919, 39.97600504, 39.17917251, 14.34626272,
       21.48014645, 21.80167231, 46.77938209, 54.7191962 , 34.61039579,
       37.4108709 , 40.76953222, 36.05666264, 33.15487656, 28.64071645,
       51.51590091, 12.42803405, 29.25759738, 50.5251848 , 45.04402359,
       43.18129478, 48.06956856, 47.34288812, 15.5087912 , 45.94026031,
       42.90117331, 36.17841914, 32.52582968, 47.60766991, 40.79127949,
       33.70295711, 34.98574387, 46.65173263, 53.31513652, 12.11617543,
```

```
51.11520309, 29.65134695, 39.54546493, 45.0826676 , 37.74385028,
26.76683727, 39.31297196, 27.49218368, 33.30306237, 46.78746026,
50.11837755, 28.72413286, 32.45447866, 44.16246335, 30.08564729,
39.77240729, 41.13743362, 8.16223898, 46.27537819, 39.04486796,
34.74272165, 11.19681438, 31.43871467, 52.46528665, 42.07550032,
53.96850005, 38.74637944, 47.8566337 , 35.91824149, 38.22528191,
49.41647402, 43.43014396, 47.48155329, 37.0674772 , 46.37742162,
52.51888963, 42.73011021, 46.27638455, 30.61408418, 15.5139466 ,
41.39706596, 46.07127248, 12.12820468, 32.86907514, 43.56159095,
41.60006555, 30.25781794, 45.39255188, 37.2707601 , 32.55287903,
51.92142642, 29.00323137, 41.04480167, 31.35760529, 46.04592274,
30.13410329, 35.58858763, 45.83264564, 37.28338595, 33.02004742,
41.71146232, 55.55067782, 44.54647213, 47.20214441, 53.97329798,
32.57751853, 43.36747413, 44.45087163, 32.75395757, 49.06614652,
40.40023515, 41.95270934, 47.89215386, 47.60766991, 44.20618986,
40.46324081, 36.41472597, 34.07881171, 40.40375213, 45.36353386,
39.45997071, 41.36461372, 46.17451037, 46.11793537, 35.83553238,
46.843513 , 44.76746246, 47.20508078, 12.04564149, 49.71804487,
47.99890606, 40.02992006, 37.46613878, 27.5978666 , 26.02502837,
43.13350893, 39.05695368, 45.7906639 , 42.9286357 , 25.17917323,
14.45031754, 38.1445481 , 33.5685453 , 32.1504816 , 47.64673246,
25.39173682, 34.36622417, 33.53483116, 32.68400639, 50.37435605,
32.62892638, 36.38937623, 47.42420387, 48.04421882, 33.16618343,
32.35761742, 31.69865035, 31.0040844 , 22.5623428 , 45.32057632,
49.58099686, 31.77735404, 33.27208186, 42.57952948, 12.42803405,
35.71812082, 49.20017862, 37.68891145, 55.95336085, 45.52186914,
47.83588792, 44.54263911, 28.77453172, 30.22289805, 35.09842758,
32.43112646, 33.90869632, 37.12970756, 12.67798011, 29.10786417,
37.79370243, 14.93709046, 35.38644169, 41.22102191, 47.78518844,
39.01098481, 12.78934324, 42.62703196, 37.02902771, 49.1282482 ,
51.92142642, 11.17800918, 49.73858094, 54.7191962 , 24.01393774,
34.78389187, 38.60612335, 37.9050797 , 49.41647402, 30.30610146,
51.68140646, 31.96721537, 40.06328623, 33.50074505, 36.33377595,
12.28246885, 32.55414981, 46.17031587, 44.55348662, 39.65305598,
12.84634954, 11.79909991, 51.29873461, 31.52334256, 41.13361271,
24.82651519, 41.75571833, 47.04578249, 12.91800838, 34.54850724,
```

`Y_train`

377	56.8
128	60.7
364	33.1
254	51.8
190	42.3
...	
319	26.9
206	44.0
332	39.6
129	41.0
130	37.5

`Name: Y house price of unit area, Length: 289, dtype: float64`

`mean_squared_error(Y_train,Y1_pred_train)`

```
72.21054469609783
```

```
r2_score(Y_train, Y1_pred_train)
```

```
0.6021773629143302
```

▼ Testing Error and Accuracy

```
Y1_pred_test = reg1.predict(X_test)
```

```
mean_squared_error(Y_test, Y1_pred_test)
```

```
94.27507102517012
```

```
r2_score(Y_test, Y1_pred_test)
```

```
0.49449730201844755
```

▼ Plot

```
sns.pairplot(df)
```

<seaborn.axisgrid.PairGrid at 0x7f5dc6f13c10>



▼ 2. Linear Regression Model (Ridge)

```

reg2 = linear_model.Ridge(alpha=0.5)
reg2.fit(X_train, Y_train)

