1 Importing data from music files into Octave

Fourier analysis of music files is a pleasing application of concepts within linear algebra, in particular the utility of inner product spaces.

Several utilities and websites (e.g., ⟨action | listentoyoutube.com | (begin (system "firefox http://www.listentoyoutube.com/"))⟩) will accept as input a YouTube link and convert the soundtrack to an mp3 file. As an example the lovely posthumous (published in 1995) Waltz in A minor by Frédéric Chopin (1810-1849), as transcribed for guitar, has been saved as an mp3 file in the directory `~/courses/MATH547/lessons/musicfiles`, along with the musical score.

```
   Shell session inside TeXmacs pid = 22529
Shell] cd ~/courses/MATH547/lessons/musicfiles
Shell] ls
   s.mat  ValseAminorChopinGuitar.mp3  ValseAminorChopinGuitar.pdf
Shell]
```

The mp3 file essentially contains samples of the air pressure our auditory system interprets as sound. *Mathematica* has excellent facilities for conversion between various file formats. Here are the commands that read the mp3 file and produce a mat file suitable for reading into Octave. The conversion process takes about a minute on a 2017-compliant CCI laptop.

```
Mathematica
In[1]:= SetDirectory["~/courses/MATH547/lessons/musicfiles"]
/home/student/courses/MATH547/lessons/musicfiles
In[2]:= s=Import["ValseAminorChopinGuitar.mp3"];
Null
In[3]:=
```

The 1,1,1 component of the internal *Mathematica* internal sound representation contains the pressure data.

```
In[3]:= Export["ChopinWaltzAminor.mat",s[[1,1,1]]];
Null
In[4]:=
```

The mat file can subsequently be read into Octave, and a portion of the overall sound recording can be selected.

```
octave> cd ~/courses/MATH547/lessons/musicfiles
octave> load ChopinWaltzAminor
octave> who
   Variables in the current scope:

   Expression1  ans          dispans      prompt       r

octave> s=Expression1; size(s)
   ans =

      4862592         1
```

```
octave> frate=44100; trec=0.25; m=floor(trec*frate)
   m =  11025
octave> tstart=5; i0=floor(tstart*frate)
   i0 =  220500
octave> f=s(i0+1:i0+m); t=(1:m)'/frate;
octave> plot(t,f)
octave> print -dpng ChopinWaltzSegment.png
octave>
```

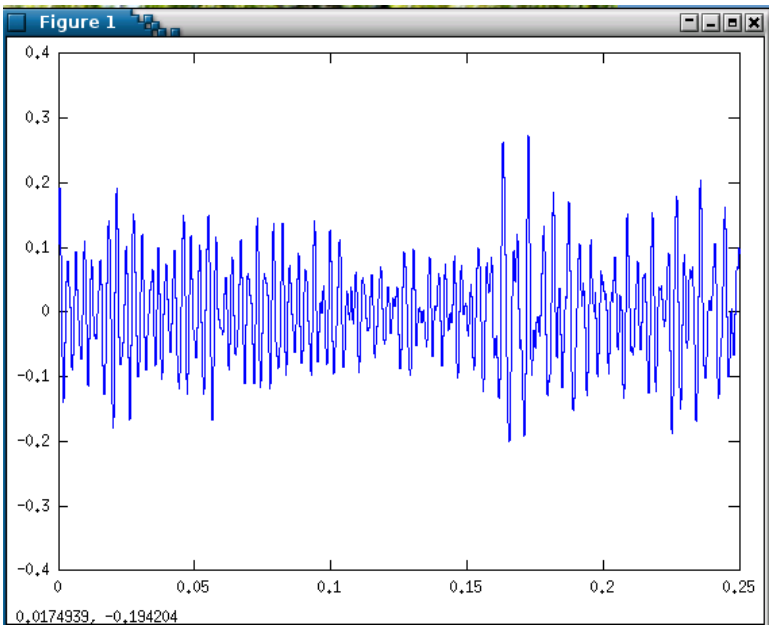

Figure 1. Pressure samples representing 0.25 seconds of the Chopin waltz, starting at second 5 of the recording. The pressure trace is a superposition of sine, cosine waves of various frequencies.