KNN With Outlier Removal

Import Libraries

In [94]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.neighbors import KNeighborsRegressor, KNeighborsClassifier
```

Import Dataset

In [55]:
```
path_to_file = './housing.csv'
df = pd.read_csv(path_to_file)
```

In [56]:
```
df.head()
```

Out[56]:

	MedInc	HouseAge	AveRooms	AveBedrms	Population	AveOccup	Latitude	Longitude	Med
0	8.3252	41	6.984127	1.023810	322	2.555556	37.88	-122.23	
1	8.3014	21	6.238137	0.971880	2401	2.109842	37.86	-122.22	
2	7.2574	52	8.288136	1.073446	496	2.802260	37.85	-122.24	
3	5.6431	52	5.817352	1.073059	558	2.547945	37.85	-122.25	
4	3.8462	52	6.281853	1.081081	565	2.181467	37.85	-122.25	

Analysis of Data

In [57]:
```
df.shape
```

Out[57]:
```
(20640, 9)
```

In [58]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 20640 entries, 0 to 20639
Data columns (total 9 columns):
 #   Column       Non-Null Count  Dtype  
---  ------       --------------  -----  
 0   MedInc       20640 non-null  float64
 1   HouseAge     20640 non-null  int64  
 2   AveRooms     20640 non-null  float64
 3   AveBedrms    20640 non-null  float64
 4   Population   20640 non-null  int64  
 5   AveOccup     20640 non-null  float64
 6   Latitude     20640 non-null  float64
 7   Longitude    20640 non-null  float64
 8   MedHouseVal  20640 non-null  float64
dtypes: float64(7), int64(2)
memory usage: 1.4 MB
```

Inference

- There is not any null value.
- There is not any column with object type.

Outlier Removal

In [59]:
```
plt.figure(figsize=(16,20))
plt.subplot(4,2,1)
sns.boxplot(df['MedInc'])

plt.subplot(4,2,2)
sns.boxplot(df['HouseAge'])

plt.subplot(4,2,3)
sns.boxplot(df['AveRooms'])

plt.subplot(4,2,4)
sns.boxplot(df['AveBedrms'])

plt.subplot(4,2,5)
sns.boxplot(df['Population'])

plt.subplot(4,2,6)
sns.boxplot(df['AveOccup'])

plt.subplot(4,2,7)
sns.boxplot(df['Latitude'])

plt.subplot(4,2,8)
sns.boxplot(df['Longitude'])

plt.show()
```

```
G:\anaconda\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the f
ollowing variable as a keyword arg: x. From version 0.12, the only valid positiona
l argument will be `data`, and passing other arguments without an explicit keyword
will result in an error or misinterpretation.
  warnings.warn(
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  warnings.warn(
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  warnings.warn(
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  warnings.warn(
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  warnings.warn(
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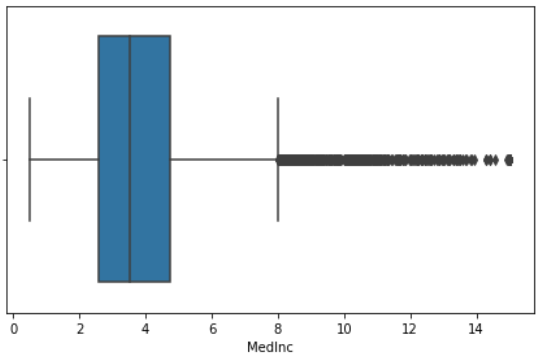
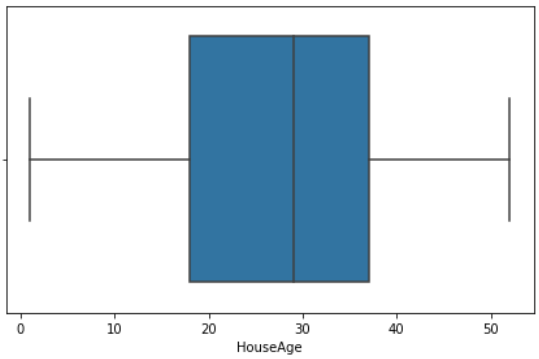
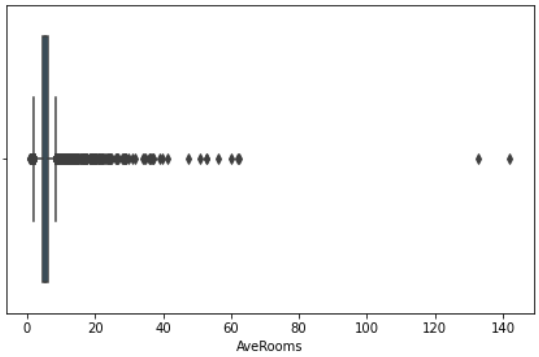
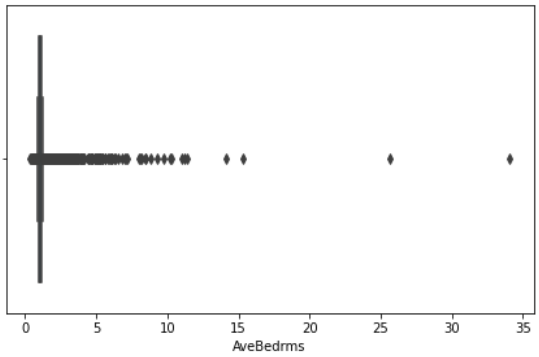
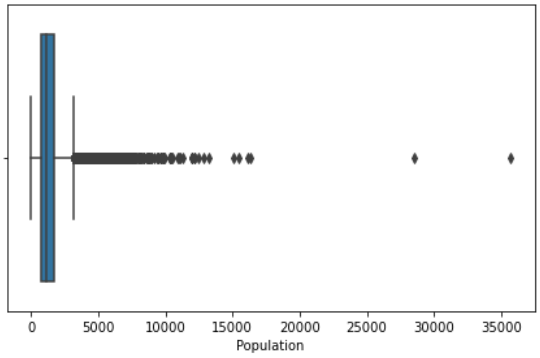
l argument will be `data`, and passing other arguments without an explicit keyword
will result in an error or misinterpretation.
  warnings.warn(
```

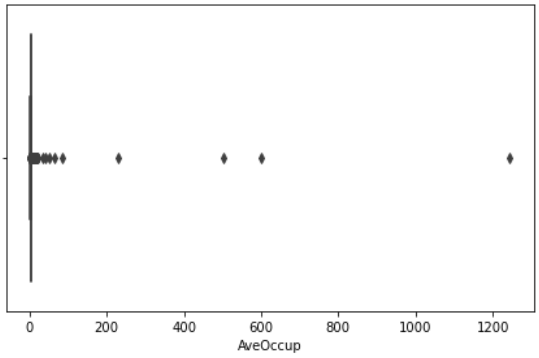


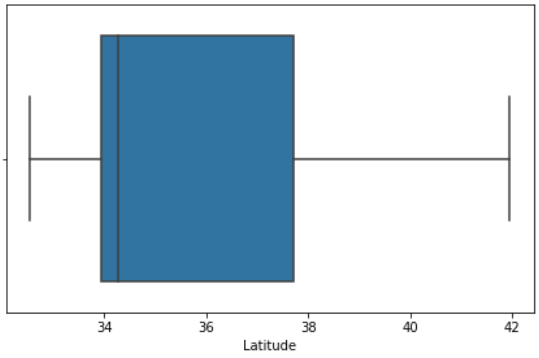


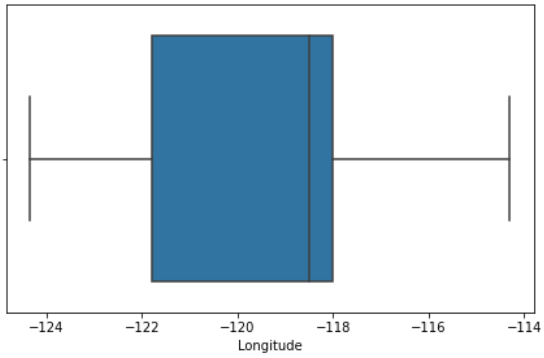










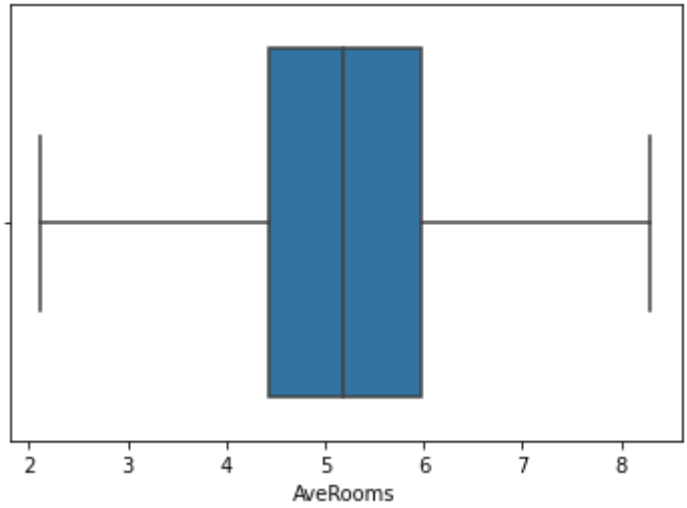


In [62]:
```
q1 = df["AveRooms"].quantile(0.25)
q3 = df["AveRooms"].quantile(0.75)
iqr = q3-q1
low = q1 - 1.5*iqr
high = q3 + 1.5*iqr

df = df[~((df['AveRooms'] >= high) | (df['AveRooms']<= low))]
sns.boxplot(df['AveRooms'])
```

```
G:\anaconda\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the f
ollowing variable as a keyword arg: x. From version 0.12, the only valid positiona
l argument will be `data`, and passing other arguments without an explicit keyword
will result in an error or misinterpretation.
  warnings.warn(
```

Out[62]: <AxesSubplot:xlabel='AveRooms'>

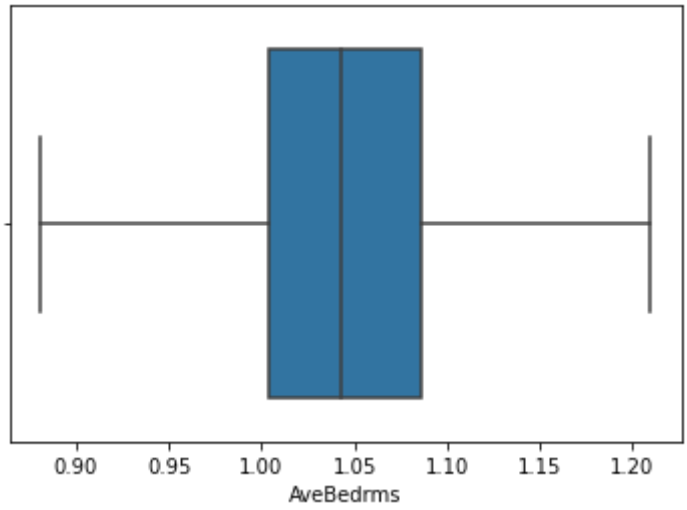


In [69]:
```
q1 = df["AveBedrms"].quantile(0.25)
q3 = df["AveBedrms"].quantile(0.75)
iqr = q3-q1
low = q1 - 1.5*iqr
high = q3 + 1.5*iqr

df = df[~((df['AveBedrms'] >= high) | (df['AveBedrms']<= low))]
sns.boxplot(df['AveBedrms'])
```

```
G:\anaconda\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the f
ollowing variable as a keyword arg: x. From version 0.12, the only valid positiona
l argument will be `data`, and passing other arguments without an explicit keyword
will result in an error or misinterpretation.
  warnings.warn(
```

Out[69]: <AxesSubplot:xlabel='AveBedrms'>

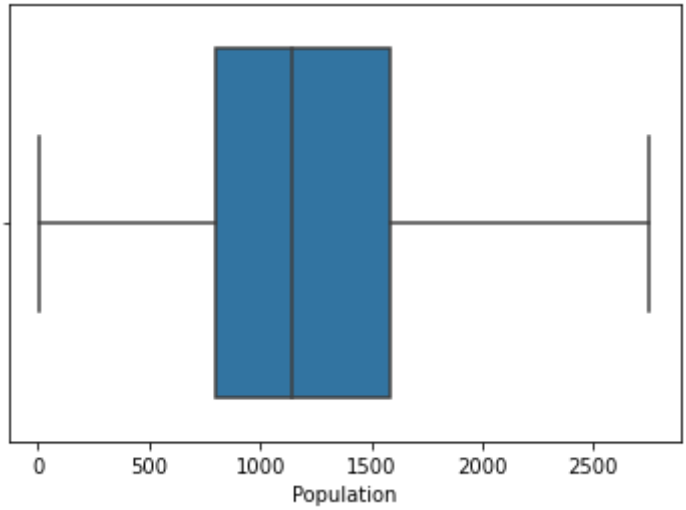


In [74]:
```
q1 = df["Population"].quantile(0.25)
q3 = df["Population"].quantile(0.75)
iqr = q3-q1
low = q1 - 1.5*iqr
high = q3 + 1.5*iqr

df = df[~((df['Population'] >= high) | (df['Population']<= low))]
sns.boxplot(df['Population'])
```

```
G:\anaconda\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the f
ollowing variable as a keyword arg: x. From version 0.12, the only valid positiona
l argument will be `data`, and passing other arguments without an explicit keyword
will result in an error or misinterpretation.
  warnings.warn(
```

Out[74]: <AxesSubplot:xlabel='Population'>

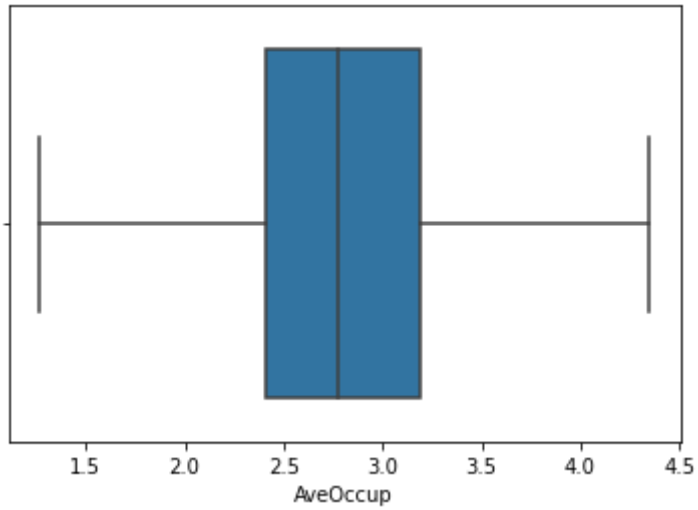


In [80]:
```
q1 = df["AveOccup"].quantile(0.25)
q3 = df["AveOccup"].quantile(0.75)
iqr = q3-q1
low = q1 - 1.5*iqr
high = q3 + 1.5*iqr

df = df[~((df['AveOccup'] >= high) | (df['AveOccup']<= low))]
sns.boxplot(df['AveOccup'])
```

```
G:\anaconda\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the f
ollowing variable as a keyword arg: x. From version 0.12, the only valid positiona
l argument will be `data`, and passing other arguments without an explicit keyword
will result in an error or misinterpretation.
  warnings.warn(
```

Out[80]: <AxesSubplot:xlabel='AveOccup'>



Train Test Split


```
X = df.drop(['MedHouseVal'], axis = 1)
```

In [82]:
```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.25, random_st
```

In [83]:
```
X_train
```

Out[83]:

	MedInc	HouseAge	AveRooms	AveBedrms	Population	AveOccup	Latitude	Longitude
10726	11.0138	16	7.306991	1.060790	868	2.638298	33.64	-117.81
9906	3.4543	12	4.801042	1.046875	2293	2.388542	38.32	-122.28
11947	4.6327	34	5.552817	0.957746	880	3.098592	33.93	-117.44
9134	4.8667	14	6.925743	1.136139	1236	3.059406	34.51	-118.07
6347	2.0156	44	4.076923	1.153846	502	4.290598	34.06	-117.75
...	...	...	...	...	...	...	...	...
17184	4.5625	21	4.667954	1.193050	801	3.092664	37.50	-122.49
6813	3.2361	28	3.654054	0.956757	543	2.935135	34.10	-118.07
981	6.8132	4	6.359838	0.998652	1895	2.553908	37.68	-121.85
20020	1.5893	17	4.244337	1.066343	1912	3.093851	36.07	-119.04
9242	2.5388	12	4.508816	0.954660	1399	3.523929	36.98	-120.07

12196 rows × 8 columns

In [84]:
```
X_test
```

Out[84]:

	MedInc	HouseAge	AveRooms	AveBedrms	Population	AveOccup	Latitude	Longitude
17095	3.9290	36	4.678241	1.002315	1117	2.585648	37.47	-122.24
13785	2.7028	29	4.828326	1.137339	1760	2.517883	34.03	-117.04
2880	1.3750	35	4.050847	1.031477	1041	2.520581	35.38	-118.97
8063	6.4468	43	5.948198	0.925676	1011	2.277027	33.83	-118.19
17648	6.0791	23	6.119910	1.015837	1180	2.669683	37.25	-121.89
...	...	...	...	...	...	...	...	...
8561	4.1818	22	4.426056	1.065141	1225	2.156690	33.93	-118.41
3895	3.2250	33	4.285714	1.072084	2118	2.775885	34.20	-118.53
19466	3.1625	16	5.992347	1.137755	1302	3.321429	37.68	-120.97
4689	2.3375	40	4.129252	1.013605	777	1.761905	34.07	-118.36
11168	4.1167	33	4.601179	0.933202	1367	2.685658	33.82	-117.99

4066 rows × 8 columns

Scaling Dataset

```
scaler.fit(X_train)
X_train = scaler.transform(X_train)
X_test = scaler.transform(X_test)
```

In [86]:
```
X_train
```

Out[86]:
```
array([[ 3.96529227, -1.12990404,  1.87674182, ..., -0.28905557,
        -0.95589406,  0.92501103],
       [-0.25974173, -1.45631436, -0.4062846 , ..., -0.71074472,
         1.23981314, -1.30709423],
       [ 0.39887062,  0.33894244,  0.27861465, ...,  0.48810571,
        -0.81983528,  1.10977142],
       ...,
       [ 1.61756056, -2.10913502,  1.01384548, ..., -0.43153909,
         0.93954549, -1.0923727 ],
       [-1.3020975 , -1.04830145, -0.91346664, ...,  0.48010197,
         0.18418468,  0.31080757],
       [-0.77141825, -1.45631436, -0.67251451, ...,  1.20624757,
         0.61112775, -0.20352541]])
```

In [87]:
```
col_names=['MedInc', 'HouseAge', 'AveRooms', 'AveBedrms', 'Population', 'AveOccup',
scaled_df = pd.DataFrame(X_train, columns=col_names)
scaled_df.describe()
```

Out[87]:

	MedInc	HouseAge	AveRooms	AveBedrms	Population	AveOccup
count	1.219600e+04	1.219600e+04	1.219600e+04	1.219600e+04	1.219600e+04	1.219600e+04
mean	-7.778662e-17	1.611990e-16	1.572300e-16	-1.648949e-16	5.990798e-17	5.897764e-16
std	1.000041e+00	1.000041e+00	1.000041e+00	1.000041e+00	1.000041e+00	1.000041e+00
min	-1.890791e+00	-2.353943e+00	-2.836138e+00	-2.592897e+00	-2.144074e+00	-2.610157e+00
25%	-7.168692e-01	-8.034937e-01	-6.993266e-01	-6.817842e-01	-7.356713e-01	-6.824827e-01
50%	-1.590552e-01	9.413469e-02	-3.644057e-02	-3.713085e-02	-1.485411e-01	-6.414291e-02
75%	5.152344e-01	6.653528e-01	6.482085e-01	6.530779e-01	6.266127e-01	6.301155e-01
max	6.193251e+00	1.807789e+00	2.778775e+00	2.617318e+00	2.726800e+00	2.596455e+00

Training and Prediction For Regression

In [88]:
```
regressor = KNeighborsRegressor(n_neighbors=5)
regressor.fit(X_train, y_train)
```

Out[88]:
```
KNeighborsRegressor
KNeighborsRegressor()
```

In [89]:
```
y_pred = regressor.predict(X_test)
```

In [90]:
```
from sklearn.metrics import mean_absolute_error, mean_squared_error

mae = mean_absolute_error(y_test, y_pred)
mse = mean_squared_error(y_test, y_pred)
pred, squared=False)
```

```
print(f'mae: {mae}')
print(f'mse: {mse}')
print(f'rmse: {rmse}')
```

```
mae: 0.4423957250368913
mse: 0.39249224151982975
rmse: 0.626492012335217
```

In [91]:
```
regressor.score(X_test, y_test)
```

Out[91]:
```
0.6889819935603496
```

Tuning the parameters of KNN Regression

Best Value of K

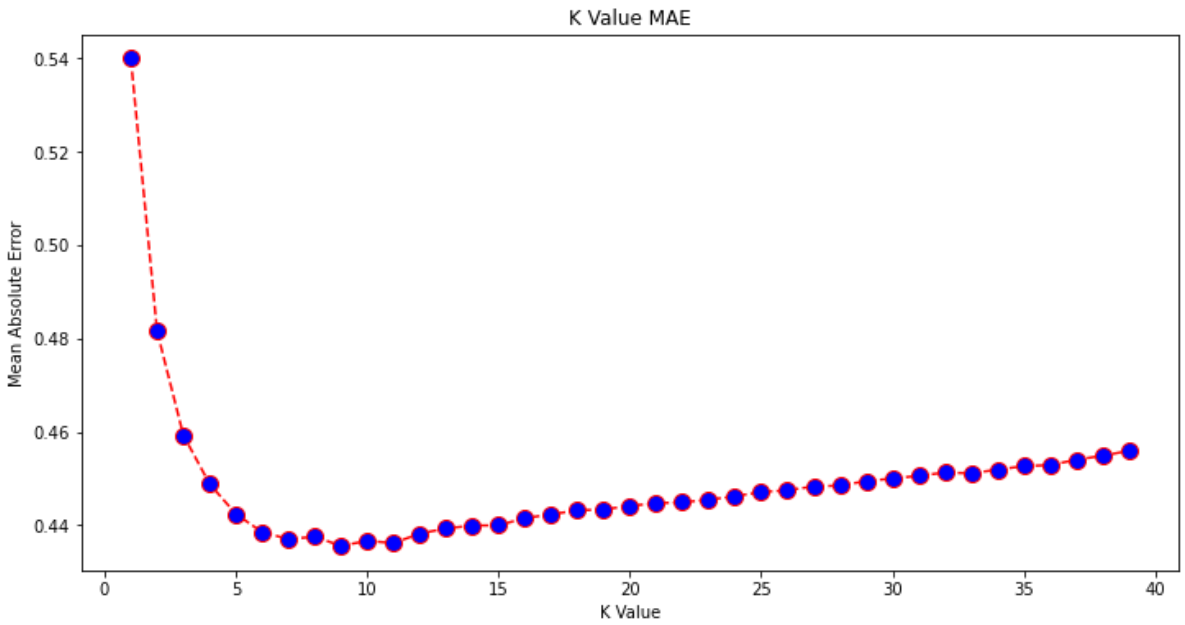
In [92]:
```
error = []

# Calculating MAE error for K values between 1 and 39
for i in range(1, 40):
    knn = KNeighborsRegressor(n_neighbors=i)
    knn.fit(X_train, y_train)
    pred_i = knn.predict(X_test)
    mae = mean_absolute_error(y_test, pred_i)
    error.append(mae)
```

In [93]:
```
plt.figure(figsize=(12, 6))
plt.plot(range(1, 40), error, color='red',
         linestyle='dashed', marker='o',
         markerfacecolor='blue', markersize=10)

plt.title('K Value MAE')
plt.xlabel('K Value')
plt.ylabel('Mean Absolute Error')
```

Out[93]:
```
Text(0, 0.5, 'Mean Absolute Error')
```



8

Inference

- Looking at the plot, it seems the lowest MAE value is when *__K__* is *__8__*.

In [97]:
```
knn_reg8 = KNeighborsRegressor(n_neighbors=8)
knn_reg8.fit(X_train, y_train)
y_pred8 = knn_reg8.predict(X_test)
r2 = knn_reg8.score(X_test, y_test)

mae8 = mean_absolute_error(y_test, y_pred8)
mse8 = mean_squared_error(y_test, y_pred8)
rmse8 = mean_squared_error(y_test, y_pred8, squared=False)
print(f'r2: {r2}, \nmae: {mae8} \nmse: {mse8} \nrmse: {rmse8}')
```

```
r2: 0.702721456111149,
mae: 0.4375316087678307
mse: 0.37515359120960284
rmse: 0.6124978295550139
```

Conclusion For Regression

1. *__Observation before outlier removal__*

- r2: 0.6887495617137436,
- mae: 0.43631325936692505
- mse: 0.4118522151025172
- rmse: 0.6417571309323467

2. *__Observation after outlier removal and k value selection__*

- r2: 0.702721456111149
- mae: 0.4375316087678307
- mse: 0.37515359120960284
- rmse: 0.6124978295550139

Training and Prediction For Classification

In [98]:
```
df["MedHouseValCat"] = pd.qcut(df["MedHouseVal"], 4, retbins=False, labels=[1, 2, 3
```

In [100…
```
y = df['MedHouseValCat']
X = df.drop(['MedHouseVal'], axis = 1)
```

In [102…
```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.25, random_st
```

In [103…
```
scaler = StandardScaler()
scaler.fit(X_train)

X_train = scaler.transform(X_train)
X_test = scaler.transform(X_test)
```

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

Out[113]:

```
KNeighborsClassifier()
```

In [114…

```
y_pred = classifier.predict(X_test)
```

```
G:\anaconda\lib\site-packages\sklearn\neighbors\_classification.py:237: FutureWarn
ing: Unlike other reduction functions (e.g. `skew`, `kurtosis`), the default behav
ior of `mode` typically preserves the axis it acts along. In SciPy 1.11.0, this be
havior will change: the default value of `keepdims` will become False, the `axis`
over which the statistic is taken will be eliminated, and the value None will no l
onger be accepted. Set `keepdims` to True or False to avoid this warning.
  mode, _ = stats.mode(_y[neigh_ind, k], axis=1)
```

In [115…

```
acc =  classifier.score(X_test, y_test)
print(acc)
```

```
0.9795868175110674
G:\anaconda\lib\site-packages\sklearn\neighbors\_classification.py:237: FutureWarn
ing: Unlike other reduction functions (e.g. `skew`, `kurtosis`), the default behav
ior of `mode` typically preserves the axis it acts along. In SciPy 1.11.0, this be
havior will change: the default value of `keepdims` will become False, the `axis`
over which the statistic is taken will be eliminated, and the value None will no l
onger be accepted. Set `keepdims` to True or False to avoid this warning.
  mode, _ = stats.mode(_y[neigh_ind, k], axis=1)
```

Tuning the parameters of KNN Classification

Best Value of K

In [107…

```
from sklearn.metrics import f1_score

f1s = []

for i in range(1, 40):
    knn = KNeighborsClassifier(n_neighbors=i)
    knn.fit(X_train, y_train)
    pred_i = knn.predict(X_test)
    f1s.append(f1_score(y_test, pred_i, average='weighted'))
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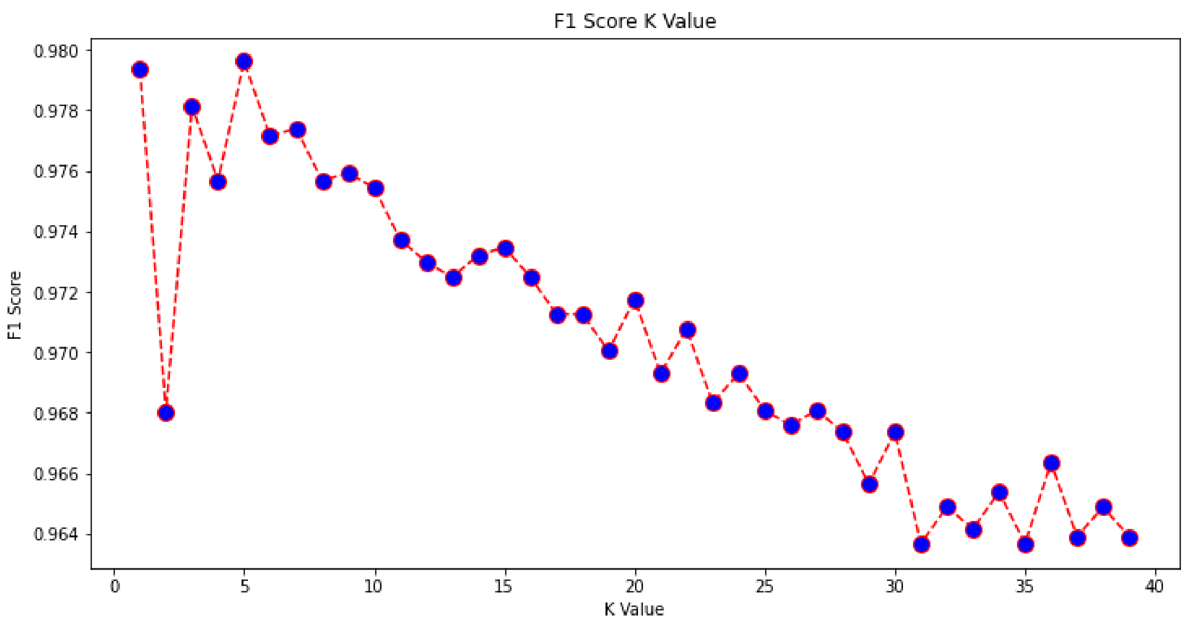
  mode, _ = stats.mode(_y[neigh_ind, k], axis=1)
```

In [108…

```
plt.figure(figsize=(12, 6))
plt.plot(range(1, 40), f1s, color='red', linestyle='dashed', marker='o',
         markerfacecolor='blue', markersize=10)
plt.title('F1 Score K Value')
plt.xlabel('K Value')
plt.ylabel('F1 Score')
```

Out[108]: Text(0, 0.5, 'F1 Score')



In [112…

```
plt.figure(figsize=(12, 6))
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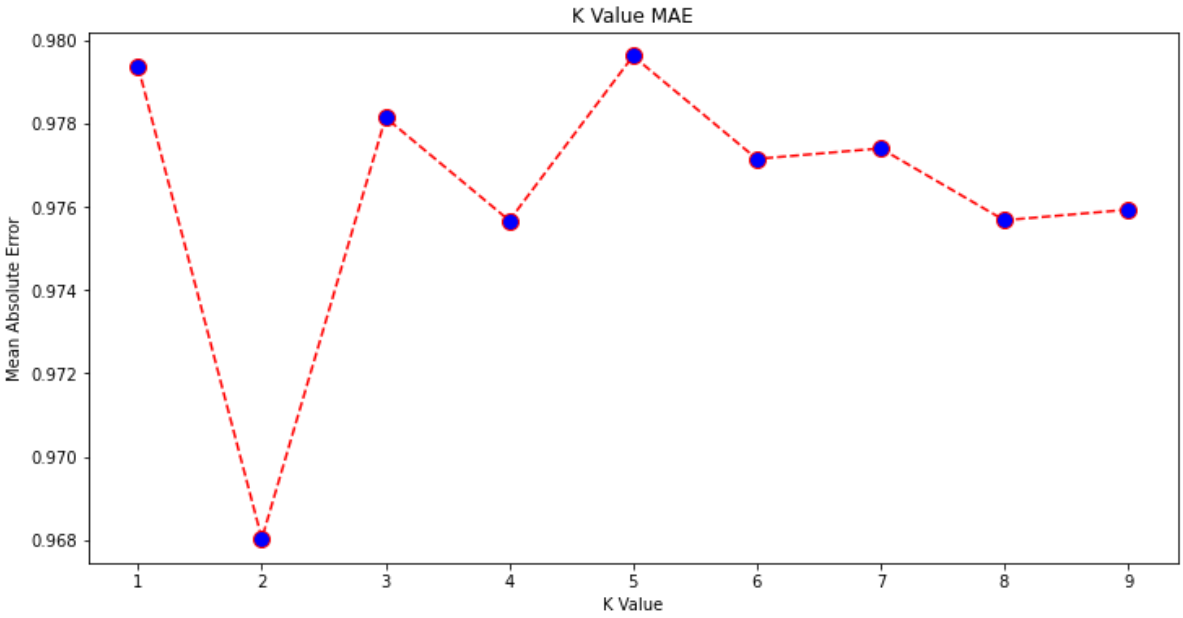
        markerfacecolor='blue', markersize=10)
plt.title('K Value MAE')
plt.xlabel('K Value')
plt.ylabel('Mean Absolute Error')
```

Out[112]: Text(0, 0.5, 'Mean Absolute Error')



Inference

- Looking at the plot, it seems the max f1s value is when *__K__* is *__5__*.

In [116…

```
knn_class5 = KNeighborsRegressor(n_neighbors=5)
knn_class5.fit(X_train, y_train)
y_pred5 = knn_class5.predict(X_test)
acc =  classifier.score(X_test, y_test)
print(acc)
```

```
0.9795868175110674
```

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  mode, _ = stats.mode(_y[neigh_ind, k], axis=1)
```

Conclusion For Classification

1. *__Observation before outlier removal__*

- 0.7874031007751938

2. *__Observation after outlier removal and k value selection__*

- acc: 0.9795868175110674

In [ ]: