In [1]:
```
import numpy as np  #numerical computing
import matplotlib.pyplot as plt    #data visualization
import pandas as pd       #manipulate data in tabular format (load data and
import seaborn as sns; sns.set()     #drawing statistical graphics(modeling)

#Scikit-learn is a machine learning library that provides simple and efficie
from sklearn import metrics
from sklearn.model_selection import KFold
from sklearn.model_selection import cross_val_score
from sklearn.preprocessing import StandardScaler #scaling
#regression model
from sklearn.linear_model import LinearRegression
from sklearn.tree import DecisionTreeRegressor
from sklearn.ensemble import RandomForestRegressor
from sklearn.svm import SVR
#evaluate model
from sklearn.metrics import r2_score, mean_absolute_error, mean_squared_errc

import warnings
warnings.filterwarnings('ignore')
```

In [2]:
```
#LOAD DATASET
house_rent_dataset = pd.read_csv("/Users/yangshence/Desktop/ds_research/data
house_rent_dataset.head()
```

Out[2]:

	Posted On	BHK	Rent	Size	Floor	Area Type	Area Locality	City	Furnishing Status	
0	2022-05-18	2	10000	1100	Ground out of 2	Super Area	Bandel	Kolkata	Unfurnished	Bach
1	2022-05-13	2	20000	800	1 out of 3	Super Area	Phool Bagan, Kankurgachi	Kolkata	Semi-Furnished	Bach
2	2022-05-16	2	17000	1000	1 out of 3	Super Area	Salt Lake City Sector 2	Kolkata	Semi-Furnished	Bach
3	2022-07-04	2	10000	800	1 out of 2	Super Area	Dumdum Park	Kolkata	Unfurnished	Bach
4	2022-05-09	2	7500	850	1 out of 2	Carpet Area	South Dum Dum	Kolkata	Unfurnished	

In [5]:
```
house_rent_dataset.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 4746 entries, 0 to 4745
Data columns (total 12 columns):
 #   Column             Non-Null Count  Dtype 
---  ------             --------------  ----- 
 0   Posted On          4746 non-null   object
 1   BHK                4746 non-null   int64 
 2   Rent               4746 non-null   int64 
 3   Size               4746 non-null   int64 
 4   Floor              4746 non-null   object
 5   Area Type          4746 non-null   object
 6   Area Locality      4746 non-null   object
 7   City               4746 non-null   object
 8   Furnishing Status  4746 non-null   object
 9   Tenant Preferred   4746 non-null   object
 10  Bathroom           4746 non-null   int64 
 11  Point of Contact   4746 non-null   object
dtypes: int64(4), object(8)
memory usage: 445.1+ KB
```

In [6]:
```
house_rent_dataset.describe()
```

Out[6]:

	BHK	Rent	Size	Bathroom
count	4746.000000	4.746000e+03	4746.000000	4746.000000
mean	2.083860	3.499345e+04	967.490729	1.965866
std	0.832256	7.810641e+04	634.202328	0.884532
min	1.000000	1.200000e+03	10.000000	1.000000
25%	2.000000	1.000000e+04	550.000000	1.000000
50%	2.000000	1.600000e+04	850.000000	2.000000
75%	3.000000	3.300000e+04	1200.000000	2.000000
max	6.000000	3.500000e+06	8000.000000	10.000000

In [7]:
```
'''cleaning'''
#check missing values for all cols --> NO missing value
house_rent_dataset.isnull().sum()
```

Out[7]:
```
Posted On            0
BHK                  0
Rent                 0
Size                 0
Floor                0
Area Type            0
Area Locality        0
City                 0
Furnishing Status    0
Tenant Preferred     0
Bathroom             0
Point of Contact     0
dtype: int64
```

In [11]:
```
print(np.where(house_rent_dataset['Rent']>2000000))

# Dropping the rows with high rent
house_rent_dataset.drop([1837], axis=0, inplace=True)
```

```
(array([1836]),)
```

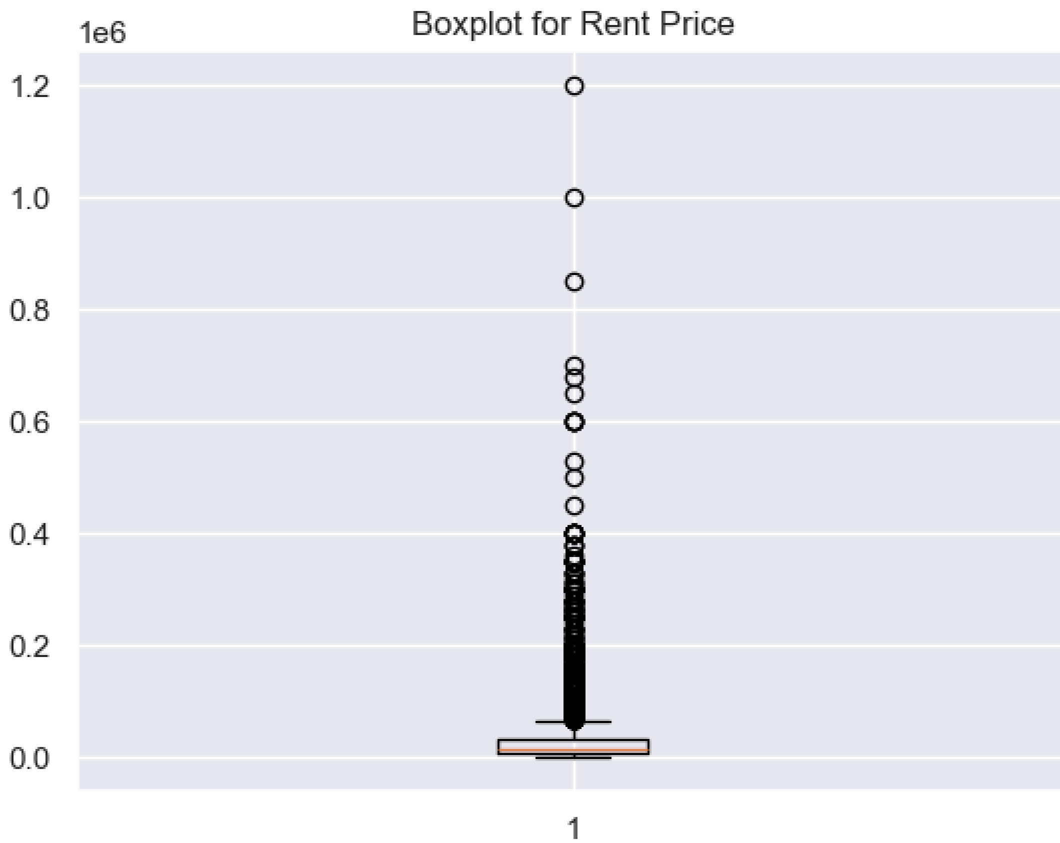
In [13]:
```
print(house_rent_dataset['Rent']>2000000)
```

```
1       False
2       False
3       False
4       False
5       False
        ...
4741    False
4742    False
4743    False
4744    False
4745    False
Name: Rent, Length: 4744, dtype: bool
```

