Measurements of turn-taking and linguistic behaviors in clinical settings

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NPI NeuroPsychologie Interventionnelle

Overview

1) Introduction and motivations

2) Human expert annotation vs Crowdsourcing vs Automatic Methods

3) Conclusion

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1) **Introduction and motivations**

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Current follow-up in Neurodegenerative Diseases

Now at the **Hospital**

- Once/Twice a year
- Specialized and fastidious tests
- Analysis by experts
- Wearisome and Expensive

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- Analysis by experts
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- Limitations in Clinical Trials
- Limited understanding of the disease
- Only reactions and not prevention of difficult life events

Clinical question

How to monitor the evolution of neurodegenerative diseases under less controlled conditions, more frequently and automatically?

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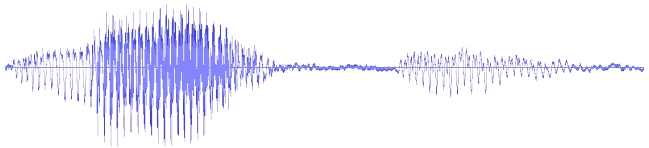
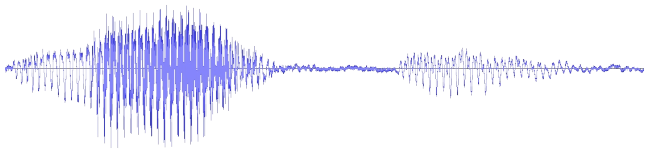


Clinical question

How to monitor the evolution of neurodegenerative diseases under less controlled conditions, more frequently and automatically?

Alzheimer's Disease
KC Fraser, JA Meltzer, F Rudzicz 2016



Frontotemporal Dementia
Zimerrer et al. 2020

Primary Progressive Aphasia
Wilson et al. 2010, Fraser et al. 2014

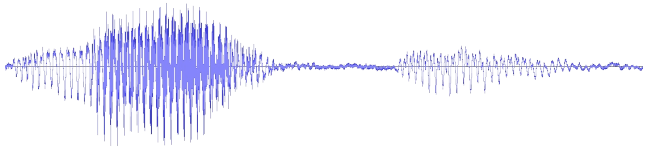
Parkinson's Disease
A Tsanas, MA Little, PE McSharry, LO Ramig 2010

Huntington's Disease
Riad et al. 2020

Multiple Sclerosis
J Rusz et al. 2018

Researcher’s/Engineer’s problem

Then, how do we obtain measurements of naturalistic turn-taking and linguistic behaviors for clinical applications?



- **Acoustic**
  (Prosody, Intensity
  Articulation, Respiration)
- **Linguistic**
  (Vocabulary, Syntax,
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- **Language use and interaction**
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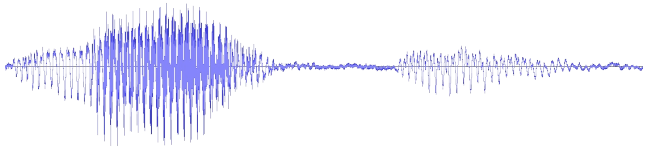

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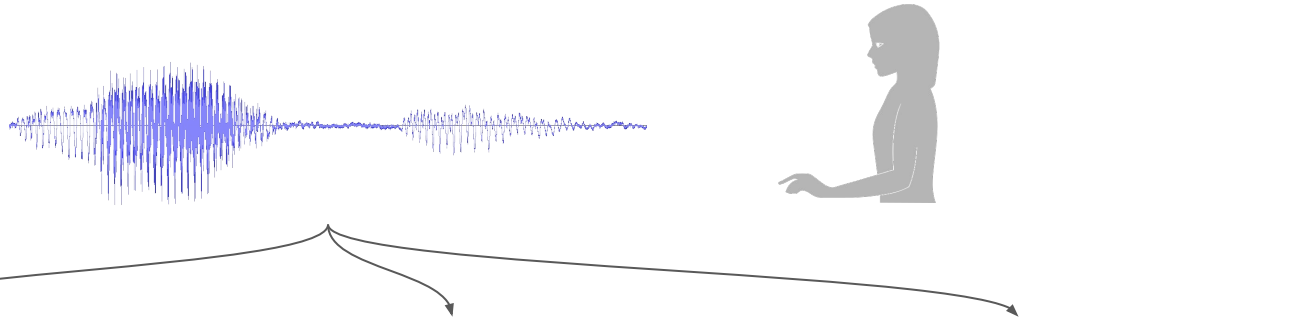
Human expert annotations



