coursera-solution

August 3, 2023

[1]:
```
import pandas as pd
import matplotlib.pyplot as plt
import statsmodels.api as sm
from scipy import stats
```

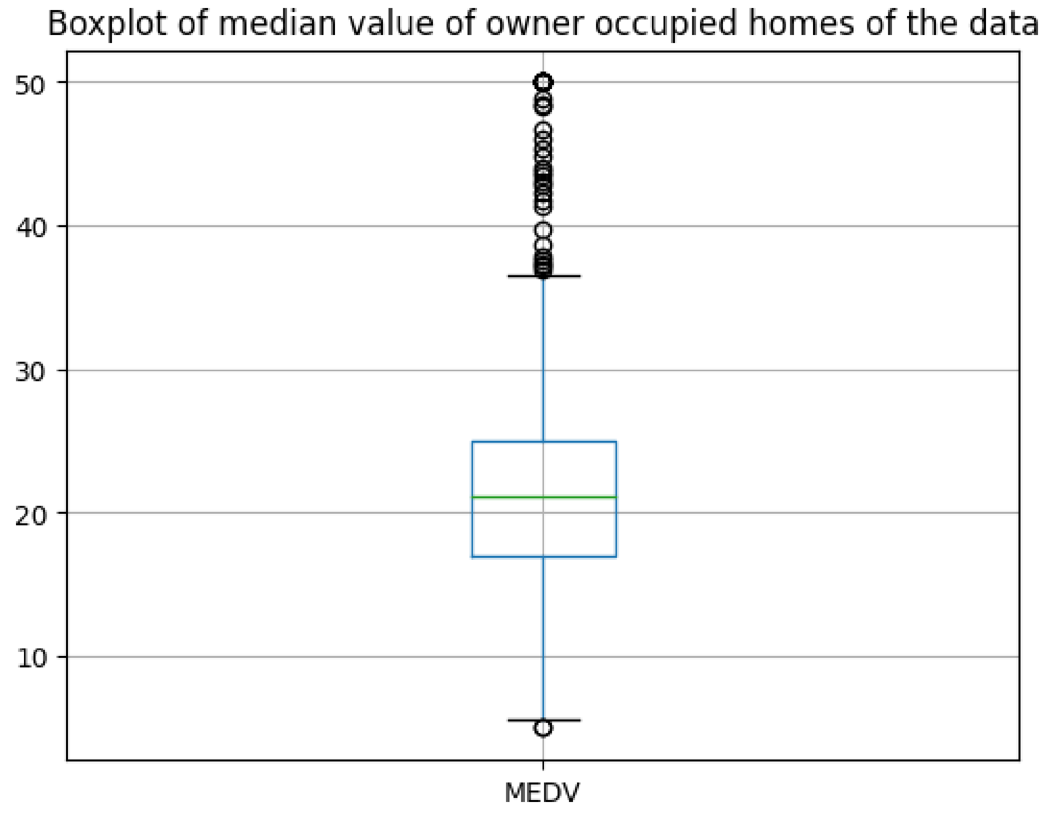
[3]:
```
boston_url = 'https://cf-courses-data.s3.us.cloud-object-storage.appdomain.
 ↪cloud/IBMDeveloperSkillsNetwork-ST0151EN-SkillsNetwork/labs/boston_housing.
 ↪csv'
boston_df = pd.read_csv(boston_url)
```

1 Task 4: Descriptive Analysis

[4]:
```
boston_df.info()
```

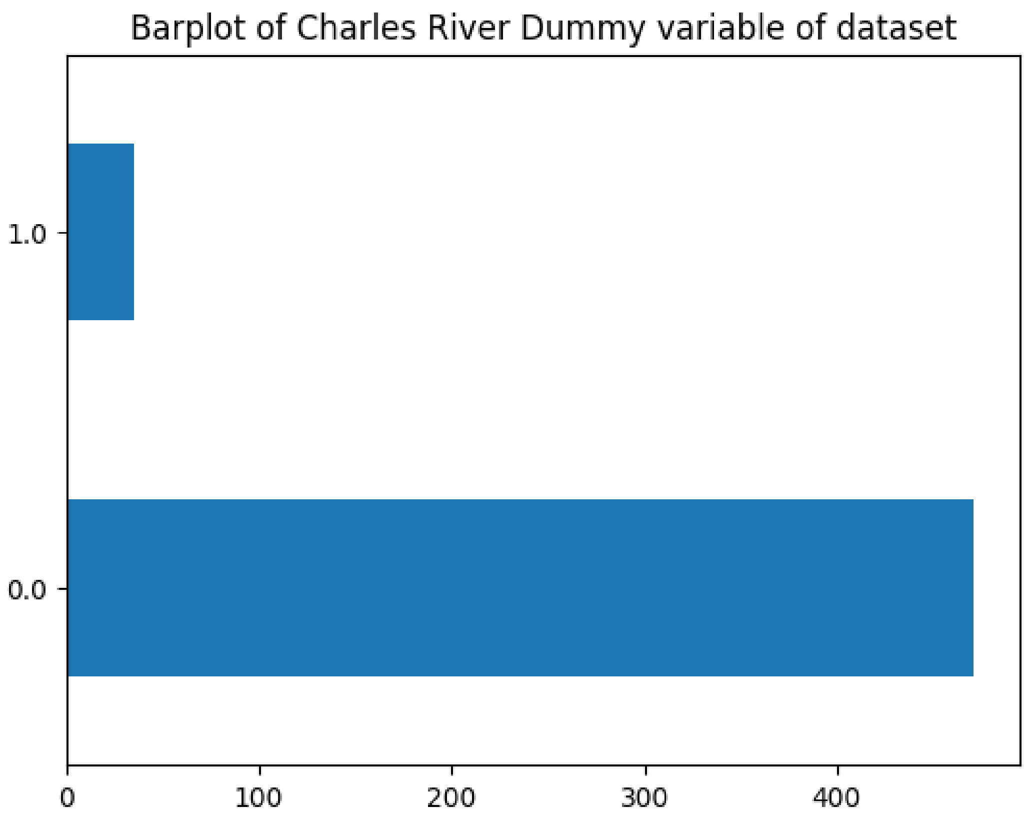
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 506 entries, 0 to 505
Data columns (total 14 columns):
 #   Column      Non-Null Count  Dtype
---  ------      --------------  -----
 0   Unnamed: 0  506 non-null    int64
 1   CRIM        506 non-null    float64
 2   ZN          506 non-null    float64
 3   INDUS       506 non-null    float64
 4   CHAS        506 non-null    float64
 5   NOX         506 non-null    float64
 6   RM          506 non-null    float64
 7   AGE         506 non-null    float64
 8   DIS         506 non-null    float64
 9   RAD         506 non-null    float64
 10  TAX         506 non-null    float64
 11  PTRATIO     506 non-null    float64
 12  LSTAT       506 non-null    float64
 13  MEDV        506 non-null    float64
dtypes: float64(13), int64(1)
memory usage: 55.5 KB
```

```
[5]: boston_df.boxplot('MEDV')
     plt.title('Boxplot of median value of owner occupied homes of the data')
     plt.show()
```



From the boxplot we see a median of about 21, with most outliers above the maximum

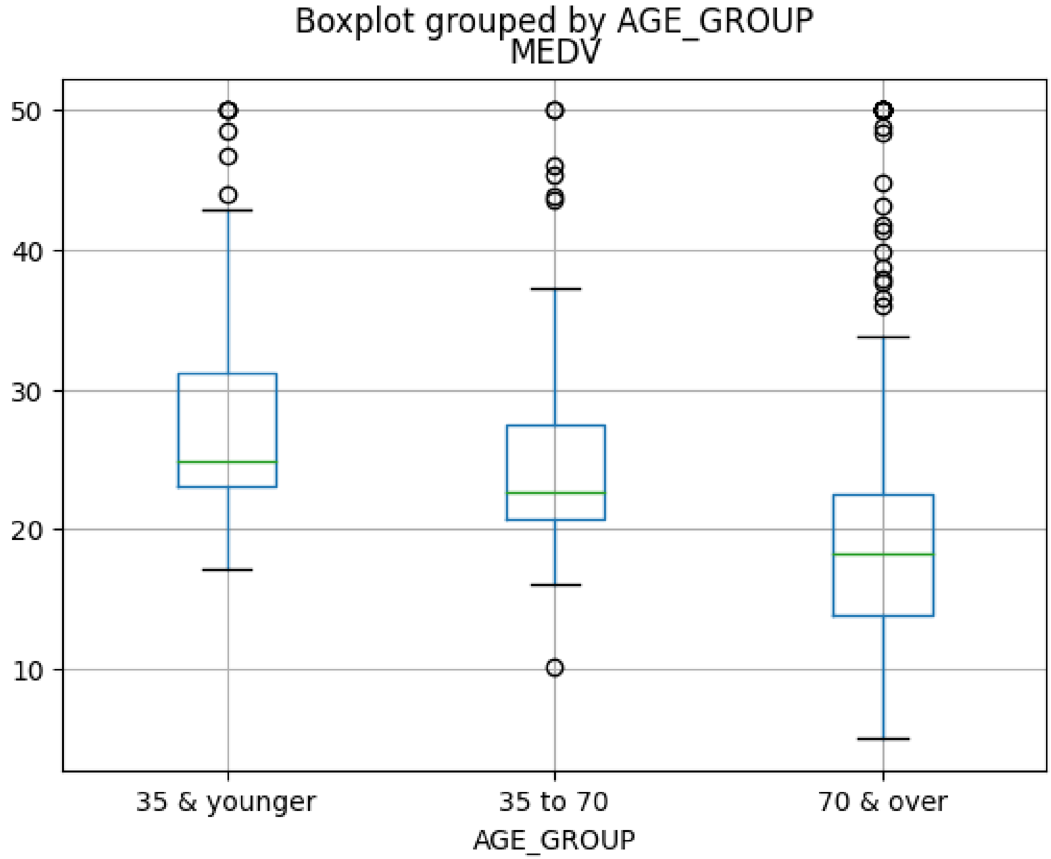
```
[6]: boston_df.CHAS.value_counts().plot.barh()
     plt.title('Barplot of Charles River Dummy variable of dataset')
     plt.show()
```



Barplot of Charles River Dummy variable of dataset

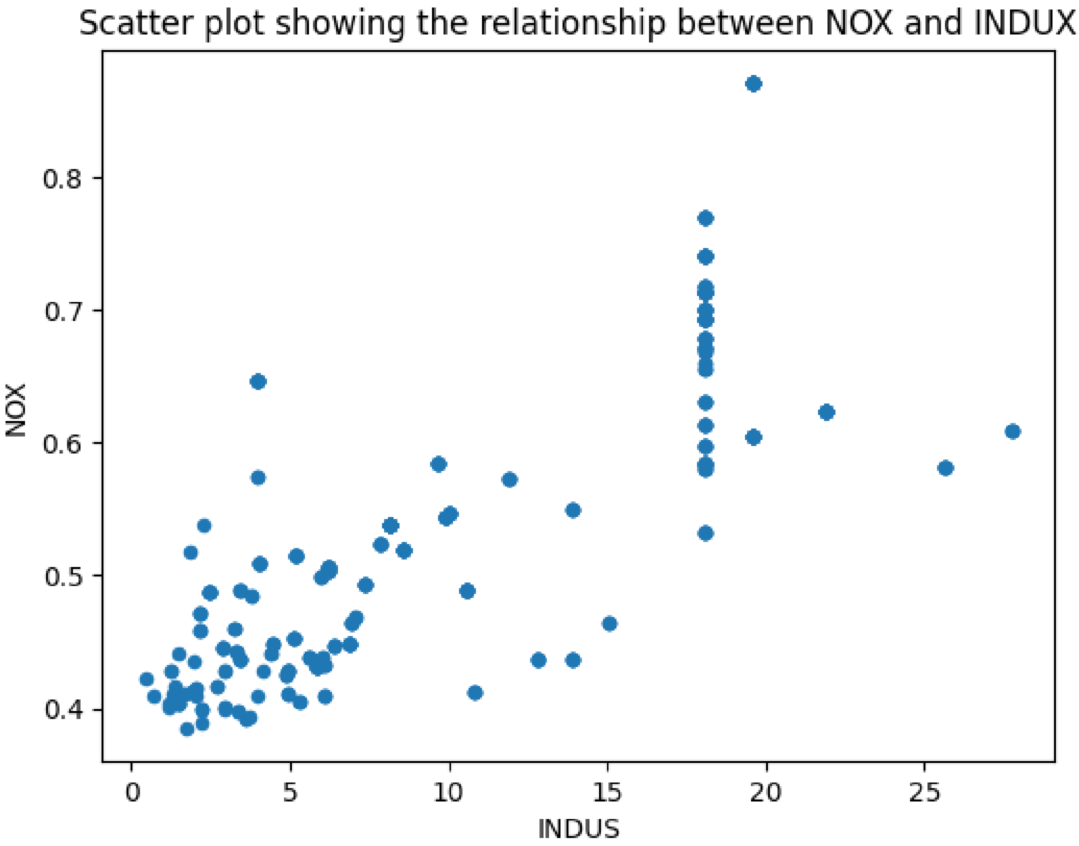
We can see that this categorical field has most values to be 0

[7]:
```
age_1 = '35 & younger'
age_2 = '35 to 70'
age_3 = '70 & over'
boston_df['AGE_GROUP'] = boston_df.AGE.apply(lambda x: age_1 if x<=35 else␣
 ↪age_2 if x< 70 else age_3)
boston_df.boxplot('MEDV', by='AGE_GROUP')
plt.show()
```



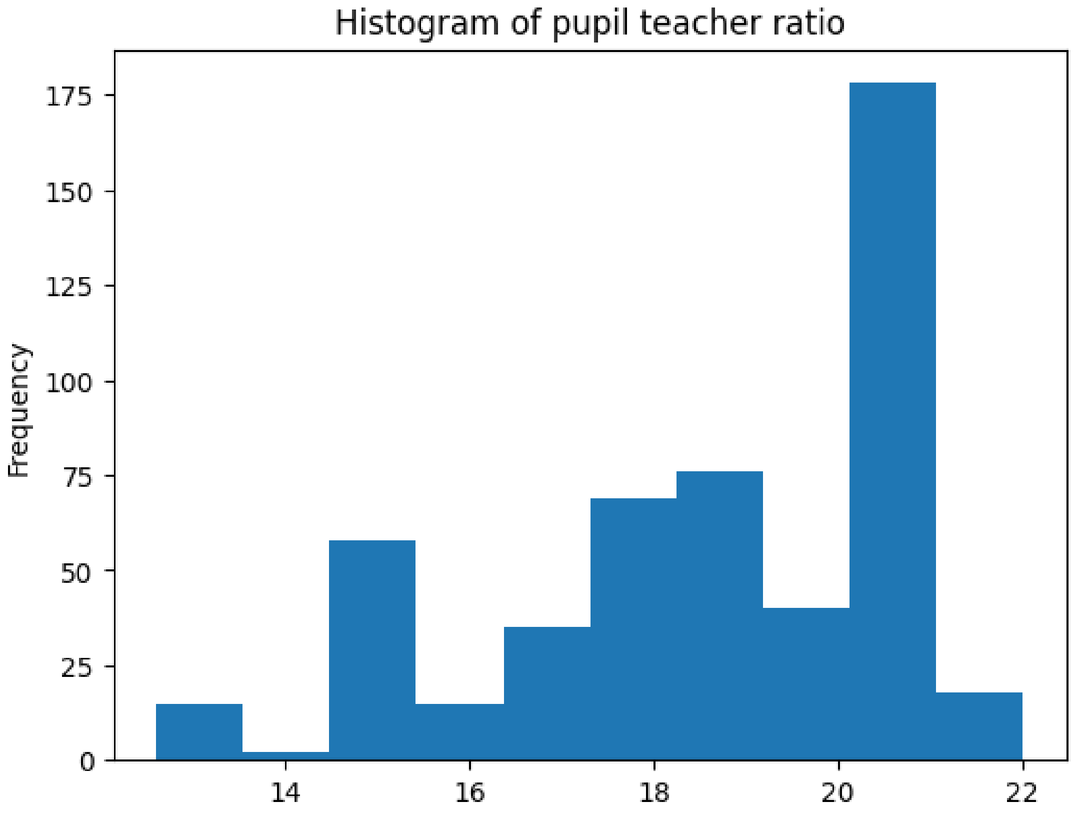
viewing the boxplot by age groups show a decline in median of MEDV and an increase in outliers as age group increases

[9]:
```
boston_df.plot.scatter('INDUS', 'NOX')
plt.title('Scatter plot showing the relationship between NOX and INDUX')
plt.show()
```



There seems to be some correlation between the two variables

[10]:
```
boston_df.PTRATIO.plot.hist()
plt.title('Histogram of pupil teacher ratio')
plt.show()
```



appears to have a skew to the right

2 Task 5: Hypothesis Testing

2.1 Is there a significant difference in MEDV for houses bounded by Charles River or not?

- null hypothesis: u1 = u2
- aplha = 0.05

[11]:
```
stats.levene(boston_df.query('CHAS== 1').MEDV, boston_df.query('CHAS== 0').
 ↪MEDV, center='mean')
```

[11]:
```
LeveneResult(statistic=8.75190489604598, pvalue=0.003238119367639829)
```

p-val < alpha, we can assume unequal variance

[13]:
```
stats.ttest_ind(a = boston_df.query('CHAS== 1').MEDV,
                b = boston_df.query('CHAS== 0').MEDV,
                equal_var=False)
```

[13]:
```
Ttest_indResult(statistic=3.113291312794837, pvalue=0.003567170098137517)
```

Conclusion: p-val < alpha, hence we reject the null hypothesis as there is enough evidence that the means of the two groups differ

2.2 Is there a difference in Median values of houses for each proportion of owner coupied units build prior to 1940?

- null hypothesis: u1 = u2 = u3
- alpha = 0.05

[15]:
```
stats.levene(
    boston_df.query(f"AGE_GROUP == '{age_1}'").MEDV,
    boston_df.query(f"AGE_GROUP == '{age_2}'").MEDV,
    boston_df.query(f"AGE_GROUP == '{age_3}'").MEDV,
    center='mean'
)
```

[15]:
```
LeveneResult(statistic=2.7806200293748304, pvalue=0.06295337343259205)
```

hence we can assume equal variance

[16]:
```
stats.f_oneway(
    boston_df.query(f"AGE_GROUP == '{age_1}'").MEDV,
    boston_df.query(f"AGE_GROUP == '{age_2}'").MEDV,
    boston_df.query(f"AGE_GROUP == '{age_3}'").MEDV
)
```

[16]:
```
F_onewayResult(statistic=36.40764999196599, pvalue=1.7105011022702984e-15)
```

Conclusion: The p-val * 2 < alpha, hence we reject the null hypothesis as there is enough evidence that at lesr one group mean differs

2.3 Can we conclude that there is no relationship between NOX and INDUS?

- null hypothesis: there is no correlation between NOX and INDUS
- alpha = 0.05

[17]:
```
stats.pearsonr(boston_df.NOX, boston_df.INDUS)
```

[17]:
```
PearsonRResult(statistic=0.7636514469209151, pvalue=7.913361061239527e-98)
```

Conclusion: p-val is less than alpha, we reject the null hypothesis and coclude that there is a relationship between NOX and INDUS

3 What is the impact of an additional DIS on the MEDV?

[18]:
```
X = sm.add_constant(boston_df.DIS)
y = boston_df.MEDV
```

```python
model = sm.OLS(y, X).fit()
model.summary()
```

[18]:

```
<class 'statsmodels.iolib.summary.Summary'>
"""
                            OLS Regression Results
==============================================================================
Dep. Variable:                   MEDV   R-squared:                       0.062
Model:                            OLS   Adj. R-squared:                  0.061
Method:                 Least Squares   F-statistic:                     33.58
Date:                Thu, 03 Aug 2023   Prob (F-statistic):           1.21e-08
Time:                        09:18:09   Log-Likelihood:                -1823.9
No. Observations:                 506   AIC:                             3652.
Df Residuals:                     504   BIC:                             3660.
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const         18.3901      0.817     22.499      0.000      16.784      19.996
DIS            1.0916      0.188      5.795      0.000       0.722       1.462
==============================================================================
Omnibus:                      139.779   Durbin-Watson:                   0.570
Prob(Omnibus):                  0.000   Jarque-Bera (JB):              305.104
Skew:                           1.466   Prob(JB):                     5.59e-67
Kurtosis:                       5.424   Cond. No.                         9.32
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly
specified.
"""
```

Conclusion: An additional DIS will lead to an increase of 1.0916 in MEDV according to the regression model

[ ]:

```python

```