In [14]:
```
from sklearn.neural_network import MLPClassifier
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler

import numpy as np
import matplotlib.pyplot as plt
seed = 1234
np.random.seed(seed)
```

In [15]:
```
def unpickle(file):
    import pickle
    with open(file, 'rb') as fo:
        dict = pickle.load(fo, encoding='bytes')
    return dict
```

In [17]:
```
# read file get X, y, testing X, testing y
original = unpickle("cifar-10-batches-py/data_batch_1")
Label_names = unpickle("cifar-10-batches-py/batches.meta")
y = original[b'labels']
X = original[b'data']
test_data = unpickle("cifar-10-batches-py/test_batch")
X_te = test_data[b'data']
y_te = test_data[b'labels']
# print(X_te)
```

In [18]:
```
# regulate X and testing X
scaler = StandardScaler()
scaler.fit(X)

X = scaler.transform(X)
X_te= scaler.transform(X_te)
```

In [19]:
```
# seperate X to training data X_tr, y_tr and validating data X_val, y_val
X_tr, y_tr = X[:5000], y[:5000]
X_val, y_val = X[5000:10000], y[5000:10000]
```

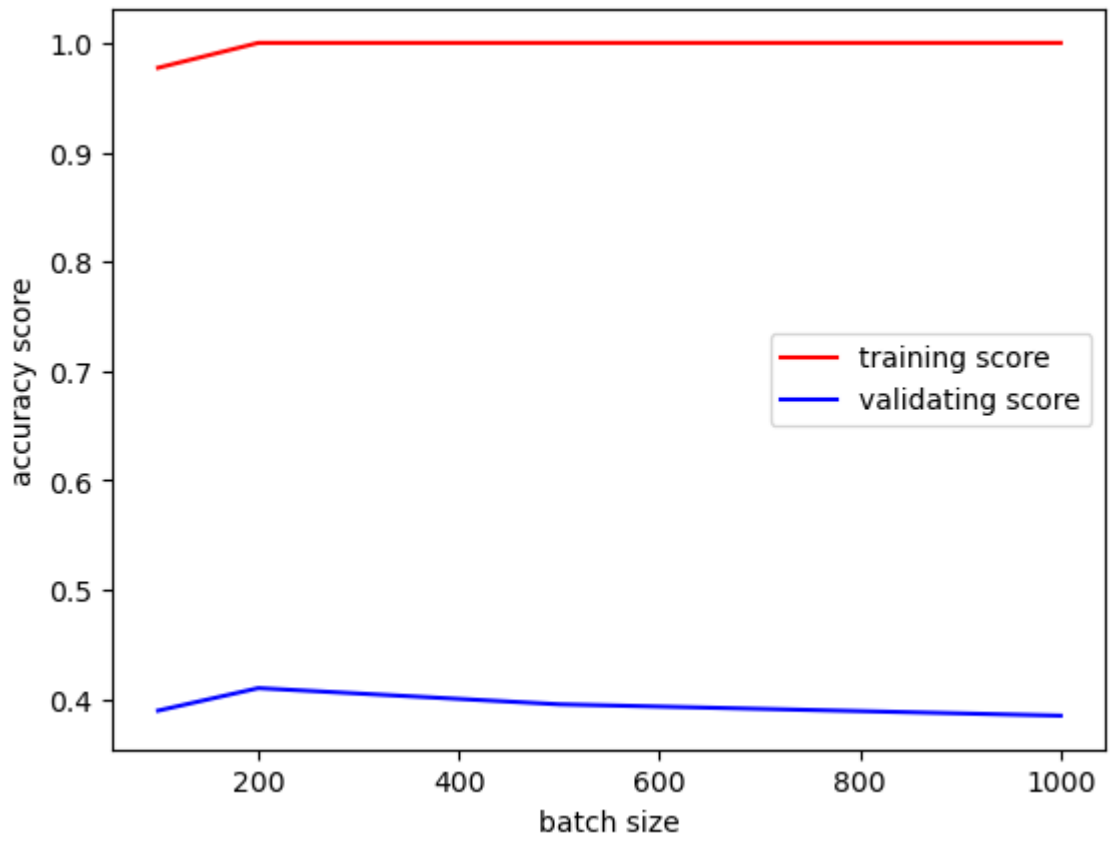
In [20]:
```
# checking accuracy score of hidden layers on mlp
hidden_sizes = [(100, 100,100,100), (100, 100, 100, 100, 100)]
tr_scores = []
val_scores = []
for i in hidden_sizes:
    mlp = MLPClassifier(hidden_layer_sizes=i, alpha=0.001, activation="relu")
    mlp.fit(X_tr, y_tr)
    tr_score = mlp.score(X_tr, y_tr)
    val_score = mlp.score(X_val, y_val)
    tr_scores.append(tr_score)
    val_scores.append(val_score)
    print("training score is", tr_score,"; validating score is", val_score,
                "hidden layer size is", i)
```

```
training score is 1.0 ; validating score is 0.3964 hidden layer size is (100, 100, 100, 100)
training score is 1.0 ; validating score is 0.4046 hidden layer size is (100, 100, 100, 100, 100)
```

In [24]:
```
# find best accuracy score of batch size on mlp
batch_sizes = [100, 200, 500, 1000]
tr_scores = []
val_scores = []
for i in batch_sizes:
    mlp = MLPClassifier(hidden_layer_sizes=(100, 100, 100, 100, 100), alpha=0.001, batch_size = i, activation='relu')
    mlp.fit(X_tr, y_tr)
    tr_score = mlp.score(X_tr, y_tr)
    val_score = mlp.score(X_val, y_val)
    tr_scores.append(tr_score)
    val_scores.append(val_score)
    print("training score is", tr_score,"; validating score is", val_score,
                "hidden layer size is (100, 100, 100, 100, 100); alpha is 0.001; batch_size is", i)
#draw graph
fig, axes = plt.subplots()
axes.plot(batch_sizes, tr_scores, color='red', label='training score')
axes.plot(batch_sizes, val_scores, color='blue', label ='validating score')
axes.set_xlabel("batch size")
axes.set_ylabel('accuracy score')
axes.legend()
```

```
training score is 0.9772 ; validating score is 0.3892 hidden layer size is (100, 100, 100, 100, 100); alpha is 0.001;
batch_size is 100
training score is 1.0 ; validating score is 0.4098 hidden layer size is (100, 100, 100, 100, 100); alpha is 0.001; ba
tch_size is 200
training score is 1.0 ; validating score is 0.395 hidden layer size is (100, 100, 100, 100, 100); alpha is 0.001; bat
ch_size is 500
training score is 1.0 ; validating score is 0.3846 hidden layer size is (100, 100, 100, 100, 100); alpha is 0.001; ba
tch_size is 1000
```

Out[24]:
```
<matplotlib.legend.Legend at 0x7fba90091930>
```

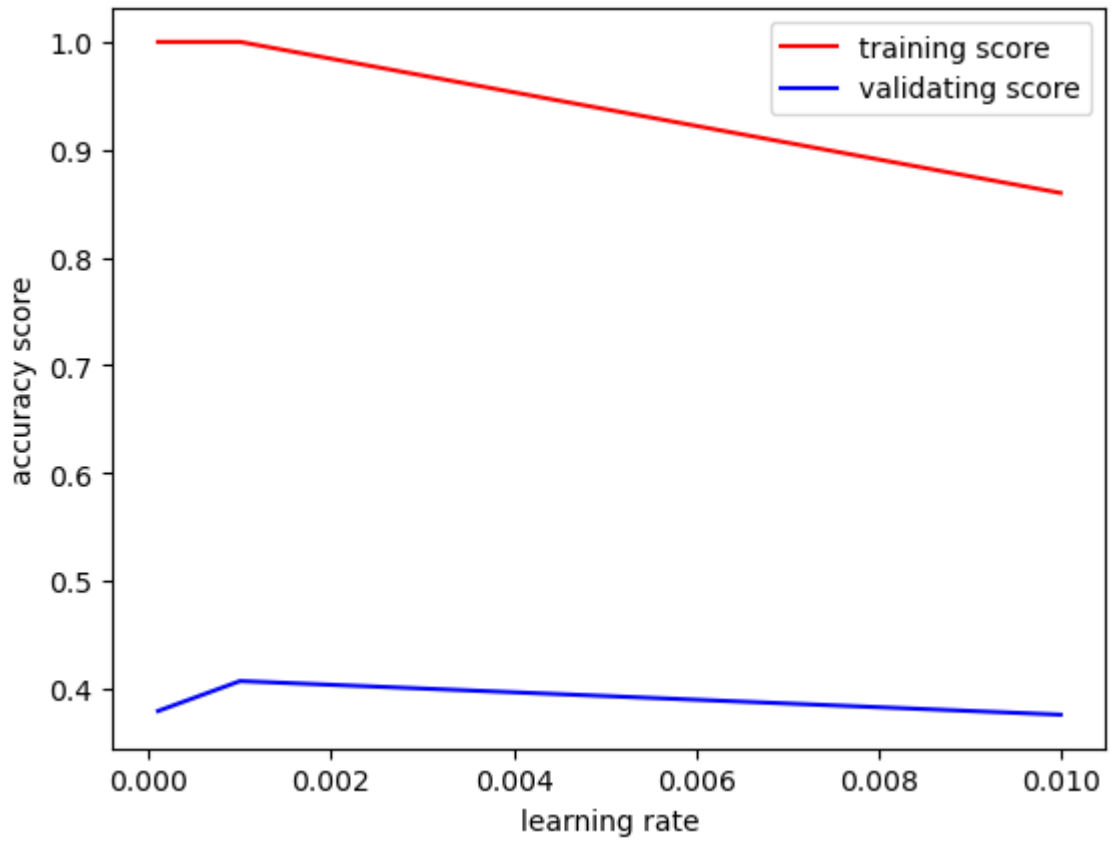


In [25]:
```
# find best accuracy score of learning rate on mlp
learning_rate = [0.0001, 0.001, 0.01]
tr_scores = []
val_scores = []
for i in learning_rate:
    mlp = MLPClassifier(hidden_layer_sizes=(100, 100, 100, 100, 100), alpha=0.001, learning_rate_init = i, activation=
                        max_iter = 400)
    mlp.fit(X_tr, y_tr)
    tr_score = mlp.score(X_tr, y_tr)
    val_score = mlp.score(X_val, y_val)
    tr_scores.append(tr_score)
    val_scores.append(val_score)
    print("training score is", tr_score,"; validating score is", val_score,
                  "hidden layer size is (100, 100, 100, 100, 100); alpha is 0.001; learning rate is", i)

#draw graph
fig, axes = plt.subplots()
axes.plot(learning_rate, tr_scores, color='red', label='training score')
axes.plot(learning_rate, val_scores, color='blue', label ='validating score')
axes.set_xlabel("learning rate")
axes.set_ylabel('accuracy score')
axes.legend()
```

```
training score is 1.0 ; validating score is 0.379 hidden layer size is (100, 100, 100, 100, 100); alpha is 0.001; lea
rning rate is 0.0001
training score is 1.0 ; validating score is 0.4068 hidden layer size is (100, 100, 100, 100, 100); alpha is 0.001; le
arning rate is 0.001
training score is 0.8598 ; validating score is 0.3756 hidden layer size is (100, 100, 100, 100, 100); alpha is 0.001;
learning rate is 0.01
```

Out[25]: <matplotlib.legend.Legend at 0x7fba900de4a0>



In [26]:
```
# testing data accuracy score
mlp = MLPClassifier(hidden_layer_sizes=(100, 100, 100, 100, 100), alpha=0.001, activation='relu',random_state=seed)
mlp.fit(X_tr, y_tr)
print(mlp.score(X_te, y_te))
```

```
0.3879
```