In [1]:

```
import matplotlib.pyplot as plt
import numpy as np
import librosa
import librosa.display
import IPython.display as ipd
```

Loading Audio Files

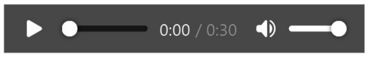
In [2]:

```
debussy_file = "audio/debussy.wav"
redhot_file = "audio/redhot.wav"
duke_file = "audio/duke.wav"
```

In [3]:

```
ipd.Audio(debussy_file)
```

Out[3]:

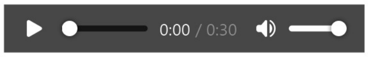


0:00 / 0:30

In [4]:

```
ipd.Audio(redhot_file)
```

Out[4]:



0:00 / 0:30

In [5]:

```
ipd.Audio(duke_file)
```

Out[5]:

0:00 / 0:30

In [6]:

```
# load audio files with librosa
debussy, sr = librosa.load(debussy_file)
redhot, _ = librosa.load(redhot_file)
duke, _ = librosa.load(duke_file)
```

Root-mean-squared energy with Librosa

In [7]:

```
FRAME_SIZE = 1024
HOP_LENGTH = 512
```

In [10]:

```
rms_debussy = librosa.feature.rms(y=debussy, frame_length=FRAME_SIZE, hop_length=HOP_LENGTH)[0]
rms_redhot = librosa.feature.rms(y=redhot, frame_length=FRAME_SIZE, hop_length=HOP_LENGTH)[0]
rms_duke = librosa.feature.rms(y=duke, frame_length=FRAME_SIZE, hop_length=HOP_LENGTH)[0]
```

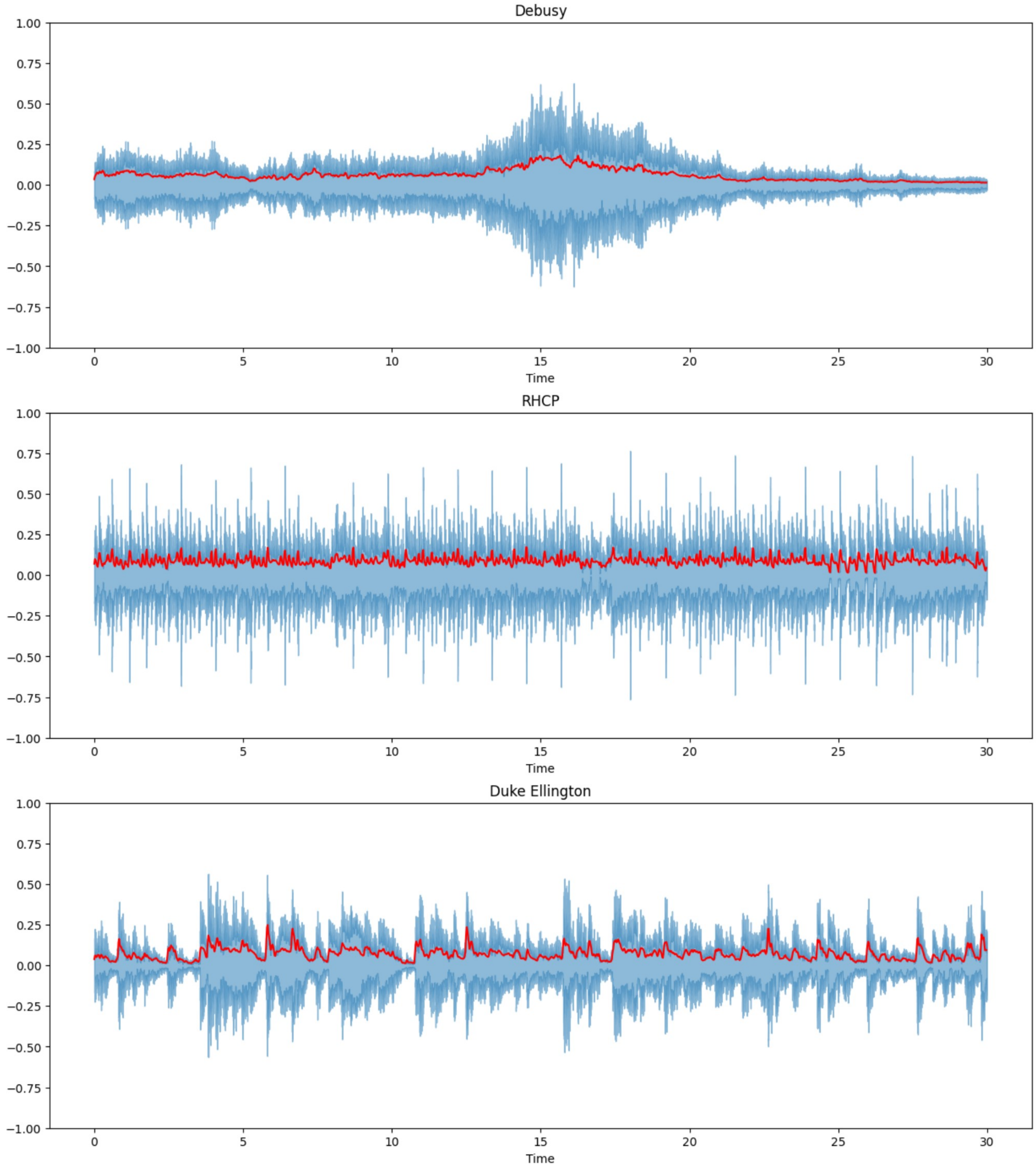
Visualise RMSE + waveform

In [11]:

```
frames = range(len(rms_debussy))
t = librosa.frames_to_time(frames, hop_length=HOP_LENGTH)
```

In [13]:

```
# rms energy is graphed in red

plt.figure(figsize=(15, 17))

ax = plt.subplot(3, 1, 1)
librosa.display.waveshow(debussy, alpha=0.5)
plt.plot(t, rms_debussy, color="r")
plt.ylim((-1, 1))
plt.title("Debusy")

plt.subplot(3, 1, 2)
librosa.display.waveshow(redhot, alpha=0.5)
plt.plot(t, rms_redhot, color="r")
plt.ylim((-1, 1))
plt.title("RHCP")

plt.subplot(3, 1, 3)
librosa.display.waveshow(duke, alpha=0.5)
plt.plot(t, rms_duke, color="r")
plt.ylim((-1, 1))
plt.title("Duke Ellington")

plt.show()
```



RMSE from scratch

In [14]:

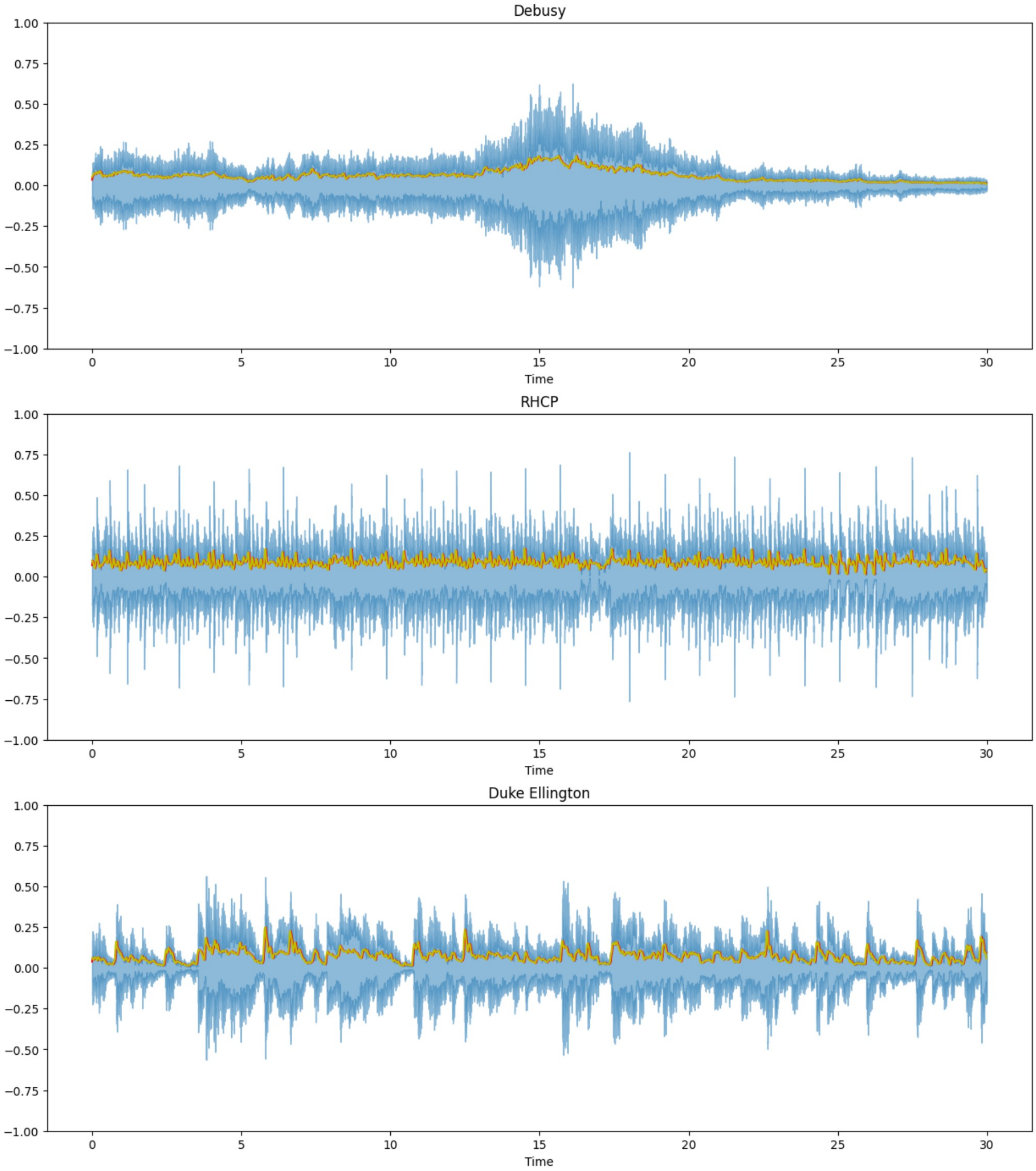
```
def rmse(signal, frame_size, hop_length):
    rmse = []

    # calculate rmse for each frame
    for i in range(0, len(signal), hop_length):
        rmse_current_frame = np.sqrt(sum(signal[i:i+frame_size]**2) / frame_size)
        rmse.append(rmse_current_frame)
    return np.array(rmse)
```

In [15]:

```
rms_debussy1 = rmse(debussy, FRAME_SIZE, HOP_LENGTH)
rms_redhot1 = rmse(redhot, FRAME_SIZE, HOP_LENGTH)
rms_duke1 = rmse(duke, FRAME_SIZE, HOP_LENGTH)
```

In [17]:

```
plt.figure(figsize=(15, 17))

ax = plt.subplot(3, 1, 1)
librosa.display.waveshow(debussy, alpha=0.5)
plt.plot(t, rms_debussy, color="r")
plt.plot(t, rms_debussy1, color="y")
plt.ylim((-1, 1))
plt.title("Debusy")

plt.subplot(3, 1, 2)
librosa.display.waveshow(redhot, alpha=0.5)
plt.plot(t, rms_redhot, color="r")
plt.plot(t, rms_redhot1, color="y")
plt.ylim((-1, 1))
plt.title("RHCP")

plt.subplot(3, 1, 3)
librosa.display.waveshow(duke, alpha=0.5)
plt.plot(t, rms_duke, color="r")
plt.plot(t, rms_duke1, color="y")
plt.ylim((-1, 1))
plt.title("Duke Ellington")

plt.show()
```



Zero-crossing rate with Librosa

In [18]:

```
zcr_debussy = librosa.feature.zero_crossing_rate(debussy, frame_length=FRAME_SIZE, hop_length=HOP_LENGTH)[0]
zcr_redhot = librosa.feature.zero_crossing_rate(redhot, frame_length=FRAME_SIZE, hop_length=HOP_LENGTH)[0]
zcr_duke = librosa.feature.zero_crossing_rate(duke, frame_length=FRAME_SIZE, hop_length=HOP_LENGTH)[0]
```

In [19]:

```
zcr_debussy.size
```

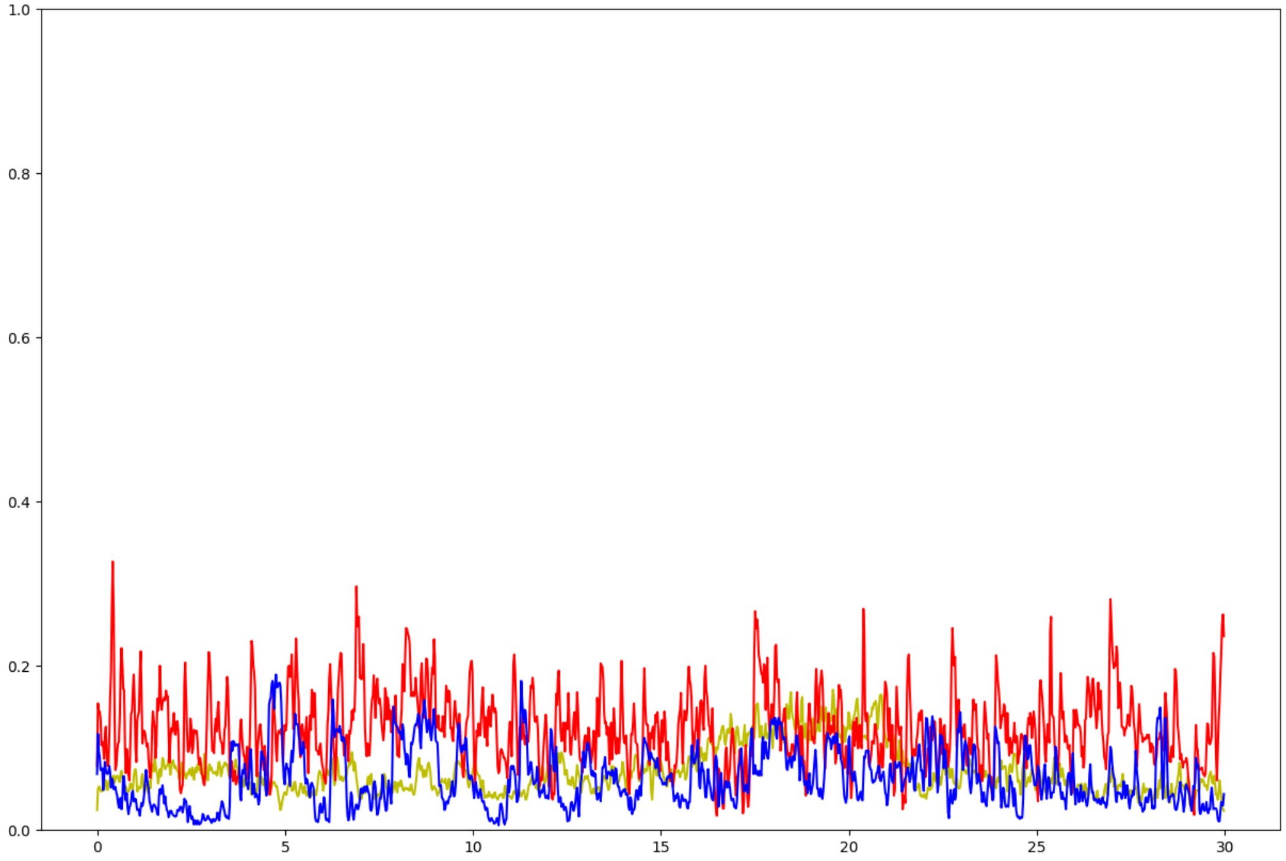
Out[19]:

```
1292
```

Visualise zero-crossing rate with Librosa

In [20]:

```
plt.figure(figsize=(15, 10))

plt.plot(t, zcr_debussy, color="y")
plt.plot(t, zcr_redhot, color="r")
plt.plot(t, zcr_duke, color="b")
plt.ylim(0, 1)
plt.show()
```



ZCR: Voice vs Noise

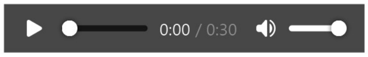
In [21]:

```
voice_file = "audio/voice.wav"
noise_file = "audio/noise.wav"
```

In [22]:

```
ipd.Audio(voice_file)
```

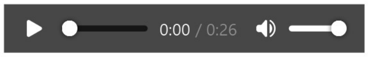
Out[22]:



In [23]:

```
ipd.Audio(noise_file)
```

Out[23]:



In [24]:

```
# load audio files
voice, _ = librosa.load(voice_file, duration=15)
noise, _ = librosa.load(noise_file, duration=15)
```

In [25]:

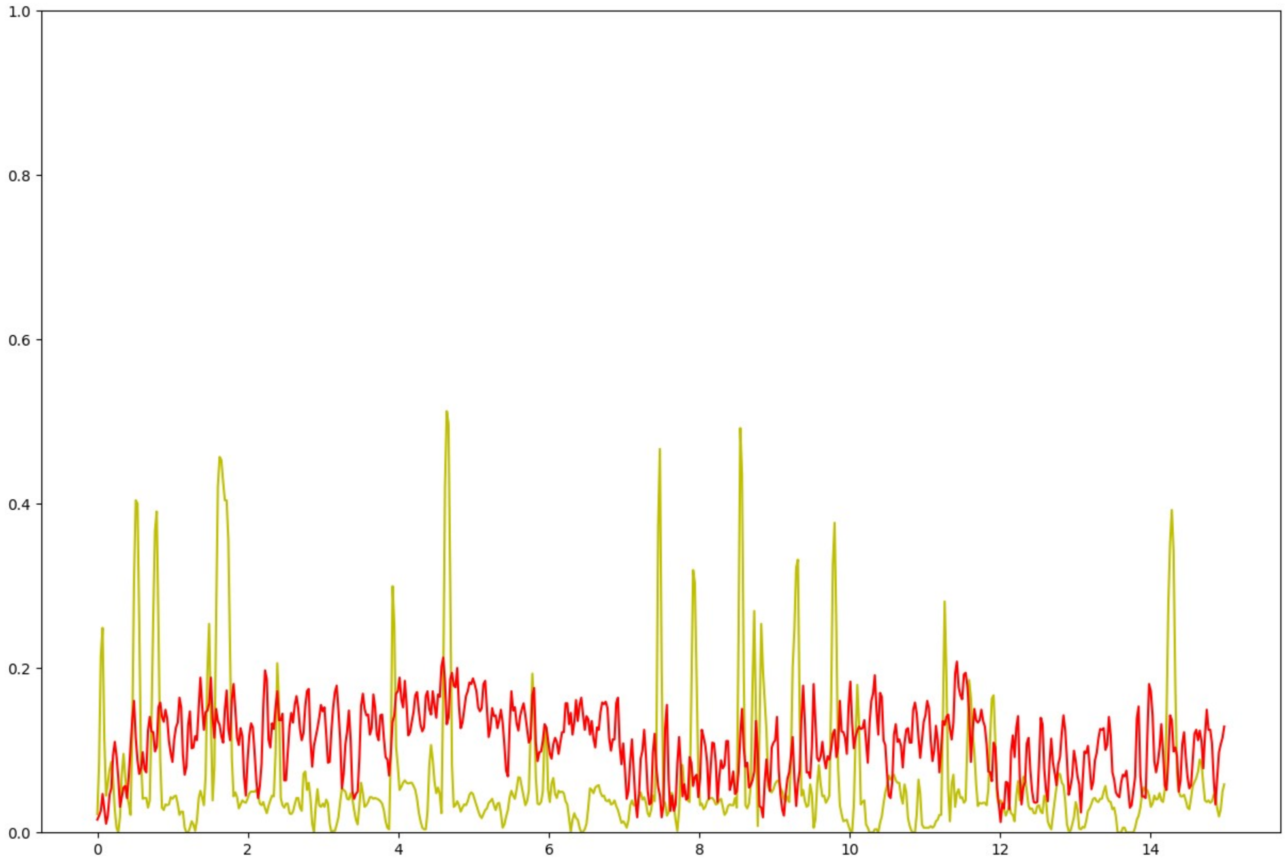
```
# get ZCR
zcr_voice = librosa.feature.zero_crossing_rate(voice, frame_length=FRAME_SIZE, hop_length=HOP_LENGTH)[0]
zcr_noise = librosa.feature.zero_crossing_rate(noise, frame_length=FRAME_SIZE, hop_length=HOP_LENGTH)[0]
```

In [26]:

```
frames = range(len(zcr_voice))
t = librosa.frames_to_time(frames, hop_length=HOP_LENGTH)
```

In [27]:

```
plt.figure(figsize=(15, 10))

plt.plot(t, zcr_voice, color="y")
plt.plot(t, zcr_noise, color="r")
plt.ylim(0, 1)
plt.show()
```


1.0
0.8
0.6
0.4
0.2
0.0
0
2
4
6
8
10
12
14