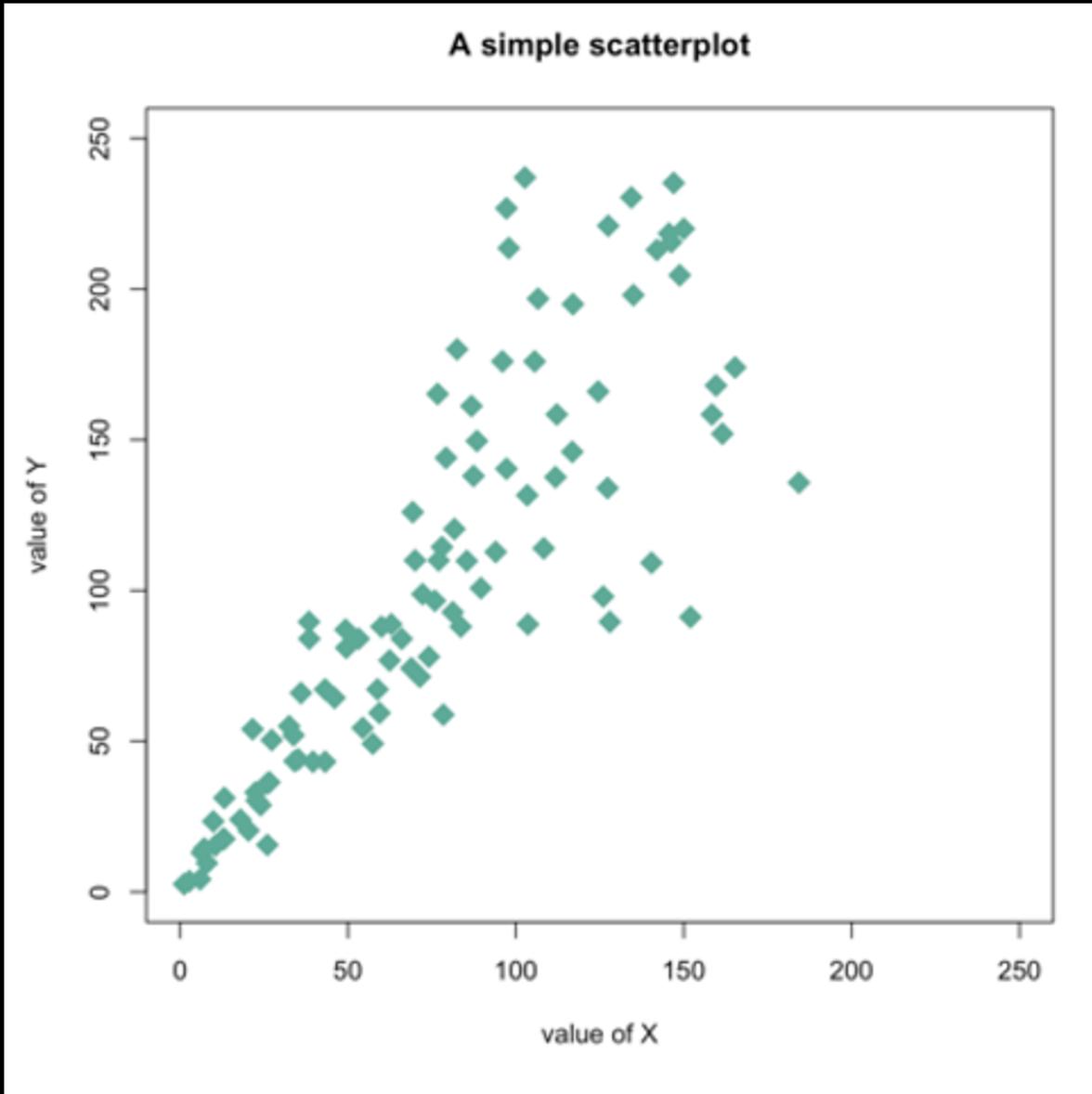




Making Data Accessible: Tactile and Sonified Data

Ruth Vanstone & Krista
Mitchnick



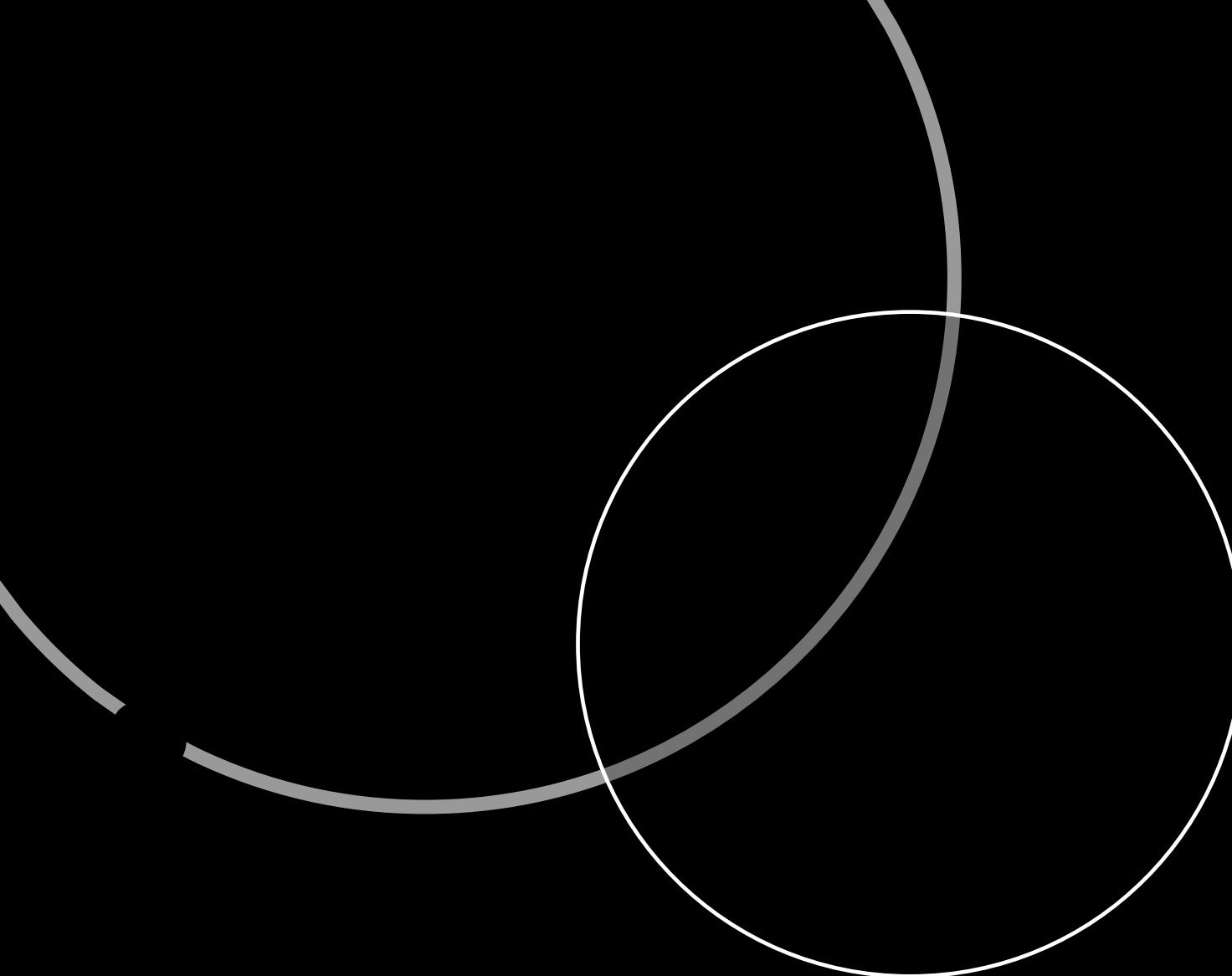
Dr. Jill Rich



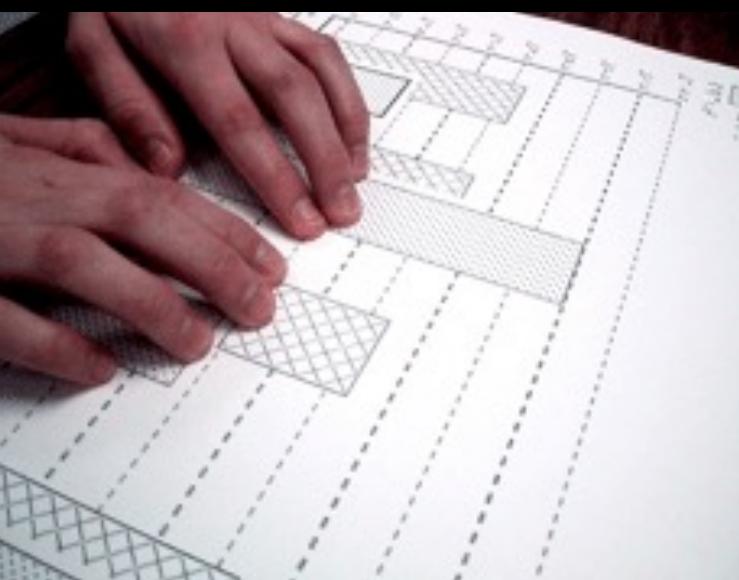
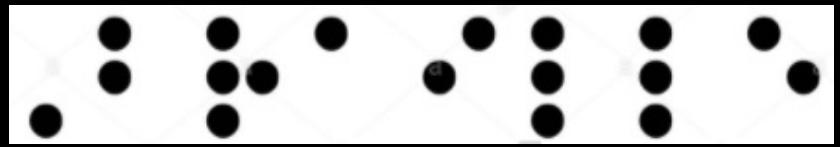
David Lepofsky
(husband)



I don't really use charts. I avoid it or ask people to describe them."

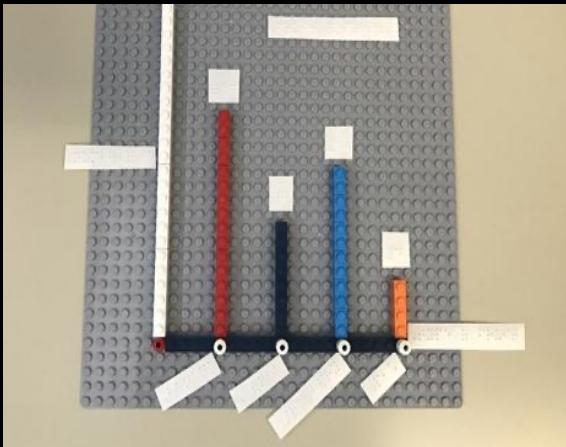


