wave

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1 Preamble: Dependencies

NumPy and Matplotlib are Python Libraries that are widely used in scientific computing and data visualisation.

```
In [ ]: from numpy import *
        from matplotlib.pyplot import *
        %matplotlib inline
```

The `audio` package is a collection of Python modules that I have developped for this course:

- use `audio.wave` to read/write WAVE files,
- use `audio.io` to play/record sound data,
- use `audio.bitstream` to read/write binary data.

```
In [38]: import audio.io
         import audio.wave
         from audio.bitstream import BitStream
```

2 Synthesis of Pure Tones

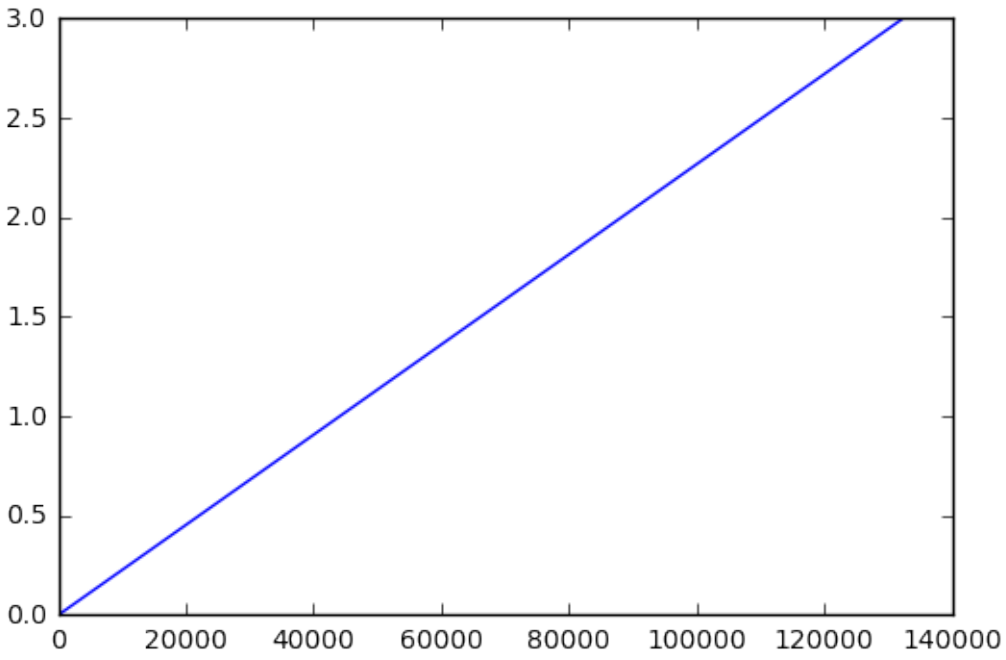
```
In [1]: df = 44100.0
        dt = 1.0 / df
        f = 440.0
        T = 3.0
```

```
In [7]: t = r_[0.0:T:dt] # see also: arange, linspace, etc.
        t[-1] # the last value (T) is excluded
```

```
Out[7]: 2.9999773242630385
```

```
In [8]: plot(t)
```

```
Out[8]: [<matplotlib.lines.Line2D at 0x7faac804b450>]
```

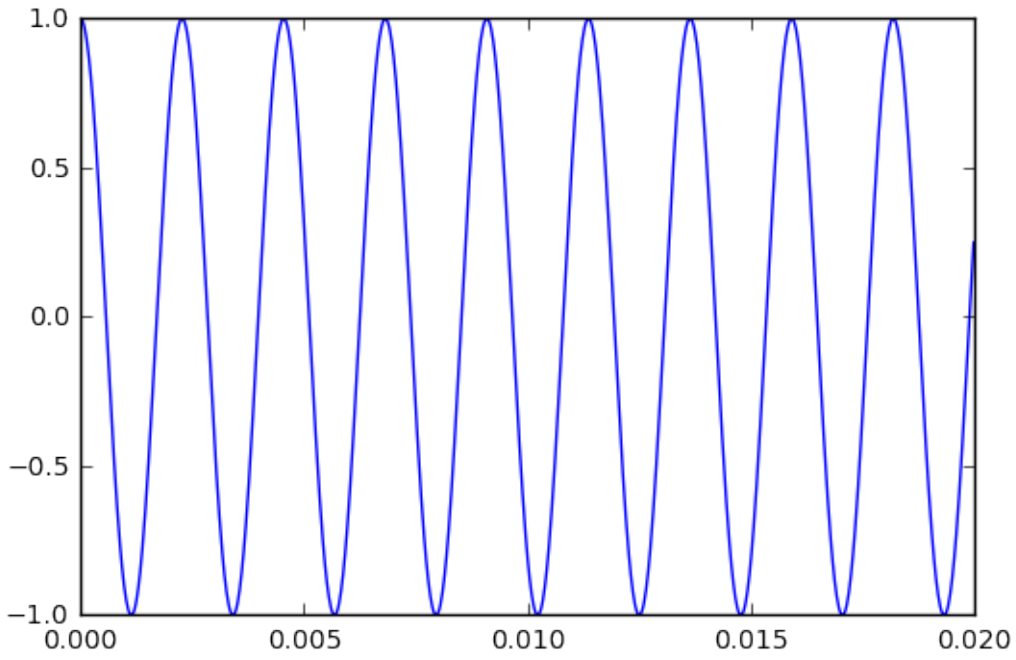



```
In [9]: A4 = cos(2*pi*f*t)

In [11]: audio.io.play(A4)

In [13]: ts = t[t<20.0/1000.0] # 20 ms
         A4s = A4[t<20.0/1000.0]
         plot(ts, A4s)

Out[13]: [<matplotlib.lines.Line2D at 0x7faac3016310>]
```




```
In [17]: def make_tone(symbol):
             number = int(symbol[1:])
             f = 27.5 * 2 ** number
             x = cos(2*pi*f*t)
             audio.wave.write(x, symbol + ".wav")
             return x
```

```
In [20]: A8 = make_tone("A8")
         audio.io.play(A8)
```

```
In [21]: A = []
         for i in range(0,11):
             symbol = "A" + str(i)
             A.append(make_tone(symbol))
```

```
In [24]: for i, sound in enumerate(A):
             print "A" + str(i)
             audio.io.play(sound)
```

```
A0
A1
A2
A3
A4
A5
```

```
A6
A7
A8
A9
A10
```

```
In [25]: 27.5 * 2**10

Out[25]: 28160.0

In [26]: audio.io.play(A[10])

In [27]: for sound in A:
             print mean(sound*sound)
```

```
0.5
0.5
0.5
0.5
0.5
0.5
0.5
0.5
0.5
0.5
0.5
```

```
In [30]: def L(x):
             return 96.0 + 10.0 * log10(mean(x*x))

In [31]: L(A[4])

Out[31]: 92.989700043360187
```

3 WAVE Format Header Analysis

```
In [33]: audio.io.play(A[4])

In [34]: audio.io.play(A[4], df=16000)
```

Wave format documentation: http://soundfile.sapp.org/doc/WaveFormat/

```
In [36]: raw = open("A4.wav").read() # raw is a 'str' (string)
         print raw[:4], raw[8:12]
```

```
RIFF WAVE
```

```
In [39]: raw = open("A4.wav").read()
         stream = BitStream(raw)
         print stream.read(str, 4)
         _ = stream.read(str, 4)
         print stream.read(str, 4)
```

```
RIFF
WAVE
```

```
In [44]: raw = open("A4.wav").read()
         stream = BitStream(raw)
         _ = stream.read(str, 22)
         print stream.read(uint16).newbyteorder() # 2-byte integer (little end.)
         print stream.read(uint32).newbyteorder() # 4-byte integer (little end.)
```

```
1
44100
```

4 Quantization and Signal-to-Noise Ratio

```
In [45]: A4q = audio.wave.read("A4.wav")
         e = A4 - A4q
         SNR = sqrt(mean(A4*A4) / mean(e * e))
         print SNR
```

```
77863.1828913
```

```
In [46]: print 20.0 * log10(SNR) # SNR in dB
```

```
97.8266430567
```