Ridge(alpha=0.5)

reg2.coef_
array([ 5.29274328e+00, -2.43142026e-01, -5.17584317e-03,
       1.50659251e+00,
       1.39398123e+01,  1.88271989e+00])

reg2.intercept_
-11190.39542993792

```

▼ Training Error and Accuracy

```
Y2_pred_train = reg2.predict(X_train)
```

```
Y2_pred_train
```

```
array([53.242762 , 39.54512605, 41.91228434, 44.77705086, 43.84958491,
       47.3878371 , 7.95503799, 49.39558114, 33.60058798, 42.917883 ,
       43.5680915 , 43.91859495, 32.10606056, 44.52628928, 49.88295134,
       30.37001889, 42.27286971, 16.73561876, 47.10237792, 52.88884253,
       45.91879146, 27.89482255, 48.29824331, 37.67465636, 35.14051759,
       33.01584607, 45.93949592, 45.77653249, 29.27754537, 29.69755569,
       50.41341905, 35.96810902, 24.0914191 , 36.72272731, 45.41769147,
       37.753515 , 45.61960793, 14.06823134, 45.53955505, 15.87604484,
       41.75356485, 40.12493499, 47.76084952, 33.3126436 , 37.95965005,
       35.72993026, 41.82024989, 33.6135518 , 35.2944865 , 30.46963094,
       47.46223717, 34.1507462 , 27.86844788, 40.78237564, 29.56004925,
       48.32564732, 48.90131664, 44.69656623, 34.68996984, 47.55117469,
       46.55150353, 54.18771415, 42.52556494, 37.39900656, 44.16828566,
       32.84903171, 44.39367892, 36.58233777, 25.93737796, 42.11223022,
       35.40498374, 25.55623008, 40.45590281, 43.6175918 , 16.90910227,
       25.89902902, 26.36359145, 43.98821893, 55.43795736, 35.31494677,
       36.43308176, 43.04674846, 39.22700636, 34.54315962, 27.25199522,
       50.19754633, 15.26580851, 26.81612299, 50.80863234, 45.77344268,
       43.54634505, 46.59479928, 49.5923447 , 17.84327518, 48.08866988,
       45.14068345, 38.97220253, 34.68762789, 45.22893864, 45.49852686,
       33.54255743, 35.72993026, 40.52329048, 54.79892934, 14.09254554,
       49.75824864, 28.8676808 , 35.59023836, 40.1180956 , 38.07715251,
       27.18909713, 38.63205761, 27.99474991, 27.82615467, 48.9509907 ,
       49.63874774, 29.28726225, 32.52104405, 49.16243296, 30.42447363,
       42.23941047, 41.87406255, 4.10887334, 44.47138492, 37.72617187,
       37.03028591, 11.34802419, 29.44446609, 51.1688093 , 42.65163589,
       54.60799039, 38.33145839, 47.13826131, 38.50545554, 32.84903171,
       46.90368885, 45.361549 , 46.19853083, 32.258602 , 44.80161529,
       50.08073481, 37.5341269 , 40.10830699, 32.57781075, 15.33228891,
       43.36247343, 43.53410499, 12.89494752, 33.82031946, 41.81025442,
       41.15685823, 31.63474827, 40.47391101, 34.90094889, 33.52141696,
       50.64213677, 29.66526935, 40.69872527, 29.8193514 , 43.50979079,
       30.91551256, 35.34657087, 44.46648189, 37.48651175, 32.77472726,
       44.46162608, 54.11549278, 43.31076949, 44.78434821, 51.99114572,
       33.42008101, 36.83325931, 46.1657503 , 33.00042894, 48.21246741,
       40.55854185, 37.74719619, 42.36803828, 45.22893864, 46.21583018,
       39.80320526, 41.08230332, 33.01984414, 38.01511785, 44.37318881,
       41.22834209, 42.04670997, 44.43322298, 48.32564732, 34.39884797,
       45.13873004, 46.10167959, 52.52249331, 12.87798583, 47.82838693,
       48.22730063, 44.38630981, 37.1149724 , 28.41557609, 21.90284728,
       44.91210605, 38.80904113, 44.32955765, 45.05201434, 22.34209445,
       19.32137631, 38.5164502 , 32.31383708, 34.2726444 , 46.58419665,
       25.8353727 , 34.63086119, 33.86000286, 33.05712342, 49.43147232,
       35.28860765, 41.05798912, 45.77148925, 46.57048508, 34.20274514,
       31.29792351, 32.03222109, 30.75575977, 27.16532158, 42.70413801,
       49.23078311, 31.73261007, 33.07365279, 45.8488036 , 15.26580851,
       33.82209018, 45.89229633, 37.93110219, 54.11911373, 47.19999672,
       45.39220327, 49.58270919, 30.21691054, 19.40917291, 33.88396693,
       32.22373648, 33.17045849, 35.74853313, 13.36933394, 30.91258405,
```

```
40.31450033, 19.66706134, 36.16922795, 41.7287211 , 45.34357487,  
43.79304074, 15.19524716, 41.64814441, 36.57082931, 46.18240363,  
50.64213677, 7.27658138, 50.81452486, 55.43795736, 24.52437832,  
34.5329628 , 41.24847389, 37.86288978, 46.90368885, 31.90645145,  
52.08318976, 32.50468383, 40.60382627, 35.09284221, 36.29606911,  
14.4326766 , 33.43648296, 46.21425516, 44.76374025, 37.18515087,  
14.90349106, 12.08062974, 49.86321938, 31.39316133, 41.82001156,  
33.52675603, 41.37651269, 49.31459888, 17.99401976, 39.62891312,  
...
```

Y_train

```
377    56.8  
128    60.7  
364    33.1  
254    51.8  
190    42.3  
...  
319    26.9  
206    44.0  
332    39.6  
129    41.0  
130    37.5  
Name: Y house price of unit area, Length: 289, dtype: float64
```

```
mean_squared_error(Y_train,Y2_pred_train)
```

```
78.79568286111693
```

```
r2_score(Y_train, Y2_pred_train)
```

```
0.5658984919903313
```

▼ Testing Error and Accuracy

```
Y2_pred_test = reg2.predict(X_test)
```

```
mean_squared_error(Y_test, Y2_pred_test)
```

```
93.5398246177431
```

```
r2_score(Y_test, Y2_pred_test)
```

```
0.498439691439044
```

▼ Plot

```
sns.pairplot(df)
```

```
<seaborn.axisgrid.PairGrid at 0x7f5dc1429790>
```



▼ 3. Linear Regression (Lasso)

Figure 10. Scatter plots showing the relationship between the number of clusters (n) and the number of nodes (m) for each dataset.