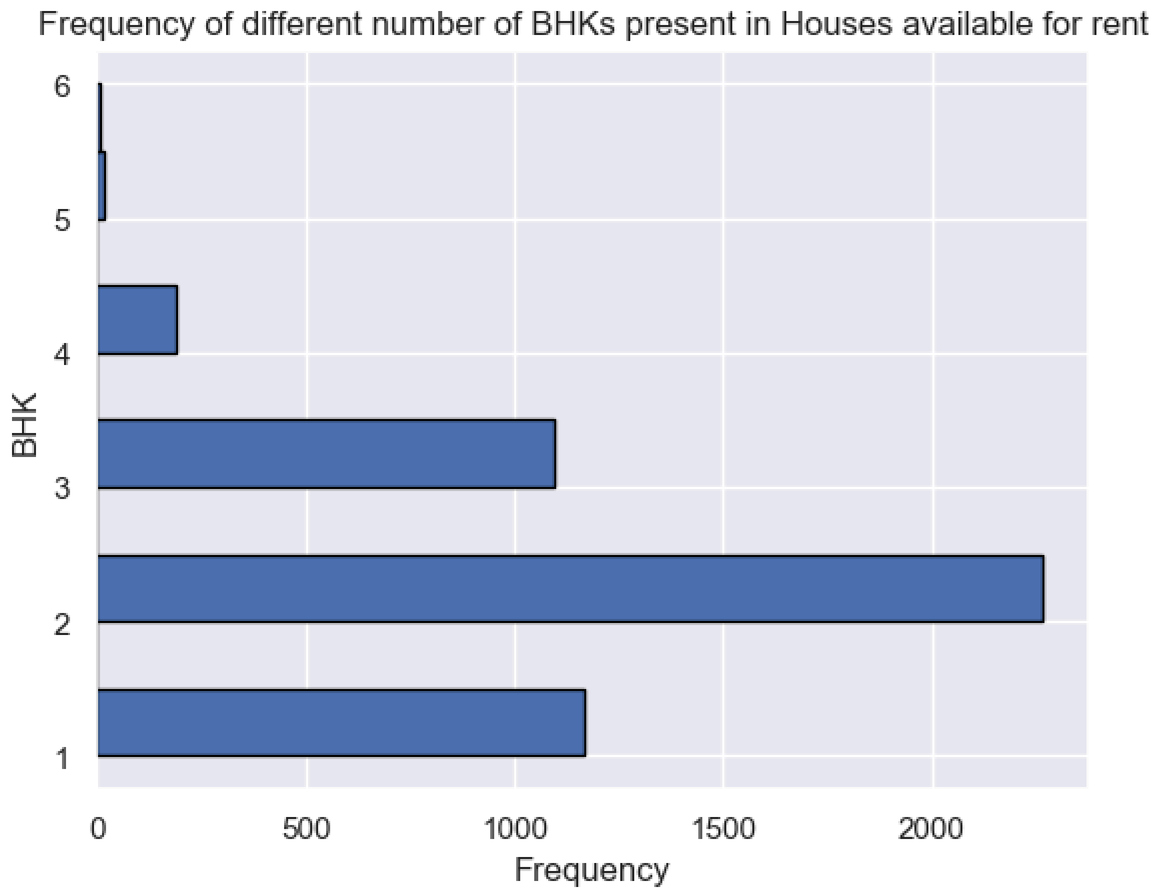
Data Visualization

In [14]:
```
# Visualization
x = house_rent_dataset.Rent
plt.hist(x,orientation='horizontal',ec='black',bins=40)
plt.title('Rent Prices Distribution Histogram')
plt.xlabel('Frequency')
plt.ylabel('Rent')
plt.show()
```

In [15]:
```
plt.boxplot(house_rent_dataset['Rent'])
plt.title('Boxplot for Rent Price')
plt.show()
```

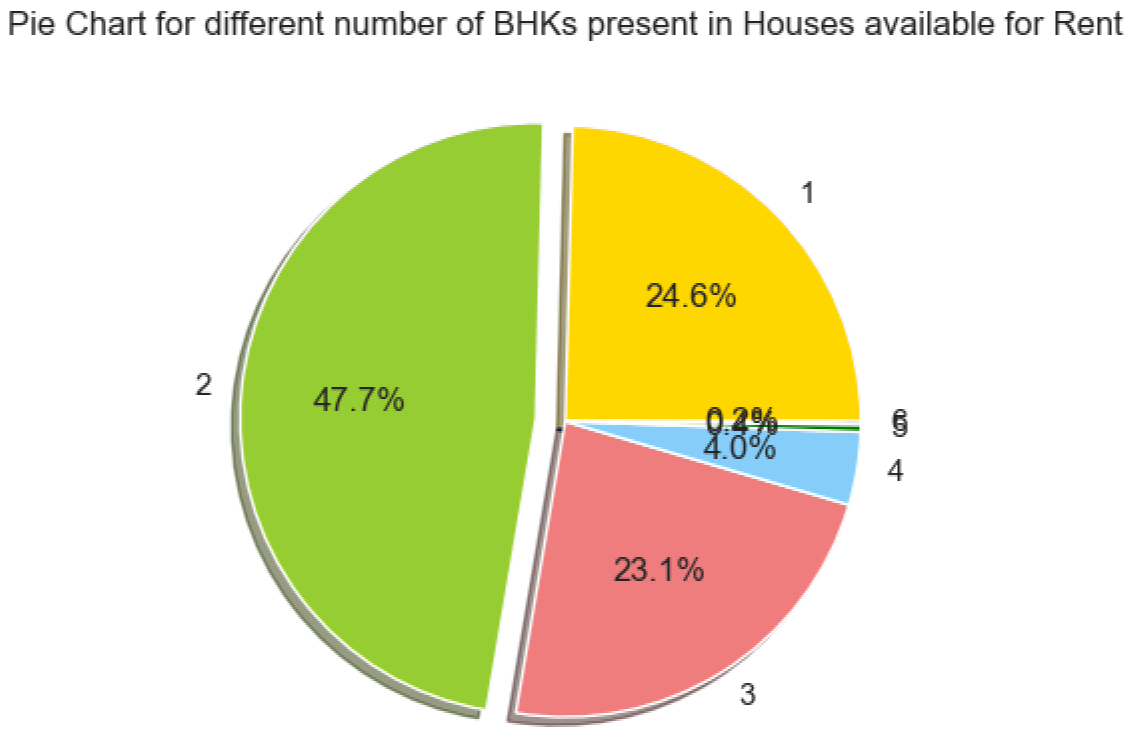


In [16]:
```
x = house_rent_dataset.BHK
plt.hist(x,orientation='horizontal',ec='black')
plt.title('Frequency of different number of BHKs present in Houses available
plt.xlabel('Frequency')
plt.ylabel('BHK')
plt.show()
```

