In [1]:
```
# Update sklearn to prevent version mismatches
!pip install sklearn --upgrade
```

```
Requirement already up-to-date: sklearn in /Users/rselvanayagam/opt/anaconda3/envs/PythonAdv/lib/python3.
6/site-packages (0.0)
Requirement already satisfied, skipping upgrade: scikit-learn in /Users/rselvanayagam/opt/anaconda3/envs/P
ythonAdv/lib/python3.6/site-packages (from sklearn) (0.23.1)
Requirement already satisfied, skipping upgrade: threadpoolctl>=2.0.0 in /Users/rselvanayagam/opt/anaconda
3/envs/PythonAdv/lib/python3.6/site-packages (from scikit-learn->sklearn) (2.1.0)
Requirement already satisfied, skipping upgrade: numpy>=1.13.3 in /Users/rselvanayagam/opt/anaconda3/envs/
PythonAdv/lib/python3.6/site-packages (from scikit-learn->sklearn) (1.18.5)
Requirement already satisfied, skipping upgrade: joblib>=0.11 in /Users/rselvanayagam/opt/anaconda3/envs/P
ythonAdv/lib/python3.6/site-packages (from scikit-learn->sklearn) (0.15.1)
Requirement already satisfied, skipping upgrade: scipy>=0.19.1 in /Users/rselvanayagam/opt/anaconda3/envs/
PythonAdv/lib/python3.6/site-packages (from scikit-learn->sklearn) (1.5.0)
```

In [2]:
```
# install joblib. This will be used to save your model.
# Restart your kernel after installing
!pip install joblib
```

```
Requirement already satisfied: joblib in /Users/rselvanayagam/opt/anaconda3/envs/PythonAdv/lib/python3.6/s
ite-packages (0.15.1)
```

In [3]:
```
import numpy as np
import pandas as pd
```

In [4]:
```
import warnings
warnings.simplefilter('ignore')
```

Read the CSV and Perform Basic Data Cleaning

In [5]:
```
df = pd.read_csv("exoplanet_data.csv")
# Drop the null columns where all values are null
df = df.dropna(axis='columns', how='all')
# Drop the null rows
df = df.dropna()
df.head()
```

Out[5]:

	koi_disposition	koi_fpflag_nt	koi_fpflag_ss	koi_fpflag_co	koi_fpflag_ec	koi_period	koi_period_err1	koi_period_err2	koi_time0bk	koi_time0bk
0	CONFIRMED	0	0	0	0	54.418383	2.479000e-04	-2.479000e-04	162.513840	0.0
1	FALSE POSITIVE	0	1	0	0	19.899140	1.490000e-05	-1.490000e-05	175.850252	0.0
2	FALSE POSITIVE	0	1	0	0	1.736952	2.630000e-07	-2.630000e-07	170.307565	0.0
3	CONFIRMED	0	0	0	0	2.525592	3.760000e-06	-3.760000e-06	171.595550	0.0
4	CONFIRMED	0	0	0	0	4.134435	1.050000e-05	-1.050000e-05	172.979370	0.0

5 rows × 41 columns

In [6]:
```
# https://exoplanetarchive.ipac.caltech.edu/docs/API_kepcandidate_columns.html#stellar_param
df.columns
```

Out[6]:
```
Index(['koi_disposition', 'koi_fpflag_nt', 'koi_fpflag_ss', 'koi_fpflag_co',
       'koi_fpflag_ec', 'koi_period', 'koi_period_err1', 'koi_period_err2',
       'koi_time0bk', 'koi_time0bk_err1', 'koi_time0bk_err2', 'koi_impact',
       'koi_impact_err1', 'koi_impact_err2', 'koi_duration',
       'koi_duration_err1', 'koi_duration_err2', 'koi_depth', 'koi_depth_err1',
       'koi_depth_err2', 'koi_prad', 'koi_prad_err1', 'koi_prad_err2',
       'koi_teq', 'koi_insol', 'koi_insol_err1', 'koi_insol_err2',
       'koi_model_snr', 'koi_tce_plnt_num', 'koi_steff', 'koi_steff_err1',
       'koi_steff_err2', 'koi_slogg', 'koi_slogg_err1', 'koi_slogg_err2',
       'koi_srad', 'koi_srad_err1', 'koi_srad_err2', 'ra', 'dec',
       'koi_kepmag'],
      dtype='object')
```

In [7]:
```
Xtemp = df[['koi_fpflag_nt', 'koi_fpflag_ss', 'koi_fpflag_co', 'koi_fpflag_ec', 'koi_period','koi_time0bk','
Xtemp
```

Out[7]:

	koi_fpflag_nt	koi_fpflag_ss	koi_fpflag_co	koi_fpflag_ec	koi_period	koi_time0bk	koi_slogg	koi_srad	koi_impact	koi_duration	...	koi_
0	0	0	0	0	54.418383	162.513840	4.467	0.927	0.586	4.50700	...	
1	0	1	0	0	19.899140	175.850252	4.544	0.868	0.969	1.78220	...	1
2	0	1	0	0	1.736952	170.307565	4.564	0.791	1.276	2.40641	...	3
3	0	0	0	0	2.525592	171.595550	4.438	1.046	0.701	1.65450	...	
4	0	0	0	0	4.134435	172.979370	4.486	0.972	0.762	3.14020	...	
...	...	...	...	...	...	...	...	...	...	...	...	
6986	0	0	0	1	8.589871	132.016100	4.296	1.088	0.765	4.80600	...	
6987	0	1	1	0	0.527699	131.705093	4.529	0.903	1.252	3.22210	...	2
6988	0	0	0	0	1.739849	133.001270	4.444	1.031	0.043	3.11400	...	
6989	0	0	1	0	0.681402	132.181750	4.447	1.041	0.147	0.86500	...	
6990	0	0	1	1	4.856035	135.993300	4.385	1.193	0.134	3.07800	...	

6991 rows × 21 columns

In [8]:
```
data = df[['koi_disposition']]
data_binary_encoded = pd.get_dummies(data, columns=["koi_disposition"])
data_binary_encoded.columns = [["candidate","confirmed","false_positive"]]
y = data_binary_encoded
y
```

Out[8]:

	candidate	confirmed	false_positive
0	0	1	0
1	0	0	1
2	0	0	1
3	0	1	0
4	0	1	0
...	...	...	...
6986	0	0	1
6987	0	0	1
6988	1	0	0
6989	0	0	1
6990	0	0	1

6991 rows × 3 columns

In [9]:
```
from sklearn.ensemble import RandomForestClassifier
rf = RandomForestClassifier(n_estimators=200)
rf = rf.fit(Xtemp, y)
```

In [10]:
```
# Random Forests in sklearn will automatically calculate feature importance
importances = rf.feature_importances_
importances
```

Out[10]:
```
array([0.12178749, 0.09713193, 0.12334678, 0.04518292, 0.04071193,
       0.02590656, 0.0171137 , 0.01738939, 0.03999669, 0.03092709,
       0.05033517, 0.08650906, 0.03579343, 0.03145336, 0.1203928 ,
       0.02099363, 0.01637584, 0.01813813, 0.02049618, 0.01943367,
       0.02058426])
```

In [11]:
```
# We can sort the features by their importance
sorted(zip(rf.feature_importances_, Xtemp), reverse=True)
```

Out[11]:
```
[(0.12334677763503492, 'koi_fpflag_co'),
 (0.12178748530320883, 'koi_fpflag_nt'),
 (0.12039280419331896, 'koi_model_snr'),
 (0.09713192614077362, 'koi_fpflag_ss'),
 (0.0865090640050493 6, 'koi_prad'),
 (0.050335170037067826, 'koi_depth'),
 (0.04518292149834225, 'koi_fpflag_ec'),
 (0.0407119305424771, 'koi_period'),
 (0.039996688656071214, 'koi_impact'),
 (0.03579342714205082, 'koi_teq'),
 (0.031453355253225145, 'koi_insol'),
 (0.03092709418087506, 'koi_duration'),
 (0.025906561853095804, 'koi_time0bk'),
 (0.02099363291722159, 'koi_steff'),
 (0.02058425626266225, 'koi_kepmag'),
 (0.020496181321954698, 'ra'),
 (0.019433674250334276, 'dec'),
 (0.018138125427133493, 'koi_srad'),
 (0.017389388800643595, 'koi_srad'),
 (0.017113697892214234, 'koi_slogg'),
 (0.016375836687244908, 'koi_slogg')]
```

In [12]:
```
X = Xtemp.drop(columns=['ra','dec','koi_kepmag','koi_srad','koi_slogg'])
X
```

Out[12]:

	koi_fpflag_nt	koi_fpflag_ss	koi_fpflag_co	koi_fpflag_ec	koi_period	koi_time0bk	koi_impact	koi_duration	koi_depth	koi_prad	koi_teq	k
0	0	0	0	0	54.418383	162.513840	0.586	4.50700	874.8	2.83	443	
1	0	1	0	0	19.899140	175.850252	0.969	1.78220	10829.0	14.60	638	
2	0	1	0	0	1.736952	170.307565	1.276	2.40641	8079.2	33.46	1395	
3	0	0	0	0	2.525592	171.595550	0.701	1.65450	603.3	2.75	1406	
4	0	0	0	0	4.134435	172.979370	0.762	3.14020	686.0	2.77	1160	
...	...	...	...	...	...	...	...	...	...	...	...	
6986	0	0	0	1	8.589871	132.016100	0.765	4.80600	87.7	1.11	929	
6987	0	1	1	0	0.527699	131.705093	1.252	3.22210	1579.2	29.35	2088	
6988	0	0	0	0	1.739849	133.001270	0.043	3.11400	48.5	0.72	1608	
6989	0	0	1	0	0.681402	132.181750	0.147	0.86500	103.6	1.07	2218	
6990	0	0	1	1	4.856035	135.993300	0.134	3.07800	76.7	1.05	1266	

6991 rows × 14 columns

In [ ]:
```
```

Select your features (columns)

In [13]:
```
# Set features. This will also be used as your x values.
selected_features = X.columns
selected_features
```

Out[13]:
```
Index(['koi_fpflag_nt', 'koi_fpflag_ss', 'koi_fpflag_co', 'koi_fpflag_ec',
       'koi_period', 'koi_time0bk', 'koi_impact', 'koi_duration', 'koi_depth',
       'koi_prad', 'koi_teq', 'koi_insol', 'koi_model_snr', 'koi_steff'],
      dtype='object')
```

Create a Train Test Split

Use `koi_disposition` for the y values

In [14]:
```
from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X, y, random_state=42)
```

In [15]:
```
X_train.head()
```

Out[15]:

	koi_fpflag_nt	koi_fpflag_ss	koi_fpflag_co	koi_fpflag_ec	koi_period	koi_time0bk	koi_impact	koi_duration	koi_depth	koi_prad	koi_teq	k
6122	0	0	0	0	6.768901	133.077240	0.150	3.61600	123.1	1.24	1017	
6370	0	1	0	1	0.733726	132.020050	0.291	2.30900	114.6	0.86	1867	
2879	1	0	0	0	7.652707	134.460380	0.970	79.89690	641.1	3.21	989	
107	0	0	0	0	7.953547	174.662240	0.300	2.63120	875.4	2.25	696	
29	0	0	0	0	4.959319	172.258529	0.831	2.22739	9802.0	12.21	1103	

In [ ]:
```
```

Scale and Train the Model

In [16]:
```
# Create a StandardScater model and fit it to the training data
from sklearn.neighbors import KNeighborsClassifier
from sklearn.preprocessing import StandardScaler
X_scaler = StandardScaler().fit(X_train)
X_train_scaled = X_scaler.transform(X_train)
X_test_scaled = X_scaler.transform(X_test)
```

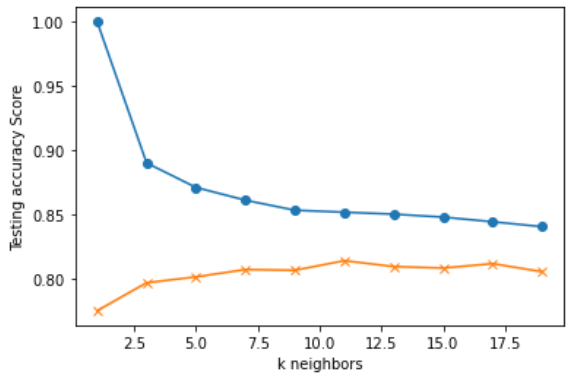
In [17]:
```
# Transform the training and testing data using the X_scaler and y_scaler models

X_train_scaled = X_scaler.transform(X_train)
X_test_scaled = X_scaler.transform(X_test)
```

In [18]:
```
# Loop through different k values to see which has the highest accuracy
train_scores = []
test_scores = []
for k in range(1, 20, 2):
    knn = KNeighborsClassifier(n_neighbors=k)
    knn.fit(X_train_scaled, y_train)
    train_score = knn.score(X_train_scaled, y_train)
    test_score = knn.score(X_test_scaled, y_test)
    train_scores.append(train_score)
    test_scores.append(test_score)
    print(f"k: {k}, Train/Test Score: {train_score:.3f}/{test_score:.3f}")

import matplotlib.pyplot as plt
plt.plot(range(1, 20, 2), train_scores, marker='o')
plt.plot(range(1, 20, 2), test_scores, marker="x")
plt.xlabel("k neighbors")
plt.ylabel("Testing accuracy Score")
plt.show()
```

```
k: 1, Train/Test Score: 1.000/0.775
k: 3, Train/Test Score: 0.890/0.797
k: 5, Train/Test Score: 0.871/0.801
k: 7, Train/Test Score: 0.861/0.807
k: 9, Train/Test Score: 0.853/0.807
k: 11, Train/Test Score: 0.852/0.814
k: 13, Train/Test Score: 0.850/0.809
k: 15, Train/Test Score: 0.848/0.808
k: 17, Train/Test Score: 0.844/0.812
k: 19, Train/Test Score: 0.841/0.805
```



In [19]:
```
# Note that k: 11 seems to be the best choice for this dataset
knn = KNeighborsClassifier(n_neighbors=11)
knn.fit(X_train_scaled, y_train)
print('k=11 Test Accuracy: %.3f' % knn.score(X_test_scaled, y_test))
```

```
k=11 Test Accuracy: 0.814
```

In [ ]:

Note: KNeighborsClassifier scored 81.4%