Title: House Price Prediction)

In [2]:
```
# Edit all the Mardown cells below with the appropriate information
# Run all cells, containing your code
# Save this Jupyter with the outputs of your executed cells
# PS: Save again the notebook with this outcome.
# PSPS: Don't forget to include the dataset in your submission
```

Team:

- Taichun Chao

Course: CISD 43 – BIG DATA (Spring, 2024)

Problem Statement * This project is about house price predictions. - **Data: USA-Housing.csv** - Data detail: - Avg. Area Income, Datatype: float - Avg. Area House Age, Datatype: float - Avg. Area Number of Rooms, Datatype: float - Avg. Area Number of Rooms, Datatype: float - Area Population, Datatype: float - Price, Datatype: float - address, Datatype: object This project is to predict USAhouse pricese in general. I want to find out the price is related to such condition. For Example, I want to know if the more bed room will have better price * **Keywords:** House price prediction, real estate ,...,

Required packages

- Add instructions to install the required packages

In [6]:
```
## import library
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split
```

In [7]:
```
#import warnings
import warnings
warnings.filterwarnings('ignore')
```

1.Read and Clean data

- This set of data is pretty clean, it does not miss any number
- I modify the field name and drop the Address

In [11]:
```
#read the data
data = pd.read_csv("data/USA_Housing.csv")
data.head()
```

Out[11]:

	Avg. Area Income	Avg. Area House Age	Avg. Area Number of Rooms	Avg. Area Number of Bedrooms	Area Population	Price	
0	79545.458574	5.682861	7.009188	4.09	23086.800503	1.059034e+06	208 Michael F 674\nLaura
1	79248.642455	6.002900	6.730821	3.09	40173.072174	1.505891e+06	188 Johns Suite 0 Kathl
2	61287.067179	5.865890	8.512727	5.13	36882.159400	1.058988e+06	9127 Stravenue\nDa W
3	63345.240046	7.188236	5.586729	3.26	34310.242831	1.260617e+06	USS Barnett\
4	59982.197226	5.040555	7.839388	4.23	26354.109472	6.309435e+05	USNS Raymo A

In [13]:
```
#Check the missing numbers, or useingdata.isnull().sum()
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 5000 entries, 0 to 4999
Data columns (total 7 columns):
 #   Column                       Non-Null Count  Dtype  
---  ------                       --------------  -----  
 0   Avg. Area Income             5000 non-null   float64
 1   Avg. Area House Age          5000 non-null   float64
 2   Avg. Area Number of Rooms    5000 non-null   float64
 3   Avg. Area Number of Bedrooms 5000 non-null   float64
 4   Area Population              5000 non-null   float64
 5   Price                        5000 non-null   float64
 6   Address                      5000 non-null   object 
dtypes: float64(6), object(1)
memory usage: 273.6+ KB
```

In [15]:
```
# We want to compare the room, bedroom and price
# We don't need the address now, we remove the column of address
data = data.drop(["Address"], axis=1)
data.tail()
```

Out[15]:

	Avg. Area Income	Avg. Area House Age	Avg. Area Number of Rooms	Avg. Area Number of Bedrooms	Area Population	Price
4995	60567.944140	7.830362	6.137356	3.46	22837.361035	1.060194e+06
4996	78491.275435	6.999135	6.576763	4.02	25616.115489	1.482618e+06
4997	63390.686886	7.250591	4.805081	2.13	33266.145490	1.030730e+06
4998	68001.331235	5.534388	7.130144	5.44	42625.620156	1.198657e+06
4999	65510.581804	5.992305	6.792336	4.07	46501.283803	1.298950e+06

In [17]:
```
#replace the the '.' to '' and " " tp '_', Ex. 'Avg. Area Income' to 'Avg Area Inco
# then replace again to 'Avg_Area_Income'
data.columns =data.columns.str.replace('.',"").str.replace(' ', '_')

data.describe() # to generate descriptive statistics for the data
```

Out[17]:

	Avg_Area_Income	Avg_Area_House_Age	Avg_Area_Number_of_Rooms	Avg_Area_Nun
count	5000.000000	5000.000000	5000.000000	
mean	68583.108984	5.977222	6.987792	
std	10657.991214	0.991456	1.005833	
min	17796.631190	2.644304	3.236194	
25%	61480.562388	5.322283	6.299250	
50%	68804.286404	5.970429	7.002902	
75%	75783.338666	6.650808	7.665871	
max	107701.748378	9.519088	10.759588	

In [19]:
```
# Round the decimal to 2
data = data.round(decimals=2)
data.head()
```

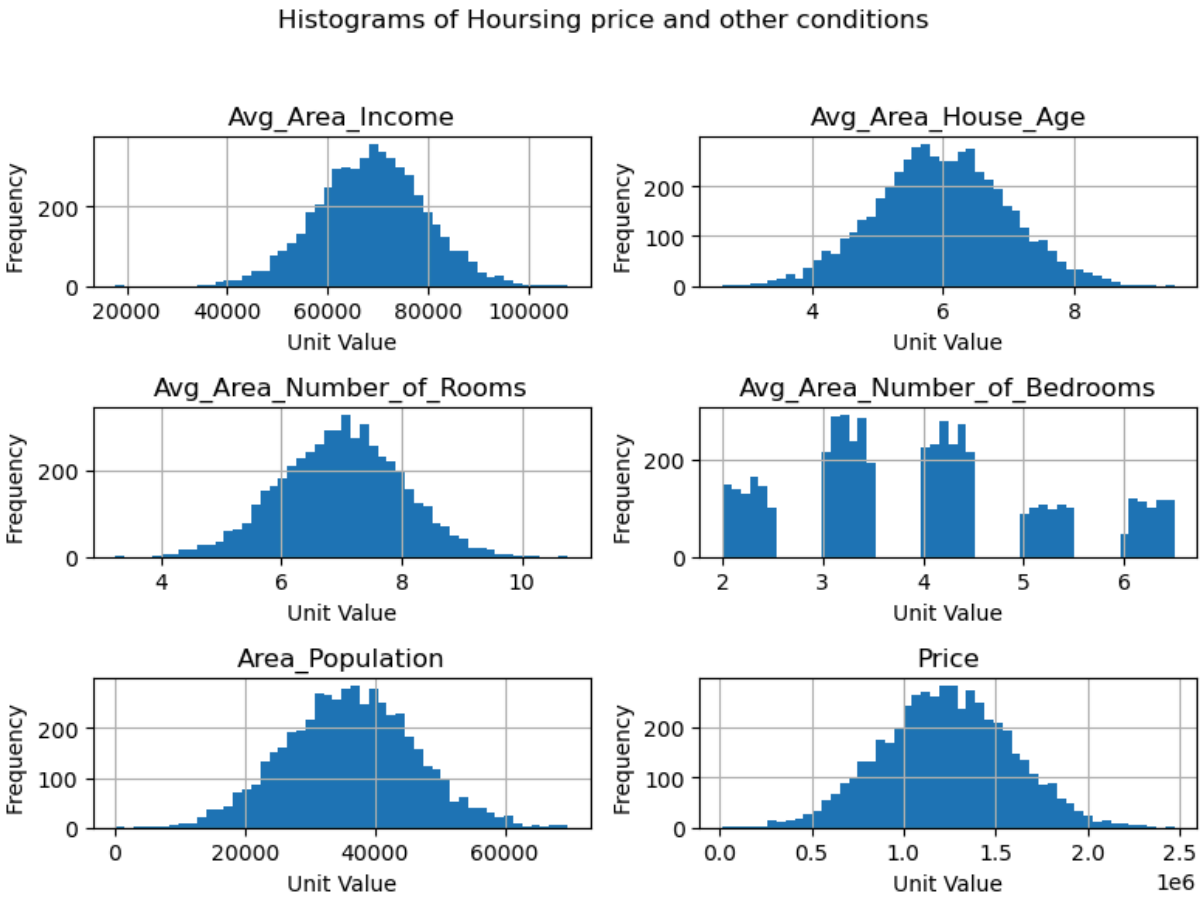
Out[19]:

	Avg_Area_Income	Avg_Area_House_Age	Avg_Area_Number_of_Rooms	Avg_Area_Number_
0	79545.46	5.68	7.01	
1	79248.64	6.00	6.73	
2	61287.07	5.87	8.51	
3	63345.24	7.19	5.59	
4	59982.20	5.04	7.84	

2.Data visualization

Histogram chart to display each item distribuation

In [23]:
```
# Make a set of historgam chart- to see the distribution of each field
axes = data.hist(figsize=(8, 6), bins=50)

# Iterate over each subplot and set the titles
for ax in axes.flatten():
    ax.set_xlabel('Unit Value')
    ax.set_ylabel('Frequency ')

plt.suptitle('Histograms of Hoursing price and other conditions')
plt.tight_layout(rect=[0, 0, 1, 0.95])  # Adjust the padding to make room for the s
plt.show()
```

