Machine Learning of Remote Video Interviews for Quantification of Cognitive Impairment and Psychological Well-Being in Older Adults

EMORY UNIVERSITY

THE I-CONECT STUDY
Internet-Based Conversational Engagement Clinical Trial

Georgia Tech

MGH 1811

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INTRODUCTION

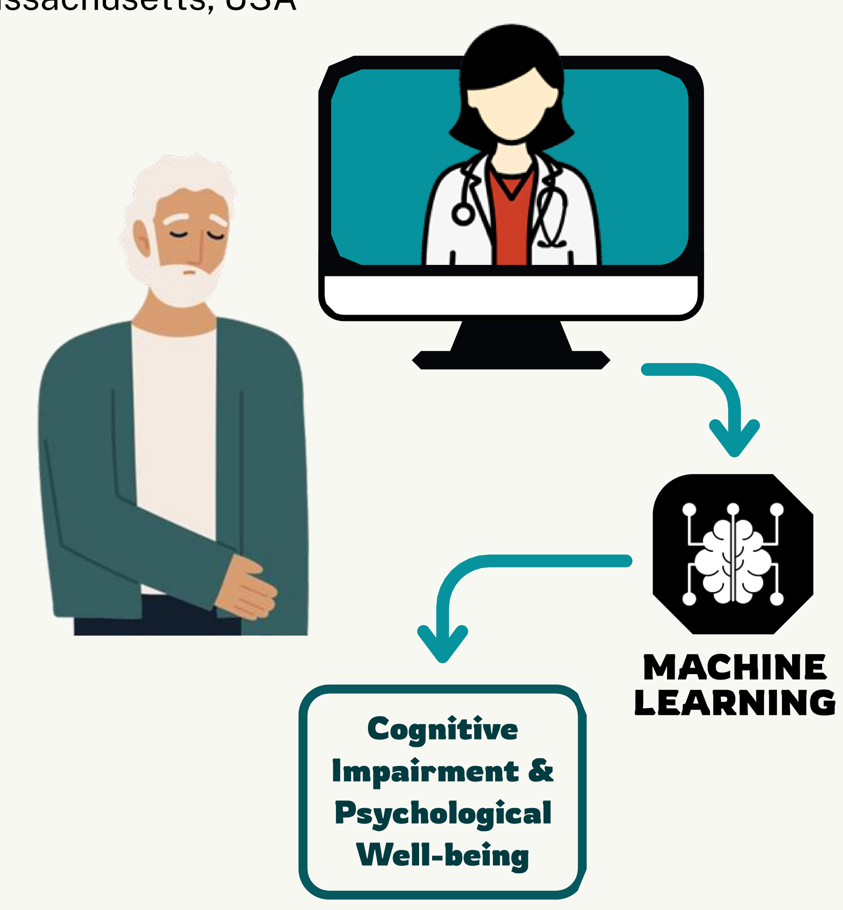
- 2060: **one in four** Americans will be **65+** ➔ rising mild cognitive impairment (MCI) and psychological well-being (PWB)[1] needs.
- Now: **160 million** Americans live in **mental health shortage** areas[2] ➔ A need for remote detection.

This study uses machine learning on remote interviews to predict:

(1) **Clinical Dementia Rating (CDR) and PWB** in older adults with and without MCI.

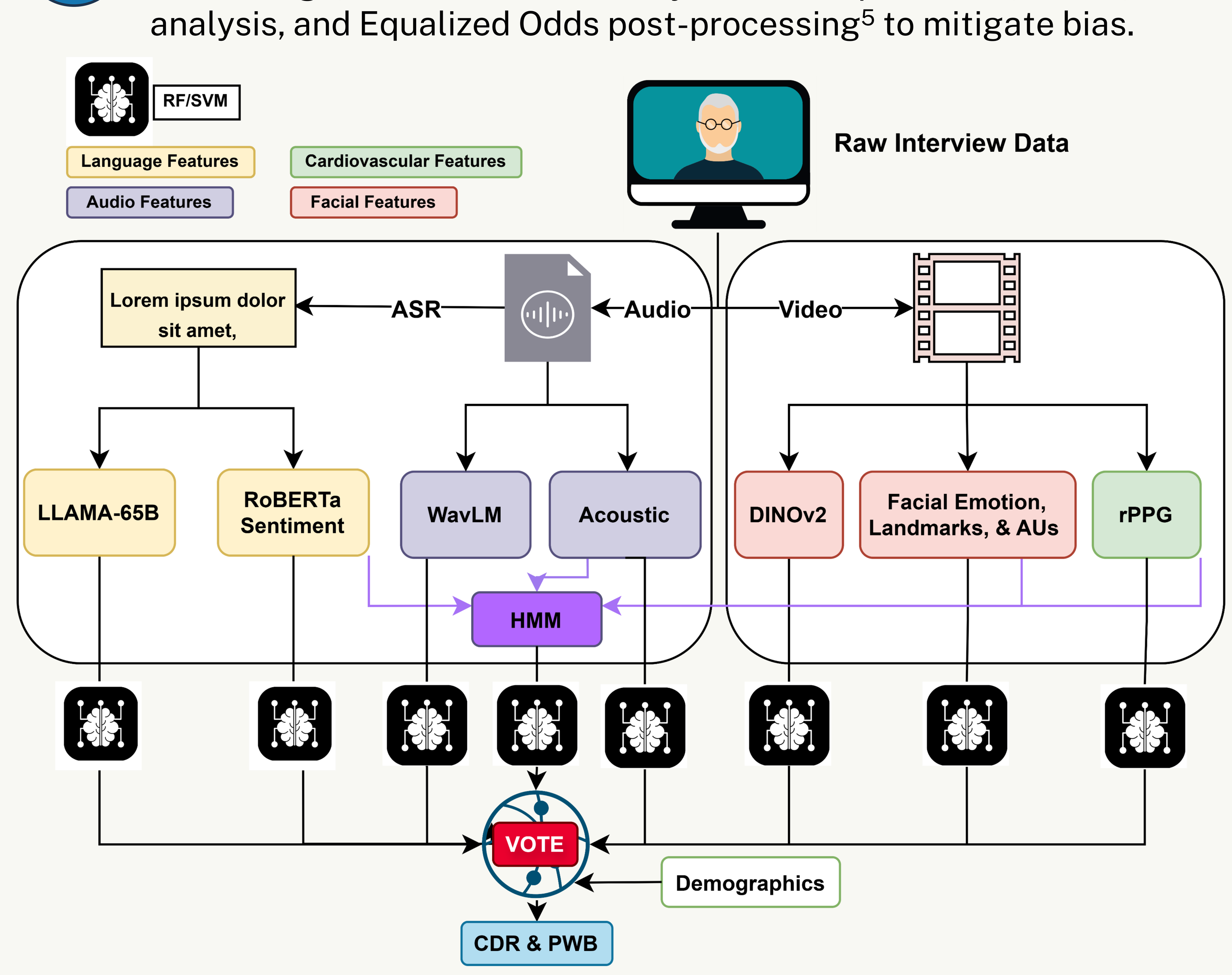
(2) **Depression and anxiety** in individuals with MCI.

