Predicting House Prices in Banglore City

Dataset is downloaded from here: https://www.kaggle.com/amitabhajoy/bengaluru-house-price-data (https://www.kaggle.com/amitabhajoy/bengaluru-house-price-data)

In [1]:
```
import pandas as pd
import numpy as np
from matplotlib import pyplot as plt
%matplotlib inline
import matplotlib
matplotlib.rcParams["figure.figsize"] = (20,10)
```

Data Load: Load banglore home prices into a dataframe

In [2]:
```
df1 = pd.read_csv("bengaluru_house_prices.csv")
df1.head()
```

Out[2]:

	area_type	availability	location	size	society	total_sqft	bath	balcony	price
0	Super built-up Area	19-Dec	Electronic City Phase II	2 BHK	Coomee	1056	2.0	1.0	39.07
1	Plot Area	Ready To Move	Chikka Tirupathi	4 Bedroom	Theanmp	2600	5.0	3.0	120.00
2	Built-up Area	Ready To Move	Uttarahalli	3 BHK	NaN	1440	2.0	3.0	62.00
3	Super built-up Area	Ready To Move	Lingadheeranahalli	3 BHK	Soiewre	1521	3.0	1.0	95.00
4	Super built-up Area	Ready To Move	Kothanur	2 BHK	NaN	1200	2.0	1.0	51.00

In [3]:
```
df1.shape
```

Out[3]:
```
(13320, 9)
```

In [4]:
```
df1.columns
```

Out[4]:
```
Index(['area_type', 'availability', 'location', 'size', 'society',
       'total_sqft', 'bath', 'balcony', 'price'],
      dtype='object')
```

In [5]:
```
df1['area_type'].unique()
```

Out[5]:
```
array(['Super built-up  Area', 'Plot  Area', 'Built-up  Area',
       'Carpet  Area'], dtype=object)
```

In [6]:
```
df1['area_type'].value_counts()
```

Out[6]:
```
Super built-up  Area    8790
Built-up  Area          2418
Plot  Area              2025
Carpet  Area              87
Name: area_type, dtype: int64
```

Drop features that are not required to build our model

In [7]:
```
df2 = df1.drop(['area_type','society','balcony','availability'],axis='columns')
df2.shape
```

Out[7]:
```
(13320, 5)
```

Data Cleaning: Handle NA values

In [8]:
```
df2.isnull().sum()
```
Out[8]:
```
location       1
size          16
total_sqft     0
bath          73
price          0
dtype: int64
```
In [9]:
```
df2.shape
```
Out[9]:
```
(13320, 5)
```
In [10]:
```
df3 = df2.dropna()
df3.isnull().sum()
```
Out[10]:
```
location      0
size          0
total_sqft    0
bath          0
price         0
dtype: int64
```
In [11]:
```
df3.shape
```
Out[11]:
```
(13246, 5)
```

Feature Engineering

Add new feature(integer) for bhk (Bedrooms Hall Kitchen)

In [12]:
```
df3['bhk'] = df3['size'].apply(lambda x: int(x.split(' ')[0]))
df3.bhk.unique()
```
```
<ipython-input-12-681cf3aca53d>: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/us
er_guide/indexing.html#returning-a-view-versus-a-copy
  df3['bhk'] = df3['size'].apply(lambda x: int(x.split(' ')[0]))
```
Out[12]:
```
array([ 2,  4,  3,  6,  1,  8,  7,  5, 11,  9, 27, 10, 19, 16, 43, 14, 12,
       13, 18])
```

Explore total_sqft feature

In [13]:
```
def is_float(x):
    try:
        float(x)
    except:
        return False
    return True
```
In [14]:
```
2+3
```
Out[14]:
```
5
```

In [15]:
```
df3[~df3['total_sqft'].apply(is_float)].head(10)
```

Out[15]:

	location	size	total_sqft	bath	price	bhk
30	Yelahanka	4 BHK	2100 - 2850	4.0	186.000	4
122	Hebbal	4 BHK	3067 - 8156	4.0	477.000	4
137	8th Phase JP Nagar	2 BHK	1042 - 1105	2.0	54.005	2
165	Sarjapur	2 BHK	1145 - 1340	2.0	43.490	2
188	KR Puram	2 BHK	1015 - 1540	2.0	56.800	2
410	Kengeri	1 BHK	34.46Sq. Meter	1.0	18.500	1
549	Hennur Road	2 BHK	1195 - 1440	2.0	63.770	2
648	Arekere	9 Bedroom	4125Perch	9.0	265.000	9
661	Yelahanka	2 BHK	1120 - 1145	2.0	48.130	2
672	Bettahalsoor	4 Bedroom	3090 - 5002	4.0	445.000	4

Above shows that total_sqft can be a range (e.g. 2100-2850). For such case we can just take average of min and max value in the range. There are other cases such as 34.46Sq. Meter which one can convert to square ft using unit conversion. I am going to just drop such corner cases to keep things simple

In [16]:
```
def convert_sqft_to_num(x):
    tokens = x.split('-')
    if len(tokens) == 2:
        return (float(tokens[0])+float(tokens[1]))/2
    try:
        return float(x)
    except:
        return None
```

In [17]:
```
df4 = df3.copy()
df4.total_sqft = df4.total_sqft.apply(convert_sqft_to_num)
df4 = df4[df4.total_sqft.notnull()]
df4.head(2)
```

Out[17]:

	location	size	total_sqft	bath	price	bhk
0	Electronic City Phase II	2 BHK	1056.0	2.0	39.07	2
1	Chikka Tirupathi	4 Bedroom	2600.0	5.0	120.00	4

For below row, it shows total_sqft as 2475 which is an average of the range 2100-2850

In [18]:
```
df4.loc[30]
```

Out[18]:
```
location      Yelahanka
size              4 BHK
total_sqft       2475.0
bath                4.0
price             186.0
bhk                   4
Name: 30, dtype: object
```

In [19]:
```
(2100+2850)/2
```

Out[19]:
```
2475.0
```

Feature Engineering

Add new feature called price per square feet

```
In [20]: df5 = df4.copy()
         df5['price_per_sqft'] = df5['price']*100000/df5['total_sqft']
         df5.head()
```

Out[20]:

	location	size	total_sqft	bath	price	bhk	price_per_sqft
0	Electronic City Phase II	2 BHK	1056.0	2.0	39.07	2	3699.810606
1	Chikka Tirupathi	4 Bedroom	2600.0	5.0	120.00	4	4615.384615
2	Uttarahalli	3 BHK	1440.0	2.0	62.00	3	4305.555556
3	Lingadheeranahalli	3 BHK	1521.0	3.0	95.00	3	6245.890861
4	Kothanur	2 BHK	1200.0	2.0	51.00	2	4250.000000

```
In [21]: df5_stats = df5['price_per_sqft'].describe()
         df5_stats

Out[21]: count    1.320000e+04
         mean     7.920759e+03
         std      1.067272e+05
         min      2.678298e+02
         25%      4.267701e+03
         50%      5.438331e+03
         75%      7.317073e+03
         max      1.200000e+07
         Name: price_per_sqft, dtype: float64

In [22]: df5.to_csv("bhp.csv",index=False)
```

Examine locations which is a categorical variable. We need to apply dimensionality reduction technique here to reduce number of locations

```
In [23]: df5.location = df5.location.apply(lambda x: x.strip())
         location_stats = df5['location'].value_counts(ascending=False)
         location_stats

Out[23]: Whitefield           533
         Sarjapur  Road       392
         Electronic City      304
         Kanakpura Road       264
         Thanisandra          235
                             ...
         Arekempanahalli        1
         Jaya Nagar East        1
         D Souza Layout         1
         Pillanna Gardens       1
         Chikbasavanapura       1
         Name: location, Length: 1287, dtype: int64

In [24]: location_stats.values.sum()

Out[24]: 13200

In [25]: len(location_stats[location_stats>10])

Out[25]: 240

In [26]: len(location_stats)

Out[26]: 1287

In [27]: len(location_stats[location_stats<=10])

Out[27]: 1047
```

Dimensionality Reduction

Any location having less than 10 data points should be tagged as "other" location. This way number of categories can be reduced by huge amount. Later on when we do one hot encoding, it will help us with having fewer dummy columns

In [28]:
```
location_stats_less_than_10 = location_stats[location_stats<=10]
location_stats_less_than_10
```

Out[28]:
```
Nagappa Reddy Layout    10
Sector 1 HSR Layout     10
Thyagaraja Nagar        10
BTM 1st Stage           10
Gunjur Palya            10
                        ..
Arekempanahalli          1
Jaya Nagar East          1
D Souza Layout           1
Pillanna Gardens         1
Chikbasavanapura         1
Name: location, Length: 1047, dtype: int64
```

In [29]:
```
len(df5.location.unique())
```

Out[29]:
```
1287
```

In [30]:
```
df5.location = df5.location.apply(lambda x: 'other' if x in location_stats_less_than_
10 else x)
len(df5.location.unique())
```

Out[30]:
```
241
```

In [31]:
```
df5.head(10)
```

Out[31]:

	location	size	total_sqft	bath	price	bhk	price_per_sqft
0	Electronic City Phase II	2 BHK	1056.0	2.0	39.07	2	3699.810606
1	Chikka Tirupathi	4 Bedroom	2600.0	5.0	120.00	4	4615.384615
2	Uttarahalli	3 BHK	1440.0	2.0	62.00	3	4305.555556
3	Lingadheeranahalli	3 BHK	1521.0	3.0	95.00	3	6245.890861
4	Kothanur	2 BHK	1200.0	2.0	51.00	2	4250.000000
5	Whitefield	2 BHK	1170.0	2.0	38.00	2	3247.863248
6	Old Airport Road	4 BHK	2732.0	4.0	204.00	4	7467.057101
7	Rajaji Nagar	4 BHK	3300.0	4.0	600.00	4	18181.818182
8	Marathahalli	3 BHK	1310.0	3.0	63.25	3	4828.244275
9	other	6 Bedroom	1020.0	6.0	370.00	6	36274.509804

Outlier Removal Using Business Logic

As a data scientist when you have a conversation with your business manager (who has expertise in real estate), he will tell you that normally square ft per bedroom is 300 (i.e. 2 bhk apartment is minimum 600 sqft. If you have for example 400 sqft apartment with 2 bhk than that seems suspicious and can be removed as an outlier. We will remove such outliers by keeping our minimum thresold per bhk to be 300 sqft

```
In [32]: df5[df5.total_sqft/df5.bhk<300].head()
```

Out[32]:

	location	size	total_sqft	bath	price	bhk	price_per_sqft
9	other	6 Bedroom	1020.0	6.0	370.0	6	36274.509804
45	HSR Layout	8 Bedroom	600.0	9.0	200.0	8	33333.333333
58	Murugeshpalya	6 Bedroom	1407.0	4.0	150.0	6	10660.980810
68	Devarachikkanahalli	8 Bedroom	1350.0	7.0	85.0	8	6296.296296
70	other	3 Bedroom	500.0	3.0	100.0	3	20000.000000

Check above data points. We have 6 bhk apartment with 1020 sqft. Another one is 8 bhk and total sqft is 600. These are clear data errors that can be removed safely

```
In [33]: df5.shape
```

```
Out[33]: (13200, 7)
```

```
In [34]: df6 = df5[~(df5.total_sqft/df5.bhk<300)]
         df6.shape
```

```
Out[34]: (12456, 7)
```

