In [54]:
```
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, GridSearchCV
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import confusion_matrix, classification_report
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier, AdaBoostClassifier
```

In [55]:
```
# Read in dataset
house_data = pd.read_csv("california_housing.csv")
```

In [56]:
```
# Identify Shape
house_data.shape
```

Out[56]: (20634, 9)

In [57]:
```
# Identify Size
house_data.size
```

Out[57]: 185706

In [58]:
```
# Get info on datatypes
house_data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 20634 entries, 0 to 20633
Data columns (total 9 columns):
 #   Column              Non-Null Count  Dtype  
---  ------              --------------  -----  
 0   MedInc              20634 non-null  float64
 1   HouseAge            20634 non-null  float64
 2   AveRooms            20634 non-null  float64
 3   AveBedrms           20634 non-null  float64
 4   Population          20634 non-null  float64
 5   AveOccup            20634 non-null  float64
 6   Latitude            20634 non-null  float64
 7   Longitude           20634 non-null  float64
 8   price_above_median  20634 non-null  int64  
dtypes: float64(8), int64(1)
memory usage: 1.4 MB
```

In [59]:
```
# Check if any duplicate rows exist in the data
house_data.duplicated().sum()
```

Out[59]: 0

In [60]:
```
# Mean Values of all Variables
house_data.mean()
```

Out[60]:
```
MedInc                   3.870795
HouseAge                28.640399
AveRooms                 5.429171
AveBedrms                1.096628
Population            1425.398081
AveOccup                 3.070449
Latitude                35.631722
Longitude             -119.569594
price_above_median       0.500000
dtype: float64
```

In [61]:
```
# Mode of all Variables
house_data.mode()
```

Out[61]:

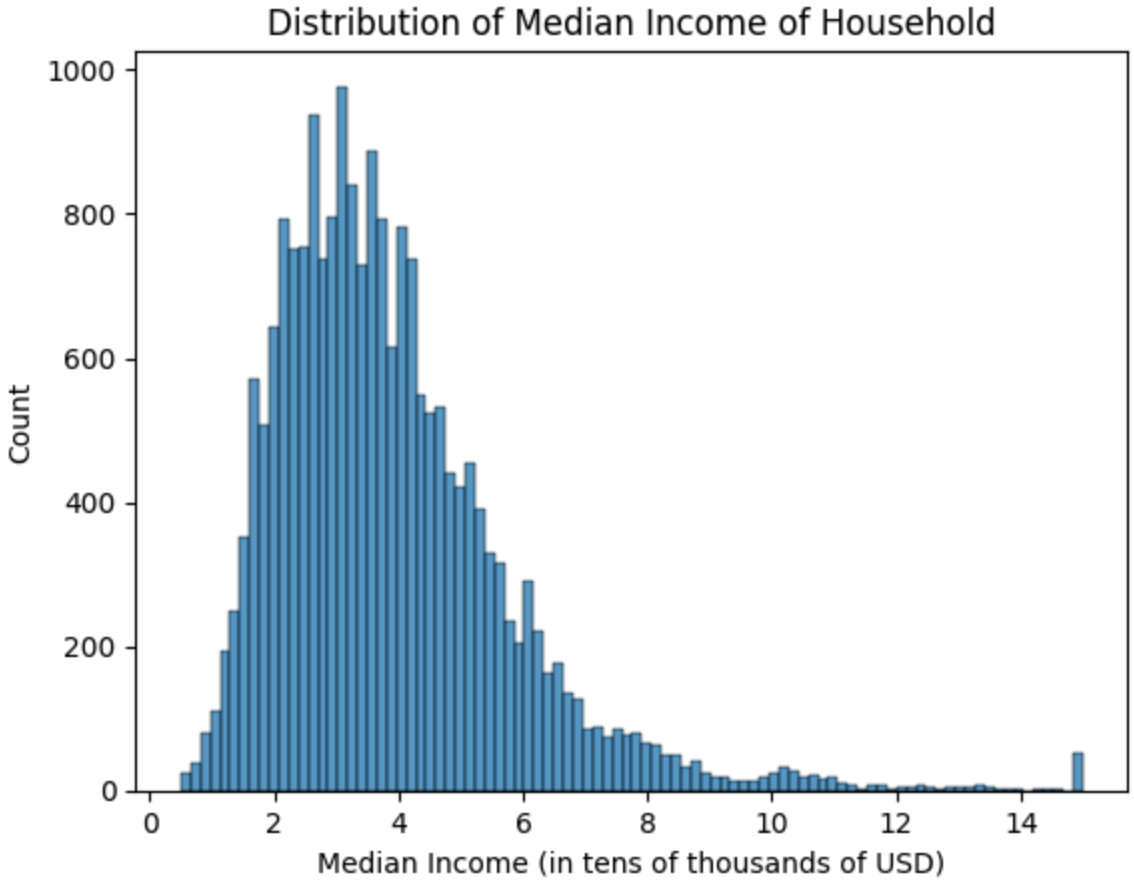
	MedInc	HouseAge	AveRooms	AveBedrms	Population	AveOccup	Latitude	Longi
0	3.1250	52.0	5.0	1.0	891.0	3.0	34.06	-1
1	15.0001	NaN	NaN	NaN	NaN	NaN	NaN	

In [62]:
```
# Median of all Variables
house_data.median()
```

Out[62]:
```
MedInc                   3.534950
HouseAge                29.000000
AveRooms                 5.229190
AveBedrms                1.048780
Population            1166.000000
AveOccup                 2.817937
Latitude                34.260000
Longitude             -118.490000
price_above_median       0.500000
dtype: float64
```

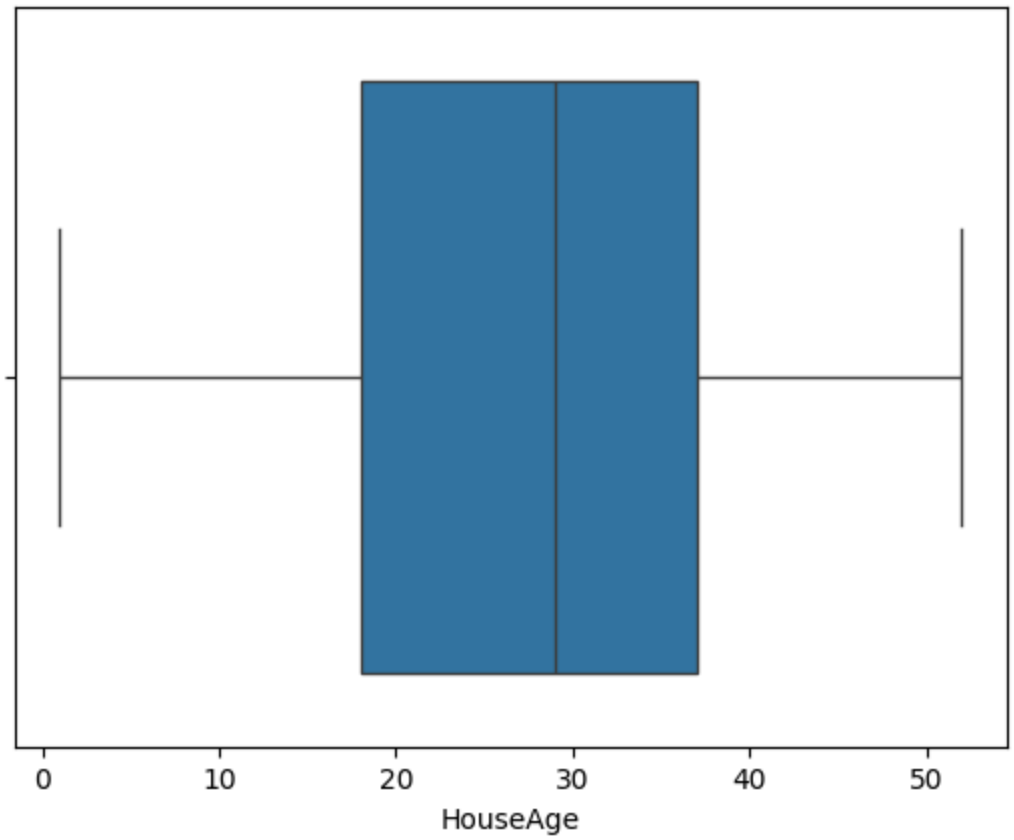
In [63]:
```
# Histogram Showing frequencies of 'MedInc'
sns.histplot(data=house_data['MedInc'])
plt.title('Distribution of Median Income of Household')
plt.xlabel('Median Income (in tens of thousands of USD)')
```

Out[63]:
```
Text(0.5, 0, 'Median Income (in tens of thousands of USD)')
```

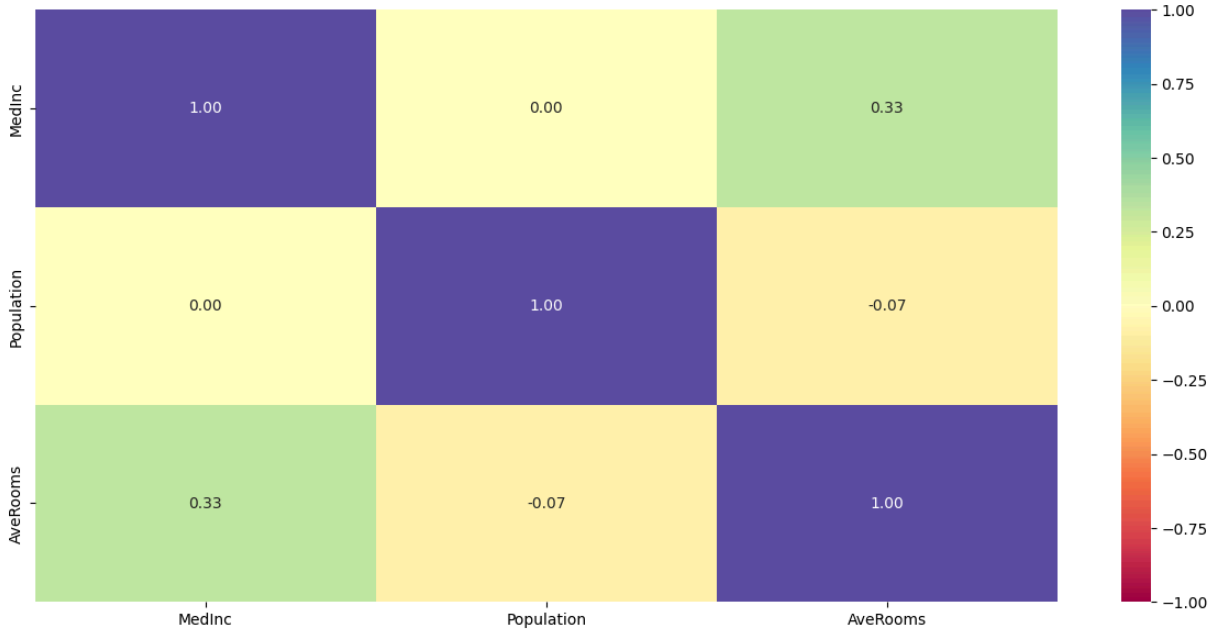


In [64]:
```
# Box Plot Showing Distribution of 'HouseAge'
sns.boxplot(data=house_data, x='HouseAge')
```

Out[64]:
```
<Axes: xlabel='HouseAge'>
```



In [65]:
```
# Heat Map to show Correlation between Columns
corr_cols=['MedInc','Population','AveRooms']
plt.figure(figsize=(15, 7))
sns.heatmap(
   house_data[corr_cols].corr(), annot=True, vmin=-1, vmax=1, fmt=".2f", cma
)
plt.show()
```



In [66]:
```
house_data.head()
```

Out[66]:

	MedInc	HouseAge	AveRooms	AveBedrms	Population	AveOccup	Latitude	Longi
0	2.1827	26.0	4.521429	0.921429	305.0	2.178571	40.05	-12
1	3.0755	32.0	4.623068	0.983353	3868.0	4.599287	32.77	-1
2	1.8235	40.0	4.701149	1.126437	928.0	3.555556	37.75	-12
3	1.4625	37.0	4.247845	1.105603	1673.0	3.605603	33.99	-11
4	1.9063	13.0	3.453125	0.984375	286.0	4.468750	33.97	-1

In [67]:
```
# Assigning subset of data as X and y
X = house_data.drop('price_above_median', axis=1)
y = house_data["price_above_median"]
```

In [68]:
```
# Splitting the data to a 70:30 Ratio
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.3, r
```

In [69]:
```
# K-nearest neighbor Model
knn = KNeighborsClassifier(n_neighbors=3)
knn.fit(X_train, y_train)
print(classification_report(y_test, knn.predict(X_test)))
```

```
              precision    recall  f1-score   support

           0       0.62      0.61      0.62      3135
           1       0.61      0.61      0.61      3056

    accuracy                           0.61      6191
   macro avg       0.61      0.61      0.61      6191
weighted avg       0.61      0.61      0.61      6191
```

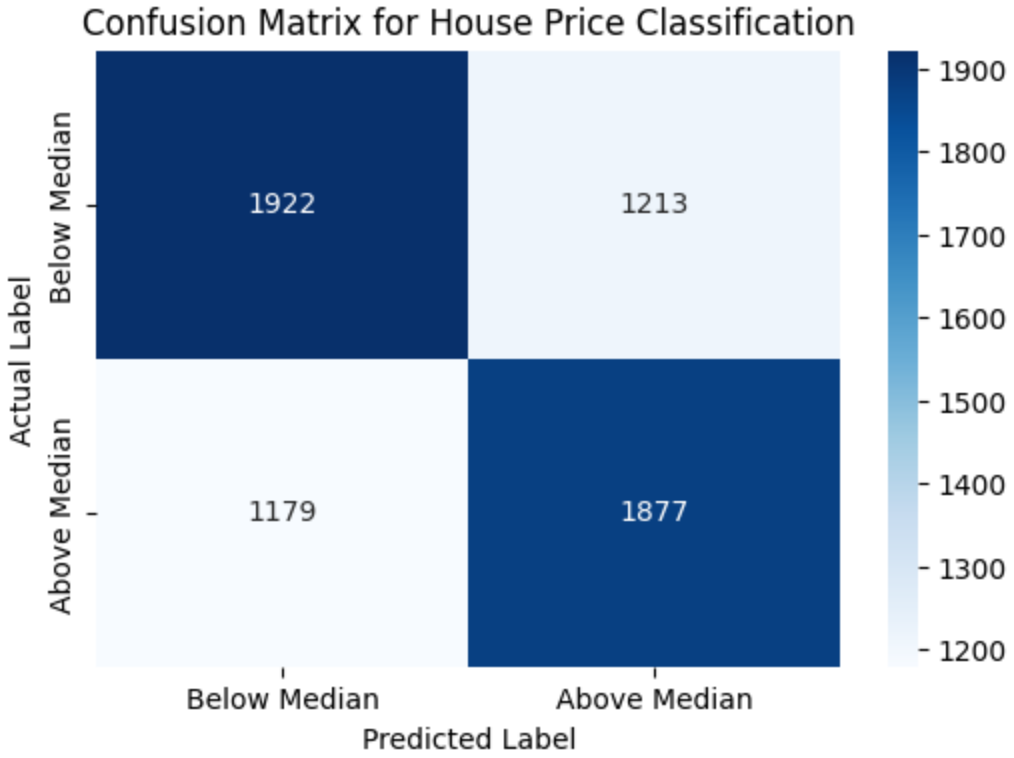
In [70]:
```
# Confusion Matrix for K-nearest neighbor Model
# Make predictions
y_pred = knn.predict(X_test)

# Compute confusion matrix
cm = confusion_matrix(y_test, y_pred)

# Print confusion matrix
print("Confusion Matrix:\n", cm)

# Visualize confusion matrix with updated labels
plt.figure(figsize=(6,4))
sns.heatmap(cm, annot=True, fmt='d', cmap="Blues",
            xticklabels=['Below Median', 'Above Median'],
            yticklabels=['Below Median', 'Above Median'])
plt.xlabel('Predicted Label')
plt.ylabel('Actual Label')
plt.title('Confusion Matrix for House Price Classification')
plt.show()
```

```
Confusion Matrix:
 [[1922 1213]
 [1179 1877]]
```



In [71]:
```
# Decision Tree Classifier
DecisionTree = DecisionTreeClassifier(random_state=1).fit(X_train, y_train)

# Print Report
print("Performance on TEST\n********************\n")
print(classification_report(y_test, DecisionTree.predict(X_test)))

print("Performance on TRAIN\n********************\n")
print(classification_report(y_train, DecisionTree.predict(X_train)))
```

```
Performance on TEST
********************

              precision    recall  f1-score   support

           0       0.85      0.85      0.85      3135
           1       0.85      0.85      0.85      3056

    accuracy                           0.85      6191
   macro avg       0.85      0.85      0.85      6191
weighted avg       0.85      0.85      0.85      6191

Performance on TRAIN
********************

              precision    recall  f1-score   support

           0       1.00      1.00      1.00      7182
           1       1.00      1.00      1.00      7261

    accuracy                           1.00     14443
   macro avg       1.00      1.00      1.00     14443
weighted avg       1.00      1.00      1.00     14443
```

In [72]:

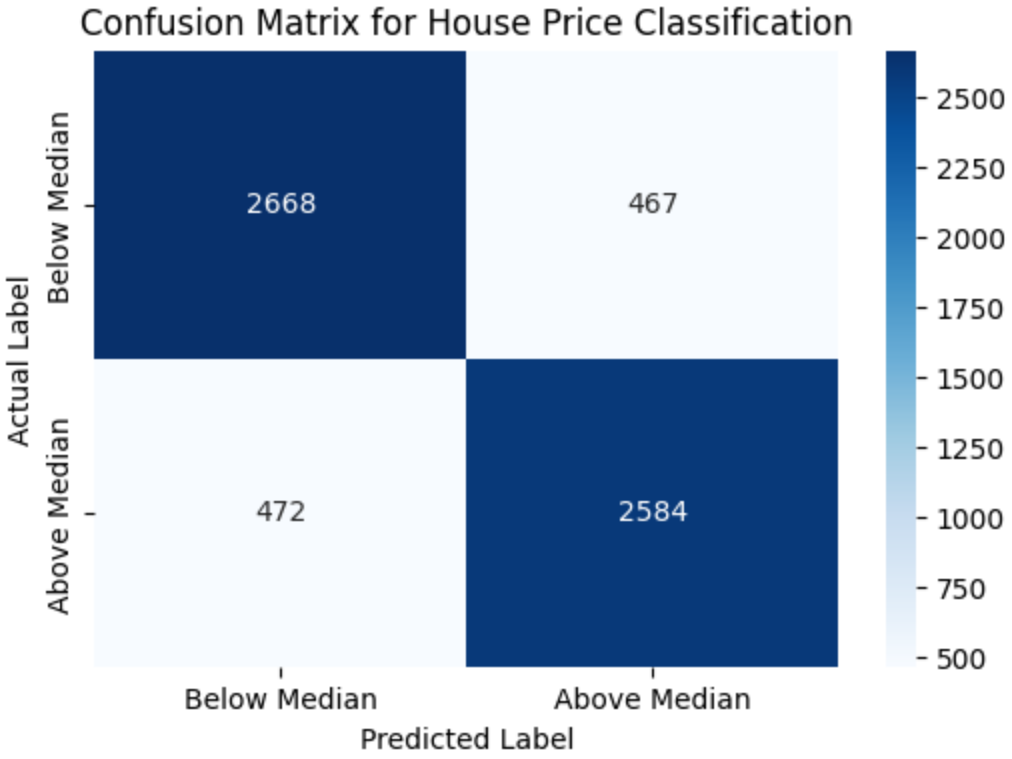
```
# Confusion Matrix for Decision Tree Classifier
# Make predictions
y_pred = DecisionTree.predict(X_test)

# Compute confusion matrix
cm = confusion_matrix(y_test, y_pred)

# Print confusion matrix
print("Confusion Matrix:\n", cm)

# Visualize confusion matrix with updated labels
plt.figure(figsize=(6,4))
sns.heatmap(cm, annot=True, fmt='d', cmap="Blues",
            xticklabels=['Below Median', 'Above Median'],
            yticklabels=['Below Median', 'Above Median'])
plt.xlabel('Predicted Label')
plt.ylabel('Actual Label')
plt.title('Confusion Matrix for House Price Classification')
plt.show()
```

```
Confusion Matrix:
 [[2668  467]
 [ 472 2584]]
```



In [73]:
```
# Random Forrest Classifier
model = RandomForestClassifier()
# param_grid = {
#    "n_estimators": np.arange(10, 100, 2),
#    "max_depth": np.arange(start=2, stop=10),
#    "min_samples_leaf": np.arange(1, 10, 2),
#    "class_weight": [{0: 0.5, 1:0.5}],
# }

param_grid = {
    "n_estimators": [10, 50, 100],  # Reduce from 45 → 3 values
    "max_depth": [3, 5, 10],  # Reduce from 8 → 3 values
    "min_samples_leaf": [1, 5, 10],  # Reduce from 5 → 3 values
    "class_weight": ["balanced", {0: 0.3, 1: 0.7}],  # Reduce from 3 → 2 val
}
gscv = GridSearchCV(model, param_grid, cv=5, scoring="recall", )
gscv.fit(X_train, y_train)
gscv.best_params_
```

Out[73]:
```
{'class_weight': {0: 0.3, 1: 0.7},
 'max_depth': 3,
 'min_samples_leaf': 10,
 'n_estimators': 50}
```

In [74]:
```
# Print Report for Random Forrest Classifier
print("Performance on TEST\n**********\n")
print(classification_report(y_test, gscv.predict(X_test), zero_division=1.0)
print("Performance on TRAIN\n**********\n")
print(classification_report(y_train, gscv.predict(X_train), zero_division=1.
```

```
Performance on TEST
********************

              precision    recall  f1-score   support

           0       0.94      0.41      0.58      3135
           1       0.62      0.97      0.76      3056

    accuracy                           0.69      6191
   macro avg       0.78      0.69      0.67      6191
weighted avg       0.78      0.69      0.66      6191

Performance on TRAIN
********************

              precision    recall  f1-score   support

           0       0.94      0.40      0.56      7182
           1       0.62      0.98      0.76      7261

    accuracy                           0.69     14443
   macro avg       0.78      0.69      0.66     14443
weighted avg       0.78      0.69      0.66     14443
```

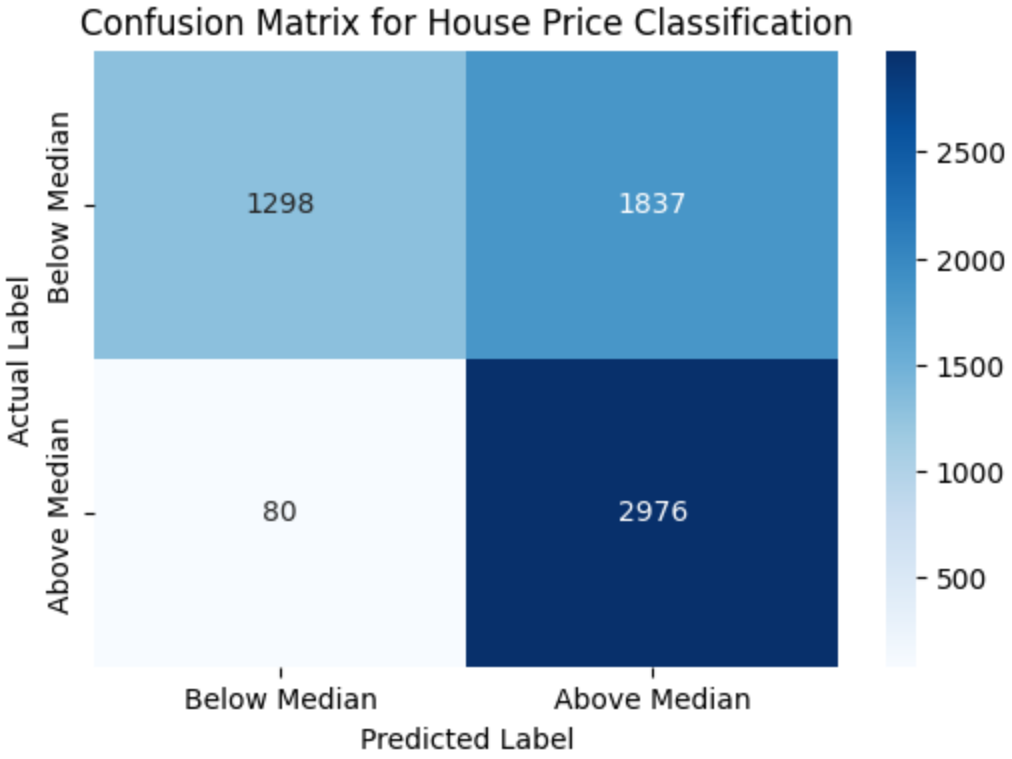
In [75]:
```
# Confusion Matrix for Random Forrest Classifier
# Make predictions
y_pred = gscv.predict(X_test)

# Compute confusion matrix
cm = confusion_matrix(y_test, y_pred)

# Print confusion matrix
print("Confusion Matrix:\n", cm)

# Visualize confusion matrix with updated labels
plt.figure(figsize=(6,4))
sns.heatmap(cm, annot=True, fmt='d', cmap="Blues",
            xticklabels=['Below Median', 'Above Median'],
            yticklabels=['Below Median', 'Above Median'])
plt.xlabel('Predicted Label')
plt.ylabel('Actual Label')
plt.title('Confusion Matrix for House Price Classification')
plt.show()
```

```
Confusion Matrix:
 [[1298 1837]
 [  80 2976]]
```



In [76]:
```
# AdaBoost Classifier
decision_tree_stump = DecisionTreeClassifier(max_depth=1)

param_grid = {
    'learning_rate': [0.1, 0.5, 1.0],
    'n_estimators': [50, 100, 200]
}

abc = AdaBoostClassifier(estimator=decision_tree_stump, random_state=42)
grid_search = GridSearchCV(abc, param_grid, cv=3, n_jobs=8)
grid_search.fit(X_train, y_train)
```

Out[76]:

▸ **GridSearchCV**

▸ **estimator: AdaBoostClassifier**

▸ **estimator: DecisionTreeClassifier**

▸ DecisionTreeClassifier

In [77]:
```
# Print Report for AdaBoost Classifier
print("Performance on TEST\n**********\n")
print(classification_report(y_test, grid_search.predict(X_test), zero_divisi
print("Performance on TRAIN\n**********\n")
print(classification_report(y_train, grid_search.predict(X_train), zero_divi
```

```
Performance on TEST
********************

              precision    recall  f1-score   support

           0       0.88      0.87      0.88      3135
           1       0.87      0.88      0.88      3056

    accuracy                           0.88      6191
   macro avg       0.88      0.88      0.88      6191
weighted avg       0.88      0.88      0.88      6191

Performance on TRAIN
********************

              precision    recall  f1-score   support

           0       0.89      0.88      0.89      7182
           1       0.89      0.89      0.89      7261

    accuracy                           0.89     14443
   macro avg       0.89      0.89      0.89     14443
weighted avg       0.89      0.89      0.89     14443
```

In [78]:

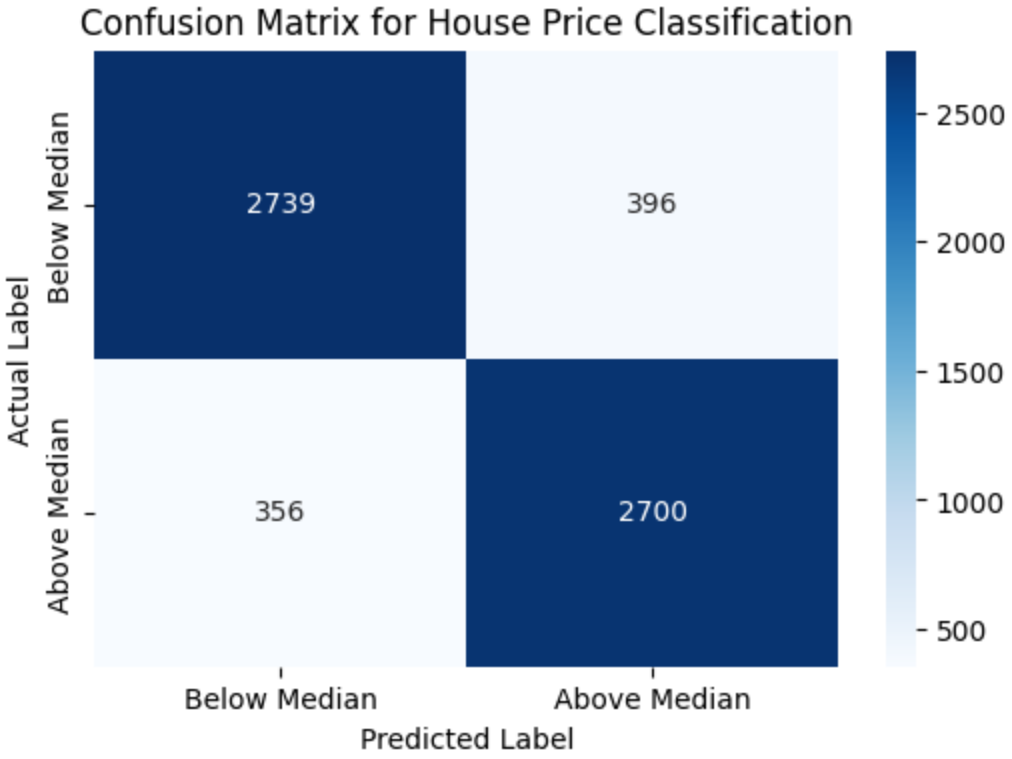
```
# Confusion Matrix for AdaBoost Classifier
# Make predictions
y_pred = grid_search.predict(X_test)

# Compute confusion matrix
cm = confusion_matrix(y_test, y_pred)

# Print confusion matrix
print("Confusion Matrix:\n", cm)

# Visualize confusion matrix with updated labels
plt.figure(figsize=(6,4))
sns.heatmap(cm, annot=True, fmt='d', cmap="Blues",
            xticklabels=['Below Median', 'Above Median'],
            yticklabels=['Below Median', 'Above Median'])
plt.xlabel('Predicted Label')
plt.ylabel('Actual Label')
plt.title('Confusion Matrix for House Price Classification')
plt.show()
```

```
Confusion Matrix:
 [[2739  396]
 [ 356 2700]]
```


Confusion Matrix for House Price Classification
Actual Label
Below Median
Above Median
2739
396
356
2700
2500
2000
1500
1000
500
Below Median
Above Median
Predicted Label

In [ ]: