Music_Genre_Analysis

December 7, 2023

[1]:
```
# Mount Google Drive to the Colab VM.
from google.colab import drive
drive.mount('/content/drive')

FOLDERNAME = "COMPSCI 682/compsci-682-project"
assert FOLDERNAME is not None, "[!] Enter the foldername."

import sys
sys.path.append('/content/drive/My Drive/{}'.format(FOLDERNAME))
# %cd /content/drive/My\ Drive/$FOLDERNAME/datasets
# !wget https://raw.githubusercontent.com/coreyker/dnn-mgr/master/gtzan/
 ↪train_filtered.txt
# !wget https://raw.githubusercontent.com/coreyker/dnn-mgr/master/gtzan/
 ↪valid_filtered.txt
# !wget https://raw.githubusercontent.com/coreyker/dnn-mgr/master/gtzan/
 ↪test_filtered.txt
%cd /content/drive/My\ Drive/$FOLDERNAME
```

```
Mounted at /content/drive
/content/drive/My Drive/COMPSCI 682/compsci-682-project
```

[2]:
```
# Setting up locale
import locale
locale.getpreferredencoding = lambda: "UTF-8"
```

[3]:
```
%load_ext autoreload
%autoreload 2

from src.configuration import *
from src.dataset import *
from src.networks import *
from src.training import *
from src.evaluation import *
from src.utils import *
import src.preprocess as pp
```

[4]:
```
# Setting up environment for using GPU or CPU as per availability
dtype = torch.float32
```

```
device = torch.device('cuda') if USE_GPU and torch.cuda.is_available() else␣
↪torch.device('cpu')
print('Using device:', device)
```

```
Using device: cuda
```

[5]:
```
# Preprocess the dataset to extract and save features
if pp.are_features_extracted("datasets/features"):
    print("Features already extracted. Proceed further...")
else:
    print("Features absent. Processing...")
    pp.generate_spectrograms(
        data_path="datasets/genres",
        save_path="datasets/features"
    )
    print("Features extracted. Proceed further...")

# Note that one song in GTZAN dataset contains data in unknown/corrupt format:␣
↪we will delete if this exists.
if os.path.exists("datasets/genres/jazz/jazz.00054.wav"):
    os.remove("datasets/genres/jazz/jazz.00054.wav")
```

```
Features already extracted. Proceed further...
```

[6]:
```
# Log details about the datasets (total 929 instances of well-split manually␣
↪annotated data from coreyker/dnn-mgr/)
train_dataset = GTZANFeatureDataset(split="train")
valid_dataset = GTZANFeatureDataset(split="valid")
test_dataset  = GTZANFeatureDataset(split="test")
print(f"Number of train instances: {len(train_dataset)} ({len(train_dataset) /␣
↪929 * 100:.2f}%)") # Expect 442 (47.58%)
print(f"Number of valid instances: {len(valid_dataset)} ({len(valid_dataset) /␣
↪929 * 100:.2f}%)") # Expect 197 (21.21%)
print(f"Number of test  instances: {len(test_dataset )} ({len(test_dataset ) /␣
↪929 * 100:.2f}%)") # Expect 290 (31.22%)
print("Number of class labels: ", len(CLASS_LABELS)) # Expect 10
print("Values of Class labels: ", CLASS_LABELS) # Expect ['blues', 'classical',␣
↪'country', 'disco', 'hiphop', 'jazz', 'metal', 'pop', 'reggae', 'rock']
```

```
Number of train instances: 442 (47.58%)
Number of valid instances: 197 (21.21%)
Number of test  instances: 290 (31.22%)
Number of class labels:  10
Values of Class labels:  ['blues', 'classical', 'country', 'disco', 'hiphop',
'jazz', 'metal', 'pop', 'reggae', 'rock']
```

[9]:
```
# Initialize the data loaders for mel spectrograms
train_loader = get_dataloader(split='train')
```

```
valid_loader = get_dataloader(split='valid')
test_loader = get_dataloader(split='test')

train_melspectrogram, train_genre = next(iter(train_loader))
test_melspectrogram, test_genre = next(iter(test_loader))

print('Training Mini-Batch Tensor Shape: %s' % str(train_melspectrogram.shape))
print('Test Mini-Batch Tensor Shape: %s' % str(test_melspectrogram.shape))
```

```
Training Mini-Batch Tensor Shape: torch.Size([32, 3, 369, 496])
Test Mini-Batch Tensor Shape: torch.Size([32, 3, 369, 496])
```

[14]:
```
speccnn_model = SpectrogramCNN() # Custom model built by us
train(speccnn_model, "best_speccnn_model_melspectrogram.ckpt", train_loader,␣
 ↪valid_loader, device, num_epochs=50, lr=1e-3, debug = True)
```

```
----------------------------------------
Epoch: [1/50], Train loss: 2.3869
Epoch: [1/50], Valid loss: 2.3214, Valid accuracy: 0.1168
----------------------------------------
Saving the best model at 0 epochs!
----------------------------------------
Epoch: [2/50], Train loss: 2.1533
Epoch: [2/50], Valid loss: 2.2430, Valid accuracy: 0.1827
----------------------------------------
Saving the best model at 1 epochs!
----------------------------------------
Epoch: [3/50], Train loss: 2.0085
Epoch: [3/50], Valid loss: 2.0722, Valid accuracy: 0.2589
----------------------------------------
Saving the best model at 2 epochs!
----------------------------------------
Epoch: [4/50], Train loss: 1.8515
Epoch: [4/50], Valid loss: 1.9482, Valid accuracy: 0.2792
----------------------------------------
Saving the best model at 3 epochs!
----------------------------------------
Epoch: [5/50], Train loss: 1.7510
Epoch: [5/50], Valid loss: 1.8721, Valid accuracy: 0.2995
----------------------------------------
Saving the best model at 4 epochs!
----------------------------------------
Epoch: [6/50], Train loss: 1.7109
Epoch: [6/50], Valid loss: 1.8246, Valid accuracy: 0.3503
----------------------------------------
Saving the best model at 5 epochs!
----------------------------------------
Epoch: [7/50], Train loss: 1.5847
```

```
Epoch: [7/50], Valid loss: 1.8030, Valid accuracy: 0.3503
---------------------------------------
Saving the best model at 6 epochs!
---------------------------------------
Epoch: [8/50], Train loss: 1.5075
Epoch: [8/50], Valid loss: 1.8001, Valid accuracy: 0.3503
---------------------------------------
Saving the best model at 7 epochs!
---------------------------------------
Epoch: [9/50], Train loss: 1.4672
Epoch: [9/50], Valid loss: 1.7914, Valid accuracy: 0.4162
---------------------------------------
Saving the best model at 8 epochs!
---------------------------------------
Epoch: [10/50], Train loss: 1.3864
Epoch: [10/50], Valid loss: 1.7558, Valid accuracy: 0.4213
---------------------------------------
Saving the best model at 9 epochs!
---------------------------------------
Epoch: [11/50], Train loss: 1.3149
Epoch: [11/50], Valid loss: 1.7544, Valid accuracy: 0.4365
---------------------------------------
Saving the best model at 10 epochs!
---------------------------------------
Epoch: [12/50], Train loss: 1.2878
Epoch: [12/50], Valid loss: 1.7501, Valid accuracy: 0.3909
---------------------------------------
Saving the best model at 11 epochs!
---------------------------------------
Epoch: [13/50], Train loss: 1.2474
Epoch: [13/50], Valid loss: 1.7368, Valid accuracy: 0.4518
---------------------------------------
Saving the best model at 12 epochs!
---------------------------------------
Epoch: [14/50], Train loss: 1.2404
Epoch: [14/50], Valid loss: 1.7093, Valid accuracy: 0.4112
---------------------------------------
Saving the best model at 13 epochs!
---------------------------------------
Epoch: [15/50], Train loss: 1.1439
Epoch: [15/50], Valid loss: 1.6229, Valid accuracy: 0.4772
---------------------------------------
Saving the best model at 14 epochs!
---------------------------------------
Epoch: [16/50], Train loss: 1.1385
Epoch: [16/50], Valid loss: 1.6777, Valid accuracy: 0.4112
---------------------------------------
---------------------------------------
```

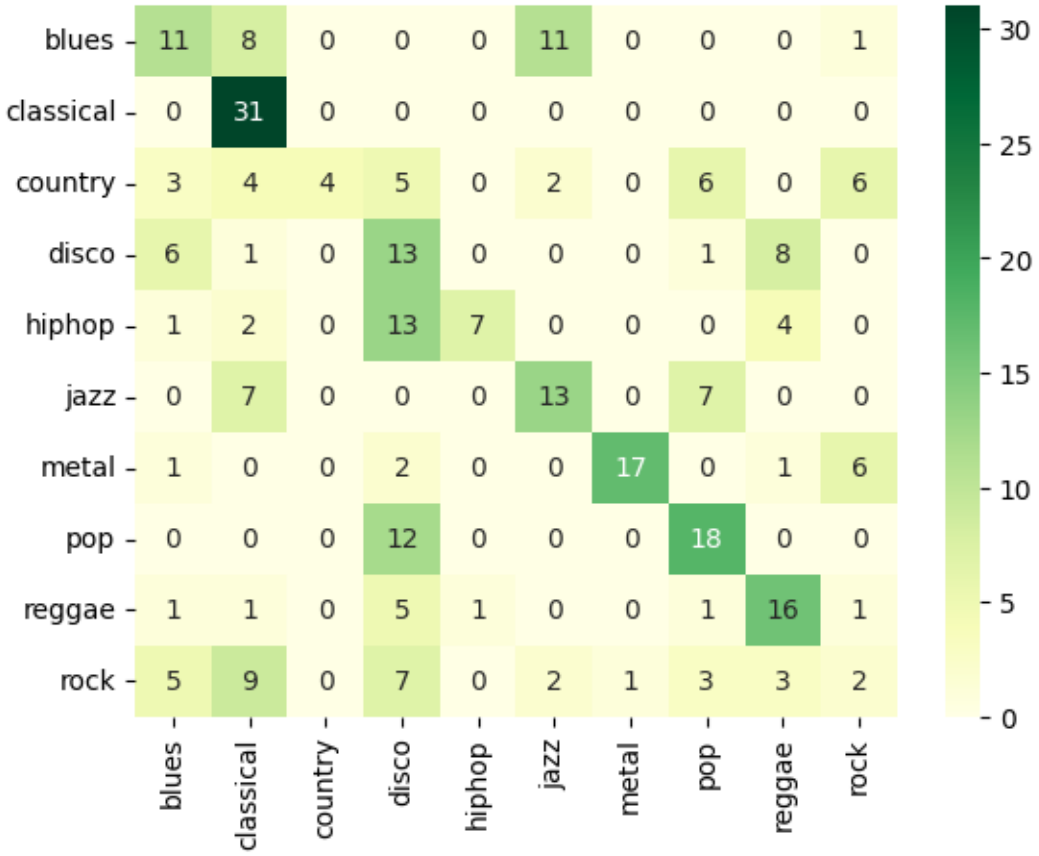
```
Epoch: [17/50], Train loss: 1.1260
Epoch: [17/50], Valid loss: 1.7568, Valid accuracy: 0.4365
----------------------------------------
----------------------------------------
Epoch: [18/50], Train loss: 1.1500
Epoch: [18/50], Valid loss: 1.7880, Valid accuracy: 0.3807
----------------------------------------
----------------------------------------
Epoch: [19/50], Train loss: 1.0458
Epoch: [19/50], Valid loss: 1.5949, Valid accuracy: 0.4619
----------------------------------------
Saving the best model at 18 epochs!
----------------------------------------
Epoch: [20/50], Train loss: 0.9913
Epoch: [20/50], Valid loss: 1.6537, Valid accuracy: 0.4873
----------------------------------------
----------------------------------------
Epoch: [21/50], Train loss: 0.9270
Epoch: [21/50], Valid loss: 1.5872, Valid accuracy: 0.4569
----------------------------------------
Saving the best model at 20 epochs!
----------------------------------------
Epoch: [22/50], Train loss: 0.9402
Epoch: [22/50], Valid loss: 1.5329, Valid accuracy: 0.5127
----------------------------------------
Saving the best model at 21 epochs!
----------------------------------------
Epoch: [23/50], Train loss: 0.8958
Epoch: [23/50], Valid loss: 1.4871, Valid accuracy: 0.5330
----------------------------------------
Saving the best model at 22 epochs!
----------------------------------------
Epoch: [24/50], Train loss: 0.9156
Epoch: [24/50], Valid loss: 1.5683, Valid accuracy: 0.4975
----------------------------------------
----------------------------------------
Epoch: [25/50], Train loss: 0.9326
Epoch: [25/50], Valid loss: 1.5265, Valid accuracy: 0.5025
----------------------------------------
----------------------------------------
Epoch: [26/50], Train loss: 0.8228
Epoch: [26/50], Valid loss: 1.5199, Valid accuracy: 0.5127
----------------------------------------
----------------------------------------
Epoch: [27/50], Train loss: 0.8579
Epoch: [27/50], Valid loss: 1.5397, Valid accuracy: 0.4822
----------------------------------------
----------------------------------------
```

```
Epoch: [28/50], Train loss: 0.8008
Epoch: [28/50], Valid loss: 1.7213, Valid accuracy: 0.4061
----------------------------------------
----------------------------------------
Epoch: [29/50], Train loss: 0.7935
Epoch: [29/50], Valid loss: 1.5113, Valid accuracy: 0.5127
----------------------------------------
----------------------------------------
Epoch: [30/50], Train loss: 0.7439
Epoch: [30/50], Valid loss: 1.6411, Valid accuracy: 0.4772
----------------------------------------
----------------------------------------
Epoch: [31/50], Train loss: 0.7535
Epoch: [31/50], Valid loss: 1.5133, Valid accuracy: 0.5025
----------------------------------------
----------------------------------------
Epoch: [32/50], Train loss: 0.7146
Epoch: [32/50], Valid loss: 1.4982, Valid accuracy: 0.5127
----------------------------------------
----------------------------------------
Epoch: [33/50], Train loss: 0.7296
Epoch: [33/50], Valid loss: 1.5069, Valid accuracy: 0.5279
----------------------------------------
----------------------------------------
Epoch: [34/50], Train loss: 0.6943
Epoch: [34/50], Valid loss: 1.5344, Valid accuracy: 0.5228
----------------------------------------
----------------------------------------
Epoch: [35/50], Train loss: 0.6830
Epoch: [35/50], Valid loss: 1.5097, Valid accuracy: 0.5127
----------------------------------------
----------------------------------------
Epoch: [36/50], Train loss: 0.6574
Epoch: [36/50], Valid loss: 1.5780, Valid accuracy: 0.5330
----------------------------------------
----------------------------------------
Epoch: [37/50], Train loss: 0.7001
Epoch: [37/50], Valid loss: 1.6931, Valid accuracy: 0.4315
----------------------------------------
----------------------------------------
Epoch: [38/50], Train loss: 0.7511
Epoch: [38/50], Valid loss: 1.7850, Valid accuracy: 0.4213
----------------------------------------
----------------------------------------
Epoch: [39/50], Train loss: 0.6465
Epoch: [39/50], Valid loss: 1.5255, Valid accuracy: 0.4873
----------------------------------------
----------------------------------------
```

```
Epoch: [40/50], Train loss: 0.6158
Epoch: [40/50], Valid loss: 1.5328, Valid accuracy: 0.5178
----------------------------------------
----------------------------------------
Epoch: [41/50], Train loss: 0.5935
Epoch: [41/50], Valid loss: 1.4699, Valid accuracy: 0.5178
----------------------------------------
Saving the best model at 40 epochs!
----------------------------------------
Epoch: [42/50], Train loss: 0.5237
Epoch: [42/50], Valid loss: 1.5705, Valid accuracy: 0.4873
----------------------------------------
----------------------------------------
Epoch: [43/50], Train loss: 0.5755
Epoch: [43/50], Valid loss: 1.7177, Valid accuracy: 0.4822
----------------------------------------
----------------------------------------
Epoch: [44/50], Train loss: 0.4974
Epoch: [44/50], Valid loss: 1.6607, Valid accuracy: 0.5178
----------------------------------------
----------------------------------------
Epoch: [45/50], Train loss: 0.5514
Epoch: [45/50], Valid loss: 1.6658, Valid accuracy: 0.5127
----------------------------------------
----------------------------------------
Epoch: [46/50], Train loss: 0.5526
Epoch: [46/50], Valid loss: 1.7019, Valid accuracy: 0.4670
----------------------------------------
----------------------------------------
Epoch: [47/50], Train loss: 0.5831
Epoch: [47/50], Valid loss: 1.7592, Valid accuracy: 0.4924
----------------------------------------
----------------------------------------
Epoch: [48/50], Train loss: 0.5194
Epoch: [48/50], Valid loss: 1.5291, Valid accuracy: 0.5076
----------------------------------------
----------------------------------------
Epoch: [49/50], Train loss: 0.4708
Epoch: [49/50], Valid loss: 1.8334, Valid accuracy: 0.4467
----------------------------------------
----------------------------------------
Epoch: [50/50], Train loss: 0.4783
Epoch: [50/50], Valid loss: 1.6373, Valid accuracy: 0.5381
----------------------------------------
```

[15]:
```
evaluate(speccnn_model, "best_speccnn_model_melspectrogram.ckpt", test_loader,␣
↪device)
```

```
----------------------------------------
Model at best_speccnn_model_melspectrogram.ckpt:
----------------------------------------
Accuracy: 0.4552
Precision: 0.5522
Recall: 0.4585
F1 Score: 0.4379
```



[16]:
```
resnet_model = ResNet18() # ResNet-18
train(resnet_model, "best_resnet_model_melspectrogram.ckpt", train_loader,␣
  ↪valid_loader, device, num_epochs=50, lr=1e-3, debug = True)
```

```
Downloading: "https://download.pytorch.org/models/resnet18-f37072fd.pth" to
/root/.cache/torch/hub/checkpoints/resnet18-f37072fd.pth
100%|      | 44.7M/44.7M [00:00<00:00, 145MB/s]

----------------------------------------
Epoch: [1/50], Train loss: 2.3955
Epoch: [1/50], Valid loss: 2.3073, Valid accuracy: 0.0812
----------------------------------------
Saving the best model at 0 epochs!
```

```
---------------------------------------
Epoch: [2/50], Train loss: 2.1335
Epoch: [2/50], Valid loss: 2.1240, Valid accuracy: 0.2843
---------------------------------------
Saving the best model at 1 epochs!
---------------------------------------
Epoch: [3/50], Train loss: 1.9365
Epoch: [3/50], Valid loss: 1.9931, Valid accuracy: 0.2843
---------------------------------------
Saving the best model at 2 epochs!
---------------------------------------
Epoch: [4/50], Train loss: 1.7967
Epoch: [4/50], Valid loss: 1.9101, Valid accuracy: 0.3350
---------------------------------------
Saving the best model at 3 epochs!
---------------------------------------
Epoch: [5/50], Train loss: 1.6978
Epoch: [5/50], Valid loss: 1.8816, Valid accuracy: 0.3198
---------------------------------------
Saving the best model at 4 epochs!
---------------------------------------
Epoch: [6/50], Train loss: 1.6063
Epoch: [6/50], Valid loss: 1.7941, Valid accuracy: 0.3756
---------------------------------------
Saving the best model at 5 epochs!
---------------------------------------
Epoch: [7/50], Train loss: 1.5040
Epoch: [7/50], Valid loss: 1.7717, Valid accuracy: 0.4112
---------------------------------------
Saving the best model at 6 epochs!
---------------------------------------
Epoch: [8/50], Train loss: 1.4448
Epoch: [8/50], Valid loss: 1.7084, Valid accuracy: 0.4162
---------------------------------------
Saving the best model at 7 epochs!
---------------------------------------
Epoch: [9/50], Train loss: 1.3726
Epoch: [9/50], Valid loss: 1.6656, Valid accuracy: 0.4213
---------------------------------------
Saving the best model at 8 epochs!
---------------------------------------
Epoch: [10/50], Train loss: 1.3262
Epoch: [10/50], Valid loss: 1.6611, Valid accuracy: 0.4315
---------------------------------------
Saving the best model at 9 epochs!
---------------------------------------
Epoch: [11/50], Train loss: 1.2689
Epoch: [11/50], Valid loss: 1.6475, Valid accuracy: 0.3858
```

```
----------------------------------------
Saving the best model at 10 epochs!
----------------------------------------
Epoch: [12/50], Train loss: 1.2254
Epoch: [12/50], Valid loss: 1.6055, Valid accuracy: 0.4365
----------------------------------------
Saving the best model at 11 epochs!
----------------------------------------
Epoch: [13/50], Train loss: 1.1951
Epoch: [13/50], Valid loss: 1.5923, Valid accuracy: 0.4569
----------------------------------------
Saving the best model at 12 epochs!
----------------------------------------
Epoch: [14/50], Train loss: 1.1423
Epoch: [14/50], Valid loss: 1.5881, Valid accuracy: 0.4467
----------------------------------------
Saving the best model at 13 epochs!
----------------------------------------
Epoch: [15/50], Train loss: 1.1189
Epoch: [15/50], Valid loss: 1.5715, Valid accuracy: 0.4975
----------------------------------------
Saving the best model at 14 epochs!
----------------------------------------
Epoch: [16/50], Train loss: 1.0586
Epoch: [16/50], Valid loss: 1.5510, Valid accuracy: 0.4721
----------------------------------------
Saving the best model at 15 epochs!
----------------------------------------
Epoch: [17/50], Train loss: 1.0420
Epoch: [17/50], Valid loss: 1.5534, Valid accuracy: 0.4315
----------------------------------------
----------------------------------------
Epoch: [18/50], Train loss: 1.0187
Epoch: [18/50], Valid loss: 1.5501, Valid accuracy: 0.4619
----------------------------------------
Saving the best model at 17 epochs!
----------------------------------------
Epoch: [19/50], Train loss: 0.9717
Epoch: [19/50], Valid loss: 1.5272, Valid accuracy: 0.4721
----------------------------------------
Saving the best model at 18 epochs!
----------------------------------------
Epoch: [20/50], Train loss: 0.9559
Epoch: [20/50], Valid loss: 1.5191, Valid accuracy: 0.5127
----------------------------------------
Saving the best model at 19 epochs!
----------------------------------------
Epoch: [21/50], Train loss: 0.9529
```

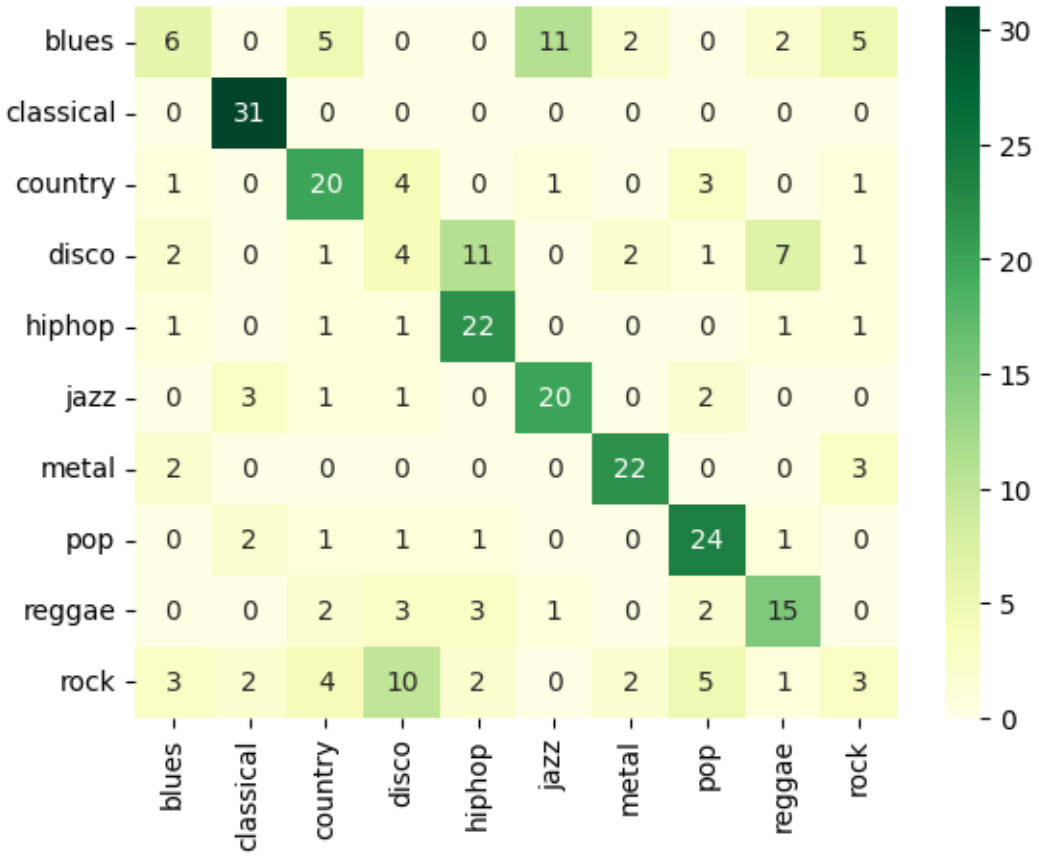
```
Epoch: [21/50], Valid loss: 1.5105, Valid accuracy: 0.4670
---------------------------------------
Saving the best model at 20 epochs!
---------------------------------------
Epoch: [22/50], Train loss: 0.9311
Epoch: [22/50], Valid loss: 1.5138, Valid accuracy: 0.5127
---------------------------------------
---------------------------------------
Epoch: [23/50], Train loss: 0.9178
Epoch: [23/50], Valid loss: 1.5460, Valid accuracy: 0.4772
---------------------------------------
---------------------------------------
Epoch: [24/50], Train loss: 0.9017
Epoch: [24/50], Valid loss: 1.5230, Valid accuracy: 0.4822
---------------------------------------
---------------------------------------
Epoch: [25/50], Train loss: 0.8748
Epoch: [25/50], Valid loss: 1.4834, Valid accuracy: 0.4975
---------------------------------------
Saving the best model at 24 epochs!
---------------------------------------
Epoch: [26/50], Train loss: 0.8338
Epoch: [26/50], Valid loss: 1.5083, Valid accuracy: 0.4975
---------------------------------------
---------------------------------------
Epoch: [27/50], Train loss: 0.8477
Epoch: [27/50], Valid loss: 1.4804, Valid accuracy: 0.4975
---------------------------------------
Saving the best model at 26 epochs!
---------------------------------------
Epoch: [28/50], Train loss: 0.8290
Epoch: [28/50], Valid loss: 1.5165, Valid accuracy: 0.4772
---------------------------------------
---------------------------------------
Epoch: [29/50], Train loss: 0.7977
Epoch: [29/50], Valid loss: 1.4653, Valid accuracy: 0.5076
---------------------------------------
Saving the best model at 28 epochs!
---------------------------------------
Epoch: [30/50], Train loss: 0.7973
Epoch: [30/50], Valid loss: 1.5164, Valid accuracy: 0.4975
---------------------------------------
---------------------------------------
Epoch: [31/50], Train loss: 0.7552
Epoch: [31/50], Valid loss: 1.4579, Valid accuracy: 0.4924
---------------------------------------
Saving the best model at 30 epochs!
---------------------------------------
```

```
Epoch: [32/50], Train loss: 0.7621
Epoch: [32/50], Valid loss: 1.5094, Valid accuracy: 0.5076
----------------------------------------
----------------------------------------
Epoch: [33/50], Train loss: 0.7266
Epoch: [33/50], Valid loss: 1.4865, Valid accuracy: 0.4822
----------------------------------------
----------------------------------------
Epoch: [34/50], Train loss: 0.7114
Epoch: [34/50], Valid loss: 1.4782, Valid accuracy: 0.5279
----------------------------------------
----------------------------------------
Epoch: [35/50], Train loss: 0.7387
Epoch: [35/50], Valid loss: 1.4780, Valid accuracy: 0.4975
----------------------------------------
----------------------------------------
Epoch: [36/50], Train loss: 0.7001
Epoch: [36/50], Valid loss: 1.4801, Valid accuracy: 0.5076
----------------------------------------
----------------------------------------
Epoch: [37/50], Train loss: 0.6755
Epoch: [37/50], Valid loss: 1.4662, Valid accuracy: 0.5076
----------------------------------------
----------------------------------------
Epoch: [38/50], Train loss: 0.6840
Epoch: [38/50], Valid loss: 1.4776, Valid accuracy: 0.5279
----------------------------------------
----------------------------------------
Epoch: [39/50], Train loss: 0.6859
Epoch: [39/50], Valid loss: 1.5038, Valid accuracy: 0.4873
----------------------------------------
----------------------------------------
Epoch: [40/50], Train loss: 0.6749
Epoch: [40/50], Valid loss: 1.4728, Valid accuracy: 0.5076
----------------------------------------
----------------------------------------
Epoch: [41/50], Train loss: 0.6814
Epoch: [41/50], Valid loss: 1.4639, Valid accuracy: 0.5127
----------------------------------------
----------------------------------------
Epoch: [42/50], Train loss: 0.6635
Epoch: [42/50], Valid loss: 1.5012, Valid accuracy: 0.4975
----------------------------------------
----------------------------------------
Epoch: [43/50], Train loss: 0.6325
Epoch: [43/50], Valid loss: 1.4611, Valid accuracy: 0.5279
----------------------------------------
----------------------------------------
```

```
Epoch: [44/50], Train loss: 0.6191
Epoch: [44/50], Valid loss: 1.5016, Valid accuracy: 0.5025
----------------------------------------
----------------------------------------
Epoch: [45/50], Train loss: 0.6006
Epoch: [45/50], Valid loss: 1.4706, Valid accuracy: 0.4924
----------------------------------------
----------------------------------------
Epoch: [46/50], Train loss: 0.5869
Epoch: [46/50], Valid loss: 1.4670, Valid accuracy: 0.5127
----------------------------------------
----------------------------------------
Epoch: [47/50], Train loss: 0.5818
Epoch: [47/50], Valid loss: 1.4780, Valid accuracy: 0.5076
----------------------------------------
----------------------------------------
Epoch: [48/50], Train loss: 0.5846
Epoch: [48/50], Valid loss: 1.4876, Valid accuracy: 0.4975
----------------------------------------
----------------------------------------
Epoch: [49/50], Train loss: 0.5866
Epoch: [49/50], Valid loss: 1.4719, Valid accuracy: 0.4975
----------------------------------------
----------------------------------------
Epoch: [50/50], Train loss: 0.5664
Epoch: [50/50], Valid loss: 1.5047, Valid accuracy: 0.5228
----------------------------------------
```

[17]:
```
evaluate(resnet_model, "best_resnet_model_melspectrogram.ckpt", test_loader,␣
  ↪device)
```

```
----------------------------------------
Model at best_resnet_model_melspectrogram.ckpt:
----------------------------------------
Accuracy: 0.5759
Precision: 0.5328
Recall: 0.5839
F1 Score: 0.5472
```



