```
##Importing packages
import pandas as pd
import numpy as np
import seaborn as sns                       #visualisation
import matplotlib.pyplot as plt
import plotly.express as px
import seaborn as sn
from scipy.stats import multivariate_normal as mvn


##Visualizing the data
df=pd.read_csv('/content/drive/MyDrive/EnhanceIT/data_cleansed.csv')
#df.head(5)


##Dropping unnecessary columns
df.drop(['Unnamed: 0', 'HOA', 'kitchen_features', 'floor_covering'], axis=1, inplace=True)


#Making additional cleaning
df['bedrooms']=df['bedrooms'].astype(int)
df['bathrooms']=df['bathrooms'].astype(int)
df = df[~(df['lot_acres'] > 10)]
df = df[~(df['lot_acres']==0)]
df = df[~(df['taxes'] >1.0e7)]
df = df[~(df['taxes'] >6.0e5)]


df
```

	sold_price	zipcode	longitude	latitude	lot_acres	taxes	year_built	bedrooms	bathrooms	sqrt_ft	garage
0	2000000.0	85750	-110.848679	32.321134	0.64	11322.00	2001	5	6	7471.0	3
1	1900000.0	85750	-110.843910	32.328460	1.16	16714.00	2002	4	4	5333.0	3
2	1800000.0	85750	-110.845560	32.327714	1.32	20206.00	2002	4	7	6800.0	3
3	1950000.0	85755	-110.992676	32.464204	1.18	21063.00	2002	4	6	6622.0	6
4	1920000.0	85718	-110.910653	32.338271	1.27	24316.00	1997	5	6	7132.0	3
...	...	...	...	...	...	...	...	...	...	...	...
4479	535000.0	85718	-110.922291	32.317496	0.18	4414.00	2002	3	2	2106.0	2

```
df[['sqrt_ft','bedrooms','bathrooms']]
```

	sqrt_ft	bedrooms	bathrooms
0	7471.0	5	6
1	5333.0	4	4
2	6800.0	4	7
3	6622.0	4	6
4	7132.0	5	6
...	...	...	...
4479	2106.0	3	2
4480	3601.0	5	3
4481	2318.0	4	3
4482	3724.0	4	4
4483	4317.0	4	4

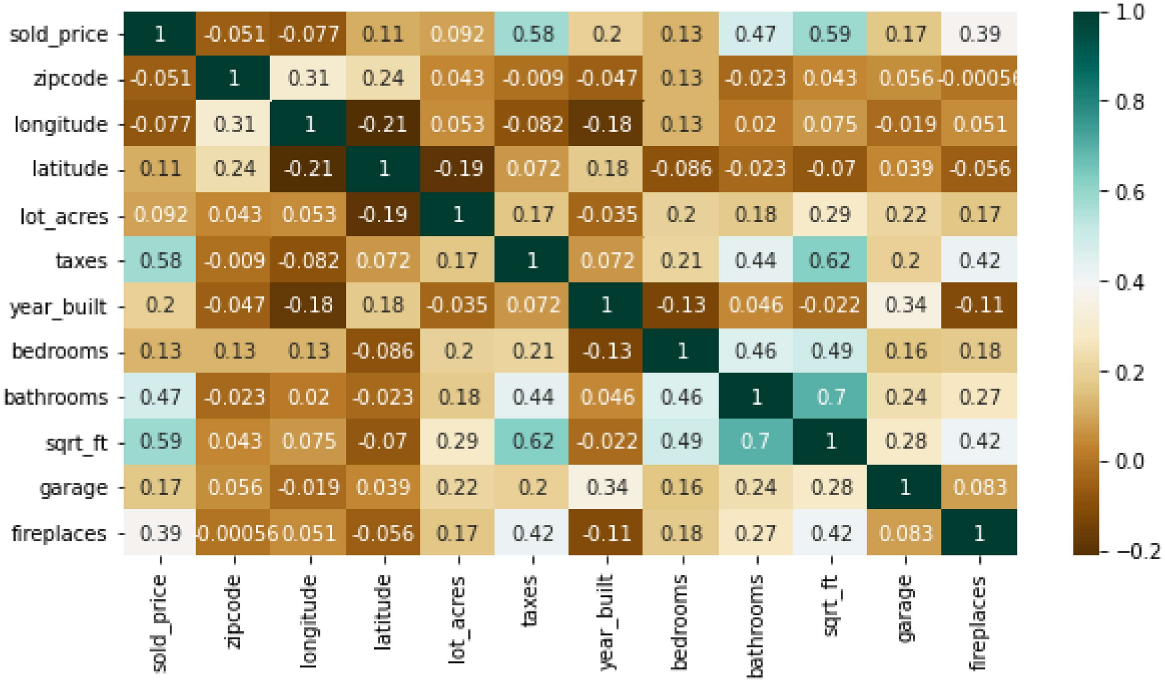
4484 rows × 3 columns

```
df.shape
```

```
(4484, 12)
```

```
plt.figure(figsize=(10,5))
c= df.corr()
sns.heatmap(c,cmap="BrBG",annot=True)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f217f3f4f10>
```




```
#Taking the columns used in the model
#df1=df.sample(frac=1) #Shuffle the data
X=df[['sqrt_ft','bedrooms']]
X
```

	sqrt_ft	bedrooms
0	7471.0	5
1	5333.0	4
2	6800.0	4
3	6622.0	4
4	7132.0	5
...	...	...
4479	2106.0	3
4480	3601.0	5
4481	2318.0	4
4482	3724.0	4
4483	4317.0	4

```
##Normalizing the data
X=(X-X.min())/(X.max()-X.min())


#Converting the data to array
X=X.to_numpy()
#Defining the dependent variable to classify
y=df.bathrooms.to_numpy()


#Dividing the data in training, validation and test
X_train=X[:3363,:]
y_train=y[:3363]
X_test=X[3363:4036,:]
y_test=y[3363:4036]
X_val=X[4036:,:]
y_val=y[4036:]
```

```
##Defining the algorithm
class KNNClassifier():
  def fit(self,X,y):
    self.X=X
    self.y=y

  def predict(self,X,K,epsilon=1e-3):

    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


##Defining the accuracy function
def accuracy(y,y_hat):
  return np.mean(y==y_hat)


#Fitting the model with the training data
knn = KNNClassifier()
knn.fit(X_train,y_train)
y_hat_train=knn.predict(X_train,10)


#Accuracy of the training model for K=10 neighbors
accuracy(y_train, y_hat_train)
```

```
0.6369313113291704
```

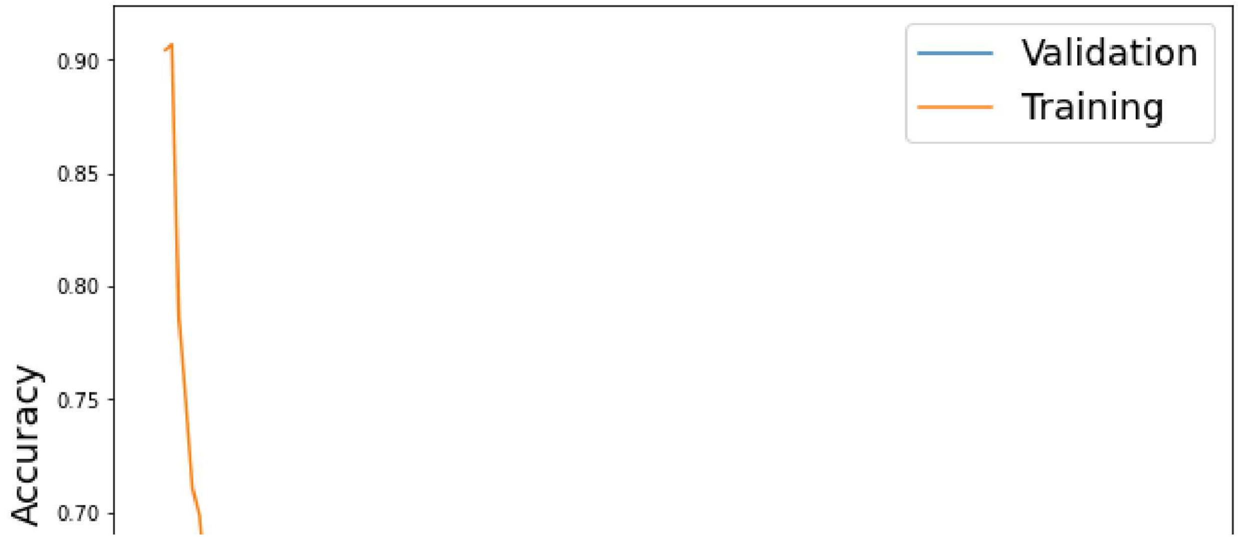
```
#Defining functions of K-neighbors to get the accueracy
```

```
def ac1(N):
  y_hat_train=knn.predict(X_train,N)
  return accuracy(y_train,y_hat_train)
neigh1=[i for i in range(1,150)]
accs1=np.zeros(len(neigh1))
for i in range(len(neigh1)):
  accs1[i]=ac1(neigh1[i])

def ac(N):
  y_hat_val=knn.predict(X_val,N)
  return accuracy(y_val,y_hat_val)
neigh=[i for i in range(1,150)]
accs=np.zeros(len(neigh))
for i in range(len(neigh)):
  accs[i]=ac(neigh[i])


plt.figure(figsize=(10,8))
plt.clf()
plt.plot(neigh,accs,label='Validation')
plt.plot(neigh1,accs1,label='Training')
#plt.plot(best_e,max_acc,'*',markersize=20,label='Best model')
plt.xlabel('Neighbors',fontsize=18)
plt.ylabel('Accuracy',fontsize=18)
plt.legend(fontsize=18)
```

<matplotlib.legend.Legend at 0x7f217ac29890>




```
#Creting a Data Frame to find the best K for the model
pd.DataFrame({'Neighbors': neigh1, 'accuracy_Train': accs, 'accuracy_Val': accs1})[10:20]
```

	Neighbors	accuracy_Train	accuracy_Val
10	11	0.620536	0.628605
11	12	0.620536	0.630984
12	13	0.633929	0.620577
13	14	0.636161	0.621172
14	15	0.629464	0.617009
15	16	0.640625	0.614630
16	17	0.642857	0.607493
17	18	0.642857	0.609575
18	19	0.640625	0.605114
19	20	0.645089	0.609575

```
#In this case we use K=24 neighbors to predict the test data
y_hat_test=knn.predict(X_test,16)
accuracy(y_test, y_hat_test)
```

```
0.6047548291233283
```

```
#Creating a data frame to compare the actual values with the predicted ones
results_test=pd.DataFrame({'Actual': y_test, 'prediction': y_hat_test})
results_test
```

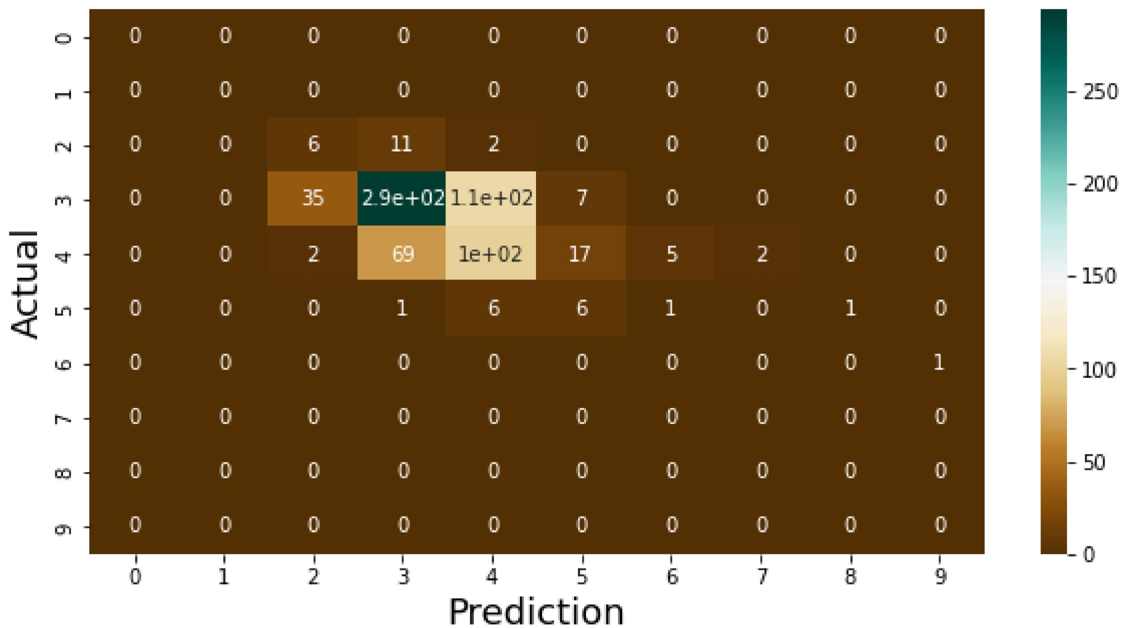
	Actual	prediction
0	3	4.0
1	4	4.0
2	3	3.0
3	3	3.0
4	5	3.0
...	...	...
668	3	4.0
669	3	3.0
670	3	3.0
671	2	3.0
672	4	4.0

673 rows × 2 columns

```
#Getting the confusion matrix of the Test data
confusion_matrix1=[]
for i in range(0,10):
```

```
  b=[]
  for j in range(0,10):
    x=results_test[(results_test['Actual']==j)&(results_test['prediction']==i)].shape[0]
    b.append(x)
  confusion_matrix1.append(b)
plt.figure(figsize=(10,5))
matrix=pd.DataFrame(confusion_matrix1)
sn.heatmap(matrix, cmap="BrBG",annot=True)
plt.xlabel('Prediction',fontsize=18)
plt.ylabel('Actual',fontsize=18)
plt.show
```

```
<function matplotlib.pyplot.show>
```

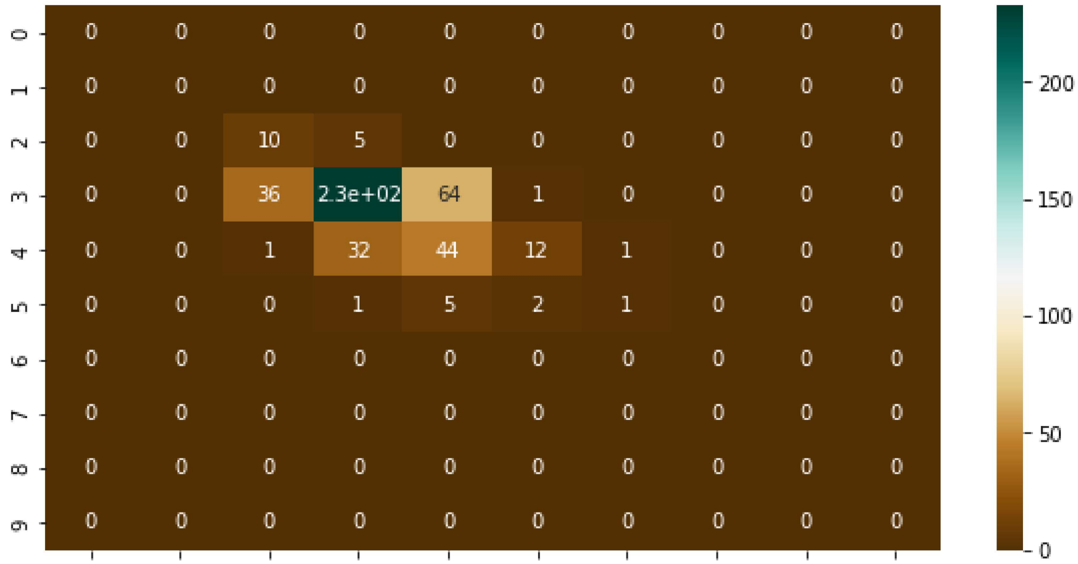



```
#Comparing the same with the Validation data
y_hat_val=knn.predict(X_val,24)
results_val=pd.DataFrame({'Actual': y_val, 'prediction': y_hat_val})
results_val.head(15)
```

	Actual	prediction
0	3	3.0
1	3	3.0
2	3	4.0
3	2	3.0
4	3	3.0
5	3	3.0
6	4	3.0
7	3	3.0
8	2	3.0
9	3	3.0
10	3	3.0
11	3	4.0
12	3	3.0
13	3	3.0

```
confusion_matrix2=[]
for i in range(0,10):
  b=[]
  for j in range(0,10):
    x=results_val[(results_val['Actual']==j)&(results_val['prediction']==i)].shape[0]
    b.append(x)
  confusion_matrix2.append(b)
plt.figure(figsize=(10,5))
matrix=pd.DataFrame(confusion_matrix2)
sn.heatmap(matrix, cmap="BrBG",annot=True)
plt.show
```

<function matplotlib.pyplot.show>



X

```
array([[0.99596706, 0.375     ],
       [0.63669971, 0.25      ],
       [0.88321291, 0.25      ],
       ...,
       [0.13006217, 0.25      ],
       [0.36632499, 0.25      ],
       [0.46597211, 0.25      ]])
```

```
Z=df[['sqrt_ft','bedrooms']]
Z_norm=(Z-Z.min())/(Z.max()-Z.min())
Y=df.bathrooms.to_numpy()
zz=Z_norm.to_numpy()
Y_Hat=knn.predict(zz,24)
Y_Hat
accuracy(Y,Y_Hat)
```

```
0.6070472792149866
```

```
cand=[]
c=0
```

```
for i in range(len(Y)):
  if Y_Hat[i]>Y[i]:
    cand.append(1)
    c=c+1
  else:
    cand.append(0)
print('The number of houses that can be candidates is', c)
```

```
The number of houses that can be candidates is 738
```

```
Z['bathrooms']=Y
Z['predicted']=Y_Hat
Z['candidate']=cand
```

```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:1: SettingWithCopyWarning:
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/user_guide/indexing.html#returning-a
  """Entry point for launching an IPython kernel.
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:2: SettingWithCopyWarning:
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/user_guide/indexing.html#returning-a

/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:3: SettingWithCopyWarning:
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/user_guide/indexing.html#returning-a
  This is separate from the ipykernel package so we can avoid doing imports until
```

```
Z.head(5)
```

	sqrt_ft	bedrooms	bathrooms	predicted	candidate
0	7471.0	5	6	6.0	0
1	5333.0	4	4	5.0	1
2	6800.0	4	7	6.0	0
3	6622.0	4	6	6.0	0

```
df['candidate']=cand
```

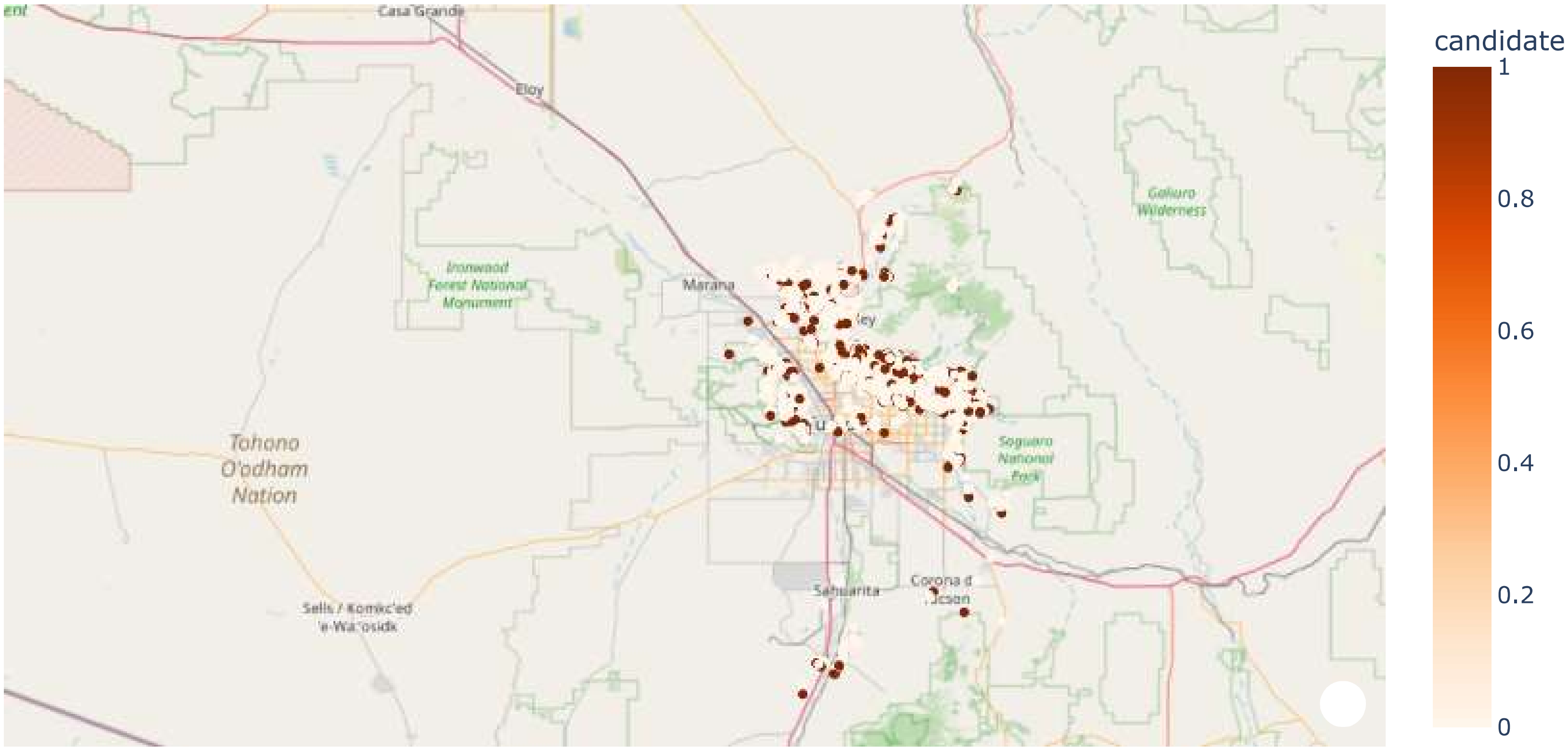
```
df
```

	sold_price	zipcode	longitude	latitude	lot_acres	taxes	year_built	bedrooms	bathrooms	sqrt_ft	garage
0	2000000.0	85750	-110.848679	32.321134	0.64	11322.00	2001	5	6	7471.0	3
1	1900000.0	85750	-110.843910	32.328460	1.16	16714.00	2002	4	4	5333.0	3
2	1800000.0	85750	-110.845560	32.327714	1.32	20206.00	2002	4	7	6800.0	3
3	1950000.0	85755	-110.992676	32.464204	1.18	21063.00	2002	4	6	6622.0	6
4	1920000.0	85718	-110.910653	32.338271	1.27	24316.00	1997	5	6	7132.0	3
...	...	...	...	...	...	...	...	...	...	...	...
4479	535000.0	85718	-110.922291	32.317496	0.18	4414.00	2002	3	2	2106.0	2
4480	495000.0	85641	-110.661829	31.907917	4.98	2017.00	2005	5	3	3601.0	3
4481	550000.0	85750	-110.858556	32.316373	1.42	4822.01	1990	4	3	2318.0	3
4482	550000.0	85745	-111.055528	32.296871	1.01	5822.93	2009	4	4	3724.0	3
4483	450000.0	85621	-110.913054	31.385259	4.16	2814.48	1988	4	4	4317.0	0

4484 rows × 13 columns

```
fig = px.scatter_mapbox(df,lat = 'latitude', lon = 'longitude', color = 'candidate',
                        center=dict(lon=-110.9, lat=32.3),
```

```
                     zoom = 9, mapbox_style = 'open-street-map',color_continuous_scale="oranges")
fig
```




```
DX=df[['sqrt_ft','bedrooms']]
G=(DX-DX.min())/(DX.max()-DX.min())
DX.min()
```

```
sqrt_ft      1544.0
bedrooms        2.0
dtype: float64
```

```
DX.max()
```

```
sqrt_ft     7495.0
bedrooms      10.0
dtype: float64
```

```
def Demo(sqrt_ft,bedrooms, bathrooms):


  y=knn.predict([[(sqrt_ft-1544)/(7495-1544),(bedrooms-2)/8]],24)
  print(y)
  if y[0]>bathrooms:
    return True
  else:
    return False
```

```
Demo(80,3,2)
```

```
[3.]
True
```

0s completed at 7:47 PM