CS 203 Final Project

Musical Sonification

Introductory Exploration of Data Sonification and its Application and Purpose

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Abstract

Data Literacy in the modern age has become increasingly critical with the popularity of the internet. It is extremely convenient to share images, videos, articles, and research conveniently. However, visual data is not the only way to convey a set of data, providing its own setbacks and challenges. An alternate and less popular method is known as Data Sonification—turning collected data into sounds. Data sonification provides another dimension of accessibility to those visually impaired or auditory learners and is useful for the researchers and the general populous alike, from understanding the severity and gravity of the Orlando Pulse Club shooting to closer understanding Parkinson's disease and looking for a cure. Data sonification is not without its own shortcomings but as a supplement, creates a much deeper and emotional effect to better inform the population on a variety of topics.

Introduction

As the world becomes more and more reliant on technology, the importance of data literacy becomes more crucial and prominent. Recently, surges of misinformation through politics have shaped our current climate with politicians sharing "alternative facts" to incite and inspire their fanbase. Notably and most recently, the UK Brexit referendum and US presidential election were supported with a "disturbing level" of misinformation (Engle, 44-45). Ergo, it is critical that electors everywhere are more informed and can navigate through misrepresented statistics and false claims, to make informed decisions for something as crucial as voting, or negligible as percent of sugar on a cereal box. Efforts to increase data literacy must start early in the classroom. Many people embrace different styles of learning: whether that be visual, kinesthetic, or auditory. Providing different means allows those unable to comprehend charts or paragraphs to grasp something they would not have been able to otherwise. It also allows a

different perspective, allowing those to contextualize information in a unique way. Data sonification is a way to represent graphs and numerical data through sound, allowing the audience to understand it through a piece of music instead. It can make data accessible to visually impaired and *auditory learners* and present a much deeper and personal story of a data set.

Accessibility

It is important to continue increasing how accessible data is. Education leaders cannot maintain a strong society without an informed populace, and this comes with making it so everyone, regardless of disability can interpret data for themselves, then forming their own opinions and making their own choices. Data sonification would open up this opportunity for an entire section of the population: for those that are illiterate or visually impaired. As a prominent activist of using data sonification so those visually impaired can learn, as well as being visually impaired herself, Dr. Wanda Diaz-Merced, described the frustration as,

> "Because I couldn't see well, I wasn't understanding anything in the classroom. Not a thing. The transmission of information just was not accessible – I couldn't see what the lecturers were writing on the board and I didn't have access to the books" (Royalty Society).

She became an astronomer specializing in data sonification and eventually improved the methods in which scientists were able to detect black holes. By incorporating sonification to the data set, not only does it make it easier for those visually impaired to understand and contribute but allows those without visual impairment to also find abnormalities in the data set to draw new conclusions. Providing an entire community with the ability to make their own choices can have

a blanket effect on the world around them, anywhere from pushing new and inclusive policy, to creating resources and spaces for a stronger community.

Uses: Memorials and Research: Purpose

In addition, data sonification also has the power to provide a new perspective on certain situations, as well as expand research capabilities and drawing new scientific discoveries to benefit society. It is uncontestable that a graph, paragraph or display of numerical values rarely or would poorly invoke an empathetic reaction—it is simply analytical and quantitative. Introducing factors such as different instruments and timbre effect how the user perceives the piece—which provides an opportunity to involve emotional responses and in turn, potential action from the data set. Sonic memorials are projects used to remember or honor a tragic event—whether it be 9/11 and the planes crashing at the twin towers, or more recently, mass shootings in America. They use sound to invoke a sense on empathy, and build on that empathy to inspire change, something that visual data is rarely able to do, build up and show the gravitas of a situation.

Reveal's released a podcast and project, documenting the process in which they memorialized the 2016 Orlando Pulse Night Club shooting using data sonification. This project was used to expand on the story of the lives lost, using a unique note to represent one person, playing a note for every year in a pattern. It encapsulates the lifespan of the 49 victims, playing up until 2016 with the youngest death at 18. The project utilized bells, as:

> "I thought of bells and bell-like tones and their meaning across different cultures. We recognize them in many places, from European village bells and the way that they signify

important moments in communities to gamelan performances and the additive effect of overtones produced by a body of many different, interdependent instruments." (Reveal).

Reveal's memorial ends with a jarring and sudden crash, representative of the sudden loss of life, shocking the listener. Although this memorial pays a tribute to each year a victim lived, Dr. Rachel Rome's Overmorrow project represents a darker side of sonic memorials. Overmorrow's purpose is to inspire action, using each note to represent a gunshot and the fatality on different instruments. (Rome). It forces the audience to sit down and listen for six minutes, inviting contemplation while sudden notes mixed in with an eerie silence play in the background, and left with a very unsettling feeling and somber mood—something not easily achievable through graphs.

Data sonification has opened new possibilities for a variety of areas of studies—several including astronomy and healthcare. In astronomy, a new path is charted in the Chandra X-ray Observatory. One of their projects sonifies the Crab Nebula, a "spinning neutron that formed when a massive star collapsed". (Mohon). Scientists paired wavelengths to different instruments, and combine the readings from different telescopes and layered them together, now able to hear all the data at once. Being able to hear a neutron, instead of just reading the data collected through telescopes offer a different perspective and approach to astronomy.

Data sonification is much more widely used in health sciences. Using SuperCollider, one group of researchers have started transcribing a patient's heart rate as part of a study to understand what information auditory data could present. Mapping factors such as heart rate and small abnormalities reveal a larger pattern that can be more helpful for diagnosis. Researchers were able to identify several illnesses, including congestive heart failure, atrial fibrillation, and obstructive sleep apnea. The study ends on, "Future work could evolve in two directions – one

towards new forms of "biometric music," the other towards new modalities of medical diagnosis." (Bellora 46). However, it not only has supplemental purposes, but can tell researchers something that had once been extremely hard to detect. At Stony Brook University, researchers are assigning musical factors into walking data, being able to hear the difference in pace of healthy individuals and those with Parkinson's disease. Eventually, researchers want the public to be able to hear their own gait to possibly correct it. (Beans, 4564.)

Downsides

Sonification is a cross between science and art—the creator must make many creative, non quantifiable decisions to either make the piece presentable. This introduces a possible conflict of interest. Hypothetically, if a scientist wanted to highlight a small difference, using a different instrument is much more significant than altering an ADSR envelope. Playing a violin with vibrato produces a much different timbre than a trumpet, though this flexibility allows for the artist to manipulate the audience's emotions, certainly a benefit of sonification. Bring creative adds complexity to the piece, are "stimuli" and "not as sonically impoverished as the simple sine-tones commonly used in listening experiments." (Ben-Tal, 232) and adds purpose to the data—flipping the scenario and finding purpose in the music rather than just for one's enjoyment. As data gets more complicated, with more variables to consider, "the relationship between the raw data and the audio becomes increasingly abstracted, potentially increasing the difficulty in conveying the science behind the sound" (Chaw). This also introduces a downside to sonification: it's not easily quantifiable. It's best when used temporally, showing a shift in difference through time, but hard to quantify or share what the audience is listening to. It's stronger at detecting change and comparison, rather than being able to understand mathematical regressions to understand where it's trending. Simply, it's a lot more qualitative than

quantitative, which is an unusual approach when it comes to something as solidly quantitative as data.

Effect and Conclusion

Regardless, as a supplement to visual means of communicating data, musical sonification offers a new perspective with a raw and significantly more powerful effect. "At their most vibrant, artworks produced from sonified data create conditions in which the perniciousness of capitalist equivalence might be subverted or undone, engendering empathy or horror by playing on sound's ability to both modulate mood and function as a an "intermediary" between varying regimes of sensory experience and information" (Akiyama, 29). Being able to manipulate emotions with data is powerful: sitting down and listening to six minutes of gunshots on a glockenspiel, listen to eighteen bells ring to memorialize a life taken too early has the power at the very least to invoke reflection. "At its best, sonification transforms data into an experience that'll stay with you, that you'll feel compelled to share with others." (Geere). It has the power to build a community off inclusivity for those visually impaired, the power to revolutionize a scientific field, and the potential to enact change.