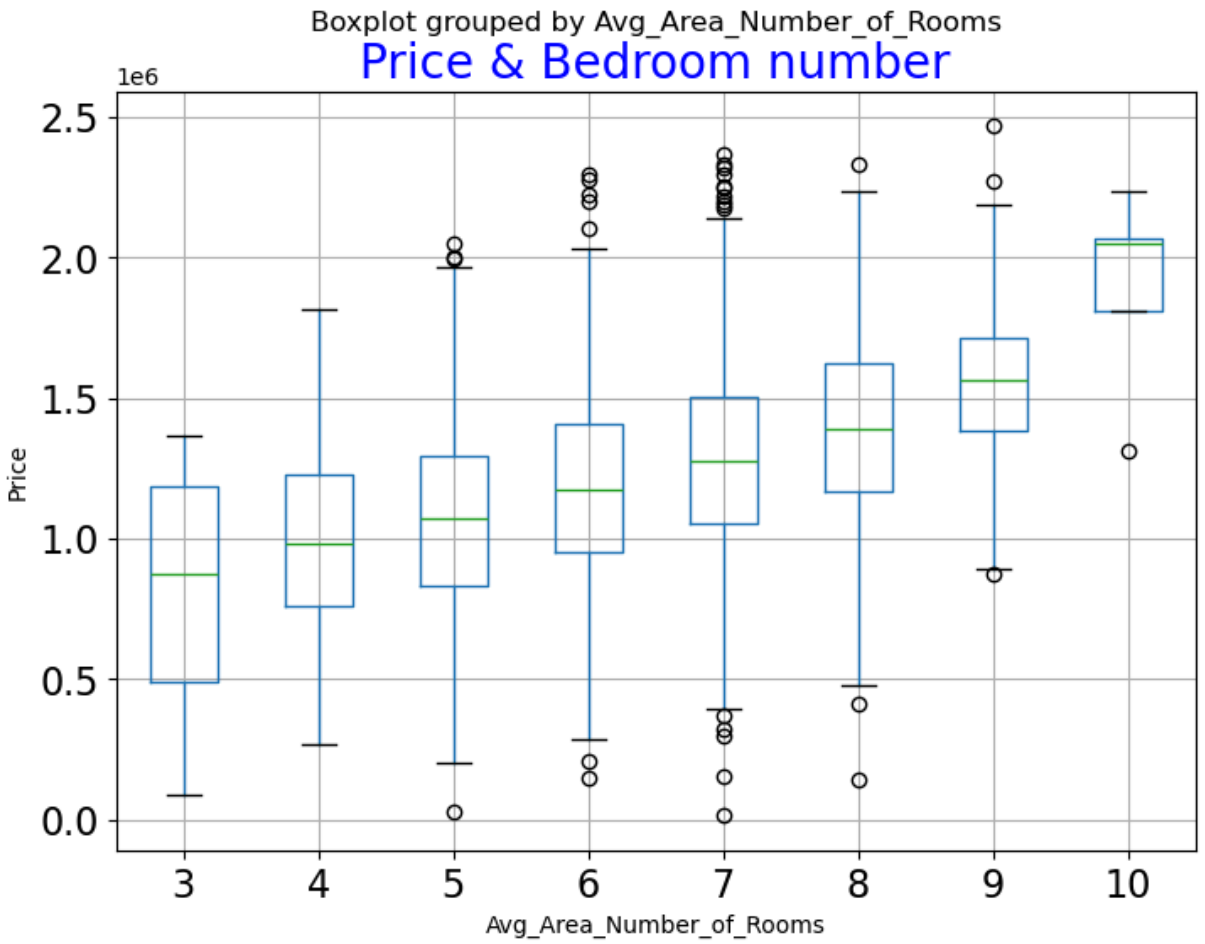


Using Box to demo the relationship of Number of the bedroom with house price

In [26]:
```
#Find th house price with bedroom number relationship
data = data.astype({"Avg_Area_Number_of_Rooms": int})
#sns.swarmplot(x='Avg_Area_Number_of_Rooms', y='Price', data=data, palette='rainbow

data.boxplot(column="Price", by ='Avg_Area_Number_of_Rooms',figsize=(8,6), fontsize
plt.title("Price & Bedroom number", loc="center", color="blue",size =20)
```

```
plt.ylabel('Price')
plt.show
```

Out[26]: <function matplotlib.pyplot.show(close=None, block=None)>



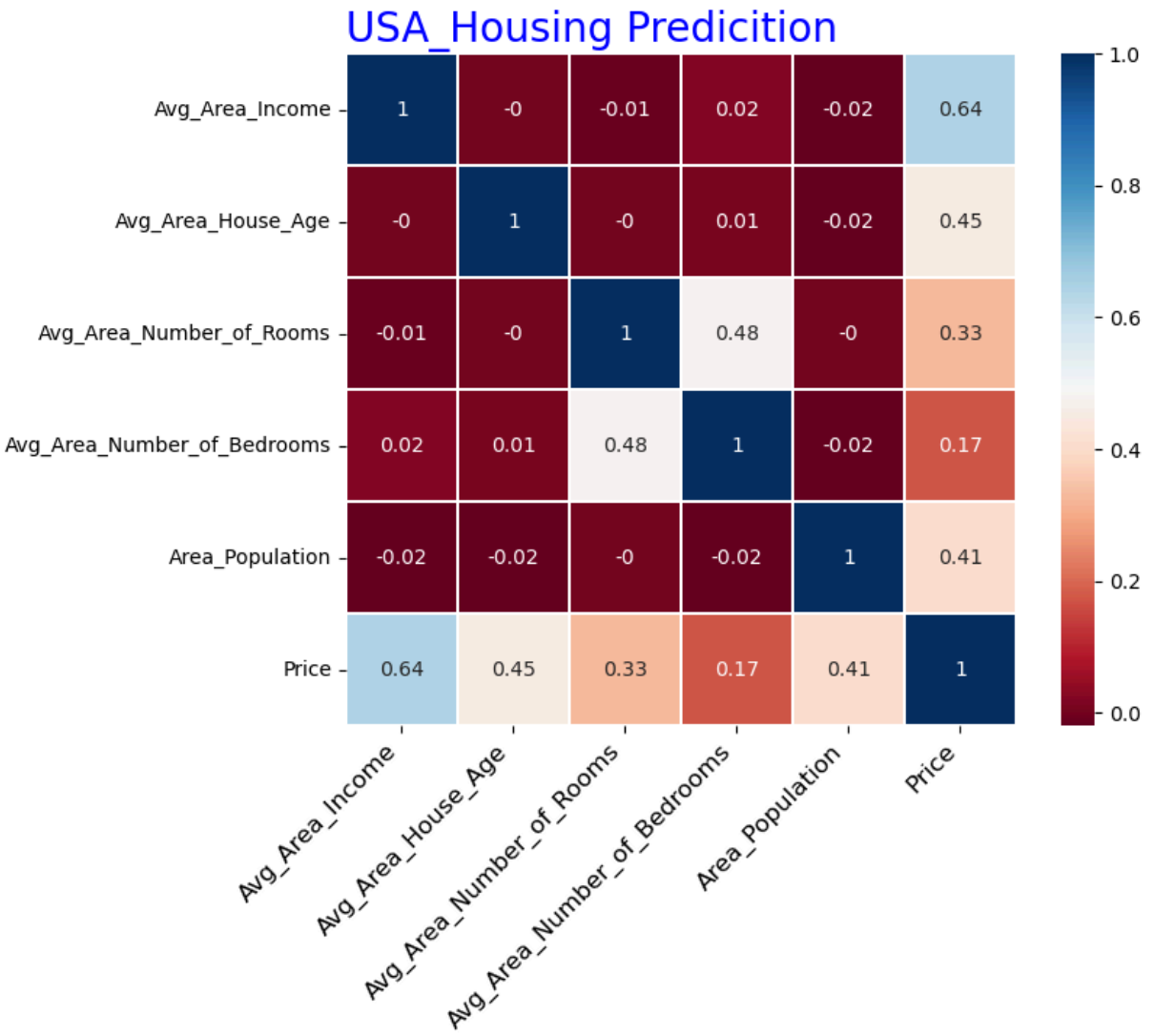
Display correlation with each item and prepare for heatmap

In [29]:
```
# Visualization of the data correlation to each other with the heatmap Chart
ax = data.corr().round(2)
ax
```

Out[29]:

	Avg_Area_Income	Avg_Area_House_Age	Avg_Area_Number_
Avg_Area_Income	1.00	-0.00	
Avg_Area_House_Age	-0.00	1.00	
Avg_Area_Number_of_Rooms	-0.01	-0.00	
Avg_Area_Number_of_Bedrooms	0.02	0.01	
Area_Population	-0.02	-0.02	
Price	0.64	0.45	

In [31]:
```
plt.figure(figsize=(8,6))
sns.heatmap(ax, annot = True, linewidth =.3, square=True,cmap='RdBu')
plt.xticks(fontsize=12, rotation=45,  ha='right')
plt.title("USA_Housing Predicition", loc="left", color="blue",size =20)
plt.show()
```



In [ ]:
```
```

Methodology

1. Explan your big data metodology

- use pandas to load data, setup the DataFrame
- use matlplotlib and seaborn for visualization chart
- use sklearn import train_test_split, to split data from tranning and test data for machine learning
- use linearRegression to check data linearity and correlation
- use StandardScaler to classify data
- use KNeighborsClassifier for knn, classification_report, for knn report

- use confusion_matrix, confusionmatrixDisplay for knn confusion matrix and display coefficient chart

2. Introduce the topics you used in your project

- Model 1
  - Linear Regression
    - use the least of the sum of error of the squared root then divide the total, to get the best-fit line
    - This best fit-line x-axis is the actual value and y-axis is the predicted value
- Model 2
  - KNN K-Nearest Neighbors: A non-labeling method used for classification and regression
  - by finding the closest train examples in the feature space (X)
    - use Euclidean Distance: to find the smallest line between two point
    - using the Standardization method to rescale the feature between 0 and 1 using mean and standard deviation

Your code starts here

Model 1 - Linear Regression

In [37]:
```
#1. look up the columns to set up the X and y array
data.columns
```

Out[37]:
```
Index(['Avg_Area_Income', 'Avg_Area_House_Age', 'Avg_Area_Number_of_Rooms',
       'Avg_Area_Number_of_Bedrooms', 'Area_Population', 'Price'],
      dtype='object')
```