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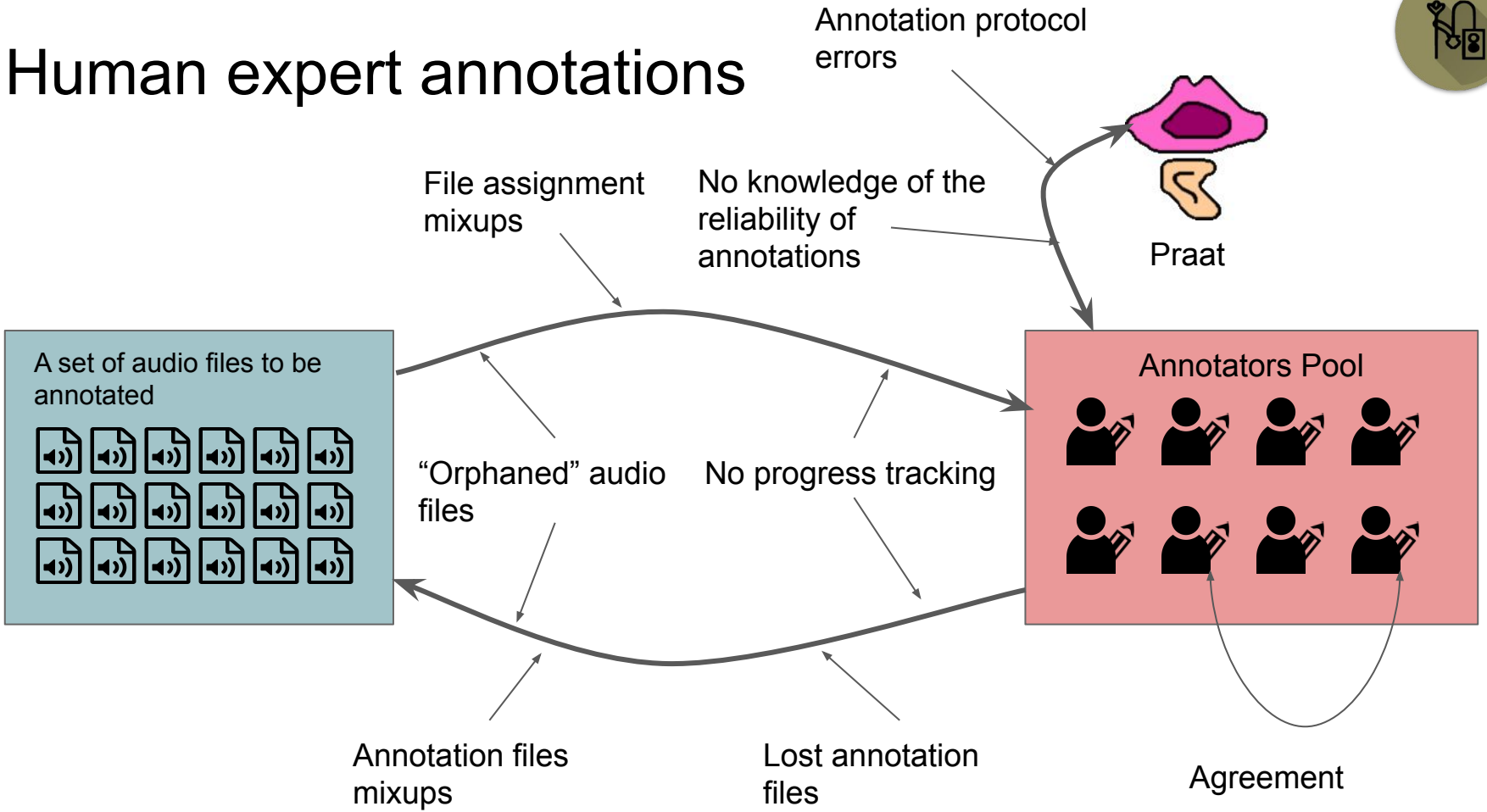

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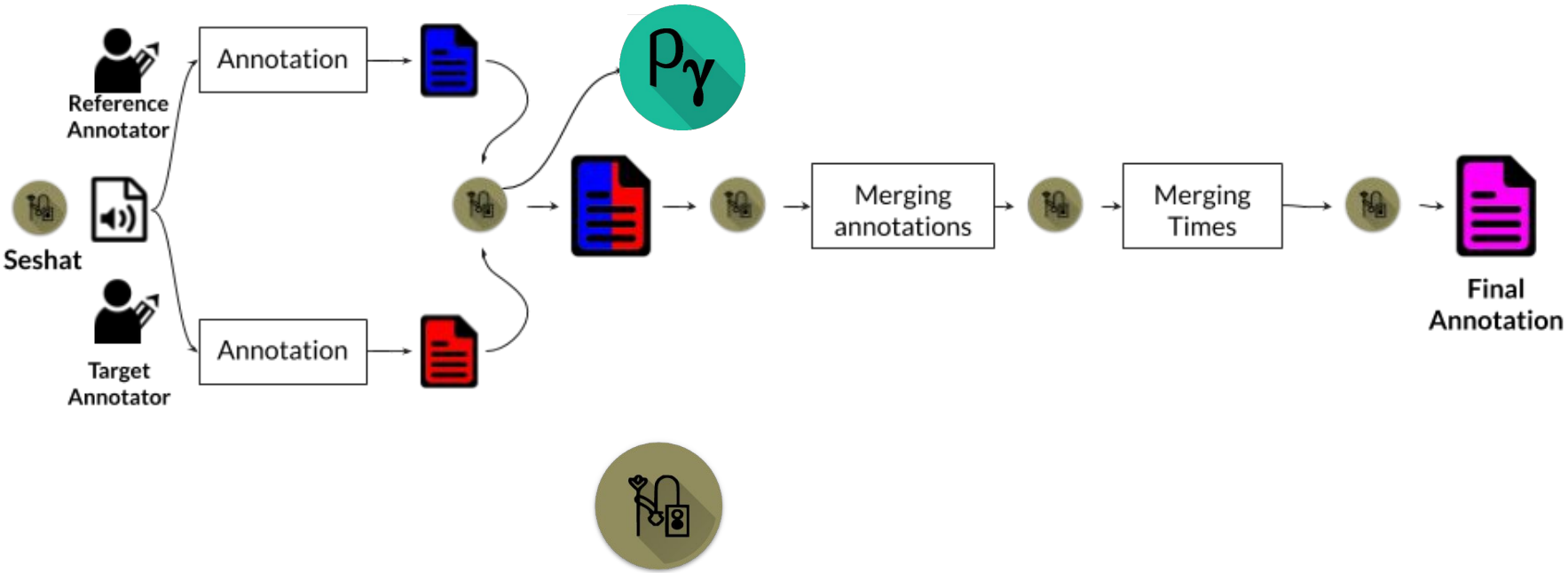
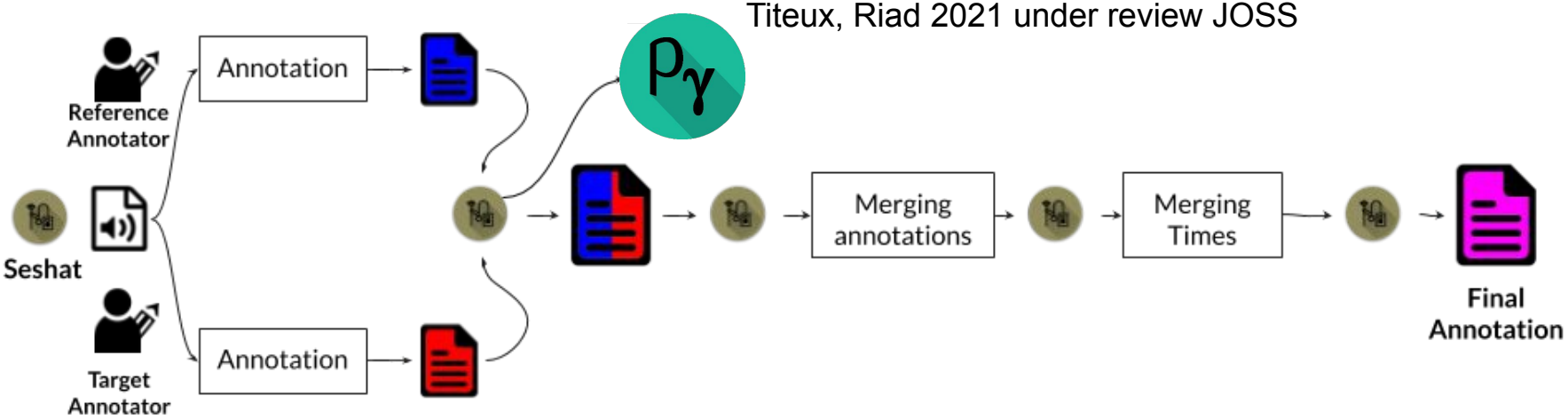


Human expert annotations

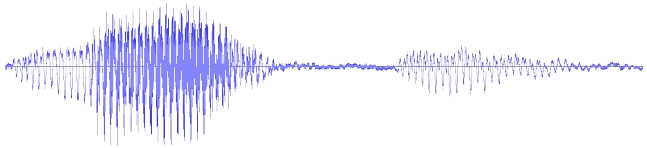
Huntington's Disease, Parkinson Disease, Daylong recordings in Amazonia

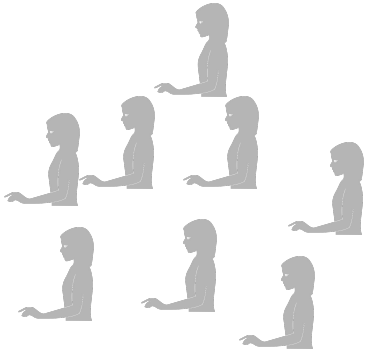


https://github.com/bootphon/pygamma-agreement
Titeux, Riad 2021 under review JOSS

https://github.com/bootphon/seshat
Titeux*, Riad* et al. LREC 2020

Crowdsourcing





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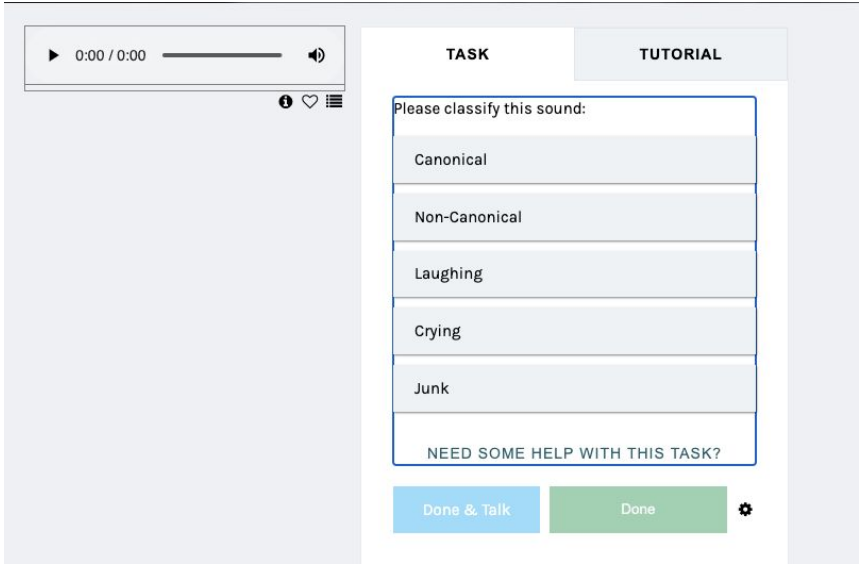
Crowdsourcing

Semenzin, …, Cristia. SLT 2021

https://www.zooniverse.org/



Angelman's Syndrome

Angleman's Syndrome:

10 children (6 males, 4 females; age range 11-53 months, mean=41.5 months)

Control:

10 low-risk control children (6 males, 4 females; age range 4-18 months, mean=11.7 months)

Crowdsourcing

Semenzin, …, Cristia. SLT 2021

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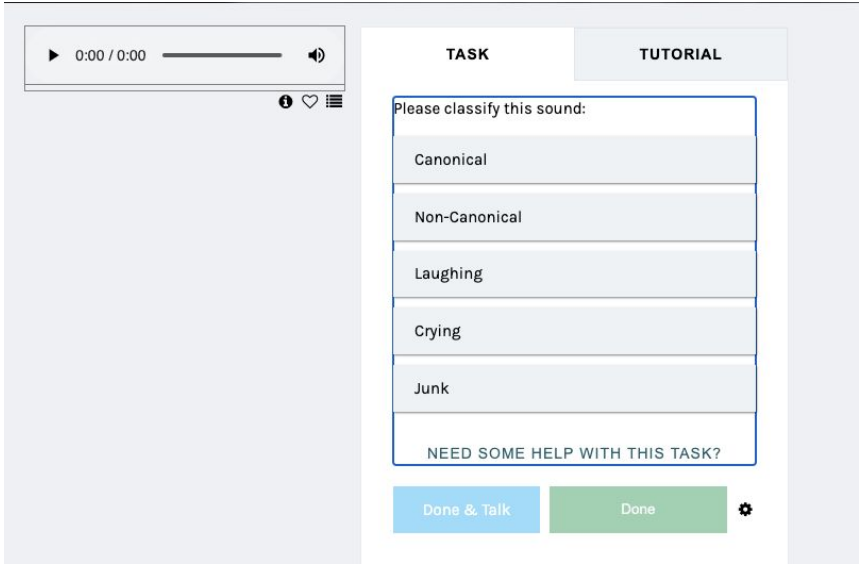

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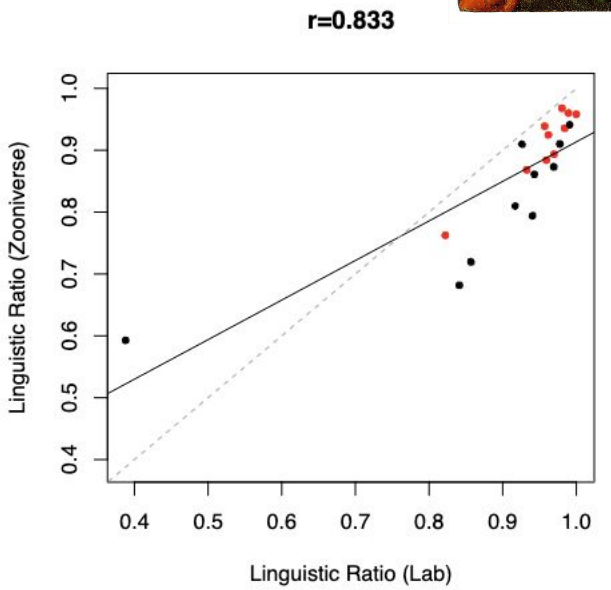
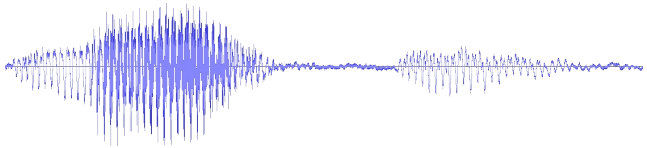
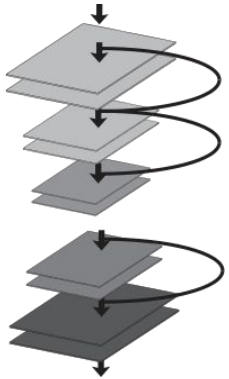


Fig. 3. Individual children's linguistic ratio according to Zooniverse versus Lab annotations. Black points correspond to children diagnosed with Angelman Syndrome, red for low-risk control.

Automatic methods





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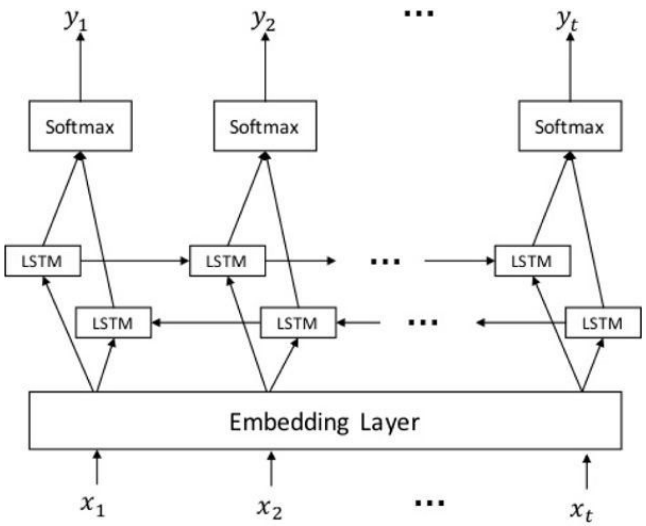


https://github.com/MarvinLvn/voice-type-classifier

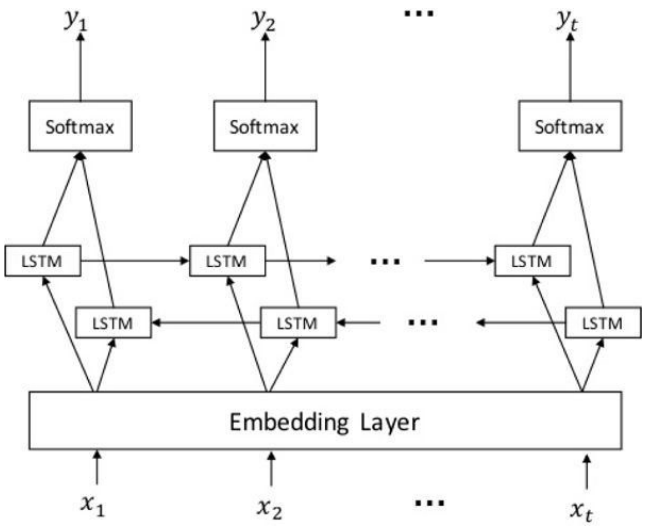
Huntington's Disease

Table 1. Interviewee demographics and clinical scores

	Controls	Huntington's disease Gene carriers	
Sub-groups	C	PreHD	HD
N	22	18	54
Gender	10F/12M	10F/8M	32F/22M
Age (years)	54.1 (8.6)	50.1 (11.8)	53.5 (11.3)
CAG Triplets	≤ 35	41.5 (1.7)	44.2 (3.3)
TFC [20]	—	13.0 (0.0)	10.4 (2.1)
TMS	—	0.33 (1.0)	34.3 (15.6)

Automatic methods

Riad et al. 2021



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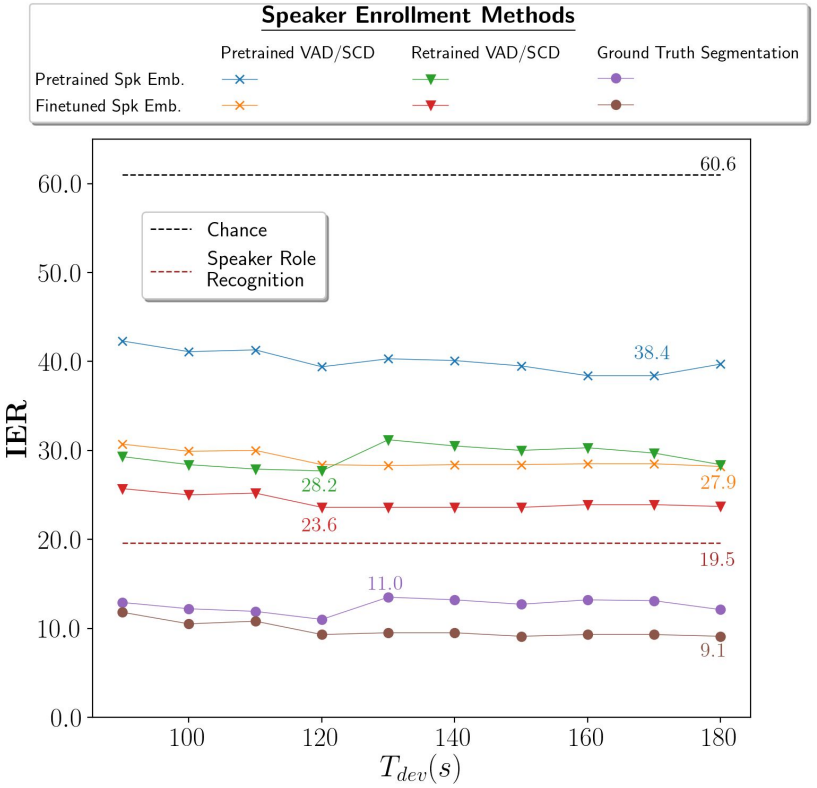

Automatic methods

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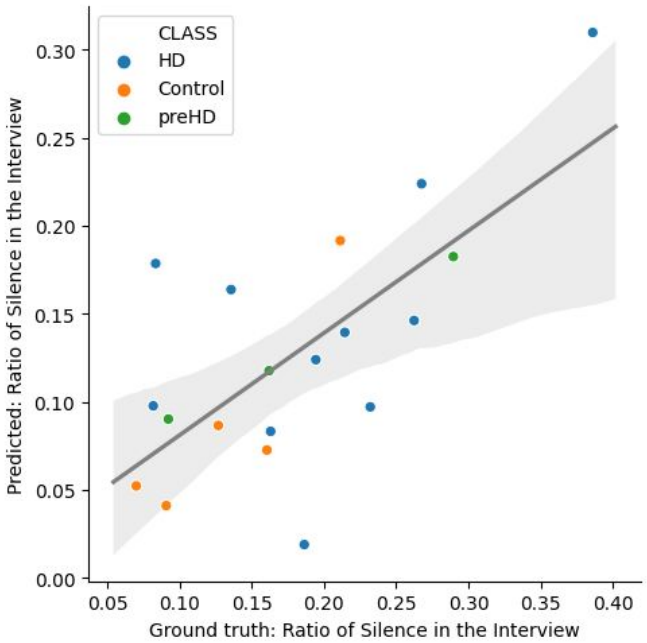

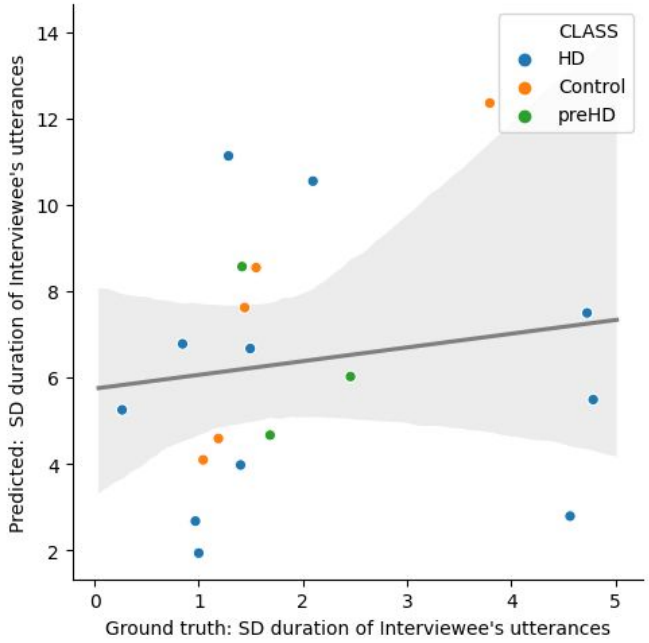

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Comparison

	Human expert annotations
Reliability	+++
Cost	+++
Privacy	-
Scalability	---
Skills to launch such project	Organization, Data management

Comparison

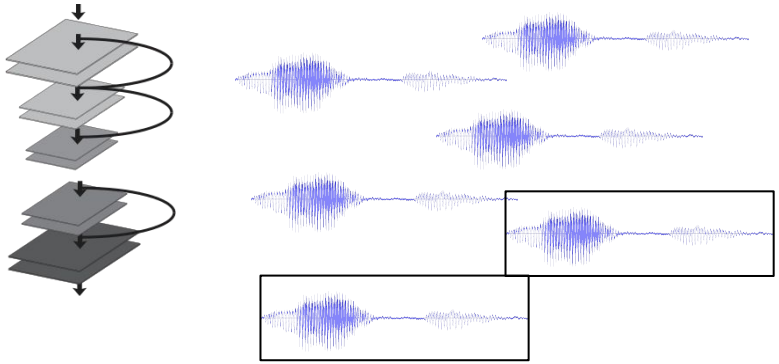
	Human expert annotations	Crowdsourcing
Reliability	+++	+(depends on how much can be shared)
Cost	+++	~ (depends)
Privacy	-	---
Scalability	---	+
Skills to launch such project	Organization, Data management	Organization, Data management

Comparison

	Human expert annotations	Crowdsourcing	Automatic methods
Reliability	+++	+(depends on how much can be shared)	+ (depends on training data)
Cost	+++	~ (depends)	+
Privacy	-	---	~ (models can leak training data)
Scalability	---	+	+++
Skills to launch such project	Organization, Data management	Organization, Data management	Engineering systems, Machine Learning

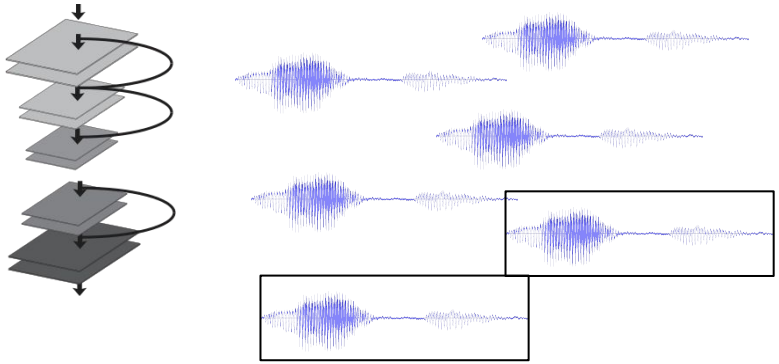
Future work

Self-supervised learning

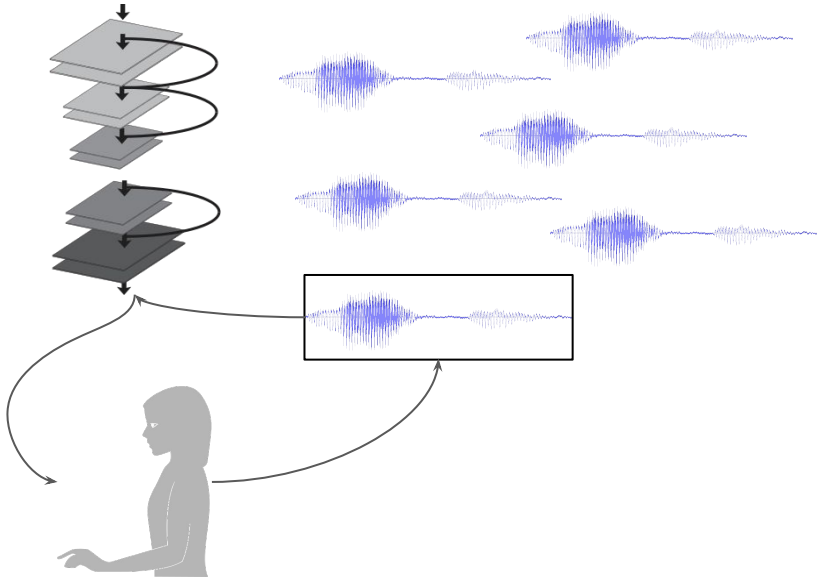


Future work

Self-supervised learning



Active learning



Thank you!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Justine Montillot


Marine Lunven


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Laurie Lemoine

Julien Karadayi


Mathieu Bernard


Frank Rudzicz

Emmanuel Dupoux 


Philippe Remy


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Lorna Le Stanc


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Elodie Idoux


Alex Cristia


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