Auditory graph evolution by the example of spurious correlations

Bernhard Zeller

Institute of Electronic Music and Acoustics, University of Music and Performing Arts Graz, Austria

bernhard.zeller@student.kug.ac.at

Katharina Vogt

Institute of Electronic Music and Acoustics, University of Music and Performing Arts Graz, Austria

katharina.vogt@kug.ac.at

ABSTRACT

Auditory graphs can be seen as an alternative to visual graphs or as an additional element to display data. This paper will offer an approach on how a simple sound mapping can be improved into a mental model. The ironic nature of the chosen dataset is reflected in the sound enhancing the data visualization.

1. INTRODUCTION

The usage of single dimension auditory graphs as an abstract representation of data usually evokes informational loss in comparison to the original data sheet due to the higher level of abstraction [3]. The fundamental requirements in the development of auditory graphs should be to minimize this waste and maximize the information content. The authors of this paper suggests, that a useful way to save the primary information is to evolve the auditory graph from a simple one-dimensional abstraction into a mental model or an acoustic event. This paper describes this process on the example of a chosen data set.

2. EVOLUTION IN THEORY

This paper evolved from a student's project, that will be reported in Sec. 3. Referring to this project, in a first step the used data has to be defined because it effects the design of the auditory graph. The underlying data is a one-dimensional spread sheet containing the value of a variable vs. an order parameter. A classical auditory graph can be understood as a sonified pendant to the two dimensional visual graph by mapping a value with the help of „low-level“ acoustic dimensions in time [1, 2].

Probably the most simple way to create an auditory graph out of a data string is to map the value of the data-variable to a parameter like pitch, intensity or timbre analogous to the y-axis of a visual graph. Order parameters, as, e.g. different points in time, are visually presented on the x-axis. In the auditory representation, they will simply be mapped by consecutively playing them. This method is called analytic mapping and forms the counterpart to the metaphoric method in which a particular sound represents a whole image or a shape [7]. For the first stage of development of the auditory graph the author suggests to mix these two methods and create the “analytic metaphoric model”. Basically auditory graphs use abstract sounds like simple MIDI-Notes for representing values. In order to add a metaphorical association of sound and source this simple tones have to be replaced by an auditory-icon-like object. Auditory icons can be described as “caricatures of naturally occurring sounds” and are “based on the way people listen to the world in their everyday lives” [10]. The characteristics of auditory icons should make it easy to evoke a link between a data-source and a sound.

As mentioned in [6] metaphoric sounds should be motivated by their meanings. So the sound has to be familiar to the underlying data which should be represented. There is a guideline in [4] which describes how to gain an appropriate sound. First the sound designer has to become familiar with the data and define features which should be covered by the sonification. Next there should be a discussion with people, who are specialists in the domain the data derives from. It is essential to consider their ideas and perceptions while implementing a sound. "Ideally, the sound is designed in a way that it fits the metaphors of the final users." [4]

Metaphoric auditory graphs still present the values of data by simply changing first order acoustic dimensions like pitch, loudness or timbre. For a mental model, the mapping sound is expected to behave similarly to the sound source instead of just shifting one parameter. If the value of a variable changes there will not only be modification in pitch, loudness and timbre, but in the sound itself. [1] There is a suggestion, that *“it is possible to find changes in acoustic parameters that map unambiguously to changes in source or event characteristics"* [1]. To provide an example, the display of money using a coin sound might be a reasonable choice for a data set; the mapping of *more* money might involve the acoustic behaviour of more coins, and can't simply be a mainpulated version of the one-coin sound.

3. EVOLUTION IN EXERCISE

In this section the evolution of an analytic metaphoric model is described using the example of spuriuos correlation data. So this should be a short summary about the project itself and how the auditory graph progress was done.

Spurious correlationship is a term to describe the correlation between two variables without any causal context [9]. The underlying data can be found in the internet at [8]. The creator of this page has implemented an algorithm to compare statistical data and find correlations between different variables. The result is presented by a spreadsheet containing the data and a visual graph which helps to immediatly recognize the correlation. The intention of the author of this paper was to find a possibility for an auditive representation.

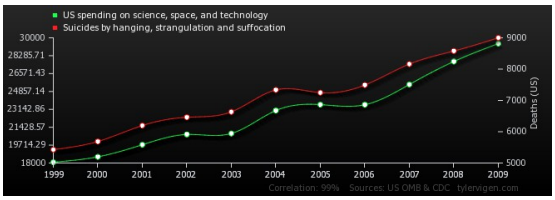

Figure 1: Data example: Spurious correlation with a correlation degree of 0.99 between US spending on science, space and technology and Suicides by hanging, strangulation and suffocation between 1999 and 2009 as visual graph [8]

First the data of interesting and especially peculiar comparisons has been written into an spreadsheet analysis program and imported into SuperCollider – a programming environment optimized for realtime sound synthesis. After normalizing the data signals and mapping them exponentially between the frequencies from 220 to 440 Hz the command .cpsmidi was used to simply transform the data into MIDI-notes.

Because the MIDI sounds were judged annoying the author tried to find an appropriate sound with the help of a sequencer and synthesizer. A piano synthesizer was used, because of its pleasant sound and short duration of the single notes, which made it easy to follow the development. Up to this stage, the mapping followed a classical auditory graph.

In order to find metaphoric sounds the data was grouped into categories and can thus be used for different combinations: finance, death, consumption, law and applause. The authors made preliminary decisions based on his experience searched five appropriate sound examples on Freesound.org or generated some by recording for each category. They contained metaphoric sounds for each category:

- finance: variations of coins hitting the ground
- death: groan, breath, scream, church bell
- consumption: crunch, smack
- law: handcuffs, pistol shot, hammering
- applause: hands clapping, cheering crowd

To decide about the most appropriate sound, a first pilot survey and discussion with colleagues was done. Taking into account some changes following from the pilot test, the author tested the sounds with 10 participants, all students of electrical sound engineering. The participants listened to the five sounds of each category three times and rated them. The final sounds following from this questionnaire can be found here [11].

In a first result, these metaphoric sounds have been used to display the data using simple pitch shifting of the sounds. Two graphs of a spurious correlation can be played sequentially using the different sounds of their respective categories. An example is given in sound here [11]. It's the same example as shown in Fig. 1. The attached sound example are preliminary results as the use of mapping the data onto the low-level parameter of pitch is not satisfactory in the authors' opinion.

4. OUTLOOK AND CONCLUSION

The added value of this metaphoric display of the dataset is quite obvious with the given example, especially the ironic character of the spurious correlations that is not reflected at all in the neutral visual display. As the final step in the evolution of the auditory graph, the metaphoric sounds will have to be transformed into mental models. The author's idea to reach this aim is to use the tools of granular synthesis.

As a final step, another survey is envisaged to answer the question, if the mental model works better than simple auditory mapping.

5. REFERENCES

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