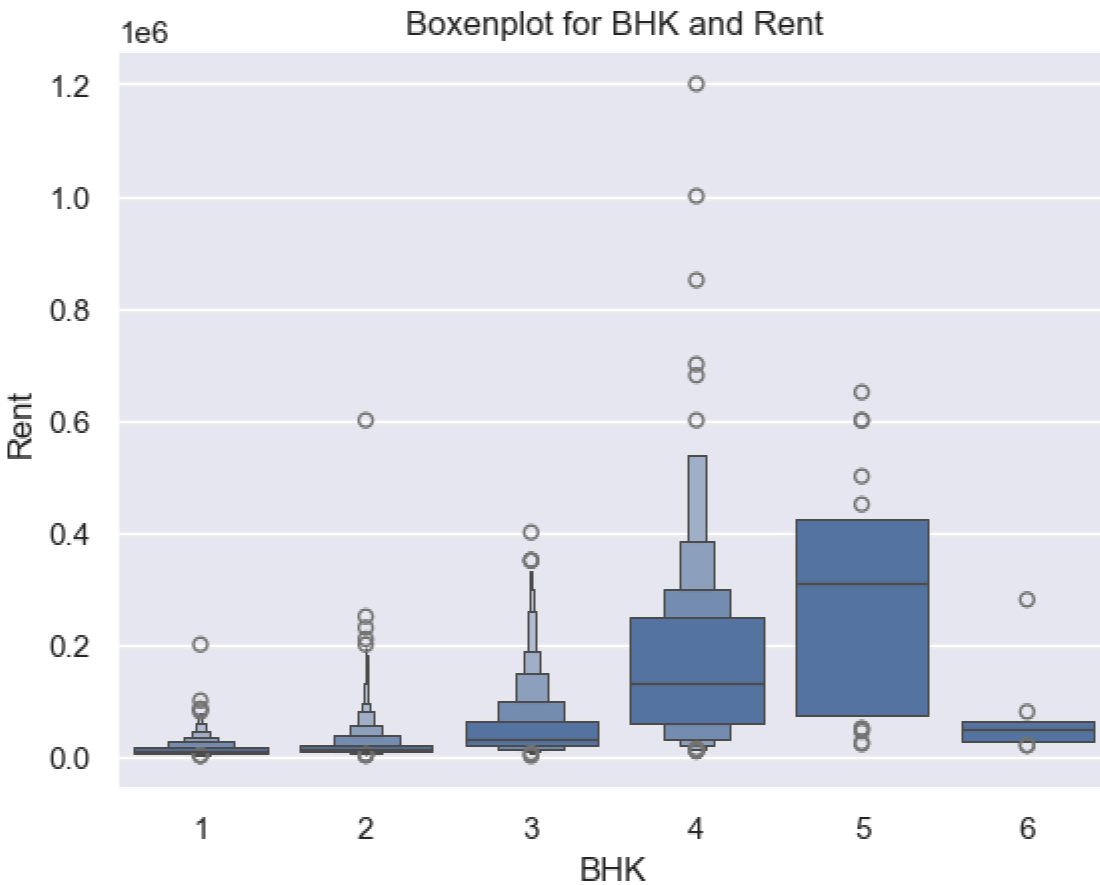


In [17]:
```
category_counts = house_rent_dataset.BHK.value_counts()
print(category_counts)
sizes = [1167, 2265, 1097, 189,19,8]
labels = ['1', '2', '3', '4','5','6']
colors = ['gold', 'yellowgreen', 'lightcoral', 'lightskyblue','green','blue'
explode = (0, 0.1, 0, 0, 0, 0)
plt.pie(sizes, explode=explode, labels=labels, colors=colors, autopct='%1.1f
plt.title('Pie Chart for different number of BHKs present in Houses availabl
plt.show()
```

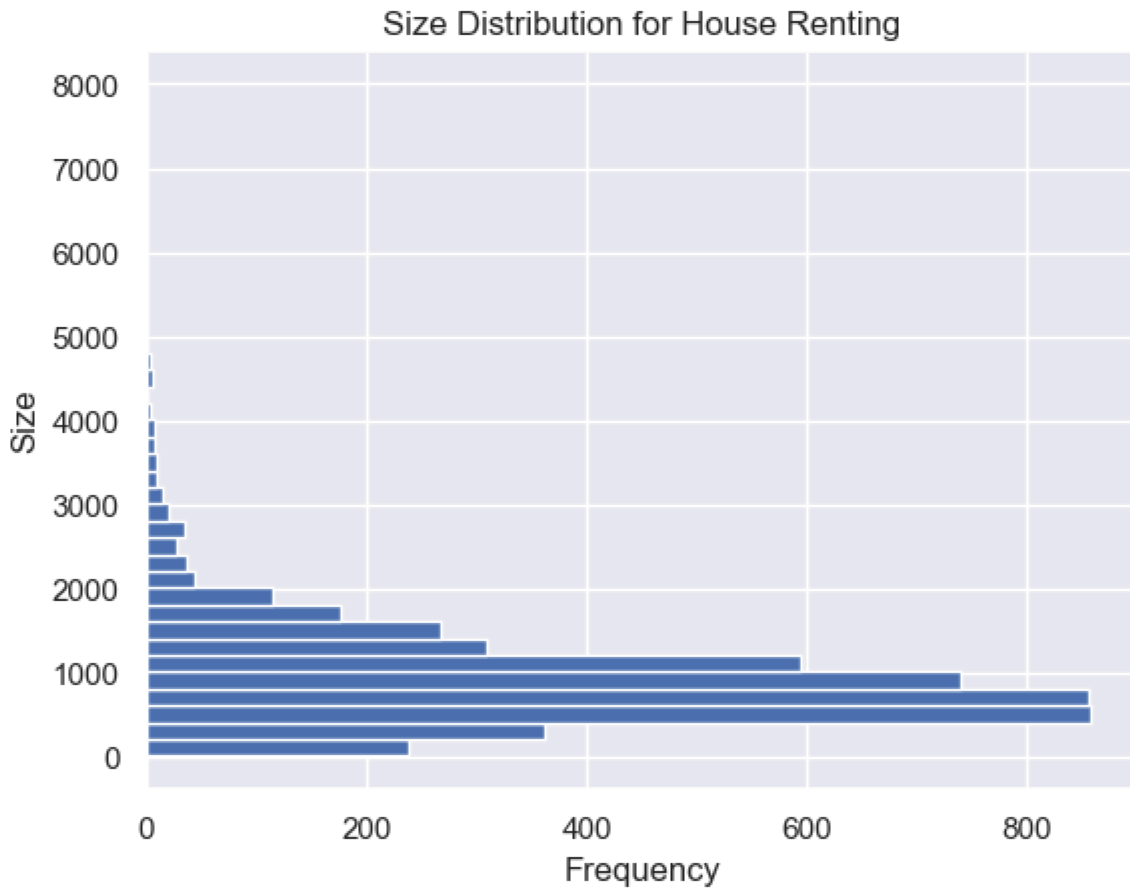
```
BHK
2    2264
1    1167
3    1097
4     189
5      19
6       8
Name: count, dtype: int64
```



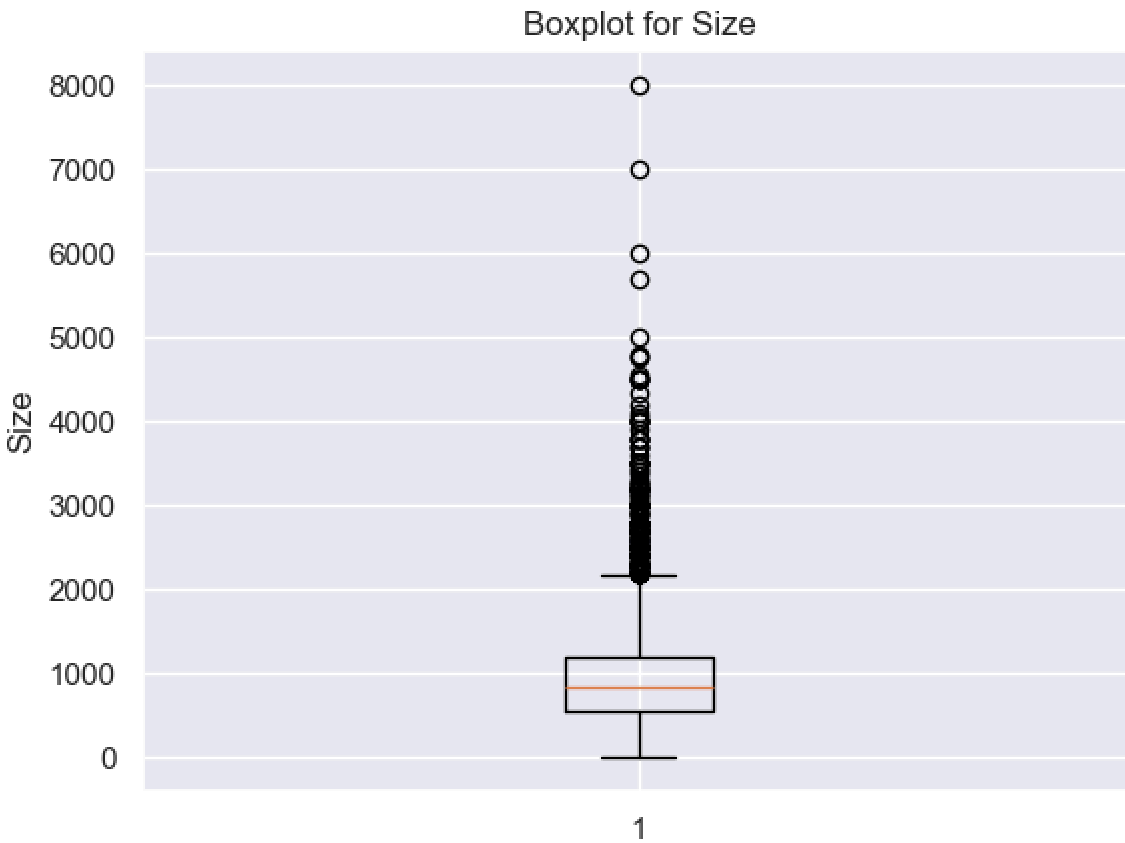
In [18]:
```
fig,axes = plt.subplots()
sns.boxenplot(x=house_rent_dataset.BHK,y=house_rent_dataset.Rent)
plt.title('Boxenplot for BHK and Rent')
plt.show()
```



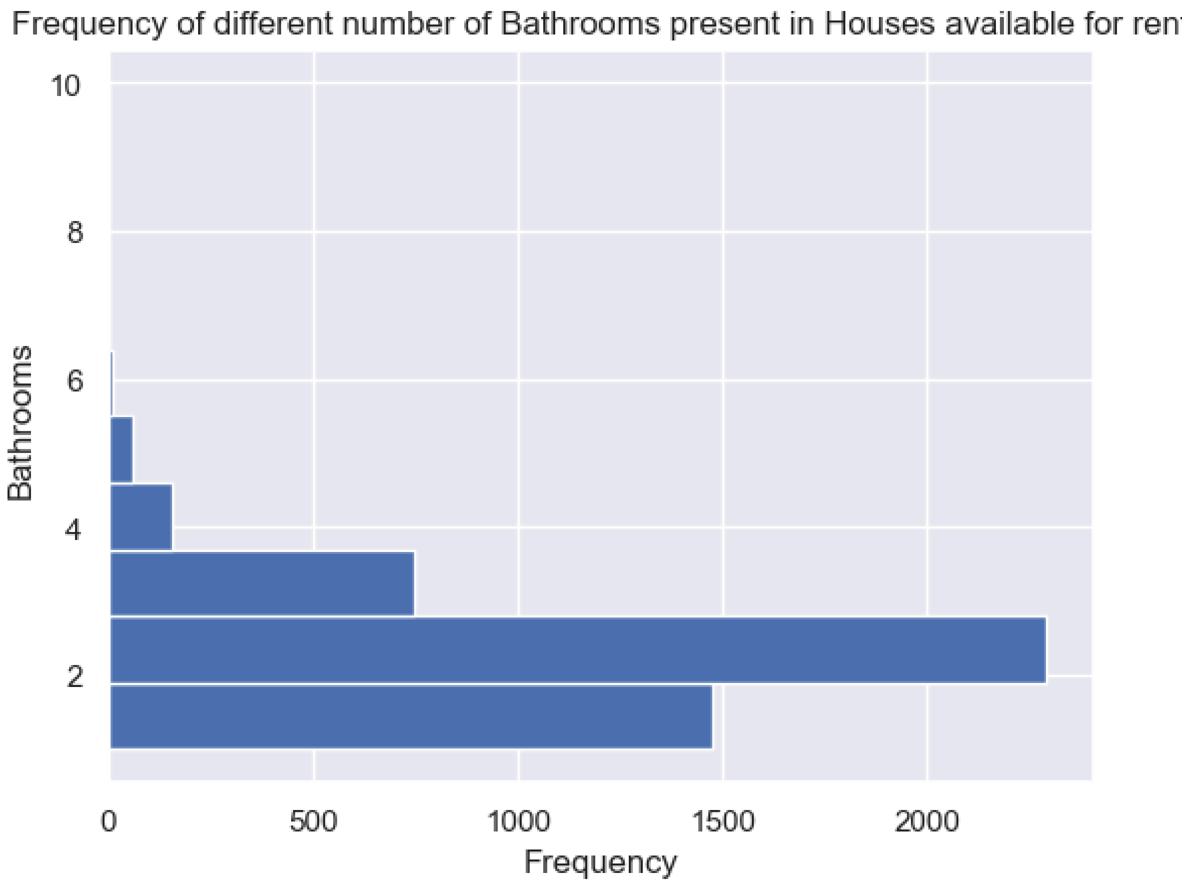
In [19]:
```
x = house_rent_dataset.Size
plt.hist(x,orientation='horizontal',bins=40)
plt.title('Size Distribution for House Renting')
plt.xlabel('Frequency')
plt.ylabel('Size')
plt.show()
```