[18]:
```
effnet_model = EfficientNetV2S() # EfficientNetv2-S
train(effnet_model, "best_effnet_model_melspectrogram.ckpt", train_loader,␣
 ↪valid_loader, device, num_epochs=50, lr=1e-3, debug = True)
```

```
Downloading: "https://download.pytorch.org/models/efficientnet_v2_s-
dd5fe13b.pth" to /root/.cache/torch/hub/checkpoints/efficientnet_v2_s-
dd5fe13b.pth
100%|      | 82.7M/82.7M [00:00<00:00, 163MB/s]

----------------------------------------
Epoch: [1/50], Train loss: 2.2671
Epoch: [1/50], Valid loss: 2.2570, Valid accuracy: 0.1675
----------------------------------------
Saving the best model at 0 epochs!
----------------------------------------
Epoch: [2/50], Train loss: 2.0468
Epoch: [2/50], Valid loss: 1.9998, Valid accuracy: 0.3858
----------------------------------------
Saving the best model at 1 epochs!
----------------------------------------
Epoch: [3/50], Train loss: 1.8906
```

```
Epoch: [3/50], Valid loss: 1.8688, Valid accuracy: 0.4162
---------------------------------------
Saving the best model at 2 epochs!
---------------------------------------
Epoch: [4/50], Train loss: 1.7604
Epoch: [4/50], Valid loss: 1.7926, Valid accuracy: 0.4670
---------------------------------------
Saving the best model at 3 epochs!
---------------------------------------
Epoch: [5/50], Train loss: 1.6472
Epoch: [5/50], Valid loss: 1.7379, Valid accuracy: 0.4518
---------------------------------------
Saving the best model at 4 epochs!
---------------------------------------
Epoch: [6/50], Train loss: 1.5641
Epoch: [6/50], Valid loss: 1.6771, Valid accuracy: 0.4772
---------------------------------------
Saving the best model at 5 epochs!
---------------------------------------
Epoch: [7/50], Train loss: 1.4886
Epoch: [7/50], Valid loss: 1.6492, Valid accuracy: 0.4721
---------------------------------------
Saving the best model at 6 epochs!
---------------------------------------
Epoch: [8/50], Train loss: 1.4251
Epoch: [8/50], Valid loss: 1.6155, Valid accuracy: 0.4873
---------------------------------------
Saving the best model at 7 epochs!
---------------------------------------
Epoch: [9/50], Train loss: 1.3717
Epoch: [9/50], Valid loss: 1.6029, Valid accuracy: 0.4772
---------------------------------------
Saving the best model at 8 epochs!
---------------------------------------
Epoch: [10/50], Train loss: 1.3139
Epoch: [10/50], Valid loss: 1.5703, Valid accuracy: 0.4822
---------------------------------------
Saving the best model at 9 epochs!
---------------------------------------
Epoch: [11/50], Train loss: 1.2841
Epoch: [11/50], Valid loss: 1.5493, Valid accuracy: 0.4822
---------------------------------------
Saving the best model at 10 epochs!
---------------------------------------
Epoch: [12/50], Train loss: 1.2887
Epoch: [12/50], Valid loss: 1.5374, Valid accuracy: 0.4670
---------------------------------------
Saving the best model at 11 epochs!
```

```
---------------------------------------
Epoch: [13/50], Train loss: 1.2071
Epoch: [13/50], Valid loss: 1.5322, Valid accuracy: 0.5127
---------------------------------------
Saving the best model at 12 epochs!
---------------------------------------
Epoch: [14/50], Train loss: 1.1962
Epoch: [14/50], Valid loss: 1.5248, Valid accuracy: 0.5025
---------------------------------------
Saving the best model at 13 epochs!
---------------------------------------
Epoch: [15/50], Train loss: 1.1229
Epoch: [15/50], Valid loss: 1.4869, Valid accuracy: 0.5127
---------------------------------------
Saving the best model at 14 epochs!
---------------------------------------
Epoch: [16/50], Train loss: 1.1373
Epoch: [16/50], Valid loss: 1.4883, Valid accuracy: 0.5127
---------------------------------------
---------------------------------------
Epoch: [17/50], Train loss: 1.1243
Epoch: [17/50], Valid loss: 1.4837, Valid accuracy: 0.4975
---------------------------------------
Saving the best model at 16 epochs!
---------------------------------------
Epoch: [18/50], Train loss: 1.0452
Epoch: [18/50], Valid loss: 1.4629, Valid accuracy: 0.5127
---------------------------------------
Saving the best model at 17 epochs!
---------------------------------------
Epoch: [19/50], Train loss: 1.0333
Epoch: [19/50], Valid loss: 1.4650, Valid accuracy: 0.5381
---------------------------------------
---------------------------------------
Epoch: [20/50], Train loss: 1.0108
Epoch: [20/50], Valid loss: 1.4612, Valid accuracy: 0.5381
---------------------------------------
Saving the best model at 19 epochs!
---------------------------------------
Epoch: [21/50], Train loss: 1.0000
Epoch: [21/50], Valid loss: 1.4652, Valid accuracy: 0.5381
---------------------------------------
---------------------------------------
Epoch: [22/50], Train loss: 0.9891
Epoch: [22/50], Valid loss: 1.4588, Valid accuracy: 0.5228
---------------------------------------
Saving the best model at 21 epochs!
---------------------------------------
```

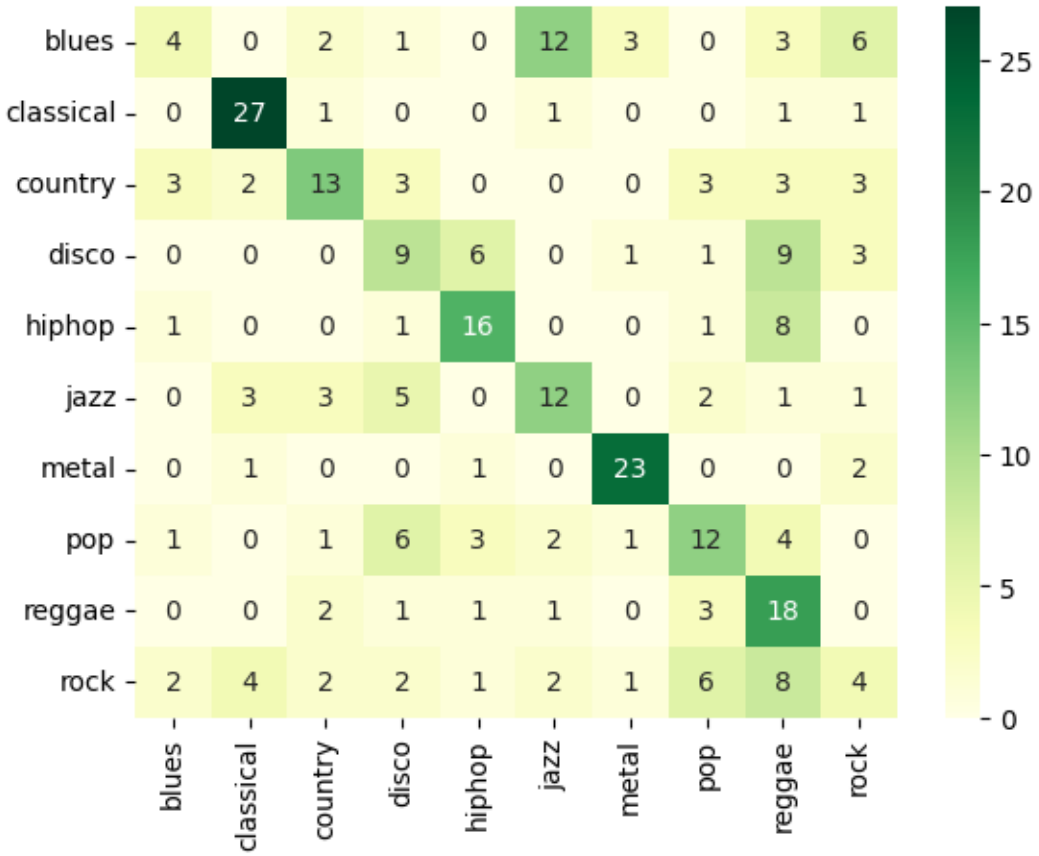
```
Epoch: [23/50], Train loss: 0.9882
Epoch: [23/50], Valid loss: 1.4621, Valid accuracy: 0.5076
----------------------------------------
----------------------------------------
Epoch: [24/50], Train loss: 0.9314
Epoch: [24/50], Valid loss: 1.4397, Valid accuracy: 0.5533
----------------------------------------
Saving the best model at 23 epochs!
----------------------------------------
Epoch: [25/50], Train loss: 0.9457
Epoch: [25/50], Valid loss: 1.4431, Valid accuracy: 0.5279
----------------------------------------
----------------------------------------
Epoch: [26/50], Train loss: 0.9337
Epoch: [26/50], Valid loss: 1.4345, Valid accuracy: 0.5381
----------------------------------------
Saving the best model at 25 epochs!
----------------------------------------
Epoch: [27/50], Train loss: 0.8747
Epoch: [27/50], Valid loss: 1.4420, Valid accuracy: 0.5279
----------------------------------------
----------------------------------------
Epoch: [28/50], Train loss: 0.8849
Epoch: [28/50], Valid loss: 1.4333, Valid accuracy: 0.5381
----------------------------------------
Saving the best model at 27 epochs!
----------------------------------------
Epoch: [29/50], Train loss: 0.8956
Epoch: [29/50], Valid loss: 1.4272, Valid accuracy: 0.5330
----------------------------------------
Saving the best model at 28 epochs!
----------------------------------------
Epoch: [30/50], Train loss: 0.8845
Epoch: [30/50], Valid loss: 1.4422, Valid accuracy: 0.5431
----------------------------------------
----------------------------------------
Epoch: [31/50], Train loss: 0.8332
Epoch: [31/50], Valid loss: 1.4071, Valid accuracy: 0.5533
----------------------------------------
Saving the best model at 30 epochs!
----------------------------------------
Epoch: [32/50], Train loss: 0.8530
Epoch: [32/50], Valid loss: 1.4228, Valid accuracy: 0.5381
----------------------------------------
----------------------------------------
Epoch: [33/50], Train loss: 0.8252
Epoch: [33/50], Valid loss: 1.4358, Valid accuracy: 0.5279
----------------------------------------
```

```
----------------------------------------
Epoch: [34/50], Train loss: 0.8246
Epoch: [34/50], Valid loss: 1.4159, Valid accuracy: 0.5381
----------------------------------------
----------------------------------------
Epoch: [35/50], Train loss: 0.8065
Epoch: [35/50], Valid loss: 1.4288, Valid accuracy: 0.5076
----------------------------------------
----------------------------------------
Epoch: [36/50], Train loss: 0.8108
Epoch: [36/50], Valid loss: 1.4071, Valid accuracy: 0.5330
----------------------------------------
Saving the best model at 35 epochs!
----------------------------------------
Epoch: [37/50], Train loss: 0.7804
Epoch: [37/50], Valid loss: 1.4186, Valid accuracy: 0.5381
----------------------------------------
----------------------------------------
Epoch: [38/50], Train loss: 0.7810
Epoch: [38/50], Valid loss: 1.4064, Valid accuracy: 0.5431
----------------------------------------
Saving the best model at 37 epochs!
----------------------------------------
Epoch: [39/50], Train loss: 0.7888
Epoch: [39/50], Valid loss: 1.4061, Valid accuracy: 0.5431
----------------------------------------
Saving the best model at 38 epochs!
----------------------------------------
Epoch: [40/50], Train loss: 0.8049
Epoch: [40/50], Valid loss: 1.3956, Valid accuracy: 0.5228
----------------------------------------
Saving the best model at 39 epochs!
----------------------------------------
Epoch: [41/50], Train loss: 0.7687
Epoch: [41/50], Valid loss: 1.4054, Valid accuracy: 0.5330
----------------------------------------
----------------------------------------
Epoch: [42/50], Train loss: 0.7261
Epoch: [42/50], Valid loss: 1.4183, Valid accuracy: 0.5279
----------------------------------------
----------------------------------------
Epoch: [43/50], Train loss: 0.7542
Epoch: [43/50], Valid loss: 1.3982, Valid accuracy: 0.5533
----------------------------------------
----------------------------------------
Epoch: [44/50], Train loss: 0.7369
Epoch: [44/50], Valid loss: 1.4138, Valid accuracy: 0.5431
----------------------------------------
```

```
----------------------------------------
Epoch: [45/50], Train loss: 0.7196
Epoch: [45/50], Valid loss: 1.3965, Valid accuracy: 0.5584
----------------------------------------
----------------------------------------
Epoch: [46/50], Train loss: 0.7206
Epoch: [46/50], Valid loss: 1.4135, Valid accuracy: 0.5482
----------------------------------------
----------------------------------------
Epoch: [47/50], Train loss: 0.7074
Epoch: [47/50], Valid loss: 1.4243, Valid accuracy: 0.5381
----------------------------------------
----------------------------------------
Epoch: [48/50], Train loss: 0.6868
Epoch: [48/50], Valid loss: 1.4037, Valid accuracy: 0.5330
----------------------------------------
----------------------------------------
Epoch: [49/50], Train loss: 0.7314
Epoch: [49/50], Valid loss: 1.3936, Valid accuracy: 0.5482
----------------------------------------
Saving the best model at 48 epochs!
----------------------------------------
Epoch: [50/50], Train loss: 0.7123
Epoch: [50/50], Valid loss: 1.4491, Valid accuracy: 0.5076
----------------------------------------
```

[19]:
```
evaluate(effnet_model, "best_effnet_model_melspectrogram.ckpt", test_loader,␣
  ↪device)
```

```
----------------------------------------
Model at best_effnet_model_melspectrogram.ckpt:
----------------------------------------
Accuracy: 0.4759
Precision: 0.4677
Recall: 0.4850
F1 Score: 0.4618
```



[20]:
```
# Initialize the data loaders for spectrograms
train_loader = get_dataloader(split='train', selected_feature = "spectrogram")
valid_loader = get_dataloader(split='valid', selected_feature = "spectrogram")
test_loader = get_dataloader(split='test', selected_feature = "spectrogram")

# train_spectrogram, train_genre = next(iter(train_loader))
# test_spectrogram, test_genre = next(iter(test_loader))

# print('Training Mini-Batch Tensor Shape: %s' % str(train_melspectrogram.
  ↪shape))
# print('Test Mini-Batch Tensor Shape: %s' % str(test_melspectrogram.shape))
```

[21]:
```
speccnn_model = SpectrogramCNN() # Custom model built by us
train(speccnn_model, "best_speccnn_model_spectrogram.ckpt", train_loader,␣
  ↪valid_loader, device, num_epochs=50, lr=1e-3, debug = True)
```

```
----------------------------------------
Epoch: [1/50], Train loss: 2.3476
Epoch: [1/50], Valid loss: 2.3532, Valid accuracy: 0.1015
----------------------------------------
```

```
Saving the best model at 0 epochs!
---------------------------------------
Epoch: [2/50], Train loss: 2.1226
Epoch: [2/50], Valid loss: 2.2427, Valid accuracy: 0.2030
---------------------------------------
Saving the best model at 1 epochs!
---------------------------------------
Epoch: [3/50], Train loss: 1.9534
Epoch: [3/50], Valid loss: 2.1090, Valid accuracy: 0.2234
---------------------------------------
Saving the best model at 2 epochs!
---------------------------------------
Epoch: [4/50], Train loss: 1.9066
Epoch: [4/50], Valid loss: 2.0617, Valid accuracy: 0.2538
---------------------------------------
Saving the best model at 3 epochs!
---------------------------------------
Epoch: [5/50], Train loss: 1.7968
Epoch: [5/50], Valid loss: 2.0515, Valid accuracy: 0.2386
---------------------------------------
Saving the best model at 4 epochs!
---------------------------------------
Epoch: [6/50], Train loss: 1.7070
Epoch: [6/50], Valid loss: 2.0640, Valid accuracy: 0.2386
---------------------------------------
---------------------------------------
Epoch: [7/50], Train loss: 1.6809
Epoch: [7/50], Valid loss: 2.0097, Valid accuracy: 0.2589
---------------------------------------
Saving the best model at 6 epochs!
---------------------------------------
Epoch: [8/50], Train loss: 1.6461
Epoch: [8/50], Valid loss: 1.9424, Valid accuracy: 0.2741
---------------------------------------
Saving the best model at 7 epochs!
---------------------------------------
Epoch: [9/50], Train loss: 1.5796
Epoch: [9/50], Valid loss: 1.8627, Valid accuracy: 0.3503
---------------------------------------
Saving the best model at 8 epochs!
---------------------------------------
Epoch: [10/50], Train loss: 1.5517
Epoch: [10/50], Valid loss: 1.9404, Valid accuracy: 0.2792
---------------------------------------
---------------------------------------
Epoch: [11/50], Train loss: 1.4858
Epoch: [11/50], Valid loss: 1.8595, Valid accuracy: 0.3452
---------------------------------------
```

```
Saving the best model at 10 epochs!
---------------------------------------
Epoch: [12/50], Train loss: 1.4501
Epoch: [12/50], Valid loss: 1.7558, Valid accuracy: 0.3503
---------------------------------------
Saving the best model at 11 epochs!
---------------------------------------
Epoch: [13/50], Train loss: 1.4462
Epoch: [13/50], Valid loss: 1.7753, Valid accuracy: 0.3959
---------------------------------------
---------------------------------------
Epoch: [14/50], Train loss: 1.4252
Epoch: [14/50], Valid loss: 1.8635, Valid accuracy: 0.3452
---------------------------------------
---------------------------------------
Epoch: [15/50], Train loss: 1.3634
Epoch: [15/50], Valid loss: 1.7090, Valid accuracy: 0.3909
---------------------------------------
Saving the best model at 14 epochs!
---------------------------------------
Epoch: [16/50], Train loss: 1.2687
Epoch: [16/50], Valid loss: 1.6937, Valid accuracy: 0.3858
---------------------------------------
Saving the best model at 15 epochs!
---------------------------------------
Epoch: [17/50], Train loss: 1.2803
Epoch: [17/50], Valid loss: 1.6481, Valid accuracy: 0.4518
---------------------------------------
Saving the best model at 16 epochs!
---------------------------------------
Epoch: [18/50], Train loss: 1.2441
Epoch: [18/50], Valid loss: 1.6717, Valid accuracy: 0.3909
---------------------------------------
---------------------------------------
Epoch: [19/50], Train loss: 1.2097
Epoch: [19/50], Valid loss: 1.8737, Valid accuracy: 0.3350
---------------------------------------
---------------------------------------
Epoch: [20/50], Train loss: 1.1819
Epoch: [20/50], Valid loss: 1.6173, Valid accuracy: 0.4112
---------------------------------------
Saving the best model at 19 epochs!
---------------------------------------
Epoch: [21/50], Train loss: 1.0820
Epoch: [21/50], Valid loss: 1.5776, Valid accuracy: 0.4162
---------------------------------------
Saving the best model at 20 epochs!
---------------------------------------
```

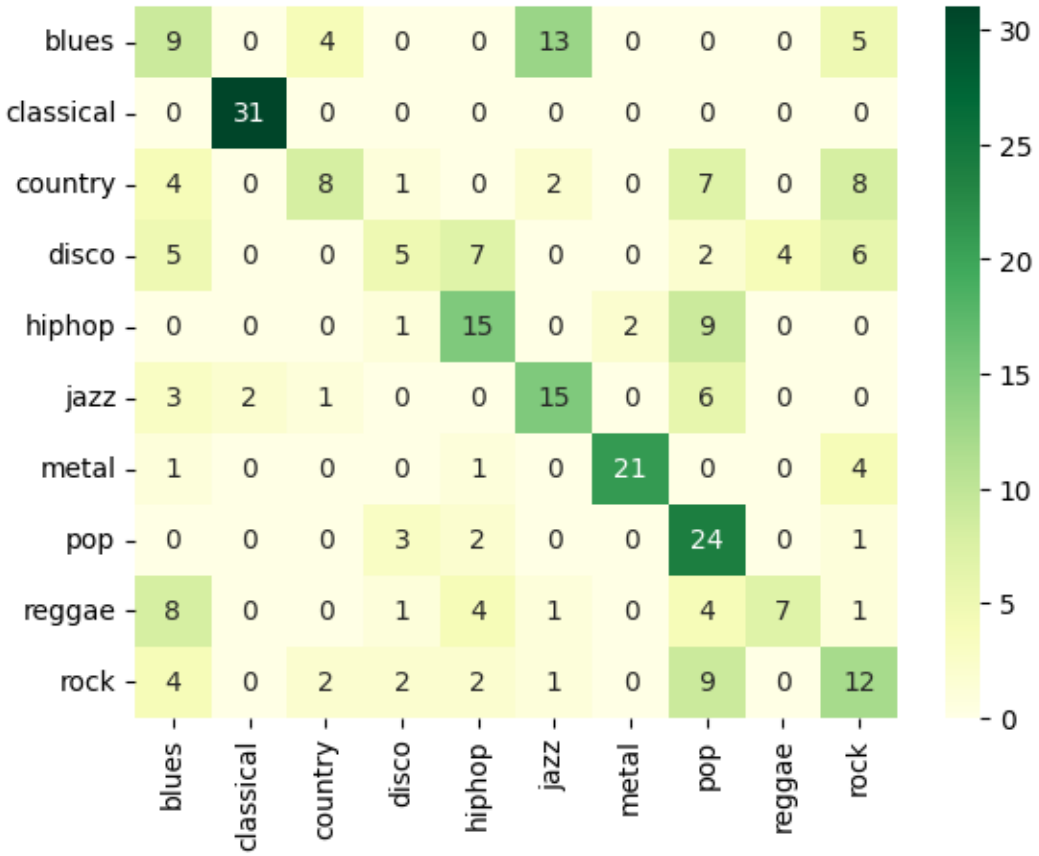
```
Epoch: [22/50], Train loss: 1.0732
Epoch: [22/50], Valid loss: 1.5224, Valid accuracy: 0.4772
---------------------------------------
Saving the best model at 21 epochs!
---------------------------------------
Epoch: [23/50], Train loss: 1.0836
Epoch: [23/50], Valid loss: 1.6139, Valid accuracy: 0.4112
---------------------------------------
---------------------------------------
Epoch: [24/50], Train loss: 1.0650
Epoch: [24/50], Valid loss: 1.5281, Valid accuracy: 0.4264
---------------------------------------
---------------------------------------
Epoch: [25/50], Train loss: 1.0410
Epoch: [25/50], Valid loss: 1.5797, Valid accuracy: 0.4569
---------------------------------------
---------------------------------------
Epoch: [26/50], Train loss: 0.9533
Epoch: [26/50], Valid loss: 1.5648, Valid accuracy: 0.4061
---------------------------------------
---------------------------------------
Epoch: [27/50], Train loss: 0.9818
Epoch: [27/50], Valid loss: 1.6942, Valid accuracy: 0.4112
---------------------------------------
---------------------------------------
Epoch: [28/50], Train loss: 0.9679
Epoch: [28/50], Valid loss: 1.7874, Valid accuracy: 0.3909
---------------------------------------
---------------------------------------
Epoch: [29/50], Train loss: 0.9290
Epoch: [29/50], Valid loss: 1.4163, Valid accuracy: 0.4822
---------------------------------------
Saving the best model at 28 epochs!
---------------------------------------
Epoch: [30/50], Train loss: 1.0066
Epoch: [30/50], Valid loss: 1.6017, Valid accuracy: 0.4416
---------------------------------------
---------------------------------------
Epoch: [31/50], Train loss: 0.9105
Epoch: [31/50], Valid loss: 1.3102, Valid accuracy: 0.5736
---------------------------------------
Saving the best model at 30 epochs!
---------------------------------------
Epoch: [32/50], Train loss: 0.8618
Epoch: [32/50], Valid loss: 1.5078, Valid accuracy: 0.5381
---------------------------------------
---------------------------------------
Epoch: [33/50], Train loss: 0.8695
```

```
Epoch: [33/50], Valid loss: 1.4798, Valid accuracy: 0.4619
----------------------------------------
----------------------------------------
Epoch: [34/50], Train loss: 0.8235
Epoch: [34/50], Valid loss: 1.9080, Valid accuracy: 0.3756
----------------------------------------
----------------------------------------
Epoch: [35/50], Train loss: 0.7966
Epoch: [35/50], Valid loss: 1.5019, Valid accuracy: 0.4365
----------------------------------------
----------------------------------------
Epoch: [36/50], Train loss: 0.8384
Epoch: [36/50], Valid loss: 1.8467, Valid accuracy: 0.3756
----------------------------------------
----------------------------------------
Epoch: [37/50], Train loss: 0.7751
Epoch: [37/50], Valid loss: 1.5109, Valid accuracy: 0.4873
----------------------------------------
----------------------------------------
Epoch: [38/50], Train loss: 0.7567
Epoch: [38/50], Valid loss: 1.5357, Valid accuracy: 0.4822
----------------------------------------
----------------------------------------
Epoch: [39/50], Train loss: 0.7465
Epoch: [39/50], Valid loss: 1.3781, Valid accuracy: 0.5279
----------------------------------------
----------------------------------------
Epoch: [40/50], Train loss: 0.7674
Epoch: [40/50], Valid loss: 1.6174, Valid accuracy: 0.4924
----------------------------------------
----------------------------------------
Epoch: [41/50], Train loss: 0.7267
Epoch: [41/50], Valid loss: 1.3523, Valid accuracy: 0.6142
----------------------------------------
----------------------------------------
Epoch: [42/50], Train loss: 0.7179
Epoch: [42/50], Valid loss: 1.4985, Valid accuracy: 0.4975
----------------------------------------
----------------------------------------
Epoch: [43/50], Train loss: 0.6909
Epoch: [43/50], Valid loss: 1.6161, Valid accuracy: 0.5076
----------------------------------------
----------------------------------------
Epoch: [44/50], Train loss: 0.6369
Epoch: [44/50], Valid loss: 1.4548, Valid accuracy: 0.5228
----------------------------------------
----------------------------------------
Epoch: [45/50], Train loss: 0.6227
```

```
Epoch: [45/50], Valid loss: 1.3285, Valid accuracy: 0.5635
----------------------------------------
----------------------------------------
Epoch: [46/50], Train loss: 0.6566
Epoch: [46/50], Valid loss: 1.5960, Valid accuracy: 0.4924
----------------------------------------
----------------------------------------
Epoch: [47/50], Train loss: 0.6413
Epoch: [47/50], Valid loss: 1.8024, Valid accuracy: 0.4416
----------------------------------------
----------------------------------------
Epoch: [48/50], Train loss: 0.6780
Epoch: [48/50], Valid loss: 1.4749, Valid accuracy: 0.5076
----------------------------------------
----------------------------------------
Epoch: [49/50], Train loss: 0.6462
Epoch: [49/50], Valid loss: 1.4643, Valid accuracy: 0.4924
----------------------------------------
----------------------------------------
Epoch: [50/50], Train loss: 0.5690
Epoch: [50/50], Valid loss: 1.6031, Valid accuracy: 0.4822
----------------------------------------
```

[22]:
```
evaluate(speccnn_model, "best_speccnn_model_spectrogram.ckpt", test_loader,␣
↪device)
```

```
----------------------------------------
Model at best_speccnn_model_spectrogram.ckpt:
----------------------------------------
Accuracy: 0.5069
Precision: 0.5342
Recall: 0.5063
F1 Score: 0.4959
```



[23]:
```
resnet_model = ResNet18() # ResNet-18
train(resnet_model, "best_resnet_model_spectrogram.ckpt", train_loader,␣
  ↪valid_loader, device, num_epochs=50, lr=1e-3, debug = True)
```

```
----------------------------------------
Epoch: [1/50], Train loss: 2.3556
Epoch: [1/50], Valid loss: 2.2668, Valid accuracy: 0.1472
----------------------------------------
Saving the best model at 0 epochs!
----------------------------------------
Epoch: [2/50], Train loss: 2.0943
Epoch: [2/50], Valid loss: 2.0968, Valid accuracy: 0.2843
----------------------------------------
Saving the best model at 1 epochs!
----------------------------------------
Epoch: [3/50], Train loss: 1.8901
Epoch: [3/50], Valid loss: 1.9381, Valid accuracy: 0.3807
----------------------------------------
Saving the best model at 2 epochs!
----------------------------------------
```

```
Epoch: [4/50], Train loss: 1.7322
Epoch: [4/50], Valid loss: 1.8843, Valid accuracy: 0.3147
---------------------------------------
Saving the best model at 3 epochs!
---------------------------------------
Epoch: [5/50], Train loss: 1.6034
Epoch: [5/50], Valid loss: 1.8213, Valid accuracy: 0.3959
---------------------------------------
Saving the best model at 4 epochs!
---------------------------------------
Epoch: [6/50], Train loss: 1.5131
Epoch: [6/50], Valid loss: 1.7716, Valid accuracy: 0.3807
---------------------------------------
Saving the best model at 5 epochs!
---------------------------------------
Epoch: [7/50], Train loss: 1.4220
Epoch: [7/50], Valid loss: 1.7174, Valid accuracy: 0.4518
---------------------------------------
Saving the best model at 6 epochs!
---------------------------------------
Epoch: [8/50], Train loss: 1.3687
Epoch: [8/50], Valid loss: 1.7472, Valid accuracy: 0.3706
---------------------------------------
---------------------------------------
Epoch: [9/50], Train loss: 1.3314
Epoch: [9/50], Valid loss: 1.6606, Valid accuracy: 0.3959
---------------------------------------
Saving the best model at 8 epochs!
---------------------------------------
Epoch: [10/50], Train loss: 1.3040
Epoch: [10/50], Valid loss: 1.6960, Valid accuracy: 0.4264
---------------------------------------
---------------------------------------
Epoch: [11/50], Train loss: 1.2089
Epoch: [11/50], Valid loss: 1.6314, Valid accuracy: 0.4061
---------------------------------------
Saving the best model at 10 epochs!
---------------------------------------
Epoch: [12/50], Train loss: 1.1964
Epoch: [12/50], Valid loss: 1.6418, Valid accuracy: 0.4467
---------------------------------------
---------------------------------------
Epoch: [13/50], Train loss: 1.1388
Epoch: [13/50], Valid loss: 1.6168, Valid accuracy: 0.4213
---------------------------------------
Saving the best model at 12 epochs!
---------------------------------------
Epoch: [14/50], Train loss: 1.1167
```

```
Epoch: [14/50], Valid loss: 1.6181, Valid accuracy: 0.4315
---------------------------------------
---------------------------------------
Epoch: [15/50], Train loss: 1.1033
Epoch: [15/50], Valid loss: 1.5978, Valid accuracy: 0.4619
---------------------------------------
Saving the best model at 14 epochs!
---------------------------------------
Epoch: [16/50], Train loss: 1.0406
Epoch: [16/50], Valid loss: 1.5682, Valid accuracy: 0.4467
---------------------------------------
Saving the best model at 15 epochs!
---------------------------------------
Epoch: [17/50], Train loss: 1.0167
Epoch: [17/50], Valid loss: 1.5730, Valid accuracy: 0.4518
---------------------------------------
---------------------------------------
Epoch: [18/50], Train loss: 1.0046
Epoch: [18/50], Valid loss: 1.5607, Valid accuracy: 0.4822
---------------------------------------
Saving the best model at 17 epochs!
---------------------------------------
Epoch: [19/50], Train loss: 0.9678
Epoch: [19/50], Valid loss: 1.5302, Valid accuracy: 0.4315
---------------------------------------
Saving the best model at 18 epochs!
---------------------------------------
Epoch: [20/50], Train loss: 0.9245
Epoch: [20/50], Valid loss: 1.5484, Valid accuracy: 0.4670
---------------------------------------
---------------------------------------
Epoch: [21/50], Train loss: 0.9133
Epoch: [21/50], Valid loss: 1.5159, Valid accuracy: 0.4670
---------------------------------------
Saving the best model at 20 epochs!
---------------------------------------
Epoch: [22/50], Train loss: 0.8821
Epoch: [22/50], Valid loss: 1.5298, Valid accuracy: 0.4619
---------------------------------------
---------------------------------------
Epoch: [23/50], Train loss: 0.8804
Epoch: [23/50], Valid loss: 1.5278, Valid accuracy: 0.4315
---------------------------------------
---------------------------------------
Epoch: [24/50], Train loss: 0.8817
Epoch: [24/50], Valid loss: 1.5081, Valid accuracy: 0.4721
---------------------------------------
Saving the best model at 23 epochs!
```

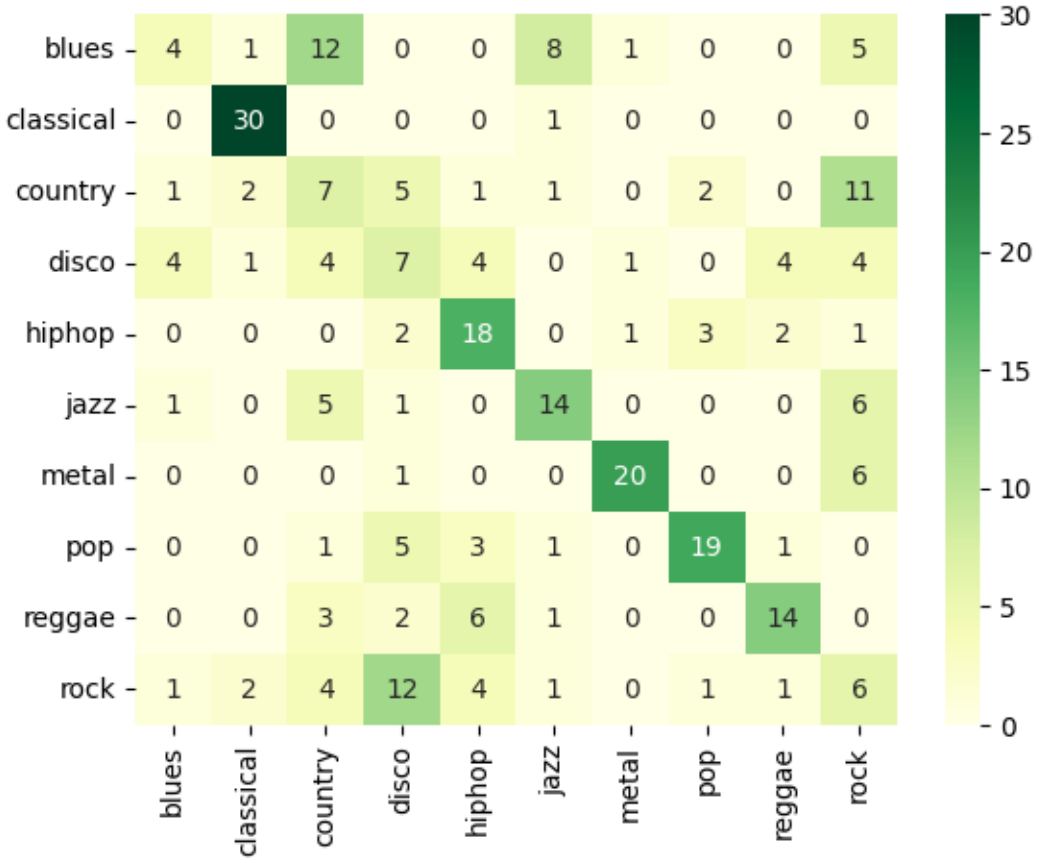
```
----------------------------------------
Epoch: [25/50], Train loss: 0.8346
Epoch: [25/50], Valid loss: 1.5110, Valid accuracy: 0.4518
----------------------------------------
----------------------------------------
Epoch: [26/50], Train loss: 0.8368
Epoch: [26/50], Valid loss: 1.5064, Valid accuracy: 0.4772
----------------------------------------
Saving the best model at 25 epochs!
----------------------------------------
Epoch: [27/50], Train loss: 0.8280
Epoch: [27/50], Valid loss: 1.5385, Valid accuracy: 0.4721
----------------------------------------
----------------------------------------
Epoch: [28/50], Train loss: 0.8102
Epoch: [28/50], Valid loss: 1.4871, Valid accuracy: 0.4772
----------------------------------------
Saving the best model at 27 epochs!
----------------------------------------
Epoch: [29/50], Train loss: 0.7801
Epoch: [29/50], Valid loss: 1.5004, Valid accuracy: 0.4365
----------------------------------------
----------------------------------------
Epoch: [30/50], Train loss: 0.7781
Epoch: [30/50], Valid loss: 1.4831, Valid accuracy: 0.4822
----------------------------------------
Saving the best model at 29 epochs!
----------------------------------------
Epoch: [31/50], Train loss: 0.7546
Epoch: [31/50], Valid loss: 1.4890, Valid accuracy: 0.4619
----------------------------------------
----------------------------------------
Epoch: [32/50], Train loss: 0.7577
Epoch: [32/50], Valid loss: 1.4938, Valid accuracy: 0.4670
----------------------------------------
----------------------------------------
Epoch: [33/50], Train loss: 0.7270
Epoch: [33/50], Valid loss: 1.4773, Valid accuracy: 0.4822
----------------------------------------
Saving the best model at 32 epochs!
----------------------------------------
Epoch: [34/50], Train loss: 0.7112
Epoch: [34/50], Valid loss: 1.4922, Valid accuracy: 0.4518
----------------------------------------
----------------------------------------
Epoch: [35/50], Train loss: 0.7358
Epoch: [35/50], Valid loss: 1.5126, Valid accuracy: 0.4822
----------------------------------------
```

```
---------------------------------------
Epoch: [36/50], Train loss: 0.6861
Epoch: [36/50], Valid loss: 1.5050, Valid accuracy: 0.4619
---------------------------------------
---------------------------------------
Epoch: [37/50], Train loss: 0.7093
Epoch: [37/50], Valid loss: 1.5082, Valid accuracy: 0.4670
---------------------------------------
---------------------------------------
Epoch: [38/50], Train loss: 0.7083
Epoch: [38/50], Valid loss: 1.4669, Valid accuracy: 0.4721
---------------------------------------
Saving the best model at 37 epochs!
---------------------------------------
Epoch: [39/50], Train loss: 0.6526
Epoch: [39/50], Valid loss: 1.5025, Valid accuracy: 0.4670
---------------------------------------
---------------------------------------
Epoch: [40/50], Train loss: 0.6965
Epoch: [40/50], Valid loss: 1.4639, Valid accuracy: 0.4822
---------------------------------------
Saving the best model at 39 epochs!
---------------------------------------
Epoch: [41/50], Train loss: 0.6440
Epoch: [41/50], Valid loss: 1.4729, Valid accuracy: 0.4873
---------------------------------------
---------------------------------------
Epoch: [42/50], Train loss: 0.6379
Epoch: [42/50], Valid loss: 1.4661, Valid accuracy: 0.4670
---------------------------------------
---------------------------------------
Epoch: [43/50], Train loss: 0.6107
Epoch: [43/50], Valid loss: 1.4670, Valid accuracy: 0.4822
---------------------------------------
---------------------------------------
Epoch: [44/50], Train loss: 0.6100
Epoch: [44/50], Valid loss: 1.4760, Valid accuracy: 0.4721
---------------------------------------
---------------------------------------
Epoch: [45/50], Train loss: 0.6327
Epoch: [45/50], Valid loss: 1.4822, Valid accuracy: 0.4822
---------------------------------------
---------------------------------------
Epoch: [46/50], Train loss: 0.6170
Epoch: [46/50], Valid loss: 1.4656, Valid accuracy: 0.4721
---------------------------------------
---------------------------------------
Epoch: [47/50], Train loss: 0.5987
```

```
Epoch: [47/50], Valid loss: 1.4594, Valid accuracy: 0.5025
----------------------------------------
Saving the best model at 46 epochs!
----------------------------------------
Epoch: [48/50], Train loss: 0.5978
Epoch: [48/50], Valid loss: 1.5000, Valid accuracy: 0.4619
----------------------------------------
----------------------------------------
Epoch: [49/50], Train loss: 0.5713
Epoch: [49/50], Valid loss: 1.4498, Valid accuracy: 0.4924
----------------------------------------
Saving the best model at 48 epochs!
----------------------------------------
Epoch: [50/50], Train loss: 0.6043
Epoch: [50/50], Valid loss: 1.5022, Valid accuracy: 0.4873
----------------------------------------
```

[24]:
```
evaluate(resnet_model, "best_resnet_model_spectrogram.ckpt", test_loader,␣
↪device)
```

```
----------------------------------------
Model at best_resnet_model_spectrogram.ckpt:
----------------------------------------
Accuracy: 0.4793
Precision: 0.5030
Recall: 0.4857
F1 Score: 0.4850
```



[25]:
```
effnet_model = EfficientNetV2S() # EfficientNetv2-S
train(effnet_model, "best_effnet_model_spectrogram.ckpt", train_loader,␣
 ↪valid_loader, device, num_epochs=50, lr=1e-3, debug = True)
```

```
----------------------------------------
Epoch: [1/50], Train loss: 2.2556
Epoch: [1/50], Valid loss: 2.2398, Valid accuracy: 0.2437
----------------------------------------
Saving the best model at 0 epochs!
----------------------------------------
Epoch: [2/50], Train loss: 2.0613
Epoch: [2/50], Valid loss: 2.0607, Valid accuracy: 0.3096
----------------------------------------
Saving the best model at 1 epochs!
----------------------------------------
Epoch: [3/50], Train loss: 1.9198
Epoch: [3/50], Valid loss: 1.9549, Valid accuracy: 0.3553
----------------------------------------
Saving the best model at 2 epochs!
----------------------------------------
```

```
Epoch: [4/50], Train loss: 1.8167
Epoch: [4/50], Valid loss: 1.9096, Valid accuracy: 0.3909
---------------------------------------
Saving the best model at 3 epochs!
---------------------------------------
Epoch: [5/50], Train loss: 1.7358
Epoch: [5/50], Valid loss: 1.8527, Valid accuracy: 0.3959
---------------------------------------
Saving the best model at 4 epochs!
---------------------------------------
Epoch: [6/50], Train loss: 1.6660
Epoch: [6/50], Valid loss: 1.8249, Valid accuracy: 0.3959
---------------------------------------
Saving the best model at 5 epochs!
---------------------------------------
Epoch: [7/50], Train loss: 1.6021
Epoch: [7/50], Valid loss: 1.7840, Valid accuracy: 0.4010
---------------------------------------
Saving the best model at 6 epochs!
---------------------------------------
Epoch: [8/50], Train loss: 1.6030
Epoch: [8/50], Valid loss: 1.7812, Valid accuracy: 0.3909
---------------------------------------
Saving the best model at 7 epochs!
---------------------------------------
Epoch: [9/50], Train loss: 1.5356
Epoch: [9/50], Valid loss: 1.7459, Valid accuracy: 0.3959
---------------------------------------
Saving the best model at 8 epochs!
---------------------------------------
Epoch: [10/50], Train loss: 1.4268
Epoch: [10/50], Valid loss: 1.6983, Valid accuracy: 0.4162
---------------------------------------
Saving the best model at 9 epochs!
---------------------------------------
Epoch: [11/50], Train loss: 1.4666
Epoch: [11/50], Valid loss: 1.7271, Valid accuracy: 0.4213
---------------------------------------
---------------------------------------
Epoch: [12/50], Train loss: 1.3943
Epoch: [12/50], Valid loss: 1.6651, Valid accuracy: 0.4264
---------------------------------------
Saving the best model at 11 epochs!
---------------------------------------
Epoch: [13/50], Train loss: 1.3845
Epoch: [13/50], Valid loss: 1.6752, Valid accuracy: 0.4162
---------------------------------------
---------------------------------------
```

```
Epoch: [14/50], Train loss: 1.2636
Epoch: [14/50], Valid loss: 1.6517, Valid accuracy: 0.4315
----------------------------------------
Saving the best model at 13 epochs!
----------------------------------------
Epoch: [15/50], Train loss: 1.3411
Epoch: [15/50], Valid loss: 1.6512, Valid accuracy: 0.4213
----------------------------------------
Saving the best model at 14 epochs!
----------------------------------------
Epoch: [16/50], Train loss: 1.2617
Epoch: [16/50], Valid loss: 1.6058, Valid accuracy: 0.4365
----------------------------------------
Saving the best model at 15 epochs!
----------------------------------------
Epoch: [17/50], Train loss: 1.2531
Epoch: [17/50], Valid loss: 1.6221, Valid accuracy: 0.4315
----------------------------------------
----------------------------------------
Epoch: [18/50], Train loss: 1.2752
Epoch: [18/50], Valid loss: 1.6522, Valid accuracy: 0.4061
----------------------------------------
----------------------------------------
Epoch: [19/50], Train loss: 1.1442
Epoch: [19/50], Valid loss: 1.5943, Valid accuracy: 0.4264
----------------------------------------
Saving the best model at 18 epochs!
----------------------------------------
Epoch: [20/50], Train loss: 1.1869
Epoch: [20/50], Valid loss: 1.5913, Valid accuracy: 0.4365
----------------------------------------
Saving the best model at 19 epochs!
----------------------------------------
Epoch: [21/50], Train loss: 1.1411
Epoch: [21/50], Valid loss: 1.5752, Valid accuracy: 0.4416
----------------------------------------
Saving the best model at 20 epochs!
----------------------------------------
Epoch: [22/50], Train loss: 1.2226
Epoch: [22/50], Valid loss: 1.6182, Valid accuracy: 0.4213
----------------------------------------
----------------------------------------
Epoch: [23/50], Train loss: 1.1000
Epoch: [23/50], Valid loss: 1.5776, Valid accuracy: 0.4416
----------------------------------------
----------------------------------------
Epoch: [24/50], Train loss: 1.1617
Epoch: [24/50], Valid loss: 1.5776, Valid accuracy: 0.4619
```

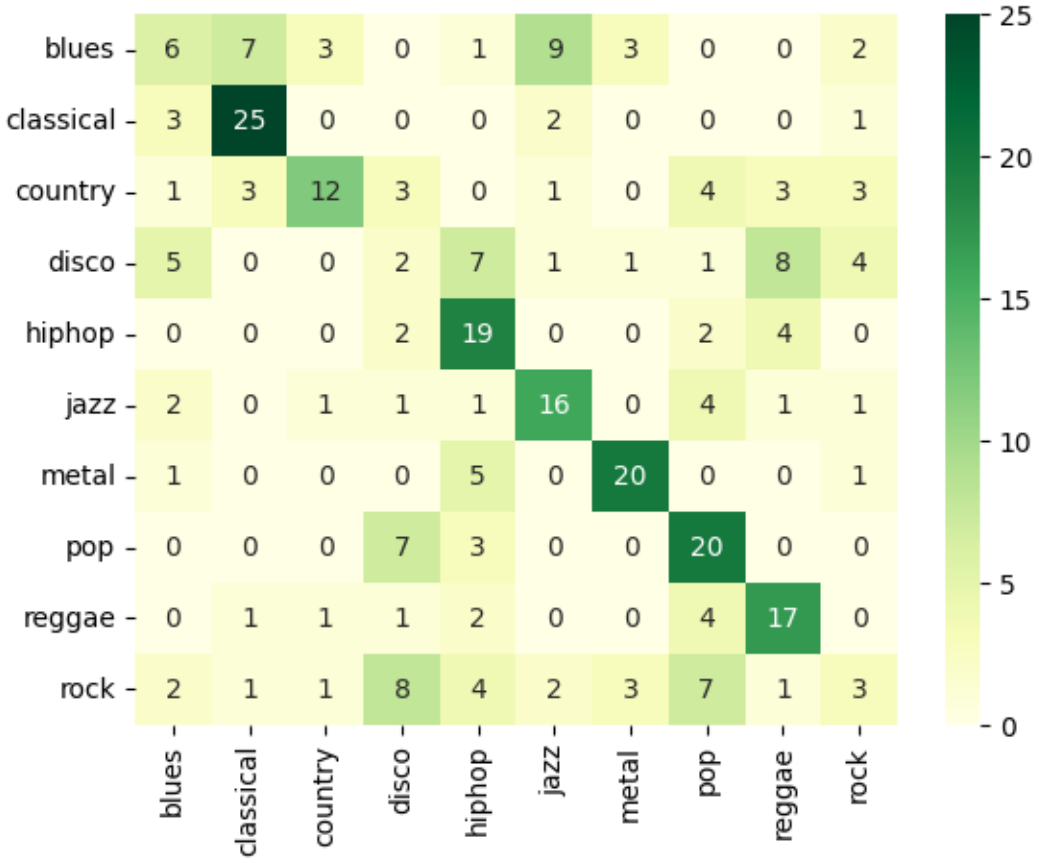
```
---------------------------------------
---------------------------------------
Epoch: [25/50], Train loss: 1.1352
Epoch: [25/50], Valid loss: 1.5665, Valid accuracy: 0.4670
---------------------------------------
Saving the best model at 24 epochs!
---------------------------------------
Epoch: [26/50], Train loss: 1.0710
Epoch: [26/50], Valid loss: 1.5595, Valid accuracy: 0.4569
---------------------------------------
Saving the best model at 25 epochs!
---------------------------------------
Epoch: [27/50], Train loss: 1.0420
Epoch: [27/50], Valid loss: 1.5652, Valid accuracy: 0.4518
---------------------------------------
---------------------------------------
Epoch: [28/50], Train loss: 1.0898
Epoch: [28/50], Valid loss: 1.5556, Valid accuracy: 0.4721
---------------------------------------
Saving the best model at 27 epochs!
---------------------------------------
Epoch: [29/50], Train loss: 1.0172
Epoch: [29/50], Valid loss: 1.5368, Valid accuracy: 0.4721
---------------------------------------
Saving the best model at 28 epochs!
---------------------------------------
Epoch: [30/50], Train loss: 1.0606
Epoch: [30/50], Valid loss: 1.5399, Valid accuracy: 0.4873
---------------------------------------
---------------------------------------
Epoch: [31/50], Train loss: 1.0445
Epoch: [31/50], Valid loss: 1.5475, Valid accuracy: 0.4518
---------------------------------------
---------------------------------------
Epoch: [32/50], Train loss: 1.0019
Epoch: [32/50], Valid loss: 1.5356, Valid accuracy: 0.4619
---------------------------------------
Saving the best model at 31 epochs!
---------------------------------------
Epoch: [33/50], Train loss: 1.0381
Epoch: [33/50], Valid loss: 1.5316, Valid accuracy: 0.4721
---------------------------------------
Saving the best model at 32 epochs!
---------------------------------------
Epoch: [34/50], Train loss: 0.9833
Epoch: [34/50], Valid loss: 1.5333, Valid accuracy: 0.4416
---------------------------------------
---------------------------------------
```

```
Epoch: [35/50], Train loss: 0.9886
Epoch: [35/50], Valid loss: 1.5436, Valid accuracy: 0.4569
----------------------------------------
----------------------------------------
Epoch: [36/50], Train loss: 0.9556
Epoch: [36/50], Valid loss: 1.5581, Valid accuracy: 0.4365
----------------------------------------
----------------------------------------
Epoch: [37/50], Train loss: 1.0276
Epoch: [37/50], Valid loss: 1.5556, Valid accuracy: 0.4670
----------------------------------------
----------------------------------------
Epoch: [38/50], Train loss: 0.9976
Epoch: [38/50], Valid loss: 1.5541, Valid accuracy: 0.4518
----------------------------------------
----------------------------------------
Epoch: [39/50], Train loss: 0.9778
Epoch: [39/50], Valid loss: 1.5508, Valid accuracy: 0.4518
----------------------------------------
----------------------------------------
Epoch: [40/50], Train loss: 0.9837
Epoch: [40/50], Valid loss: 1.5559, Valid accuracy: 0.4619
----------------------------------------
----------------------------------------
Epoch: [41/50], Train loss: 0.9578
Epoch: [41/50], Valid loss: 1.5279, Valid accuracy: 0.4670
----------------------------------------
Saving the best model at 40 epochs!
----------------------------------------
Epoch: [42/50], Train loss: 0.9555
Epoch: [42/50], Valid loss: 1.5313, Valid accuracy: 0.4772
----------------------------------------
----------------------------------------
Epoch: [43/50], Train loss: 0.9198
Epoch: [43/50], Valid loss: 1.5212, Valid accuracy: 0.4822
----------------------------------------
Saving the best model at 42 epochs!
----------------------------------------
Epoch: [44/50], Train loss: 0.9405
Epoch: [44/50], Valid loss: 1.5098, Valid accuracy: 0.4772
----------------------------------------
Saving the best model at 43 epochs!
----------------------------------------
Epoch: [45/50], Train loss: 0.9729
Epoch: [45/50], Valid loss: 1.5352, Valid accuracy: 0.4721
----------------------------------------
----------------------------------------
Epoch: [46/50], Train loss: 0.8716
```

```
Epoch: [46/50], Valid loss: 1.5265, Valid accuracy: 0.4721
----------------------------------------
----------------------------------------
Epoch: [47/50], Train loss: 0.9491
Epoch: [47/50], Valid loss: 1.5464, Valid accuracy: 0.4670
----------------------------------------
----------------------------------------
Epoch: [48/50], Train loss: 0.8708
Epoch: [48/50], Valid loss: 1.5380, Valid accuracy: 0.4670
----------------------------------------
----------------------------------------
Epoch: [49/50], Train loss: 0.8430
Epoch: [49/50], Valid loss: 1.5330, Valid accuracy: 0.4670
----------------------------------------
----------------------------------------
Epoch: [50/50], Train loss: 0.8536
Epoch: [50/50], Valid loss: 1.5187, Valid accuracy: 0.4721
----------------------------------------
```

[26]:
```
evaluate(effnet_model, "best_effnet_model_spectrogram.ckpt", test_loader,␣
↪device)
```

```
----------------------------------------
Model at best_effnet_model_spectrogram.ckpt:
----------------------------------------
Accuracy: 0.4828
Precision: 0.4611
Recall: 0.4920
F1 Score: 0.4639
```



[27]:
```
# Initialize the data loaders for mfccs
train_loader = get_dataloader(split='train', selected_feature = "mfcc")
valid_loader = get_dataloader(split='valid', selected_feature = "mfcc")
test_loader = get_dataloader(split='test', selected_feature = "mfcc")

# train_spectrogram, train_genre = next(iter(train_loader))
# test_spectrogram, test_genre = next(iter(test_loader))

# print('Training Mini-Batch Tensor Shape: %s' % str(train_melspectrogram.
  ↪shape))
# print('Test Mini-Batch Tensor Shape: %s' % str(test_melspectrogram.shape))
```

[28]:
```
speccnn_model = SpectrogramCNN() # Custom model built by us
train(speccnn_model, "best_speccnn_model_mfcc.ckpt", train_loader,␣
  ↪valid_loader, device, num_epochs=50, lr=1e-3, debug = True)
```

```
----------------------------------------
Epoch: [1/50], Train loss: 2.4066
Epoch: [1/50], Valid loss: 2.3220, Valid accuracy: 0.0863
----------------------------------------
```

```
Saving the best model at 0 epochs!
---------------------------------------
Epoch: [2/50], Train loss: 2.2881
Epoch: [2/50], Valid loss: 2.2668, Valid accuracy: 0.1878
---------------------------------------
Saving the best model at 1 epochs!
---------------------------------------
Epoch: [3/50], Train loss: 2.1422
Epoch: [3/50], Valid loss: 2.1297, Valid accuracy: 0.2589
---------------------------------------
Saving the best model at 2 epochs!
---------------------------------------
Epoch: [4/50], Train loss: 2.0765
Epoch: [4/50], Valid loss: 2.0243, Valid accuracy: 0.2487
---------------------------------------
Saving the best model at 3 epochs!
---------------------------------------
Epoch: [5/50], Train loss: 1.9848
Epoch: [5/50], Valid loss: 2.1202, Valid accuracy: 0.1523
---------------------------------------
---------------------------------------
Epoch: [6/50], Train loss: 1.8935
Epoch: [6/50], Valid loss: 2.0617, Valid accuracy: 0.2234
---------------------------------------
---------------------------------------
Epoch: [7/50], Train loss: 1.8449
Epoch: [7/50], Valid loss: 2.0534, Valid accuracy: 0.2183
---------------------------------------
---------------------------------------
Epoch: [8/50], Train loss: 1.7546
Epoch: [8/50], Valid loss: 2.0162, Valid accuracy: 0.2437
---------------------------------------
Saving the best model at 7 epochs!
---------------------------------------
Epoch: [9/50], Train loss: 1.7436
Epoch: [9/50], Valid loss: 1.9246, Valid accuracy: 0.2640
---------------------------------------
Saving the best model at 8 epochs!
---------------------------------------
Epoch: [10/50], Train loss: 1.6648
Epoch: [10/50], Valid loss: 1.8775, Valid accuracy: 0.2893
---------------------------------------
Saving the best model at 9 epochs!
---------------------------------------
Epoch: [11/50], Train loss: 1.6407
Epoch: [11/50], Valid loss: 1.9037, Valid accuracy: 0.2843
---------------------------------------
---------------------------------------
```

```
Epoch: [12/50], Train loss: 1.5746
Epoch: [12/50], Valid loss: 1.9437, Valid accuracy: 0.2081
----------------------------------------
----------------------------------------
Epoch: [13/50], Train loss: 1.5703
Epoch: [13/50], Valid loss: 1.8332, Valid accuracy: 0.3147
----------------------------------------
Saving the best model at 12 epochs!
----------------------------------------
Epoch: [14/50], Train loss: 1.5182
Epoch: [14/50], Valid loss: 1.9521, Valid accuracy: 0.2386
----------------------------------------
----------------------------------------
Epoch: [15/50], Train loss: 1.4718
Epoch: [15/50], Valid loss: 1.8141, Valid accuracy: 0.2944
----------------------------------------
Saving the best model at 14 epochs!
----------------------------------------
Epoch: [16/50], Train loss: 1.4213
Epoch: [16/50], Valid loss: 1.7709, Valid accuracy: 0.3096
----------------------------------------
Saving the best model at 15 epochs!
----------------------------------------
Epoch: [17/50], Train loss: 1.3495
Epoch: [17/50], Valid loss: 1.8753, Valid accuracy: 0.3096
----------------------------------------
----------------------------------------
Epoch: [18/50], Train loss: 1.3635
Epoch: [18/50], Valid loss: 1.7349, Valid accuracy: 0.3249
----------------------------------------
Saving the best model at 17 epochs!
----------------------------------------
Epoch: [19/50], Train loss: 1.2684
Epoch: [19/50], Valid loss: 1.6701, Valid accuracy: 0.4010
----------------------------------------
Saving the best model at 18 epochs!
----------------------------------------
Epoch: [20/50], Train loss: 1.2454
Epoch: [20/50], Valid loss: 1.8039, Valid accuracy: 0.3401
----------------------------------------
----------------------------------------
Epoch: [21/50], Train loss: 1.2232
Epoch: [21/50], Valid loss: 2.0306, Valid accuracy: 0.3147
----------------------------------------
----------------------------------------
Epoch: [22/50], Train loss: 1.1614
Epoch: [22/50], Valid loss: 1.6857, Valid accuracy: 0.3655
----------------------------------------
```

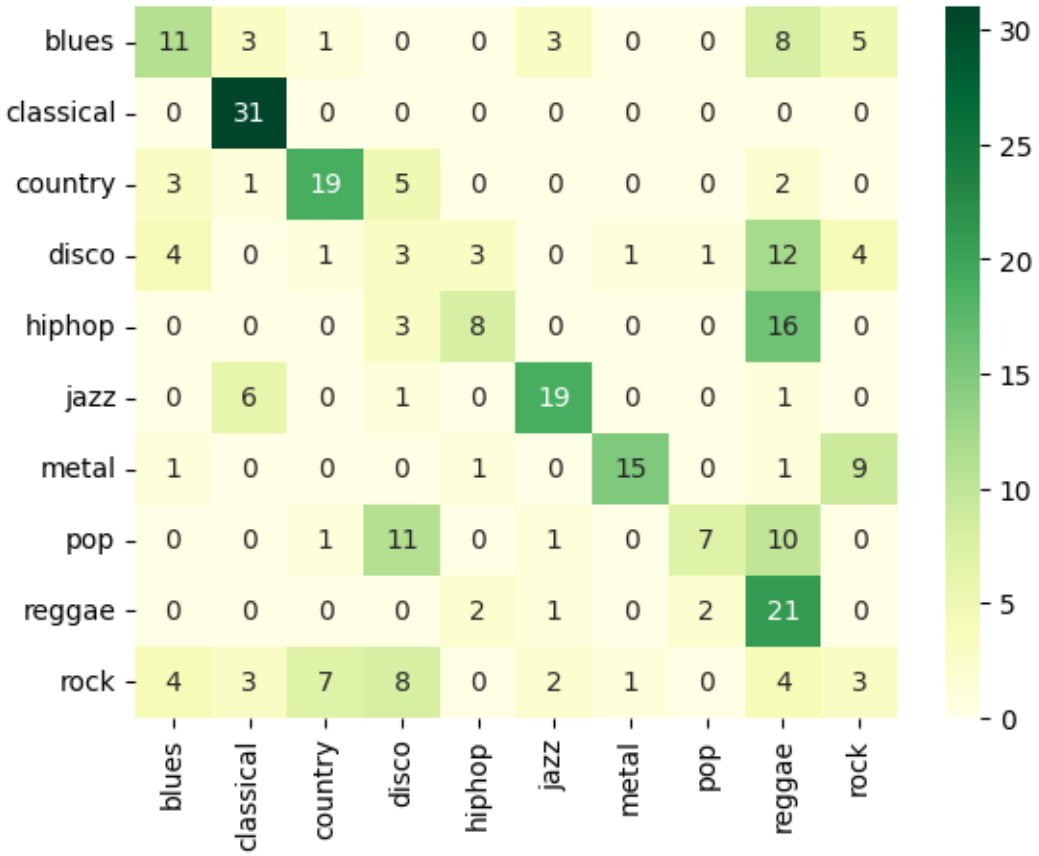
```
---------------------------------------
Epoch: [23/50], Train loss: 1.1442
Epoch: [23/50], Valid loss: 1.7334, Valid accuracy: 0.3807
---------------------------------------
---------------------------------------
Epoch: [24/50], Train loss: 1.1353
Epoch: [24/50], Valid loss: 1.6638, Valid accuracy: 0.4112
---------------------------------------
Saving the best model at 23 epochs!
---------------------------------------
Epoch: [25/50], Train loss: 1.1123
Epoch: [25/50], Valid loss: 1.7463, Valid accuracy: 0.3807
---------------------------------------
---------------------------------------
Epoch: [26/50], Train loss: 1.0956
Epoch: [26/50], Valid loss: 1.7404, Valid accuracy: 0.3909
---------------------------------------
---------------------------------------
Epoch: [27/50], Train loss: 1.0641
Epoch: [27/50], Valid loss: 1.6413, Valid accuracy: 0.4112
---------------------------------------
Saving the best model at 26 epochs!
---------------------------------------
Epoch: [28/50], Train loss: 1.0649
Epoch: [28/50], Valid loss: 1.7941, Valid accuracy: 0.3858
---------------------------------------
---------------------------------------
Epoch: [29/50], Train loss: 1.0329
Epoch: [29/50], Valid loss: 1.9574, Valid accuracy: 0.3350
---------------------------------------
---------------------------------------
Epoch: [30/50], Train loss: 1.0030
Epoch: [30/50], Valid loss: 1.7554, Valid accuracy: 0.3706
---------------------------------------
---------------------------------------
Epoch: [31/50], Train loss: 1.0165
Epoch: [31/50], Valid loss: 1.8816, Valid accuracy: 0.3807
---------------------------------------
---------------------------------------
Epoch: [32/50], Train loss: 0.9762
Epoch: [32/50], Valid loss: 1.6346, Valid accuracy: 0.4467
---------------------------------------
Saving the best model at 31 epochs!
---------------------------------------
Epoch: [33/50], Train loss: 0.9408
Epoch: [33/50], Valid loss: 1.8096, Valid accuracy: 0.4213
---------------------------------------
---------------------------------------
```

```
Epoch: [34/50], Train loss: 0.9181
Epoch: [34/50], Valid loss: 1.6966, Valid accuracy: 0.4213
----------------------------------------
----------------------------------------
Epoch: [35/50], Train loss: 0.8816
Epoch: [35/50], Valid loss: 1.7079, Valid accuracy: 0.4365
----------------------------------------
----------------------------------------
Epoch: [36/50], Train loss: 0.8841
Epoch: [36/50], Valid loss: 1.9066, Valid accuracy: 0.3706
----------------------------------------
----------------------------------------
Epoch: [37/50], Train loss: 0.8595
Epoch: [37/50], Valid loss: 1.7505, Valid accuracy: 0.4467
----------------------------------------
----------------------------------------
Epoch: [38/50], Train loss: 0.8731
Epoch: [38/50], Valid loss: 1.8575, Valid accuracy: 0.4061
----------------------------------------
----------------------------------------
Epoch: [39/50], Train loss: 0.8284
Epoch: [39/50], Valid loss: 1.6176, Valid accuracy: 0.4467
----------------------------------------
Saving the best model at 38 epochs!
----------------------------------------
Epoch: [40/50], Train loss: 0.8243
Epoch: [40/50], Valid loss: 1.9219, Valid accuracy: 0.3807
----------------------------------------
----------------------------------------
Epoch: [41/50], Train loss: 0.7945
Epoch: [41/50], Valid loss: 1.9255, Valid accuracy: 0.4061
----------------------------------------
----------------------------------------
Epoch: [42/50], Train loss: 0.7697
Epoch: [42/50], Valid loss: 1.8254, Valid accuracy: 0.4416
----------------------------------------
----------------------------------------
Epoch: [43/50], Train loss: 0.7389
Epoch: [43/50], Valid loss: 1.8405, Valid accuracy: 0.4416
----------------------------------------
----------------------------------------
Epoch: [44/50], Train loss: 0.7271
Epoch: [44/50], Valid loss: 1.8929, Valid accuracy: 0.4112
----------------------------------------
----------------------------------------
Epoch: [45/50], Train loss: 0.7190
Epoch: [45/50], Valid loss: 2.1704, Valid accuracy: 0.3858
----------------------------------------
```

```
----------------------------------------
Epoch: [46/50], Train loss: 0.7764
Epoch: [46/50], Valid loss: 1.8365, Valid accuracy: 0.4365
----------------------------------------
----------------------------------------
Epoch: [47/50], Train loss: 0.7362
Epoch: [47/50], Valid loss: 1.9890, Valid accuracy: 0.4264
----------------------------------------
----------------------------------------
Epoch: [48/50], Train loss: 0.6971
Epoch: [48/50], Valid loss: 2.0569, Valid accuracy: 0.4061
----------------------------------------
----------------------------------------
Epoch: [49/50], Train loss: 0.6852
Epoch: [49/50], Valid loss: 2.0974, Valid accuracy: 0.3858
----------------------------------------
----------------------------------------
Epoch: [50/50], Train loss: 0.6999
Epoch: [50/50], Valid loss: 1.7070, Valid accuracy: 0.4873
----------------------------------------
```

[29]:
```
evaluate(speccnn_model, "best_speccnn_model_mfcc.ckpt", test_loader, device)
```

```
----------------------------------------
Model at best_speccnn_model_mfcc.ckpt:
----------------------------------------
Accuracy: 0.4724
Precision: 0.5242
Recall: 0.4782
F1 Score: 0.4646
```



[30]:
```
resnet_model = ResNet18() # ResNet-18
train(resnet_model, "best_resnet_model_mfcc.ckpt", train_loader, valid_loader,␣
 ↪device, num_epochs=50, lr=1e-3, debug = True)
```

```
----------------------------------------
Epoch: [1/50], Train loss: 2.3303
Epoch: [1/50], Valid loss: 2.2937, Valid accuracy: 0.1371
----------------------------------------
Saving the best model at 0 epochs!
----------------------------------------
Epoch: [2/50], Train loss: 2.0969
Epoch: [2/50], Valid loss: 2.1279, Valid accuracy: 0.2234
----------------------------------------
Saving the best model at 1 epochs!
----------------------------------------
Epoch: [3/50], Train loss: 1.9504
Epoch: [3/50], Valid loss: 2.0178, Valid accuracy: 0.2843
----------------------------------------
Saving the best model at 2 epochs!
----------------------------------------
```

```
Epoch: [4/50], Train loss: 1.8661
Epoch: [4/50], Valid loss: 1.9508, Valid accuracy: 0.3046
---------------------------------------
Saving the best model at 3 epochs!
---------------------------------------
Epoch: [5/50], Train loss: 1.7613
Epoch: [5/50], Valid loss: 1.9537, Valid accuracy: 0.2843
---------------------------------------
---------------------------------------
Epoch: [6/50], Train loss: 1.6955
Epoch: [6/50], Valid loss: 1.8949, Valid accuracy: 0.3147
---------------------------------------
Saving the best model at 5 epochs!
---------------------------------------
Epoch: [7/50], Train loss: 1.5960
Epoch: [7/50], Valid loss: 1.8734, Valid accuracy: 0.3096
---------------------------------------
Saving the best model at 6 epochs!
---------------------------------------
Epoch: [8/50], Train loss: 1.5350
Epoch: [8/50], Valid loss: 1.8466, Valid accuracy: 0.3147
---------------------------------------
Saving the best model at 7 epochs!
---------------------------------------
Epoch: [9/50], Train loss: 1.4929
Epoch: [9/50], Valid loss: 1.8484, Valid accuracy: 0.3350
---------------------------------------
---------------------------------------
Epoch: [10/50], Train loss: 1.4284
Epoch: [10/50], Valid loss: 1.8275, Valid accuracy: 0.3096
---------------------------------------
Saving the best model at 9 epochs!
---------------------------------------
Epoch: [11/50], Train loss: 1.3980
Epoch: [11/50], Valid loss: 1.8222, Valid accuracy: 0.3299
---------------------------------------
Saving the best model at 10 epochs!
---------------------------------------
Epoch: [12/50], Train loss: 1.3516
Epoch: [12/50], Valid loss: 1.8074, Valid accuracy: 0.3553
---------------------------------------
Saving the best model at 11 epochs!
---------------------------------------
Epoch: [13/50], Train loss: 1.3117
Epoch: [13/50], Valid loss: 1.7867, Valid accuracy: 0.3452
---------------------------------------
Saving the best model at 12 epochs!
---------------------------------------
```

```
Epoch: [14/50], Train loss: 1.2827
Epoch: [14/50], Valid loss: 1.7758, Valid accuracy: 0.3655
---------------------------------------
Saving the best model at 13 epochs!
---------------------------------------
Epoch: [15/50], Train loss: 1.2339
Epoch: [15/50], Valid loss: 1.7608, Valid accuracy: 0.3858
---------------------------------------
Saving the best model at 14 epochs!
---------------------------------------
Epoch: [16/50], Train loss: 1.2272
Epoch: [16/50], Valid loss: 1.7592, Valid accuracy: 0.3655
---------------------------------------
Saving the best model at 15 epochs!
---------------------------------------
Epoch: [17/50], Train loss: 1.2362
Epoch: [17/50], Valid loss: 1.7835, Valid accuracy: 0.3503
---------------------------------------
---------------------------------------
Epoch: [18/50], Train loss: 1.1599
Epoch: [18/50], Valid loss: 1.7596, Valid accuracy: 0.3604
---------------------------------------
---------------------------------------
Epoch: [19/50], Train loss: 1.1356
Epoch: [19/50], Valid loss: 1.7818, Valid accuracy: 0.3553
---------------------------------------
---------------------------------------
Epoch: [20/50], Train loss: 1.1088
Epoch: [20/50], Valid loss: 1.7554, Valid accuracy: 0.3756
---------------------------------------
Saving the best model at 19 epochs!
---------------------------------------
Epoch: [21/50], Train loss: 1.1069
Epoch: [21/50], Valid loss: 1.7550, Valid accuracy: 0.3807
---------------------------------------
Saving the best model at 20 epochs!
---------------------------------------
Epoch: [22/50], Train loss: 1.0799
Epoch: [22/50], Valid loss: 1.7458, Valid accuracy: 0.3807
---------------------------------------
Saving the best model at 21 epochs!
---------------------------------------
Epoch: [23/50], Train loss: 1.0416
Epoch: [23/50], Valid loss: 1.7841, Valid accuracy: 0.3249
---------------------------------------
---------------------------------------
Epoch: [24/50], Train loss: 1.0296
Epoch: [24/50], Valid loss: 1.7532, Valid accuracy: 0.3655
```

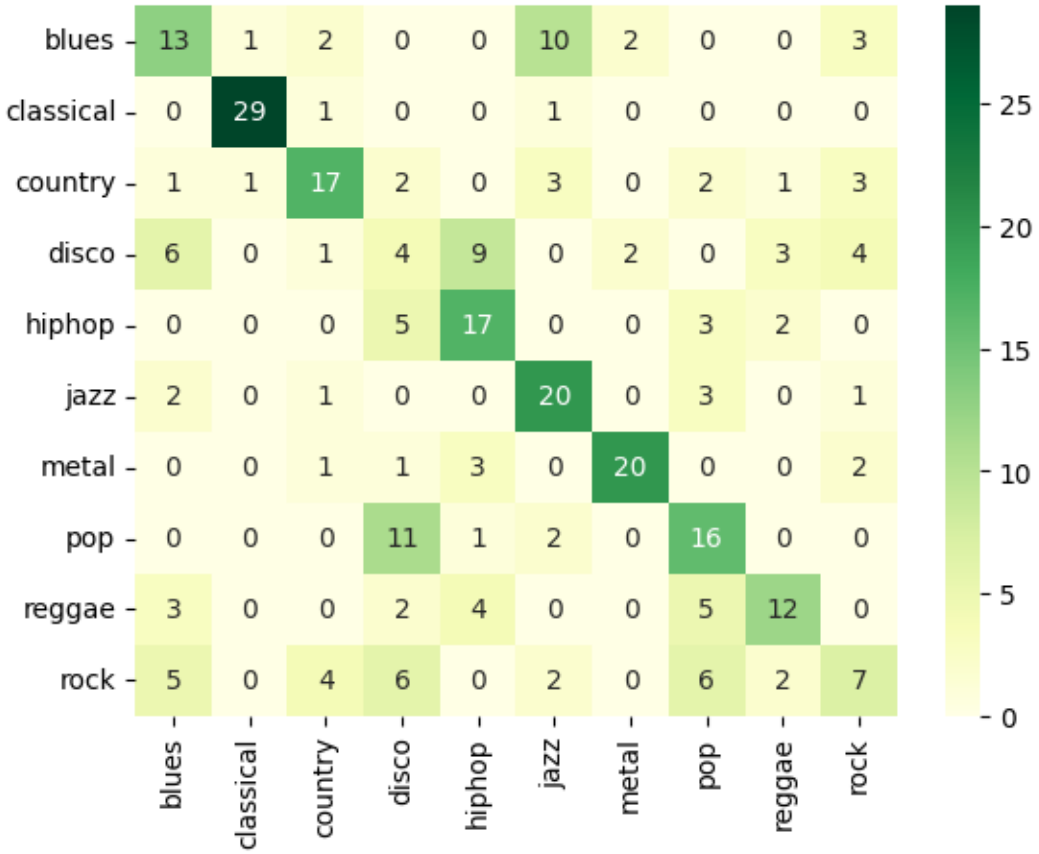
```
----------------------------------------
----------------------------------------
Epoch: [25/50], Train loss: 1.0126
Epoch: [25/50], Valid loss: 1.7406, Valid accuracy: 0.3909
----------------------------------------
Saving the best model at 24 epochs!
----------------------------------------
Epoch: [26/50], Train loss: 0.9980
Epoch: [26/50], Valid loss: 1.7632, Valid accuracy: 0.3350
----------------------------------------
----------------------------------------
Epoch: [27/50], Train loss: 0.9789
Epoch: [27/50], Valid loss: 1.7424, Valid accuracy: 0.4010
----------------------------------------
----------------------------------------
Epoch: [28/50], Train loss: 0.9580
Epoch: [28/50], Valid loss: 1.7521, Valid accuracy: 0.3604
----------------------------------------
----------------------------------------
Epoch: [29/50], Train loss: 0.9471
Epoch: [29/50], Valid loss: 1.7739, Valid accuracy: 0.3756
----------------------------------------
----------------------------------------
Epoch: [30/50], Train loss: 0.9155
Epoch: [30/50], Valid loss: 1.7438, Valid accuracy: 0.3858
----------------------------------------
----------------------------------------
Epoch: [31/50], Train loss: 0.8895
Epoch: [31/50], Valid loss: 1.7621, Valid accuracy: 0.3706
----------------------------------------
----------------------------------------
Epoch: [32/50], Train loss: 0.9272
Epoch: [32/50], Valid loss: 1.7424, Valid accuracy: 0.3604
----------------------------------------
----------------------------------------
Epoch: [33/50], Train loss: 0.8784
Epoch: [33/50], Valid loss: 1.7762, Valid accuracy: 0.3604
----------------------------------------
----------------------------------------
Epoch: [34/50], Train loss: 0.8781
Epoch: [34/50], Valid loss: 1.7604, Valid accuracy: 0.3604
----------------------------------------
----------------------------------------
Epoch: [35/50], Train loss: 0.8557
Epoch: [35/50], Valid loss: 1.7757, Valid accuracy: 0.3655
----------------------------------------
----------------------------------------
Epoch: [36/50], Train loss: 0.8471
```

```
Epoch: [36/50], Valid loss: 1.7682, Valid accuracy: 0.3706
---------------------------------------
---------------------------------------
Epoch: [37/50], Train loss: 0.8482
Epoch: [37/50], Valid loss: 1.7820, Valid accuracy: 0.3807
---------------------------------------
---------------------------------------
Epoch: [38/50], Train loss: 0.8194
Epoch: [38/50], Valid loss: 1.7455, Valid accuracy: 0.3807
---------------------------------------
---------------------------------------
Epoch: [39/50], Train loss: 0.8016
Epoch: [39/50], Valid loss: 1.7538, Valid accuracy: 0.3959
---------------------------------------
---------------------------------------
Epoch: [40/50], Train loss: 0.8435
Epoch: [40/50], Valid loss: 1.7915, Valid accuracy: 0.3655
---------------------------------------
---------------------------------------
Epoch: [41/50], Train loss: 0.8026
Epoch: [41/50], Valid loss: 1.7543, Valid accuracy: 0.3858
---------------------------------------
---------------------------------------
Epoch: [42/50], Train loss: 0.7649
Epoch: [42/50], Valid loss: 1.7919, Valid accuracy: 0.3401
---------------------------------------
---------------------------------------
Epoch: [43/50], Train loss: 0.7859
Epoch: [43/50], Valid loss: 1.7398, Valid accuracy: 0.4162
---------------------------------------
Saving the best model at 42 epochs!
---------------------------------------
Epoch: [44/50], Train loss: 0.7705
Epoch: [44/50], Valid loss: 1.7622, Valid accuracy: 0.3858
---------------------------------------
---------------------------------------
Epoch: [45/50], Train loss: 0.7555
Epoch: [45/50], Valid loss: 1.7631, Valid accuracy: 0.3706
---------------------------------------
---------------------------------------
Epoch: [46/50], Train loss: 0.7608
Epoch: [46/50], Valid loss: 1.7705, Valid accuracy: 0.3756
---------------------------------------
---------------------------------------
Epoch: [47/50], Train loss: 0.7281
Epoch: [47/50], Valid loss: 1.7782, Valid accuracy: 0.3655
---------------------------------------
---------------------------------------
```

```
Epoch: [48/50], Train loss: 0.7034
Epoch: [48/50], Valid loss: 1.7695, Valid accuracy: 0.4112
----------------------------------------
----------------------------------------
Epoch: [49/50], Train loss: 0.6871
Epoch: [49/50], Valid loss: 1.7685, Valid accuracy: 0.3807
----------------------------------------
----------------------------------------
Epoch: [50/50], Train loss: 0.7057
Epoch: [50/50], Valid loss: 1.7879, Valid accuracy: 0.3959
----------------------------------------
```

[31]:
```
evaluate(resnet_model, "best_resnet_model_mfcc.ckpt", test_loader, device)
```

```
----------------------------------------
Model at best_resnet_model_mfcc.ckpt:
----------------------------------------
Accuracy: 0.5345
Precision: 0.5394
Recall: 0.5384
F1 Score: 0.5332
```



[32]:
```
effnet_model = EfficientNetV2S() # EfficientNetv2-S
train(effnet_model, "best_effnet_model_mfcc.ckpt", train_loader, valid_loader,␣
 ↪device, num_epochs=50, lr=1e-3, debug = True)
```

```
----------------------------------------
Epoch: [1/50], Train loss: 2.2662
Epoch: [1/50], Valid loss: 2.2680, Valid accuracy: 0.1777
----------------------------------------
Saving the best model at 0 epochs!
----------------------------------------
Epoch: [2/50], Train loss: 2.1213
Epoch: [2/50], Valid loss: 2.1392, Valid accuracy: 0.2487
----------------------------------------
Saving the best model at 1 epochs!
----------------------------------------
Epoch: [3/50], Train loss: 2.0286
Epoch: [3/50], Valid loss: 2.0662, Valid accuracy: 0.2640
----------------------------------------
Saving the best model at 2 epochs!
----------------------------------------
Epoch: [4/50], Train loss: 1.9275
Epoch: [4/50], Valid loss: 2.0285, Valid accuracy: 0.2437
----------------------------------------
Saving the best model at 3 epochs!
----------------------------------------
Epoch: [5/50], Train loss: 1.8642
Epoch: [5/50], Valid loss: 1.9819, Valid accuracy: 0.2893
----------------------------------------
Saving the best model at 4 epochs!
----------------------------------------
Epoch: [6/50], Train loss: 1.8015
Epoch: [6/50], Valid loss: 1.9661, Valid accuracy: 0.2690
----------------------------------------
Saving the best model at 5 epochs!
----------------------------------------
Epoch: [7/50], Train loss: 1.7581
Epoch: [7/50], Valid loss: 1.9456, Valid accuracy: 0.2741
----------------------------------------
Saving the best model at 6 epochs!
----------------------------------------
Epoch: [8/50], Train loss: 1.6695
Epoch: [8/50], Valid loss: 1.9221, Valid accuracy: 0.3147
----------------------------------------
Saving the best model at 7 epochs!
----------------------------------------
Epoch: [9/50], Train loss: 1.6417
```

```
Epoch: [9/50], Valid loss: 1.9186, Valid accuracy: 0.3046
---------------------------------------
Saving the best model at 8 epochs!
---------------------------------------
Epoch: [10/50], Train loss: 1.5905
Epoch: [10/50], Valid loss: 1.8966, Valid accuracy: 0.2995
---------------------------------------
Saving the best model at 9 epochs!
---------------------------------------
Epoch: [11/50], Train loss: 1.5796
Epoch: [11/50], Valid loss: 1.8983, Valid accuracy: 0.2944
---------------------------------------
---------------------------------------
Epoch: [12/50], Train loss: 1.5499
Epoch: [12/50], Valid loss: 1.9101, Valid accuracy: 0.2893
---------------------------------------
---------------------------------------
Epoch: [13/50], Train loss: 1.5156
Epoch: [13/50], Valid loss: 1.8906, Valid accuracy: 0.2995
---------------------------------------
Saving the best model at 12 epochs!
---------------------------------------
Epoch: [14/50], Train loss: 1.4607
Epoch: [14/50], Valid loss: 1.8904, Valid accuracy: 0.3046
---------------------------------------
Saving the best model at 13 epochs!
---------------------------------------
Epoch: [15/50], Train loss: 1.4291
Epoch: [15/50], Valid loss: 1.8690, Valid accuracy: 0.3198
---------------------------------------
Saving the best model at 14 epochs!
---------------------------------------
Epoch: [16/50], Train loss: 1.4380
Epoch: [16/50], Valid loss: 1.8656, Valid accuracy: 0.3147
---------------------------------------
Saving the best model at 15 epochs!
---------------------------------------
Epoch: [17/50], Train loss: 1.4205
Epoch: [17/50], Valid loss: 1.8658, Valid accuracy: 0.2944
---------------------------------------
---------------------------------------
Epoch: [18/50], Train loss: 1.3972
Epoch: [18/50], Valid loss: 1.8771, Valid accuracy: 0.3096
---------------------------------------
---------------------------------------
Epoch: [19/50], Train loss: 1.4016
Epoch: [19/50], Valid loss: 1.8794, Valid accuracy: 0.3096
---------------------------------------
```

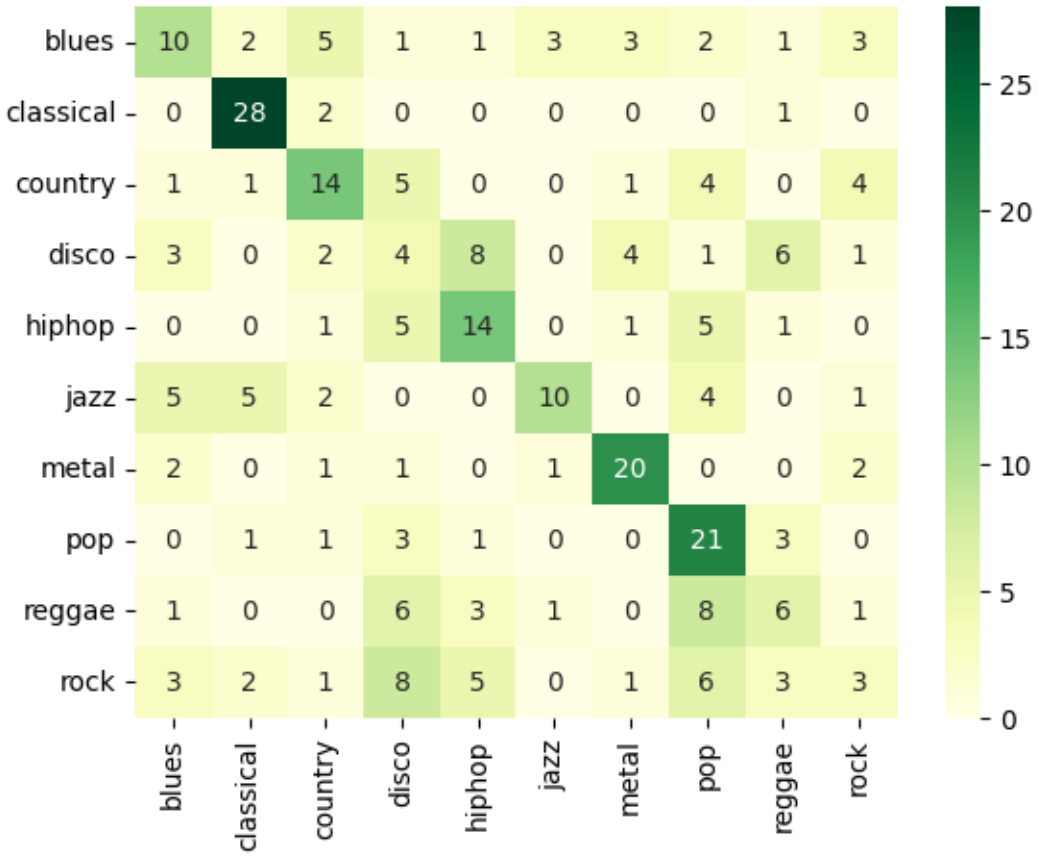
```
----------------------------------------
Epoch: [20/50], Train loss: 1.3475
Epoch: [20/50], Valid loss: 1.8805, Valid accuracy: 0.2944
----------------------------------------
----------------------------------------
Epoch: [21/50], Train loss: 1.3811
Epoch: [21/50], Valid loss: 1.8785, Valid accuracy: 0.3046
----------------------------------------
----------------------------------------
Epoch: [22/50], Train loss: 1.3168
Epoch: [22/50], Valid loss: 1.8864, Valid accuracy: 0.3299
----------------------------------------
----------------------------------------
Epoch: [23/50], Train loss: 1.2649
Epoch: [23/50], Valid loss: 1.8764, Valid accuracy: 0.3096
----------------------------------------
----------------------------------------
Epoch: [24/50], Train loss: 1.2791
Epoch: [24/50], Valid loss: 1.8570, Valid accuracy: 0.3198
----------------------------------------
Saving the best model at 23 epochs!
----------------------------------------
Epoch: [25/50], Train loss: 1.2991
Epoch: [25/50], Valid loss: 1.8498, Valid accuracy: 0.3096
----------------------------------------
Saving the best model at 24 epochs!
----------------------------------------
Epoch: [26/50], Train loss: 1.2633
Epoch: [26/50], Valid loss: 1.8578, Valid accuracy: 0.2944
----------------------------------------
----------------------------------------
Epoch: [27/50], Train loss: 1.2350
Epoch: [27/50], Valid loss: 1.8617, Valid accuracy: 0.2995
----------------------------------------
----------------------------------------
Epoch: [28/50], Train loss: 1.2652
Epoch: [28/50], Valid loss: 1.8549, Valid accuracy: 0.3046
----------------------------------------
----------------------------------------
Epoch: [29/50], Train loss: 1.3000
Epoch: [29/50], Valid loss: 1.8547, Valid accuracy: 0.2944
----------------------------------------
----------------------------------------
Epoch: [30/50], Train loss: 1.2627
Epoch: [30/50], Valid loss: 1.8539, Valid accuracy: 0.2995
----------------------------------------
----------------------------------------
Epoch: [31/50], Train loss: 1.2106
```

```
Epoch: [31/50], Valid loss: 1.8615, Valid accuracy: 0.3147
----------------------------------------
----------------------------------------
Epoch: [32/50], Train loss: 1.1706
Epoch: [32/50], Valid loss: 1.8727, Valid accuracy: 0.3147
----------------------------------------
----------------------------------------
Epoch: [33/50], Train loss: 1.2238
Epoch: [33/50], Valid loss: 1.8635, Valid accuracy: 0.3096
----------------------------------------
----------------------------------------
Epoch: [34/50], Train loss: 1.1770
Epoch: [34/50], Valid loss: 1.8645, Valid accuracy: 0.3147
----------------------------------------
----------------------------------------
Epoch: [35/50], Train loss: 1.1690
Epoch: [35/50], Valid loss: 1.8637, Valid accuracy: 0.3198
----------------------------------------
----------------------------------------
Epoch: [36/50], Train loss: 1.2060
Epoch: [36/50], Valid loss: 1.8528, Valid accuracy: 0.2995
----------------------------------------
----------------------------------------
Epoch: [37/50], Train loss: 1.1201
Epoch: [37/50], Valid loss: 1.8568, Valid accuracy: 0.3096
----------------------------------------
----------------------------------------
Epoch: [38/50], Train loss: 1.1145
Epoch: [38/50], Valid loss: 1.8276, Valid accuracy: 0.3299
----------------------------------------
Saving the best model at 37 epochs!
----------------------------------------
Epoch: [39/50], Train loss: 1.0926
Epoch: [39/50], Valid loss: 1.8506, Valid accuracy: 0.3096
----------------------------------------
----------------------------------------
Epoch: [40/50], Train loss: 1.1463
Epoch: [40/50], Valid loss: 1.8553, Valid accuracy: 0.2944
----------------------------------------
----------------------------------------
Epoch: [41/50], Train loss: 1.0948
Epoch: [41/50], Valid loss: 1.8542, Valid accuracy: 0.3046
----------------------------------------
----------------------------------------
Epoch: [42/50], Train loss: 1.1167
Epoch: [42/50], Valid loss: 1.8505, Valid accuracy: 0.3249
----------------------------------------
----------------------------------------
```

```
Epoch: [43/50], Train loss: 1.1420
Epoch: [43/50], Valid loss: 1.8444, Valid accuracy: 0.3147
----------------------------------------
----------------------------------------
Epoch: [44/50], Train loss: 1.1404
Epoch: [44/50], Valid loss: 1.8737, Valid accuracy: 0.3096
----------------------------------------
----------------------------------------
Epoch: [45/50], Train loss: 1.0893
Epoch: [45/50], Valid loss: 1.8588, Valid accuracy: 0.3046
----------------------------------------
----------------------------------------
Epoch: [46/50], Train loss: 1.0606
Epoch: [46/50], Valid loss: 1.8799, Valid accuracy: 0.2995
----------------------------------------
----------------------------------------
Epoch: [47/50], Train loss: 1.0471
Epoch: [47/50], Valid loss: 1.8722, Valid accuracy: 0.3249
----------------------------------------
----------------------------------------
Epoch: [48/50], Train loss: 1.0454
Epoch: [48/50], Valid loss: 1.8639, Valid accuracy: 0.3350
----------------------------------------
----------------------------------------
Epoch: [49/50], Train loss: 1.0374
Epoch: [49/50], Valid loss: 1.9092, Valid accuracy: 0.3350
----------------------------------------
----------------------------------------
Epoch: [50/50], Train loss: 1.0123
Epoch: [50/50], Valid loss: 1.8795, Valid accuracy: 0.3299
----------------------------------------
```

[33]:
```
evaluate(effnet_model, "best_effnet_model_mfcc.ckpt", test_loader, device)
```

```
----------------------------------------
Model at best_effnet_model_mfcc.ckpt:
----------------------------------------
Accuracy: 0.4483
Precision: 0.4390
Recall: 0.4485
F1 Score: 0.4315
```


blues 10 2 5 1 1 3 3 2 1 3
classical 0 28 2 0 0 0 0 0 1 0
country 1 1 14 5 0 0 1 4 0 4
disco 3 0 2 4 8 0 4 1 6 1
hiphop 0 0 1 5 14 0 1 5 1 0
jazz 5 5 2 0 0 10 0 4 0 1
metal 2 0 1 1 0 1 20 0 0 2
pop 0 1 1 3 1 0 0 21 3 0
reggae 1 0 0 6 3 1 0 8 6 1
rock 3 2 1 8 5 0 1 6 3 3
blues
classical
country
disco
hiphop
jazz
metal
pop
reggae
rock
25
20
15
10
5
0