● Braille &
Other
Tactile
Mediums



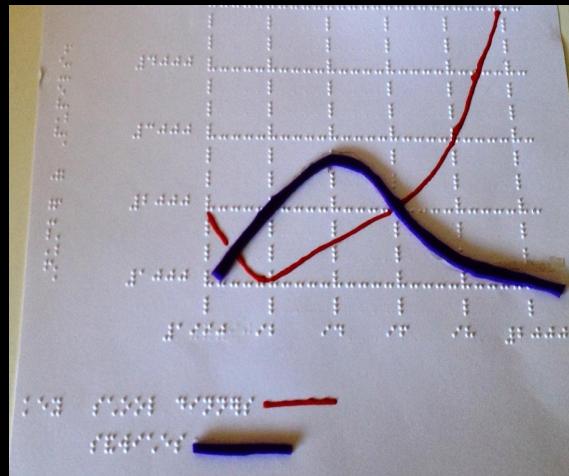
Learning Graphics

Lego



Board displays

Heat-sensitive swell paper



Embossed/raised graphs

Plastic molds

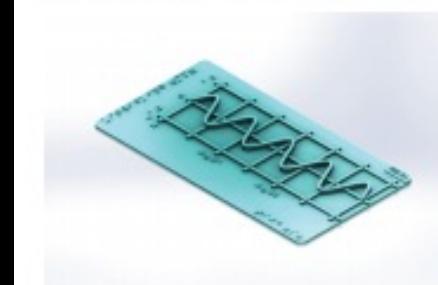


Figure 1. Model 1a.



Figure 2. Model 1b.

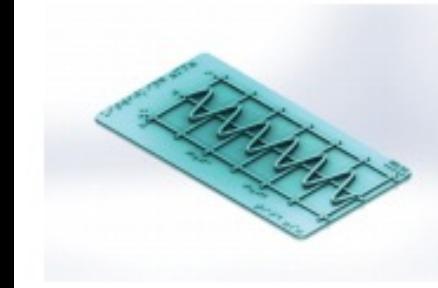
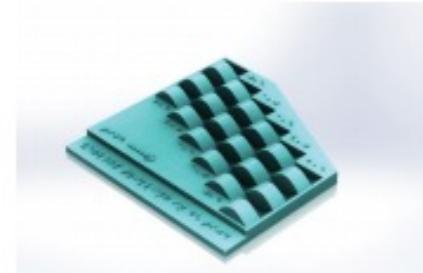


Figure 4. Model 2.



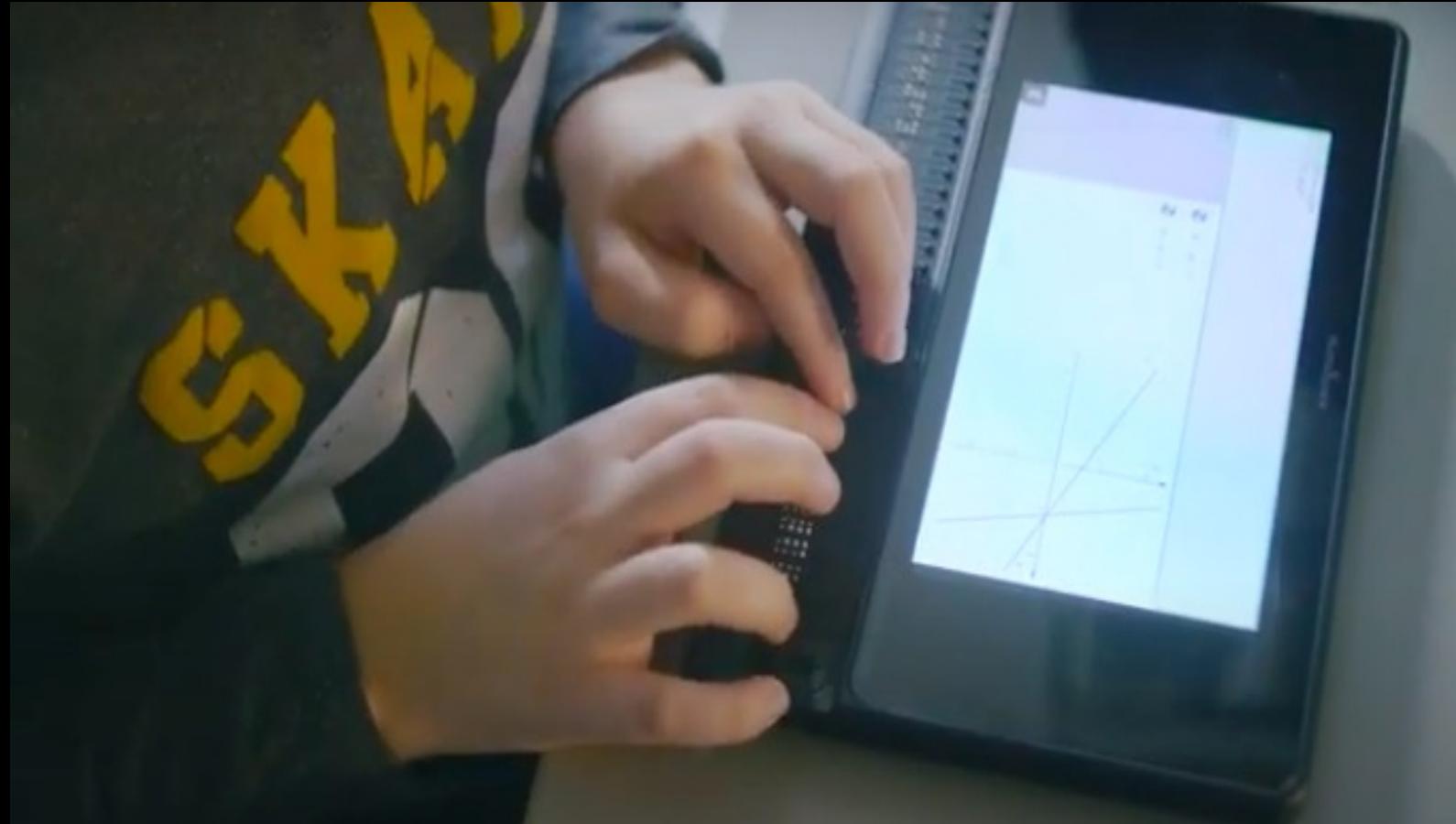
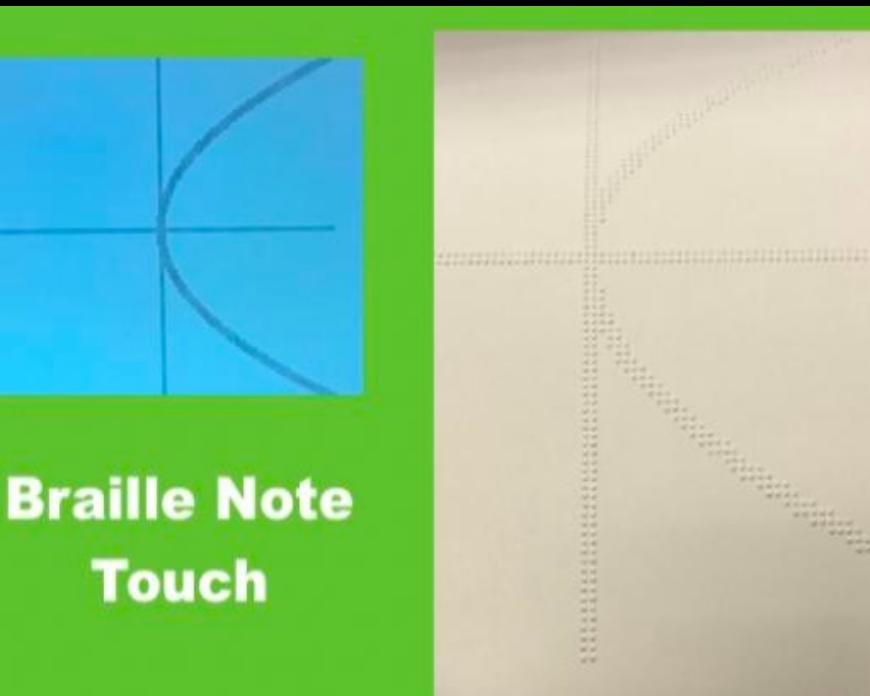
Figure 5. Model 3.

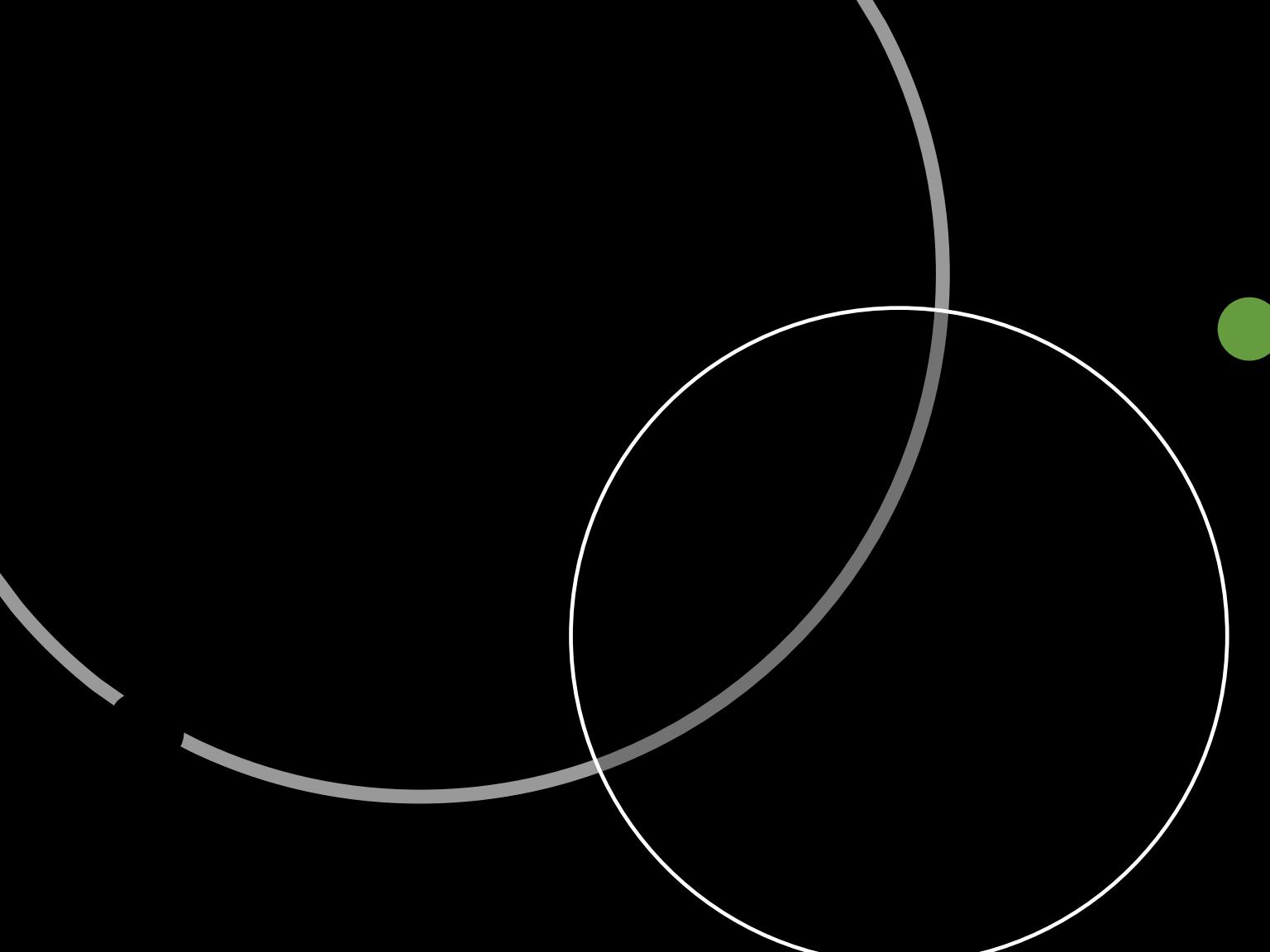


Teaching/Learning about Data

IrieAT™

Braillenote Touch Plus





A graphic element on the left side of the slide features two overlapping circles. The larger circle is dark gray with a white outline, and the smaller one is white with a gray outline. They overlap in the center. To the right of this graphic, the text 'Data Sonification' is displayed.

Data
Sonification

History



- First data sonification: e.g., stethoscope – amplify existing sound sources that we couldn't hear
- Geiger–Mueller counter: turns alpha particles, otherwise undetectable by human perception, into synthetic sound source (detects radiation)
- 1954 – Pollack and Ficks – perceptual experiments about transmission of info via auditory display – used timing, frequency, loudness, spatialization, and duration of sound to see if participants could register changes in multiple dimensions – found that error rates vary significantly across variables

History

- 1974– first auditory graphing of data “augmented a scatterplot using sounds that varied along frequency, spectral content, and amplitude modulation dimensions to use in classification.”
- Bly (1982) – found that combining sound and visual yield highest accuracy for interpretation of data
- Williams et al. (1990) – had participants listen to compound sound textures (e.g., combine pitch, attack rate (how fast the sound comes on), volume etc) with multivariate glyphs and found that accuracy increases with combination of sound and graphics (but this isn’t possible for everyone and it’s clear that sound alone is very effective)

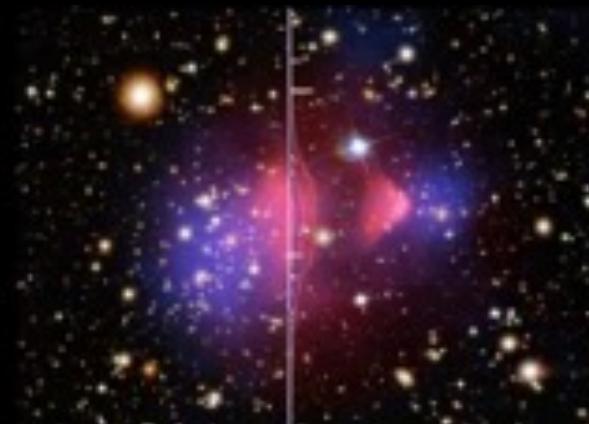
- Schito & Fabrikant, 2017

Definition

- Data sonification is a relatively new field of research (traced back to early 1990s)
- International Community for Auditory Display est. in 1992 by Gregory Kramer
- “Sonification is the transformation of data relations into perceived relations in an acoustic signal for the purposes of facilitating communication or interpretation.”
- Non-speech sound

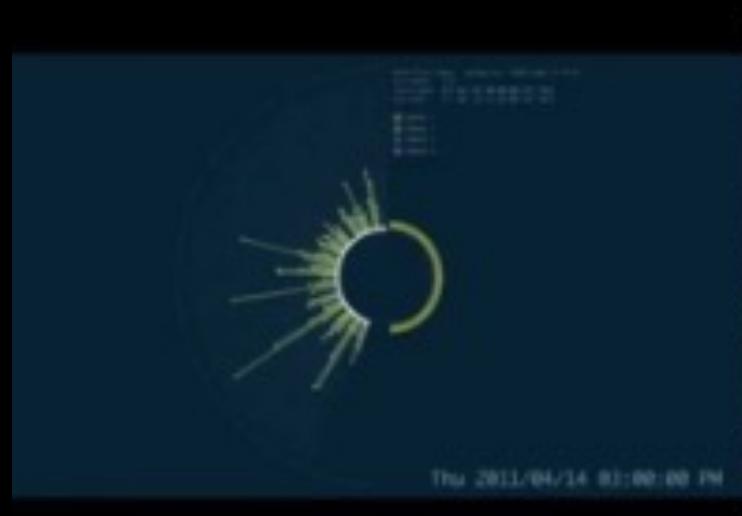
Pitch

- Pitch – useful for representing the shape of the data (high vs low)
- Easily distinguishable changes in numeric values (Flowers, 2005)



Loudness & Temporality

- Can help determine frequency of a phenomenon
- Can hear text message metadata
 - louder sounds when people were texting throughout the day, gets quieter at night
- We can also hear temporal quality of the data which can alert us to gaps or outliers in the data

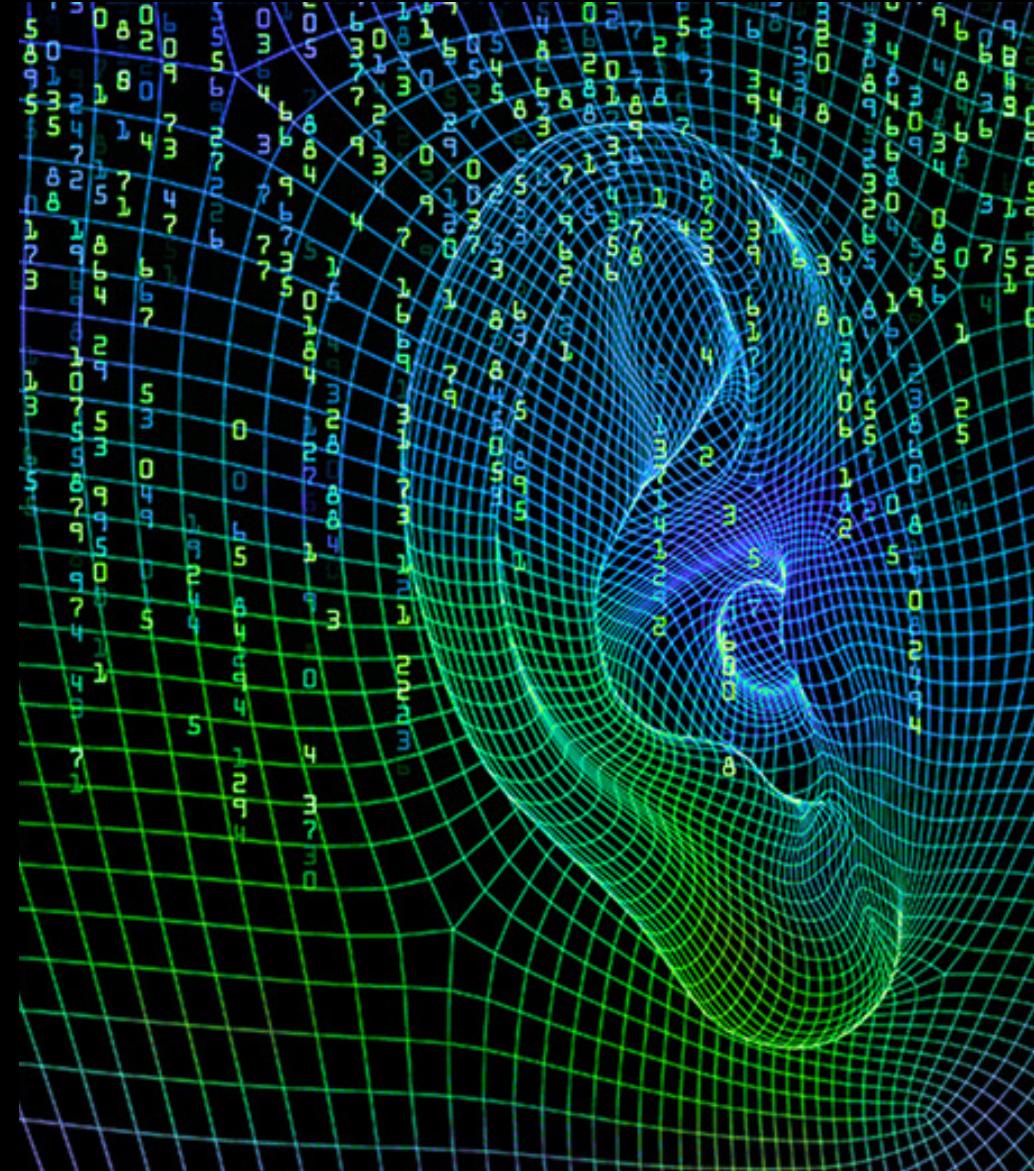


Timbre

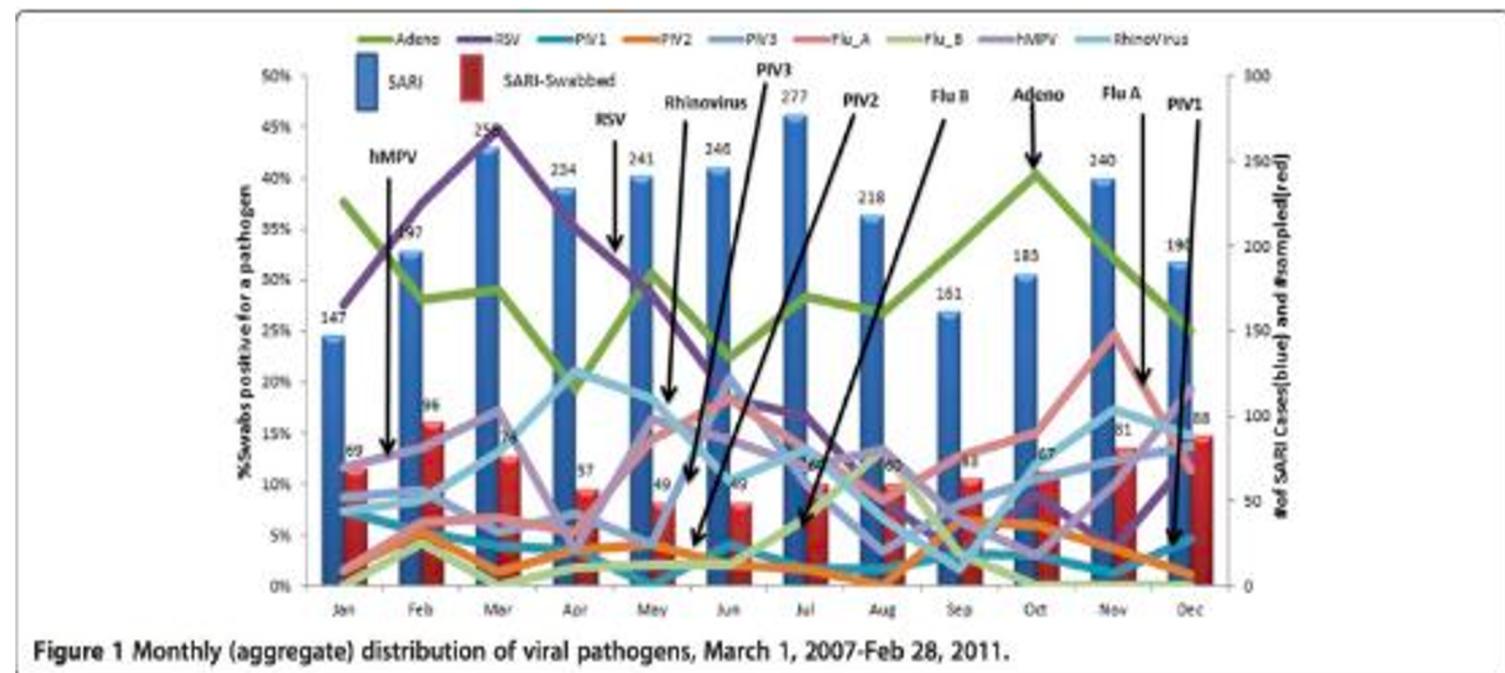
- Sound quality can help distinguish between different elements of sound and unintended grouping of variables
- Sonification can allow users to visualize graphs containing more than one variable, assigning different instruments to each (Brewster & Brown, 2003)

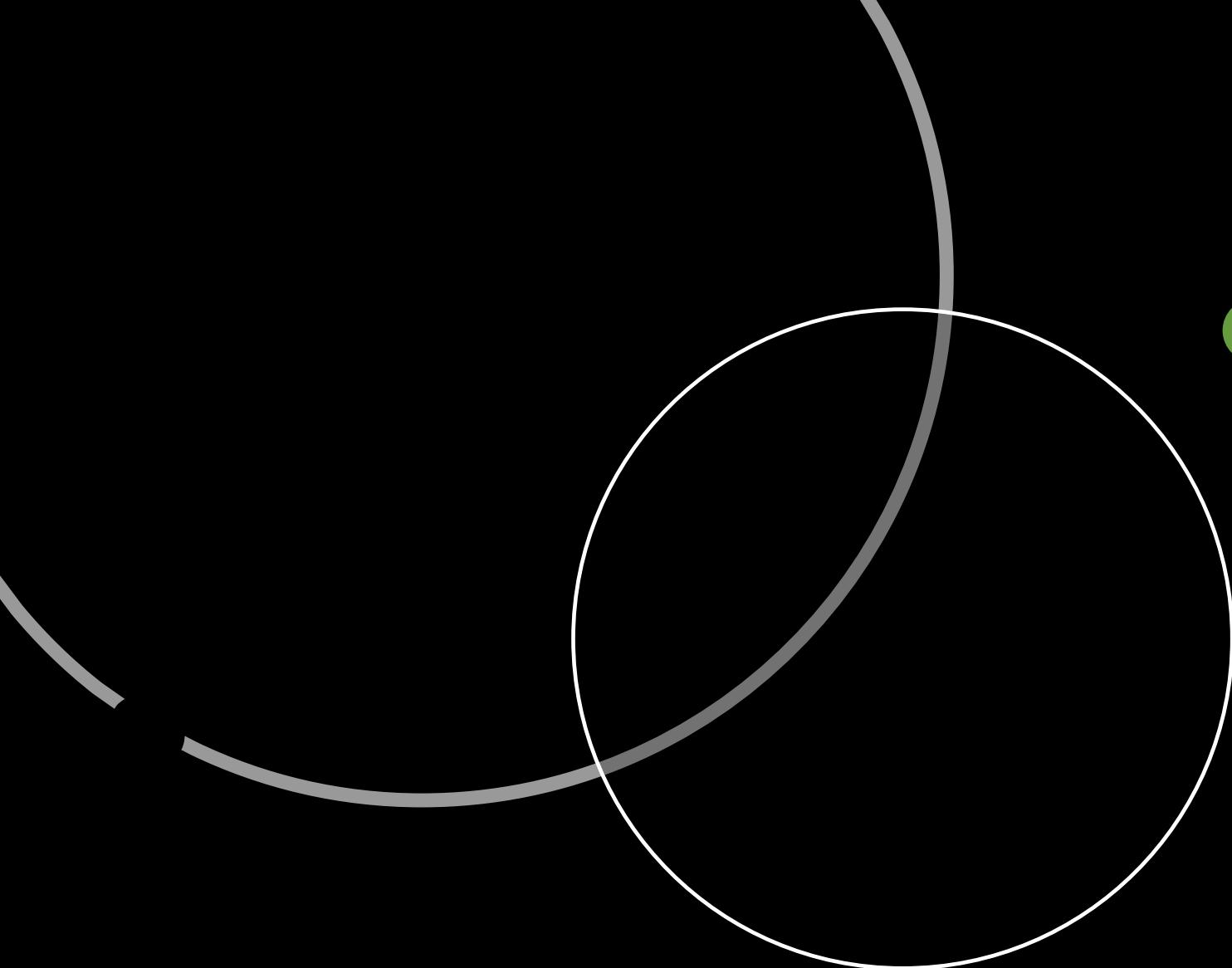
Strengths

- Temporality – we can listen to things in stereo, they can be panned from one side to the other like the way we read so it's a lot easier to use sound to indicate temporal changes and movement
- Can easily create auditory histograms from time-stamped event logs
- Is accessible and, when combined with tactile or visual data, can increase our understanding of data



Keep it simple!





- Examples
of
Accessible
Graphs

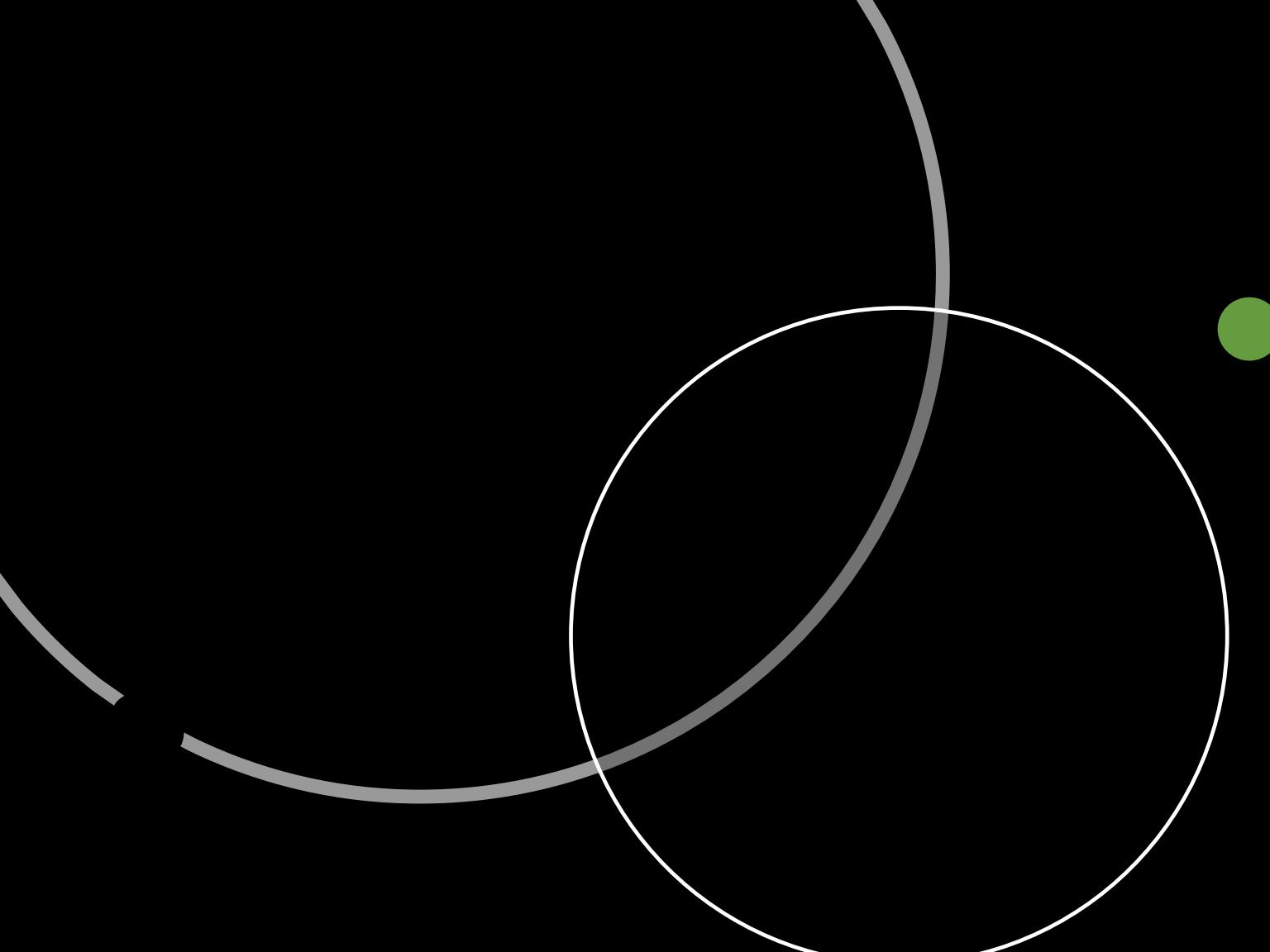
Visualizing Mathematics

[https://ewserver.di.unimi.it/audiofunctions/view?f=sin\(x\)¢er=%5b5_0%5d&scale=20&m_earcons=1](https://ewserver.di.unimi.it/audiofunctions/view?f=sin(x)¢er=%5b5_0%5d&scale=20&m_earcons=1)

SAS – Graph Excel Runner

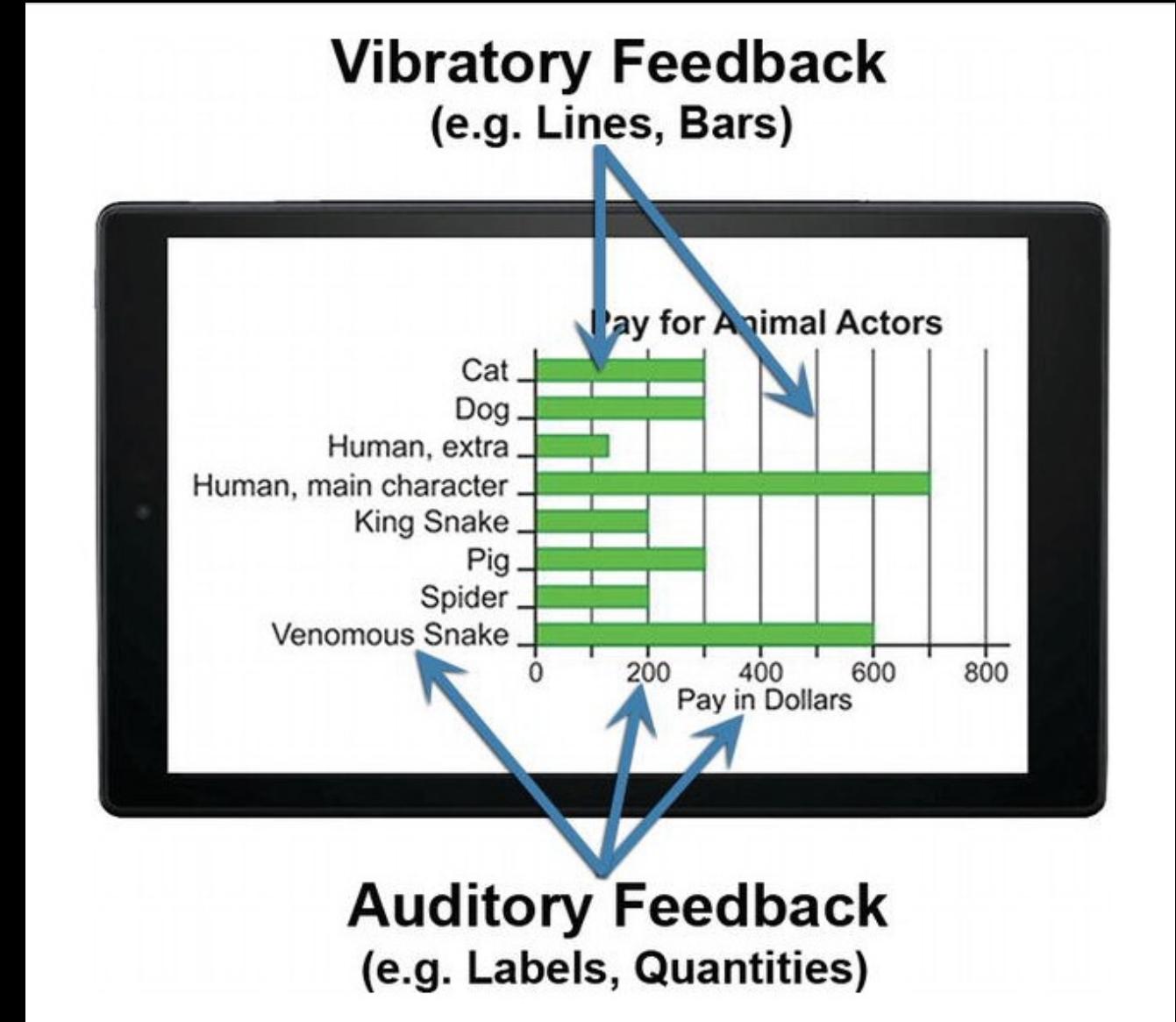


accessibledata.org

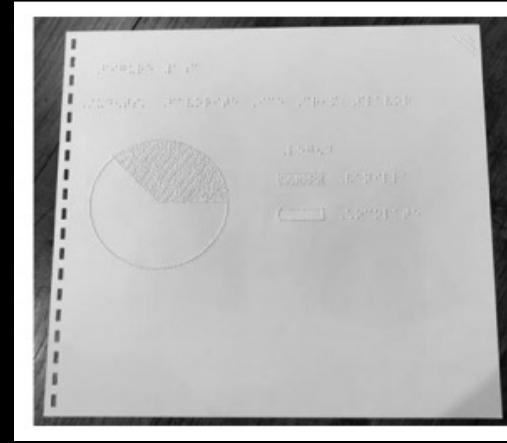
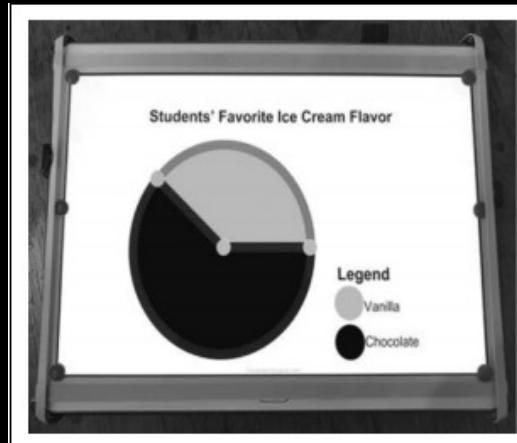


Vibrotactile Graphs

Vibrotactile Information?

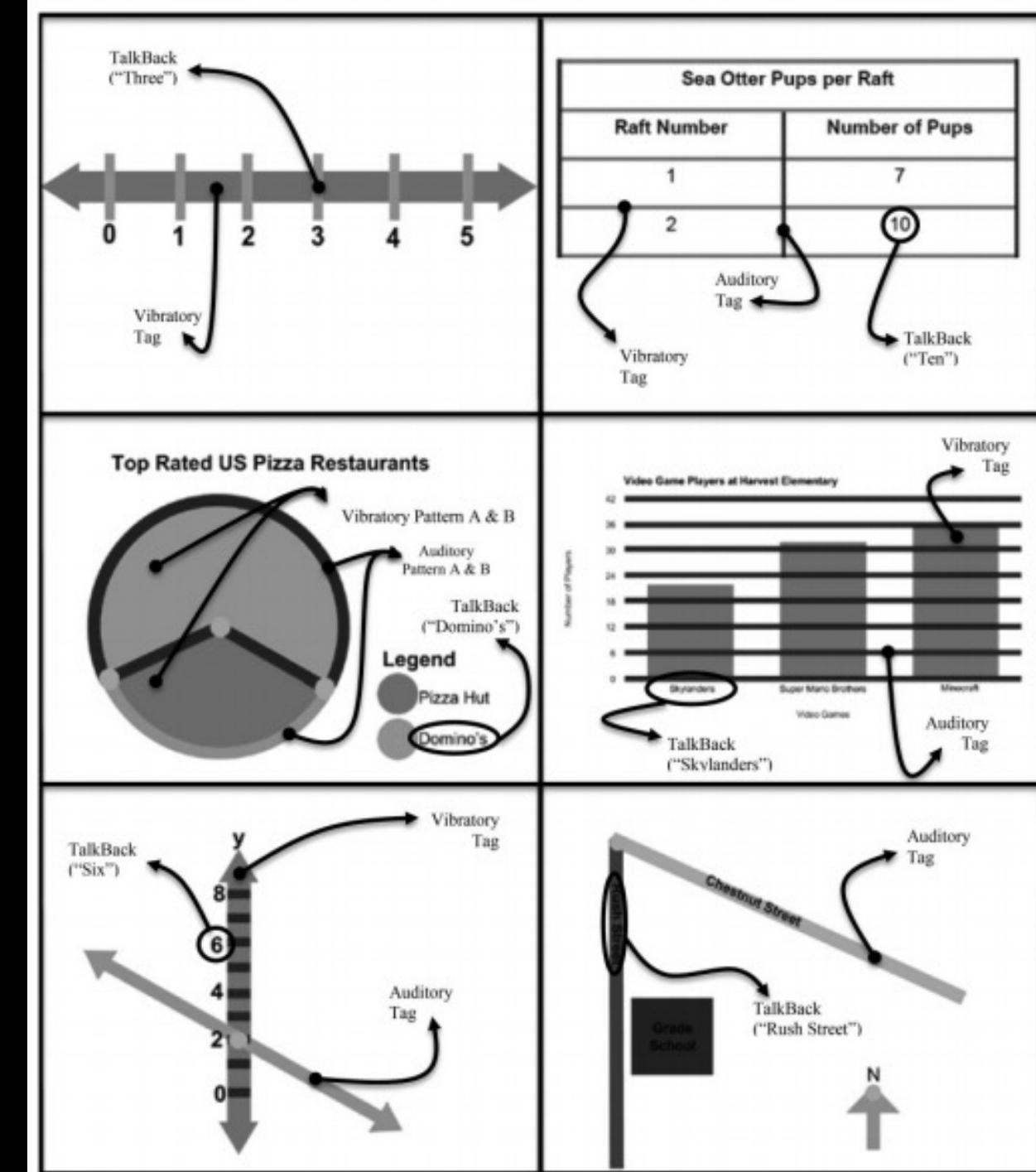


Equivalent performance



Embossed example graphic

Tab S/ViTAL



Discussion questions

- How can we use tactile displays and sonification to enhance the richness of our data
- When we introduce different tones into data sonification, how does that alter our perception of the data?
- How could data sonification be highly biased?
- Much more complex than we might think – so how do we choose the sounds we hear? Do different sounds evoke different understanding of the data?
- How could different tactile materials change our perception of the data?