In [20]:
```
plt.boxplot(x=house_rent_dataset.Size)
plt.title('Boxplot for Size')
plt.ylabel('Size')
plt.show()
```

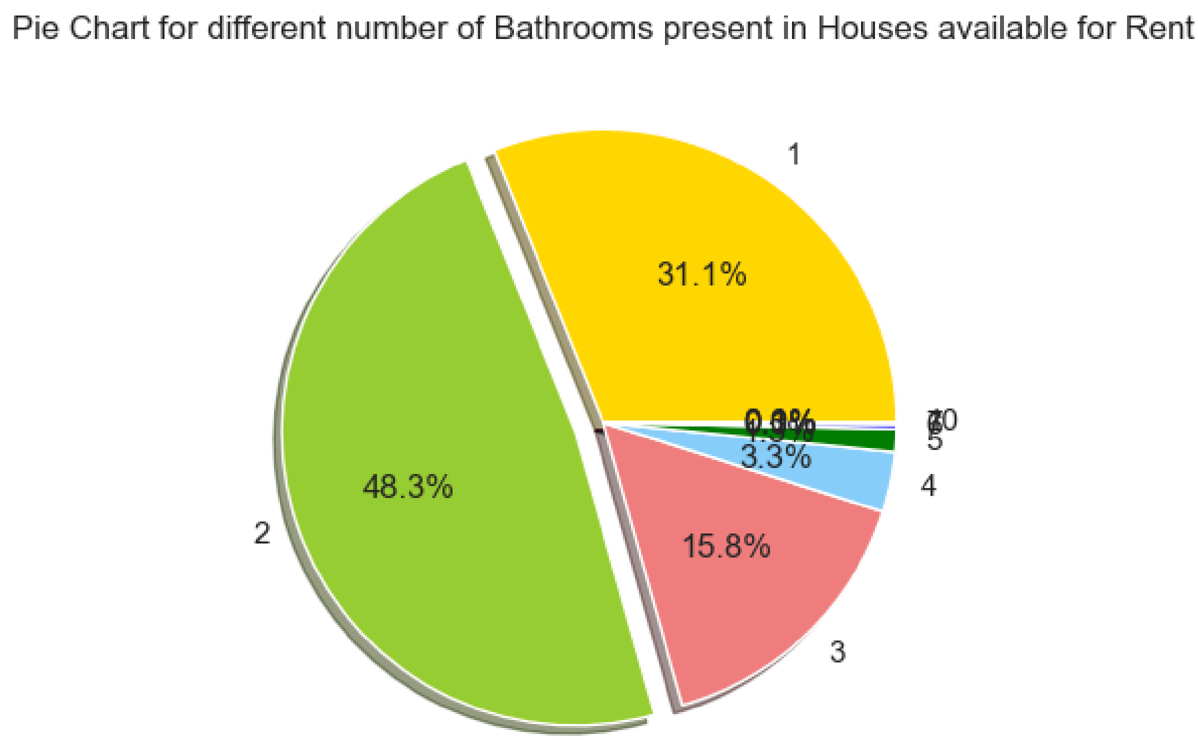


In [21]:
```
x = house_rent_dataset.Bathroom
plt.hist(x,orientation='horizontal')
plt.title('Frequency of different number of Bathrooms present in Houses avai
plt.xlabel('Frequency')
plt.ylabel('Bathrooms')
plt.show()
```

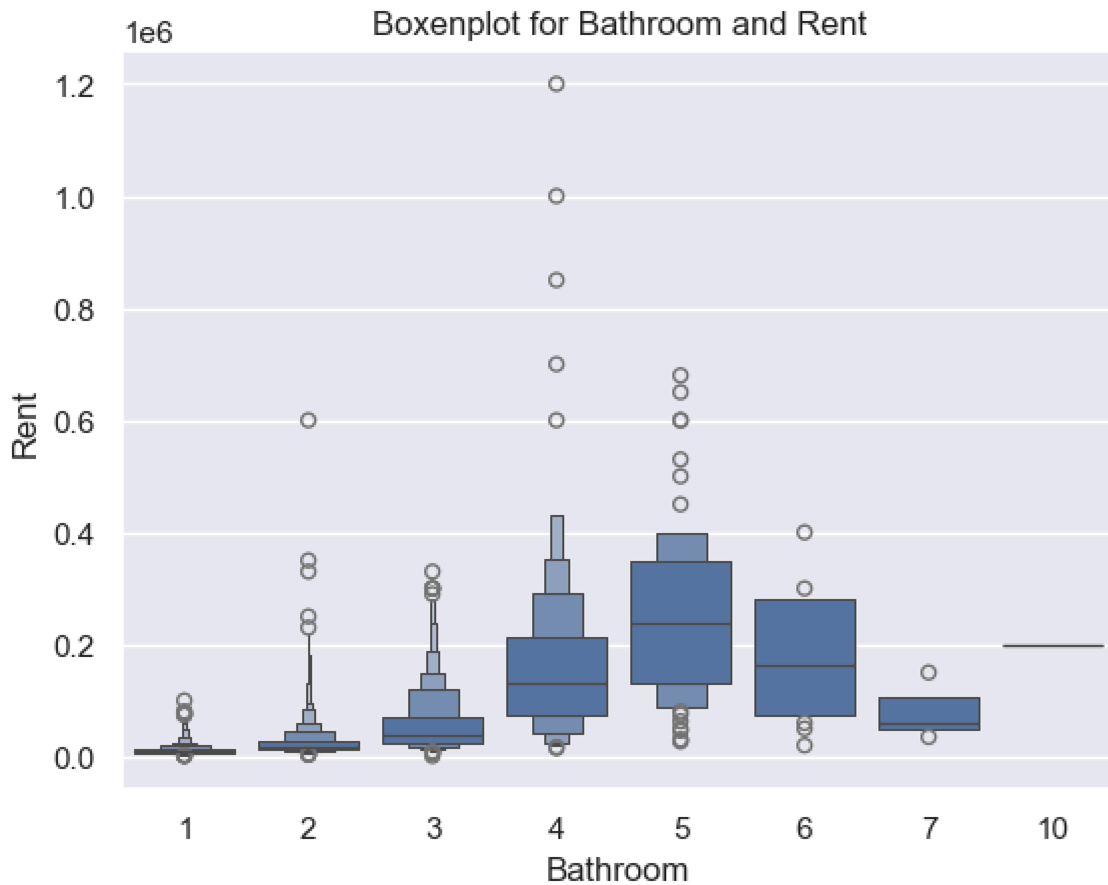


In [22]:
```
category_counts = house_rent_dataset.Bathroom.value_counts()
print(category_counts)
sizes = [1474, 2291, 748, 156,60,12,3,1]
labels = ['1', '2', '3', '4','5','6','7','10']
colors = ['gold', 'yellowgreen', 'lightcoral', 'lightskyblue','green','blue'
explode = (0, 0.1, 0, 0, 0, 0, 0, 0)
plt.pie(sizes, explode=explode, labels=labels, colors=colors, autopct='%1.1f
plt.title('Pie Chart for different number of Bathrooms present in Houses ava
plt.show()
```

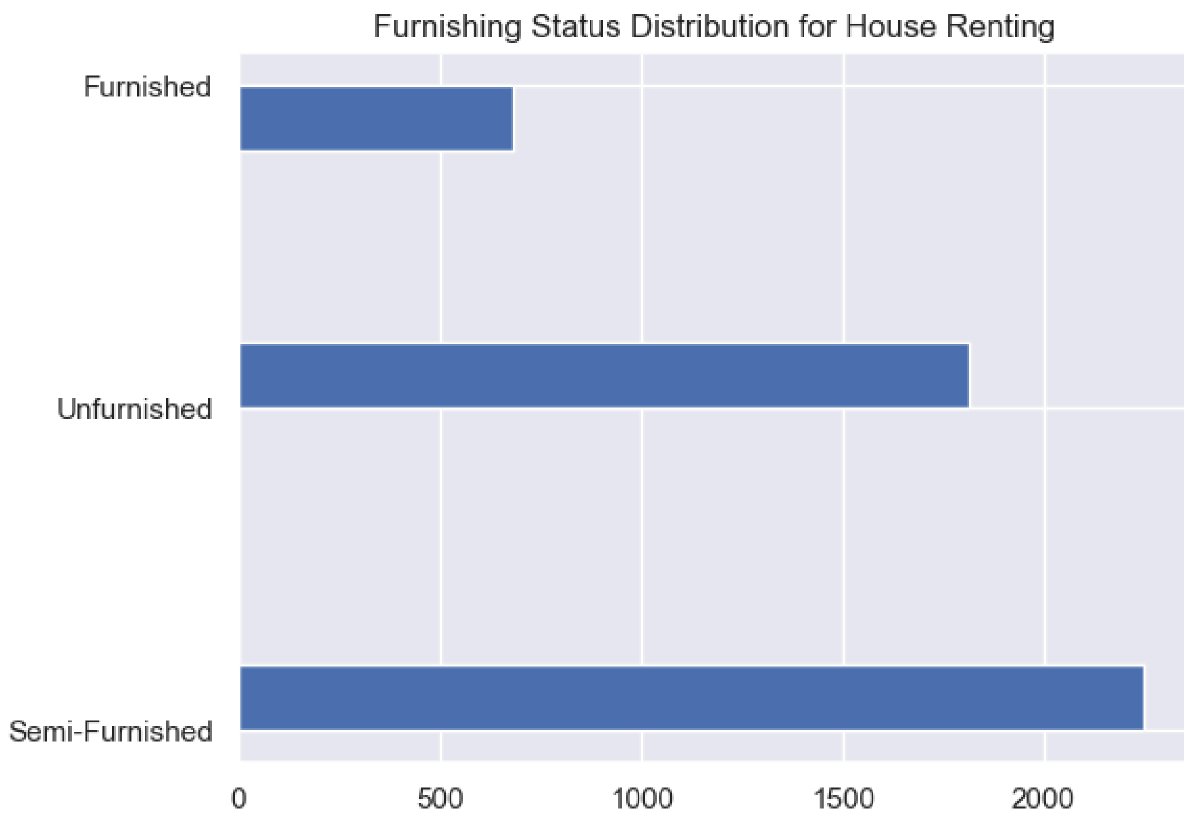
```
Bathroom
2     2290
1     1474
3      748
4      156
5       60
6       12
7        3
10       1
Name: count, dtype: int64
```



In [23]:
```
fig,axes = plt.subplots()
sns.boxenplot(x=house_rent_dataset.Bathroom,y=house_rent_dataset.Rent)
plt.title('Boxenplot for Bathroom and Rent')
plt.show()
```

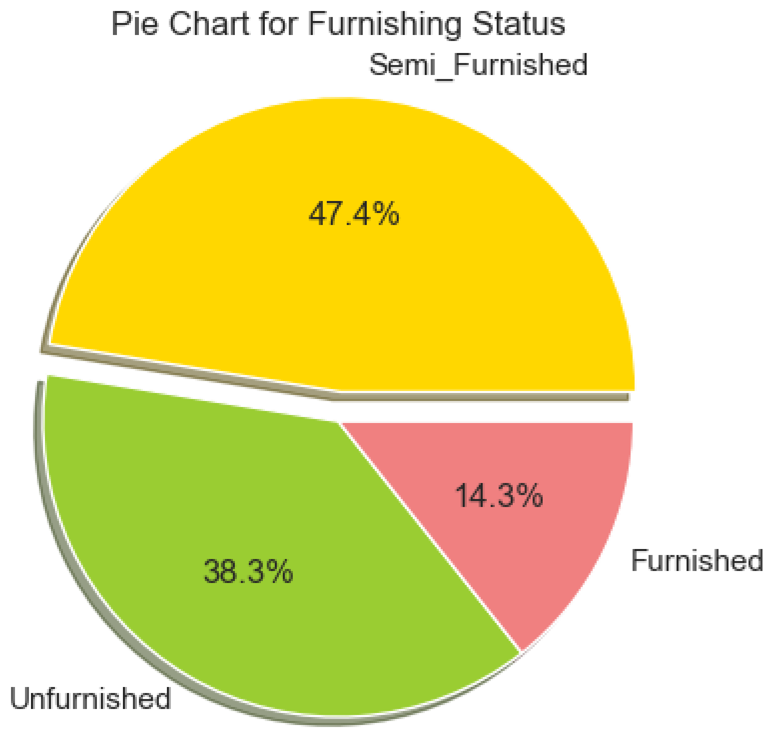


In [24]:
```
x = house_rent_dataset['Furnishing Status']
plt.hist(x,orientation='horizontal')
plt.title('Furnishing Status Distribution for House Renting')
plt.show()
```

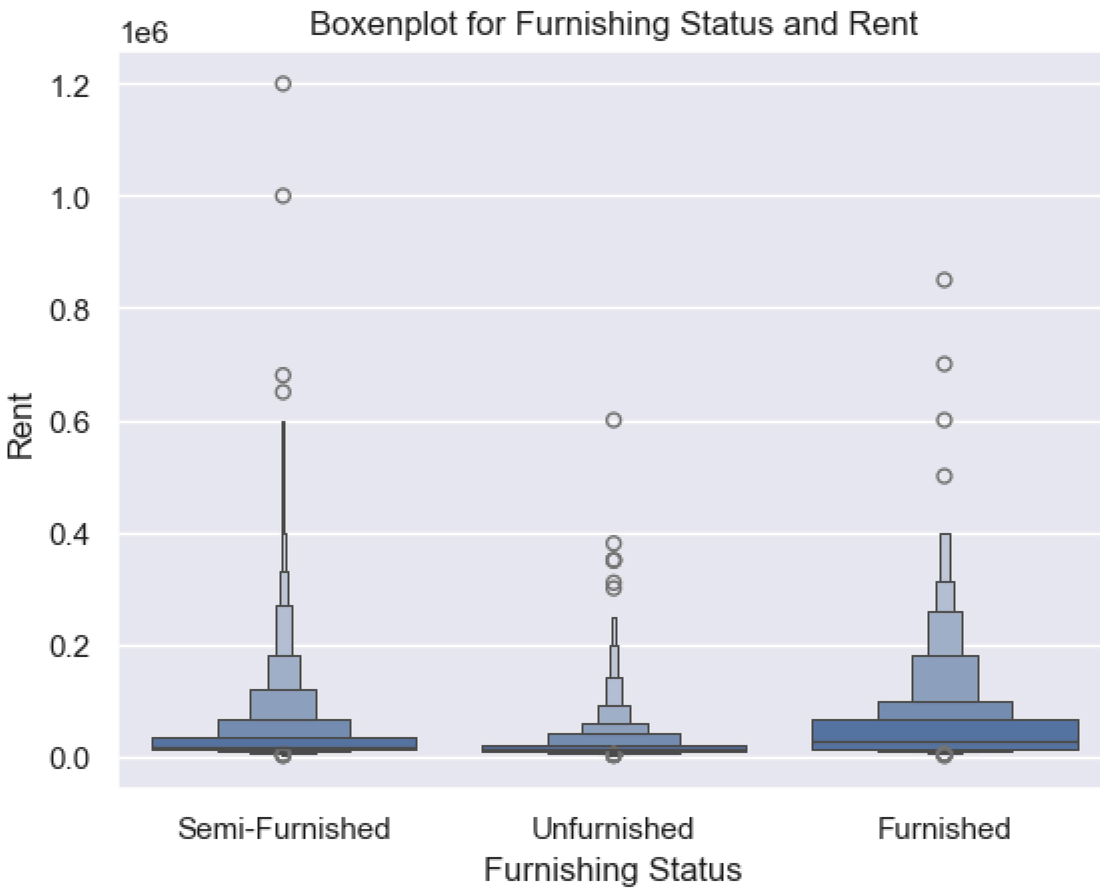


In [25]:
```
category_counts = house_rent_dataset['Furnishing Status'].value_counts()
print(category_counts)
sizes = [2250,1815, 680]
labels = ['Semi_Furnished', 'Unfurnished', 'Furnished']
colors = ['gold', 'yellowgreen', 'lightcoral']
explode = (0.1, 0, 0)
plt.pie(sizes, explode=explode, labels=labels, colors=colors, autopct='%1.1f
plt.title('Pie Chart for Furnishing Status')
plt.show()
```

```
Furnishing Status
Semi-Furnished    2250
Unfurnished       1814
Furnished          680
Name: count, dtype: int64
```



In [26]:
```
fig,axes = plt.subplots()
sns.boxenplot(x=house_rent_dataset['Furnishing Status'],y=house_rent_dataset
plt.title('Boxenplot for Furnishing Status and Rent')
plt.show()
```



Modeling

In [27]:
```
#DATA PREPROCESSING

#one hot encoding
categorical_vars = ['Area Type','Area Locality','City','Furnishing Status','
# One-hot encode the categorical variables
for col in categorical_vars:
    one_hot_encoded = pd.get_dummies(house_rent_dataset[col], dtype=int, pre
    house_rent_dataset = house_rent_dataset.join(one_hot_encoded)
    house_rent_dataset.drop(col, axis=1, inplace=True)  # Drop the original

house_rent_dataset
```

Out[27]:

	Posted On	BHK	Rent	Size	Floor	Bathroom	Area Type_Carpet Area	Area Type_Super Area	Lo Bod I
1	2022-05-13	2	20000	800	1 out of 3	1	0	1	
2	2022-05-16	2	17000	1000	1 out of 3	1	0	1	
3	2022-07-04	2	10000	800	1 out of 2	1	0	1	
4	2022-05-09	2	7500	850	1 out of 2	1	1	0	
5	2022-04-29	2	7000	600	Ground out of 1	2	0	1	
...	...	...	...	...	...	...	...	...	
4741	2022-05-18	2	15000	1000	3 out of 5	2	1	0	
4742	2022-05-15	3	29000	2000	1 out of 4	3	0	1	
4743	2022-07-10	3	35000	1750	3 out of 5	3	1	0	
4744	2022-07-06	3	45000	1500	23 out of 34	2	1	0	
4745	2022-05-04	2	15000	1000	4 out of 5	2	1	0	

4744 rows × 2253 columns

In [28]:

```
#handle floor

house_rent_dataset["Floor Number"]=house_rent_dataset['Floor'].apply(lambda 
house_rent_dataset["Total Floor"]=house_rent_dataset["Floor"].apply(lambda x
del house_rent_dataset["Floor"]

#change the ground to zero
#lower basement means "-2",and Upper basement is -1.
house_rent_dataset["Floor Number"] = house_rent_dataset["Floor Number"].repl
house_rent_dataset["Floor Number"] = house_rent_dataset["Floor Number"].repl
house_rent_dataset["Floor Number"] = house_rent_dataset["Floor Number"].repl
house_rent_dataset["Floor Number"] = house_rent_dataset["Floor Number"].repl
house_rent_dataset["Total Floor"] = house_rent_dataset["Total Floor"].replac
house_rent_dataset.head()
```

Out[28]:

	Posted On	BHK	Rent	Size	Bathroom	Area Type_Carpet Area	Area Type_Super Area	Area Locality_ in Boduppal, NH 2 2	Lo Errag
1	2022-05-13	2	20000	800	1	0	1	0	
2	2022-05-16	2	17000	1000	1	0	1	0	
3	2022-07-04	2	10000	800	1	0	1	0	
4	2022-05-09	2	7500	850	1	1	0	0	
5	2022-04-29	2	7000	600	2	0	1	0	

5 rows × 2254 columns

In [29]:

```
#handle date
house_rent_dataset['Posted On'] = pd.to_datetime(house_rent_dataset["Posted
house_rent_dataset['month posted'] = house_rent_dataset['Posted On'].dt.mont
house_rent_dataset['day posted'] = house_rent_dataset['Posted On'].dt.day
house_rent_dataset['day of week posted'] = house_rent_dataset['Posted On'].c
house_rent_dataset['quarter poster'] = house_rent_dataset['Posted On'].dt.qu
del house_rent_dataset['Posted On']
house_rent_dataset
```

Out[29]:

	BHK	Rent	Size	Bathroom	Area Type_Carpet Area	Area Type_Super Area	Area Locality_ in Boduppal, NH 2 2	Are Locality i Erragadda NH
1	2	20000	800	1	0	1	0	
2	2	17000	1000	1	0	1	0	
3	2	10000	800	1	0	1	0	
4	2	7500	850	1	1	0	0	
5	2	7000	600	2	0	1	0	
...	...	...	...	...	...	...	...	.
4741	2	15000	1000	2	1	0	0	
4742	3	29000	2000	3	0	1	0	
4743	3	35000	1750	3	1	0	0	
4744	3	45000	1500	2	1	0	0	
4745	2	15000	1000	2	1	0	0	

4744 rows × 2257 columns

In [30]:
```
#choose features(x) and target(y)
x = house_rent_dataset.drop('Rent',axis=1) #where 1 is the axis number (0 fo
y = house_rent_dataset['Rent']
```

In [31]:
```
'''kfold to split into training set and testing set '''

# Initialize K-Fold Cross-Validation
kf = KFold(n_splits=5, shuffle=True, random_state=42)

# Initialize lists to store evaluation metrics for Linear Regression
mae_lm_list = []
mse_lm_list = []
rmse_lm_list = []
r2_lm_list = []

# Initialize lists to store evaluation metrics for Decision Tree Regressor
mae_dt_list = []
mse_dt_list = []
rmse_dt_list = []
r2_dt_list = []

# Initialize lists to store evaluation metrics for Random Forest Regressor
mae_rf_list = []
mse_rf_list = []
rmse_rf_list = []
r2_rf_list = []
```

```
# K-Fold Cross-Validation
for train_index, test_index in kf.split(x):
    X_train, X_test = x.iloc[train_index], x.iloc[test_index]
    y_train, y_test = y.iloc[train_index], y.iloc[test_index]

    # Scaling the data
    sc_X = StandardScaler()
    sc_y = StandardScaler()

    X_train = sc_X.fit_transform(X_train)
    X_test = sc_X.transform(X_test)  # Use transform instead of fit_transfor
    y_train = y_train.values.reshape(-1, 1)
    y_test = y_test.values.reshape(-1, 1)

    y_train = sc_y.fit_transform(y_train)
    y_test = sc_y.transform(y_test)  # Use transform instead of fit_transfor

    # Linear regression
    lm = LinearRegression()
    lm.fit(X_train, y_train)
    lm_prediction = lm.predict(X_test)

    # Evaluation metrics for Linear Regression
    mae_lm = metrics.mean_absolute_error(y_test, lm_prediction)
    mse_lm = metrics.mean_squared_error(y_test, lm_prediction)
    rmse_lm = np.sqrt(mse_lm)
    r2_lm = metrics.r2_score(y_test, lm_prediction)

    # Append metrics to lists for Linear Regression
    mae_lm_list.append(mae_lm)
    mse_lm_list.append(mse_lm)
    rmse_lm_list.append(rmse_lm)
    r2_lm_list.append(r2_lm)

    # Decision Tree Regressor
    dt = DecisionTreeRegressor(random_state=100)
    dt.fit(X_train, y_train)
    dt_prediction = dt.predict(X_test)

    # Evaluation metrics for Decision Tree Regressor
    mae_dt = metrics.mean_absolute_error(y_test, dt_prediction)
    mse_dt = metrics.mean_squared_error(y_test, dt_prediction)
    rmse_dt = np.sqrt(mse_dt)
    r2_dt = metrics.r2_score(y_test, dt_prediction)

    # Append metrics to lists for Decision Tree Regressor
    mae_dt_list.append(mae_dt)
    mse_dt_list.append(mse_dt)
    rmse_dt_list.append(rmse_dt)
    r2_dt_list.append(r2_dt)

    # Random Forest Regressor
    rf = RandomForestRegressor(n_estimators=100, random_state=100)
    rf.fit(X_train, y_train.ravel())
    rf_prediction = rf.predict(X_test)
```

```
    # Evaluation metrics for Random Forest Regressor
    mae_rf = metrics.mean_absolute_error(y_test, rf_prediction)
    mse_rf = metrics.mean_squared_error(y_test, rf_prediction)
    rmse_rf = np.sqrt(mse_rf)
    r2_rf = metrics.r2_score(y_test, rf_prediction)

    # Append metrics to lists for Random Forest Regressor
    mae_rf_list.append(mae_rf)
    mse_rf_list.append(mse_rf)
    rmse_rf_list.append(rmse_rf)
    r2_rf_list.append(r2_rf)


# Calculate average of the metrics for Linear Regression
mae_lm_avg = np.mean(mae_lm_list)
mse_lm_avg = np.mean(mse_lm_list)
rmse_lm_avg = np.mean(rmse_lm_list)
r2_lm_avg = np.mean(r2_lm_list)

# Calculate average of the metrics for Decision Tree Regressor
mae_dt_avg = np.mean(mae_dt_list)
mse_dt_avg = np.mean(mse_dt_list)
rmse_dt_avg = np.mean(rmse_dt_list)
r2_dt_avg = np.mean(r2_dt_list)


# Calculate average of the metrics for Random Forest Regressor
mae_rf_avg = np.mean(mae_rf_list)
mse_rf_avg = np.mean(mse_rf_list)
rmse_rf_avg = np.mean(rmse_rf_list)
r2_rf_avg = np.mean(r2_rf_list)



print('Linear Regression:')
print('Average MAE:', mae_lm_avg)
print('Average MSE:', mse_lm_avg)
print('Average RMSE:', rmse_lm_avg)
print('Average R2:', r2_lm_avg)

print('\nDecision Tree Regressor:')
print('Average MAE:', mae_dt_avg)
print('Average MSE:', mse_dt_avg)
print('Average RMSE:', rmse_dt_avg)
print('Average R2:', r2_dt_avg)

print('\nRandom Forest Regressor:')
print('Average MAE:', mae_rf_avg)
print('Average MSE:', mse_rf_avg)
print('Average RMSE:', rmse_rf_avg)
print('Average R2:', r2_rf_avg)
```

```
Linear Regression:
Average MAE: 773303507790.3014
Average MSE: 6.828361383980733e+24
Average RMSE: 2326141463267.2144
Average R2: -9.2361665385052e+24

Decision Tree Regressor:
Average MAE: 0.21794491984684433
Average MSE: 0.3972929759369991
Average RMSE: 0.6095365766864367
Average R2: 0.6326639986290103

Random Forest Regressor:
Average MAE: 0.17714102454982888
Average MSE: 0.29293464801742664
Average RMSE: 0.5203900967704168
Average R2: 0.7330588570338291
```

In [ ]:

In [ ]: