

REPORT

MemoTag: Voice-Based Cognitive Decline Pattern Detection

Proof of Concept Report

Objective

To build a basic proof-of-concept pipeline that processes anonymized voice samples and extracts early indicators of cognitive stress or decline using audio features and unsupervised machine learning.

Methodology

1. Audio Preprocessing + Transcription

- Voice clips were extracted from a ZIP archive and preprocessed.
- Transcription was performed using **OpenAI's Whisper** model for robust handling of realistic, noisy input.

2. Feature Extraction

From each audio file, the following cognitive-linguistic markers were extracted:

- **Speech Rate** (words per second)
- **Number of Hesitations** (uh, um, etc.)
- **Number of Pauses** (detected using silent intervals via `librosa`)
- **Pitch Mean & Pitch Variability** (measured from pitch tracking)

3. Unsupervised Anomaly Detection

- Features were standardized using `StandardScaler`.
 - **Isolation Forest** was applied to detect anomalies potentially indicative of cognitive impairment.
 - Outliers were flagged based on abnormal speech patterns (e.g., slower speech, more pauses, flatter pitch).
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Key Observations

- Anomalous voice samples often showed:
 - Lower **speech rate**
 - Higher **pause/hesitation frequency**
 - Reduced **pitch variability**

- These align with early linguistic indicators of cognitive decline such as reduced fluency and impaired lexical access.

Technologies Used

- Python, Google Colab
- `whisper` , `librosa` , `sklearn` , `matplotlib` , `seaborn` , `pandas`

Sample Output

Filename	Speech Rate	Pauses	Hesitations	Pitch Mean	Pitch Std
sample3.wav	2.82	0	0	1312.11	987.10
(Flagged as an outlier by Isolation Forest)					

Next Steps

- Introduce **structured tasks** (e.g., sentence completion, memory recall prompts).
 - Extract **NLP-based features** like word substitutions or repetition.
 - Combine audio features with **demographic or clinical labels** for supervised learning.
 - Validate with expert-annotated cognitive assessments.
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