In [39]:
```
#2. import libray to get train_test_split
from sklearn.model_selection import train_test_split

# import the LinearRegression model
from sklearn.linear_model import LinearRegression
```

In [41]:
```
#3. setup the X, and y
X = data.drop('Price', axis =1)
y = data['Price']

#Split the dataset in training-test (80: 20)
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size= 0.2, random_st

#initializ the linear Regression model
model = LinearRegression()

# put the data to training in LinearRegression model
model.fit(X_train, y_train)
```

Out[41]:

```
▾ LinearRegression
LinearRegression()
```

In [43]:

```
#Find the correlation coefficient between the price and each condition
model.coef_
coeff_df = pd.DataFrame(model.coef_, data.columns[:-1],columns=['Coefficient'] )
coeff_df.round(2)
```

Out[43]:

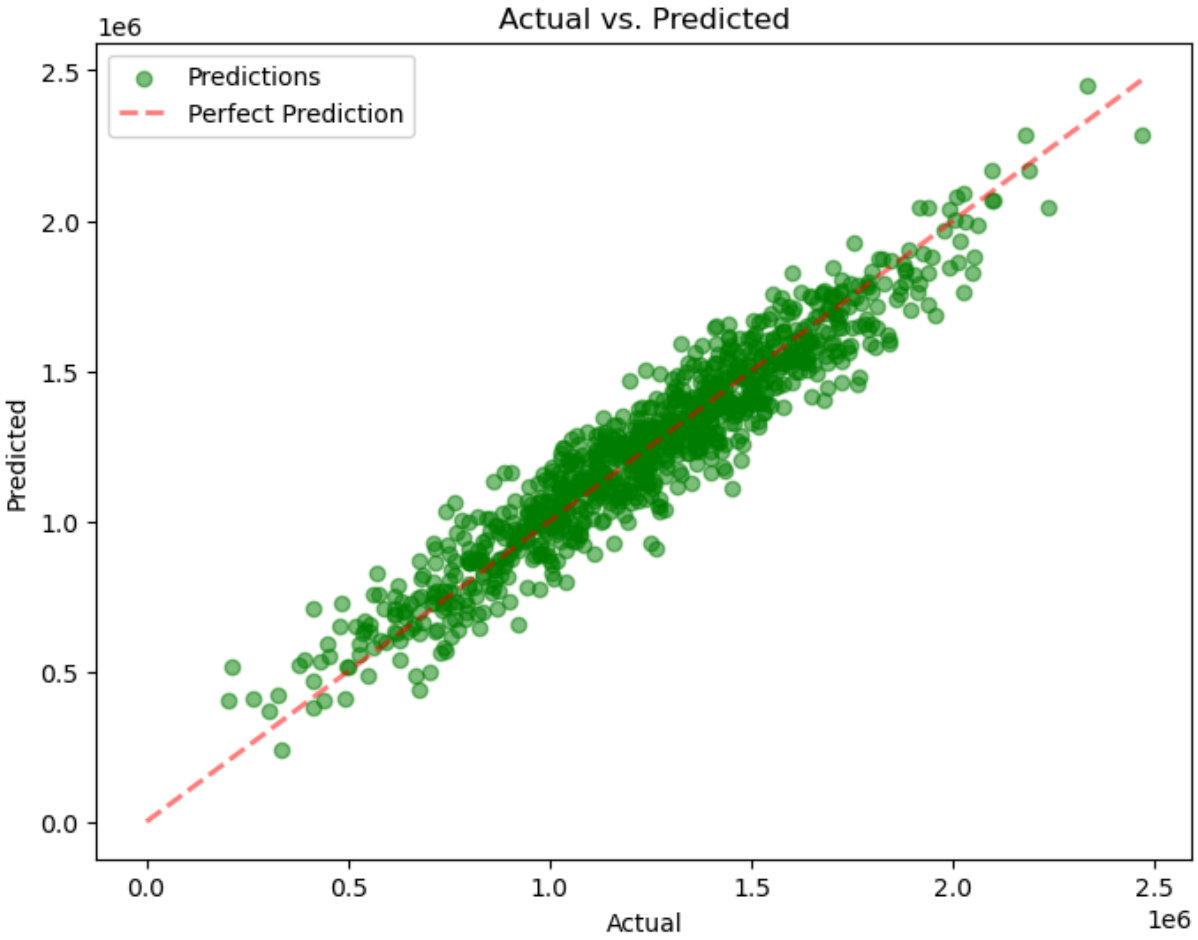
	Coefficient
Avg_Area_Income	21.63
Avg_Area_House_Age	163430.74
Avg_Area_Number_of_Rooms	109347.66
Avg_Area_Number_of_Bedrooms	3070.67
Area_Population	15.26

In [45]:

```
#4predict the data split and classification result
y_pred = model.predict(X_test)
```

In [47]:

```
#5. Graaph the training and tst result
plt.figure(figsize=(8, 6))
plt.scatter(y_test, y_pred, alpha=0.5, color ='green',label='Predictions')
plt.plot([0, max(y_test)], [0, max(y_test)], color='red', linestyle ='dashed',
              linewidth=2, markersize=12, alpha=0.5, label='Perfect Prediction')
plt.title('Actual vs. Predicted')
plt.xlabel('Actual')
plt.ylabel('Predicted')
plt.legend()
plt.show()
```



Test values

79248.642455 6.002900 6.730821 3.09 40173.072174 1.505891e+06

In [50]:
```
#Predict House price with the number of the house we have
new_house_features = pd.DataFrame({
    'Avg_Area_Income': [79248.64],
    'Avg_Area_House_Age': [6.0],
    'Avg_Area_Number_of_Rooms': [6.73],
    'Avg_Area_Number_of_Bedrooms': [3.09],
    'Area_Population': [40173.07]})
y_pd = model.predict(new_house_features)
print('Predict house value: ', y_pd.round(2))
```

```
Predict house value:  [1550214.12]
```

KNN Predicting method

Standardize the Variables

-- **Using sklearn library to import StandardScaler**

In [53]:
```
#import library to standardize everything to the same scale
from sklearn.preprocessing import StandardScaler

# create an instance of the StandardScaler to make all the data between -1 ~1
scaler = StandardScaler()  # defult constructor with no arguments
```

In [55]:
```
# Set the "Price" as the Target, so we drop the 'Price" to let the rest of the data
# This is only Standard Scaler, it does not have any output
scaler.fit(data)
```

Out[55]:
```
StandardScaler
StandardScaler()
```

In [57]:
```
# Transform the scaler object, centering and scaling the data, Transfer X data
#scaled_features = scaler.transform(data.drop('Price', axis =1))
scaled_features = scaler.transform(data)
```

In [59]:
```
#put a list of transform data to a dataframe
df_feature = pd.DataFrame(scaled_features, columns = data.columns)
df_feature.head()
```

Out[59]:

	Avg_Area_Income	Avg_Area_House_Age	Avg_Area_Number_of_Rooms	Avg_Area_Number
0	1.028660	-0.299875	0.479175	
1	1.000808	0.022921	-0.473081	
2	-0.684629	-0.108215	1.431431	
3	-0.491499	1.223318	-1.425337	
4	-0.807072	-0.945467	0.479175	

Prepare X value and y values

In [62]:
```
#Prepare X values set
dfx = df_feature.drop('Price', axis =1 )
dfx.head()
```

Out[62]:

	Avg_Area_Income	Avg_Area_House_Age	Avg_Area_Number_of_Rooms	Avg_Area_Number
0	1.028660	-0.299875	0.479175	
1	1.000808	0.022921	-0.473081	
2	-0.684629	-0.108215	1.431431	
3	-0.491499	1.223318	-1.425337	
4	-0.807072	-0.945467	0.479175	

In [64]:
```
# Find the Maximum and Minimnu number in  Modify ["Price"} column, We want to divid
M = max(df_feature['Price'])
N = min(df_feature['Price'])
Result = (M-N)/3
print(Result)
```

```
2.3159159956333872
```

In [66]:
```
#Prepare y value set
# Separate price in three different interval and put in a new column name ['PriceCa
result = []
for i in df_feature['Price'].to_numpy():
    if i > M-Result:
        result.append(1)
    elif i < N + Result:
        result.append(-1)
    else:
        result.append(0)
# Change the list to dataFrame
dfy= pd.DataFrame(result, columns= ['PriceCategory'])
dfy.head() # Check the new column to replace price
```

Out[66]:

	PriceCategory
0	0
1	0
2	0
3	0
4	-1

Feed the scaler to the KNN Machine Learning Algorithm

-- KNN is finding the number around the neighborhood

Train Test Split

In [69]:
```
#Import the required libraries
from sklearn.model_selection import train_test_split
```

In [71]:
```
#Training the data, set X as the feature Base data, and y as the Target class, or h
# X_train, X_text, y_train, y_test = train_test_split(df_feature, df['Price'], test
#usually the test_size= 0.2, and the random_state=n, n the number you pick up

X = dfx
y = dfy

#KNN Training model
X_train, X_test, y_train, y_test = train_test_split(X, y,
                                                    test_size=0.20, random_state=101)
```

