# Exploration of house data from Arizona state

```
# Impport the packages
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
import folium
```

## Data input

```
# Read the data
data = pd.read_csv('data_project.csv')
```

```
# # Display the few rows of the data
data.head(5)
```

| | Unnamed: 0 | MLS | sold_price | zipcode | longitude | latitude | lot_acres | taxe |
|---|---|---|---|---|---|---|---|---|
| **0** | 0 | 21530491 | 5300000.0 | 85637 | -110.378200 | 31.356362 | 2154.00 | 5272.0 |
| **1** | 1 | 21529082 | 4200000.0 | 85646 | -111.045371 | 31.594213 | 1707.00 | 10422.3 |
| **2** | 3 | 21919321 | 4500000.0 | 85646 | -111.035925 | 31.645878 | 636.67 | 8418.5 |
| **3** | 4 | 21306357 | 3411450.0 | 85750 | -110.813768 | 32.285162 | 3.21 | 15393.0 |
| **4** | 5 | 21528016 | 3250000.0 | 85718 | -110.910593 | 32.339090 | 1.67 | 27802.8 |

```
# Check the dimensions of the data
data.shape
```

```
(4903, 19)
```

```
data['sold_price'].min(), data['sold_price'].max()
```

```
(300000.0, 5300000.0)
```

```
# show the concise summary about data and count missing values in the dataframe
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 4903 entries, 0 to 4902
Data columns (total 19 columns):
 #   Column                        Non-Null Count  Dtype  
---  ------                        --------------  -----  
 0   Unnamed: 0                    4903 non-null   int64  
 1   MLS                           4903 non-null   int64  
 2   sold_price                    4903 non-null   float64
 3   zipcode                       4903 non-null   int64  
 4   longitude                     4903 non-null   float64
 5   latitude                      4903 non-null   float64
 6   lot_acres                     4903 non-null   float64
 7   taxes                         4903 non-null   float64
 8   year_built                    4903 non-null   int64  
 9   bedrooms                      4903 non-null   int64  
 10  bathrooms                     4903 non-null   float64
 11  sqrt_ft                       4903 non-null   float64
 12  garage                        4903 non-null   float64
 13  kitchen_features              4903 non-null   object 
 14  fireplaces                    4903 non-null   int64  
 15  floor_covering                4903 non-null   object 
 16  HOA                           4903 non-null   object 
 17  sold_price_per_sqrt_ft        4903 non-null   float64
 18  sold_price_per_sqrt_ft_range  4902 non-null   object 
dtypes: float64(9), int64(6), object(4)
memory usage: 727.9+ KB
```

```
# Descriptive statistical meaures
data.describe()
```

| | Unnamed: 0 | MLS | sold_price | zipcode | longitude | latitude |
|---|---|---|---|---|---|---|
| **count** | 4903.000000 | 4.903000e+03 | 4.903000e+03 | 4903.000000 | 4903.000000 | 4903.000000 |
| **mean** | 2495.650010 | 2.149141e+07 | 7.756850e+05 | 85724.291046 | -110.910560 | 32.315921 |
| **std** | 1443.203645 | 1.336633e+06 | 3.157269e+05 | 36.678685 | 0.120478 | 0.166568 |
| **min** | 0.000000 | 4.110917e+06 | 3.000000e+05 | 85118.000000 | -112.520168 | 31.356362 |
| **25%** | 1245.500000 | 2.141039e+07 | 5.850000e+05 | 85718.000000 | -110.978280 | 32.280525 |
| **50%** | 2494.000000 | 2.161781e+07 | 6.780000e+05 | 85737.000000 | -110.922309 | 32.319152 |
| **75%** | 3745.500000 | 2.180551e+07 | 8.390000e+05 | 85750.000000 | -110.858404 | 32.396256 |
| **max** | 4998.000000 | 2.192856e+07 | 5.300000e+06 | 86323.000000 | -109.454637 | 34.927884 |

```
# check the duplicate values
data.duplicated().sum()
```

```
0
```

## Dealing with Missing values

```
# check the missing value in each column
data.isna().sum()
```

```
     Unnamed: 0                      0
     MLS                             0
     sold_price                      0
     zipcode                         0
     longitude                       0
     latitude                        0
     lot_acres                       0
     taxes                           0
     year_built                      0
     bedrooms                        0
     bathrooms                       0
     sqrt_ft                         0
     garage                          0
     kitchen_features                0
     fireplaces                      0
     floor_covering                  0
     HOA                             0
     sold_price_per_sqrt_ft          0
     sold_price_per_sqrt_ft_range    1
     dtype: int64
```

```
data1 = data.dropna()
data1.isna().sum()
```

```
     Unnamed: 0                      0
     MLS                             0
     sold_price                      0
     zipcode                         0
     longitude                       0
     latitude                        0
     lot_acres                       0
     taxes                           0
     year_built                      0
     bedrooms                        0
     bathrooms                       0
     sqrt_ft                         0
     garage                          0
     kitchen_features                0
     fireplaces                      0
     floor_covering                  0
     HOA                             0
     sold_price_per_sqrt_ft          0
     sold_price_per_sqrt_ft_range    0
     dtype: int64
```

```
data1["sold_price_per_sqrt_ft_range"] = data1["sold_price_per_sqrt_ft_range"].astype('cate
data1["sold_price_per_sqrt_ft_range"] = data1["sold_price_per_sqrt_ft_range"].cat.codes
data1.sold_price_per_sqrt_ft_range = data1.sold_price_per_sqrt_ft_range.astype(int)
```

```
     /usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:1: SettingWithCopyWarnin
```

```
    A value is trying to be set on a copy of a slice from a DataFrame.
    Try using .loc[row_indexer,col_indexer] = value instead

    See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/us
      """Entry point for launching an IPython kernel.
    /usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:2: SettingWithCopyWarnir
    A value is trying to be set on a copy of a slice from a DataFrame.
    Try using .loc[row_indexer,col_indexer] = value instead

    See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/us

    /usr/local/lib/python3.7/dist-packages/pandas/core/generic.py:5170: SettingWithCopyWa
    A value is trying to be set on a copy of a slice from a DataFrame.
    Try using .loc[row_indexer,col_indexer] = value instead

    See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/us
      self[name] = value
```

```
data2 = data1[['longitude','latitude','sold_price_per_sqrt_ft_range']]
data2.info()
```

```
    <class 'pandas.core.frame.DataFrame'>
    Int64Index: 4902 entries, 0 to 4902
    Data columns (total 3 columns):
     #   Column                        Non-Null Count  Dtype  
    ---  ------                        --------------  -----  
     0   longitude                     4902 non-null   float64
     1   latitude                      4902 non-null   float64
     2   sold_price_per_sqrt_ft_range  4902 non-null   int64  
    dtypes: float64(2), int64(1)
    memory usage: 153.2 KB
```

```
"""
from sklearn.preprocessing import OrdinalEncoder
ord_enc = OrdinalEncoder()
data2["sold_price_per_sqrt_ft_range"] = ord_enc.fit_transform(data2[["sold_price_per_sqrt_
data2.sold_price_per_sqrt_ft_range = data2.sold_price_per_sqrt_ft_range.astype(int)
"""
```

```
    '\nfrom sklearn.preprocessing import OrdinalEncoder\nord_enc = OrdinalEncoder()\ndat
    a2["sold_price_per_sqrt_ft_range"] = ord_enc.fit_transform(data2[["sold_price_per_sq
    rt_ft_range"]])\ndata2.sold_price_per_sqrt_ft_range = data2.sold_price_per_sqrt_ft_r
```

```
# Shuffle your dataset
shuffle_df = data2.sample(frac=1)

# Define a size for your train set
train_size = int(0.8 * len(data2))

# Split your dataset
train_set = shuffle_df[:train_size]
test_set = shuffle_df[train_size:]
```

```
X_train = train_set.drop(['sold_price_per_sqrt_ft_range'], axis=1)
X_train = X_train.to_numpy()
```

```
y_train=train_set.iloc[:,-1]
y_train = y_train.to_numpy()
y_train.shape
```

```
(3921,)
```

```
X_test = test_set.drop(['sold_price_per_sqrt_ft_range'], axis=1)
X_test.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 981 entries, 1837 to 953
Data columns (total 2 columns):
 #   Column     Non-Null Count  Dtype  
---  ------     --------------  -----  
 0   longitude  981 non-null    float64
 1   latitude   981 non-null    float64
dtypes: float64(2)
memory usage: 23.0 KB
```

```
X_test = X_test.to_numpy()
X_test.shape
X_test
```

```
array([[-110.847125,   32.262861],
       [-110.833476,   32.31409 ],
       [-110.929826,   32.336238],
       ...,
       [-111.02565 ,   32.434199],
       [-111.039738,   32.274257],
       [-110.702877,   32.271099]])
```

```
y_test=test_set.iloc[:,-1]
y_test = y_test.to_numpy()
y_test.shape
```

```
(981,)
```

```
class KNNClassifier():
  def fit(self, X, y):
    self.X=X
    self.y=y

  def predict(self, X,K, epsilon=10e-15):
    N=len(X)
    y_hat = np.zeros(N)

    for i in range(N):
      dist2 =np.sum((self.X-X[i])**2,axis=1)
      idxt = np.argsort(dist2)[:K]
      gamma_k = 1/(np.sqrt(dist2[idxt]+epsilon))
      y_hat[i] = np.bincount(self.y[idxt], weights=gamma_k).argmax()

    return y_hat
```

```
knn = KNNClassifier()
```

```
knn.fit(X_train,y_train)
```

```
y_hat1 = knn.predict(X_train, 8)
```

```
y_hat = knn.predict(X_test, 8)
```

```
def accuracy(y, y_hat):
  return np.mean(y==y_hat)
```

```
accuracy(y_train, y_hat1)
```

```
     0.9987248150981892
```

```
accuracy(y_test, y_hat)
```

```
     0.6992864424057085
```

## Predicting the sold price

```
data3 = data1[['bedrooms', 'bathrooms','fireplaces','sold_price_per_sqrt_ft_range', 'sold_
data3.sold_price = data3.sold_price.astype(int)
data3
```

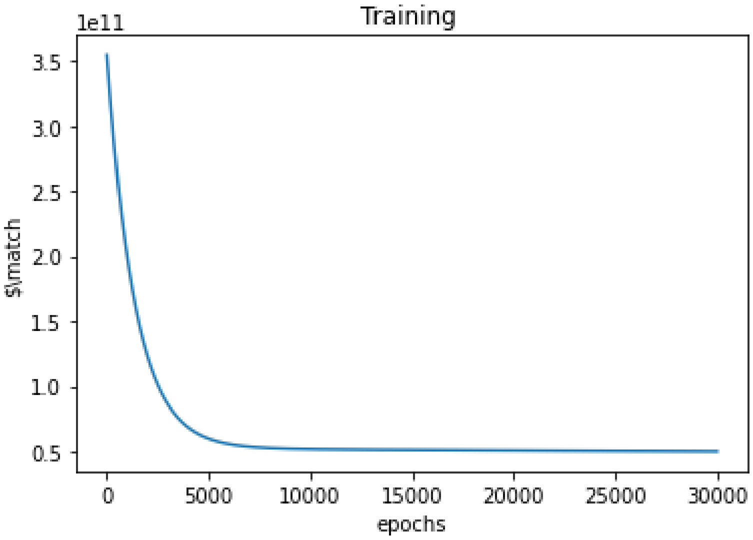
```
/usr/local/lib/python3.7/dist-packages/pandas/core/generic.py:5170: SettingWithCopyWa
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/us
  self[name] = value
```

| | bedrooms | bathrooms | fireplaces | sold_price_per_sqrt_ft_range | sold_price |
|---|---|---|---|---|---|
| **0** | 13 | 10.0 | 6 | 2 | 5300000 |
| **1** | 2 | 2.0 | 5 | 2 | 4200000 |
| **2** | 7 | 5.0 | 4 | 2 | 4500000 |
| **3** | 4 | 6.0 | 5 | 2 | 3411450 |
| **4** | 3 | 4.0 | 5 | 2 | 3250000 |
| **4898** | 3 | 2.0 | 1 | 0 | 535000 |

```
# Shuffle your dataset
shuffle_df1 = data3.sample(frac=1)

# Define a size for your train set
train_size1 = int(0.8 * len(data3))

# Split your dataset
train_set1 = shuffle_df1[:train_size1]
test_set1 = shuffle_df1[train_size1:]


X_train1 = train_set1.drop(['sold_price'], axis=1)
X_train1 = X_train1.to_numpy()


y_train1=train_set1.iloc[:,-1]
y_train1 = y_train1.to_numpy()


X_test1 = test_set1.drop(['sold_price'], axis=1)
X_test1 = X_test1.to_numpy()


y_test1=test_set1.iloc[:,-1]
y_test1 = y_test1.to_numpy()


def OLS(Y,Y_hat):
  N=Y.shape[0]
  return (1/(2*N)*np.sum((Y-Y_hat)**2))


class OurLinearRegression():
  def fit(self, X, y, eta=1e-3, epochs = 1e3, show_curve =False):

    epochs = int(epochs)
    N, D = X.shape
    Y = y
  self.W = np.random.randn(D)
  J = np.zeros(epochs)

  for epoch in range(epochs):
   Y_hat = self.predict(X)
   J[epoch] = OLS(Y,Y_hat)
   self.W -= eta*(1/N)*(X.T@(Y_hat-Y))

  if show_curve:
   plt.figure()
   plt.plot(J)
   plt.xlabel("epochs")
   plt.ylabel("$\match")
   plt.title("Training ")

 def predict(self, X):
  return X@self.W
```

```
myLireg = OurLinearRegression()
```

```
myLireg.fit(X_train1,y_train1, epochs = 3e4,eta = 1e-5, show_curve = True)
```



```
def R2(Y, Y_hat):
 return (1-(np.sum((Y-Y_hat)**2)/np.sum((Y-np.mean(Y))**2)))
```

```
y_hat_train = myLireg.predict(X_train1)
```

```
R2(y_train1,y_hat_train)
```

```
0.02515760208349438
```

```
y_hat_test = myLireg.predict(X_test1)
```

```
R2(y_test1,y_hat_test)
```

```
    0.1699112273766934
```

```
X_t = np.array([[5,4, 5,5]])
```

```
myLireg.predict(X_t)
```

```
    array([1080695.46738759])
```

```
d = data3.loc[data3['sold_price_per_sqrt_ft_range'] == 4]
d
```

| | bedrooms | bathrooms | fireplaces | sold_price_per_sqrt_ft_range | sold_price |
|---|---|---|---|---|---|
| **13** | 3 | 3.0 | 3 | 4 | 3000000 |
| **14** | 3 | 3.0 | 3 | 4 | 2600000 |
| **17** | 3 | 3.0 | 3 | 4 | 2600000 |
| **19** | 3 | 3.0 | 3 | 4 | 2600000 |
| **25** | 3 | 3.0 | 3 | 4 | 2600000 |
| **28** | 2 | 2.0 | 1 | 4 | 2500000 |
| **47** | 2 | 3.0 | 1 | 4 | 1800000 |

```
data2['sold_price_per_sqrt_ft_range'].value_counts()
```

```
    0    2516
    1    2298
    2      75
    4       7
    3       6
    Name: sold_price_per_sqrt_ft_range, dtype: int64
```