```
reg3 = linear_model.Lasso(alpha=0.1)  
reg3.fit(X_train, Y_train)
```

Lasso(alpha=0.1)

106 | Page

reg3.coef

```
array([ 4.15928182, -0.24130704, -0.00526412,  1.50776942,  0.  
      0.        ])
```

Einheit 7.5

reg3.intercept

-8331.61762341014

25.00

▼ Training Error and Accuracy

```
Y3 pred train = reg3.predict(X train)
```

Y3 pred train

```
array([53.2613528 , 39.78456334, 41.55444048, 45.16801797, 43.3946169 ,  
      47.58051206, 7.64166655, 49.47340263, 34.03311588, 43.10019518,  
      43.60506601, 43.47168875, 32.35979621, 45.08177459, 49.84819627,  
      30.73304726, 42.59499111, 16.8930234 , 46.7624272 , 52.95954576,  
      45.4263622 , 28.08720293, 48.04396654, 37.59310143, 35.16496428,  
      32.86780537, 46.01547977, 46.04920294, 29.76718282, 30.09351902,  
      49.9935596 , 36.11214879, 23.18528728, 37.14501146, 45.73403639,  
      37.48324304, 45.10642656, 14.68481154, 46.09902887, 16.22255404,  
      41.8003828 , 39.90737007, 47.93649086, 32.84957331, 37.87715515,  
      35.35035262, 42.15588013, 33.24213205, 35.83058006, 30.79801856,  
      47.1815306 , 33.88836832, 28.37629741, 40.99993644, 29.37572096,  
      48.03232103, 48.64230526, 44.17046753, 34.21031508, 47.82631674,  
      46.27078411, 53.97523551, 42.36840824, 37.77831647, 43.85859558,  
      32.48022221, 44.16312892, 36.05711719, 26.32401974, 42.48214651,  
      34.79339284, 26.17506007, 40.1780339 , 43.92233538, 16.88367377,  
      26.56293688, 26.93934785, 44.40173259, 54.94266385, 35.02926293,  
      35.92899536, 43.07334123, 39.41701663, 34.48860684, 27.73954228,  
      49.90595765, 15.63955278, 27.35110498, 51.34993804, 46.08497915,  
      43.55556399, 46.0369339 , 49.57777031, 17.61122727, 48.08214697,  
      45.15057493, 38.84425075, 34.4760751 , 44.80946758, 45.6304895 ,  
      33.31057826, 35.35035262, 39.81029485, 54.53665347, 14.70894224,
```

```
49.56073726, 29.30443591, 35.52203137, 39.56331426, 38.65551131,
27.7777658 , 38.88870615, 28.39581447, 27.26688847, 49.12402295,
49.30216034, 29.59020574, 32.6808859 , 49.75873049, 30.99204508,
42.56110046, 42.01901062, 4.28997463, 44.08346353, 37.7684753 ,
37.45858393, 11.95749138, 29.06376991, 51.24212706, 43.06221194,
54.30048448, 38.02015332, 47.36730366, 38.48666117, 32.48022221,
46.65767897, 45.72811325, 45.82360283, 32.36389753, 44.81206193,
49.91147589, 37.54588679, 39.48920517, 32.8381774 , 14.96365127,
43.44957486, 43.49265956, 12.77606167, 33.56588248, 42.1799044 ,
40.84769354, 31.59726528, 39.82596386, 35.26534933, 33.17765478,
50.25533732, 29.68849178, 40.58701829, 29.75731754, 43.46852886,
30.65592012, 35.07060006, 44.00617152, 37.86966684, 33.12446164,
44.12329621, 53.692822 , 43.51995039, 44.46008791, 52.11022561,
33.05793575, 36.96714699, 46.24971199, 32.89766634, 48.13679506,
40.57068475, 38.02313705, 41.70185208, 44.80946758, 46.39442333,
39.77148531, 41.51926443, 33.09390907, 38.26947237, 44.88774113,
41.78754645, 41.77497268, 44.89269013, 48.03232103, 34.41534124,
45.32815634, 46.2549114 , 52.36405653, 12.66625223, 47.32436838,
48.68803016, 45.06868762, 37.18120128, 28.73110133, 21.28941817,
45.28108644, 38.4652483 , 44.59838882, 44.76222359, 22.80630541,
19.23740321, 39.0007317 , 32.56946226, 34.15498542, 46.89179484,
26.06029572, 34.3187836 , 33.5681357 , 33.4271404 , 48.86581389,
35.28987348, 41.49513373, 45.38520594, 46.01280319, 33.84806512,
31.56097035, 32.4030853 , 30.72434611, 27.5506584 , 42.85048019,
48.70825254, 31.61135496, 32.93706788, 45.8068181 , 15.63955278,
33.84253929, 46.07511525, 38.21904651, 53.95233198, 46.79241685,
45.0633555 , 50.08397946, 30.28104644, 18.50638918, 33.94587726,
32.33908881, 32.64603743, 35.78179385, 13.05427553, 31.54965937,
40.64227425, 19.57274317, 35.69557301, 42.32750835, 45.0150941 ,
43.84540273, 15.54689434, 41.41270726, 36.94627216, 45.73054922,
50.25533732, 6.59684531, 51.37406875, 54.94266385, 24.83766018,
34.94659818, 41.39325571, 38.23129873, 46.65767897, 31.59369517,
52.34149709, 32.6016528 , 40.2344681 , 34.76333011, 36.16762597,
14.96300391, 33.17991227, 46.01320807, 44.48544196, 37.62729299,
15.33115019, 12.41048119, 49.37381762, 31.33213757, 41.95364335,
33.46495499, 41.42722098, 49.02544461, 18.5033239 , 39.81070858,
```

`Y_train`

377	56.8
128	60.7
364	33.1
254	51.8
190	42.3
...	
319	26.9
206	44.0
332	39.6
129	41.0
130	37.5

`Name: Y house price of unit area, Length: 289, dtype: float64`

`mean_squared_error(Y_train,Y3_pred_train)`

```
79.62551490541263
```

```
r2_score(Y_train, Y3_pred_train)
```

```
0.5613267777955517
```

▼ Testing Error and Accuracy

```
Y3_pred_test = reg3.predict(X_test)
```

```
mean_squared_error(Y_test, Y3_pred_test)
```

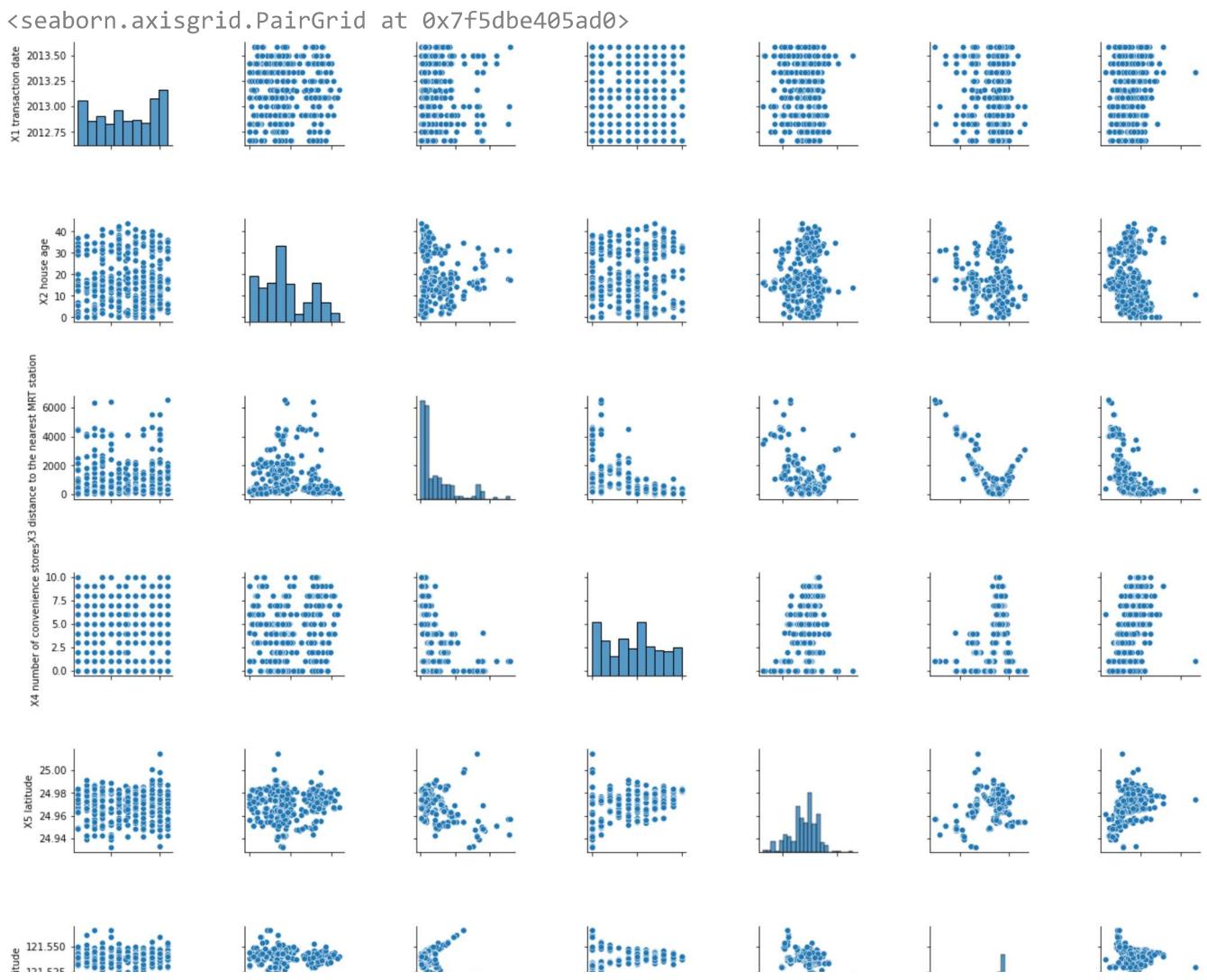
```
93.71168915730729
```

```
r2_score(Y_test, Y3_pred_test)
```

```
0.49751815420239887
```

▼ Plot

```
sns.pairplot(df)
```



▼ Splitting the data (60/40)

• — • — • — • — • — • —

```
X_train, X_test, Y_train, Y_test = train_test_split(X,Y,test_size=0.40)
```

Figure 10. The effect of the number of hidden neurons on the performance of the proposed model.

```
X_train.shape, X_test.shape, Y_train.shape, Y_test.shape
```

((248, 6), (166, 6), (248,), (166,)))

▼ 1. Linear Regression(Ordinary Least Squares)

```
reg4 = LinearRegression().fit(X_train,Y_train)
```

reg4.coef

```
array([ 4.99437913e+00, -1.91041045e-01, -4.07687561e-03,  1.31808124e+00,
       2.09767077e+02, -1.71149160e+00])
```

```
reg4.intercept_
```

```
-15043.414784984321
```

▼ Training Error and Accuracy

```
Y4_pred_train = reg4.predict(X_train)
```

```
Y4_pred_train
```

```
array([37.2426691 , 34.64812958, 33.75194816, 24.61009906, 37.246368 ,  
    45.02262471, 26.1554139 , 46.61457134, 47.5053536 , 8.94970436,  
    45.22106288, 34.88141491, 25.34983188, 45.24375624, 32.92642135,  
    30.23869532, 28.90792307, 46.4949627 , 31.81708409, 36.34571632,  
    41.77810282, 42.85078002, 33.04203391, 46.84115894, 31.7055342 ,  
    40.87899723, 52.99613221, 43.10466727, 15.78951668, 26.16722872,  
    41.34457581, 37.89763171, 34.73694197, 44.17033587, 26.25579644,  
    32.46514286, 24.27230277, 40.67573988, 38.14245923, 34.96583916,  
    41.88367794, 45.11761795, 43.99587867, 36.06285828, 48.9623671 ,  
    51.67674071, 30.10756908, 35.25289545, 43.50017004, 46.98138335,  
    42.13685961, 11.51342875, 44.56967613, 15.78951668, 36.82859472,  
    49.65501871, 33.59208546, 46.58435928, 41.68345965, 51.76664153,  
    33.87489644, 45.89580554, 39.37856766, 38.79453806, 17.22185246,  
    42.7653747 , 22.62303449, 36.3000965 , 36.72560502, 38.68573719,  
    47.00037463, 48.93428544, 43.67259272, 46.83189945, 44.45603202,  
    36.62942448, 47.01761353, 47.26850481, 37.27091101, 45.17899596,  
    31.71828753, 42.10118919, 17.88447756, 35.64832481, 11.52578808,  
    41.71125548, 30.41969455, 51.07235854, 50.48908003, 14.09513825,  
    45.80722695, 49.78571849, 46.5724194 , 41.45822664, 27.60737287,  
    41.9148158 , 31.38291709, 47.36567077, 48.26244458, 34.15088195,  
    42.00361038, 29.06003731, 43.05362309, 41.51615137, 45.17124118,  
    42.97549561, 36.93847712, 44.07031227, 50.57535906, 39.9782666 ,  
    48.10299515, 13.62890095, 13.95705587, 33.10537497, 43.9596322 ,  
    32.34726103, 47.22542424, 37.32300648, 37.99626838, 38.46440918,  
    46.49108542, 50.98879838, 4.07599261, 49.82035072, 36.34490436,  
    34.07626863, 44.23278098, 25.88233101, 30.67232867, 28.28828268,  
    40.52950804, 17.24095656, 44.32445894, 33.94017228, 33.59496269,  
    38.66328194, 30.63481026, 47.07568829, 30.69524716, 46.64285172,  
    36.5535168 , 38.29583812, 35.50233881, 46.55331529, 41.94239947,  
    47.52643434, 47.57236262, 39.06026973, 46.16642614, 41.07227222,  
    42.35009598, 16.84131358, 35.85578296, 48.46560731, 37.90059204,  
    40.44256366, 41.12064942, 14.77782808, 37.01657384, 40.81232791,  
    49.72778233, 29.3643484 , 49.05640402, 45.17947147, 14.42475405,  
    44.8726558 , 36.54769039, 16.36254978, 47.67474858, 54.33136894,  
    51.60175613, 41.46367606, 37.68000557, 47.03748009, 46.59808568,  
    36.99710999, 45.29949526, 34.7074145 , 12.02110575, 44.48484574,  
    47.39393879, 39.07170785, 44.61594449, 44.41354913, 43.17340096,  
    46.22176042, 45.31461937, 47.95699026, 42.8790298 , 34.16198961,  
    35.64832481, 38.72086965, 42.13685961, 48.22014685, 30.38563785,  
    51.60052333, 50.99488691, 52.21299429, 43.53223649, 43.60942632,
```

```
53.53551583, 47.32493661, 38.71898037, 44.8829793 , 45.40680321,  
46.85445143, 30.65174352, 34.91976996, 54.71979769, 43.78188317,  
37.96547113, 42.8790298 , 28.42210521, 47.01761353, 43.19489285,  
49.69248485, 43.84575332, 47.31602856, 47.39591682, 33.83343488,  
42.52109727, 29.35893602, 31.84302599, 45.00925791, 42.02326895,  
34.16096013, 46.84115894, 39.69952015, 38.79212148, 41.79871205,  
52.3876549 , 36.92901003, 43.60942632, 31.03023962, 24.67969777,  
47.26198509, 35.75669789, 14.72072313, 14.43964454, 49.57616942,  
34.59887277, 46.2205844 , 28.6851931 , 37.17436845, 13.82297714,  
43.16953592, 45.32542269, 35.59519042])
```

Y_train

```
319    26.9  
20     29.3  
112    23.1  
93     16.1  
91     43.2  
...  
405    37.2  
232    17.4  
293    42.5  
4      43.1  
297    28.5  
Name: Y house price of unit area, Length: 248, dtype: float64
```

mean_squared_error(Y_train, Y4_pred_train)

```
68.64911623669971
```

r2_score(Y_train, Y4_pred_train)

```
0.5897248248766711
```

▼ Testing Error and Accuracy

Y4_pred_test = reg4.predict(X_test)

mean_squared_error(Y_test, Y4_pred_test)

```
94.76814089461162
```

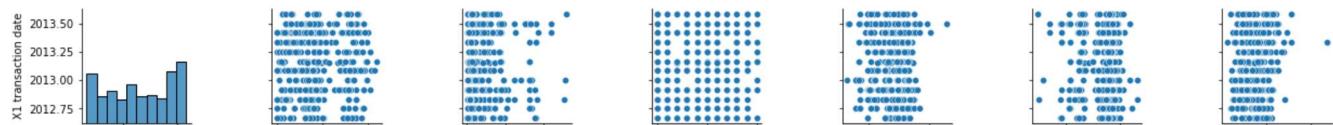
r2_score(Y_test, Y4_pred_test)

```
0.5374628378144427
```

▼ Plot

```
sns.pairplot(df)
```

```
<seaborn.axisgrid.PairGrid at 0x7f5dbd1670d0>
```



▼ 2. Linear Regression Model (Ridge)



```
reg5 = linear_model.Ridge(alpha=0.5)
reg5.fit(X_train, Y_train)
```

```
Ridge(alpha=0.5)
```



```
reg5.coef_
```

```
array([ 5.70607260e+00, -1.76003065e-01, -5.07678720e-03, 1.41084910e+00,
       9.11893474e+00, -1.45597480e+00])
```



```
reg5.intercept_
```

```
-11496.698000452256
```



▼ Training Error and Accuracy



```
Y5_pred_train = reg5.predict(X_train)
```

```
Y5_pred_train
```

```
array([41.24422698, 34.61151309, 34.51251608, 28.28277486, 33.23504924,
       48.29435107, 27.05668151, 45.0275199 , 49.16022556, 5.62142907,
       44.22857077, 35.01426216, 27.65088364, 44.32816714, 34.05489719,
       29.93671093, 31.63559407, 45.79692291, 31.74316917, 31.96525045,
       40.91757763, 42.69490635, 31.42167268, 47.93759668, 32.44487365,
       40.5253931 , 53.43145579, 45.23474705, 17.96057405, 23.06706108,
       41.19110352, 41.57496035, 35.49382009, 46.28820535, 28.51911296,
       35.12141604, 27.77140468, 43.74427071, 37.01803995, 34.78753829,
       42.94121384, 44.39535987, 42.48609875, 36.29579062, 52.51255834,
       51.1917578 , 30.02841385, 35.36618288, 43.08196885, 48.56796771,
       43.19799414, 11.68055914, 41.0645985 , 17.96057405, 37.36447442,
       48.83206749, 24.86803472, 45.78379929, 36.77989613, 52.02253795,
       34.26965042, 44.8722354 , 41.37168848, 38.49458036, 19.40692812,
       43.44312399, 22.9947786 , 35.62740129, 35.64534343, 37.99099642,
       48.54890431, 48.99828917, 42.08710275, 46.87036747, 43.59478372,
       36.63390502, 45.54978677, 47.53059148, 39.12553767, 43.1197394 ,
       31.24001924, 42.00700337, 17.82483792, 35.8221866 , 10.9748844 ,
       41.82692676, 30.28500652, 49.77094207, 49.78498162, 14.91436939,
       44.15846924, 49.07345312, 46.20029037, 39.88856335, 31.6915285 ,
```

```
45.48658803, 33.97690451, 46.45987209, 47.33739122, 33.85222447,
43.49373339, 28.9233084 , 46.22363559, 40.53947509, 40.83157603,
44.00197633, 35.68884088, 45.43258458, 50.64882072, 41.16710204,
49.26520285, 15.26817612, 16.43268413, 32.72818013, 45.15230499,
33.40027311, 48.87830574, 36.65950926, 37.11246118, 37.62266848,
48.21521965, 50.33368993, 3.71624238, 49.76865974, 32.01948151,
33.25048091, 45.71900422, 25.88803548, 33.5373205 , 28.02890126,
39.49105948, 19.42452843, 44.15018749, 29.81054368, 33.80645185,
37.9686859 , 31.37055134, 45.51048434, 32.55351155, 46.6807965 ,
35.51707813, 40.35323277, 34.9707653 , 46.18269007, 43.41957388,
48.23768599, 46.45263522, 38.60558536, 47.63265389, 43.17051796,
42.72813857, 19.29748642, 32.1517219 , 45.7072588 , 36.49758677,
39.62341221, 41.01872234, 15.5818248 , 34.87502867, 42.12001616,
49.28816288, 21.75834594, 49.89760357, 45.22799101, 16.18588963,
41.5685068 , 34.9494848 , 20.84278551, 44.79525136, 53.19142884,
50.1935067 , 43.43930131, 33.72625357, 45.47528372, 45.07047667,
37.06350143, 45.2448821 , 34.06071668, 9.08346492, 45.90618861,
45.98819019, 37.28879635, 42.78475201, 45.61048511, 45.58688149,
44.63207326, 40.95384874, 46.32317758, 44.05886735, 33.27819919,
35.8221866 , 38.41003637, 43.19799414, 51.97709935, 32.93257875,
49.67388394, 51.12813082, 50.95177148, 42.55281456, 45.34105465,
52.27371532, 48.52469551, 38.25368757, 43.47842029, 43.69675944,
46.37840868, 30.75873542, 34.17710157, 53.02063314, 41.83183788,
37.54737231, 44.05886735, 31.24803652, 45.54978677, 44.86745062,
49.47967119, 43.45975801, 45.99615744, 49.04157173, 34.15015748,
41.61312077, 28.68663943, 32.13245265, 43.74076234, 39.82583614,
34.53029238, 47.93759668, 39.24196861, 38.03017469, 38.90254224,
53.703554 , 35.39359428, 45.34105465, 31.82655506, 28.25583468,
46.27003336, 35.69954573, 19.26817628, 16.53245166, 49.53005342,
35.54358568, 48.01573371, 31.24588976, 40.00621292, 14.01645038,
44.14819419, 43.70042615, 36.02785441])
```

`Y_train`

319	26.9
20	29.3
112	23.1
93	16.1
91	43.2
...	
405	37.2
232	17.4
293	42.5
4	43.1
297	28.5

`Name: Y house price of unit area, Length: 248, dtype: float64`

`mean_squared_error(Y_train,Y5_pred_train)`

72.33032616608186

`r2_score(Y_train, Y5_pred_train)`

```
0.567724409849688
```

▼ Testing Error and Accuracy

```
Y5_pred_test = reg5.predict(X_test)

mean_squared_error(Y_test, Y5_pred_test)

102.21070202771007

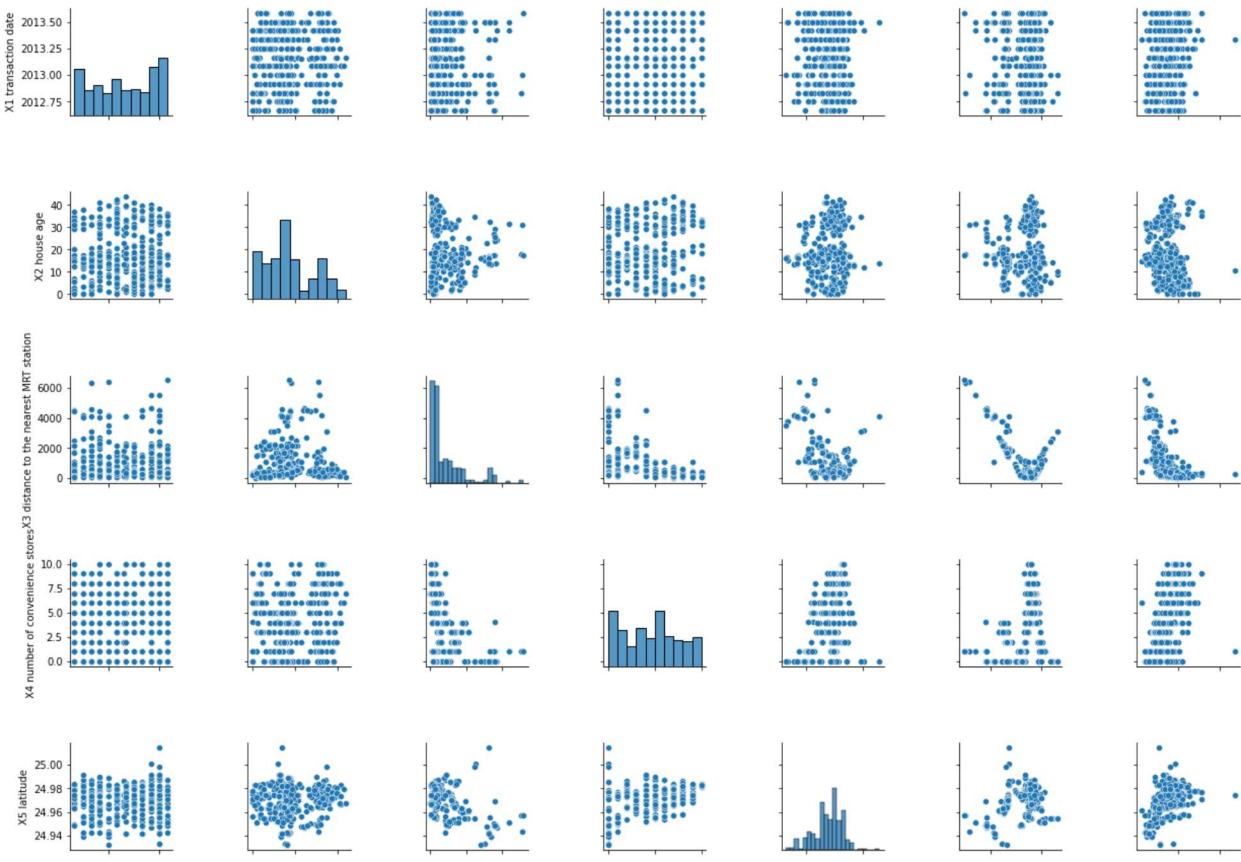
r2_score(Y_test, Y5_pred_test)

0.5011377493047491
```

▼ Plot

```
sns.pairplot(df)
```

```
<seaborn.axisgrid.PairGrid at 0x7f5dbbe62e90>
```



▼ 3. Linear Regression (Lasso)



```
reg6 = linear_model.Lasso(alpha=0.1)
reg6.fit(X_train, Y_train)
```

```
Lasso(alpha=0.1)
```



```
reg6.coef_
```

```
array([ 4.57970944, -0.17555623, -0.00508059,  1.41245639,  0.,
       0.        ])
```

```
reg6.intercept_
```

```
-9178.42594884891
```

▼ Training Error and Accuracy

```
Y6_pred_train = reg6.predict(X_train)
```

Y6_pred_train

```
array([41.2767447 , 34.32345381, 34.25667857, 28.72475995, 32.95344437,
       48.76771734, 27.37714858, 45.46876349, 48.90128765, 5.97779979,
       44.41399522, 34.77922305, 27.89306927, 44.55006085, 33.92293162,
       30.36694418, 32.07050249, 46.11228633, 31.79955365, 31.78159134,
       40.92956517, 42.26583102, 31.34217982, 48.50916632, 32.38013192,
       40.47211028, 53.20072409, 45.17180566, 18.13223684, 22.60741616,
       41.16010257, 41.89563733, 36.09089667, 46.05397735, 29.1508711 ,
       34.79496366, 28.30250792, 43.92929907, 37.0238639 , 34.47419197,
       42.94995178, 44.43251146, 42.84849346, 35.82432465, 52.41686541,
       50.71451203, 30.31209398, 35.08164851, 42.82134264, 48.59206221,
       43.30006601, 12.33992083, 40.49509641, 18.13223684, 37.44590939,
       48.66021169, 24.23754364, 45.60777717, 37.02518249, 52.07335236,
       33.86120987, 44.49728331, 41.49850052, 38.82224451, 19.19143911,
       43.51219933, 23.32774575, 35.65905365, 36.12995687, 38.29428642,
       48.07821885, 48.95691336, 42.46084327, 46.90803946, 43.21818856,
       36.78471841, 45.15210557, 47.28802525, 39.7442972 , 43.57191456,
       31.66085784, 41.67509193, 17.49362677, 35.44420877, 10.66191869,
       41.49679482, 30.56227984, 49.3761789 , 49.42502317, 14.83751812,
       44.04228946, 48.97161527, 45.68212369, 39.68570059, 31.38396692,
       45.50604816, 33.66805592, 46.2744563 , 46.94298663, 33.72693612,
       43.5205177 , 29.30106228, 46.80021201, 40.17389817, 40.233421 ,
       43.81877804, 35.69431986, 45.63692709, 50.98109187, 41.66344574,
       48.98422146, 15.89710202, 16.81657179, 33.09622524, 45.45559191,
       33.5457894 , 48.80852793, 36.59772974, 37.26102907, 37.63430912,
       47.85655932, 49.76136111, 4.02002224, 50.27352697, 32.20726619,
       33.46098997, 46.01938076, 26.18967846, 33.68943168, 28.59349738,
       39.78463781, 19.20899473, 44.37381479, 29.32984864, 33.52100903,
       37.79294884, 31.70350945, 45.20630056, 32.40536162, 46.56286977,
       35.90679876, 40.5091195 , 35.00880213, 45.66456807, 43.46442665,
       48.0336744 , 46.75047285, 38.72440804, 47.84480636, 43.1992026 ,
       43.26511189, 19.09550014, 32.07189429, 45.07128939, 36.97388377,
       39.63297468, 40.66964552, 15.30940223, 34.75011119, 42.42825721,
       48.86562645, 21.07027163, 50.37417088, 44.89116063, 16.62680225,
       41.77695229, 34.938819 , 20.73225086, 44.34616887, 52.70077326,
       49.97291447, 43.66425877, 33.35111588, 45.17118931, 44.76740998,
       36.74108084, 44.93485061, 33.99338521, 8.59391878, 46.01704297,
       45.4971102 , 37.2668256 , 42.95002897, 45.63743481, 45.16595613,
       44.42240534, 40.35463083, 46.1189958 , 44.5446666 , 33.60109504,
       35.44420877, 37.87868588, 43.30006601, 51.69949417, 33.4644781 ,
       49.53141788, 51.36578746, 51.01992063, 42.21408633, 44.99289408,
       51.97107303, 48.24880679, 38.46756892, 43.57065938, 43.67514949,
       46.10301033, 30.76046274, 34.39730953, 52.88719839, 42.18521749,
       38.06201275, 44.5446666 , 31.59338467, 45.15210557, 44.61277819,
       49.04406317, 43.99823291, 45.80403539, 48.9721781 , 33.77642456,
       41.8150448 , 29.23621297, 31.85272323, 44.20095146, 40.16592711,
       34.24527538, 48.50916632, 39.47301533, 37.9907293 , 39.21456314,
       53.42883707, 35.28840335, 44.99289408, 32.06606971, 28.69318844,
       45.88864295, 35.19931249, 19.73531206, 16.89342353, 48.99348139,
       35.20186856, 47.95301854, 31.86747096, 40.13288953, 14.38446267,
       44.73199951, 43.96451904, 36.40637728])
```

Y_train

319 26.9

```
20      29.3
112     23.1
93      16.1
91      43.2
...
405     37.2
232     17.4
293     42.5
4       43.1
297     28.5
Name: Y house price of unit area, Length: 248, dtype: float64
```

```
mean_squared_error(Y_train,Y6_pred_train)
```

```
72.81164742067025
```

```
r2_score(Y_train, Y6_pred_train)
```

```
0.5648478373190825
```

▼ Testing Error and Accuracy

```
Y6_pred_test = reg6.predict(X_test)
```

```
mean_squared_error(Y_test, Y6_pred_test)
```

```
102.43854438148233
```

```
r2_score(Y_test, Y6_pred_test)
```

```
0.5000257136064157
```

▼ Plot

```
sns.pairplot(df)
```

<seaborn.axisgrid.PairGrid at 0x7f5dbab25fd0>