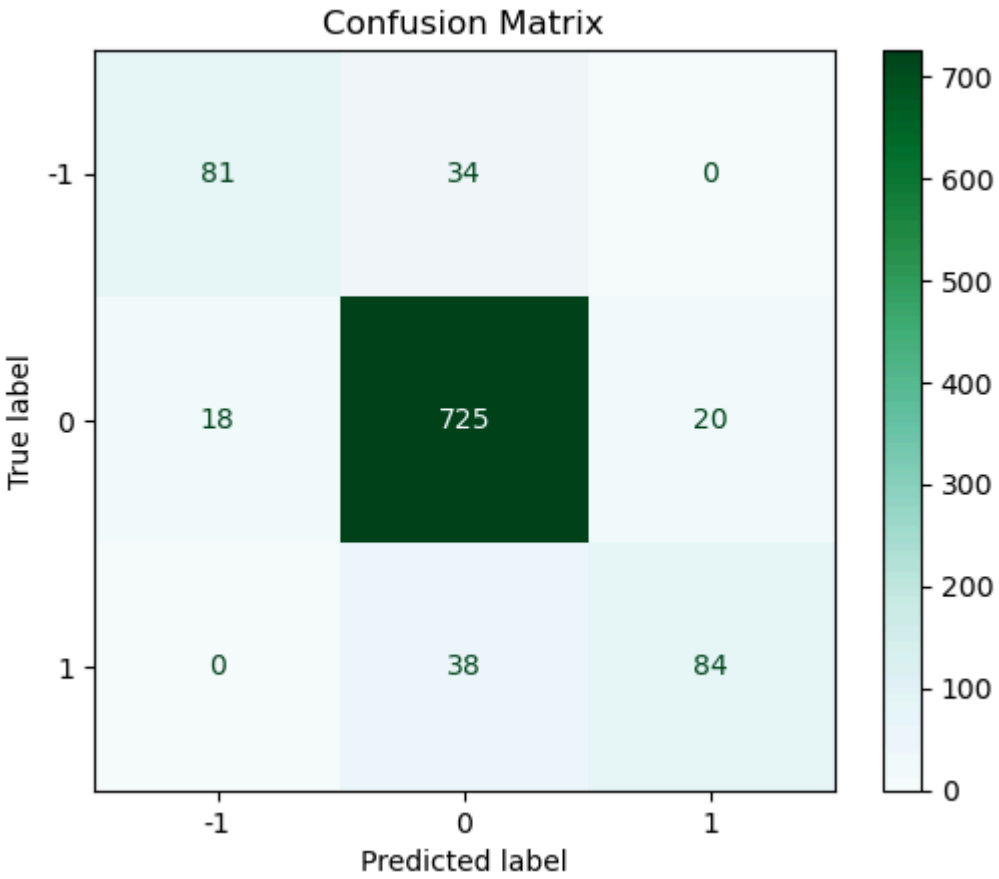
In [73]:
```
# Import KNeighborsClassifier, and report library
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import classification_report, confusion_matrix,ConfusionMatrix
```

In [75]:
```
#Create an instance of KNeighborsClassifier, We set the number = 1 first
k = 5
knn = KNeighborsClassifier(n_neighbors =k, p =2) # p=2 euclidean Distance

#Call fit method for knn and pass the training data
knn.fit(X_train,y_train)
```

Out[75]:
```
KNeighborsClassifier()
```

In [77]:
```
#use X values to get a y_prediction
y_pred = knn.predict(X_test)
labels =[-1, 0, 1]  # I separate the price with -1, 0, and 1 as low, medium, and hi
cm = confusion_matrix(y_test, y_pred, labels=knn.classes_)
disp = ConfusionMatrixDisplay(confusion_matrix=cm, display_labels=knn.classes_)

#KNN Predict report
print('\nClassification report\n',classification_report(y_test,y_pred))

# Making confusion matrix, and chart
print("Confusion Matrix: \n",cm, '\n')

disp.plot(cmap=plt.cm.BuGn)
plt.title('Confusion Matrix')
plt.show()
```

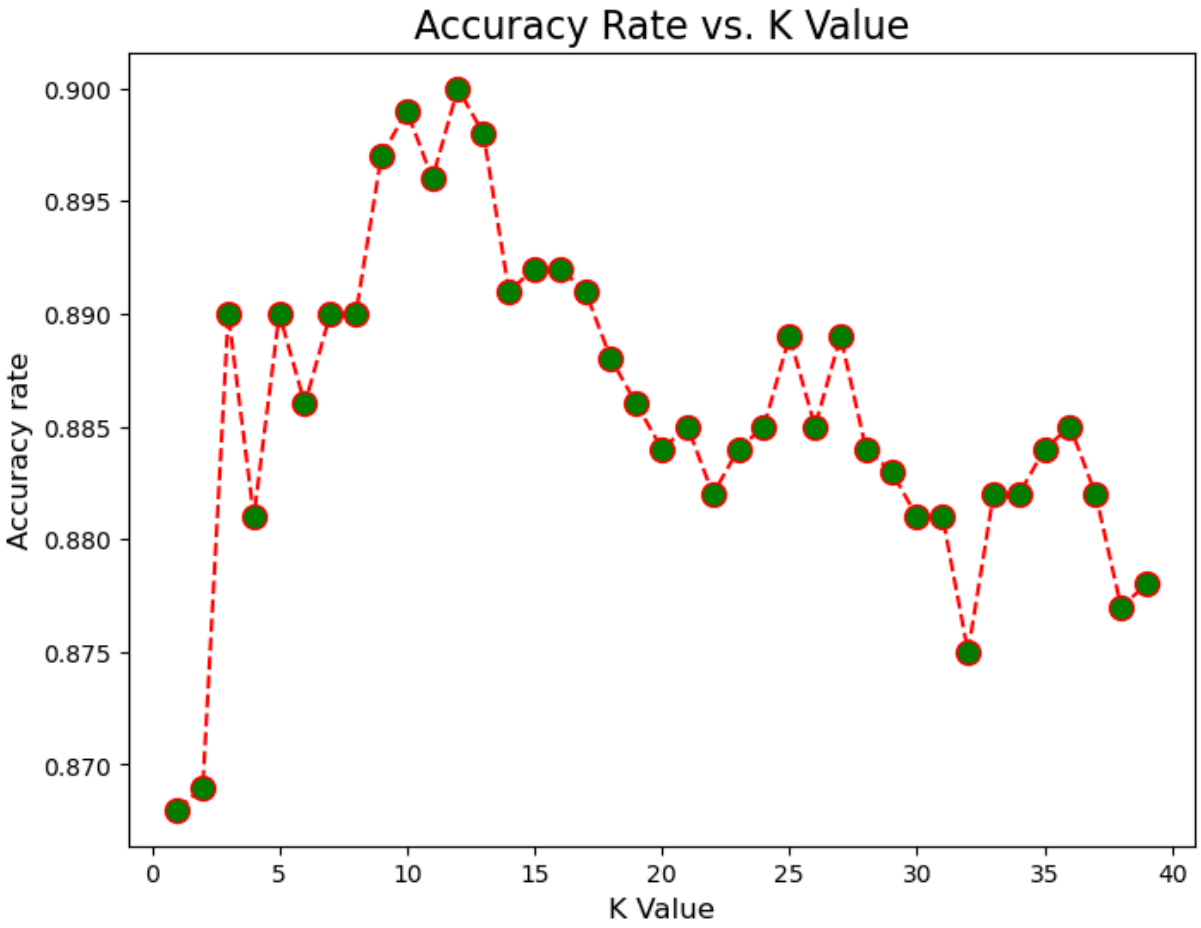
```
Classification report
              precision    recall  f1-score   support

          -1       0.82      0.70      0.76       115
           0       0.91      0.95      0.93       763
           1       0.81      0.69      0.74       122

    accuracy                           0.89      1000
   macro avg       0.85      0.78      0.81      1000
weighted avg       0.89      0.89      0.89      1000

Confusion Matrix:
 [[ 81  34   0]
 [ 18 725  20]
 [  0  38  84]]
```



Using the accuracy method to pick optimize k

In [80]:
```
acc = []
from sklearn import metrics
for i in range(1,40):
    neigh = KNeighborsClassifier(n_neighbors = i).fit(X_train,y_train)
    yhat = neigh.predict(X_test)
    acc.append(metrics.accuracy_score(y_test, yhat))

plt.figure(figsize=(8,6))
plt.plot(range(1,40),acc,color = 'red',linestyle='dashed',
         marker='o',markerfacecolor='green', markersize=10)

plt.title('Accuracy Rate vs. K Value', fontsize =16)
#add xlabel
plt.xlabel('K Value', fontsize=12)

#add ylabel
plt.ylabel('Accuracy rate', fontsize=12)

print("Maximum accuracy:-",max(acc),"at K =",acc.index(max(acc)))
```

```
Maximum accuracy:- 0.9 at K = 11
```



Conclusions

- From the describe, the average price = 1.232073e+06 and the Max price = 2.469066e+06
- From the visualization boxplot, the highest price is for bedrooms 5, 6, 7, 8. There are not so many 10 bedrooms, and the price is not the highest
- From the correlation heatmap, the "income", "age of the house", "room of the house", and "population" direct the high house prices.
- From the linear Regression, I test my predicted formula, the price is growing up
- Hourse price is also related to the city, State, and location. Since I took out the address, the comparison was limited to room number, bedrooms, salary, and population. The output will be less accurate.

- Linear Regression test: the new price is a little higher than the price it has before
- The house pricing prediction K number needs to be around 11 other samples, the accuracy will be better

References

- Academic (if any)
- Online (if any) --https://towardsdatascience.com/how-to-find-the-optimal-value-of-k-in-knn-35d936e554eb#Distance%20Metrics

In [ ]:

Credits

- If you use and/or adapt your code from existing projects, you must provide links and acknowldge the authors.

> *This code is based The class example KNN_Classification Example 4 (for loop to find k does not work)
>
> - Class example 6 to modify the ConfussionMatrixDisplay
> - Medium web for linearRegression, accuracy to find k

In [88]:
```
# End of Project
```

In [ ]: