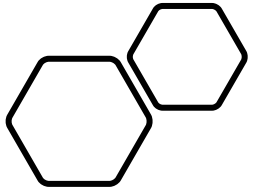

Rethinking Language
Computational approaches to speech and language assessment for clinical studies

How to Share Your Data in a GDPR-Compliant Way

4th CLARIN/DELAD workshop

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About me

- Linguist with PhD in Psychology, Linguistic, and Neuroscience

- Now
  - Post-doc fellow @UNIFI
  - Lecturer @UNIBS

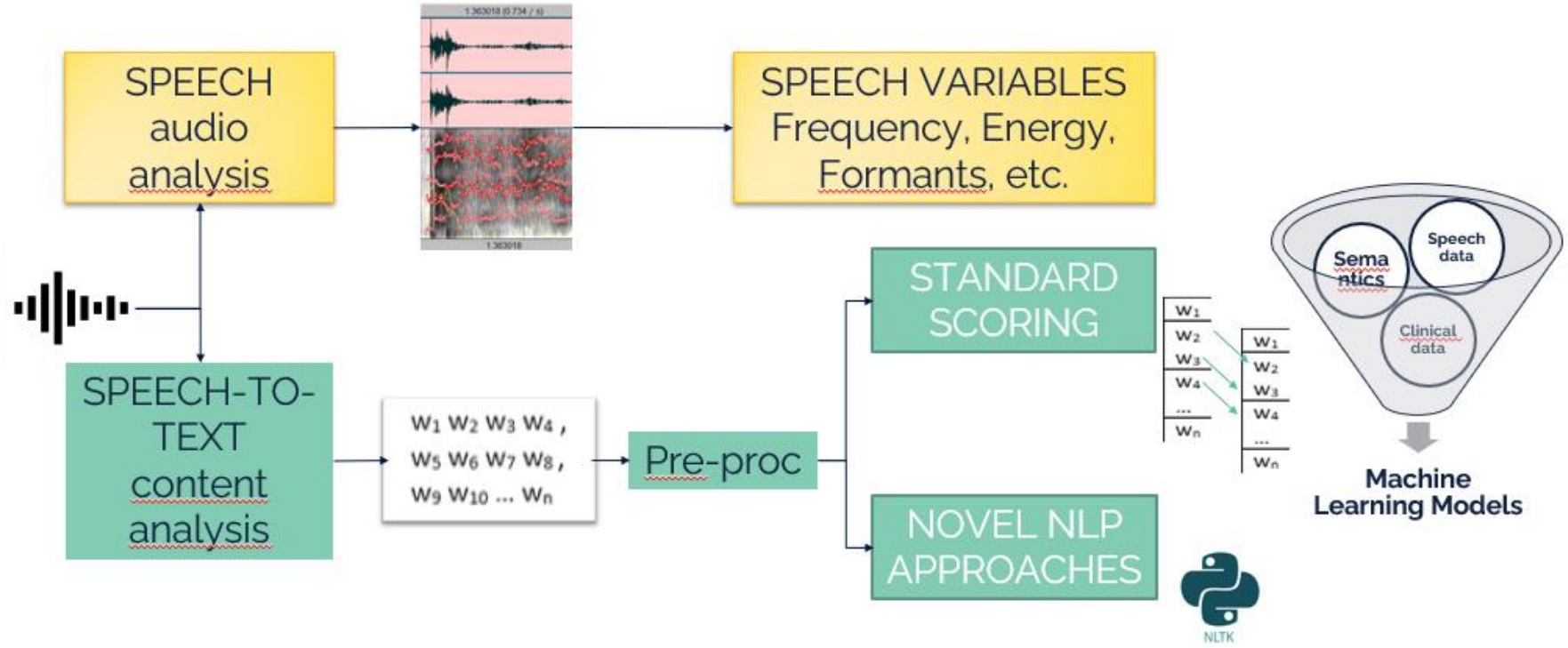
Why should we rethink speech and language assessment in the clinical practice?

