M5_T02

March 10, 2023

1 Sprint 5

1.1 Tasca M5 T02

1.1.1 Exercici 1

Parteix el conjunt de dades adjunt en train i test. Estudia els dos conjunts per separat, a nivell descriptiu.

També adjunt trobaràs una descripció de les diferents variables del dataset.

[1]:
```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split

cols=['CRIM','ZN','INDUS','CHAS','NOX','RM','AGE','DIS','RAD','TAX','PTRATIO','B','LSTAT','MED
df=pd.read_csv('housing data.csv', sep=',',encoding='unicode-escape',names=cols)
df.head()
```

[1]:
```
      CRIM    ZN  INDUS  CHAS    NOX     RM   AGE     DIS  RAD    TAX  \
0  0.00632  18.0   2.31     0  0.538  6.575  65.2  4.0900    1  296.0
1  0.02731   0.0   7.07     0  0.469  6.421  78.9  4.9671    2  242.0
2  0.02729   0.0   7.07     0  0.469  7.185  61.1  4.9671    2  242.0
3  0.03237   0.0   2.18     0  0.458  6.998  45.8  6.0622    3  222.0
4  0.06905   0.0   2.18     0  0.458  7.147  54.2  6.0622    3  222.0

   PTRATIO       B  LSTAT  MEDV
0     15.3  396.90   4.98  24.0
1     17.8  396.90   9.14  21.6
2     17.8  392.83   4.03  34.7
3     18.7  394.63   2.94  33.4
4     18.7  396.90   5.33  36.2
```

[2]:
```
X_train, X_test = train_test_split(df, test_size=0.2, random_state = 7)
```

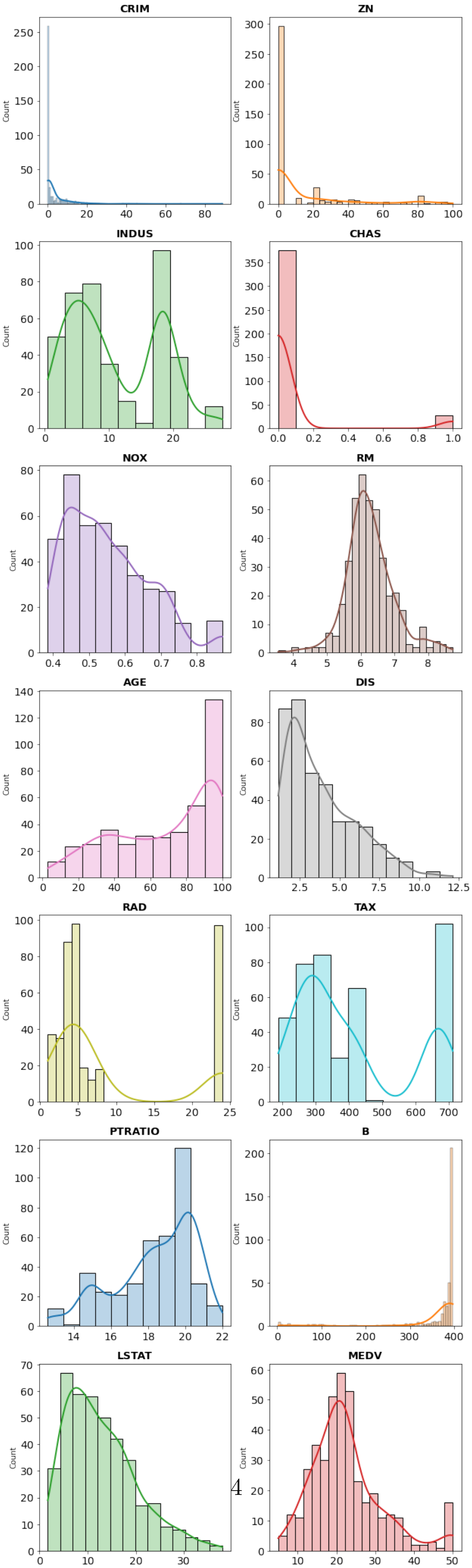
[58]:
```
def vardesc(var):
    nulls=var.isna().sum().sort_values()
    desc=var.select_dtypes(include=['float64', 'int']).describe().round(2)
    print(var.shape,'\n','Nombre de valors nuls al subdataset:','\n',nulls,'\n')
    print(var.info(),'\n')
    display(desc)

vardesc(X_train)
```

```
(404, 14)
 Nombre de valors nuls al subdataset:
 CRIM       0
ZN         0
INDUS      0
CHAS       0
NOX        0
RM         0
AGE        0
DIS        0
RAD        0
TAX        0
PTRATIO    0
B          0
LSTAT      0
MEDV       0
dtype: int64

<class 'pandas.core.frame.DataFrame'>
Int64Index: 404 entries, 355 to 175
Data columns (total 14 columns):
 #   Column   Non-Null Count  Dtype
---  ------   --------------  -----
 0   CRIM     404 non-null    float64
 1   ZN       404 non-null    float64
 2   INDUS    404 non-null    float64
 3   CHAS     404 non-null    int64
 4   NOX      404 non-null    float64
 5   RM       404 non-null    float64
 6   AGE      404 non-null    float64
 7   DIS      404 non-null    float64
 8   RAD      404 non-null    int64
 9   TAX      404 non-null    float64
 10  PTRATIO  404 non-null    float64
 11  B        404 non-null    float64
 12  LSTAT    404 non-null    float64
 13  MEDV     404 non-null    float64
dtypes: float64(12), int64(2)
memory usage: 47.3 KB
None
```

```
         CRIM      ZN   INDUS    CHAS     NOX      RM     AGE     DIS     RAD  \
count  404.00  404.00  404.00  404.00  404.00  404.00  404.00  404.00  404.00
mean     3.40   11.39   11.07    0.07    0.55    6.27   68.35    3.82    9.09
std      8.21   23.41    7.01    0.25    0.12    0.71   28.32    2.13    8.51
min      0.01    0.00    0.46    0.00    0.38    3.56    2.90    1.14    1.00
25%      0.08    0.00    5.08    0.00    0.45    5.88   44.15    2.09    4.00
50%      0.22    0.00    8.56    0.00    0.53    6.18   76.95    3.28    5.00
75%      2.66   12.50   18.10    0.00    0.62    6.62   94.52    5.21    8.00
max     88.98  100.00   27.74    1.00    0.87    8.72  100.00   12.13   24.00

          TAX  PTRATIO       B   LSTAT    MEDV
count  404.00   404.00  404.00  404.00  404.00
mean   401.95    18.39  359.05   12.76   22.52
std    166.37     2.17   87.17    7.28    9.25
min    187.00    12.60    2.52    1.73    5.00
25%    277.00    17.00  376.14    7.09   16.95
50%    330.00    18.80  391.96   11.43   20.95
75%    666.00    20.20  396.35   17.11   25.08
max    711.00    22.00  396.90   37.97   50.00
```

[65]:

```
# Distribution graph for each numerical variable

df1=X_train

fig, axes = plt.subplots(ncols=2, nrows=7, figsize=(10, 15))
axes = axes.flat
columnas_numeric = df1.select_dtypes(include=['float64', 'int']).columns

for i, column in enumerate(columnas_numeric):
    sns.histplot(
        data     = df1,
        x        = column,
        stat     = "count",
        kde      = True,
        color    = (list(plt.rcParams['axes.prop_cycle'])*2)[i]["color"],
        line_kws= {'linewidth': 2},
        alpha    = 0.3,
        ax       = axes[i]
    )
    axes[i].set_title(column, fontsize = 14, fontweight = "bold")
    axes[i].tick_params(labelsize = 14)
    axes[i].set_xlabel("")

plt.subplots_adjust(top = 2)
```


CRIM
Count
0
50
100
150
200
250
0
20
40
60
80
ZN
Count
0
50
100
150
200
250
300
0
20
40
60
80
100
INDUS
Count
0
20
40
60
80
100
0
10
20
CHAS
Count
0
50
100
150
200
250
300
350
0.0
0.2
0.4
0.6
0.8
1.0
NOX
Count
0
20
40
60
80
0.4
0.5
0.6
0.7
0.8
RM
Count
0
10
20
30
40
50
60
4
5
6
7
8
AGE
Count
0
20
40
60
80
100
120
140
0
20
40
60
80
100
DIS
Count
0
20
40
60
80
2.5
5.0
7.5
10.0
12.5
RAD
Count
0
20
40
60
80
100
0
5
10
15
20
25
TAX
Count
0
20
40
60
80
100
200
300
400
500
600
700
PTRATIO
Count
0
20
40
60
80
100
120
14
16
18
20
22
B
Count
0
50
100
150
200
0
100
200
300
400
LSTAT
Count
0
10
20
30
40
50
60
70
0
10
20
30
MEDV
Count
0
10
20
30
40
50
60
10
20
30
40
50

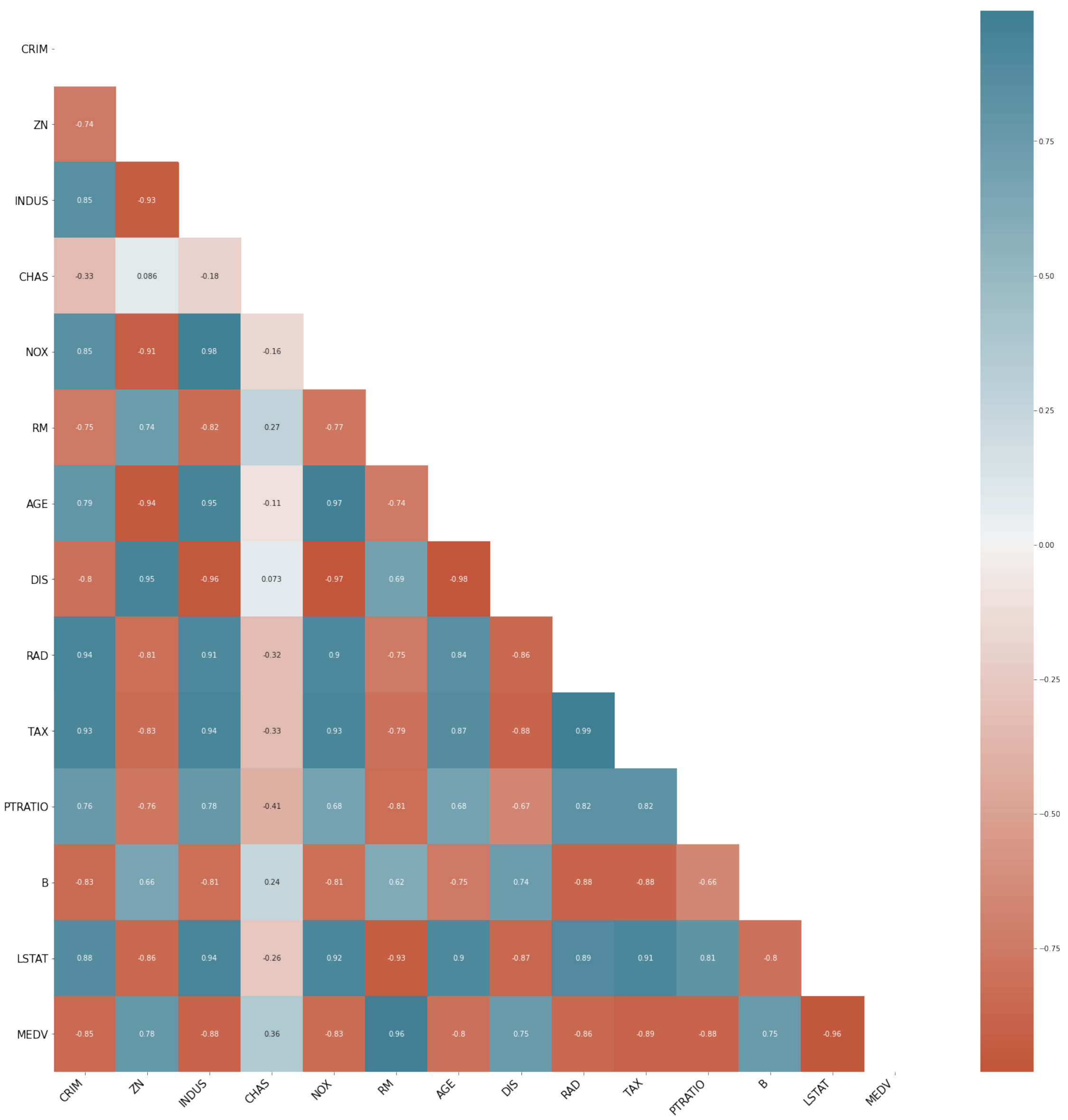
[181]:

```
# Heatmap matrix of correlations

fig, ax = plt.subplots(nrows=1, ncols=1, figsize=(27, 27))

corr= df1.select_dtypes(include=['float64', 'int']).corr(method='pearson').
 ↪corr()

matrix = np.triu(corr)

sns.heatmap(corr,
            annot=True,
            mask=matrix,
            cmap=sns.diverging_palette(20, 220, n=200),
            annot_kws = {"size": 10})

ax.set_xticklabels(
    ax.get_xticklabels(),
    rotation = 45,
    horizontalalignment = 'right',
)
ax.set_yticklabels(
    ax.get_yticklabels(),
    rotation = 0,
    horizontalalignment = 'right',
)
ax.tick_params(labelsize = 15)

fig.suptitle('Heatmap Correlation Matrix for X_train', fontsize = 30,␣
 ↪fontweight = "bold")
```

[181]:

```
Text(0.5, 0.98, 'Heatmap Correlation Matrix for X_train')
```

Heatmap Correlation Matrix for X_train



[63]:
```
vardesc(X_test)
```

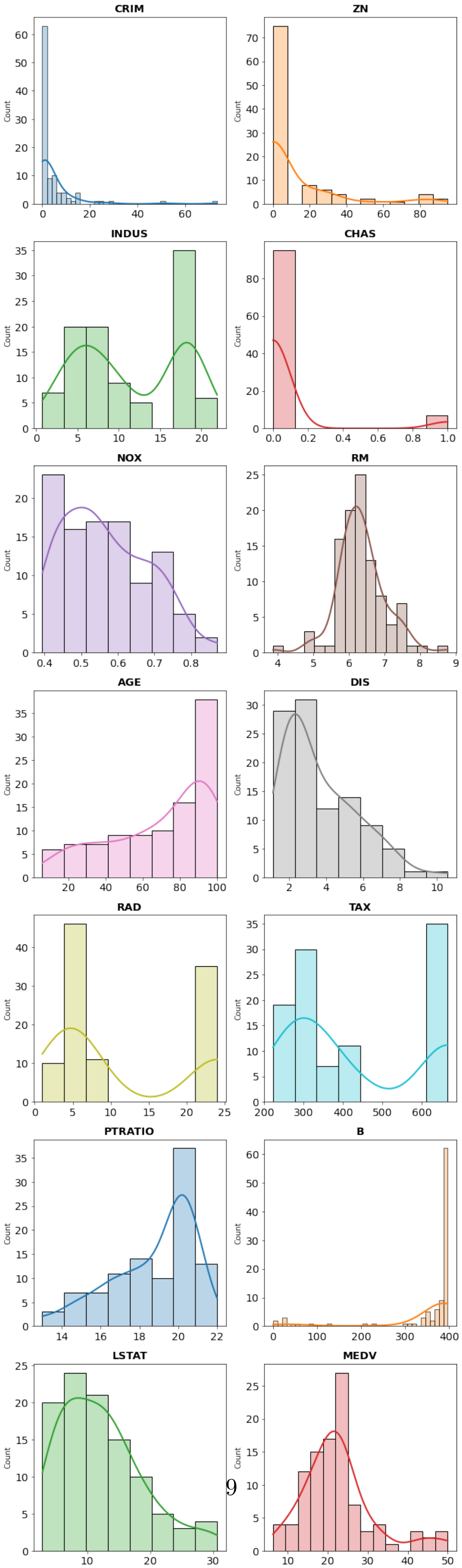
```
(102, 14)
 Nombre de valors nuls al subdataset:
 CRIM       0
ZN         0
INDUS      0
CHAS       0
```

```
NOX        0
RM         0
AGE        0
DIS        0
RAD        0
TAX        0
PTRATIO    0
B          0
LSTAT      0
MEDV       0
dtype: int64

<class 'pandas.core.frame.DataFrame'>
Int64Index: 102 entries, 357 to 26
Data columns (total 14 columns):
 #   Column   Non-Null Count  Dtype
---  ------   --------------  -----
 0   CRIM     102 non-null    float64
 1   ZN       102 non-null    float64
 2   INDUS    102 non-null    float64
 3   CHAS     102 non-null    int64
 4   NOX      102 non-null    float64
 5   RM       102 non-null    float64
 6   AGE      102 non-null    float64
 7   DIS      102 non-null    float64
 8   RAD      102 non-null    int64
 9   TAX      102 non-null    float64
 10  PTRATIO  102 non-null    float64
 11  B        102 non-null    float64
 12  LSTAT    102 non-null    float64
 13  MEDV     102 non-null    float64
dtypes: float64(12), int64(2)
memory usage: 12.0 KB
None

         CRIM      ZN   INDUS    CHAS     NOX      RM     AGE     DIS     RAD  \
count  102.00  102.00  102.00  102.00  102.00  102.00  102.00  102.00  102.00
mean     4.45   11.26   11.41    0.07    0.57    6.34   69.45    3.70   11.36
std      9.99   23.10    6.28    0.25    0.12    0.69   27.58    2.00    9.28
min      0.02    0.00    0.74    0.00    0.39    3.86    6.00    1.13    1.00
25%      0.09    0.00    5.70    0.00    0.47    5.95   50.18    2.15    4.00
50%      0.50    0.00    9.90    0.00    0.54    6.27   80.60    3.03    6.00
75%      4.84   20.00   18.10    0.00    0.66    6.65   91.78    4.93   24.00
max     73.53   95.00   21.89    1.00    0.87    8.78  100.00   10.59   24.00

          TAX  PTRATIO       B   LSTAT    MEDV
count  102.00   102.00  102.00  102.00  102.00
```

```
mean   433.16    18.73  347.26   12.22   22.57
std    175.49     2.14  106.03    6.59    9.03
min    222.00    13.00    0.32    2.88    6.30
25%    289.00    17.40  371.81    6.80   17.35
50%    342.50    19.70  390.80   11.18   21.80
75%    666.00    20.20  395.66   15.50   24.80
max    666.00    22.00  396.90   30.62   50.00
```

[67]:

```
# Distribution graph for each numerical variable

df2=X_test

fig, axes = plt.subplots(ncols=2, nrows=7, figsize=(10, 15))
axes = axes.flat
columnas_numeric = df2.select_dtypes(include=['float64', 'int']).columns


for ii, column in enumerate(columnas_numeric):
    sns.histplot(
        data     = df2,
        x        = column,
        stat     = "count",
        kde      = True,
        color    = (list(plt.rcParams['axes.prop_cycle'])*2)[ii]["color"],
        line_kws= {'linewidth': 2},
        alpha    = 0.3,
        ax       = axes[ii]
    )
    axes[ii].set_title(column, fontsize = 14, fontweight = "bold")
    axes[ii].tick_params(labelsize = 14)
    axes[ii].set_xlabel("")

plt.subplots_adjust(top = 2)
```

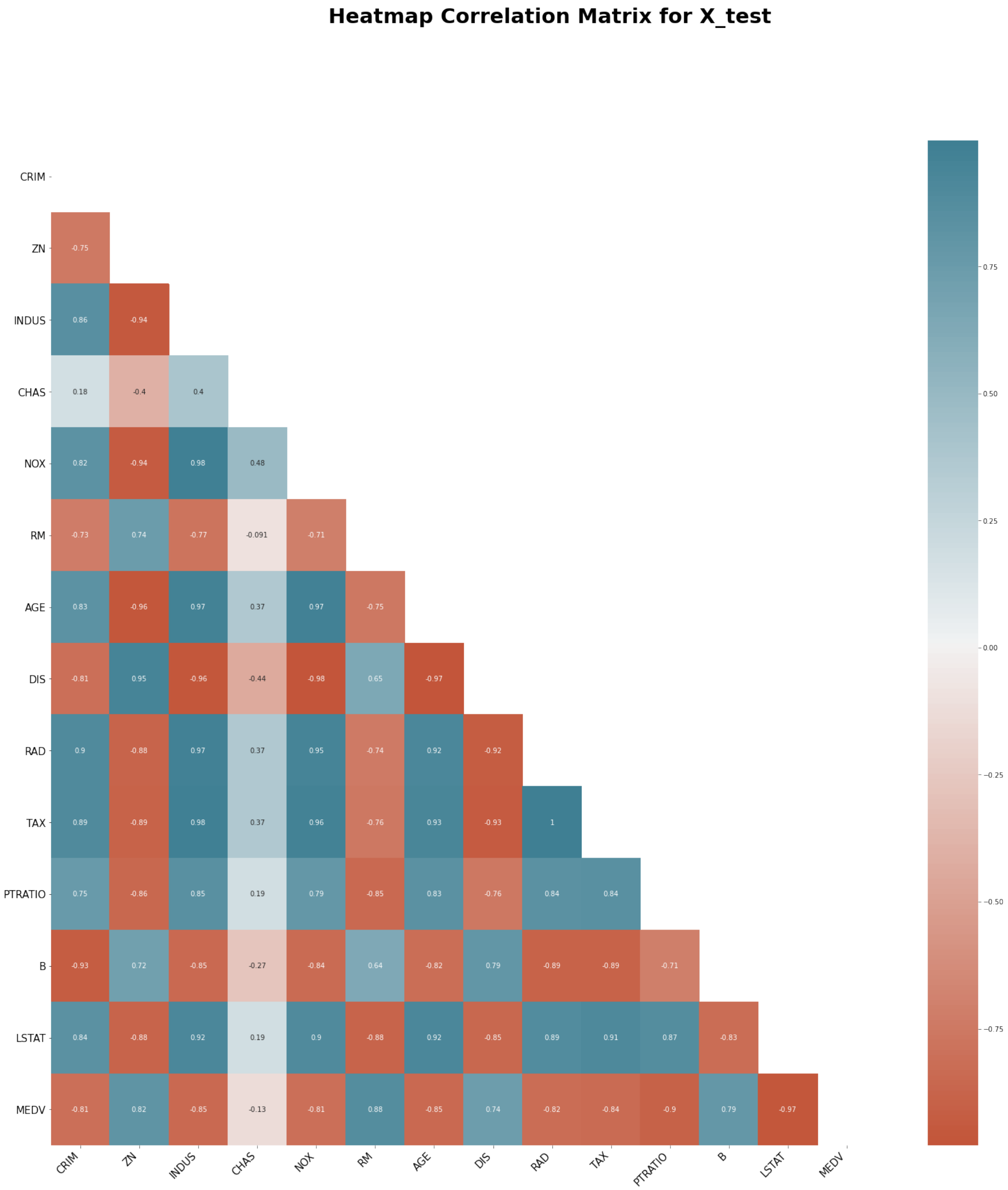

CRIM
Count
0
10
20
30
40
50
60
0
20
40
60
ZN
Count
0
10
20
30
40
50
60
70
0
20
40
60
80
INDUS
Count
0
5
10
15
20
25
30
35
0
5
10
15
20
CHAS
Count
0
20
40
60
80
0.0
0.2
0.4
0.6
0.8
1.0
NOX
Count
0
5
10
15
20
0.4
0.5
0.6
0.7
0.8
RM
Count
0
5
10
15
20
25
4
5
6
7
8
9
AGE
Count
0
5
10
15
20
25
30
35
20
40
60
80
100
DIS
Count
0
5
10
15
20
25
30
2
4
6
8
10
RAD
Count
0
10
20
30
40
0
5
10
15
20
25
TAX
Count
0
5
10
15
20
25
30
35
200
300
400
500
600
PTRATIO
Count
0
5
10
15
20
25
30
35
14
16
18
20
22
B
Count
0
10
20
30
40
50
60
0
100
200
300
400
LSTAT
Count
0
5
10
15
20
25
10
20
30
MEDV
Count
0
5
10
15
20
25
10
20
30
40
50

[182]:

```
# Heatmap matrix of correlations

fig, ax = plt.subplots(nrows=1, ncols=1, figsize=(27, 27))

corr= df2.select_dtypes(include=['float64', 'int']).corr(method='pearson').
 ↪corr()

matrix = np.triu(corr)

sns.heatmap(corr,
            annot=True,
            mask=matrix,
            cmap=sns.diverging_palette(20, 220, n=200),
            annot_kws = {"size": 10})

ax.set_xticklabels(
    ax.get_xticklabels(),
    rotation = 45,
    horizontalalignment = 'right',
)
ax.set_yticklabels(
    ax.get_yticklabels(),
    rotation = 0,
    horizontalalignment = 'right',
)
ax.tick_params(labelsize = 15)

fig.suptitle('Heatmap Correlation Matrix for X_test', fontsize = 30, fontweight␣
 ↪= "bold")
```

[182]:

```
Text(0.5, 0.98, 'Heatmap Correlation Matrix for X_test')
```



- Veiem en l'anàlisis descriptiu que les tendències generals i histogrames de les variables són similars entre train i test però hi ha alguna diferència a l'hora de les distribucions ja que en el cas del test, el nombre de valors es bastant més petit que el de train. A més, podem veure als heatmaps que les correlacions no varien exageradament en la majoria de casos.

1.1.2 Exercici 2

Aplica algun procés de transformació (estandarditzar les dades numèriques, crear columnes dummies, polinomis…).

[135]:
```
chas_dummy = pd.get_dummies(X_train['CHAS'], prefix='CHAS')
dfD = pd.concat([X_train, chas_dummy], axis=1)
dfD = dfD.drop('CHAS', axis=1) # remove the original column
dfD
```

[135]:
```
        CRIM    ZN  INDUS    NOX     RM   AGE      DIS  RAD    TAX  PTRATIO  \
355  0.10659  80.0   1.91  0.413  5.936  19.5  10.5857    4  334.0     22.0
460  4.81213   0.0  18.10  0.713  6.701  90.0   2.5975   24  666.0     20.2
120  0.06899   0.0  25.65  0.581  5.870  69.7   2.2577    2  188.0     19.1
346  0.06162   0.0   4.39  0.442  5.898  52.3   8.0136    3  352.0     18.8
457  8.20058   0.0  18.10  0.713  5.936  80.3   2.7792   24  666.0     20.2
..       …     …     …      …     …    …       …   …      …        …
67   0.05789  12.5   6.07  0.409  5.878  21.4   6.4980    4  345.0     18.9
502  0.04527   0.0  11.93  0.573  6.120  76.7   2.2875    1  273.0     21.0
25   0.84054   0.0   8.14  0.538  5.599  85.7   4.4546    4  307.0     21.0
196  0.04011  80.0   1.52  0.404  7.287  34.1   7.3090    2  329.0     12.6
175  0.06664   0.0   4.05  0.510  6.546  33.1   3.1323    5  296.0     16.6

          B  LSTAT  MEDV  CHAS_0  CHAS_1
355  376.04   5.57  20.6       1       0
460  255.23  16.42  16.4       1       0
120  389.15  14.37  22.0       1       0
346  364.61  12.67  17.2       1       0
457    3.50  16.94  13.5       1       0
..       …      …     …       …       …
67   396.21   8.10  22.0       1       0
502  396.90   9.08  20.6       1       0
25   303.42  16.51  13.9       1       0
196  396.90   4.08  33.3       1       0
175  390.96   5.33  29.4       1       0

[404 rows x 15 columns]
```

[174]:
```
rad_dummy = pd.get_dummies(X_train['RAD'], prefix='RAD')
dfD2 = pd.concat([X_train, rad_dummy], axis=1)
dfD2 = dfD2.drop('RAD', axis=1) # remove the original column
dfD2 = pd.concat([dfD2,chas_dummy], axis=1)
dfD2
```

[174]:
```
        CRIM    ZN  INDUS  CHAS    NOX     RM   AGE      DIS    TAX  PTRATIO  \
355  0.10659  80.0   1.91     0  0.413  5.936  19.5  10.5857  334.0     22.0
460  4.81213   0.0  18.10     0  0.713  6.701  90.0   2.5975  666.0     20.2
120  0.06899   0.0  25.65     0  0.581  5.870  69.7   2.2577  188.0     19.1
```

```
346  0.06162   0.0   4.39     0  0.442  5.898  52.3   8.0136  352.0     18.8
457  8.20058   0.0  18.10     0  0.713  5.936  80.3   2.7792  666.0     20.2
..       …    …     …    …     …     …    …        …     …       …
67   0.05789  12.5   6.07     0  0.409  5.878  21.4   6.4980  345.0     18.9
502  0.04527   0.0  11.93     0  0.573  6.120  76.7   2.2875  273.0     21.0
25   0.84054   0.0   8.14     0  0.538  5.599  85.7   4.4546  307.0     21.0
196  0.04011  80.0   1.52     0  0.404  7.287  34.1   7.3090  329.0     12.6
175  0.06664   0.0   4.05     0  0.510  6.546  33.1   3.1323  296.0     16.6

     …  RAD_2  RAD_3  RAD_4  RAD_5  RAD_6  RAD_7  RAD_8  RAD_24  CHAS_0  \
355  …      0      0      1      0      0      0      0       0       1
460  …      0      0      0      0      0      0      0       1       1
120  …      1      0      0      0      0      0      0       0       1
346  …      0      1      0      0      0      0      0       0       1
457  …      0      0      0      0      0      0      0       1       1
..   …    …    …    …    …    …    …    …     …     …
67   …      0      0      1      0      0      0      0       0       1
502  …      0      0      0      0      0      0      0       0       1
25   …      0      0      1      0      0      0      0       0       1
196  …      1      0      0      0      0      0      0       0       1
175  …      0      0      0      1      0      0      0       0       1

     CHAS_1
355       0
460       0
120       0
346       0
457       0
..      …
67        0
502       0
25        0
196       0
175       0

[404 rows x 24 columns]
```

- Dummy columns afegidas en referència a les columnes CHAS i RAD que hem vist que en l'anterior exploració de dades poden assolir un grup reduït de valors.

[141]:

```
from sklearn import preprocessing
from sklearn.preprocessing import PolynomialFeatures

scaler = preprocessing.StandardScaler().fit(X_train)
X_scaled = scaler.transform(X_train)
X_trainS=pd.DataFrame(X_scaled,columns=cols)
```

```
poly = PolynomialFeatures(degree=2, include_bias=False)
X_poly = poly.fit_transform(X_trainS.drop('MEDV', axis=1))
df_poly = pd.DataFrame(X_poly, columns=poly.get_feature_names(X_trainS.columns[:
 ↪-1]))

# Add the target variable back to the dataframe
df_poly['MEDV'] = X_trainS['MEDV']
df_poly.round(2)
```

[141]:

```
     CRIM    ZN  INDUS  CHAS   NOX    RM   AGE   DIS   RAD   TAX  …  \
0   -0.40  2.94  -1.31 -0.27 -1.20 -0.47 -1.73  3.18 -0.60 -0.41  …
1    0.17 -0.49   1.00 -0.27  1.40  0.61  0.77 -0.57  1.75  1.59  …
2   -0.41 -0.49   2.08 -0.27  0.25 -0.57  0.05 -0.73 -0.83 -1.29  …
3   -0.41 -0.49  -0.95 -0.27 -0.95 -0.53 -0.57  1.97 -0.72 -0.30  …
4    0.58 -0.49   1.00 -0.27  1.40 -0.47  0.42 -0.49  1.75  1.59  …
..    …   …    …   …   …   …   …   …   …   …  …
399 -0.41  0.05  -0.71 -0.27 -1.24 -0.56 -1.66  1.26 -0.60 -0.34  …
400 -0.41 -0.49   0.12 -0.27  0.18 -0.21  0.30 -0.72 -0.95 -0.78  …
401 -0.31 -0.49  -0.42 -0.27 -0.12 -0.95  0.61  0.30 -0.60 -0.57  …
402 -0.41  2.94  -1.36 -0.27 -1.28  1.44 -1.21  1.64 -0.83 -0.44  …
403 -0.41 -0.49  -1.00 -0.27 -0.36  0.39 -1.25 -0.32 -0.48 -0.64  …

     TAX PTRATIO  TAX B  TAX LSTAT  PTRATIO^2  PTRATIO B  PTRATIO LSTAT  \
0          -0.68  -0.08       0.40       2.78       0.33          -1.65
1           1.33  -1.89       0.80       0.70      -1.00           0.42
2          -0.42  -0.45      -0.28       0.11       0.11           0.07
3          -0.06  -0.02       0.00       0.04       0.01          -0.00
4           1.33  -6.49       0.91       0.70      -3.42           0.48
..           …    …        …        …        …            …
399        -0.08  -0.15       0.22       0.06       0.10          -0.15
400        -0.94  -0.34       0.39       1.45       0.52          -0.61
401        -0.69   0.37      -0.29       1.45      -0.77           0.62
402         1.17  -0.19       0.52       7.13      -1.16           3.19
403         0.53  -0.23       0.65       0.68      -0.30           0.84

       B^2  B LSTAT  LSTAT^2  MEDV
0     0.04    -0.19     0.98 -0.21
1     1.42    -0.60     0.25 -0.66
2     0.12     0.08     0.05 -0.06
3     0.00    -0.00     0.00 -0.58
4    16.68    -2.35     0.33 -0.98
..     …      …      …   …
399   0.18    -0.27     0.41 -0.06
400   0.19    -0.22     0.26 -0.21
401   0.41    -0.33     0.27 -0.93
402   0.19    -0.52     1.43  1.17
403   0.13    -0.37     1.05  0.74
```

```
[404 rows x 105 columns]
```

- Creació de múltiples columnes a partir dels polinomis de grau 2 i estandaritzades amb StandardScaler() (mitjana igual a zero).

1.1.3 Exercici 3

Resumeix les noves columnes generades de manera estadística i gràfica

```
[126]: def tidy_corr_matrix(corr_mat):

           corr_mat = corr_mat.stack().reset_index()
           corr_mat.columns = ['variable_1','variable_2','r']
           corr_mat = corr_mat.loc[corr_mat['variable_1'] != corr_mat['variable_2'], :]
           corr_mat['abs_r'] = np.abs(corr_mat['r'])
           corr_mat = corr_mat.sort_values('abs_r', ascending=False)

           return(corr_mat)


       corr_matrix = X_trainS.select_dtypes(include=['float64', 'int']).
        ↪corr(method='pearson')
       tidy_corr_matrix(corr_matrix).head(22)
```

```
[126]:     variable_1 variable_2         r     abs_r
       134        TAX        RAD  0.895147  0.895147
       121        RAD        TAX  0.895147  0.895147
       102        DIS        NOX -0.765258  0.765258
       63         NOX        DIS -0.765258  0.765258
       32       INDUS        NOX  0.755818  0.755818
       58         NOX      INDUS  0.755818  0.755818
       187       MEDV         RM  0.748919  0.748919
       83          RM       MEDV  0.748919  0.748919
       91         AGE        DIS -0.745199  0.745199
       104        DIS        AGE -0.745199  0.745199
       181      LSTAT       MEDV -0.736015  0.736015
       194       MEDV      LSTAT -0.736015  0.736015
       88         AGE        NOX  0.729836  0.729836
       62         NOX        AGE  0.729836  0.729836
       100        DIS      INDUS -0.702219  0.702219
       35       INDUS        DIS -0.702219  0.702219
       128        TAX      INDUS  0.694047  0.694047
       37       INDUS        TAX  0.694047  0.694047
       21          ZN        DIS  0.656811  0.656811
       99         DIS         ZN  0.656811  0.656811
       8         CRIM        RAD  0.648274  0.648274
       112        RAD       CRIM  0.648274  0.648274
```

[161]:

```
display(chas_dummy.describe().round(2))
display(rad_dummy.describe().round(2))
display(df_poly.describe().round(2))
```

```
       CHAS_0  CHAS_1
count  404.00  404.00
mean     0.93    0.07
std      0.25    0.25
min      0.00    0.00
25%      1.00    0.00
50%      1.00    0.00
75%      1.00    0.00
max      1.00    1.00
```

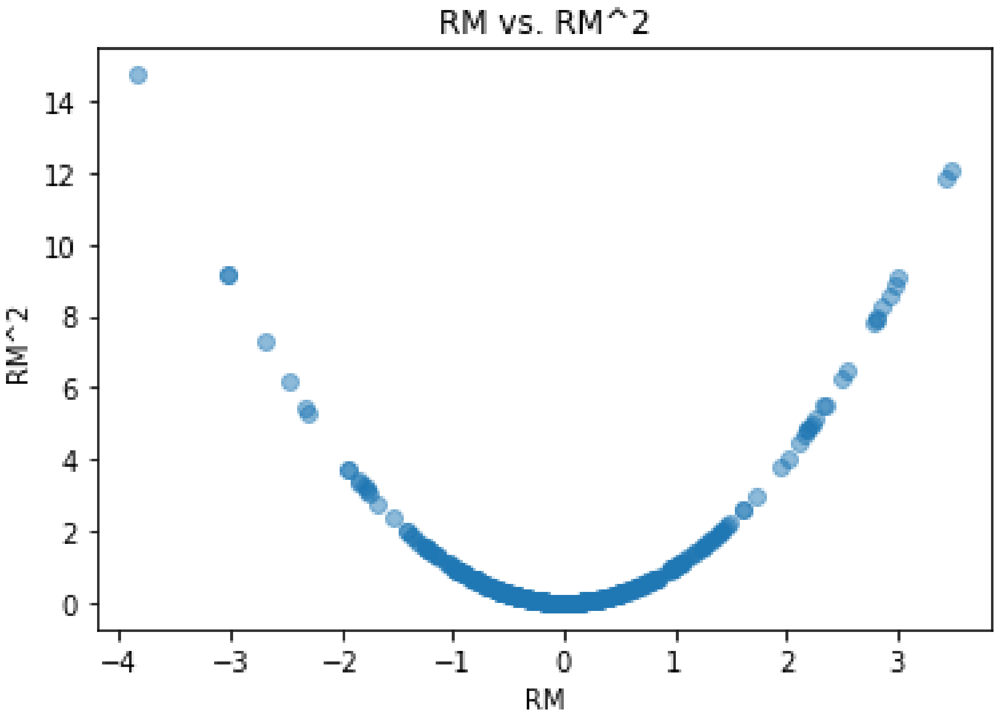
```
        RAD_1   RAD_2   RAD_3   RAD_4   RAD_5   RAD_6   RAD_7   RAD_8  RAD_24
count  404.00  404.00  404.00  404.00  404.00  404.00  404.00  404.00  404.00
mean     0.04    0.05    0.09    0.22    0.24    0.05    0.03    0.04    0.24
std      0.21    0.21    0.28    0.41    0.43    0.21    0.17    0.21    0.43
min      0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00
25%      0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00
50%      0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00
75%      0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00
max      1.00    1.00    1.00    1.00    1.00    1.00    1.00    1.00    1.00
```

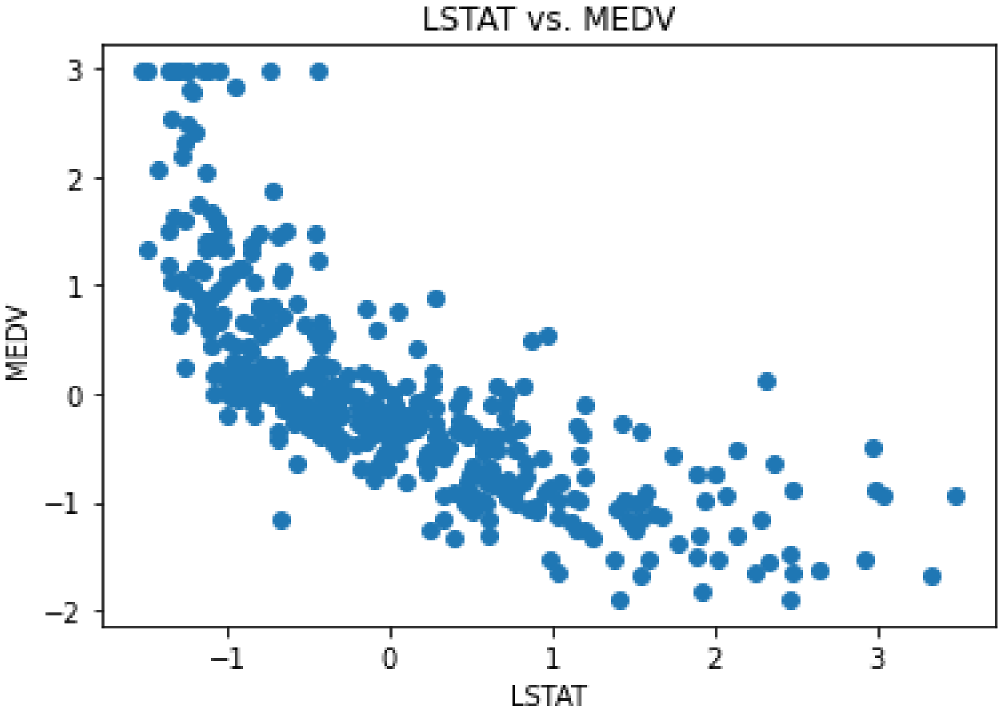
```
         CRIM      ZN   INDUS    CHAS     NOX      RM     AGE     DIS     RAD  \
count  404.00  404.00  404.00  404.00  404.00  404.00  404.00  404.00  404.00
mean    -0.00    0.00   -0.00    0.00   -0.00   -0.00   -0.00    0.00    0.00
std      1.00    1.00    1.00    1.00    1.00    1.00    1.00    1.00    1.00
min     -0.41   -0.49   -1.52   -0.27   -1.44   -3.84   -2.31   -1.26   -0.95
25%     -0.41   -0.49   -0.86   -0.27   -0.90   -0.56   -0.86   -0.81   -0.60
50%     -0.39   -0.49   -0.36   -0.27   -0.17   -0.14    0.30   -0.25   -0.48
75%     -0.09    0.05    1.00   -0.27    0.63    0.49    0.93    0.65   -0.13
max     10.43    3.79    2.38    3.66    2.77    3.48    1.12    3.90    1.75

          TAX  …  TAX PTRATIO   TAX B  TAX LSTAT  PTRATIO^2  PTRATIO B  \
count  404.00  …       404.00  404.00     404.00     404.00     404.00
mean    -0.00  …         0.45   -0.44       0.55       1.00      -0.17
std      1.00  …         0.73    1.38       1.05       1.29       0.93
min     -1.29  …        -0.94   -6.51      -2.57       0.00      -3.84
25%     -0.75  …        -0.05   -0.34      -0.00       0.11      -0.32
50%     -0.43  …         0.26   -0.19       0.34       0.70       0.00
75%      1.59  …         1.33    0.00       0.87       1.45       0.25
max      1.86  …         2.71    0.81       5.51       7.13       5.28

       PTRATIO LSTAT     B^2  B LSTAT  LSTAT^2    MEDV
count         404.00  404.00   404.00   404.00  404.00
mean            0.37    1.00    -0.37     1.00    0.00
std             0.95    3.17     1.37     1.58    1.00
```

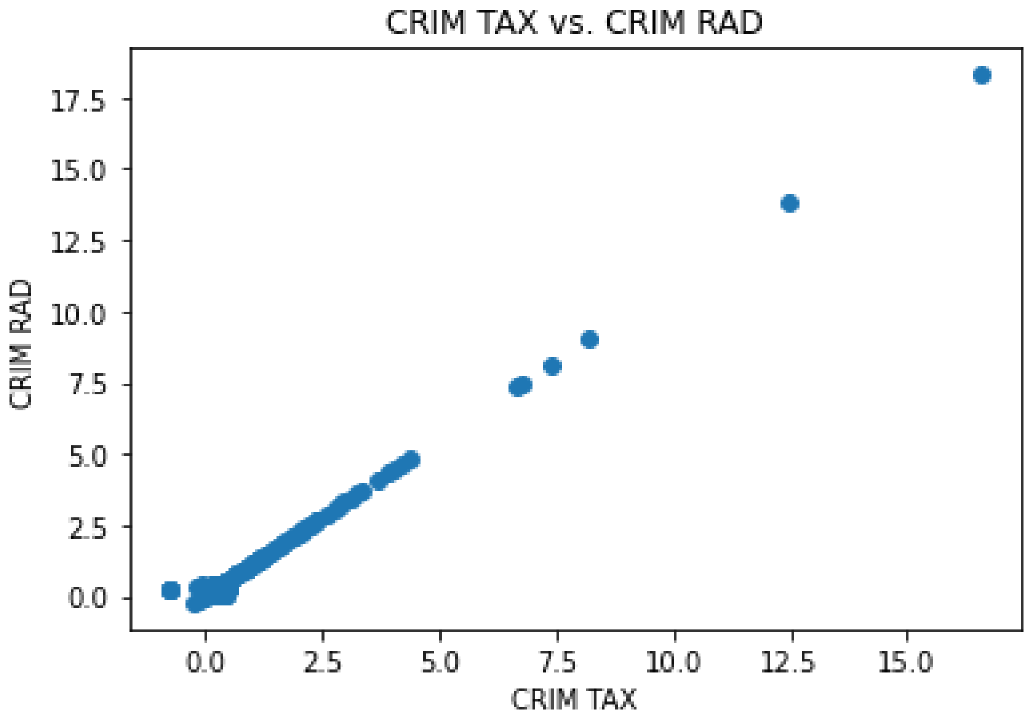
```
min             -3.87    0.00   -11.28     0.00   -1.90
25%             -0.08    0.10    -0.34     0.13   -0.60
50%              0.21    0.16    -0.15     0.51   -0.17
75%              0.76    0.19     0.07     1.20    0.28
max              3.87   16.77     1.51    12.03    2.97

[8 rows x 105 columns]
```

[171]:

```
# Select columns for plotting
x = df_poly['RM']
y1 = df_poly['RM^2']
y2 = df_poly['LSTAT']
y3 = df_poly['MEDV']
y4 = df_poly['CRIM TAX']
y5 = df_poly['CRIM RAD']

# Create scatter plots
plt.scatter(x, y1, alpha=0.5)
plt.xlabel('RM')
plt.ylabel('RM^2')
plt.title('RM vs. RM^2')
plt.show()

plt.scatter(y2, y3)
plt.xlabel('LSTAT')
plt.ylabel('MEDV')
plt.title('LSTAT vs. MEDV')
plt.show()

plt.scatter(y4, y5)
plt.xlabel('CRIM TAX')
plt.ylabel('CRIM RAD')
plt.title('CRIM TAX vs. CRIM RAD')
plt.show()
```


RM vs. RM^2
RM^2
14
12
10
8
6
4
2
0
−4
−3
−2
−1
0
1
2
3
RM

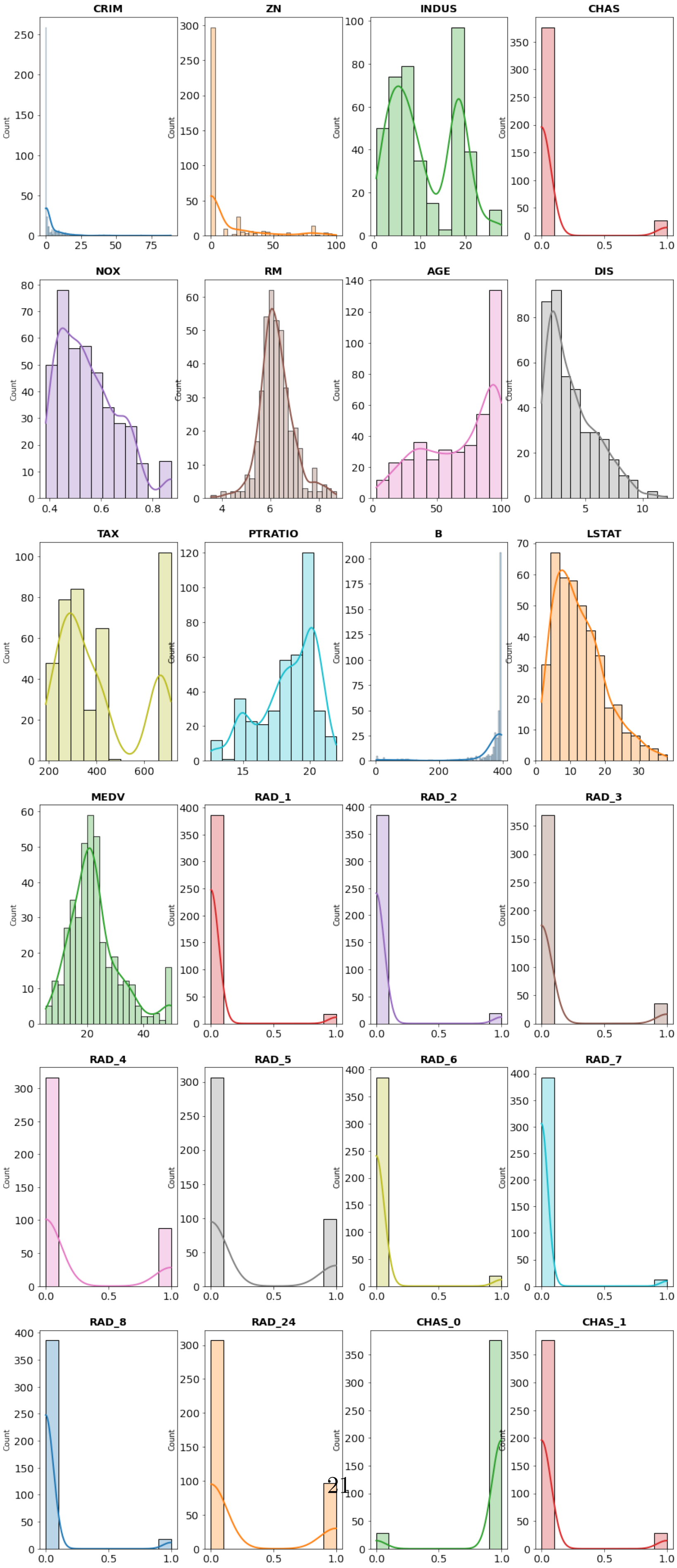

LSTAT vs. MEDV
MEDV
3
2
1
0
−1
−2
−1
0
1
2
3
LSTAT



[180]:

```
# Distribution graph for each variable

df=dfD2

fig, axes = plt.subplots(ncols=4, nrows=6, figsize=(15, 15))
axes = axes.flat
columnas_numeric = df.columns


for ii, column in enumerate(columnas_numeric):
    sns.histplot(
        data    = df,
        x       = column,
        stat    = "count",
        kde     = True,
        color   = (list(plt.rcParams['axes.prop_cycle'])*3)[ii]["color"],
        line_kws= {'linewidth': 2},
        alpha   = 0.3,
        ax      = axes[ii]
    )
    axes[ii].set_title(column, fontsize = 14, fontweight = "bold")
    axes[ii].tick_params(labelsize = 14)
    axes[ii].set_xlabel("")
```

```
plt.subplots_adjust(top = 2)
```


CRIM
ZN
INDUS
CHAS
NOX
RM
AGE
DIS
TAX
PTRATIO
B
LSTAT
MEDV
RAD_1
RAD_2
RAD_3
RAD_4
RAD_5
RAD_6
RAD_7
RAD_8
RAD_24
CHAS_0
CHAS_1
Count
0
25
50
75
100
0.0
0.5
1.0
0.4
0.6
0.8
4
6
8
5
10
20
30
40
200
400
600
15

[ ]:

```
```