Outlier Removal Using Standard Deviation and Mean

```
In [35]: df6.price_per_sqft.describe()
```

```
Out[35]: count     12456.000000
         mean       6308.502826
         std        4168.127339
         min         267.829813
         25%        4210.526316
         50%        5294.117647
         75%        6916.666667
         max      176470.588235
         Name: price_per_sqft, dtype: float64
```

Here we find that min price per sqft is 267 rs/sqft whereas max is 12000000, this shows a wide variation in property prices. We should remove outliers per location using mean and one standard deviation

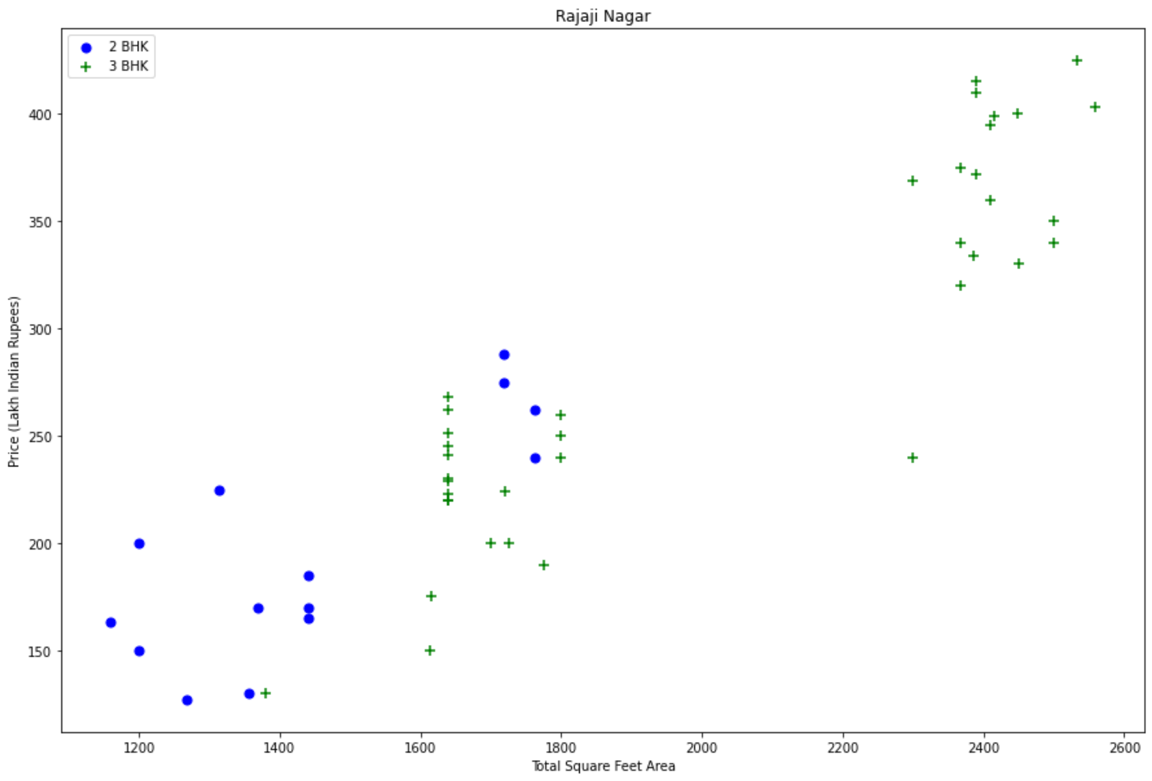
```
In [36]: def remove_pps_outliers(df):
             df_out = pd.DataFrame()
             for key, subdf in df.groupby('location'):
                 m = np.mean(subdf.price_per_sqft)
                 st = np.std(subdf.price_per_sqft)
                 reduced_df = subdf[(subdf.price_per_sqft>(m-st)) & (subdf.price_per_sqft<=(m+
         st))]
                 df_out = pd.concat([df_out,reduced_df],ignore_index=True)
             return df_out
         df7 = remove_pps_outliers(df6)
         df7.shape
```

```
Out[36]: (10242, 7)
```

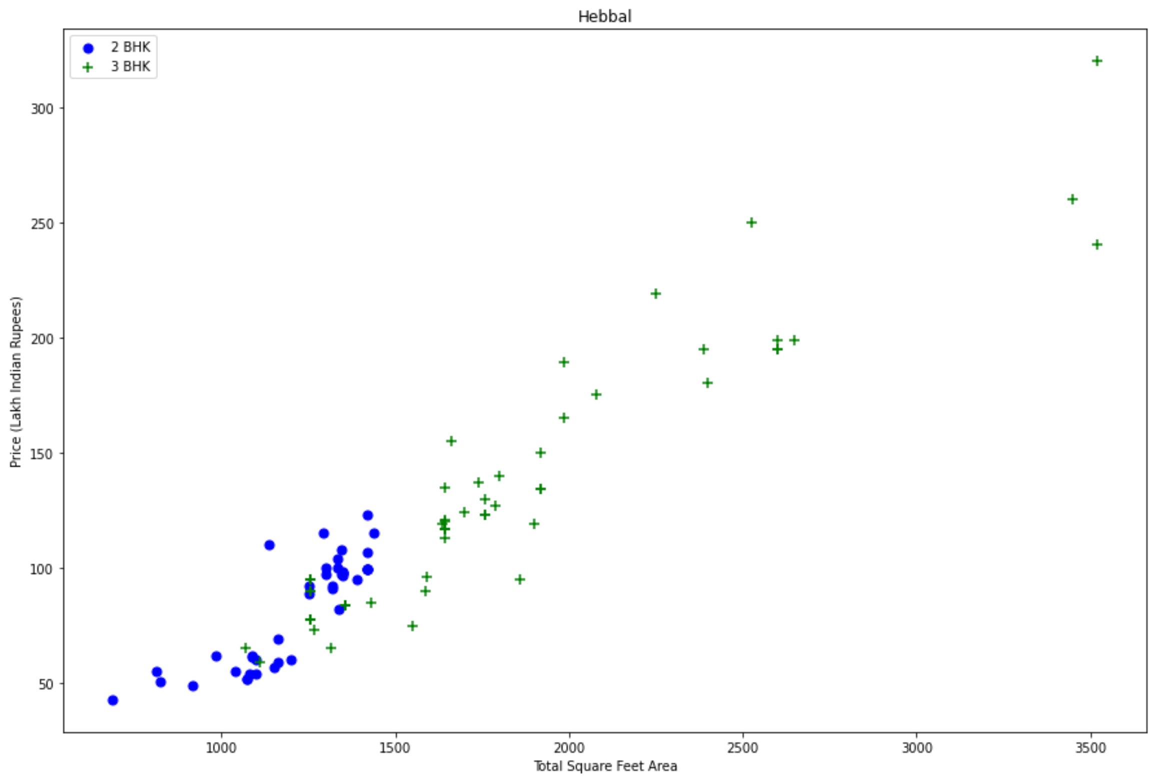
Let's check if for a given location how does the 2 BHK and 3 BHK property prices look like

```
In [37]: def plot_scatter_chart(df,location):
             bhk2 = df[(df.location==location) & (df.bhk==2)]
             bhk3 = df[(df.location==location) & (df.bhk==3)]
             matplotlib.rcParams['figure.figsize'] = (15,10)
             plt.scatter(bhk2.total_sqft,bhk2.price,color='blue',label='2 BHK', s=50)
             plt.scatter(bhk3.total_sqft,bhk3.price,marker='+', color='green',label='3 BHK', s
         =50)
             plt.xlabel("Total Square Feet Area")
             plt.ylabel("Price (Lakh Indian Rupees)")
             plt.title(location)
             plt.legend()

         plot_scatter_chart(df7,"Rajaji Nagar")
```



In [38]:
```
plot_scatter_chart(df7,"Hebbal")
```



We should also remove properties where for same location, the price of (for example) 3 bedroom apartment is less than 2 bedroom apartment (with same square ft area). What we will do is for a given location, we will build a dictionary of stats per bhk, i.e.

```
{
    '1' : {
        'mean': 4000,
        'std: 2000,
        'count': 34
    },
    '2' : {
        'mean': 4300,
        'std: 2300,
        'count': 22
    },
}
```

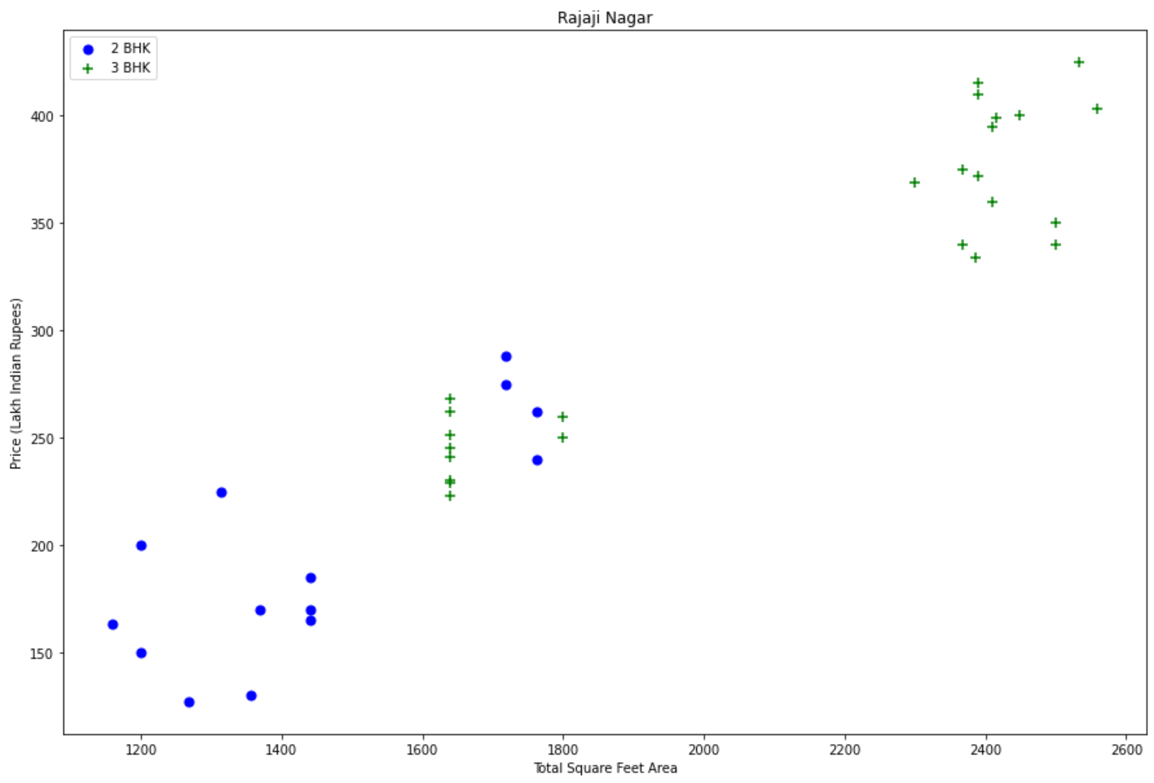
Now we can remove those 2 BHK apartments whose price_per_sqft is less than mean price_per_sqft of 1 BHK apartment

In [39]:
```
def remove_bhk_outliers(df):
    exclude_indices = np.array([])
    for location, location_df in df.groupby('location'):
        bhk_stats = {}
        for bhk, bhk_df in location_df.groupby('bhk'):
            bhk_stats[bhk] = {
                'mean': np.mean(bhk_df.price_per_sqft),
                'std': np.std(bhk_df.price_per_sqft),
                'count': bhk_df.shape[0]
            }
        for bhk, bhk_df in location_df.groupby('bhk'):
            stats = bhk_stats.get(bhk-1)
            if stats and stats['count']>5:
                exclude_indices = np.append(exclude_indices, bhk_df[bhk_df.price_per_
sqft<(stats['mean'])].index.values)
    return df.drop(exclude_indices,axis='index')
df8 = remove_bhk_outliers(df7)
# df8 = df7.copy()
df8.shape
```

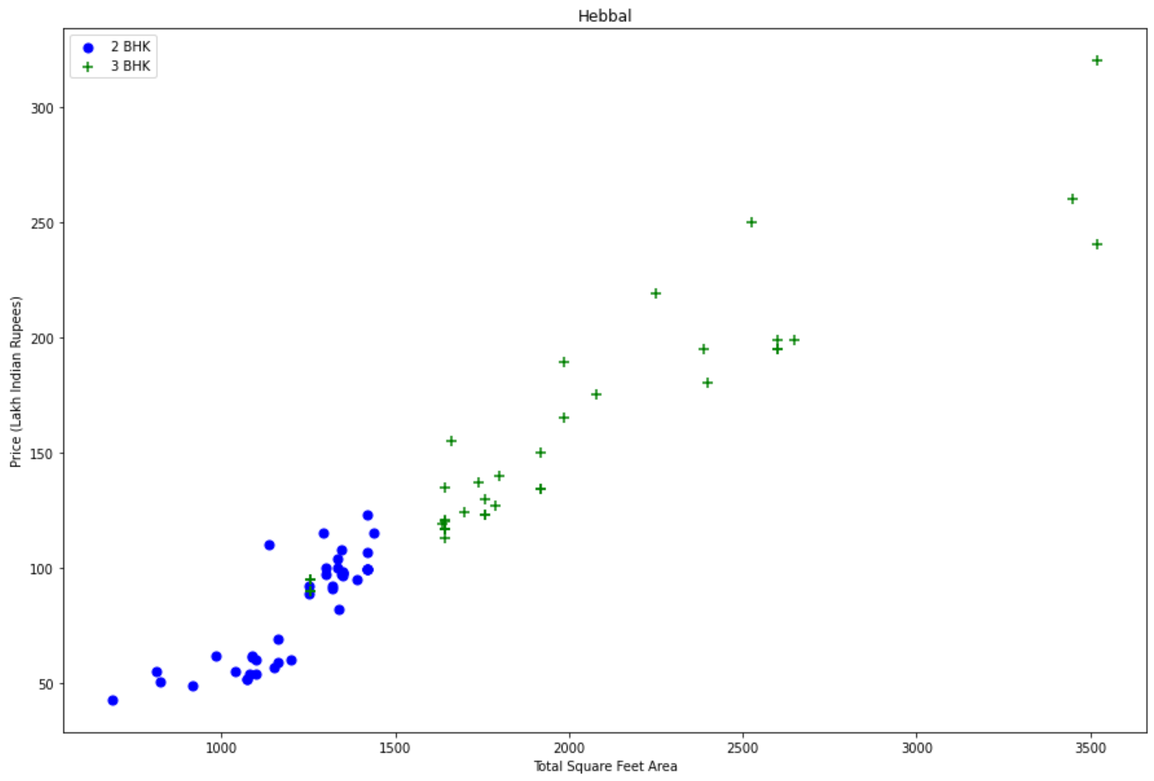
Out[39]:
```
(7317, 7)
```

Plot same scatter chart again to visualize price_per_sqft for 2 BHK and 3 BHK properties

```
In [40]: plot_scatter_chart(df8,"Rajaji Nagar")
```



```
In [41]: plot_scatter_chart(df8,"Hebbal")
```



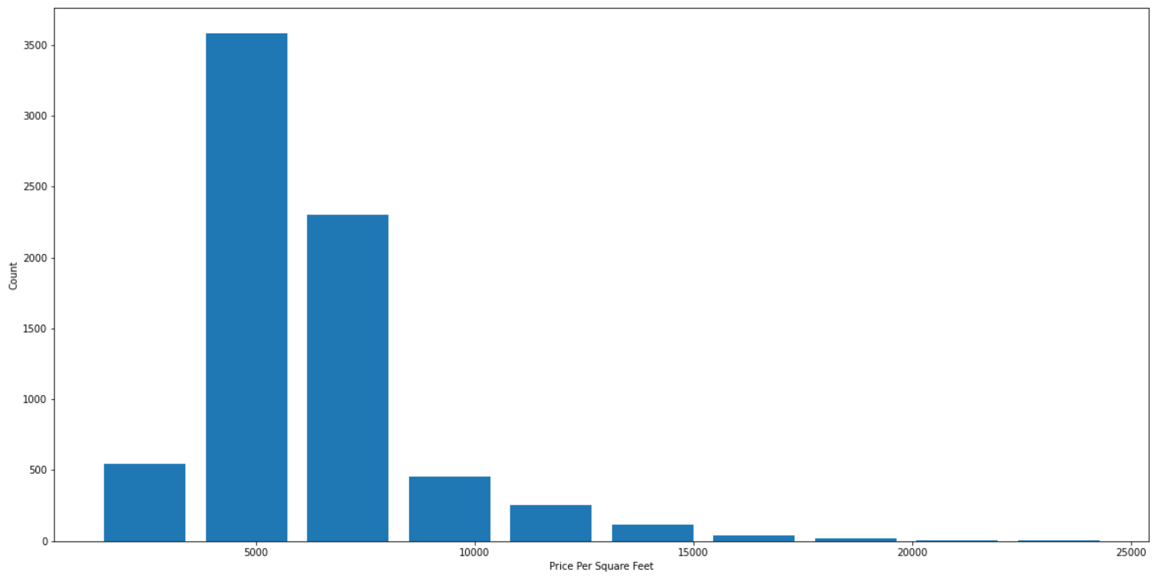
Based on above charts we can see that data points highlighted in red below are outliers and they are being removed due to remove_bhk_outliers function