- In a wide range of mental disorders, cognitive and affective symptoms are expressed in language and measured by assessing speech
  - Clinicians trained do that almost intuitively
  - There are standardized tests available, but
    - Paper-and-pencil
    - requires verbatim transcriptions and manual scoring
    - can only tap on surface phenomena

→ Time consuming and barrier to frequent/remote monitoring

Double path to language assessment

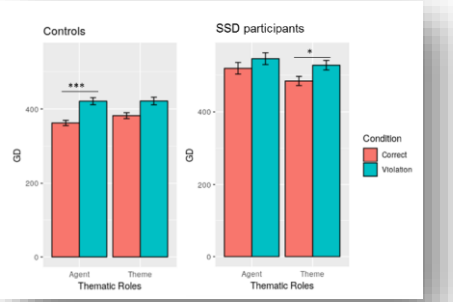
- Digital tools now available to model:
  - speech content: word vectors (LSA, word2vec, BERT, …)
  - Audio: spectral analysis to extract acoustic and paralinguistic aspects of voice



Our work so far
Analysis of syntactic and semantic content

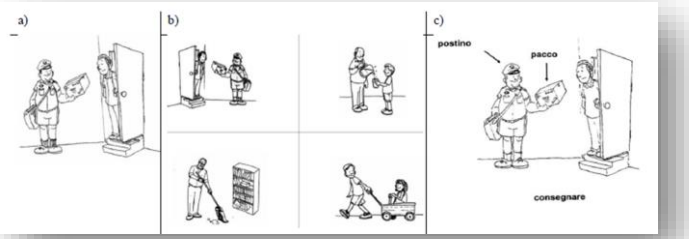
In schizophrenia some semantic violations are more tolerable than others - it depends on whether the grammatical subject is an agent or not!

Barattieri di San Pietro, C., de Girolamo, G., Luzzatti, C., & Marelli, M. (2022). Agency of Subjects and Eye Movements in Schizophrenia Spectrum Disorders. *Journal of Psycholinguistic Research*, 1-21.



Schizophrenia presents with language-specific deficits similar to those found in agrammatism

Barattieri di San Pietro, C. et al. (2022). Processing Argument Structure and Syntactic Complexity in People with Schizophrenia Spectrum Disorders. *Journal of Communication Disorders*, 106182



ML models based on DSM-derived measures of VF less accurate than models built on human-based ratings in classifying people with dementia.

Barattieri di San Pietro, C., Marelli, M., & Reverberi, C. (2021). Moving from Human Ratings to Word Vectors to Classify People with Focal Dementias: Are We There Yet?. CLiC-it.

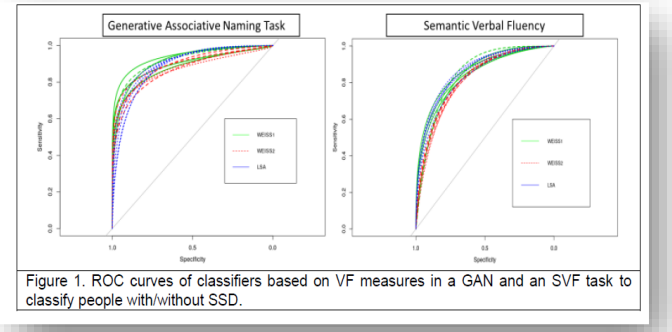


Figure 1. ROC curves of classifiers based on VF measures in a GAN and an SVF task to classify people with/without SSD.

What is going on
Clinical applications of voice and language analysis

- Application to very diverse clinical conditions
  - Psychiatric: BP, MDD, eating disorders…
  - Neurodevelopmental: ADHD, Autism…
  - Neurological: MCI, AD, strokes…
- With very diverse objectives:
  - Characterization of language in disorders
  - Classify subjects (patients vs controls, high risk vs low risk)
  - Predict prognosis (MCI to AD), conversion of high-risk subjects
  - Response to treatment
  - Monitor relapse and mood state (MDD and BP)
  - Remote monitoring
  - Personalized rehabilitation
- Analysing every possible audio feature
  - Must be clinically relevant!
  - Reduced variance of F0 in depression (monotonous speech)
  - Reduced speech rate (bradicynesia as negative symptom in BD, MDD, SZ)
  - Incoherence of responses (positive symptom in SZ)
  - Augmented speech rate (pressured speech – SZ and maniac state in BD)
  - Affective words (depressed mood in MDD and BP, negative symptom in SZ)

Bridging healthcare and IT - SPEAKapp

51 healthy participants, downloaded & installed app & completed all tests remotely.

- Data integrity: 99%
- Data quality: 90%
- WER: 10%
- Usability: 88.5%

→ Consistency of features: system variables in line with values in controlled environments

https://www.gatekeeper-project.eu

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 857223

Ab.Acus

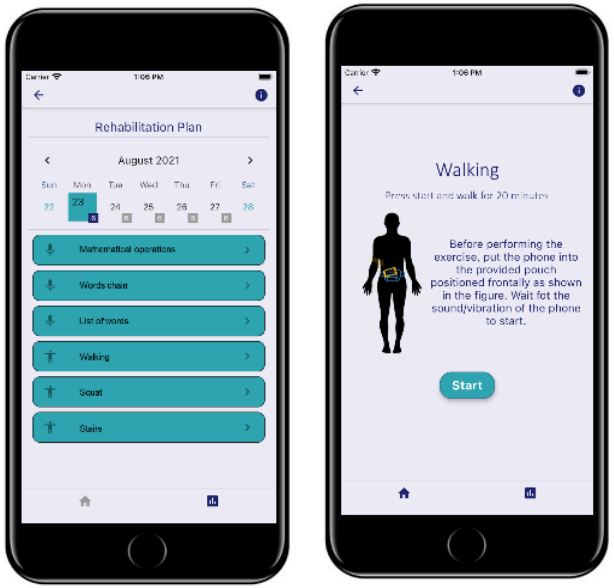
Clinical application
NLP, verbal performance and Digital Mental Health

- Objectives:
  - Primary: Identify language markers of symptoms severity in people with SMI (SZ, BD) via mobile app (SPEAKapp) to collect audio and standard diagnositc measures
  - Secondary: test acceptability of the system
- Methods
  - Observational, cross-validation study.
  - Test association of semantic and acustic features with patterns of symptom severity (for each clinical condition)
  - Participants: estimated 35+35
- Status
  - Pending EC approval. Data collection to begin in Jan ‘23 (approx)

FSE REACT-EU Competitive Research Grant Axis-IV DM 1062/2021: “Natural Language Processing in Digital Mental Health” - 2022-2024

PHY-CO! - Physical and Cognitive Rehabilitation Framework

- Cognitive and physical stimulation activities
  - Standard neuropsychological exercises
  - Physical exercises
- Status: ongoing
- Setting: rehabilitative outpatient clinics



This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No 857188.

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FORLILPSI
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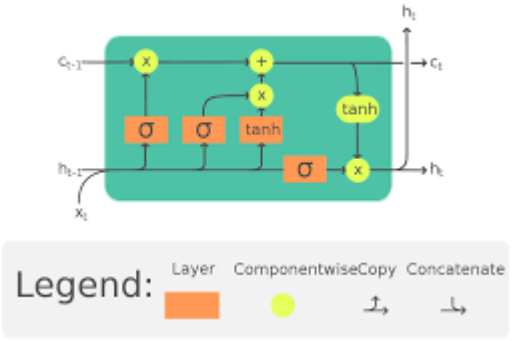
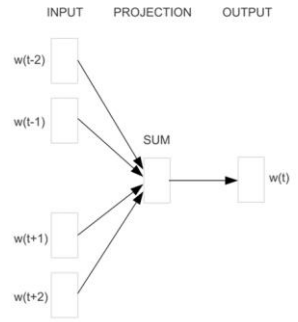
Fine-tuning tools: Navigating textual ambiguity

MULTI WordNet

- Interplay between textual features and individual's ability to understand the text
- Computational measures of textual ambiguity
  - Lexical → n. synsets on MultiWordNet
  - Syntactic → surprisal index based on Long-Short-Term-Memory neural network
  - Pragmatic→ cosine distance btw metaphoric/literal expressions and their context, based on word2vec WEISS





Levelling up - Automated analysis of pragmatics

- Analysis of pragmatics in rehabilitation of neurological disorders (strokes)
- Data: N=30 patients (dx lesions), pre-post rehabilitation
  - MRI
  - EEG
  - neuropsychological evaluation & **audio samples**
- Status: data collection T1 completed, T2 ongoing

SAN CAMILLO IRCCS SRL

Going international
SWETALY mentoring programme

- Swedish-Italian cooperation on Health and Aging
- Secondary analysis on existing data from MCI patients
  - eye-movements
  - **audio recordings**
- Obj: find early digital markers of dementia

UNIVERSITY OF GOTHENBURG

SWETALY

My questions to the DELAD community

- Audio files
  - considered as health-related data («biosample») under GDPR and Italian law, and subjected to strict regulations
  - Some previously collected and more to come – how can **collaboration and replicability of results** be realized?
  - How can data be made available to the community, if at all possible? **Under which terms**?
- What about **anonymization tools**?
- Must be **paired with clinical data**

Thanks!

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