

# THE DESIGN SPACE OF AUDITORY DATA

What does a data distribution sound like?

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## MOTIVATION

With the rise of both virtual assistants and software-embedded devices, audio-first interactions are becoming more prevalent in daily life. However, there are not yet industry standards for communicating the droves of data generated by ubiquitous computing via sound experiences – particularly through emergent smart speaker interfaces. We imagine a future in which we are able to explore data by ear: how might Alexa enable us to understand complex datasets?

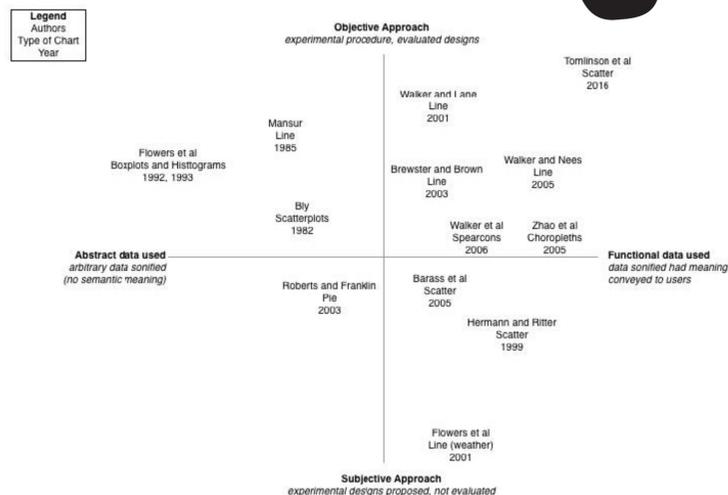
## Prototype Design

Most of the papers did not have access to the original sounds, so we recreated 3 methods with data from the 2010 U.S. Census and 2015 American Community Survey. We integrated these into a voice user interface (VUI) for conversational data exploration called, “Tally Ho.”



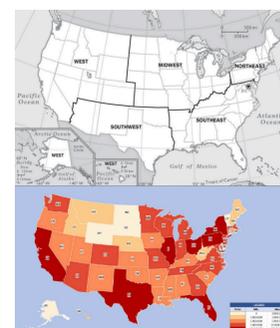
## Literature Review

We conducted an interdisciplinary literature review on “data sonification,” shaping our analysis on based on visual analogs of the following “auditory graph” types: Histogram, Box Plot, Choropleth Map, Pie Chart, Scatter Plot, and Line Graph.

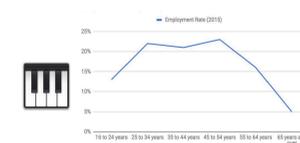


## Conceptual Framework

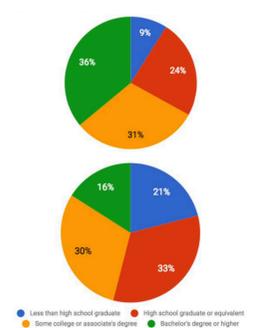
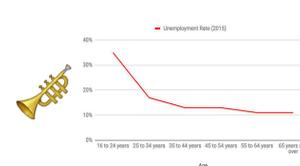
The selection of papers demonstrated great variety: some demonstrated creative intent with more memorable, musical designs, while many focused on accurate, scientific representations. We thus developed a framework mapping reviewed papers along 2 dimensions: abstract vs. functional data (X-axis) and objective vs. subjective validation approach (Y-axis).



Population by Region and State



Employment and Unemployment by Age



Employment and Unemployment by Education

## Usability Testing

We evaluated our VUI with participants (n=5) ranging with no smart speaker experience to owning and using a smart speaker daily. Hear the stimuli for yourself and see if you can hear the auditory graphs below!

## CONCLUSIONS AND FUTURE WORK

Our prototype used pitch, timbre, and rhythm to represent data points, category differences, and overall trends: users were able to hear these distinctions and interpret them mostly correctly after hearing a scripted explanation from the VUI. Our results suggest that users generally enjoyed the experience of hearing data – finding it “cool,” “fun,” and even “powerful” – but also had difficulty remembering key insights as passive listeners. Continuing to develop interaction patterns for auditory data exploration will benefit not only those who are visually impaired or limited in numeracy skills, but also those who are curious about making sense of data through alternative means – ultimately, improving accessibility of information for all.

