Problem 2

b

In [1]:
```
import numpy as np
from scipy.io import loadmat
import matplotlib.pyplot as plt
from sklearn.svm import LinearSVC

X = np.array([[2,1],[1.5,1],[0.5,1],[-0.5,1]])
y = np.array([[1],[1],[-1],[-1]])

wLS = np.linalg.inv(X.T@X)@X.T@y
print("weight vector :")
print(wLS)

yout = np.sign(X@wLS)

print("y obtained from wLS :")
print(yout)
print("element matching of yout and y :")
print(yout==y)
```

```
weight vector :
[[ 0.94915254]
 [-0.83050847]]
y obtained from wLS :
[[ 1.]
 [ 1.]
 [-1.]
 [-1.]]
element matching of yout and y :
[[ True]
 [ True]
 [ True]
 [ True]]
```

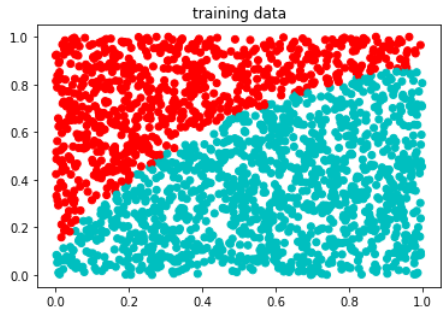
d

In [2]:
```
X = np.array([[2,1],[1.5,1],[0.5,1],[4,1]])
y = np.array([[1],[1],[-1],[-1]])

wLS = np.linalg.inv(X.T@X)@X.T@y
print("weight vector :")
print(wLS)

yout = np.sign(X@wLS)

print("y obtained from wLS :")
print(yout)
print("element matching of yout and y :")
print(yout==y)
```

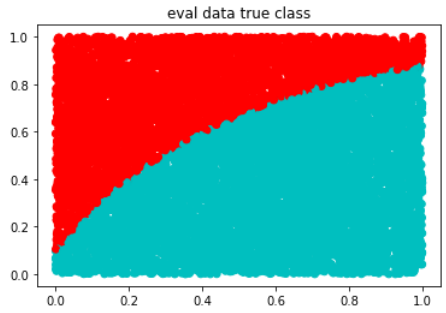
```
weight vector :
[[-0.15384615]
 [ 0.30769231]]
y obtained from wLS :
[[ 0.]
 [ 1.]
 [ 1.]
 [-1.]]
element matching of yout and y :
[[False]
 [ True]
 [False]
 [ True]]
```

Problem 3

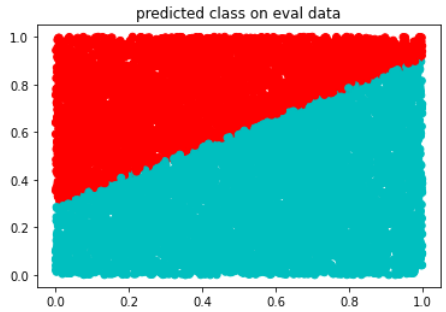
In [3]:
```
in_data = loadmat('classifier_data.mat')

x_train = in_data['x_train']
x_eval = in_data['x_eval']
y_train = in_data['y_train']
y_eval = in_data['y_eval']

n_eval = np.size(y_eval)
n_train = np.size(y_train)

plt.scatter(x_train[:,0],x_train[:,1], color=['c' if i==-1 else 'r' for i in y_train[:,0]])
plt.title('training data')
plt.show()
```



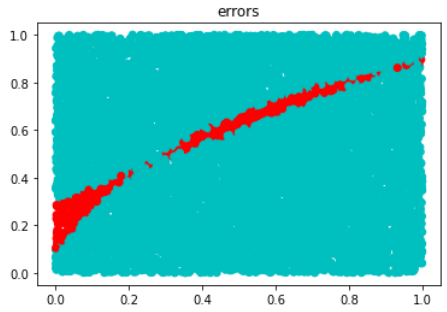
In [4]:
```
plt.scatter(x_eval[:,0],x_eval[:,1], color=['c' if i==-1 else 'r' for i in y_eval[:,0]])
plt.title('eval data true class')
plt.show()
```



In [5]:
```
## Classifier 1
x_train_1 = np.hstack(( x_train, np.ones((n_train,1)) ))
x_eval_1 = np.hstack(( x_eval, np.ones((n_eval,1)) ))

# Train classifier using linear SVM from SK Learn library
clf = LinearSVC(random_state=0, tol=1e-8)
clf.fit(x_train_1, np.squeeze(y_train))
w_opt = clf.coef_.transpose()

#uncomment this line to use least squares classifier
w_opt = np.linalg.inv(x_train_1.T@x_train_1)@x_train_1.T@y_train

y_hat_outlier = np.sign(x_eval_1@w_opt)
plt.scatter(x_eval[:,0],x_eval[:,1], color=['c' if i==-1 else 'r' for i in y_hat_outlier[:,0]])
plt.title('predicted class on eval data')
plt.show()
```



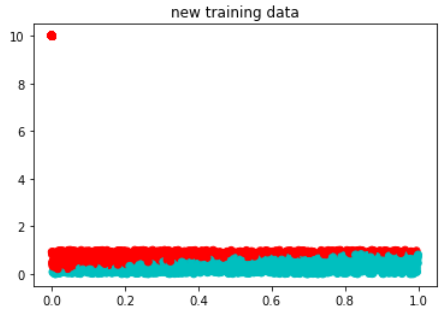
In [6]:
```
error_vec = [0 if i[0]==i[1] else 1 for i in np.hstack((y_hat_outlier, y_eval))]
plt.scatter(x_eval[:,0],x_eval[:,1], color=['c' if i==0 else 'r' for i in error_vec])
plt.title('errors')
plt.show()

print('Errors: '+ str(sum(error_vec)))
```



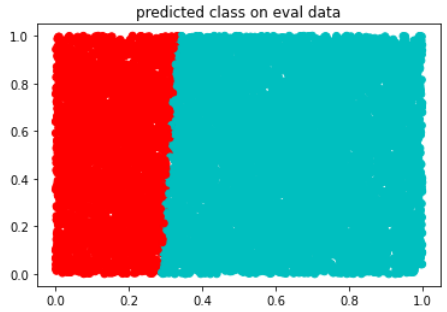

```
Errors: 495
```

Add correct points far from boundary

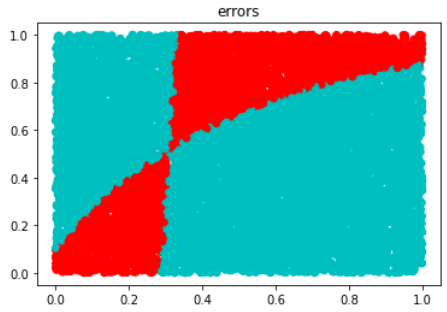
In [7]:
```
## create new, correctly labeled points
n_new = 1000 #number of new datapoints
x_train_new = np.hstack((np.zeros((n_new,1)), 10*np.ones((n_new,1))))
y_train_new = np.ones((n_new,1))

## add these to the training data
x_train_outlier = np.vstack((x_train,x_train_new))
y_train_outlier = np.vstack((y_train,y_train_new))
plt.scatter(x_train_outlier[:,0],x_train_outlier[:,1], color=['c' if i==-1 else 'r' for i in y_train_outlier[:,0]])
plt.title('new training data')
plt.show()
```



In [8]:
```
x_train_outlier_1 = np.hstack((x_train_outlier, np.ones((n_train+n_new,1)) ))
x_eval_1 = np.hstack((x_eval, np.ones((n_eval,1)) ))

#Train classifier using off the shelf SVM from sklearn
clf = LinearSVC(random_state=0, tol=1e-5)
clf.fit(x_train_outlier_1, np.squeeze(y_train_outlier))
w_opt_outlier = clf.coef_.transpose()

#uncomment this line to use least squares classifier
w_opt_outlier = np.linalg.inv(x_train_outlier_1.T@x_train_outlier_1)@x_train_outlier_1.T@y_train_outlier

y_hat_outlier = np.sign(x_eval_1@w_opt_outlier)
plt.scatter(x_eval[:,0],x_eval[:,1], color=['c' if i==-1 else 'r' for i in y_hat_outlier[:,0]])
plt.title('predicted class on eval data')
plt.show()
```



In [9]:
```
error_vec = [0 if i[0]==i[1] else 1 for i in np.hstack((y_hat_outlier, y_eval))]
plt.scatter(x_eval[:,0],x_eval[:,1], color=['c' if i==0 else 'r' for i in error_vec])
plt.title('errors')
plt.show()

print('Errors: '+ str(sum(error_vec)))
```




```
Errors: 2668
```

In [ ]: