emmanuelnk_DL4E_Assignement_2

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0.1 Assignment 2 - Developing an Automatic Recording Unit (ARU) with a Raspberry Pi

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```
[1]: # You might need to restart the runtime after running this code. You'll only
     # have to do this once per runtime. Once you restart, you do not need to run␣
      ↪this again
     !git clone https://github.com/scikit-maad/scikit-maad.git
```

```
Cloning into 'scikit-maad'…
remote: Enumerating objects: 10604, done.
remote: Counting objects: 100% (1337/1337), done.
remote: Compressing objects: 100% (537/537), done.
remote: Total 10604 (delta 802), reused 1209 (delta 752), pack-reused 9267
Receiving objects: 100% (10604/10604), 183.25 MiB | 21.63 MiB/s, done.
Resolving deltas: 100% (7747/7747), done.
Updating files: 100% (267/267), done.
```

```
[2]: # !pip install librosa==0.8.1
     !pip install scikit-maad
```

```
Collecting scikit-maad
  Downloading scikit_maad-1.4.0-py3-none-any.whl (152 kB)
                             152.5/152.5

kB 3.3 MB/s eta 0:00:00
Requirement already satisfied: numpy>=1.21 in
/usr/local/lib/python3.10/dist-packages (from scikit-maad) (1.25.2)
Requirement already satisfied: scipy>=1.8 in /usr/local/lib/python3.10/dist-
packages (from scikit-maad) (1.11.4)
Requirement already satisfied: scikit-image>=0.19 in
/usr/local/lib/python3.10/dist-packages (from scikit-maad) (0.19.3)
Requirement already satisfied: pandas>=1.5 in /usr/local/lib/python3.10/dist-
packages (from scikit-maad) (1.5.3)
Collecting resampy>=0.4 (from scikit-maad)
  Downloading resampy-0.4.2-py3-none-any.whl (3.1 MB)
                             3.1/3.1 MB
12.2 MB/s eta 0:00:00
Requirement already satisfied: matplotlib>=3.6 in
```

```
/usr/local/lib/python3.10/dist-packages (from scikit-maad) (3.7.1)
Requirement already satisfied: contourpy>=1.0.1 in
/usr/local/lib/python3.10/dist-packages (from matplotlib>=3.6->scikit-maad)
(1.2.0)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.10/dist-
packages (from matplotlib>=3.6->scikit-maad) (0.12.1)
Requirement already satisfied: fonttools>=4.22.0 in
/usr/local/lib/python3.10/dist-packages (from matplotlib>=3.6->scikit-maad)
(4.48.1)
Requirement already satisfied: kiwisolver>=1.0.1 in
/usr/local/lib/python3.10/dist-packages (from matplotlib>=3.6->scikit-maad)
(1.4.5)
Requirement already satisfied: packaging>=20.0 in
/usr/local/lib/python3.10/dist-packages (from matplotlib>=3.6->scikit-maad)
(23.2)
Requirement already satisfied: pillow>=6.2.0 in /usr/local/lib/python3.10/dist-
packages (from matplotlib>=3.6->scikit-maad) (9.4.0)
Requirement already satisfied: pyparsing>=2.3.1 in
/usr/local/lib/python3.10/dist-packages (from matplotlib>=3.6->scikit-maad)
(3.1.1)
Requirement already satisfied: python-dateutil>=2.7 in
/usr/local/lib/python3.10/dist-packages (from matplotlib>=3.6->scikit-maad)
(2.8.2)
Requirement already satisfied: pytz>=2020.1 in /usr/local/lib/python3.10/dist-
packages (from pandas>=1.5->scikit-maad) (2023.4)
Requirement already satisfied: numba>=0.53 in /usr/local/lib/python3.10/dist-
packages (from resampy>=0.4->scikit-maad) (0.58.1)
Requirement already satisfied: networkx>=2.2 in /usr/local/lib/python3.10/dist-
packages (from scikit-image>=0.19->scikit-maad) (3.2.1)
Requirement already satisfied: imageio>=2.4.1 in /usr/local/lib/python3.10/dist-
packages (from scikit-image>=0.19->scikit-maad) (2.31.6)
Requirement already satisfied: tifffile>=2019.7.26 in
/usr/local/lib/python3.10/dist-packages (from scikit-image>=0.19->scikit-maad)
(2024.2.12)
Requirement already satisfied: PyWavelets>=1.1.1 in
/usr/local/lib/python3.10/dist-packages (from scikit-image>=0.19->scikit-maad)
(1.5.0)
Requirement already satisfied: llvmlite<0.42,>=0.41.0dev0 in
/usr/local/lib/python3.10/dist-packages (from numba>=0.53->resampy>=0.4->scikit-
maad) (0.41.1)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.10/dist-
packages (from python-dateutil>=2.7->matplotlib>=3.6->scikit-maad) (1.16.0)
Installing collected packages: resampy, scikit-maad
Successfully installed resampy-0.4.2 scikit-maad-1.4.0
```

```
[3]: !pip install -U librosa
     !pip freeze | grep librosa
```

```
Requirement already satisfied: librosa in /usr/local/lib/python3.10/dist-
packages (0.10.1)
Requirement already satisfied: audioread>=2.1.9 in
/usr/local/lib/python3.10/dist-packages (from librosa) (3.0.1)
Requirement already satisfied: numpy!=1.22.0,!=1.22.1,!=1.22.2,>=1.20.3 in
/usr/local/lib/python3.10/dist-packages (from librosa) (1.25.2)
Requirement already satisfied: scipy>=1.2.0 in /usr/local/lib/python3.10/dist-
packages (from librosa) (1.11.4)
Requirement already satisfied: scikit-learn>=0.20.0 in
/usr/local/lib/python3.10/dist-packages (from librosa) (1.2.2)
Requirement already satisfied: joblib>=0.14 in /usr/local/lib/python3.10/dist-
packages (from librosa) (1.3.2)
Requirement already satisfied: decorator>=4.3.0 in
/usr/local/lib/python3.10/dist-packages (from librosa) (4.4.2)
Requirement already satisfied: numba>=0.51.0 in /usr/local/lib/python3.10/dist-
packages (from librosa) (0.58.1)
Requirement already satisfied: soundfile>=0.12.1 in
/usr/local/lib/python3.10/dist-packages (from librosa) (0.12.1)
Requirement already satisfied: pooch>=1.0 in /usr/local/lib/python3.10/dist-
packages (from librosa) (1.8.0)
Requirement already satisfied: soxr>=0.3.2 in /usr/local/lib/python3.10/dist-
packages (from librosa) (0.3.7)
Requirement already satisfied: typing-extensions>=4.1.1 in
/usr/local/lib/python3.10/dist-packages (from librosa) (4.9.0)
Requirement already satisfied: lazy-loader>=0.1 in
/usr/local/lib/python3.10/dist-packages (from librosa) (0.3)
Requirement already satisfied: msgpack>=1.0 in /usr/local/lib/python3.10/dist-
packages (from librosa) (1.0.7)
Requirement already satisfied: llvmlite<0.42,>=0.41.0dev0 in
/usr/local/lib/python3.10/dist-packages (from numba>=0.51.0->librosa) (0.41.1)
Requirement already satisfied: platformdirs>=2.5.0 in
/usr/local/lib/python3.10/dist-packages (from pooch>=1.0->librosa) (4.2.0)
Requirement already satisfied: packaging>=20.0 in
/usr/local/lib/python3.10/dist-packages (from pooch>=1.0->librosa) (23.2)
Requirement already satisfied: requests>=2.19.0 in
/usr/local/lib/python3.10/dist-packages (from pooch>=1.0->librosa) (2.31.0)
Requirement already satisfied: threadpoolctl>=2.0.0 in
/usr/local/lib/python3.10/dist-packages (from scikit-learn>=0.20.0->librosa)
(3.2.0)
Requirement already satisfied: cffi>=1.0 in /usr/local/lib/python3.10/dist-
packages (from soundfile>=0.12.1->librosa) (1.16.0)
Requirement already satisfied: pycparser in /usr/local/lib/python3.10/dist-
packages (from cffi>=1.0->soundfile>=0.12.1->librosa) (2.21)
Requirement already satisfied: charset-normalizer<4,>=2 in
/usr/local/lib/python3.10/dist-packages (from
requests>=2.19.0->pooch>=1.0->librosa) (3.3.2)
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.10/dist-
packages (from requests>=2.19.0->pooch>=1.0->librosa) (3.6)
```

```
Requirement already satisfied: urllib3<3,>=1.21.1 in
/usr/local/lib/python3.10/dist-packages (from
requests>=2.19.0->pooch>=1.0->librosa) (2.0.7)
Requirement already satisfied: certifi>=2017.4.17 in
/usr/local/lib/python3.10/dist-packages (from
requests>=2.19.0->pooch>=1.0->librosa) (2024.2.2)
librosa==0.10.1
```

[4]:
```python
colab = True
```

[5]:
```python
!pip install SoundFile
from google.colab import drive
from pydrive2.auth import GoogleAuth
from pydrive2.drive import GoogleDrive
from google.colab import auth
from oauth2client.client import GoogleCredentials
import zipfile
```

```
Requirement already satisfied: SoundFile in /usr/local/lib/python3.10/dist-
packages (0.12.1)
Requirement already satisfied: cffi>=1.0 in /usr/local/lib/python3.10/dist-
packages (from SoundFile) (1.16.0)
Requirement already satisfied: pycparser in /usr/local/lib/python3.10/dist-
packages (from cffi>=1.0->SoundFile) (2.21)
```

[6]:
```python
# Google Authentication
auth.authenticate_user()
gauth = GoogleAuth()
gauth.credentials = GoogleCredentials.get_application_default()
drive = GoogleDrive(gauth)
```

[7]:
```python
# Download files
downloaded = drive.CreateFile({'id':"1js1fz4Bu98NIds4cErL7NdT1efxavixp"})
downloaded.GetContentFile('Code.zip')

# Extract files to temporary location in Google Drive
with zipfile.ZipFile('Code.zip', 'r') as zip_file:
    zip_file.extractall()

# Download files
downloaded = drive.CreateFile({'id':"1ZtnBNlAttwSqiYF4XPfNLE6YX5H8HDAa"})
downloaded.GetContentFile('Data.zip')

# Extract files to temporary location in Google Drive
with zipfile.ZipFile('Data.zip', 'r') as zip_file:
    zip_file.extractall()
```

```python
[8]: # Do not delete these imports [ 0 marks]
     from Preprocessing import *
     import librosa
     import numpy as np
     import random



     #We define the two classes
     positive_class = ['1']#this corresponds to labels which reprsent present of
       ↪bird sound
     negative_class =['0']#the second case

     #Data hyper-parameters
     f_max = 15000
     f_min = 150
     n_fft = 1024 # Hann window length
     hop_length = 256 # Sepctrogram hop size
     n_mels = 128
     #
     lowpass_cutoff = 10000 # We take less than nuquist_rate
     nyquist_rate = 11025 #Nyquist rqte
     downsample_rate = 22050 #Frequence to downsqmple
     segment_duration = 3 #

     # ----------------------------
     species_folder = '.' # Should contain /Audio and /Annotations, don't change this
     file_type = 'svl' # don't change this
     audio_extension = '.wav' # don't change this
```

```python
[9]: pre_pro = Preprocessing(species_folder, lowpass_cutoff,
                     downsample_rate, nyquist_rate,
                     segment_duration,
                     positive_class, negative_class,n_fft,
                     hop_length, n_mels, f_min, f_max, file_type,
                     audio_extension)

     X,Y = pre_pro.create_dataset(False)

     pre_pro.save_data_to_pickle(X,Y)

     print("Done")
```

```
Processing: 19_19_fermat_15
Found file
Filtering…
Downsampling…
19_19_fermat_15
Reading annotations…
```

5

```
Processing: 23_2-2-2024=20_53_19
Found file
Filtering…
Downsampling…
23_2-2-2024=20_53_19
Reading annotations…
Processing: 6_2-2-2024=14_46_17
Found file
Filtering…
Downsampling…
6_2-2-2024=14_46_17
Reading annotations…
Processing: 9_2-2-2024=21_1_26
Found file
Filtering…
Downsampling…
9_2-2-2024=21_1_26
Reading annotations…
Processing: 6_2-2-2024=14_43_57
Found file
Filtering…
Downsampling…
6_2-2-2024=14_43_57
Reading annotations…
Processing: 23_2-2-2024=20_39_55
Found file
Filtering…
Downsampling…
23_2-2-2024=20_39_55
Reading annotations…
Processing: 15_audio_34
Found file
Filtering…
Downsampling…
15_audio_34
Reading annotations…
Processing: 15_audio_79
Found file
Filtering…
Downsampling…
15_audio_79
Reading annotations…
Processing: 8_emmanuel_5
Found file
Filtering…
Downsampling…
8_emmanuel_5
Reading annotations…
```

```
Processing: 23_2-2-2024=20_38_50
Found file
Filtering…
Downsampling…
23_2-2-2024=20_38_50
Reading annotations…
Processing: 2_2_someaudiofile_1
Found file
Filtering…
Downsampling…
2_2_someaudiofile_1
Reading annotations…
Processing: 5_2-2-2024=15_20_0
Found file
Filtering…
Downsampling…
5_2-2-2024=15_20_0
Reading annotations…
Processing: 12_audio_16
Found file
Filtering…
Downsampling…
12_audio_16
Reading annotations…
Processing: 22_3-2-2024=7_8_50
Found file
Filtering…
Downsampling…
22_3-2-2024=7_8_50
Reading annotations…
Processing: 19_19_fermat_5
Found file
Filtering…
Downsampling…
19_19_fermat_5
Reading annotations…
Processing: 23_2-2-2024=20_45_9
Found file
Filtering…
Downsampling…
23_2-2-2024=20_45_9
Reading annotations…
Processing: 23_2-2-2024=20_42_15
Found file
Filtering…
Downsampling…
23_2-2-2024=20_42_15
Reading annotations…
```

```
Processing: 18_3-2-2024=6_50_29
Found file
Filtering…
Downsampling…
18_3-2-2024=6_50_29
Reading annotations…
Processing: 20_r17_dariose
Found file
Filtering…
Downsampling…
20_r17_dariose
Reading annotations…
Processing: 7_7_2-2-2024=15_20_15
Found file
Filtering…
Downsampling…
7_7_2-2-2024=15_20_15
Reading annotations…
Processing: 28_2-2-2024=14_43_47
Found file
Filtering…
Downsampling…
28_2-2-2024=14_43_47
Reading annotations…
Processing: 12_audio_15
Found file
Filtering…
Downsampling…
12_audio_15
Reading annotations…
Processing: 14_2-2-2024=19_38_59
Found file
Filtering…
Downsampling…
14_2-2-2024=19_38_59
Reading annotations…
Processing: 19_19_fermat_7
Found file
Filtering…
Downsampling…
19_19_fermat_7
Reading annotations…
Processing: 7_7_2-2-2024=15_21_31
Found file
Filtering…
Downsampling…
7_7_2-2-2024=15_21_31
Reading annotations…
```

```
Processing: 21_20240203_063015
Processing: 2_2_someaudiofile_20
Found file
Filtering…
Downsampling…
2_2_someaudiofile_20
Reading annotations…
Processing: 7_7_2-2-2024=15_21_25
Found file
Filtering…
Downsampling…
7_7_2-2-2024=15_21_25
Reading annotations…
Processing: 5_2-2-2024=15_18_8
Found file
Filtering…
Downsampling…
5_2-2-2024=15_18_8
Reading annotations…
Processing: 25_2-2-2024=19_41_47
Found file
Filtering…
Downsampling…
25_2-2-2024=19_41_47
Reading annotations…
Processing: 25_2-2-2024=19_46_20
Found file
Filtering…
Downsampling…
25_2-2-2024=19_46_20
Reading annotations…
Processing: 24_2-2-2024=14_46_11
Found file
Filtering…
Downsampling…
24_2-2-2024=14_46_11
Reading annotations…
Processing: 12_audio_19
Found file
Filtering…
Downsampling…
12_audio_19
Reading annotations…
Processing: 15_audio_102
Found file
Filtering…
Downsampling…
15_audio_102
```

```
Reading annotations…
Processing: 13_2-2-2024=23_34_56
Found file
Filtering…
Downsampling…
13_2-2-2024=23_34_56
Reading annotations…
Processing: 13_2-2-2024=23_33_11
Found file
Filtering…
Downsampling…
13_2-2-2024=23_33_11
Reading annotations…
Processing: 28_2-2-2024=14_47_58
Found file
Filtering…
Downsampling…
28_2-2-2024=14_47_58
Reading annotations…
Processing: 13_2-2-2024=23_31_32
Found file
Filtering…
Downsampling…
13_2-2-2024=23_31_32
Reading annotations…
Processing: 23_2-2-2024=20_53_54
Found file
Filtering…
Downsampling…
23_2-2-2024=20_53_54
Reading annotations…
Processing: 13_2-2-2024=23_36_5
Found file
Filtering…
Downsampling…
13_2-2-2024=23_36_5
Reading annotations…
Processing: 4_4_aud4-19
Found file
Filtering…
Downsampling…
4_4_aud4-19
Reading annotations…
Processing: 15_audio_42
Found file
Filtering…
Downsampling…
15_audio_42
```

```
Reading annotations…
Processing: 24_2-2-2024=14_45_30
Found file
Filtering…
Downsampling…
24_2-2-2024=14_45_30
Reading annotations…
Processing: 28_2-2-2024=14_45_32
Found file
Filtering…
Downsampling…
28_2-2-2024=14_45_32
Reading annotations…
Processing: 6_030224-090128
Processing: 21_3-2-2024=7_18_9
Found file
Filtering…
Downsampling…
21_3-2-2024=7_18_9
Reading annotations…
Processing: 15_audio_114
Found file
Filtering…
Downsampling…
15_audio_114
Reading annotations…
Processing: 15_audio_71
Found file
Filtering…
Downsampling…
15_audio_71
Reading annotations…
Processing: 21_3-2-2024=7_27_28
Found file
Filtering…
Downsampling…
21_3-2-2024=7_27_28
Reading annotations…
Processing: 25_2-2-2024=19_42_22
Found file
Filtering…
Downsampling…
25_2-2-2024=19_42_22
Reading annotations…
Processing: 18_2_20240203_084120
Processing: 23_2-2-2024=20_49_48
Found file
Filtering…
```

```
Downsampling…
23_2-2-2024=20_49_48
Reading annotations…
Processing: 18_3-2-2024=6_50_57
Found file
Filtering…
Downsampling…
18_3-2-2024=6_50_57
Reading annotations…
Processing: 19_19_fermat_1
Found file
Filtering…
Downsampling…
19_19_fermat_1
Reading annotations…
Processing: 2_2_someaudiofile_7
Found file
Filtering…
Downsampling…
2_2_someaudiofile_7
Reading annotations…
Processing: 17_2-2-2024=15_41_32
Found file
Filtering…
Downsampling…
17_2-2-2024=15_41_32
Reading annotations…
Processing: 12_audio_3
Found file
Filtering…
Downsampling…
12_audio_3
Reading annotations…
Processing: 24_2-2-2024=14_46_5
Found file
Filtering…
Downsampling…
24_2-2-2024=14_46_5
Reading annotations…
Processing: 2_2_someaudiofile_6
Found file
Filtering…
Downsampling…
2_2_someaudiofile_6
Reading annotations…
Processing: 15_audio_9
Found file
Filtering…
```

```
Downsampling…
15_audio_9
Reading annotations…
Processing: 5_2-2-2024=15_21_4
Found file
Filtering…
Downsampling…
5_2-2-2024=15_21_4
Reading annotations…
Processing: 22_2-2-2024=14_44_19
Found file
Filtering…
Downsampling…
22_2-2-2024=14_44_19
Reading annotations…
Processing: 15_audio_86
Found file
Filtering…
Downsampling…
15_audio_86
Reading annotations…
Processing: 7_7_2-2-2024=15_23_16
Found file
Filtering…
Downsampling…
7_7_2-2-2024=15_23_16
Reading annotations…
Processing: 15_audio_56
Found file
Filtering…
Downsampling…
15_audio_56
Reading annotations…
Processing: 7_7_2-2-2024=15_24_26
Found file
Filtering…
Downsampling…
7_7_2-2-2024=15_24_26
Reading annotations…
Processing: 26_michael_4
Found file
Filtering…
Downsampling…
26_michael_4
Reading annotations…
Processing: 15_audio_90
Found file
Filtering…
```

```
Downsampling…
15_audio_90
Reading annotations…
Processing: 21_3-2-2024=7_15_14
Found file
Filtering…
Downsampling…
21_3-2-2024=7_15_14
Reading annotations…
Processing: 4_4_aud4-15
Found file
Filtering…
Downsampling…
4_4_aud4-15
Reading annotations…
Processing: 26_084431
Found file
Filtering…
Downsampling…
26_084431
Reading annotations…
Processing: 21_3-2-2024=7_11_9
Found file
Filtering…
Downsampling…
21_3-2-2024=7_11_9
Reading annotations…
Processing: 21_3-2-2024=7_26_53
Found file
Filtering…
Downsampling…
21_3-2-2024=7_26_53
Reading annotations…
Processing: 15_audio_97
Found file
Filtering…
Downsampling…
15_audio_97
Reading annotations…
Processing: 18_3-2-2024=6_50_22
Found file
Filtering…
Downsampling…
18_3-2-2024=6_50_22
Reading annotations…
Processing: 24_3
Found file
Filtering…
```

```
Downsampling…
24_3
Reading annotations…
Processing: 22_2-2-2024=14_41_59
Found file
Filtering…
Downsampling…
22_2-2-2024=14_41_59
Reading annotations…
Processing: 24_2-2-2024=14_42_40
Found file
Filtering…
Downsampling…
24_2-2-2024=14_42_40
Reading annotations…
Processing: 28_2-2-2024=14_40_58
Found file
Filtering…
Downsampling…
28_2-2-2024=14_40_58
Reading annotations…
Processing: 23_2-2-2024=20_37_39
Found file
Filtering…
Downsampling…
23_2-2-2024=20_37_39
Reading annotations…
Processing: 19_19_fermat_2
Found file
Filtering…
Downsampling…
19_19_fermat_2
Reading annotations…
Processing: 23_2-2-2024=20_46_19
Found file
Filtering…
Downsampling…
23_2-2-2024=20_46_19
Reading annotations…
Processing: 28_2-2-2024=14_41_28
Found file
Filtering…
Downsampling…
28_2-2-2024=14_41_28
Reading annotations…
Processing: 14_2-2-2024=19_38_23
Found file
Filtering…
```

```
Downsampling…
14_2-2-2024=19_38_23
Reading annotations…
Processing: 15_audio_3
Found file
Filtering…
Downsampling…
15_audio_3
Reading annotations…
Processing: 21_3-2-2024=7_31_33
Found file
Filtering…
Downsampling…
21_3-2-2024=7_31_33
Reading annotations…
Processing: 23_2-2-2024=20_41_40
Found file
Filtering…
Downsampling…
23_2-2-2024=20_41_40
Reading annotations…
Processing: 25_2-2-2024=19_44_42
Found file
Filtering…
Downsampling…
25_2-2-2024=19_44_42
Reading annotations…
Processing: 15_audio_44
Found file
Filtering…
Downsampling…
15_audio_44
Reading annotations…
Processing: 22_2-2-2024=14_39_40
Found file
Filtering…
Downsampling…
22_2-2-2024=14_39_40
Reading annotations…
Processing: 15_audio_48
Found file
Filtering…
Downsampling…
15_audio_48
Reading annotations…
Processing: 23_2-2-2024=20_52_9
Found file
Filtering…
```

```
Downsampling…
23_2-2-2024=20_52_9
Reading annotations…
Processing: 7_030224-101338
Processing: 15_audio_83
Found file
Filtering…
Downsampling…
15_audio_83
Reading annotations…
Processing: 14_3-2-2024=7_7_40
Found file
Filtering…
Downsampling…
14_3-2-2024=7_7_40
Reading annotations…
Processing: 25_2-2-2024=19_42_57
Found file
Filtering…
Downsampling…
25_2-2-2024=19_42_57
Reading annotations…
Processing: 17_2-2-2024=15_42_43
Found file
Filtering…
Downsampling…
17_2-2-2024=15_42_43
Reading annotations…
Processing: 28_2-2-2024=14_42_43
Found file
Filtering…
Downsampling…
28_2-2-2024=14_42_43
Reading annotations…
Processing: 8_emmanuel_6
Found file
Filtering…
Downsampling…
8_emmanuel_6
Reading annotations…
Processing: 20_r27_dariose
Found file
Filtering…
Downsampling…
20_r27_dariose
Reading annotations…
Processing: 5_20240203_063015
Processing: 24_2-2-2024=14_43_16
```

```
Found file
Filtering…
Downsampling…
24_2-2-2024=14_43_16
Reading annotations…
Processing: 28_2-2-2024=14_40_23
Found file
Filtering…
Downsampling…
28_2-2-2024=14_40_23
Reading annotations…
Processing: 14_2-2-2024=19_43_33
Found file
Filtering…
Downsampling…
14_2-2-2024=19_43_33
Reading annotations…
Processing: 3_030224-082609
Processing: 20_r2_dariose
Found file
Filtering…
Downsampling…
20_r2_dariose
Reading annotations…
Processing: 13_2-2-2024=23_37_15
Found file
Filtering…
Downsampling…
13_2-2-2024=23_37_15
Reading annotations…
Processing: 21_3-2-2024=7_28_38
Found file
Filtering…
Downsampling…
21_3-2-2024=7_28_38
Reading annotations…
Processing: 22_3-2-2024=7_6_28
Found file
Filtering…
Downsampling…
22_3-2-2024=7_6_28
Reading annotations…
Processing: 4_4_aud4-1
Found file
Filtering…
Downsampling…
4_4_aud4-1
Reading annotations…
```

```
Processing: 12_audio_12
Found file
Filtering…
Downsampling…
12_audio_12
Reading annotations…
Processing: 15_audio_57
Found file
Filtering…
Downsampling…
15_audio_57
Reading annotations…
Processing: 20_r13_dariose
Found file
Filtering…
Downsampling…
20_r13_dariose
Reading annotations…
Processing: 6_2-2-2024=14_48_31
Found file
Filtering…
Downsampling…
6_2-2-2024=14_48_31
Reading annotations…
Processing: 4_20240203_075055
Processing: 25_2-2-2024=19_44_7
Found file
Filtering…
Downsampling…
25_2-2-2024=19_44_7
Reading annotations…
Processing: 13_2-2-2024=23_27_56
Found file
Filtering…
Downsampling…
13_2-2-2024=23_27_56
Reading annotations…
Processing: 15_audio_67
Found file
Filtering…
Downsampling…
15_audio_67
Reading annotations…
Processing: 21_3-2-2024=7_20_1
Found file
Filtering…
Downsampling…
21_3-2-2024=7_20_1
```

```
Reading annotations…
Processing: 15_audio_5
Found file
Filtering…
Downsampling…
15_audio_5
Reading annotations…
Processing: 15_audio_116
Found file
Filtering…
Downsampling…
15_audio_116
Reading annotations…
Processing: 21_3-2-2024=7_28_3
Found file
Filtering…
Downsampling…
21_3-2-2024=7_28_3
Reading annotations…
Processing: 14_2-2-2024=19_39_35
Found file
Filtering…
Downsampling…
14_2-2-2024=19_39_35
Reading annotations…
Processing: 18_3-2-2024=6_51_3
Found file
Filtering…
Downsampling…
18_3-2-2024=6_51_3
Reading annotations…
Processing: 16_030224-090521
Processing: 6_2-2-2024=14_44_31
Found file
Filtering…
Downsampling…
6_2-2-2024=14_44_31
Reading annotations…
Processing: 20_r19_dariose
Found file
Filtering…
Downsampling…
20_r19_dariose
Reading annotations…
Processing: 23_2-2-2024=20_41_45
Found file
Filtering…
Downsampling…
```

```
23_2-2-2024=20_41_45
Reading annotations…
Processing: 15_audio_109
Found file
Filtering…
Downsampling…
15_audio_109
Reading annotations…
Processing: 23_2-2-2024=20_38_9
Found file
Filtering…
Downsampling…
23_2-2-2024=20_38_9
Reading annotations…
Processing: 24_2-2-2024=14_45_36
Found file
Filtering…
Downsampling…
24_2-2-2024=14_45_36
Reading annotations…
Processing: 15_audio_95
Found file
Filtering…
Downsampling…
15_audio_95
Reading annotations…
Processing: 8_emmanuel_8
Found file
Filtering…
Downsampling…
8_emmanuel_8
Reading annotations…
Processing: 13_2-2-2024=23_33_17
Found file
Filtering…
Downsampling…
13_2-2-2024=23_33_17
Reading annotations…
Processing: 15_audio_11
Found file
Filtering…
Downsampling…
15_audio_11
Reading annotations…
Processing: 27_audio_annotation2
Found file
Filtering…
Downsampling…
```

```
27_audio_annotation2
Reading annotations…
Processing: 24_2-2-2024=14_43_10
Found file
Filtering…
Downsampling…
24_2-2-2024=14_43_10
Reading annotations…
Processing: 14_2-2-2024=19_39_0
Found file
Filtering…
Downsampling…
14_2-2-2024=19_39_0
Reading annotations…
Processing: 17_2-2-2024=15_42_42
Found file
Filtering…
Downsampling…
17_2-2-2024=15_42_42
Reading annotations…
Processing: 22_audio1
Found file
Filtering…
Downsampling…
22_audio1
Reading annotations…
Processing: 23_2-2-2024=20_41_4
Found file
Filtering…
Downsampling…
23_2-2-2024=20_41_4
Reading annotations…
Processing: 8_emmanuel_3
Found file
Filtering…
Downsampling…
8_emmanuel_3
Reading annotations…
Processing: 11_030224-105230
Processing: 20_075055
Processing: 18_3-2-2024=6_55_37
Found file
Filtering…
Downsampling…
18_3-2-2024=6_55_37
Reading annotations…
Processing: 6_2-2-2024=14_43_21
Found file
```

```
Filtering…
Downsampling…
6_2-2-2024=14_43_21
Reading annotations…
Processing: 17_030224-102335
Processing: 3_2-2-2024=22_0_31
Found file
Filtering…
Downsampling…
3_2-2-2024=22_0_31
Reading annotations…
Processing: 15_audio_43
Found file
Filtering…
Downsampling…
15_audio_43
Reading annotations…
Processing: 5_2-2-2024=15_21_45
Found file
Filtering…
Downsampling…
5_2-2-2024=15_21_45
Reading annotations…
Done
```

0.2 Step 1: Pre-process the data

0.3 Data shapes

```python
[10]: print(X.shape)
      print(Y.shape)
```

```
(1909, 66150)
(1909,)
```

```python
[14]: test_audio = X[0]
```

```python
[15]: test_audio.shape
```

```
[15]: (66150,)
```

```python
[16]: S = librosa.feature.melspectrogram(y=test_audio, n_fft=n_fft,␣
      ↪hop_length=hop_length, n_mels=n_mels, fmin=f_min, fmax=f_max)
```
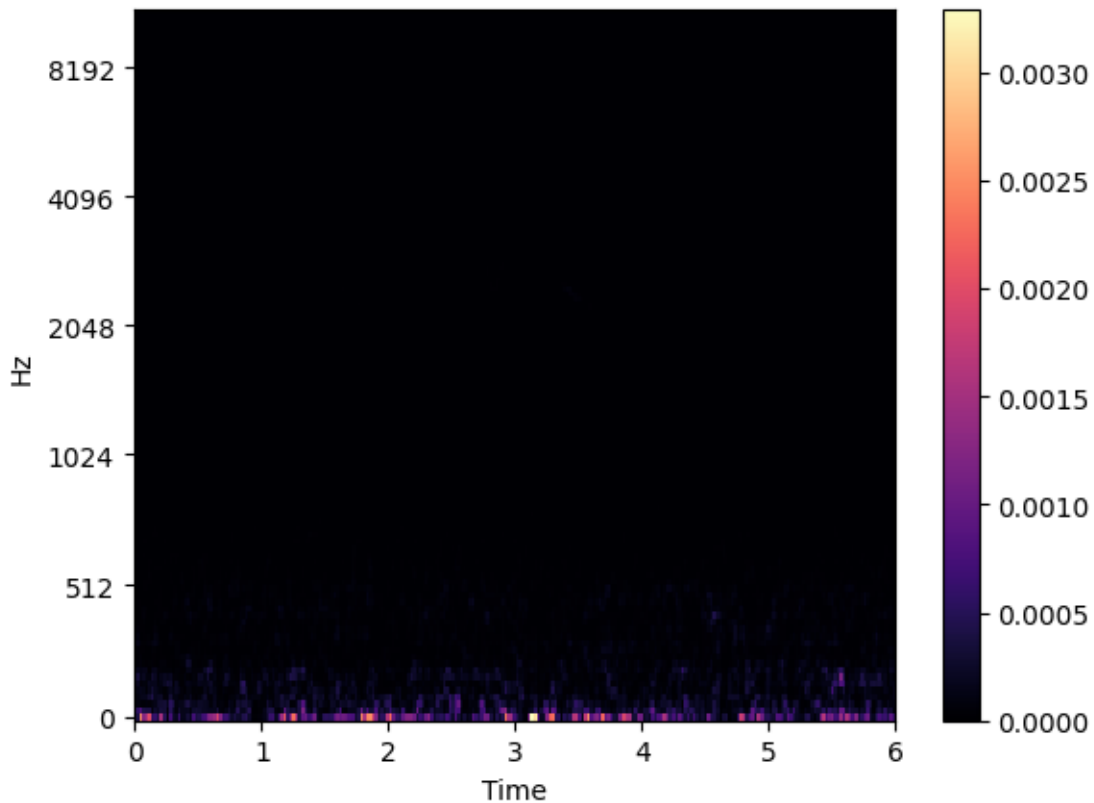
```python
[17]: # 2 View the mel spectrogram before doing anything else. Try and view a␣
      ↪spectrogram
      # that contains some type of sound.
      fig, ax = plt.subplots()
```

```
imag = librosa.display.specshow(S,x_axis='time',y_axis='mel',
  ↪sr=downsample_rate, ax=ax,)
fig.colorbar(imag, ax=ax)
```
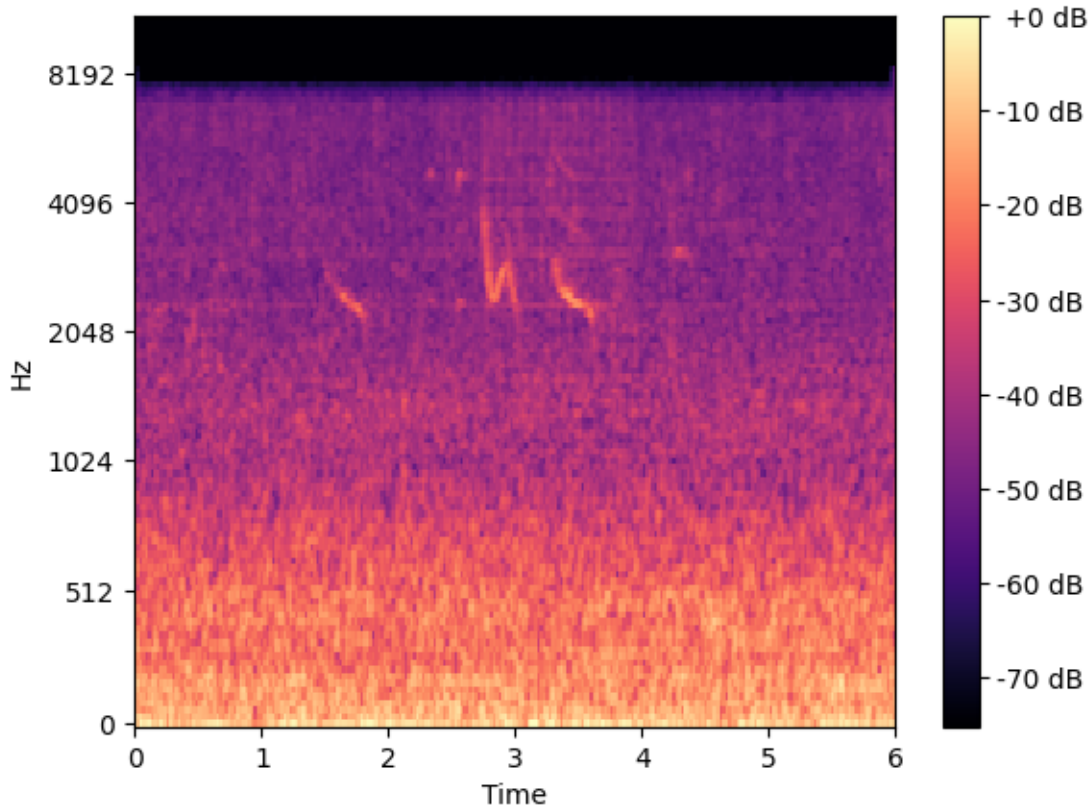
[17]: <matplotlib.colorbar.Colorbar at 0x7d8d4643a950>


```
S_dB = librosa.power_to_db(S, ref=np.max)
fig, ax = plt.subplots()
imag=librosa.display.specshow(S_dB, y_axis='mel', x_axis='time',
  ↪sr=downsample_rate,)
fig.colorbar(imag, ax=ax, format="%+3.0f dB")
```

[18]: <matplotlib.colorbar.Colorbar at 0x7d8d46c7e950>

0.3.1 Task 1: preprocessing

The data in `X` and `Y` is not fully pre-processed. `X` has segments of audio which have been extracted from the audio files along with their label in `Y`.

- Implement a function called `audio_to_spectrogram(audio)` which takes in one audio signal, and returns a mel-spectrogram.

- This function should implement some type of normalisation.

```
[19]: def audio_to_spectrogram(audio):
          S = librosa.feature.melspectrogram(y=audio, n_fft=n_fft,
          ↪hop_length=hop_length, n_mels=n_mels, fmin=f_min, fmax=f_max)
          S_db = librosa.power_to_db(S, ref=np.max)
          return S_db
```

0.3.2 Task 2

- You need to add some code which visualises 3 presence events, and 3 absence events. You are free to plot any example in `X` and `Y`. But the examples should be different.

Presence events

```
[ ]:  # random presence spectrogram
```
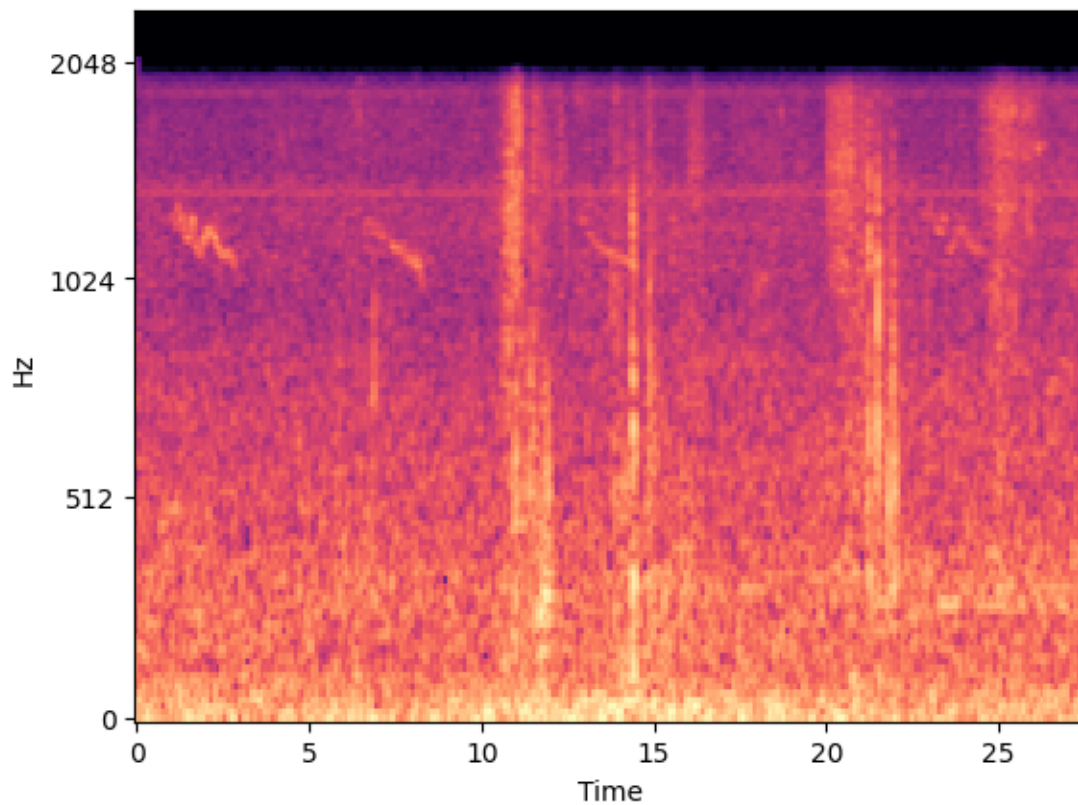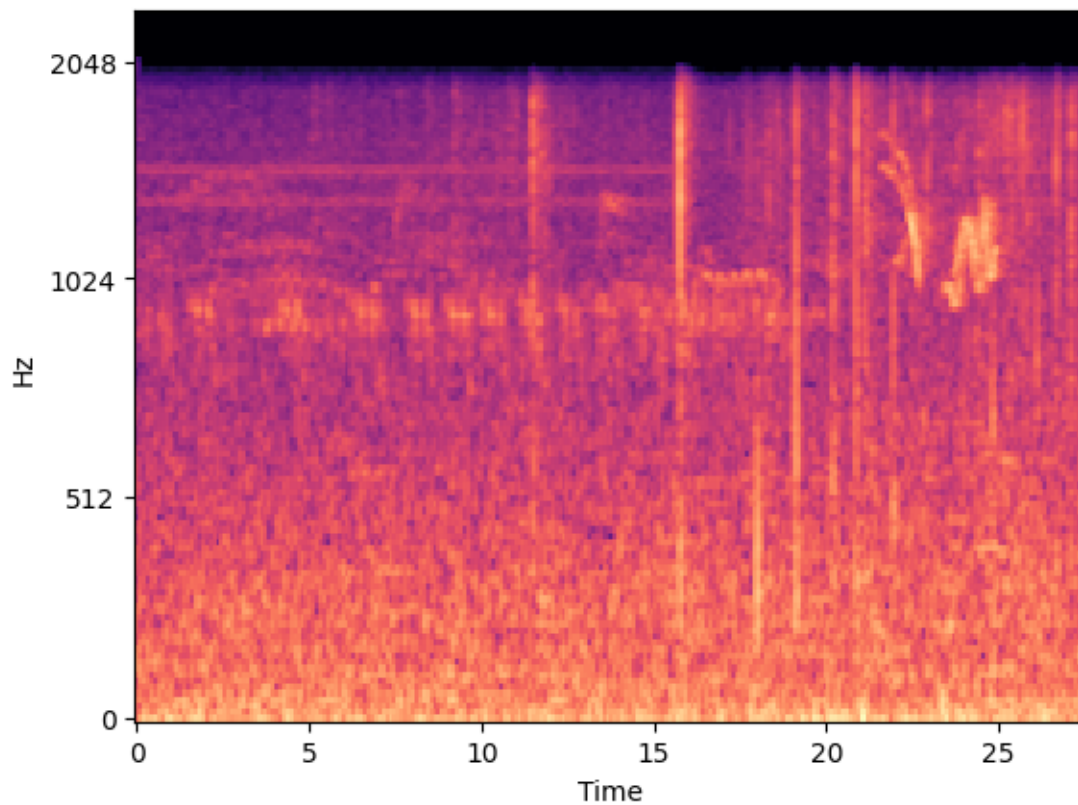
```
[26]:  Y1 = np.where(Y =='1')[0]
       random_index1 = random.randint(0,len(Y1)-1)
       X_s = audio_to_spectrogram(X[Y1[random_index1]])
       librosa.display.specshow(X_s,x_axis='time', y_axis='mel', sr=4800)
       print(Y[Y1[random_index1]],':',random_index1)# TO DO
```

1 : 738
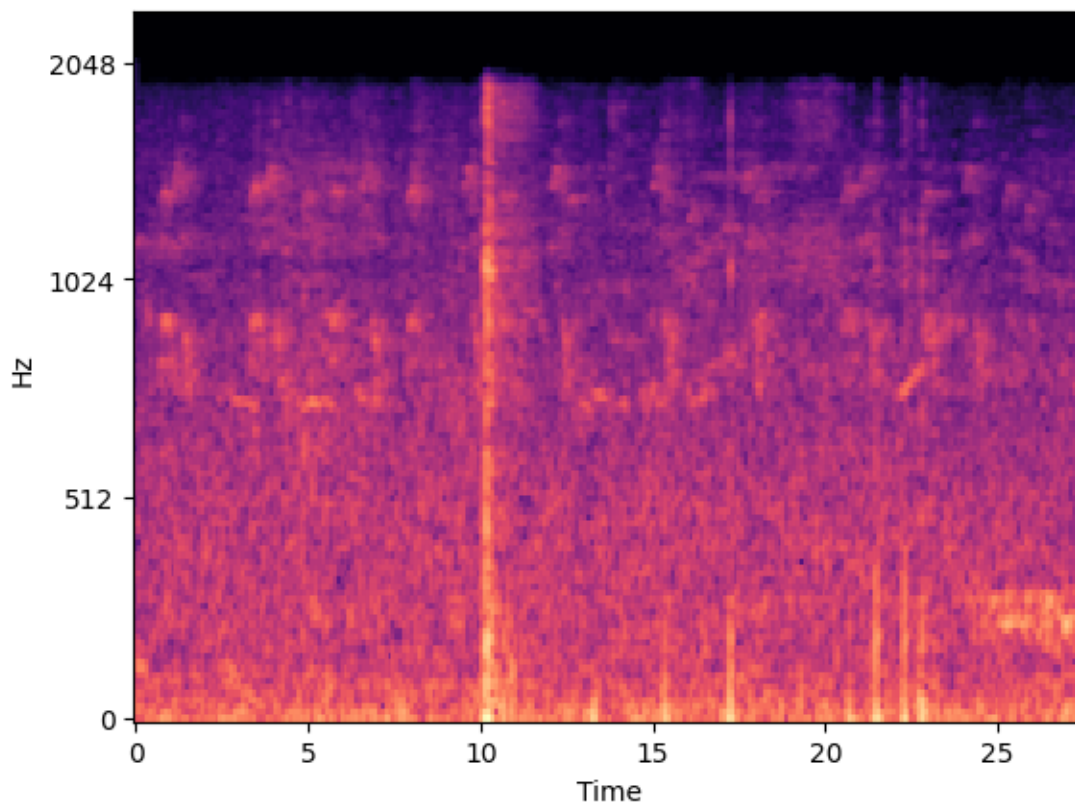

```
[ ]:  Y1 = np.where(Y =='1')[0]
       random_index1 = random.randint(0,len(Y1)-1)
       X_s = audio_to_spectrogram(X[Y1[random_index1]])
       librosa.display.specshow(X_s,x_axis='time', y_axis='mel', sr=4800)
       print(Y[Y1[random_index1]],':',random_index1)# TO DO
```
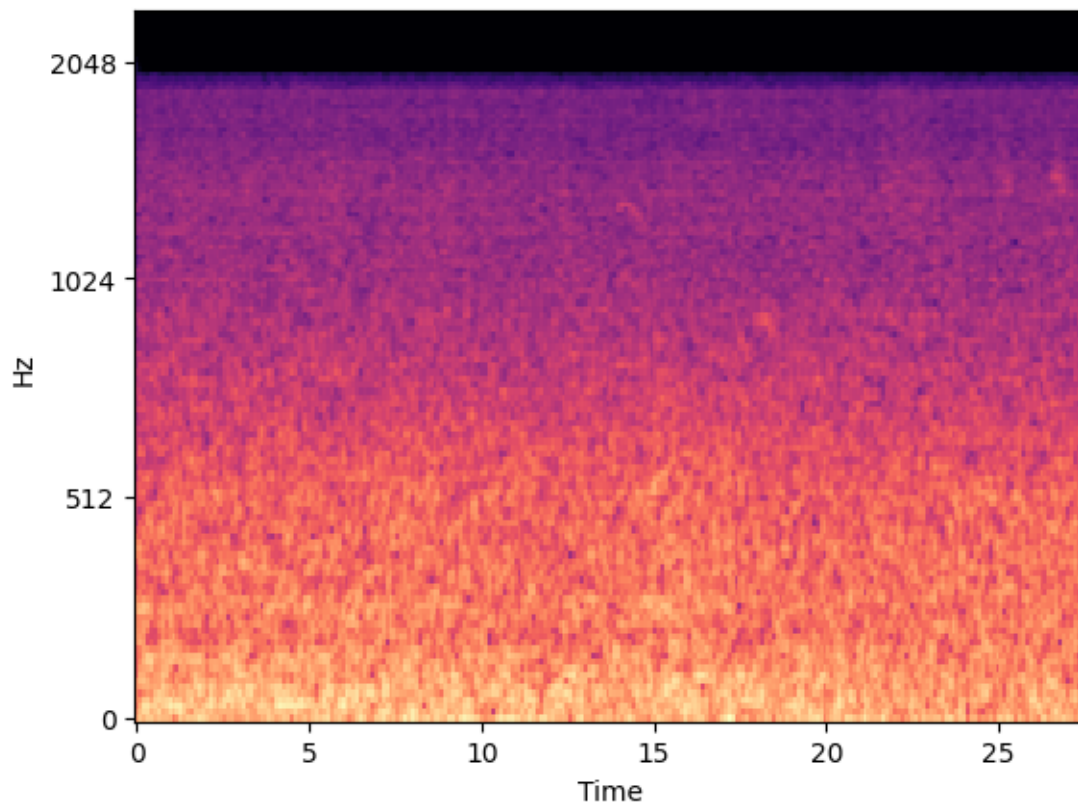
1 : 5023

```
Y1 = np.where(Y =='1')[0]
random_index1 = random.randint(0,len(Y1)-1)
X_s = audio_to_spectrogram(X[Y1[random_index1]])
librosa.display.specshow(X_s,x_axis='time', y_axis='mel', sr=4800)
print(Y[Y1[random_index1]],':',random_index1)# TO DO
```

1 : 3202

```
Y1 = np.where(Y =='0')[0]
random_index1 = random.randint(0,len(Y1)-1)
X_s = audio_to_spectrogram(X[Y1[random_index1]])
librosa.display.specshow(X_s,x_axis='time', y_axis='mel', sr=4800)
print(Y[Y1[random_index1]],':',random_index1)# TO DO
```

0 : 834

Absence events

```
Y1 = np.where(Y =='0')[0]
random_index1 = random.randint(0,len(Y1)-1)
X_s = audio_to_spectrogram(X[Y1[random_index1]])
librosa.display.specshow(X_s,x_axis='time', y_axis='mel', sr=4800)
print(Y[Y1[random_index1]],':',random_index1)# TO DO
```
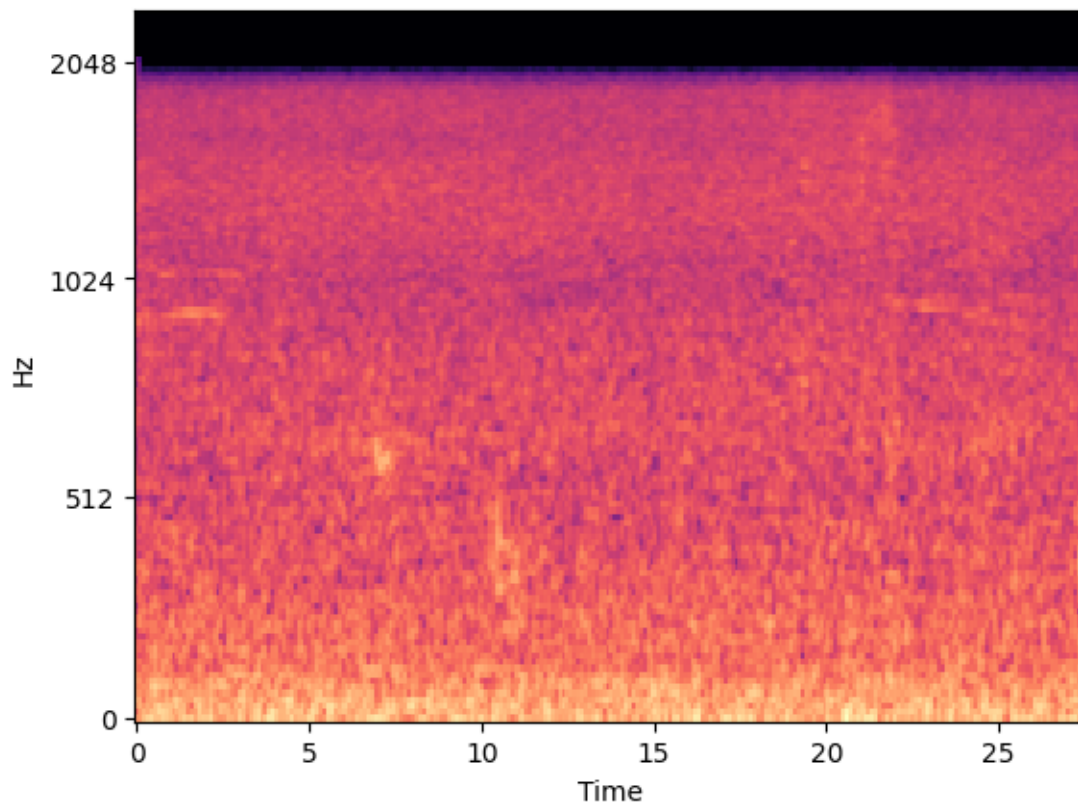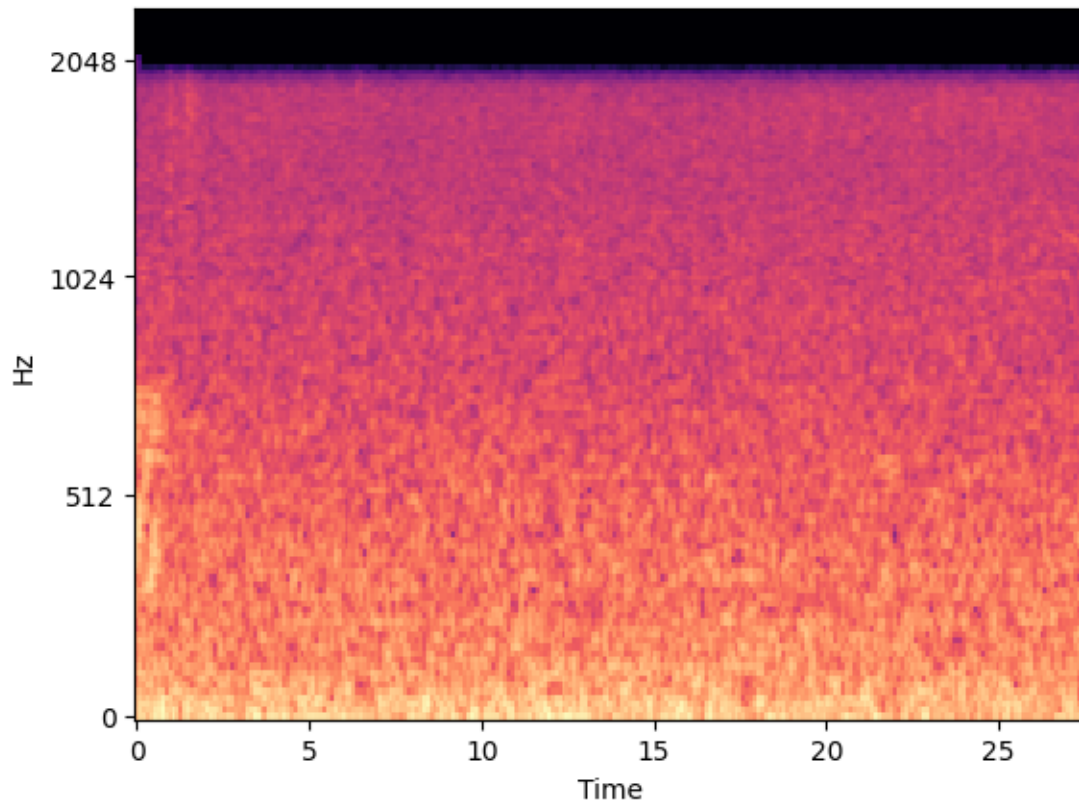
0 : 916

```
Y1 = np.where(Y =='0')[0]
random_index1 = random.randint(0,len(Y1)-1)
X_s = audio_to_spectrogram(X[Y1[random_index1]])
librosa.display.specshow(X_s,x_axis='time', y_axis='mel', sr=4800)
print(Y[Y1[random_index1]],':',random_index1)# TO DO
```

0 : 195

[20]:
```python
#Here is a function that will convert all of your audio segments into
    ↪spectrograms, using the function you wrote above.
def convert_all_to_image(segments):

    spectrograms = []
    for segment in segments:
        spectrograms.append(audio_to_spectrogram(segment))

    return np.array(spectrograms)
```

Create all the spectrograms

[21]:
```python
#Create all the spectrograms
X_S = convert_all_to_image(X)
```

[30]:
```python
X_S.shape
```

[30]: (1909, 128, 259)

[31]:
```python
#Look how many precense and absence examples are in the training data.
unique, counts = np.unique(Y, return_counts=True)
```

```
original_distribution = dict(zip(unique, counts))
print('Data distribution:',original_distribution)
```

Data distribution: {'0': 481, '1': 1428}

0.3.3 Task 3: given the values above, how many presence examples and absence examples would you like to have? You don't have to write anything down, just reflect on this.

0.3.4 Task 4:

- Implement a function that will augment one spectrogram.
- The input will be a spectrogram, and it's target.
- The output should be the modified spectogram, and the target.

This function receives one spectrogram (2D matrix).

It also receives the true target value for that spectrogram

You must implement something to change the spectrogram in some way.

You do not need to get a noisy example or any external data, do mix up or anything complicated. Only manipulate this spectrogram stored in the variable `spectrogram` in some way so that this function acts like an augmetation function.

Here, I'm gonna use Frequency masking :

```
[32]: def augment_one_spectrogram(spectrogram, true_target):
          # I generate a mel spectrogram
          new_spectrogram = np.copy(spectrogram)  # I make a copy to avoid modifying
      ↪the original

          # I apply frequency masking
          frequency_mask_width = np.random.randint(5, 15)  # Augmenting the range of
      ↪frequency mask width
          freq = np.random.randint(10, new_spectrogram.shape[0] -
      ↪frequency_mask_width - 5)  # Adjusting the range of starting index
          new_spectrogram[freq:freq + frequency_mask_width, :] = -1 # Using -1 as the
      ↪replacement value

          # Return the augmented spectrogram and the target
          return new_spectrogram, true_target
```

I want to make a checking of my function by choosing randomly an example

```
[33]: Train = augment_one_spectrogram(X_S[203],true_target=0)
      print("X_S[203] =",X_S[203],'\n\n','Train =',Train)
```

X_S[203] = [[-14.21230605 -10.10971887 -8.18760825 … -5.5651371
-13.96667573
  -15.39436494]
 [-16.83111643 -10.83082035 -9.7400247 … -4.91921544 -10.91584858

```
 -16.37213842]
[-18.2384621  -10.12533755  -6.65819527 …  -6.66925107 -12.60868316
 -12.14073141]
…
[-78.00076808 -78.00076808 -78.00076808 … -78.00076808 -78.00076808
 -78.00076808]
[-78.00076808 -78.00076808 -78.00076808 … -78.00076808 -78.00076808
 -78.00076808]
[-78.00076808 -78.00076808 -78.00076808 … -78.00076808 -78.00076808
 -78.00076808]]

Train = (array([[-14.21230605, -10.10971887,  -8.18760825, …,  -5.5651371 ,
        -13.96667573, -15.39436494],
       [-16.83111643, -10.83082035,  -9.7400247 , …,  -4.91921544,
        -10.91584858, -16.37213842],
       [-18.2384621 , -10.12533755,  -6.65819527, …,  -6.66925107,
        -12.60868316, -12.14073141],
       …,
       [-78.00076808, -78.00076808, -78.00076808, …, -78.00076808,
        -78.00076808, -78.00076808],
       [-78.00076808, -78.00076808, -78.00076808, …, -78.00076808,
        -78.00076808, -78.00076808],
       [-78.00076808, -78.00076808, -78.00076808, …, -78.00076808,
        -78.00076808, -78.00076808]]), 0)
```

```python
[34]: # Original
      plt.figure(figsize=(12, 10))
      plt.subplot(2, 2, 1)
      imag=librosa.display.specshow(X_S[203], y_axis='mel', x_axis='time',
        ↪sr=downsample_rate,)
      plt.title('Original')
      # Augmentation
      plt.subplot(2, 2, 2)
      Train_2= Train[0]
      imag=librosa.display.specshow(Train_2, y_axis='mel', x_axis='time',
        ↪sr=downsample_rate)
      plt.title('Frequency masking')
```
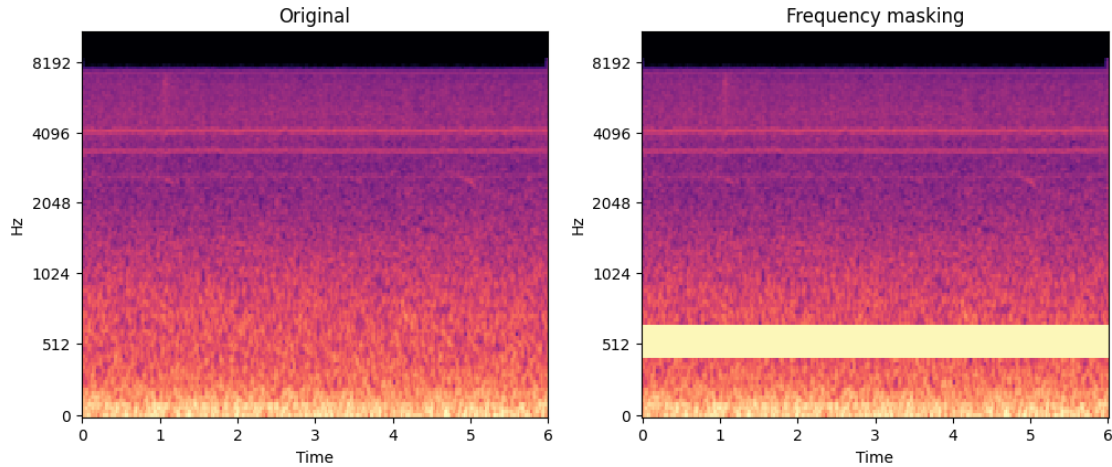
[34]: Text(0.5, 1.0, 'Frequency masking')

This function will randomly select one spectrogram which contains a presence bird call.

```python
[35]: def randomly_select_presence(all_spectrograms, targets):

          # Find all the indices where there is a presence example
          presence_indices = np.where(targets =='1')[0]

          # Randomly select index
          random_index = random.randint(0,len(presence_indices)-1)

          return all_spectrograms[presence_indices[random_index]]
```

This function will randomly select one spectrogram which does not contain a gibbon call.

```python
[36]: def randomly_select_absence(all_spectrograms, targets):

          # Find all the indices where there is a absence example
          absence_indices = np.where(targets =='0')[0]

          # Randomly select index
          random_index = random.randint(0,len(absence_indices)-1)

          return all_spectrograms[absence_indices[random_index]]
```

This function will generate one new spectrogram with a presence bird call in it.

```python
[37]: def generate_new_presence_spectrograms(all_spectrograms, all_targets, quantity):

          new_spectrograms = []
          new_targets = []

          for i in range (0, quantity):
```

34

```
    presence_spectrogram = randomly_select_presence(all_spectrograms,␣
 ↪all_targets)
    augmented_spectrogram, augmented_target =␣
 ↪augment_one_spectrogram(presence_spectrogram,

                                                        '1')


    new_spectrograms.append(augmented_spectrogram)
    new_targets.append(augmented_target)

  return np.asarray(new_spectrograms), np.asarray(new_targets)
```

This function will generate one new spectrogram without bird call in it.

```
[38]: def generate_new_absence_spectrograms(all_spectrograms, all_targets, quantity):

        new_spectrograms = []
        new_targets = []

        for i in range (0, quantity):
          absence_spectrogram = randomly_select_absence(all_spectrograms, all_targets)
          augmented_spectrogram, augmented_target =␣
      ↪augment_one_spectrogram(absence_spectrogram,

                                                          '0')


          new_spectrograms.append(augmented_spectrogram)
          new_targets.append(augmented_target)

        return np.asarray(new_spectrograms), np.asarray(new_targets)
```

0.3.5   Task 5:

- Now generate actual presence calls, here you need to specify how many you want to create, extra. The value specified in the function is the amount of extra spectrograms that you want to create, which will contain gibbon calls.

```
[53]: new_presence, new_targets = generate_new_presence_spectrograms(X_S, Y, 252) #␣
      ↪TO DO
```

Check the shapes of the newly created data

```
[54]: print(new_presence.shape)
      print(new_targets.shape)
```
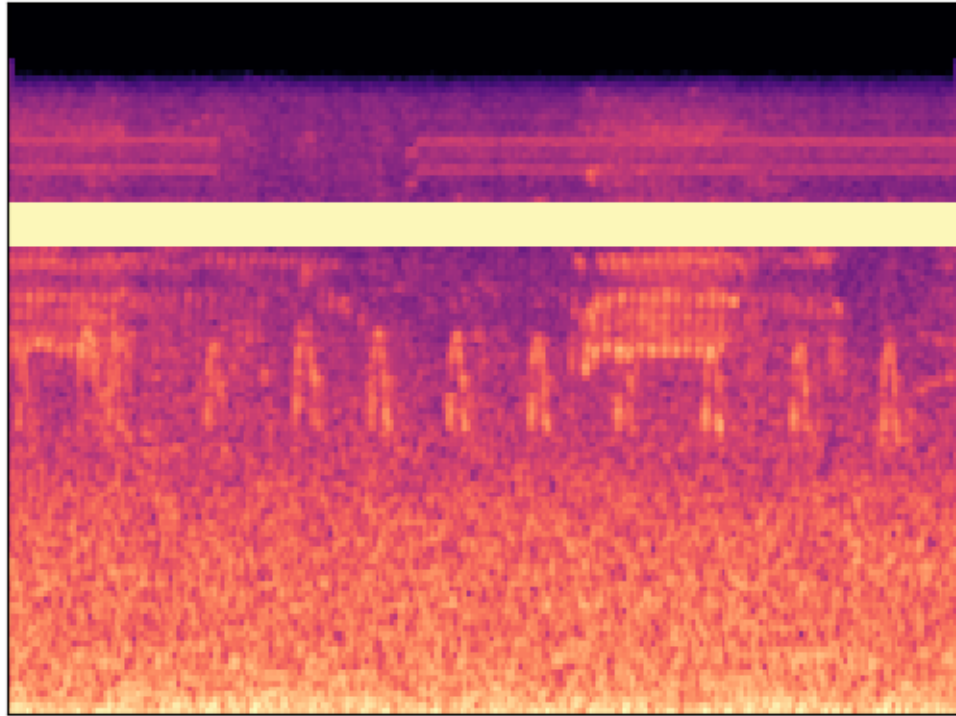
```
(252, 128, 259)
(252,)
```

0.3.6   Task 6

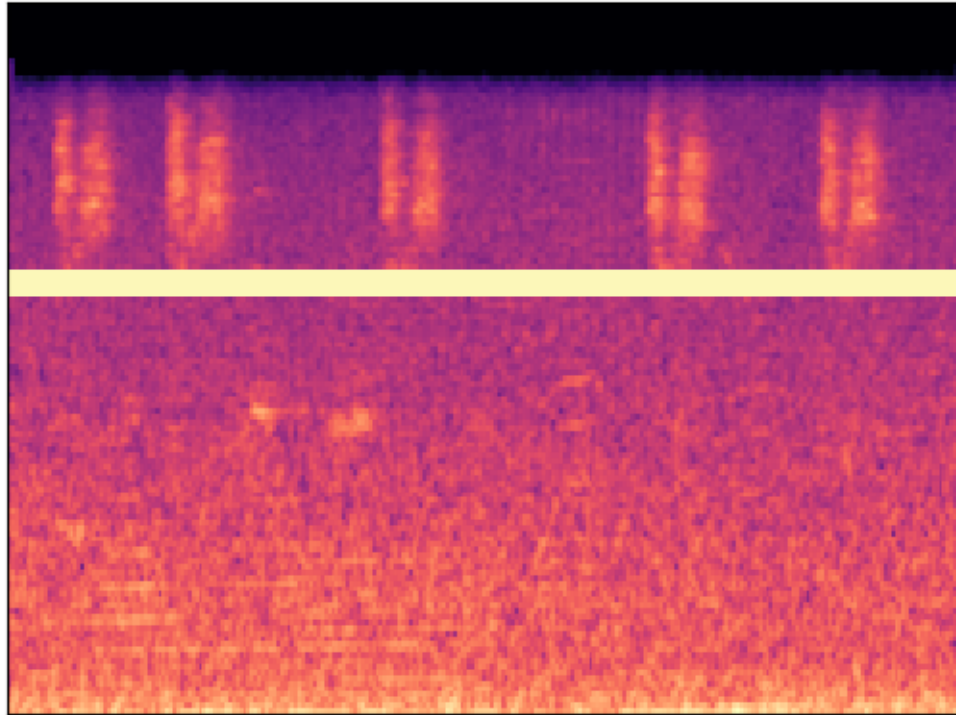Randomly select two of your newly created spectrograms, and view it.

```
[62]: librosa.display.specshow(new_presence[8])
```

[62]: <matplotlib.collections.QuadMesh at 0x7d8d462b8790>


```
[51]: librosa.display.specshow(new_presence[134])# TO DO)
```

[51]: <matplotlib.collections.QuadMesh at 0x7d8d46663bb0>

Now combine all of your existing spectrograms which contain bird calls, along with all of the newly created ones.

```
[63]: X_positive = np.concatenate([X_S[np.where(Y =='1')], new_presence])
X_positive = np.asarray(X_positive)
print(X_positive.shape)
Y_positive = np.concatenate([Y[np.where(Y =='1')], new_targets])
Y_positive = np.asarray(Y_positive)
print(Y_positive.shape)
```

```
(1680, 128, 259)
(1680,)
```

0.3.7 Task 7

- Now generate actual absence spectrograms, here you need to specify how many you want to create, extra. The value specified in the function is the amount of extra spectrograms that you want to create, which will not contain gibbon calls.

```
[64]: new_absence, new_targets = generate_new_absence_spectrograms(X_S, Y, 999) # TO␣
␣→DO)
```

Check the shapes of the newly created data

```
[65]: print(new_absence.shape)
      print(new_targets.shape)
```
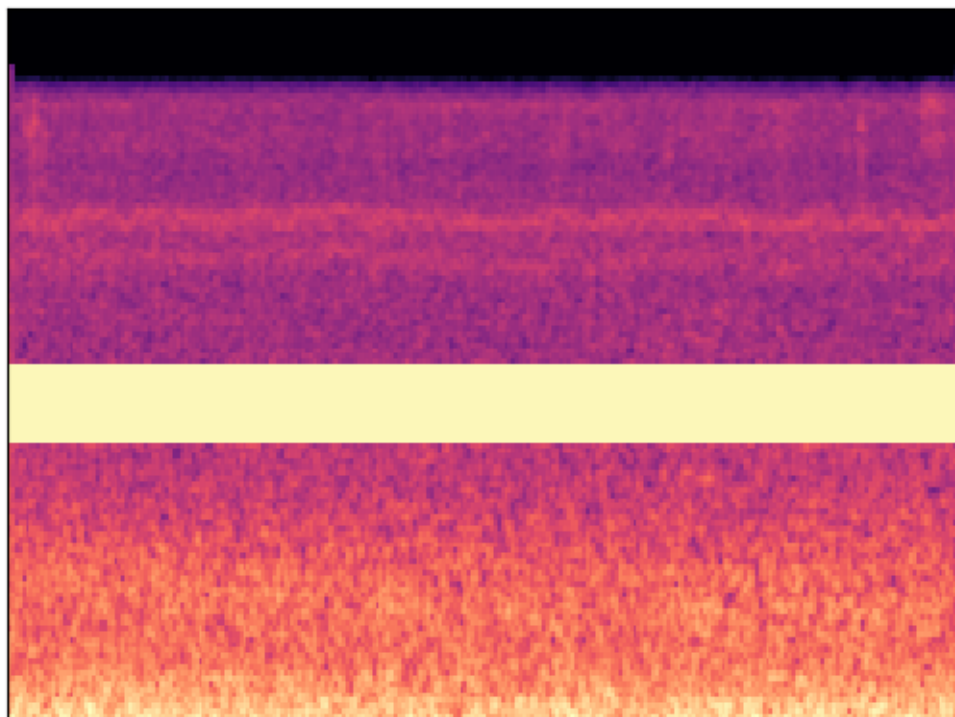
```
(999, 128, 259)
(999,)
```

0.3.8   Task 8

Randomly select two of your newly created spectrograms, and view it.

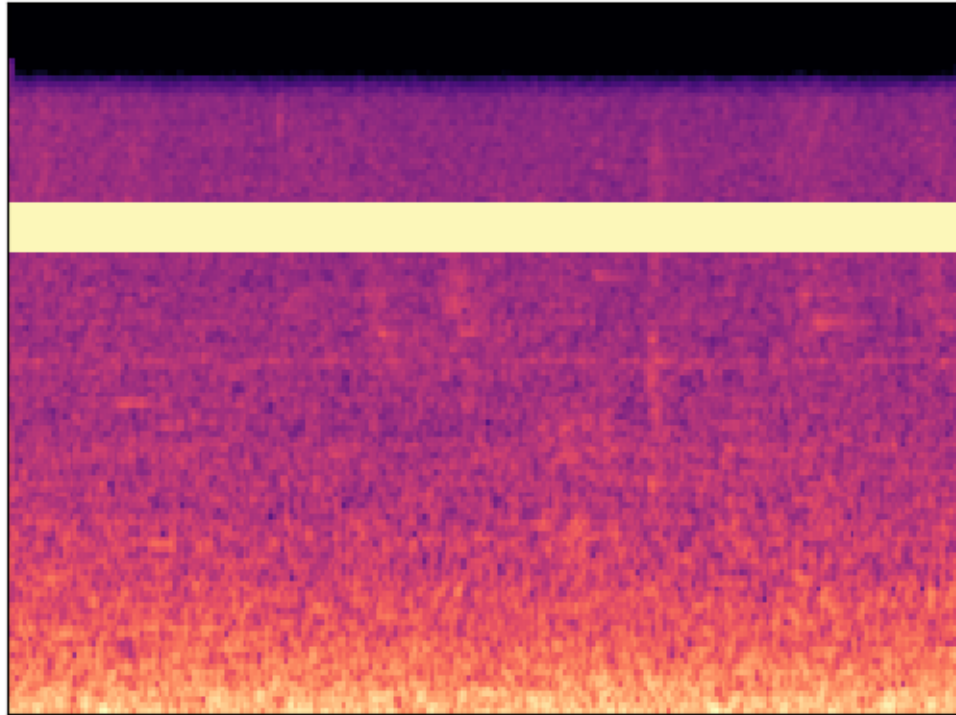```
[66]: librosa.display.specshow(new_absence[7])# TO DO)
```

[66]: <matplotlib.collections.QuadMesh at 0x7d8d461c8550>



```
[67]: librosa.display.specshow(new_absence[17])# TO DO)
```

[67]: <matplotlib.collections.QuadMesh at 0x7d8d462424a0>

Now combine all of your existing spectrograms which do not contain gibbon calls, along with all of the newly created ones.

```
[68]: X_negatives = np.concatenate([X_S[np.where(Y =='0')], new_absence])
      X_negatives = np.asarray(X_negatives)
      print(X_negatives.shape)

      Y_negatives = np.concatenate([Y[np.where(Y =='0')], new_targets])
      Y_negatives = np.asarray(Y_negatives)
      print(Y_negatives.shape)
```

```
(1480, 128, 259)
(1480,)
```

Combine all the positives features and negative features. Do the same for the targets

```
[69]: X_dataset = np.concatenate([X_positive, X_negatives])
      Y_dataset = np.concatenate([Y_positive, Y_negatives])
```

Check the shapes of the completed dataset.

```
[70]: print(X_dataset.shape)
      print(Y_dataset.shape)
```

```
(3160, 128, 259)
(3160,)
```

Reshape so that the data is in a format that is ready for Tensorflow.

```
[71]: X_dataset = np.expand_dims(X_dataset, axis=-1)
```

Check the shape again

```
[72]: print(X_dataset.shape)
      print(Y_dataset.shape)
```

```
(3160, 128, 259, 1)
(3160,)
```

Some pre-processing to convert the categorical targets into one-hot encoded ones

```
[73]: from tensorflow.keras.utils import to_categorical
      call_order = ['0','1']

      # Converting categorical string labels ('presence' and 'absence) to 0s and 1s
      for index, call_type in enumerate(call_order):
          Y_dataset = np.where(Y_dataset == call_type, index, Y_dataset)

      Y_dataset = to_categorical(Y_dataset,
                                 num_classes = 2)
```

Check shapes again

```
[74]: print(X_dataset.shape)
      print(Y_dataset.shape)
```

```
(3160, 128, 259, 1)
(3160, 2)
```

Delete some RAM

```
[75]: del X_S, Y, X
```

```
[98]: from tensorflow.keras.layers import Dense, Dropout, Flatten, MaxPool2D, Conv2D
      from tensorflow.keras.models import Sequential

      INPUT_SHAPE = (128,259, 1)
      model = Sequential()

      # Create one convolutional layer
      model.add(Conv2D(filters = 16, kernel_size = 4, input_shape = INPUT_SHAPE,
        ↪activation = 'relu'))

      # Create one max pooling layer
      model.add(MaxPool2D(pool_size = 2))

      # Create another convolutional layer
      model.add(Conv2D(filters = 32, kernel_size = 4, activation = 'relu'))
```

```python
# Create another max pooling layer
model.add(MaxPool2D(pool_size=2))

# Create another convolutional layer
model.add(Conv2D(filters = 64, kernel_size = 4, activation = 'relu'))

# Create another max pooling layer
model.add(MaxPool2D(pool_size=2))

# Create another convolutional layer
model.add(Conv2D(filters = 128, kernel_size = 4, activation = 'relu'))

# Create another max pooling layer
model.add(MaxPool2D(pool_size=2))

model.add(Flatten())

# Here we create 16 fully connected units
model.add(Dense(units = 16, activation='relu'))

# The output
model.add(Dense(2, activation = 'softmax'))
#update the weights
model.compile(loss='categorical_crossentropy',
    ↪optimizer='adam',metrics=['accuracy'])
```

0.3.9 Task 9: model training

- Implement your own network and training.
- You are free to do whatever you want and show/explain your reasoning. You are free to add text or anything else you want to share.

Train the model

```python
[99]: # TO DO
model.summary()
```

Model: "sequential_6"

```
_____
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d_23 (Conv2D)          (None, 125, 256, 16)      272

 max_pooling2d_23 (MaxPooli  (None, 62, 128, 16)       0
 ng2D)

 conv2d_24 (Conv2D)          (None, 59, 125, 32)       8224
```

41

```
max_pooling2d_24 (MaxPooli   (None, 29, 62, 32)        0
ng2D)

conv2d_25 (Conv2D)           (None, 26, 59, 64)        32832

max_pooling2d_25 (MaxPooli   (None, 13, 29, 64)        0
ng2D)

conv2d_26 (Conv2D)           (None, 10, 26, 128)       131200

max_pooling2d_26 (MaxPooli   (None, 5, 13, 128)        0
ng2D)

flatten_6 (Flatten)          (None, 8320)              0

dense_12 (Dense)             (None, 16)                133136

dense_13 (Dense)             (None, 2)                 34

=================================================================
Total params: 305698 (1.17 MB)
Trainable params: 305698 (1.17 MB)
Non-trainable params: 0 (0.00 Byte)

_____
```

```python
[100]: history = model.fit(X_dataset,Y_dataset,epochs=3,
                           validation_split=0.2)
```

```
Epoch 1/3
79/79 [==============================] - 112s 1s/step - loss: 0.7481 - accuracy:
0.6630 - val_loss: 0.5593 - val_accuracy: 0.7263
Epoch 2/3
79/79 [==============================] - 110s 1s/step - loss: 0.5570 - accuracy:
0.7211 - val_loss: 0.3521 - val_accuracy: 0.8987
Epoch 3/3
79/79 [==============================] - 109s 1s/step - loss: 0.4079 - accuracy:
0.8074 - val_loss: 0.3282 - val_accuracy: 0.9051
```

```python
[97]: #del history
```

```python
[101]: plt.plot(history.history['accuracy'])
       plt.plot(history.history['val_accuracy'])
       plt.title('model accuracy')
       plt.ylabel('accuracy')
       plt.xlabel('epoch')
       plt.legend(['train', 'test'], loc='upper left')
       plt.show()
       # summarize history for loss
```

```
plt.plot(history.history['loss'])
plt.plot(history.history['val_loss'])
plt.title('model loss')
plt.ylabel('loss')
plt.xlabel('epoch')
plt.legend(['train', 'test'], loc='upper left')
plt.show()
```