In [110]:
```
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 [111]:
```
read_file = pd.read_csv ('housing.data.txt', header = None, delim_whitespace=
True)
read_file.to_csv ('housing_data.csv', index=None)
```

In [112]:
```
housing = pd.read_csv('housing_data.csv')
```

In [113]:
```
X = housing.iloc[:, [0, 12]]
y = housing.iloc[:, 13]
```

In [114]:
```
scaler = MinMaxScaler(feature_range=(0, 1))
X = scaler.fit_transform(X)
```

In [115]:
```
bias = []
variance_total = []
```

In [116]:
```
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[tr
ain_index], y[test_index]
        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.std(variance)))
```

```
50 Folds: Mean - 0.5757919692524067 | Variance - 0.015795571237436613
```

In [117]:
```
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[tr
ain_index], y[test_index]
        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.std(variance)))
```

```
50 Folds: Mean - 0.5837544143067722 | Variance - 0.017280228900954188
```

In [118]:
```
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[tr
ain_index], y[test_index]
        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.std(variance)))
```

```
50 Folds: Mean - 0.5827062004494769 | Variance - 0.01598240009972824
```

In [119]:
```
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[tr
ain_index], y[test_index]
        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.std(variance)))
```

```
50 Folds: Mean - 0.5496511940752106 | Variance - 0.06057757606965267
```

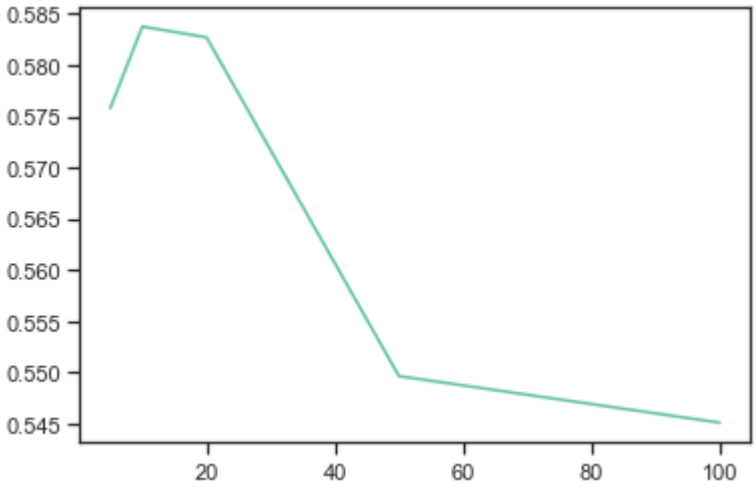
In [120]:
```
mean_score = []
variance = []
best_svr = SVR(kernel='rbf')
for i in np.arange(1,100):
    scores = []
    cv = KFold(50, shuffle= True)
    for train_index, test_index in cv.split(X):
        X_train, X_test, y_train, y_test = X[train_index], X[test_index], y[tr
ain_index], y[test_index]
        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.std(variance)))
```

```
50 Folds: Mean - 0.5451087037714807 | Variance - 0.09422791643167801
```

In [121]:
```
k = [5, 10, 20, 50, 100]
```

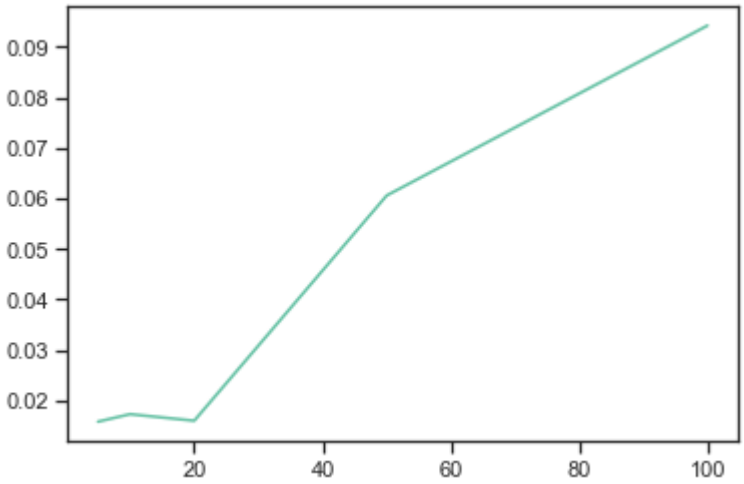
In [122]:
```
plt.plot(k, bias)
```

Out[122]:
```
[<matplotlib.lines.Line2D at 0x24e8144b370>]
```



In [132]:
```
plt.plot(k, variance_total)
```

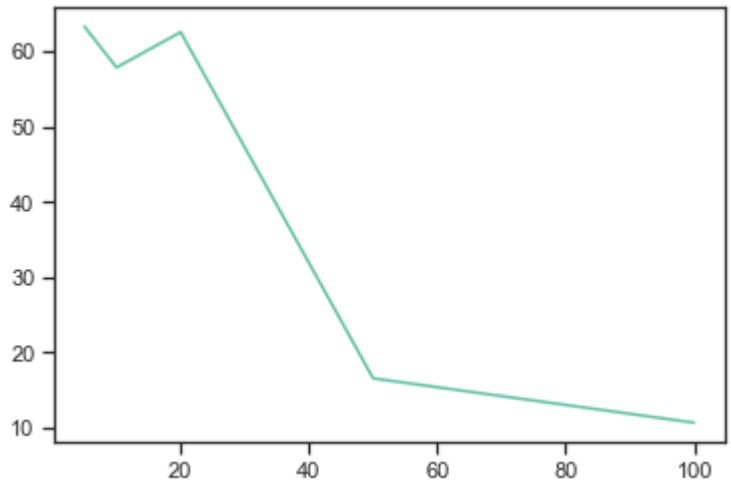
Out[132]:
```
[<matplotlib.lines.Line2D at 0x24e8165feb0>]
```



In [133]:
```
v = np.array(variance_total)
```

In [134]:
```
plt.plot(k, 1/v)
```

Out[134]:
```
[<matplotlib.lines.Line2D at 0x24e816b8a90>]
```



In [ ]:
```
# Looking at this simulation, it seems as though the claim that bias increases as variance decreases is true.
# However, in this graph, at a small K, our bias inccreases as we get larger rather than decreases.
# This is also true with our Variance. We can see that it decreases as we move from 10 to 20 folds before increasing.
```