# htnm Real estate notebook

July 4, 2021

**@htnm**

## 1 DataPreprocessing

[1]:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.preprocessing import PolynomialFeatures


class DataPreprocessing():
    def __init__(self):
        # Auto initialize necessary attributes of the object
        self.dataframe = None
        self.X = None
        self.y = None

    def read_from_csv(self):
        # Read data from .csv file into the dataframe and display the first 5␣
 ↪rows
        df = pd.read_csv('real_estate.csv', index_col='No')
        self.dataframe = df
        #print(df.head)
        #print(df.iloc[0][1])

    def set_attributes_and_output(self):
        # Set X and y to data attributes and output from the dataframe

        ##################
        # YOUR CODE HERE #
        ##################

        #print(self.dataframe)
        self.X = self.dataframe.values[:, :-1]
        self.y = self.dataframe.values[:, -1]
```

```python
    def final_train_test_data(self, attributes_list=[0,1,2,3,4,5], test_size=0.
↪2):
        # Split the data X and output y into training data and testing data
        # Output: a tuple (X_train, X_test, y_train, y_test),
        # using train_test_split with random_state=42
        return \
                 train_test_split(
                     self.X[:, attributes_list],
                     self.y,
                     random_state = 42,
                     test_size = test_size)

    def visualize_data(self):
        # Visualize relation between each attribute and output
        columns_plot = np.array(self.dataframe.columns)[:-1].reshape(3, -1)
        fig, ax = plt.subplots(3, 2, figsize=(10,8), sharey=True)
        fig.suptitle('Correlation between each attribute and the house price of␣
↪unit area')

        for i in range(3):
            for j in range(2):
                ax[i,j].scatter(self.X[:,i*2 + j], self.y, s=10,␣
↪color="bgrcmy"[i*2+j])
                ax[i,j].set_xlabel(columns_plot[i, j].split(' ', 1)[1].title())

        fig.tight_layout()
        fig.add_subplot(111, frameon=False)
        plt.tick_params(labelcolor='none', which='both', top=False,␣
↪bottom=False, left=False, right=False)
        plt.ylabel(self.dataframe.columns[-1].split(' ', 1)[1].title())
        plt.show()
```

[2]:
```python
dp = DataPreprocessing()
dp.read_from_csv()
dp.set_attributes_and_output()
print('First house\'s age:', dp.X[0][1])
print('House price/unit are:', dp.y[0])
```

```
First house's age: 32.0
House price/unit are: 37.9
```

[3]:
```python
dp = DataPreprocessing()
dp.read_from_csv()
dp.set_attributes_and_output()

X_train, X_test, y_train, y_test = \
```

```python
    dp.final_train_test_data(attributes_list=[2,4,5], test_size=0.2)
print('Shape of X_train: ', X_train.shape)
print('Shape of y_train: ', y_train.shape)
print('Shape of X_test: ', X_test.shape)
print('Shape of y_test: ', y_test.shape)
```

```
Shape of X_train:  (331, 3)
Shape of y_train:  (331,)
Shape of X_test:  (83, 3)
Shape of y_test:  (83,)
```

[4]:

```python
dp = DataPreprocessing()
dp.read_from_csv()
dp.set_attributes_and_output()

print(dp.dataframe)
dp.visualize_data()
```

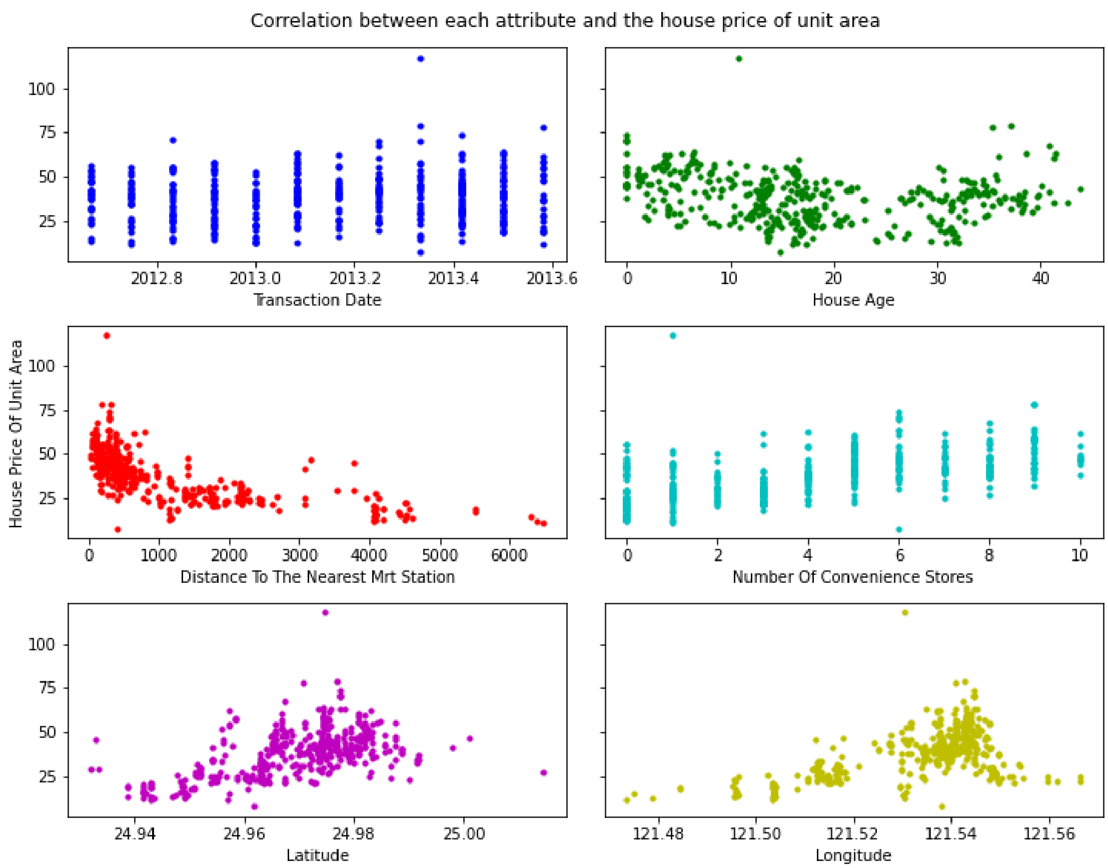
```
     X1 transaction date  X2 house age  \
No
1                2012.917          32.0
2                2012.917          19.5
3                2013.583          13.3
4                2013.500          13.3
5                2012.833           5.0
..                    …             …
410              2013.000          13.7
411              2012.667           5.6
412              2013.250          18.8
413              2013.000           8.1
414              2013.500           6.5

     X3 distance to the nearest MRT station  X4 number of convenience stores  \
No
1                                  84.87882                               10
2                                 306.59470                                9
3                                 561.98450                                5
4                                 561.98450                                5
5                                 390.56840                                5
..                                      …                              …
410                              4082.01500                                0
411                                90.45606                                9
412                               390.96960                                7
413                               104.81010                                5
414                                90.45606                                9

     X5 latitude  X6 longitude  Y house price of unit area
No
```

```
1        24.98298     121.54024                          37.9
2        24.98034     121.53951                          42.2
3        24.98746     121.54391                          47.3
4        24.98746     121.54391                          54.8
5        24.97937     121.54245                          43.1
..            …            …                        …
410      24.94155     121.50381                          15.4
411      24.97433     121.54310                          50.0
412      24.97923     121.53986                          40.6
413      24.96674     121.54067                          52.5
414      24.97433     121.54310                          63.9

[414 rows x 7 columns]
```



## 2 BaseClassRegressionAnalysis

[5]:
```
from sklearn.metrics import mean_squared_error

class BaseClassRegressionAnalysis():
    def __init__(self):
        # Initialize a regressor, which will handle the LinearRegression model
        self.regressor = LinearRegression()

    def fit(self, X, y):
        # The regressor learn from the training data with input X and output y
        self.regressor.fit(X, y)

    def predict(self, X):
        # The regressor predict the result with input X (after being trained)
        # The output has the same size as output y
        return self.regressor.predict(X)

    def mean_square_error(self, y_real, y_predict):
        # Compare the 2 output vectors: real output and prediction, using mean␣
↪square error
        return mean_squared_error(y_real, y_predict)

    def visualize_prediction(self, y_real, y_predict):
        # Visualize the 2 output vectors: real output and prediction with each␣
↪instances
        x = np.arange(y_real.shape[0]) # Numbering the instances from 0 for␣
↪x-axis of the plot
        plt.plot(x, y_real, label = 'Real')
        plt.plot(x, y_predict, label = 'Predict')
        plt.xlabel('Instances')
        plt.ylabel('Prediction & Real Prices')
        plt.legend()
        plt.show()
```

## 3 LinearRegressionAnalysis

[6]:
```
class LinearRegressionAnalysis(BaseClassRegressionAnalysis):
    pass
```

## 4 PolynomialRegressionAnalysis

[7]:
```
class PolynomialRegressionAnalysis(BaseClassRegressionAnalysis):
    def __init__(self, degree):
        super().__init__()
```

```
        self.degree = degree

    def __poly_transform(self, X):
        poly = PolynomialFeatures(degree=self.degree)
        Xt = poly.fit_transform(X)
        return Xt

    def fit(self, X, y, degree=2):
        Xt = self.__poly_transform(X)
        super().fit(Xt, y)

    def predict(self, X):
        Xt = self.__poly_transform(X)
        return super().predict(Xt)
```

# 5 Predictions

## 5.1 Linear regression predictions

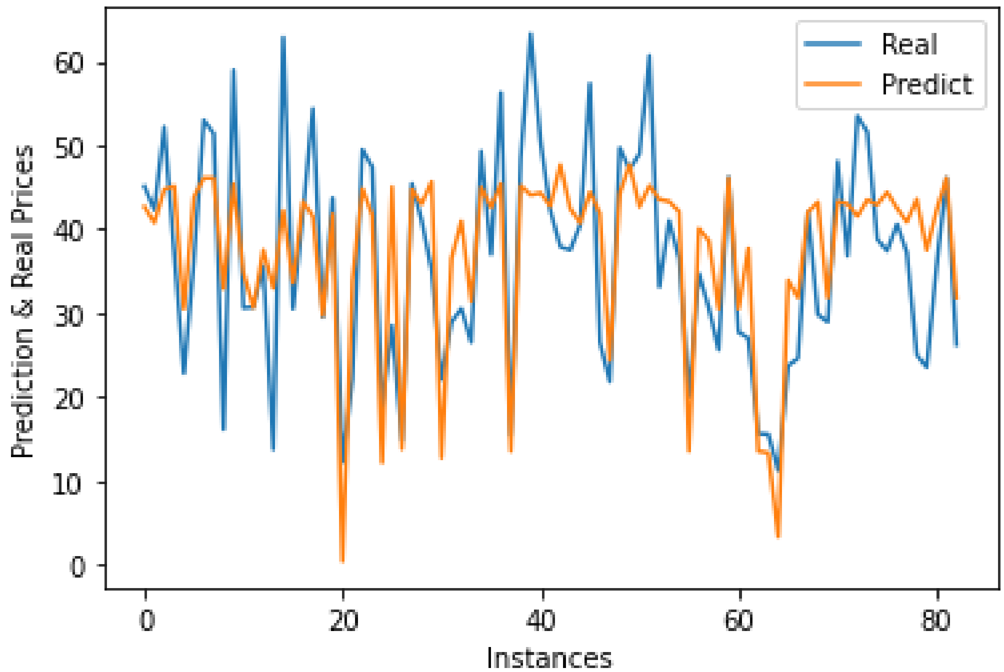
[8]:
```
# Step 1: Initialize a regressor (a model) to learn from data
lr = LinearRegressionAnalysis()

# Step 2: The regressor will learn from the input and output of training data
lr.fit(X_train, y_train)

# Step 3: After learning from training data, the model will make a prediction␣
↪based on input testing data
y_pred = lr.predict(X_test)

# Step 4: Comparision and visualization
print('First 10 instances prediction (rounded to 1 decimal place):     ', np.
↪array([round(i, 1) for i in y_pred[:10]]))
print('Real output of first 10 instances (rounded to 1 decimal place): ',␣
↪y_test[:10])
print('Mean square error: ', lr.mean_square_error(y_test, y_pred))
lr.visualize_prediction(y_test, y_pred)
```

```
First 10 instances prediction (rounded to 1 decimal place):      [42.7 40.8 44.7
45.1 30.5 43.8 46.1 46.1 32.9 45.4]
Real output of first 10 instances (rounded to 1 decimal place):  [45.1 42.3 52.2
37.3 22.8 36.3 53.  51.4 16.1 59. ]
Mean square error:  73.2442403892939
```




### 5.2 Polynomial (of degree 2) regression predictions

[9]:
```
# Step 1: Initialize a regressor (a model) to learn from data

##################
# YOUR CODE HERE #
##################
pr = PolynomialRegressionAnalysis(2)

# Step 2: The regressor will learn from the input and output of training data
X_train, X_test, y_train, y_test = \
    dp.final_train_test_data(attributes_list=[2,4,5], test_size=0.2)
pr.fit(X_train, y_train)

# Step 3: After learning from training data, the model will make a prediction␣
 ↪based on input testing data
y_pred = pr.predict(X_test)

# Step 4: Comparision and visualization
print('First 10 instances prediction (rounded to 1 decimal place):', np.
 ↪array([round(i, 1) for i in y_pred[:10]]))
print('Real output of first 10 instances (rounded to 1 decimal place):',␣
 ↪y_test[:10])
```

```
print('Mean square error (rounded to 1 decimal place):', round(pr.
 ↪mean_square_error(y_test, y_pred),1))
pr.visualize_prediction(y_test, y_pred)
```

```
First 10 instances prediction (rounded to 1 decimal place): [44.5 40.5 47.2 48.6
22.8 44.8 48.9 48.9 29.7 48.8]
Real output of first 10 instances (rounded to 1 decimal place): [45.1 42.3 52.2
37.3 22.8 36.3 53.  51.4 16.1 59. ]
Mean square error (rounded to 1 decimal place): 63.8
```