fully conv autoencoder

March 24, 2019

```
In [1]: from matplotlib import pyplot as plt
        import numpy as np
        from keras.datasets import mnist
        from keras.models import Sequential
        from keras.layers import Dense, Activation, Flatten, MaxPooling1D, UpSampling1D
        from keras.layers.convolutional import Conv1D, Conv2D
        import medleydb as mdb
        from scipy import signal
        from scipy.io import wavfile
```

```
Using TensorFlow backend.
```

1 Load the mix

```
In [65]: multitracks = mdb.load_multitracks(["Phoenix_ColliersDaughter"])
```

```
In [66]: mix = next(multitracks)
```

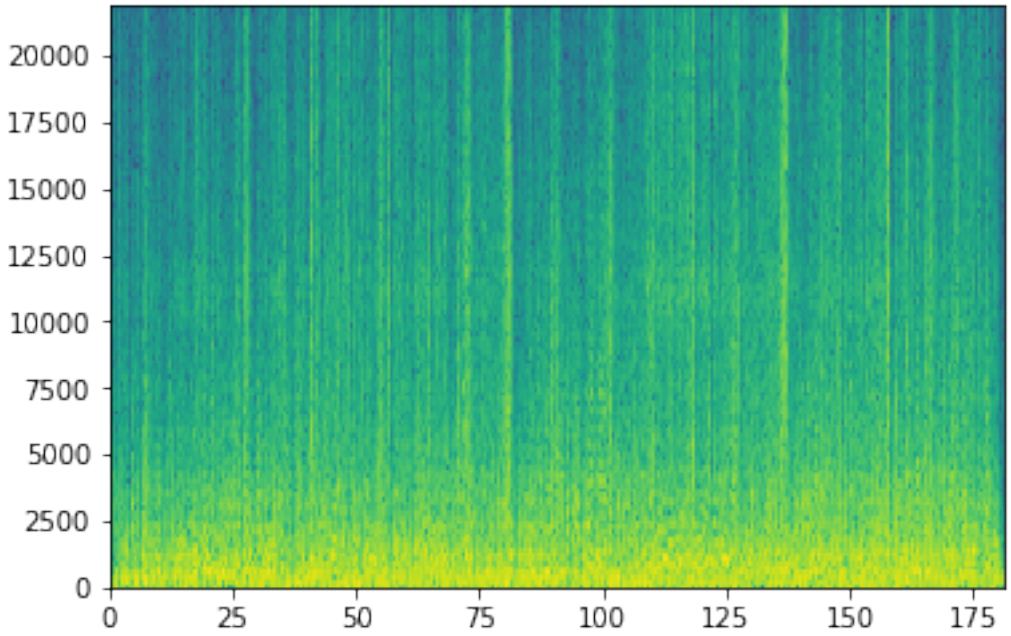
```
In [67]: sample_rate, mix_audio = wavfile.read(mix.mix_path)
         mix_audio = mix_audio.mean(1)
         mix_audio = mix_audio[sample_rate*8:int(-sample_rate*1.5)]
```

```
In [68]: samples_per_period = 256
         overlap = int(samples_per_period/2)
```

```
In [69]: freqs, times, s_mix = signal.stft(mix_audio, fs=sample_rate, nfft=samples_per_period,
                                            noverlap=overlap, nperseg=samples_per_period)

         freqs = freqs[:-1]
         s_mix = s_mix[:-1,:]
```

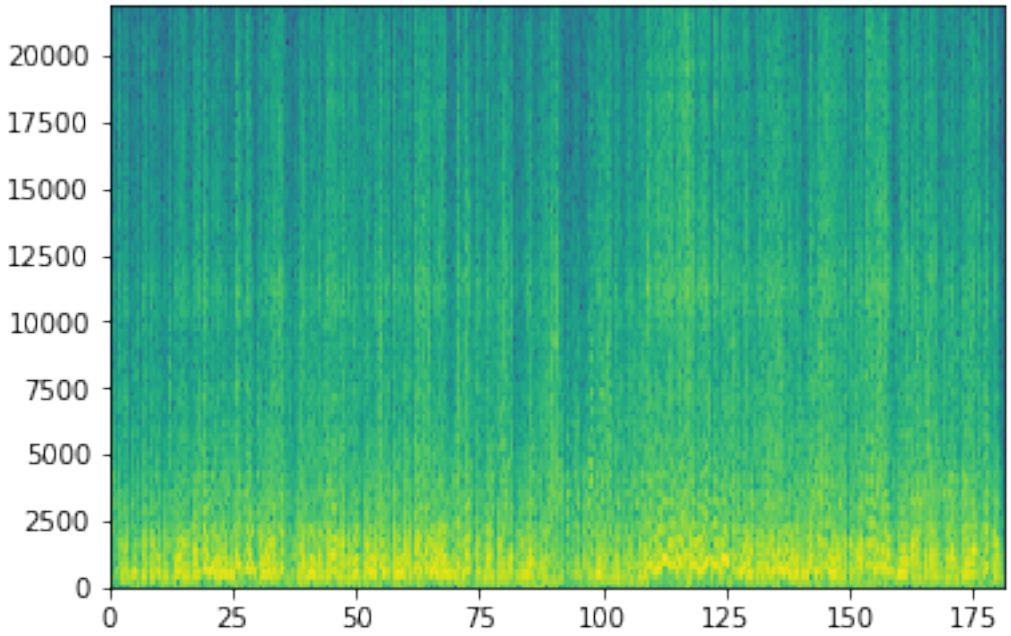
```
In [70]: plt.pcolormesh(times, freqs, 20*np.log10(np.abs(s_mix)))
```

```
Out[70]: <matplotlib.collections.QuadMesh at 0x1b498fe6630>
```



2 Load the Flute

```
In [71]: flutes = mdb.get_files_for_instrument("flute", [mix])

In [72]: flute = next(flutes)

In [73]: sample_rate, flute_audio = wavfile.read(flute)
         flute_audio = flute_audio.mean(1)
         flute_audio = flute_audio[sample_rate*8:int(-sample_rate*1.5)]

In [74]: freqs, times, s_flute = signal.stft(flute_audio, fs=sample_rate, nfft=samples_per_peri
                                                noverlap=overlap, nperseg=samples_per_perio

         freqs = freqs[:-1]
         s_flute = s_flute[:-1,:]

In [75]: plt.pcolormesh(times, freqs, 20*np.log10(np.abs(s_flute)))

Out[75]: <matplotlib.collections.QuadMesh at 0x1b487944978>
```

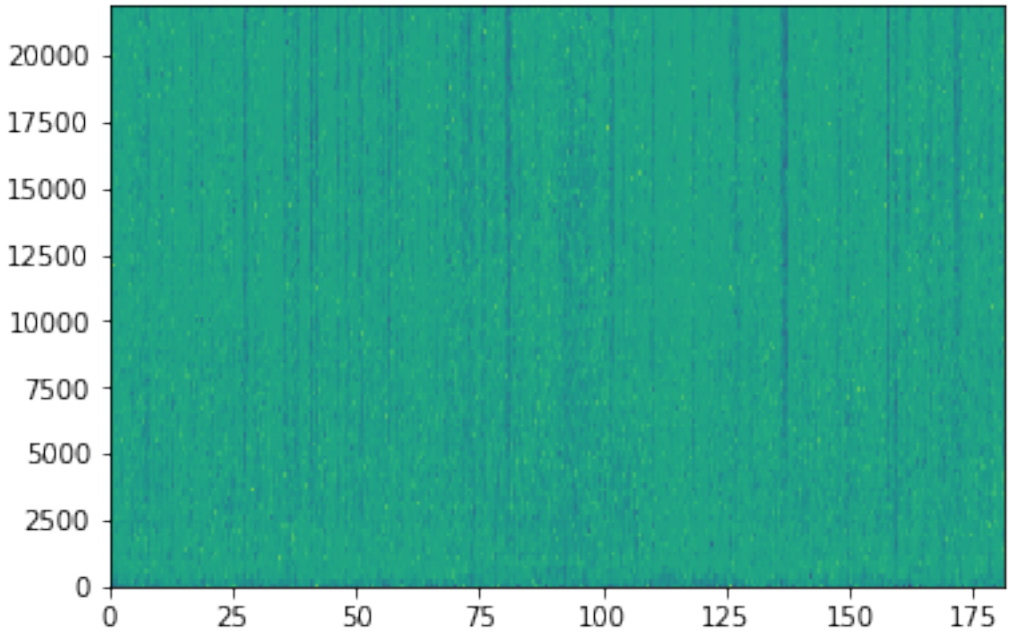


2.1 Create a mask for the flute

```
In [76]: mask_flute = s_flute / (s_flute + s_mix + 1e-9)
```

```
In [77]: plt.pcolormesh(times, freqs, 20*np.log10(np.abs(mask_flute)))
```

```
Out[77]: <matplotlib.collections.QuadMesh at 0x1b4879a9710>
```



3 Prepare the training data

```
In [78]: num_test  = int((sample_rate * 10)/samples_per_period)
         num_train = s_mix.shape[1] - num_test
         print(num_train, num_test)
```

```
60694 1722
```

```
In [79]: mix_train = s_mix.T[:num_train,:,np.newaxis]
         mix_train = np.concatenate((mix_train.real, mix_train.imag), axis=-1)
         mix_train.shape
```

```
Out[79]: (60694, 128, 2)
```

```
In [80]: flute_train = mask_flute.T[:num_train,:,np.newaxis]
         flute_train = np.concatenate((flute_train.real, flute_train.imag), axis=-1)
         flute_train.shape
```

```
Out[80]: (60694, 128, 2)
```

```
In [81]: mix_test = s_mix.T[-num_test:,:,np.newaxis]
         mix_test = np.concatenate((mix_test.real, mix_test.imag), axis=-1)
         mix_test.shape
```

```
Out[81]: (1722, 128, 2)
```

```
In [82]: flute_test = mask_flute.T[-num_test:,:,np.newaxis]
         flute_test = np.concatenate((flute_test.real, flute_test.imag), axis=-1)
         flute_test.shape
```

```
Out[82]: (1722, 128, 2)
```

```
In [83]: model = Sequential()

         model.add(Conv1D(16, 2, padding="same", input_shape=mix_train.shape[1:], activation="r
         model.add(MaxPooling1D(2, padding="same", name="MaxPooling_1"))

         model.add(Conv1D(8, 2, padding="same",  activation="relu", name="Conv1D_2"))
         model.add(MaxPooling1D(2, padding="same", name="MaxPooling_2"))

         model.add(Conv1D(4, 2, padding="same",  activation="relu", name="Conv1D_3"))
         model.add(MaxPooling1D(2, padding="same", name="MaxPooling_3"))

         model.add(Conv1D(4, 2, padding="same",  activation="relu", name="Conv1D_4"))
         model.add(UpSampling1D(2, name="UpSampling_1"))
```

```
        model.add(Conv1D(8, 2, padding="same",  activation="relu", name="Conv1D_5"))
        model.add(UpSampling1D(2, name="UpSampling_2"))

        model.add(Conv1D(16, 2, padding="same",  activation="relu", name="Conv1D_6"))
        model.add(UpSampling1D(2, name="UpSampling_3"))

        model.add(Conv1D(2, 2, padding="same",  name="Conv1D_7"))

        model.summary()
```

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
Conv1D_1 (Conv1D)            (None, 128, 16)           80
_________________________________________________________________
MaxPooling_1 (MaxPooling1D)  (None, 64, 16)            0
_________________________________________________________________
Conv1D_2 (Conv1D)            (None, 64, 8)             264
_________________________________________________________________
MaxPooling_2 (MaxPooling1D)  (None, 32, 8)             0
_________________________________________________________________
Conv1D_3 (Conv1D)            (None, 32, 4)             68
_________________________________________________________________
MaxPooling_3 (MaxPooling1D)  (None, 16, 4)             0
_________________________________________________________________
Conv1D_4 (Conv1D)            (None, 16, 4)             36
_________________________________________________________________
UpSampling_1 (UpSampling1D)  (None, 32, 4)             0
_________________________________________________________________
Conv1D_5 (Conv1D)            (None, 32, 8)             72
_________________________________________________________________
UpSampling_2 (UpSampling1D)  (None, 64, 8)             0
_________________________________________________________________
Conv1D_6 (Conv1D)            (None, 64, 16)            272
_________________________________________________________________
UpSampling_3 (UpSampling1D)  (None, 128, 16)           0
_________________________________________________________________
Conv1D_7 (Conv1D)            (None, 128, 2)            66
=================================================================
Total params: 858
Trainable params: 858
Non-trainable params: 0
_________________________________________________________________
```

```
In [84]: model.compile('adam', loss='mean_squared_error', metrics=['accuracy'])
```

```
In [85]: history = model.fit(mix_train, flute_train, batch_size=200, epochs=10)
```

```
Epoch 1/10
60694/60694 [==============================] - 63s 1ms/step - loss: 4.3759 - acc: 0.7718
Epoch 2/10
60694/60694 [==============================] - 11s 179us/step - loss: 4.1513 - acc: 0.8055
Epoch 3/10
60694/60694 [==============================] - 12s 194us/step - loss: 4.1494 - acc: 0.8079
Epoch 4/10
60694/60694 [==============================] - 12s 192us/step - loss: 4.1487 - acc: 0.8090
Epoch 5/10
60694/60694 [==============================] - 11s 183us/step - loss: 4.1483 - acc: 0.8095
Epoch 6/10
60694/60694 [==============================] - 11s 184us/step - loss: 4.1479 - acc: 0.8099
Epoch 7/10
60694/60694 [==============================] - 11s 179us/step - loss: 4.1477 - acc: 0.8103
Epoch 8/10
60694/60694 [==============================] - 11s 184us/step - loss: 4.1475 - acc: 0.8104
Epoch 9/10
60694/60694 [==============================] - 11s 181us/step - loss: 4.1474 - acc: 0.8105
Epoch 10/10
60694/60694 [==============================] - 11s 181us/step - loss: 4.1473 - acc: 0.8106
```

```
In [86]: results = model.evaluate(mix_test, flute_test)

         print(model.metrics_names)
         print(results)
```

```
1722/1722 [==============================] - 1s 359us/step
['loss', 'acc']
[0.5205799524653941, 0.8178308290471599]
```

4 Results

```
In [87]: mask_prediction = model.predict(mix_test)
         mask_prediction.shape
```

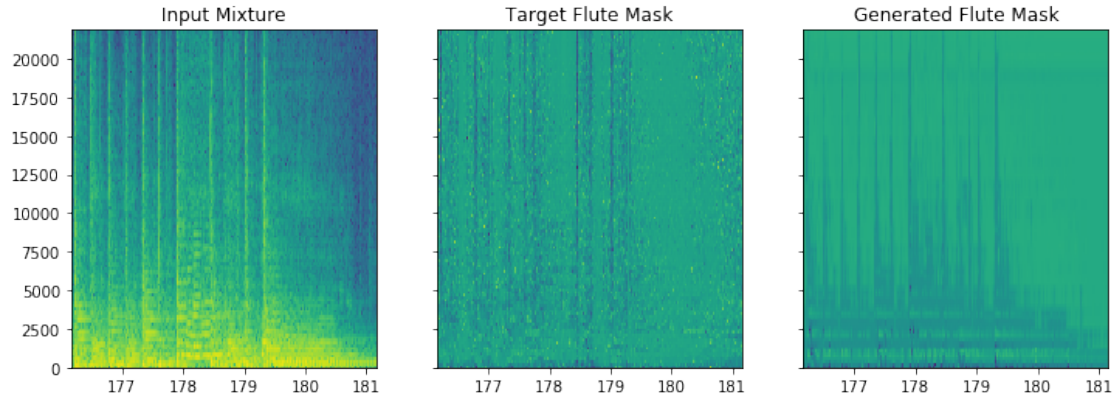
```
Out[87]: (1722, 128, 2)
```

```
In [88]: mask_prediction = np.sqrt((mask_prediction**2).sum(-1)).T
```

```
In [89]: fig, (ax1, ax2, ax3) = plt.subplots(1,3,sharey=True,figsize=(12, 4))

         ax1.set_title("Input Mixture")
         ax2.set_title("Target Flute Mask")
         ax3.set_title("Generated Flute Mask")

         ax1.pcolormesh(times[-num_test:], freqs, 20*np.log10(np.abs(s_mix[:,-num_test:])))
```

```
ax2.pcolormesh(times[-num_test:], freqs, 20*np.log10(np.abs(mask_flute[:,-num_test:])))
ax3.pcolormesh(times[-num_test:], freqs, 20*np.log10(mask_prediction))
```

Out[89]: <matplotlib.collections.QuadMesh at 0x1b489cd3240>

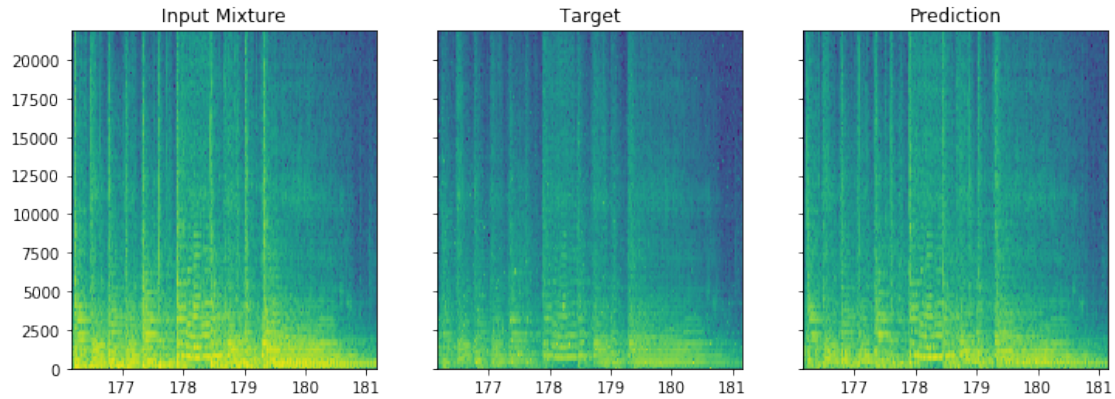


In [90]:
```
target = s_mix[:,-num_test:] * mask_flute[:,-num_test:]
```

In [91]:
```
prediction = s_mix[:,-num_test:] * mask_prediction
```

In [92]:
```
fig, (ax1, ax2, ax3) = plt.subplots(1, 3, sharey=True, figsize=(12, 4))

ax1.set_title("Input Mixture")
ax2.set_title("Target")
ax3.set_title("Prediction")

ax1.pcolormesh(times[-num_test:], freqs, 20*np.log10(np.abs(s_mix[:,-num_test:])))
ax2.pcolormesh(times[-num_test:], freqs, 20*np.log10(np.abs(target)))
ax3.pcolormesh(times[-num_test:], freqs, 20*np.log10(np.abs(prediction)))
```

Out[92]: <matplotlib.collections.QuadMesh at 0x1b489ddc668>



4.1 Let's hear it

```
In [99]: _, predicted_audio = signal.istft(prediction, fs=sample_rate)

In [100]: wavfile.write("fcn_model_flute_prediction.wav", sample_rate, predicted_audio.astype(

In [101]: _, target_audio = signal.istft(target, fs=sample_rate)

In [102]: wavfile.write("fcn_model_flute_target.wav", sample_rate, target_audio.astype(np.int1

In [103]: _, mix_audio = signal.istft(s_mix[:,-num_test:], fs=sample_rate)

In [104]: wavfile.write("fcn_model_original.wav", sample_rate, mix_audio.astype(np.int16))

In [ ]:

In [ ]:
```