Before and after outlier removal: Rajaji Nagar

Before and after outlier removal: Hebbal

```
In [42]: import matplotlib
         matplotlib.rcParams["figure.figsize"] = (20,10)
         plt.hist(df8.price_per_sqft,rwidth=0.8)
         plt.xlabel("Price Per Square Feet")
         plt.ylabel("Count")
```

```
Out[42]: Text(0, 0.5, 'Count')
```



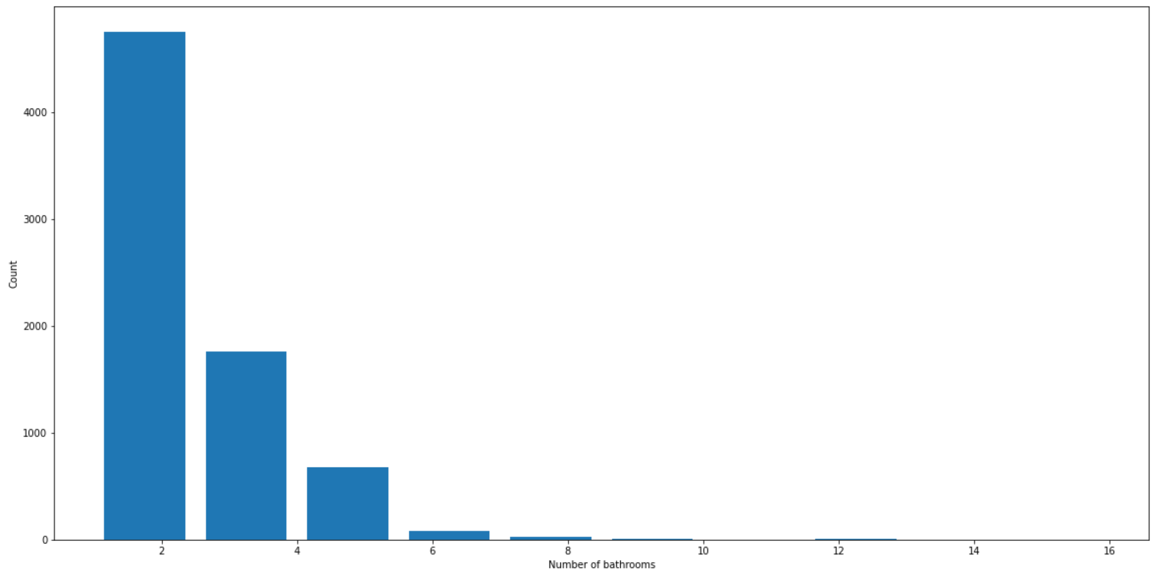
Outlier Removal Using Bathrooms Feature

```
In [43]: df8.bath.unique()
```

```
Out[43]: array([ 4.,  3.,  2.,  5.,  8.,  1.,  6.,  7.,  9., 12., 16., 13.])
```

```
In [44]: plt.hist(df8.bath,rwidth=0.8)
         plt.xlabel("Number of bathrooms")
         plt.ylabel("Count")
```

```
Out[44]: Text(0, 0.5, 'Count')
```



```
In [45]: df8[df8.bath>10]
```

Out[45]:

	location	size	total_sqft	bath	price	bhk	price_per_sqft
5277	Neeladri Nagar	10 BHK	4000.0	12.0	160.0	10	4000.000000
8483	other	10 BHK	12000.0	12.0	525.0	10	4375.000000
8572	other	16 BHK	10000.0	16.0	550.0	16	5500.000000
9306	other	11 BHK	6000.0	12.0	150.0	11	2500.000000
9637	other	13 BHK	5425.0	13.0	275.0	13	5069.124424

It is unusual to have 2 more bathrooms than number of bedrooms in a home

```
In [46]: df8[df8.bath>df8.bhk+2]
```

Out[46]:

	location	size	total_sqft	bath	price	bhk	price_per_sqft
1626	Chikkabanavar	4 Bedroom	2460.0	7.0	80.0	4	3252.032520
5238	Nagasandra	4 Bedroom	7000.0	8.0	450.0	4	6428.571429
6711	Thanisandra	3 BHK	1806.0	6.0	116.0	3	6423.034330
8408	other	6 BHK	11338.0	9.0	1000.0	6	8819.897689

Again the business manager has a conversation with you (i.e. a data scientist) that if you have 4 bedroom home and even if you have bathroom in all 4 rooms plus one guest bathroom, you will have total bath = total bed + 1 max. Anything above that is an outlier or a data error and can be removed

```
In [47]: df9 = df8[df8.bath<df8.bhk+2]
         df9.shape
```

```
Out[47]: (7239, 7)
```

```
In [48]: df9.head(2)
```

Out[48]:

	location	size	total_sqft	bath	price	bhk	price_per_sqft
0	1st Block Jayanagar	4 BHK	2850.0	4.0	428.0	4	15017.543860
1	1st Block Jayanagar	3 BHK	1630.0	3.0	194.0	3	11901.840491

```
In [49]: df10 = df9.drop(['size','price_per_sqft'],axis='columns')
         df10.head(3)
```

Out[49]:

	location	total_sqft	bath	price	bhk
0	1st Block Jayanagar	2850.0	4.0	428.0	4
1	1st Block Jayanagar	1630.0	3.0	194.0	3
2	1st Block Jayanagar	1875.0	2.0	235.0	3

Use One Hot Encoding For Location

```
In [50]: dummies = pd.get_dummies(df10.location)
         dummies.head(3)
```

Out[50]:

	1st Block Jayanagar	1st Phase JP Nagar	2nd Phase Judicial Layout	2nd Stage Nagarbhavi	5th Block Hbr Layout	5th Phase JP Nagar	6th Phase JP Nagar	7th Phase JP Nagar	8th Phase JP Nagar	9th Phase JP Nagar	...	Vishveshwarya Layout	Vishwa La
0	1	0	0	0	0	0	0	0	0	0	...	0	
1	1	0	0	0	0	0	0	0	0	0	...	0	
2	1	0	0	0	0	0	0	0	0	0	...	0	

3 rows × 241 columns

```
In [51]: df11 = pd.concat([df10,dummies.drop('other',axis='columns')],axis='columns')
         df11.head()
```

Out[51]:

	location	total_sqft	bath	price	bhk	1st Block Jayanagar	1st Phase JP Nagar	2nd Phase Judicial Layout	2nd Stage Nagarbhavi	5th Block Hbr Layout	...	Vijayanagar	Vishvesh L
0	1st Block Jayanagar	2850.0	4.0	428.0	4	1	0	0	0	0	...	0	
1	1st Block Jayanagar	1630.0	3.0	194.0	3	1	0	0	0	0	...	0	
2	1st Block Jayanagar	1875.0	2.0	235.0	3	1	0	0	0	0	...	0	
3	1st Block Jayanagar	1200.0	2.0	130.0	3	1	0	0	0	0	...	0	
4	1st Block Jayanagar	1235.0	2.0	148.0	2	1	0	0	0	0	...	0	

5 rows × 245 columns

```
In [52]: df12 = df11.drop('location',axis='columns')
         df12.head(2)
```

Out[52]:

	total_sqft	bath	price	bhk	1st Block Jayanagar	1st Phase JP Nagar	2nd Phase Judicial Layout	2nd Stage Nagarbhavi	5th Block Hbr Layout	5th Phase JP Nagar	...	Vijayanagar	Vishveshwar Layc
0	2850.0	4.0	428.0	4	1	0	0	0	0	0	...	0	
1	1630.0	3.0	194.0	3	1	0	0	0	0	0	...	0	

2 rows × 244 columns

Building a Model Using Linear Regression

```
In [53]: df12.shape
```

```
Out[53]: (7239, 244)
```

```
In [54]: X = df12.drop(['price'],axis='columns')
         X.head(3)
```

Out[54]:

	total_sqft	bath	bhk	1st Block Jayanagar	1st Phase JP Nagar	2nd Phase Judicial Layout	2nd Stage Nagarbhavi	5th Block Hbr Layout	5th Phase JP Nagar	6th Phase JP Nagar	...	Vijayanagar	Vishveshwa Lay
0	2850.0	4.0	4	1	0	0	0	0	0	0	...	0	
1	1630.0	3.0	3	1	0	0	0	0	0	0	...	0	
2	1875.0	2.0	3	1	0	0	0	0	0	0	...	0	

3 rows × 243 columns

```
In [55]: X.shape
```

```
Out[55]: (7239, 243)
```

```
In [56]: X.to_csv('Fitted_bhp.csv')
```

```
In [57]: y = df12.price
         y.head(3)
```

```
Out[57]: 0    428.0
         1    194.0
         2    235.0
         Name: price, dtype: float64
```

```
In [58]: len(y)
```

```
Out[58]: 7239
```

```
In [59]: from sklearn.model_selection import train_test_split
         X_train, X_test, y_train, y_test = train_test_split(X,y,test_size=0.2,random_state=1
         0)
```

```
In [60]: from sklearn.linear_model import LinearRegression
         lr_clf = LinearRegression()
         lr_clf.fit(X_train,y_train)
         lr_clf.score(X_test,y_test)
```

```
Out[60]: 0.8629132245229443
```

Use K Fold cross validation to measure accuracy of our LinearRegression model

```
In [61]: from sklearn.model_selection import ShuffleSplit
         from sklearn.model_selection import cross_val_score

         cv = ShuffleSplit(n_splits=5, test_size=0.2, random_state=0)

         cross_val_score(LinearRegression(), X, y, cv=cv)
```

```
Out[61]: array([0.82702546, 0.86027005, 0.85322178, 0.8436466 , 0.85481502])
```

We can see that in 5 iterations we get a score above 80% all the time. This is pretty good but we want to test few other algorithms for regression to see if we can get even better score. We will use GridSearchCV for this purpose

Find best model using GridSearchCV

```
In [62]: from sklearn.model_selection import GridSearchCV

         from sklearn.linear_model import Lasso
         from sklearn.tree import DecisionTreeRegressor

         def find_best_model_using_gridsearchcv(X,y):
             algos = {
                 'linear_regression' : {
                     'model': LinearRegression(),
                     'params': {
                         'normalize': [True, False]
                     }
                 },
                 'lasso': {
                     'model': Lasso(),
                     'params': {
                         'alpha': [1,2],
                         'selection': ['random', 'cyclic']
                     }
                 },
                 'decision_tree': {
                     'model': DecisionTreeRegressor(),
                     'params': {
                         'criterion' : ['mse','friedman_mse'],
                         'splitter': ['best','random']
                     }
                 }
             }
             scores = []
             cv = ShuffleSplit(n_splits=5, test_size=0.2, random_state=0)
             for algo_name, config in algos.items():
                 gs =  GridSearchCV(config['model'], config['params'], cv=cv, return_train_sco
         re=False)
                 gs.fit(X,y)
                 scores.append({
                     'model': algo_name,
                     'best_score': gs.best_score_,
                     'best_params': gs.best_params_
                 })

             return pd.DataFrame(scores,columns=['model','best_score','best_params'])

         find_best_model_using_gridsearchcv(X,y)
```

Out[62]:

	model	best_score	best_params
0	linear_regression	0.847796	{'normalize': False}
1	lasso	0.726857	{'alpha': 2, 'selection': 'random'}
2	decision_tree	0.708579	{'criterion': 'friedman_mse', 'splitter': 'best'}

Based on above results we can say that LinearRegression gives the best score. Hence we will use that.

