



Norwegian University of  
Science and Technology



# **MCT4046: Sonification and Sound Design**

Fundamentals Sonification I

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# What is sonification?



## What is sonification? [1]



- "Audio representation of multivariate data" (Bly 1994)
- "A mapping of numerically represented relations in some domain under study to relations in an acoustic domain (*a technique*) for the purposes of interpreting, understanding, or communicating relations in the domain under study." (Scaletti 1994)
- "A mapping of information (content, data) to perceptual relations in the acoustic domain to meet the information requirements of an information processing activity (*a process*).” (Barrass 1997)

## What is sonification? [1]



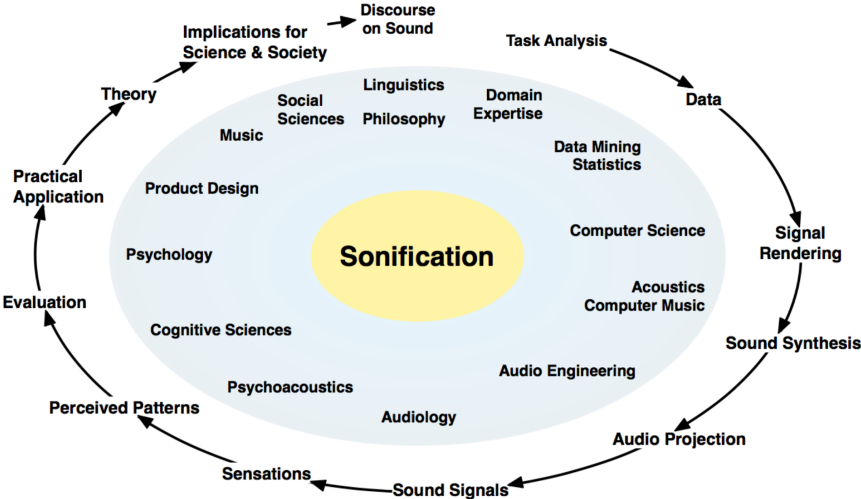
- “The use of non-speech audio to convey information. More specifically, sonification is the transformation of data relations into perceived relations in an acoustic signal for the purposes of facilitating communication or interpretation” (Kramer et al. 1999)
- “Representation of data relations in sound relations” (Anderson et al. 2002)
- “Sonification is the acoustic representation of data for relational interpretation by listeners, for the purpose of increasing their knowledge of the source from which the data was acquired” (Worrall 2009)

## What is auditory display? [2]



- "**Auditory Display** encompasses all aspects of a human-machine interaction system, including the setup, speakers or headphones, modes of interaction with the display system, and any technical solution for the gathering, processing, and computing necessary to obtain sound in response to the data.
- In contrast, **sonification** is a core component of an auditory display: the technique of rendering sound in response to data and interactions."

# The interdisciplinary circle of sonification [2]



## How to classify sonifications? [1]



- Based on data sources? (e.g. electrocardiogram, stock market, hearing aids)
- Based on data type? (e.g. analog, digital, real time, spatial, temporal)
- Based on target applications? (e.g. medical, entertainment, accessibility, data mining, seismology)
- Based on the medium? (e.g. interactive, linear, mobile devices, desktop)

## How to classify sonifications? [1]



Two categories in a representational continuum: **analogic** vs. symbolic.

- Analogic: establishes a relation between the source and the target. "The purpose of analogic representation is to make the structure of the information better suited or simpler for the target than it was in its original form." (connotative). Example: A Geiger counter (<https://www.youtube.com/watch?v=upPiJ9v0YiY>).



## How to classify sonifications? [1]



Two categories in a representational continuum: analogic vs. **symbolic**.

- Symbolic: establishes an abstract relation between the source and the target. "A categorical sign for what is being represented" (denotative). Example: Stockmarket sonification ([https://www.youtube.com/watch?v=N\\_y1V\\_3b65o](https://www.youtube.com/watch?v=N_y1V_3b65o))

# Types of data representation [1]



- Discrete
- Continuous
- Interactive

## Discrete [1]



Discrete data representations are representations in which every data point (datum) is sonified with an individual auditory event.

- Auditory Warnings: Alarms and Alerts
- Auditory Icons: Using real-world sounds to reflect various computer activities.
- Earcons: Use structured sequences of synthetic tones, nonverbal audio messages.
- Speech Noises: Digitally processing sounds so that they have some of the acoustic properties of speech.

## Continuous [1]



Continuous data representations (CDRs) treat data as analogically continuous (e.g. real-time operation of machines, stock markets, the environment).

- Audification: a technique for translating data directly into sound e.g. review a long time period of data in a few minutes (e.g. global climate change

<https://www.youtube.com/watch?v=MUTk-e3ikmw>, seismic data

<https://www.youtube.com/watch?v=BmyALYtDOWA>, a year of your life

<http://datasonification.tumblr.com/post/32796145749/brian-house-sonifies-the-data-from-a-year-of-his>).

## Continuous [1]



- Processed Audification: when the data needs to be “massaged” beforehand, or when there are not enough data to sustain it, then it is possible to apply signal-processing techniques.
- Parametric mapping: technique for representing high-dimensional data as sound. Sometimes referred to as sonic scatter plots. Typically, data dimensions are mapped to sound parameters, which can be physical (frequency, amplitude); psychophysical (pitch, loudness); or perceptually coherent complexes (timbre, rhythm). Examples:  
<https://sonification.de/handbook/chapters/chapter15/>

## Sonification reserach [1]



The Sonification Report considered the field of sonification research to consist of three principal components: (1) research in perception and cognition, (2) development of research and application tools, and (3) design and applications using the sonification techniques.

## ICAD [1, 2]



The first International Conference on Auditory Display (ICAD) was held in 1992. Aim to understand all aspects of Auditory Display, a systematic study of using computers to “display” information to the human auditory system.

<https://www.icad.org/>

## The future of sonification [1]



"For sonification design to advance as a practice, sonification designing needs to be practiced and critiqued and its designs interpreted, not just listened to as 'furniture music' (musique d'ameublement, after Satie)."



# References



- [1] David Worrall. “An introduction to data sonification”. In: *The Oxford Handbook of Computer Music*. 2009.
- [2] Thomas Hermann, Andy Hunt, and John G Neuhoff. “Introduction”. In: *The Sonification Handbook*. Logos Verlag Berlin, Germany, 2011.