In [8]:

```
import numpy as np
import matplotlib.pyplot as plt
from sklearn import datasets, linear_model
from sklearn.preprocessing import MinMaxScaler
from sklearn.svm import SVR
from sklearn.model_selection import KFold
import pandas as pd
from pandas import DataFrame, Series
import seaborn as sns
sns.set(style='ticks', palette='Set2')
%matplotlib inline
```

In [10]:

```
#read_file = pd.read_csv ('housing.data.txt', header = None, delim_whitespace= T
#read_file.to_csv ('housing_data.csv', index=None)
```

In [11]:

```
housing = pd.read_csv('housing_data.csv')
```

In [12]:

```
X = housing.iloc[:, [0, 12]]
y = housing.iloc[:, 13]
```

In [13]:

```
scaler = MinMaxScaler(feature_range=(0, 1))
X = scaler.fit_transform(X)
```

In [14]:

```
bias = []
variance_total = []
```

In [15]:

```
mean_score = []
variance = []
best_svr = SVR(kernel='rbf')
for i in np.arange(1,100):
    scores = []
    cv = KFold(5, shuffle= True)
    for train_index, test_index in cv.split(X):
        X_train, X_test, y_train, y_test = X[train_index], X[test_index], y[trai
        best_svr.fit(X_train, y_train)
        scores.append(best_svr.score(X_test, y_test))
    mean_score.append(np.mean(scores))
    variance.append(np.std(scores))
bias.append(np.mean(mean_score))
variance_total.append(np.std(variance))
print("50 Folds: Mean - " + str(np.mean(mean_score)) + " | Variance - " + str(np
```

```
50 Folds: Mean - 0.5756046264442204 | Variance - 0.016212145750192245
```

In [16]:

```
mean_score = []
variance = []
best_svr = SVR(kernel='rbf')
for i in np.arange(1,100):
    scores = []
    cv = KFold(10, shuffle= True)
    for train_index, test_index in cv.split(X):
        X_train, X_test, y_train, y_test = X[train_index], X[test_index], y[trai
        best_svr.fit(X_train, y_train)
        scores.append(best_svr.score(X_test, y_test))
    mean_score.append(np.mean(scores))
    variance.append(np.std(scores))
bias.append(np.mean(mean_score))
variance_total.append(np.std(variance))
print("50 Folds: Mean - " + str(np.mean(mean_score)) + " | Variance - " + str(np
```

```
50 Folds: Mean - 0.5833956249966143 | Variance - 0.017251725110677237
```

In [17]:

```
mean_score = []
variance = []
best_svr = SVR(kernel='rbf')
for i in np.arange(1,100):
    scores = []
    cv = KFold(20, shuffle= True)
    for train_index, test_index in cv.split(X):
        X_train, X_test, y_train, y_test = X[train_index], X[test_index], y[trai
        best_svr.fit(X_train, y_train)
        scores.append(best_svr.score(X_test, y_test))
    mean_score.append(np.mean(scores))
    variance.append(np.std(scores))
bias.append(np.mean(mean_score))
variance_total.append(np.std(variance))
print("50 Folds: Mean - " + str(np.mean(mean_score)) + " | Variance - " + str(np
```

```
50 Folds: Mean - 0.5824509527907801 | Variance - 0.017676315213079788
```

In [18]:

```
mean_score = []
variance = []
best_svr = SVR(kernel='rbf')
for i in np.arange(1,100):
    scores = []
    cv = KFold(50, shuffle= True)
    for train_index, test_index in cv.split(X):
        X_train, X_test, y_train, y_test = X[train_index], X[test_index], y[trai
        best_svr.fit(X_train, y_train)
        scores.append(best_svr.score(X_test, y_test))
    mean_score.append(np.mean(scores))
    variance.append(np.std(scores))
bias.append(np.mean(mean_score))
variance_total.append(np.std(variance))
print("50 Folds: Mean - " + str(np.mean(mean_score)) + " | Variance - " + str(np
```

```
50 Folds: Mean - 0.5438518638280582 | Variance - 0.07102601150329856
```

In [19]:

```
mean_score = []
variance = []
best_svr = SVR(kernel='rbf')
for i in np.arange(1,100):
    scores = []
    cv = KFold(50, shuffle= True)
    for train_index, test_index in cv.split(X):
        X_train, X_test, y_train, y_test = X[train_index], X[test_index], y[trai
        best_svr.fit(X_train, y_train)
        scores.append(best_svr.score(X_test, y_test))
    mean_score.append(np.mean(scores))
    variance.append(np.std(scores))
bias.append(np.mean(mean_score))
variance_total.append(np.std(variance))
print("50 Folds: Mean - " + str(np.mean(mean_score)) + " | Variance - " + str(np
```

```
50 Folds: Mean - 0.5426904073913306 | Variance - 0.2241660726495882
```

In [20]:

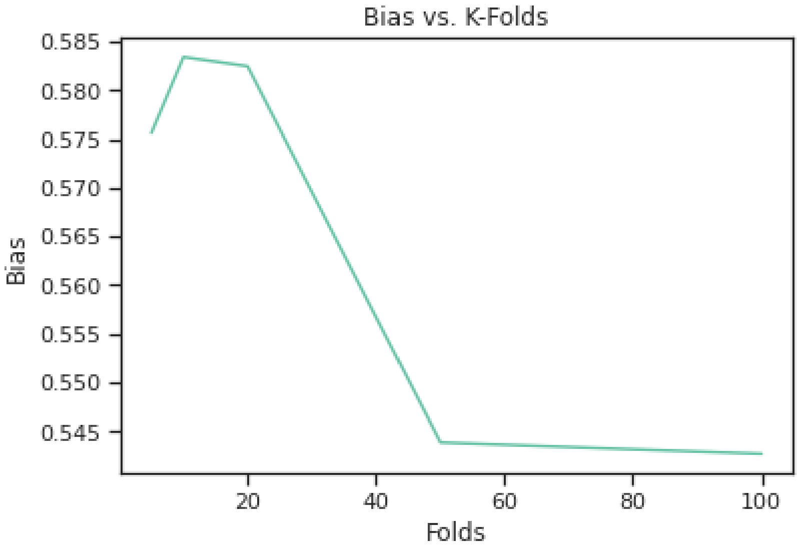
```
k = [5, 10, 20, 50, 100]
```

In [21]:

```
plt.plot(k, bias)
plt.title('Bias vs. K-Folds')
plt.xlabel('Folds')
plt.ylabel('Bias')
```

Out[21]:

```
Text(0, 0.5, 'Bias')
```

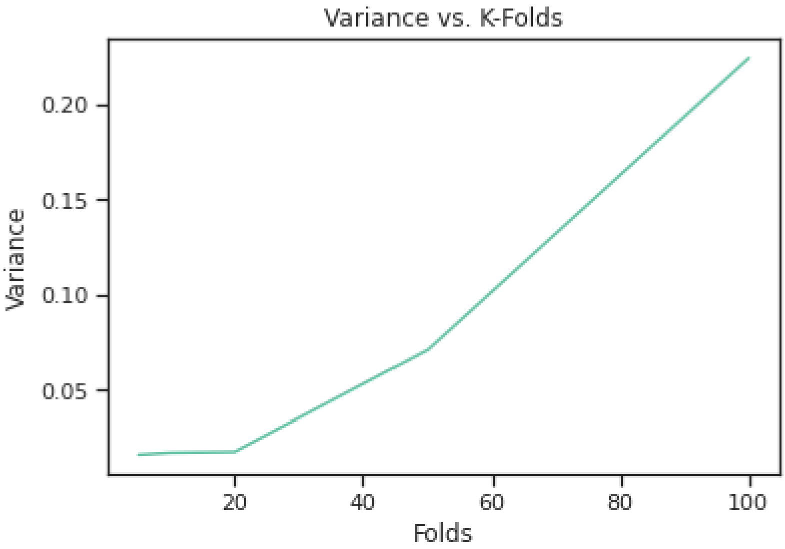


In [22]:

```
plt.plot(k, variance_total)
plt.title('Variance vs. K-Folds')
plt.xlabel('Folds')
plt.ylabel('Variance')
```

Out[22]:

```
Text(0, 0.5, 'Variance')
```



In [26]:

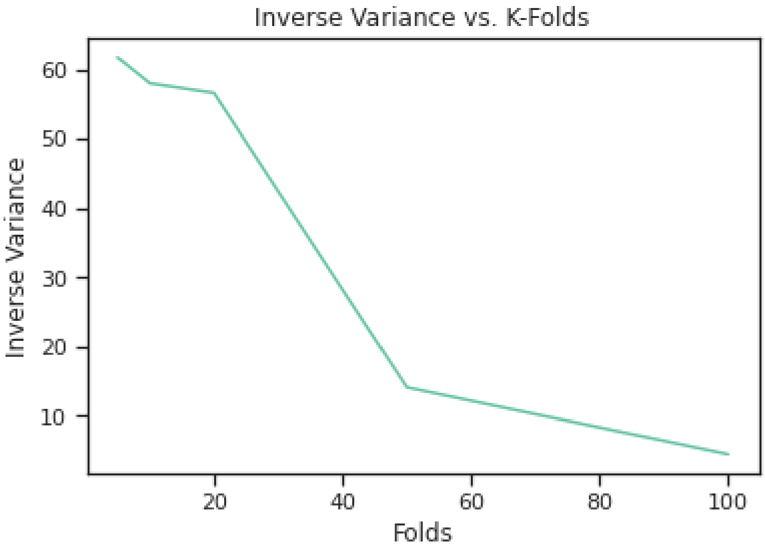
```
v = np.array(variance_total)
```

In [27]:

```
plt.plot(k, 1/v)
plt.title('Inverse Variance vs. K-Folds')
plt.xlabel('Folds')
plt.ylabel('Inverse Variance')
```

Out[27]:

```
Text(0, 0.5, 'Inverse Variance')
```



In [ ]:

```
# Looking at this simulation, it seems as though the claim that bias increases a
# However, in this graph, at a small K, our bias inccreases as we get larger rat
# This is also sometimes true with our Variance. During some iterations, we can
```