In [1]:
```
import os
import torch
import librosa

import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline

from datasets import AudioDataset

import sklearn.metrics as met
# hyper parameters
MAX_EPOCH = 100
```

In [2]:
```
# path to urban sound 8k
data_root = "/home/wew016/UrbanSound8K/"
# path to label
label_path = "/home/wew016/UrbanSound8K/metadata/UrbanSound8K.csv"
```

In [5]:
```
# initialize dataset (feature can be "mfcc" or "spec")
audio_dataset = AudioDataset(3, DataRoot=data_root, LabelPath=label_path
, feature="mfcc_mean_80", mode="train")
```

```
verify mfcc_mean_80 feature success
```

In [6]:
```
# initialize dataloader
data_loader = torch.utils.data.DataLoader(audio_dataset, batch_size=len(
audio_dataset), shuffle=True, num_workers=1)

for idx, data in enumerate(data_loader):
        x_train, y_train = data
        print(x_train.shape)
        print(y_train.shape)
```

```
torch.Size([7807, 80])
torch.Size([7807])
```

In [7]:
```
x_train=x_train.numpy()
x_train.shape
```

Out[7]:
```
(7807, 80)
```

In [8]:
```
y_train=y_train.numpy()
y_train.shape
```

Out[8]:
```
(7807,)
```

In [9]:
```
audio_dataset_test = AudioDataset(3, DataRoot=data_root, LabelPath=label
_path, feature="mfcc_mean_80", mode="test")
```

```
verify mfcc_mean_80 feature success
```

In [10]:
```
# initialize dataloader
data_loader_test = torch.utils.data.DataLoader(audio_dataset_test, batch
_size=len(audio_dataset_test), shuffle=True, num_workers=1)
```

```
for idx, data in enumerate(data_loader_test):
        x_test, y_test = data
        print(x_test.shape)
        print(y_test.shape)
```

```
torch.Size([925, 80])
torch.Size([925])
```

In [11]:
```
x_test=x_test.numpy()
x_test.shape
```

Out[11]:
```
(925, 80)
```

In [12]:
```
y_test=y_test.numpy()
y_test.shape
```

Out[12]:
```
(925,)
```

XGBOOST Model

In [13]:
```
from xgboost import XGBClassifier
```

In [14]:
```
model_xgboost = XGBClassifier(learning_rate =0.2,
                      n_estimators=150,
                      max_depth=4,
                      num_class=10,
                      min_child_weight=5,
                      gamma=0.1,
                      subsample=0.5,
                      colsample_bytree=0.5,
                      objective='multi:softmax',
                      seed=50)
```

In [15]:
```
model_xgboost.fit(x_train,y_train)
```

Out[15]:
```
XGBClassifier(base_score=0.5, booster='gbtree', colsample_bylevel=1,
              colsample_bynode=1, colsample_bytree=0.5, gamma=0.1, gpu_i
d=-1,
              importance_type='gain', interaction_constraints='',
              learning_rate=0.2, max_delta_step=0, max_depth=4,
              min_child_weight=5, missing=nan, monotone_constraints='()'
,
              n_estimators=150, n_jobs=0, num_class=10, num_parallel_tre
e=1,
              objective='multi:softprob', random_state=50, reg_alpha=0,
              reg_lambda=1, scale_pos_weight=None, seed=50, subsample=0.
5,
              tree_method='exact', validate_parameters=1, verbosity=None
)
```

In [16]:
```
pred_train_xgboost = model_xgboost.predict(x_train)
met.accuracy_score(y_train,pred_train_xgboost)
```

Out[16]:
```
0.9994876392980658
```

In [17]:
```
pred_test_xgboost = model_xgboost.predict(x_test)
```

In [18]:
```
y_test
```

Out[18]:
```
array([9, 7, 8, 0, 9, 2, 3, 4, 7, 4, 2, 3, 1, 2, 0, 5, 3, 5, 2, 2, 3, 2,
       2, 3, 2, 1, 6, 6, 7, 0, 7, 5, 8, 2, 0, 9, 7, 5, 1, 0, 4, 7, 1, 7,
       9, 5, 4, 8, 3, 0, 2, 8, 9, 4, 5, 7, 4, 0, 1, 5, 3, 7, 3, 4, 7, 4,
       4, 7, 3, 4, 2, 1, 4, 3, 3, 9, 5, 6, 3, 3, 7, 4, 2, 5, 2, 5, 7, 3,
       8, 4, 0, 0, 0, 9, 5, 5, 5, 9, 2, 7, 2, 4, 5, 2, 4, 2, 7, 9, 5, 4,
       7, 7, 6, 4, 3, 0, 4, 9, 8, 8, 7, 5, 1, 5, 9, 8, 3, 4, 3, 8, 8, 8,
       9, 3, 5, 2, 8, 9, 7, 3, 1, 3, 9, 7, 2, 4, 9, 7, 2, 7, 7, 8, 2, 2,
       2, 7, 0, 9, 7, 5, 9, 4, 9, 3, 4, 3, 7, 9, 3, 7, 8, 0, 9, 8, 2, 7,
       6, 7, 5, 8, 4, 7, 0, 5, 9, 8, 3, 0, 5, 1, 4, 2, 4, 8, 9, 5, 2, 5,
       0, 0, 8, 0, 0, 2, 8, 4, 8, 7, 5, 8, 0, 1, 5, 8, 7, 3, 4, 8, 0, 6,
       2, 2, 8, 7, 2, 7, 2, 5, 3, 7, 8, 6, 9, 0, 9, 1, 2, 2, 2, 8, 8, 6,
       0, 4, 3, 6, 7, 8, 7, 7, 5, 0, 1, 4, 2, 2, 5, 3, 3, 2, 5, 0, 6, 9,
       9, 5, 2, 3, 5, 2, 7, 3, 4, 0, 4, 9, 4, 9, 8, 3, 0, 9, 7, 9, 3, 8,
       5, 0, 8, 6, 5, 2, 3, 0, 0, 8, 0, 8, 9, 7, 2, 5, 3, 3, 2, 8, 4, 9,
       7, 3, 5, 9, 5, 7, 0, 4, 8, 0, 2, 8, 5, 0, 5, 2, 4, 9, 2, 4, 7, 7,
       8, 4, 3, 9, 8, 5, 7, 0, 1, 0, 8, 0, 0, 1, 3, 5, 9, 5, 1, 4, 6, 3,
       7, 9, 0, 0, 8, 5, 0, 0, 9, 8, 3, 6, 3, 4, 8, 5, 8, 4, 8, 0, 7, 5,
       0, 5, 2, 9, 0, 7, 4, 9, 2, 8, 1, 5, 9, 6, 4, 4, 4, 1, 2, 5, 5, 3,
       3, 2, 0, 3, 4, 9, 8, 6, 0, 7, 0, 3, 1, 2, 8, 0, 9, 7, 4, 2, 7, 7,
       7, 0, 5, 0, 5, 9, 2, 1, 5, 4, 0, 7, 3, 7, 3, 2, 3, 2, 5, 5, 9, 9,
       4, 9, 2, 5, 8, 9, 8, 8, 8, 1, 0, 4, 4, 9, 4, 8, 9, 6, 8, 9, 5, 1,
       7, 2, 0, 3, 0, 4, 8, 0, 4, 7, 0, 7, 9, 8, 9, 0, 3, 4, 3, 1, 2, 2,
       9, 1, 7, 9, 7, 3, 5, 8, 7, 4, 8, 2, 9, 8, 1, 2, 6, 5, 3, 9, 0, 7,
       6, 7, 3, 3, 7, 0, 5, 2, 5, 0, 4, 9, 7, 7, 8, 4, 5, 8, 8, 3, 5, 7,
       8, 7, 5, 4, 4, 8, 5, 8, 9, 1, 7, 8, 8, 7, 4, 4, 6, 8, 8, 2, 7, 4,
       9, 3, 7, 0, 1, 5, 8, 8, 5, 9, 4, 3, 4, 7, 8, 2, 6, 9, 4, 0, 5, 3,
       3, 7, 9, 2, 5, 8, 1, 1, 4, 2, 0, 9, 3, 3, 1, 8, 1, 8, 5, 2, 0, 3,
       8, 0, 9, 5, 8, 9, 9, 7, 7, 9, 7, 8, 3, 2, 4, 2, 2, 8, 4, 2, 5, 0,
       4, 5, 4, 8, 3, 9, 5, 8, 8, 4, 4, 7, 6, 5, 4, 9, 7, 9, 6, 5, 4, 8,
       8, 5, 6, 0, 0, 0, 1, 4, 3, 6, 9, 2, 8, 9, 3, 5, 0, 9, 9, 7, 4, 0,
       7, 3, 3, 7, 0, 3, 8, 4, 4, 2, 9, 9, 9, 3, 4, 3, 5, 2, 8, 4, 8, 2,
       3, 1, 0, 5, 1, 7, 5, 3, 9, 2, 8, 3, 2, 2, 3, 3, 6, 7, 9, 6, 3, 8,
       7, 9, 4, 5, 7, 5, 7, 2, 4, 7, 2, 7, 2, 5, 1, 7, 5, 2, 5, 4, 2, 5,
       6, 6, 9, 0, 4, 3, 8, 6, 2, 2, 6, 0, 7, 9, 9, 1, 6, 0, 5, 7, 8, 7,
       9, 5, 9, 0, 8, 5, 5, 4, 0, 1, 8, 2, 7, 9, 7, 7, 8, 7, 0, 3, 8, 1,
       2, 1, 8, 8, 7, 2, 6, 9, 2, 0, 8, 9, 0, 8, 5, 3, 4, 0, 7, 3, 0, 8,
       9, 7, 8, 8, 7, 8, 3, 3, 6, 1, 6, 9, 4, 4, 0, 7, 4, 3, 3, 2, 8, 8,
       5, 7, 4, 7, 2, 5, 0, 7, 0, 8, 5, 9, 5, 2, 3, 7, 8, 8, 5, 3, 8, 4,
       0, 1, 4, 1, 3, 7, 0, 3, 2, 3, 3, 0, 3, 2, 4, 5, 7, 0, 2, 8, 3, 7,
       3, 0, 5, 9, 4, 9, 2, 2, 4, 3, 5, 5, 4, 9, 8, 0, 7, 4, 3, 2, 5, 4,
       9, 8, 0, 2, 7, 3, 9, 4, 1, 7, 8, 9, 0, 7, 5, 5, 0, 2, 7, 7, 1, 5,
       2, 5, 3, 7, 0, 8, 7, 7, 8, 6, 0, 8, 8, 9, 5, 9, 0, 0, 8, 6, 7, 5,
       4])
```

In [19]:
```
pred_test_xgboost
```

Out[19]:
```
array([2, 9, 8, 9, 9, 2, 3, 4, 7, 3, 2, 3, 1, 2, 5, 7, 9, 4, 2, 2, 9, 2,
       2, 2, 3, 1, 6, 6, 7, 3, 9, 7, 9, 2, 9, 1, 9, 5, 1, 2, 5, 9, 1, 9,
       9, 9, 3, 3, 3, 5, 2, 8, 9, 3, 4, 9, 4, 9, 1, 7, 3, 7, 3, 4, 4, 4,
       8, 7, 3, 4, 2, 1, 4, 3, 2, 9, 9, 6, 1, 2, 8, 4, 2, 5, 2, 7, 2, 2,
       8, 9, 3, 3, 3, 9, 5, 4, 7, 1, 3, 9, 2, 4, 4, 9, 3, 2, 7, 9, 4, 5,
       9, 2, 6, 9, 3, 5, 8, 9, 8, 8, 9, 4, 1, 3, 9, 8, 2, 9, 2, 8, 8, 2,
       9, 3, 7, 2, 9, 9, 9, 3, 1, 3, 2, 9, 3, 9, 9, 9, 2, 0, 9, 8, 6, 2,
       3, 7, 9, 9, 9, 7, 9, 4, 1, 3, 3, 3, 9, 2, 3, 9, 8, 5, 2, 2, 2, 7,
       6, 9, 4, 5, 3, 9, 3, 4, 9, 8, 3, 3, 9, 1, 4, 2, 9, 8, 2, 4, 2, 7,
       9, 7, 8, 2, 3, 9, 8, 4, 8, 7, 3, 8, 2, 1, 5, 8, 7, 3, 4, 9, 2, 6,
       3, 2, 0, 9, 2, 7, 2, 0, 3, 9, 8, 6, 9, 3, 5, 1, 2, 2, 2, 8, 8, 3,
       2, 3, 9, 6, 7, 8, 7, 7, 9, 2, 1, 4, 2, 3, 9, 3, 3, 2, 4, 0, 6, 2,
       5, 5, 2, 3, 5, 2, 9, 3, 3, 3, 9, 9, 5, 9, 8, 3, 2, 2, 9, 9, 3, 8,
       9, 3, 8, 6, 4, 2, 2, 9, 2, 8, 5, 8, 4, 9, 2, 7, 3, 2, 2, 8, 4, 9,
```

```
9, 2, 7, 2, 4, 7, 2, 4, 8, 2, 2, 8, 5, 3, 2, 2, 4, 9, 2, 3, 4, 9,
0, 4, 3, 2, 8, 7, 9, 7, 1, 5, 9, 5, 3, 1, 9, 4, 9, 4, 1, 4, 6, 6,
9, 2, 0, 3, 8, 5, 2, 2, 9, 8, 3, 6, 3, 4, 8, 7, 8, 4, 8, 5, 9, 4,
9, 4, 3, 9, 2, 0, 3, 9, 2, 8, 1, 7, 9, 6, 4, 3, 4, 1, 3, 4, 7, 3,
3, 6, 2, 3, 4, 1, 8, 6, 2, 4, 9, 3, 1, 2, 8, 3, 0, 7, 4, 2, 9, 9,
9, 3, 9, 2, 9, 9, 2, 1, 5, 2, 7, 9, 3, 5, 3, 2, 3, 3, 4, 5, 9, 2,
3, 9, 2, 7, 8, 6, 8, 8, 0, 1, 5, 4, 4, 1, 3, 8, 2, 6, 2, 9, 9, 1,
4, 2, 5, 2, 9, 4, 9, 5, 2, 7, 3, 9, 3, 2, 9, 3, 2, 4, 3, 1, 3, 2,
9, 5, 7, 9, 9, 9, 5, 8, 4, 5, 8, 2, 9, 7, 1, 2, 3, 4, 3, 9, 9, 0,
6, 0, 8, 3, 7, 2, 5, 2, 5, 7, 4, 5, 5, 9, 9, 3, 9, 8, 8, 2, 5, 4,
8, 9, 7, 5, 3, 8, 4, 8, 9, 1, 9, 2, 8, 9, 4, 8, 6, 8, 8, 2, 9, 3,
9, 5, 2, 9, 1, 6, 8, 5, 5, 9, 3, 3, 3, 7, 9, 3, 6, 9, 2, 9, 4, 8,
3, 4, 9, 9, 3, 8, 1, 1, 4, 2, 3, 9, 9, 3, 1, 8, 1, 8, 4, 9, 3, 2,
8, 5, 2, 3, 8, 0, 9, 4, 7, 9, 0, 8, 1, 2, 3, 2, 2, 0, 4, 2, 7, 7,
0, 6, 4, 8, 3, 2, 5, 8, 8, 3, 4, 5, 6, 4, 4, 2, 7, 2, 6, 2, 4, 8,
8, 5, 6, 3, 3, 2, 1, 4, 3, 6, 9, 2, 8, 9, 3, 4, 7, 9, 9, 4, 4, 9,
9, 3, 9, 9, 9, 3, 9, 4, 4, 2, 9, 9, 2, 3, 5, 3, 7, 2, 8, 6, 8, 2,
3, 1, 2, 4, 1, 9, 9, 3, 9, 3, 0, 3, 2, 2, 8, 2, 6, 9, 9, 6, 3, 8,
5, 9, 5, 9, 9, 7, 5, 3, 3, 9, 2, 5, 2, 4, 1, 9, 7, 3, 7, 2, 2, 4,
6, 3, 9, 5, 4, 3, 8, 6, 2, 2, 6, 2, 7, 2, 4, 1, 6, 5, 4, 9, 8, 7,
3, 7, 9, 5, 8, 9, 7, 4, 9, 1, 8, 3, 9, 9, 9, 7, 8, 9, 2, 3, 8, 1,
9, 1, 2, 8, 7, 3, 6, 9, 9, 5, 8, 9, 5, 2, 4, 3, 4, 2, 7, 9, 0, 8,
4, 9, 8, 8, 4, 8, 3, 3, 6, 1, 6, 9, 4, 4, 3, 9, 4, 9, 2, 2, 8, 8,
4, 9, 4, 5, 2, 9, 9, 7, 2, 2, 4, 9, 4, 2, 3, 9, 8, 8, 6, 3, 8, 4,
3, 1, 5, 1, 2, 7, 9, 3, 2, 3, 9, 5, 3, 3, 9, 7, 9, 3, 2, 8, 8, 2,
3, 3, 5, 9, 4, 9, 3, 3, 3, 3, 7, 5, 9, 2, 8, 2, 9, 9, 2, 3, 5, 3,
9, 8, 2, 2, 7, 2, 2, 4, 1, 9, 8, 9, 2, 9, 7, 5, 3, 2, 9, 9, 1, 4,
2, 4, 3, 2, 9, 8, 9, 9, 8, 6, 2, 8, 8, 2, 9, 9, 3, 2, 8, 6, 9, 7,
4])
```

In [20]:
```
met.accuracy_score(y_test,pred_test_xgboost)
```

Out[20]:
```
0.5102702702702703
```

In [21]:
```
met.confusion_matrix(y_test,pred_test_xgboost)
```

Out[21]:
```
array([[ 3,  0, 28, 27,  0, 18,  0,  6,  0, 18],
       [ 0, 42,  0,  0,  0,  1,  0,  0,  0,  0],
       [ 0,  0, 72, 20,  0,  0,  2,  0,  0,  6],
       [ 0,  2, 18, 64,  0,  1,  1,  0,  4, 10],
       [ 1,  0,  4, 23, 51,  8,  1,  0,  3,  9],
       [ 1,  0,  2,  4, 34, 21,  3, 27,  0, 15],
       [ 0,  0,  0,  3,  0,  0, 33,  0,  0,  0],
       [ 5,  0,  5,  0, 10,  7,  0, 29,  1, 63],
       [ 5,  0,  8,  1,  0,  2,  0,  1, 94,  8],
       [ 2,  5, 21,  2,  3,  3,  1,  0,  0, 63]])
```

SVM Model

In [22]:
```
import sklearn
from sklearn.svm import SVC
from sklearn.model_selection import GridSearchCV
```

In [23]:
```
import warnings
warnings.filterwarnings('ignore')
```

In [ ]:
```
svr = SVC()
parameters = {'kernel':('linear', 'rbf'), 'C':[1, 2, 4], 'gamma':[0.125,
```

```
 0.25, 0.5 ,1, 2, 4]}
clf = GridSearchCV(svr, parameters, scoring='f1_samples')
clf.fit(x_train, y_train)
print('The parameters of the best model are: ')
print(clf.best_params_)
```

In [24]:
```
model_svm = sklearn.svm.SVC(C=0.75,
                            kernel='rbf',
                            degree=3,
                            gamma='auto',
                            coef0=0.0,
                            shrinking=True,
                            probability=False,
                            tol=0.001,
                            cache_size=200,
                            class_weight=None,
                            verbose=False,
                            max_iter=-1,
                            decision_function_shape=None,
                            random_state=None)
```

In [25]:
```
model_svm.fit(x_train,y_train)
```

Out[25]:
```
SVC(C=0.75, cache_size=200, class_weight=None, coef0=0.0,
    decision_function_shape=None, degree=3, gamma='auto', kernel='rbf',
    max_iter=-1, probability=False, random_state=None, shrinking=True,
    tol=0.001, verbose=False)
```

In [26]:
```
pred_train_svm = model_svm.predict(x_train)
met.accuracy_score(y_train,pred_train_svm)
```

Out[26]:
```
0.9980786473677469
```

In [27]:
```
pred_test_svm = model_svm.predict(x_test)
met.accuracy_score(y_test,pred_test_svm)
```

Out[27]:
```
0.10918918918918918
```

RandomForest Model

In [28]:
```
from sklearn.ensemble import RandomForestClassifier
```

In [29]:
```
model_RF = RandomForestClassifier(n_estimators=100 ,criterion = "entropy
", bootstrap= False)
```

In [30]:
```
model_RF.fit(x_train,y_train)
```

Out[30]:
```
RandomForestClassifier(bootstrap=False, class_weight=None, criterion='en
tropy',
                       max_depth=None, max_features='auto', max_leaf_nod
es=None,
                       min_impurity_decrease=0.0, min_impurity_split=Non
e,
                       min_samples_leaf=1, min_samples_split=2,
                       min_weight_fraction_leaf=0.0, n_estimators=100,
                       n_jobs=None, oob_score=False, random_state=None,
                       verbose=0, warm_start=False)
```

In [31]:
```
pred_train_RF = model_RF.predict(x_train)
met.accuracy_score(y_train,pred_train_RF)
```

Out[31]:
```
1.0
```

In [32]:
```
pred_test_RF = model_RF.predict(x_test)
met.accuracy_score(y_test,pred_test_RF)
```

Out[32]:
```
0.52
```

KNN Model

In [33]:
```
from sklearn.neighbors import KNeighborsClassifier
```

In [34]:
```
model_KNN = KNeighborsClassifier(n_neighbors=10,
                                 weights='uniform',
                                 algorithm='auto',
                                 leaf_size=30,
                                 p=2,
                                 metric='minkowski',
                                 metric_params=None,
                                 n_jobs=None)
```

In [35]:
```
model_KNN.fit(x_train,y_train)
```

Out[35]:
```
KNeighborsClassifier(algorithm='auto', leaf_size=30, metric='minkowski',
                     metric_params=None, n_jobs=None, n_neighbors=10, p=
2,
                     weights='uniform')
```

In [36]:
```
pred_train_KNN = model_KNN.predict(x_train)
met.accuracy_score(y_train,pred_train_KNN)
```

Out[36]:
```
0.8560266427565005
```

In [37]:
```
pred_test_KNN = model_KNN.predict(x_test)
met.accuracy_score(y_test,pred_test_KNN)
```

Out[37]:
```
0.3772972972972973
```

KNN Model

In [ ]:
```

```