In [1]:

```
import numpy as np
from sklearn.neural_network import MLPClassifier
from sklearn.model_selection import train_test_split as splitter
from sklearn.model_selection import KFold
from sklearn.preprocessing import StandardScaler
from sklearn.metrics import mean_squared_error as mse
import sklearn.metrics as metrics
from scipy import interp
import matplotlib.pyplot as plt
from sklearn.metrics import confusion_matrix as confusion

features = np.genfromtxt("./Aggregated_Data.csv", delimiter=",", useco
ls=(1, 3, 4, 5))
target = np.genfromtxt("./Aggregated_Data.csv", delimiter=",", usecols
=8)
X = np.delete(features,[0], axis=0)
Y = np.delete(target, [0], axis=0)

# split data into train/test sets
x_train, x_test, y_train, y_test = splitter(X, Y, test_size=0.25, rand
om_state=0)

# scale the data, which is 'highly recommended' for MLP
scaler = StandardScaler()
scaler.fit(x_train)
x_train = scaler.transform(x_train)
x_test = scaler.transform(x_test)

# init and fit the model
network = MLPClassifier(solver='lbfgs', alpha=1e-5, hidden_layer_sizes
=(3,), random_state=0, shuffle=True)
network.fit(x_train, y_train)

# score on test data
score = network.score(x_test, y_test)
print(score)

#looked at this: https://scikit-learn.org/stable/modules/neural_networ
ks_supervised.html
#and this: https://scikit-learn.org/stable/modules/generated/sklearn.n
eural_network.MLPClassifier.html#sklearn.neural_network.MLPClassifier
```

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0.952
```

In [2]:
```
x_train, x_test, y_train, y_test = splitter(X, Y, test_size=0.25, rand
om_state=0)

def cv(neuron_count, folds):
    kf = KFold(n_splits=folds, shuffle=False)
    err = []

    for train_idx, test_idx in kf.split(x_train, y_train):
        xtr_cv, xte_cv = x_train[train_idx], x_train[test_idx]
        ytr_cv, yte_cv = y_train[train_idx], y_train[test_idx]

        s = StandardScaler().fit(xtr_cv)
        xtr_cv = s.transform(xtr_cv)
        xte_cv = s.transform(xte_cv)

        classifier = MLPClassifier(solver='lbfgs', alpha=1e-5, hidden_
layer_sizes=(neuron_count,), random_state=0, shuffle=True)
        classifier.fit(xtr_cv, ytr_cv)
        yte_pred = classifier.predict(xte_cv)
        err.append(mse(yte_pred, yte_cv))

    return np.mean(err)

neuron_counts = [3, 5, 10, 20, 35, 60, 100]
cv_err = []
for num in neuron_counts:
    cv_err.append(cv(num, 5))

# rescale data after CV
x_train = scaler.transform(x_train)
x_test = scaler.transform(x_test)

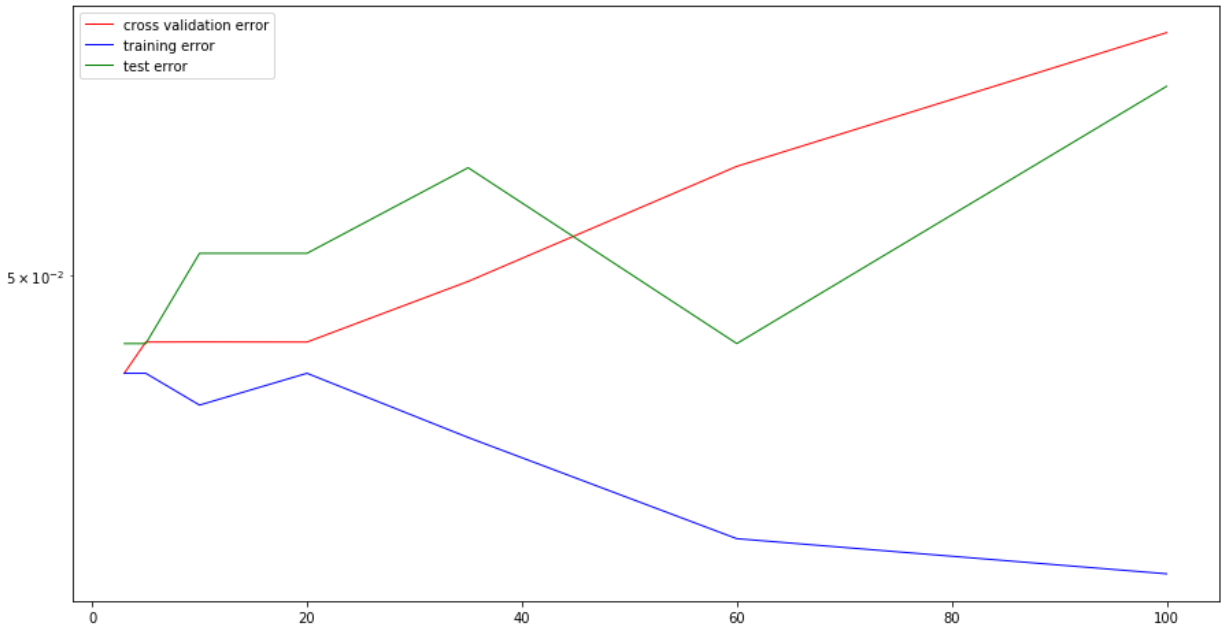

# calculate train/test error for various neuron count
train_err = []
test_err = []
for num in neuron_counts:
    n = MLPClassifier(solver='lbfgs', alpha=1e-5, hidden_layer_sizes=(
num,), random_state=0, shuffle=True)
    n.fit(x_train, y_train)

    tr_pred = n.predict(x_train)
    te_pred = n.predict(x_test)

    train_err.append(mse(tr_pred, y_train))
    test_err.append(mse(te_pred, y_test))

plt.rcParams['figure.figsize'] = (15.0, 8.0)
plt.semilogy(neuron_counts, cv_err, 'r', neuron_counts, train_err, 'b'
, neuron_counts, test_err, 'g', linewidth=1)
plt.legend(['cross validation error', 'training error', 'test error'],
loc='upper left')
```

Out[2]: <matplotlib.legend.Legend at 0x1a17447828>




In [ ]:

In [3]:

```
def plot_confusion_matrix(matrix, title, color):

    plt.rcParams['figure.figsize'] = (5.0, 5.0)

    fig = plt.figure()
    ax = fig.add_subplot(111)
    cax = ax.matshow(matrix)
    plt.title(title)
    #fig.colorbar(cax)

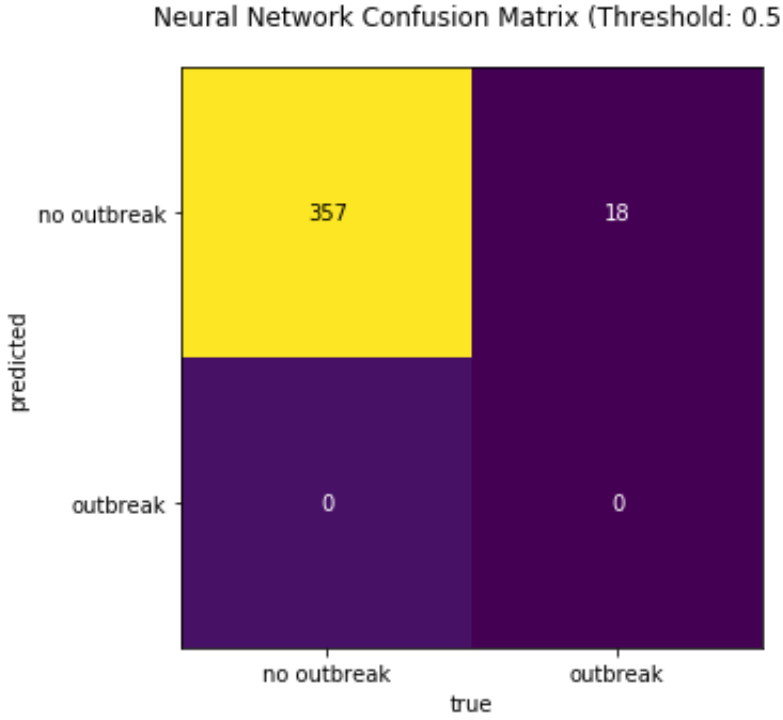
    ax.xaxis.tick_bottom()
    labels = ['no outbreak', 'outbreak']
    ax.set_xticklabels([''] + labels)
    ax.set_yticklabels([''] + labels)
    plt.xlabel('true')
    plt.ylabel('predicted')

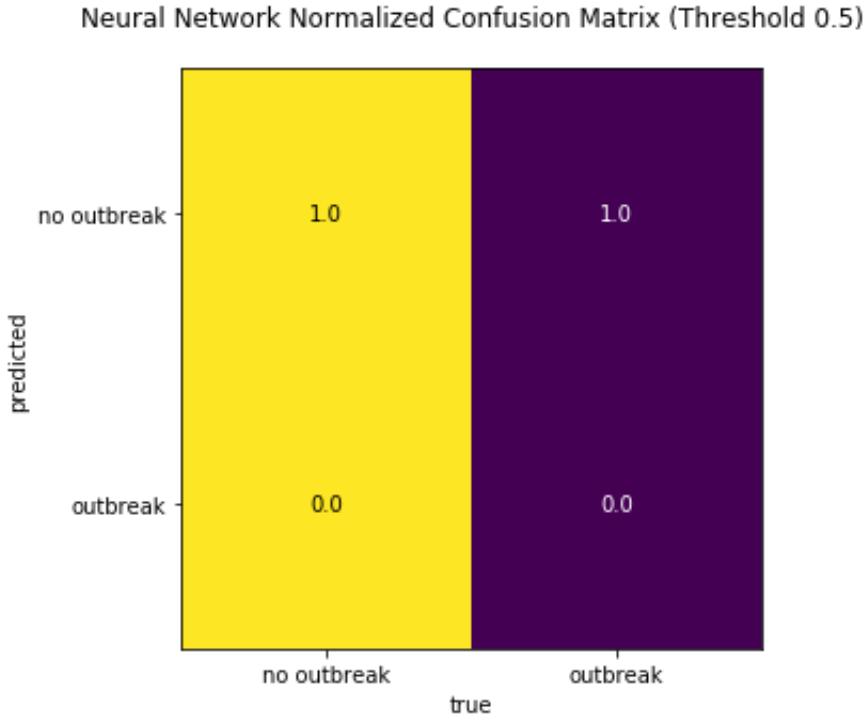
    plt.text(0, 0, str(matrix[0][0]), horizontalalignment="center", ve
rticalalignment="center" ,color="black")
    plt.text(0, 1, str(matrix[0][1]), horizontalalignment="center", ve
rticalalignment="center" ,color=color)
    plt.text(1, 0, str(matrix[1][0]), horizontalalignment="center", ve
rticalalignment="center" ,color="white")
    plt.text(1, 1, str(matrix[1][1]), horizontalalignment="center", ve
rticalalignment="center" ,color="white")
    plt.show()

    #print('true negatives: {}'.format(matrix[0][0]))
    #print('false positive: {}'.format(matrix[0][1]))
    #print('false negatives: {}'.format(matrix[1][0]))
    #print('true positive: {}'.format(matrix[1][1]))

prediction = network.predict(x_test)
matrix = confusion(y_test, prediction, [0,1])
norm = matrix.astype('float') / matrix.sum(axis=1)[:, np.newaxis]
plot_confusion_matrix(matrix, "Neural Network Confusion Matrix (Thresh
old: 0.5)", "white")
plot_confusion_matrix(norm, "Neural Network Normalized Confusion Matri
x (Threshold 0.5)", "black")

#used this:https://scikit-learn.org/stable/modules/generated/sklearn.m
etrics.confusion_matrix.html
#and this:https://stackoverflow.com/questions/19233771/sklearn-plot-co
nfusion-matrix-with-labels/48018785
```


Neural Network Confusion Matrix (Threshold: 0.5)
no outbreak
outbreak
predicted
357
18
0
0
no outbreak
outbreak
true


Neural Network Normalized Confusion Matrix (Threshold 0.5)
no outbreak
outbreak
predicted
1.0
1.0
0.0
0.0
no outbreak
outbreak
true

```
---------------------------------------------------------------------
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TypeError                                 Traceback (most recent cal
l last)
<ipython-input-3-2262f587a53b> in <module>
     32 plot_confusion_matrix(matrix, "Neural Network Confusion Matr
ix (Threshold: 0.5)", "white")
     33 plot_confusion_matrix(norm, "Neural Network Normalized Confu
sion Matrix (Threshold 0.5)", "black")
---> 34 plot_confusion_matrix()

TypeError: plot_confusion_matrix() missing 3 required positional arg
uments: 'matrix', 'title', and 'color'
```

In [ ]:

```
def plot_roc():
    probs = network.predict_proba(x_test)[:,1]
    fpr, tpr, thresh = metrics.roc_curve(y_test, probs)
    auc = metrics.auc(fpr, tpr)

    plt.plot(fpr, tpr, c='r', label='AUC: {}'.format(auc))
    plt.ylabel('true positive rate')
    plt.xlabel('false positive rate')

    plt.legend()
    plt.show()

plot_roc()

#looked at this for roc:https://scikit-learn.org/stable/modules/genera
ted/sklearn.metrics.roc_curve.html
```