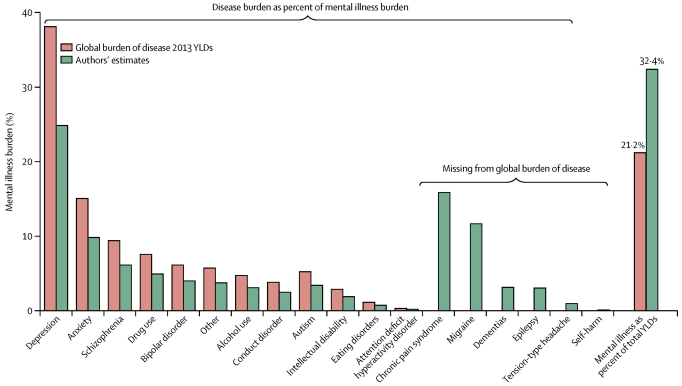
DTU

Interpretable and transferable methods for the detection of mental disorders

Acoustic emotion recognition

Mental health



- Mental illness is one of the leading causes of global disease burden (Prince et al., 2007; Vigo et al., 2016).
- In Denmark, 15% of youth will be diagnosed with a psychiatric disorder before their 18th birthday (Dalsgaard et al., 2020).

Obsessive Compulsive Disorder (OCD)

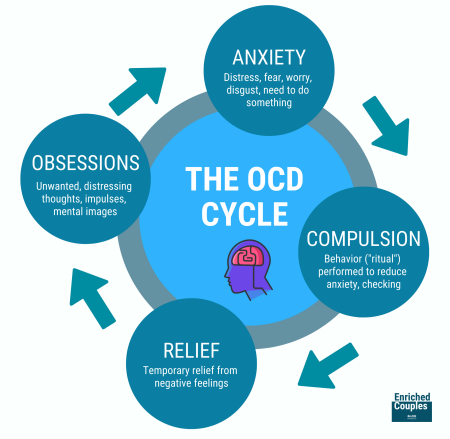


Figure: Obsessions and compulsions behave cyclically. Original image from `https://medium.com/amalgam/ocd-is-not-what-you-think-it-is-ee818028e79c`

- Mental disorder wherein "People are caught in a cycle of obsession and compulsions".
- Obsessions $\rightarrow$ intrusive and disruptive urges, thoughts, images, etc.
- Compulsions $\rightarrow$ behavior to overcome obsessions, distress.
- In 2010, anxiety disorders - including obsessive-compulsive disorders -alone cost Europe over €74 billion (Gustavsson et al., 2011).

Objectives: OCD detection and intervention

Identify and predict impending OCD events and provide useful interventions
$\rightarrow$ progression and severity of disorder.
Aid in delivering cognitive behavioral therapy to patients.

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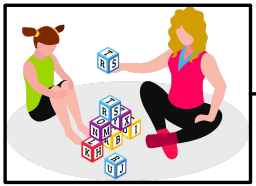
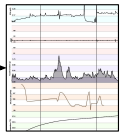
Information modalities



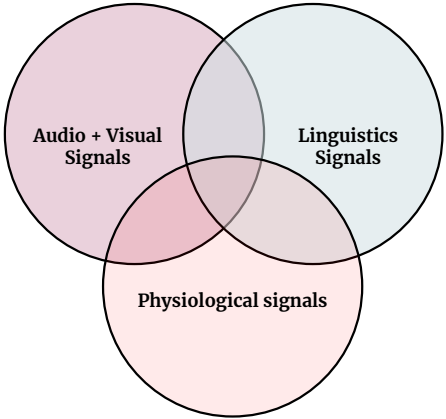
Therapy sessions

Videos

Wearable device



Heart-rate, EDA, Accelerometer



Affect detection from acoustics: Speech emotion recognition

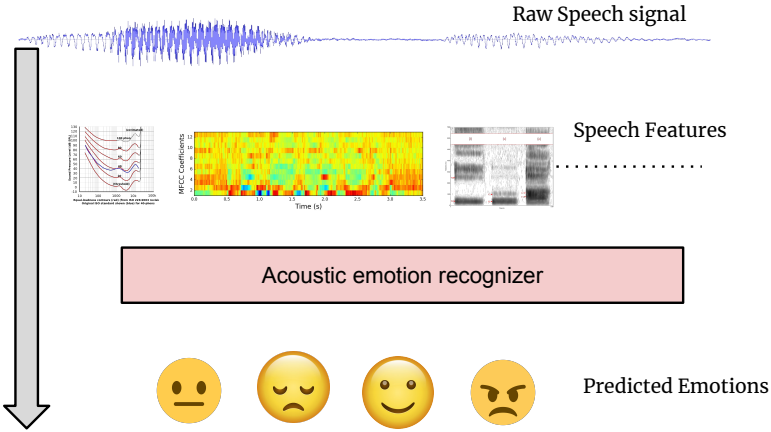


Figure: Image sources https://medium.com/prathena/the-dummys-guide-to-mfcc-aceab2450fd; https://commons.wikimedia.org/wiki/File:Lindos1.svg; https://commons.wikimedia.org/wiki/File:Spectrogram_-iua-.png

Methods used for speech emotion recognition

- Domain matured over 20 years
- Predominantly signal processing and machine learning, Deep learning
- Lingering challenges: Generalization, shortage and inequity in data and annotation, black-box nature of recent algorithms.

Latent representation studies using Autoencoders

- Autoencoder: MMSE $E(x_{\text{input}} - x_{\text{true}})^2$
- Undercomplete autoencoder: $x_{\text{input}} = x_{\text{true}}$
- Denoising autoencoder: $x_{\text{input}} = x_{\text{true}} + N$, $N \in \mathcal{N}(0, 1)$

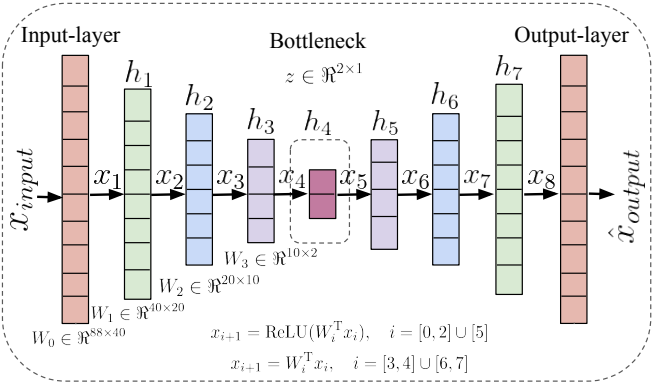


Figure: Autoencoder architecture

Results

- Classification accuracy using support vector classifier on latent space.
- Accuracy decreases over the transfer datasets $\rightarrow$ UAE, DAE generalizing best.

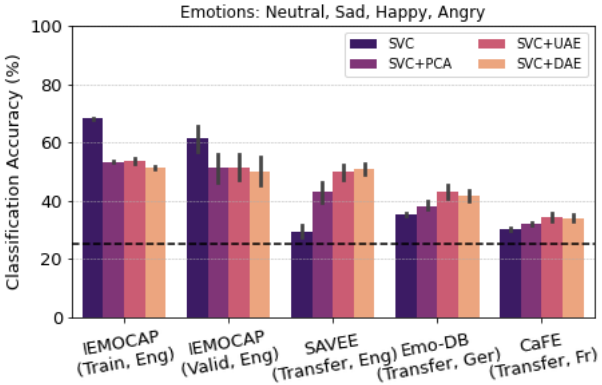


Figure: Unweighted accuracy over training, validation and transfer datasets

Q. Which emotions are more expressive than others?

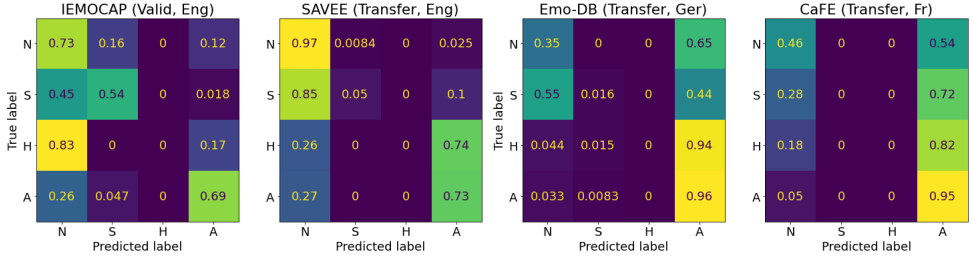
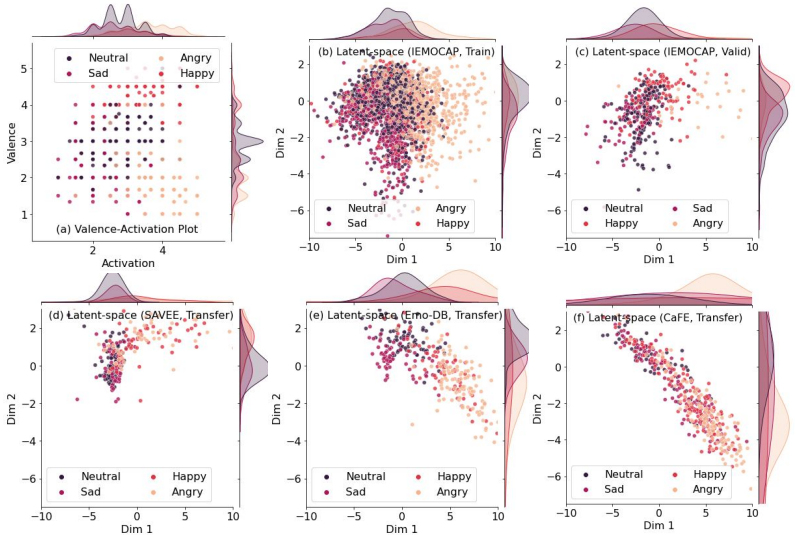


Figure: Confusion matrix

Robustness: Recording conditions and language



Most relevant features: Neutral-Sad

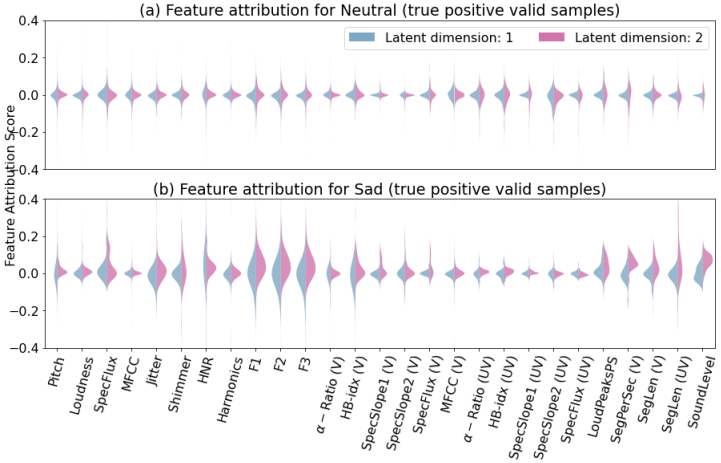


Figure: Feature attributions

Most relevant features: Neutral-Anger

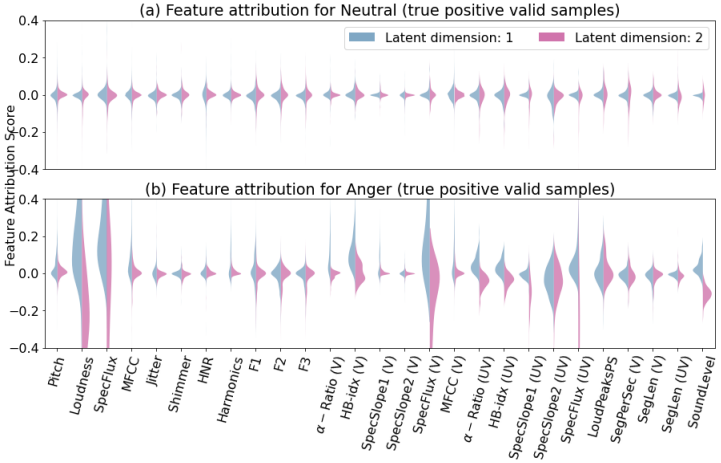


Figure: Feature attributions

Most relevant features: Neutral-Happy

Figure: Feature attributions

Concluding remarks

- *“No health without mental health"*
- Human experts + Technology $\rightarrow$ detection, intervention of mental disorders.
- Decision making process $\rightarrow$ interpretable.
- Autoencoders variants for acoustic affect recognition.
- Emotions labelled as anger and neutral most consistent over validation and transfer datasets.
- Identified input features influencing the clustering of the emotion categories.

References I

Under review:
Das, Sneha, Nicole Nadine Lønfeldt, Anne Katrine Pagsberg, and Line H. Clemmensen. *"Towards Interpretable and Transferable Speech Emotion Recognition: Latent Representation Based Analysis of Features, Methods and Corpora."* arXiv preprint arXiv:2105.02055 (2021).

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1. Prince, Martin, et al. "No health without mental health." The lancet 370.9590 (2007): 859-877.
2. Vigo, D., Thornicroft, G., & Atun, R. (2016). Estimating the true global burden of mental illness. The Lancet Psychiatry, 3(2), 171–178. https://doi.org/10.1016/S2215-0366(15)00505-2
3. Gustavsson, Anders, et al. "Cost of disorders of the brain in Europe 2010." European neuropsychopharmacology 21.10 (2011): 718-779.

References II

4 Dalsgaard, Søren, et al. "Incidence rates and cumulative incidences of the full spectrum of diagnosed mental disorders in childhood and adolescence." JAMA psychiatry 77.2 (2020): 155-164.

Thank you!