Test the model for few properties

```
In [63]: def predict_price(location,sqft,bath,bhk):
             loc_index = np.where(X.columns==location)[0][0]

             x = np.zeros(len(X.columns))
             x[0] = sqft
             x[1] = bath
             x[2] = bhk
             if loc_index >= 0:
                 x[loc_index] = 1

             return lr_clf.predict([x])[0]
```

```
In [64]: predict_price('1st Phase JP Nagar',1000, 2, 2)
```

```
Out[64]: 83.86570258312172
```

```
In [65]: predict_price('1st Phase JP Nagar',1000, 3, 3)
```

```
Out[65]: 86.08062284986931
```

```
In [66]: predict_price('Indira Nagar',1000, 2, 2)
```

```
Out[66]: 193.311977331799
```

```
In [67]: predict_price('Indira Nagar',1000, 3, 3)
```

```
Out[67]: 195.52689759854664
```

Export the tested model to a pickle file

```
In [68]: import pickle
         with open('banglore_home_prices_model.pickle','wb') as f:
             pickle.dump(lr_clf,f)
```

Export location and column information to a file that will be useful later on in our prediction application

```
In [69]: import json
         columns = {
             'data_columns' : [col.lower() for col in X.columns]
         }
         with open("columns.json","w") as f:
             f.write(json.dumps(columns))
```

Modifying Predict price function for GUI

```
In [70]: locations = list(X.columns[3:])
         def predict_price_for_gui(Area,BHK,Bathrooms,Location):
             if(BHK==0 or BHK>5 or Bathrooms==0 or Bathrooms>5):
                 return 'Invalid input'


             loc_index = np.where(X.columns==Location)[0][0]

             x = np.zeros(len(X.columns))
             x[0] = Area
             x[1] = Bathrooms
             x[2] = BHK
             if loc_index >= 0:
                 x[loc_index] = 1

             return lr_clf.predict([x])[0]
```

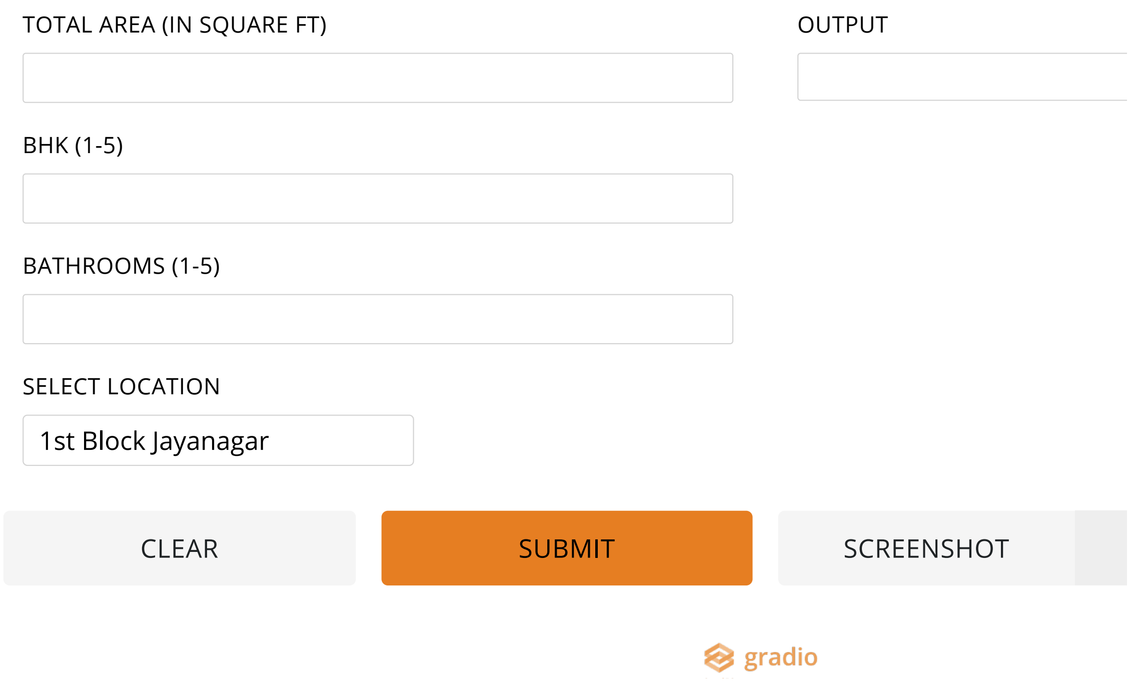
Preparing GUI

```
In [71]: import gradio as gr
```

```
In [72]: inp = [gr.inputs.Number(label='Total Area (in square ft)'),gr.inputs.Number(label='BH
         K (1-5)'),gr.inputs.Number(label='Bathrooms (1-5)'),gr.inputs.Dropdown(locations,labe
         l='Select Location')]
         oup = gr.outputs.Textbox()
```

```
In [73]: gr.Interface(fn=predict_price_for_gui, inputs=inp, outputs=oup, capture_session=Tru
         e).launch()

         Running locally at: http://127.0.0.1:7860/
         To create a public link, set `share=True` in `launch()`.
         Interface loading below...
```



```
Out[73]: (<Flask 'gradio.networking'>, 'http://127.0.0.1:7860/', None)
```