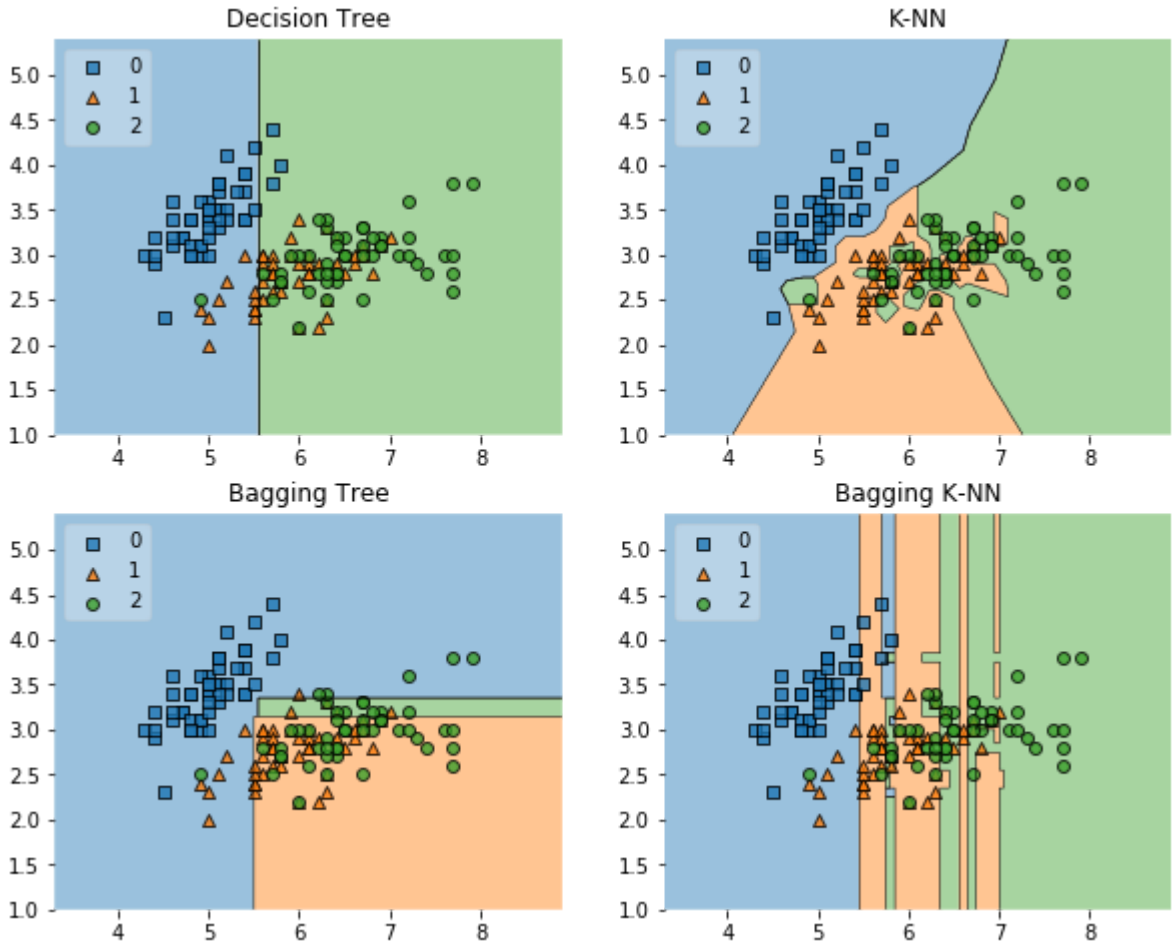
In [1]:
```
%matplotlib inline

import itertools
import numpy as np

import seaborn as sns
import matplotlib.pyplot as plt
import matplotlib.gridspec as gridspec

from sklearn import datasets

from sklearn.tree import DecisionTreeClassifier
from sklearn.neighbors import KNeighborsClassifier
from sklearn.linear_model import LogisticRegression
from sklearn.ensemble import RandomForestClassifier

from sklearn.ensemble import BaggingClassifier
from sklearn.model_selection import cross_val_score, train_test_split

from mlxtend.plotting import plot_learning_curves
from mlxtend.plotting import plot_decision_regions

np.random.seed(0)
```

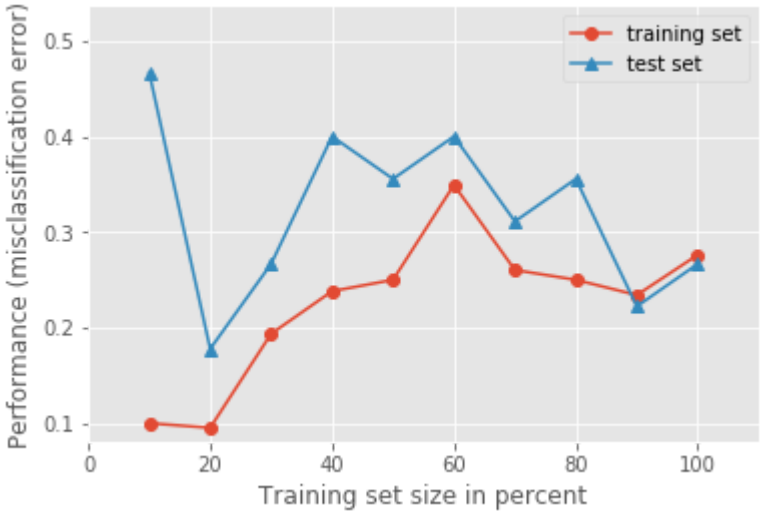
In [2]:
```
iris = datasets.load_iris()
X, y = iris.data[:, 0:2], iris.target

clf1 = DecisionTreeClassifier(criterion='entropy', max_depth=1)
clf2 = KNeighborsClassifier(n_neighbors=1)

bagging1 = BaggingClassifier(base_estimator=clf1, n_estimators=10, max_samples=0
bagging2 = BaggingClassifier(base_estimator=clf2, n_estimators=10, max_samples=0
```

In [4]:
```
label = ['Decision Tree', 'K-NN', 'Bagging Tree', 'Bagging K-NN']
clf_list = [clf1, clf2, bagging1, bagging2]

fig = plt.figure(figsize=(10, 8))
gs = gridspec.GridSpec(2, 2)
grid = itertools.product([0,1],repeat=2)

for clf, label, grd in zip(clf_list, label, grid):
    scores = cross_val_score(clf, X, y, cv=3, scoring='accuracy')
    print("Accuracy: %.2f (+/- %.2f) [%s]" %(scores.mean(), scores.std(), label))

    clf.fit(X, y)
    ax = plt.subplot(gs[grd[0], grd[1]])
    fig = plot_decision_regions(X=X, y=y, clf=clf, legend=2)
    plt.title(label)

plt.show()
```

```
Accuracy: 0.63 (+/- 0.02) [Decision Tree]
Accuracy: 0.70 (+/- 0.02) [K-NN]
Accuracy: 0.66 (+/- 0.02) [Bagging Tree]
Accuracy: 0.61 (+/- 0.02) [Bagging K-NN]
```

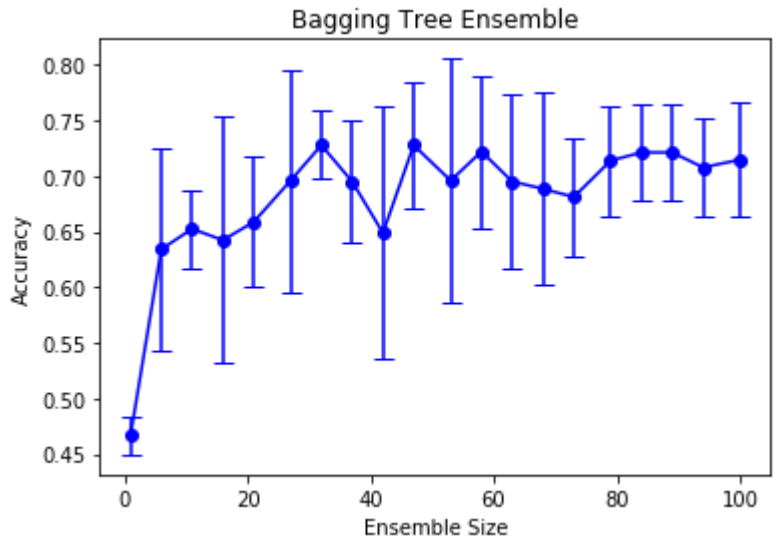


In [5]:
```
#plot learning curves
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_s

plt.figure()
plot_learning_curves(X_train, y_train, X_test, y_test, bagging1, print_model=Fals
plt.show()
```



In [8]:
```
#Ensemble Size
num_est = np.linspace(1,100,20).astype(int)
bg_clf_cv_mean = []
bg_clf_cv_std = []
for n_est in num_est:
    bg_clf = BaggingClassifier(base_estimator=clf1, n_estimators=n_est, max_samp
    scores = cross_val_score(bg_clf, X, y, cv=3, scoring='accuracy')
    bg_clf_cv_mean.append(scores.mean())
    bg_clf_cv_std.append(scores.std())
```

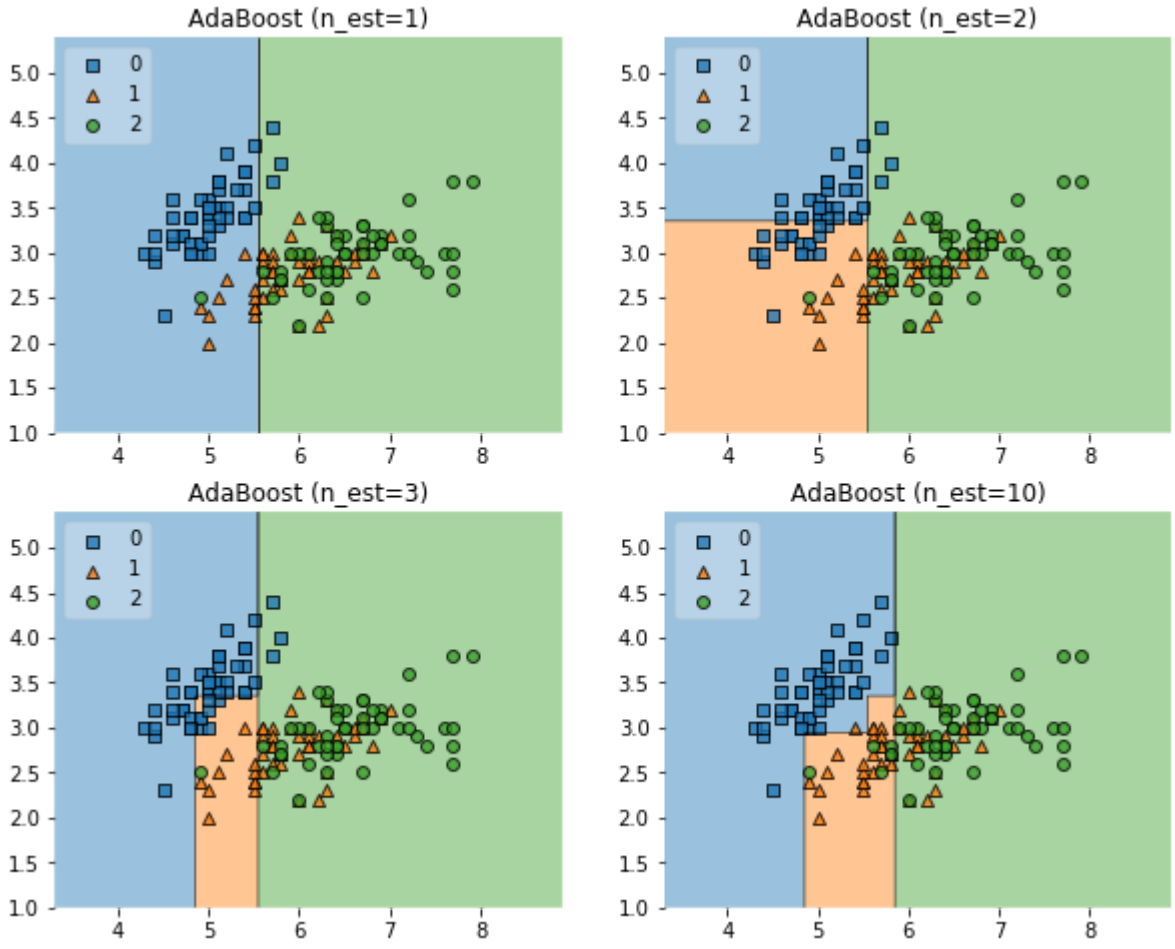
In [9]:
```
plt.figure()
(_, caps, _) = plt.errorbar(num_est, bg_clf_cv_mean, yerr=bg_clf_cv_std, c='blue
for cap in caps:
    cap.set_markeredgewidth(1)
plt.ylabel('Accuracy'); plt.xlabel('Ensemble Size'); plt.title('Bagging Tree Ens
plt.show()
```



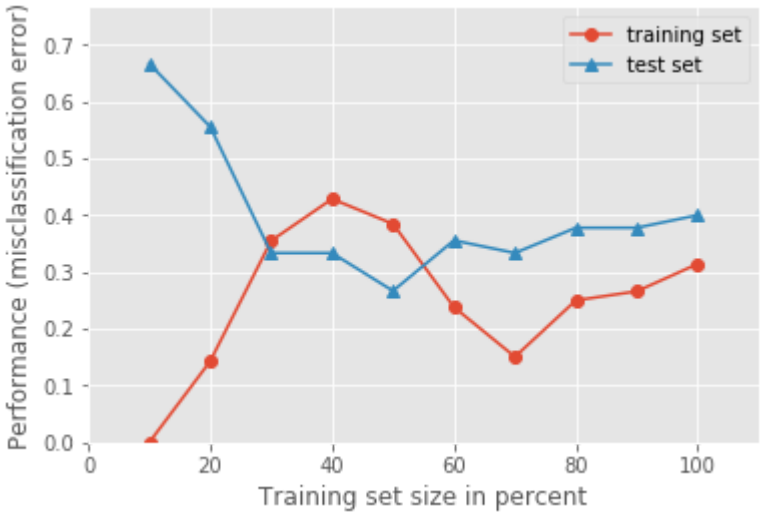
In [10]:
```
import itertools
import numpy as np

import seaborn as sns
import matplotlib.pyplot as plt
import matplotlib.gridspec as gridspec

from sklearn import datasets

from sklearn.tree import DecisionTreeClassifier
from sklearn.neighbors import KNeighborsClassifier
from sklearn.linear_model import LogisticRegression

from sklearn.ensemble import AdaBoostClassifier
from sklearn.model_selection import cross_val_score, train_test_split

from mlxtend.plotting import plot_learning_curves
from mlxtend.plotting import plot_decision_regions
```

In [11]:
```
iris = datasets.load_iris()
X, y = iris.data[:, 0:2], iris.target

#XOR dataset
#X = np.random.randn(200, 2)
#y = np.array(map(int,np.logical_xor(X[:, 0] > 0, X[:, 1] > 0)))

clf = DecisionTreeClassifier(criterion='entropy', max_depth=1)

num_est = [1, 2, 3, 10]
label = ['AdaBoost (n_est=1)', 'AdaBoost (n_est=2)', 'AdaBoost (n_est=3)', 'AdaB
```

In [12]:
```
fig = plt.figure(figsize=(10, 8))
gs = gridspec.GridSpec(2, 2)
grid = itertools.product([0,1],repeat=2)

for n_est, label, grd in zip(num_est, label, grid):
    boosting = AdaBoostClassifier(base_estimator=clf, n_estimators=n_est)
    boosting.fit(X, y)
    ax = plt.subplot(gs[grd[0], grd[1]])
    fig = plot_decision_regions(X=X, y=y, clf=boosting, legend=2)
    plt.title(label)

plt.show()
```

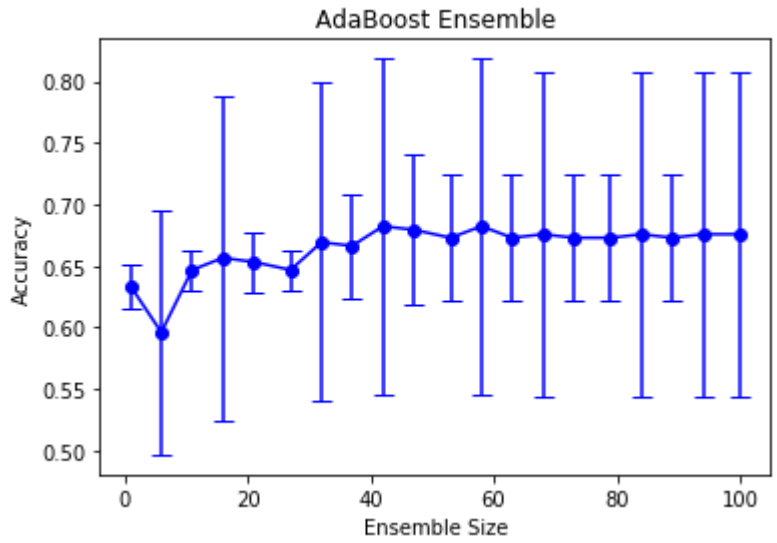


In [13]:
```
#plot learning curves
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_s

boosting = AdaBoostClassifier(base_estimator=clf, n_estimators=10)

plt.figure()
plot_learning_curves(X_train, y_train, X_test, y_test, boosting, print_model=Fals
plt.show()
```



In [16]:
```
#Ensemble Size
num_est = np.linspace(1,100,20).astype(int)
bg_clf_cv_mean = []
bg_clf_cv_std = []
for n_est in num_est:
    ada_clf = AdaBoostClassifier(base_estimator=clf, n_estimators=n_est)
    scores = cross_val_score(ada_clf, X, y, cv=3, scoring='accuracy')
    bg_clf_cv_mean.append(scores.mean())
    bg_clf_cv_std.append(scores.std())
```

In [17]:
```
plt.figure()
(_, caps, _) = plt.errorbar(num_est, bg_clf_cv_mean, yerr=bg_clf_cv_std, c='blue
for cap in caps:
    cap.set_markeredgewidth(1)
plt.ylabel('Accuracy'); plt.xlabel('Ensemble Size'); plt.title('AdaBoost Ensembl
plt.show()
```



In [18]:
```
import itertools
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
import matplotlib.gridspec as gridspec

from sklearn import datasets

from sklearn.linear_model import LogisticRegression
from sklearn.neighbors import KNeighborsClassifier
from sklearn.naive_bayes import GaussianNB
from sklearn.ensemble import RandomForestClassifier
from mlxtend.classifier import StackingClassifier

from sklearn.model_selection import cross_val_score, train_test_split

from mlxtend.plotting import plot_learning_curves
from mlxtend.plotting import plot_decision_regions
```

In [19]:
```
iris = datasets.load_iris()
X, y = iris.data[:, 1:3], iris.target

clf1 = KNeighborsClassifier(n_neighbors=1)
clf2 = RandomForestClassifier(random_state=1)
clf3 = GaussianNB()
lr = LogisticRegression()
sclf = StackingClassifier(classifiers=[clf1, clf2, clf3],
                          meta_classifier=lr)
```

In [21]:
```
label = ['KNN', 'Random Forest', 'Naive Bayes', 'Stacking Classifier']
clf_list = [clf1, clf2, clf3, sclf]

fig = plt.figure(figsize=(10,8))
gs = gridspec.GridSpec(2, 2)
grid = itertools.product([0,1],repeat=2)

clf_cv_mean = []
clf_cv_std = []
for clf, label, grd in zip(clf_list, label, grid):

    scores = cross_val_score(clf, X, y, cv=3, scoring='accuracy')
    print("Accuracy: %.2f (+/- %.2f) [%s]" %(scores.mean(), scores.std(), label)
    clf_cv_mean.append(scores.mean())
    clf_cv_std.append(scores.std())

    clf.fit(X, y)
    ax = plt.subplot(gs[grd[0], grd[1]])
    fig = plot_decision_regions(X=X, y=y, clf=clf)
    plt.title(label)

plt.show()
```

```
Accuracy: 0.91 (+/- 0.01) [KNN]

c:\users\mglewis\appdata\local\programs\python\python37\lib\site-packages\sklea
rn\ensemble\forest.py:246: FutureWarning: The default value of n_estimators wil
l change from 10 in version 0.20 to 100 in 0.22.
  "10 in version 0.20 to 100 in 0.22.", FutureWarning)
c:\users\mglewis\appdata\local\programs\python\python37\lib\site-packages\sklea
rn\ensemble\forest.py:246: FutureWarning: The default value of n_estimators wil
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  "10 in version 0.20 to 100 in 0.22.", FutureWarning)
c:\users\mglewis\appdata\local\programs\python\python37\lib\site-packages\sklea
rn\ensemble\forest.py:246: FutureWarning: The default value of n_estimators wil
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  "10 in version 0.20 to 100 in 0.22.", FutureWarning)
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rn\ensemble\forest.py:246: FutureWarning: The default value of n_estimators wil
l change from 10 in version 0.20 to 100 in 0.22.
  "10 in version 0.20 to 100 in 0.22.", FutureWarning)

Accuracy: 0.93 (+/- 0.05) [Random Forest]
Accuracy: 0.92 (+/- 0.03) [Naive Bayes]

c:\users\mglewis\appdata\local\programs\python\python37\lib\site-packages\sklea
rn\linear_model\logistic.py:433: FutureWarning: Default solver will be changed
to 'lbfgs' in 0.22. Specify a solver to silence this warning.
  FutureWarning)
c:\users\mglewis\appdata\local\programs\python\python37\lib\site-packages\sklea
rn\linear_model\logistic.py:460: FutureWarning: Default multi_class will be cha
nged to 'auto' in 0.22. Specify the multi_class option to silence this warning.
  "this warning.", FutureWarning)
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rn\linear_model\logistic.py:433: FutureWarning: Default solver will be changed
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  FutureWarning)
```

```
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  FutureWarning)
c:\users\mglewis\appdata\local\programs\python\python37\lib\site-packages\sklea
rn\linear_model\logistic.py:460: FutureWarning: Default multi_class will be cha
nged to 'auto' in 0.22. Specify the multi_class option to silence this warning.
  "this warning.", FutureWarning)

Accuracy: 0.95 (+/- 0.03) [Stacking Classifier]
```
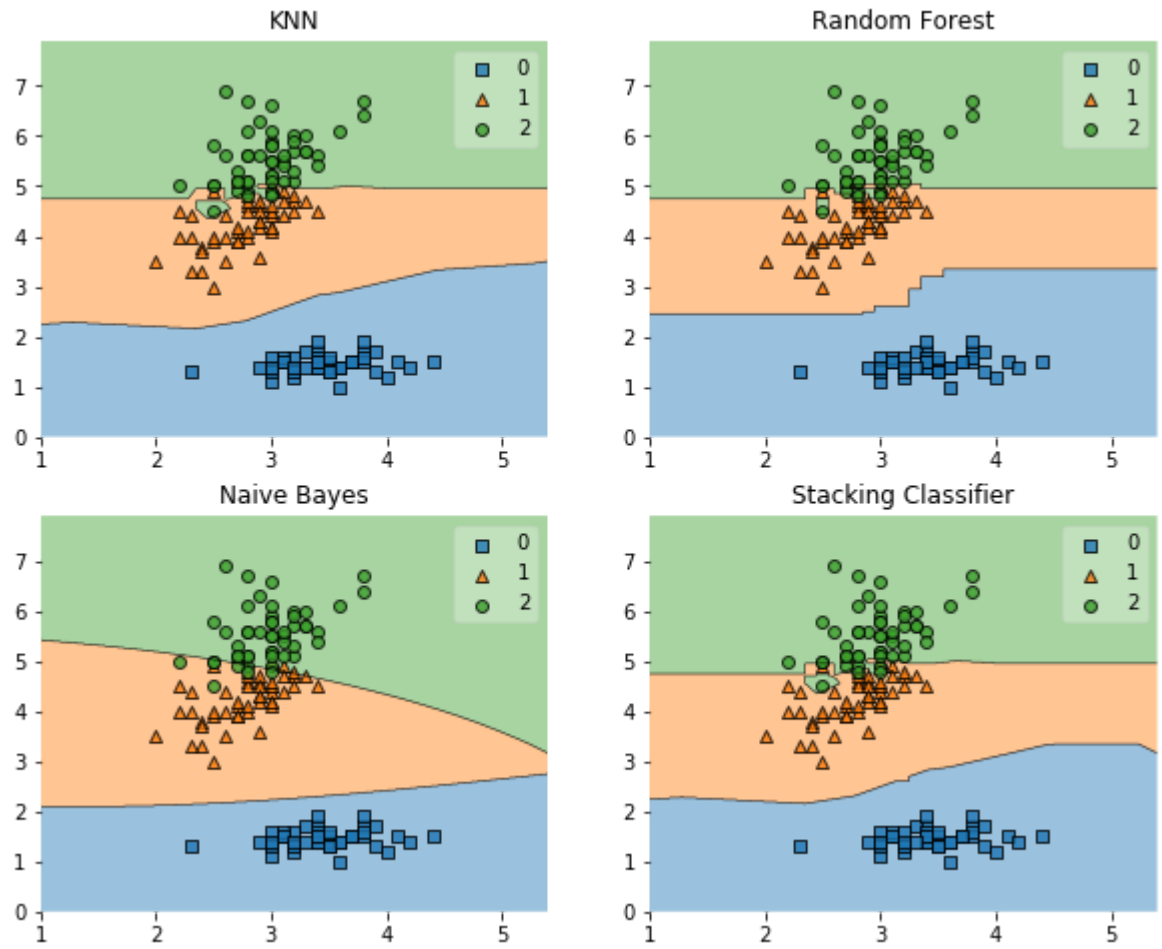
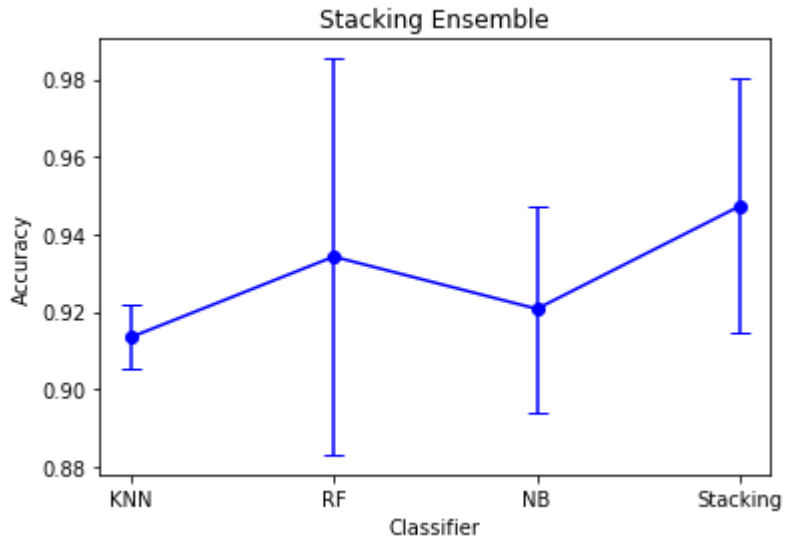



In [22]:
```
#plot classifier accuracy
plt.figure()
(_, caps, _) = plt.errorbar(range(4), clf_cv_mean, yerr=clf_cv_std, c='blue', fm
for cap in caps:
    cap.set_markeredgewidth(1)
plt.xticks(range(4), ['KNN', 'RF', 'NB', 'Stacking'])
plt.ylabel('Accuracy'); plt.xlabel('Classifier'); plt.title('Stacking Ensemble')
plt.show()
```



In [23]:

```
#plot learning curves
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_s

plt.figure()
plot_learning_curves(X_train, y_train, X_test, y_test, sclf, print_model=False, s
plt.show()
```

```
c:\users\mglewis\appdata\local\programs\python\python37\lib\site-packages\sklea
rn\linear_model\logistic.py:433: FutureWarning: Default solver will be changed
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c:\users\mglewis\appdata\local\programs\python\python37\lib\site-packages\sklea
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c:\users\mglewis\appdata\local\programs\python\python37\lib\site-packages\sklea
```

```
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  FutureWarning)
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  "this warning.", FutureWarning)
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  "this warning.", FutureWarning)
c:\users\mglewis\appdata\local\programs\python\python37\lib\site-packages\sklea
rn\linear_model\logistic.py:433: FutureWarning: Default solver will be changed
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  FutureWarning)
c:\users\mglewis\appdata\local\programs\python\python37\lib\site-packages\sklea
rn\linear_model\logistic.py:460: FutureWarning: Default multi_class will be cha
nged to 'auto' in 0.22. Specify the multi_class option to silence this warning.
  "this warning.", FutureWarning)
```

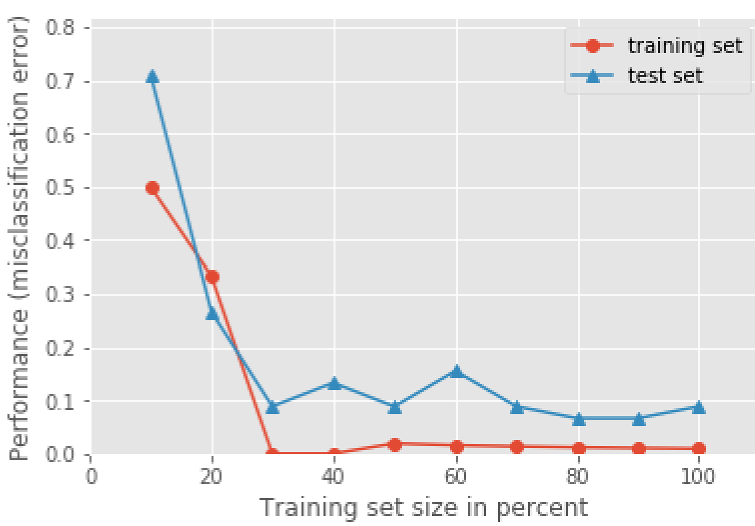

In [ ]: