Sheetmusic: Making music from spreadsheets

Thomas Levine
csv soundsystem
_@thomaslevine.com

ABSTRACT
The spreadsheet is an intuitive paradigm for the expression of musical scores. I'll discuss how you can turn data into music with our Sheetmusic software and show examples of how csv soundsystem turns spreadsheets into data-driven music videos.

Keywords
music, spreadsheets, gastronomification, data analysis

1. INTRODUCTION
In our production of data-driven music videos, we have recognized a need for data analysis software and music software to be more strongly integrated. We wanted a more seamless transition between modeling and music, and we wanted it to be easier for data analysts to work with music. We have developed tools like Sheetmusic (`http://github.com/csv/sheetmusic`) to bridge this gap.

2. HOW IT WORKS
We've found that the tabular representation of data aligns very well with typical representations of music. Sheetmusic works by mapping these two concepts to each other.

We can think of data tables as collections of similar things, with the same sorts of information being collected about each thing. In tidy data tables [2] each row corresponds to an observation (a thing), and each column corresponds to a variable. We add more rows to the table as we observe more things, and we add more columns to the table as we collect more information about each thing.

We can think of music as a composition of many different sounds over time, with sounds coming from many different instruments. In musical scores we represent time as movement from left to right, and we represent different instruments by different staves (stacked on top of each other). The staff becomes wider as the song gets longer, (They are often spread across multiple pages.) and we add more staves as we add more instruments.

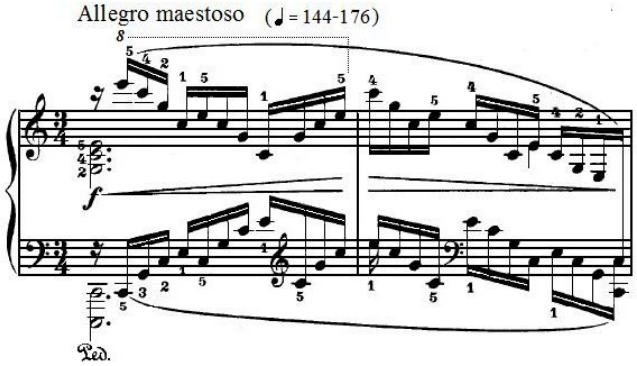

Figure 1: Chopin's Étude Op. 10, No. 1. as ordinary sheet music

If we constrain the manner of data and of music, we can losslessly convert between the data table concept and the musical staff concept. As an example, let's look at a passage from Chopin's Étude Op. 10, No. 1. [3]. Figure 2 represents it in ordinary sheet music.

Table 2 displays it as a data table as comma-separated values. (Well almost; it doesn't include the two chords of dotted half notes.)

Rather than composing music as traditional sheet music, we can use a table-editing program of our choice to compose this sort of table.

3. HOW TO USE IT
Sheetmusic is implemented as a JavaScript function that loads data from a Google Spreadsheet. Given the URL of a spreadsheet, Sheetmusic downloads the spreadsheet contents and plays them in a browser.

The spreadsheet is organized as follows. Each column corresponds to a musical track, and different tracks can have different music instruments. Row corresponds to a beat (of time). Each cell contains the frequency of sound to be played, represented either as a number (Hertz) or in scientific notation (C4, D4, &c.).

Left Hand	Right Hand
(NA)	(NA)
C2	E6
G2	C6
C3	G5
E3	C5
C3	E5
G3	C5
C4	G4
E4	C4
C4	G4
G4	C5
C5	G5
E5	C6
C5	G5
G4	C5
C4	G5
E4	C5
C4	G4
G3	C4
C3	E4
E3	C4
C3	G3
G2	E3
C2	C3

Table 1: Chopin's Étude Op. 10, No. 1. as a data table

Sheetmusic accomplishes the playback of music, and this leaves the data analyst to use conventional spreadsheet approaches for composing music. For example, the following function can be used to produce a major scale in a spreadsheet column.

```
# For example: ionian(440, 8)
function ionian(base, n) {
 var s = [0, 2, 4, 5, 7, 9, 11, 12]
 function freq(i) {
  return base*Math.pow(2,(Math.floor(i/12)+s[i])/12)
 }
 var scale=[]; for (var i=0; i<n; i++) scale.push(i)
 return scale.map(freq)
}
```

Once you have a major scale in one column, you can easily make chords with a spreadsheet function like this.

```
=A1*2^(4/12)
```

If you put this in cell B1, A1 and B1 will form a major third interval [4]. You can read more about the determination of frequencies on Wikipedia [5].

4. WHY MAKE DATA-DRIVEN MUSIC

We created sheetmusic and similar tools out of a need to produce data-driven music, but I neglected to explain why we needed to do that. Here are some of the uses that we have found for data-driven music and music videos.

4.1 Analyzing complex data

Now that we're collecting so much data, we are reaching the limits of data visualization. When produced and interpreted by capable people, a good data visualization can represent about eight different variables. If we want to visualize more variables than that, we must settle for a reduced version of the data. By leveraging the sense of sound, we expand our sensory bandwidth and enable the representation of higher-dimensional data.

In the long term, we really need to gastronomify (turn into food) data in order to experience them with all of the senses. Unfortunately, that isn't feasible right now; until we develop cheaper taste and smell APIs, we are stuck with what we have on our smartphones, laptops, &c., which is vision, hearing and touch. We need to make data music videos in order to make the most of these tools.

4.2 Reaching young people

Combining data with music may also appeal to a younger audience. According to the fictional eleven-year-old Emma Gertlowitz whose crush recently switched from Justin Bieber to Nate Silver [6], "[S]tatisticians are the new sexy vampires, only even more pasty." This example is just part of a larger trend: data is "in".

The White House used the appeal of data and music to advertise the State of the Union Address; they published a video advertisement to YouTube that used pie charts and dubstep, presumably to appeal to a younger audience [1].

4.3 Education

I find that a major hurdle in the understanding of quantitative disciplines is an intuition of how to break complex concepts into discrete numbers. I find that mapping numbers to things other than graphs gets people thinking a bit more about what the numbers mean.

4.4 People who can't see

Data visualizations are typically not accompanied by an equivalent alternative for people who can't see. We can redundantly express data across multiple senses in order that people of varied ability can all experience a particular data analysis.

5. REFERENCES

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