(3) **6- and 12-month cognitive status** from speech in baseline interviews.

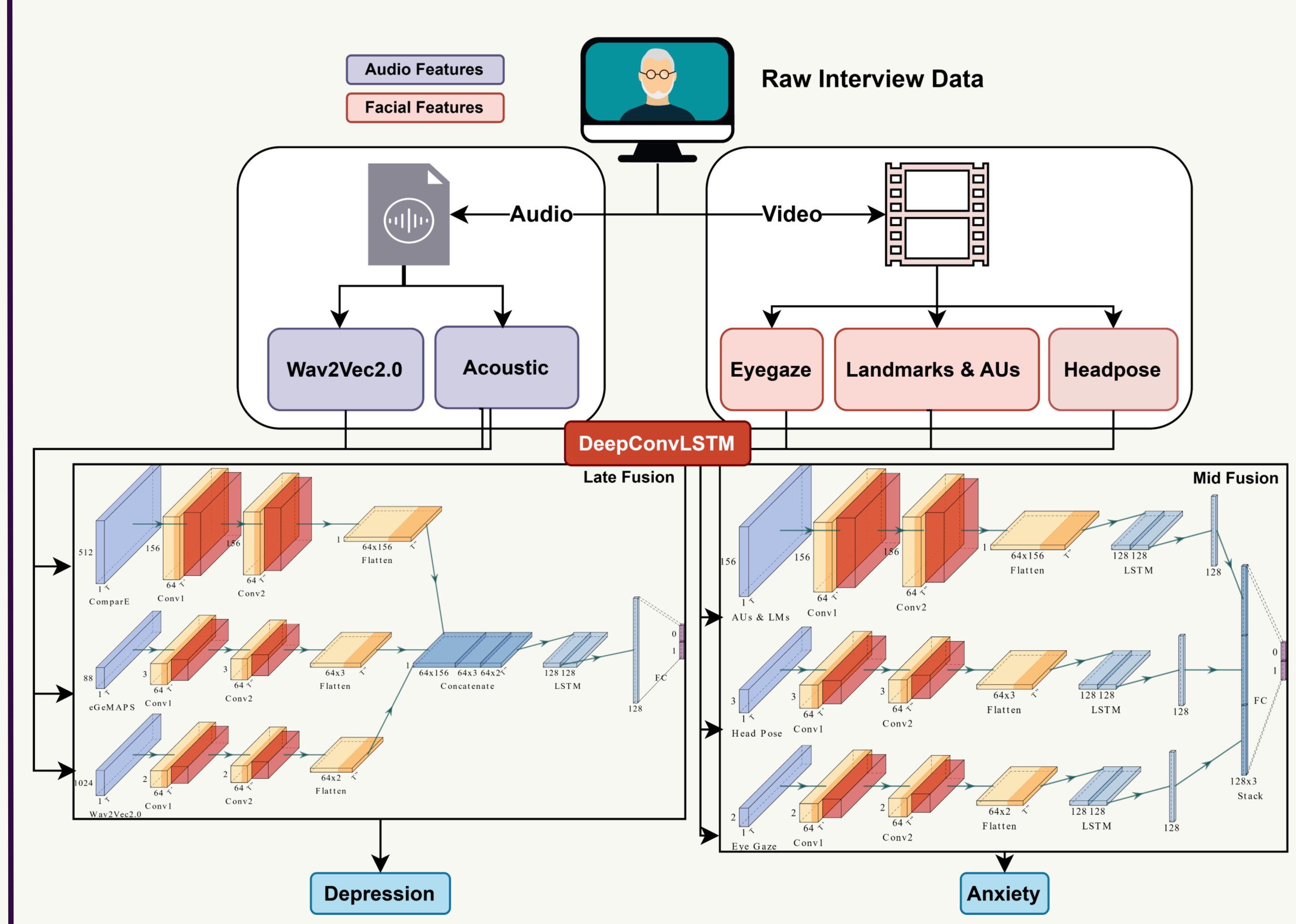


METHODOLOGY

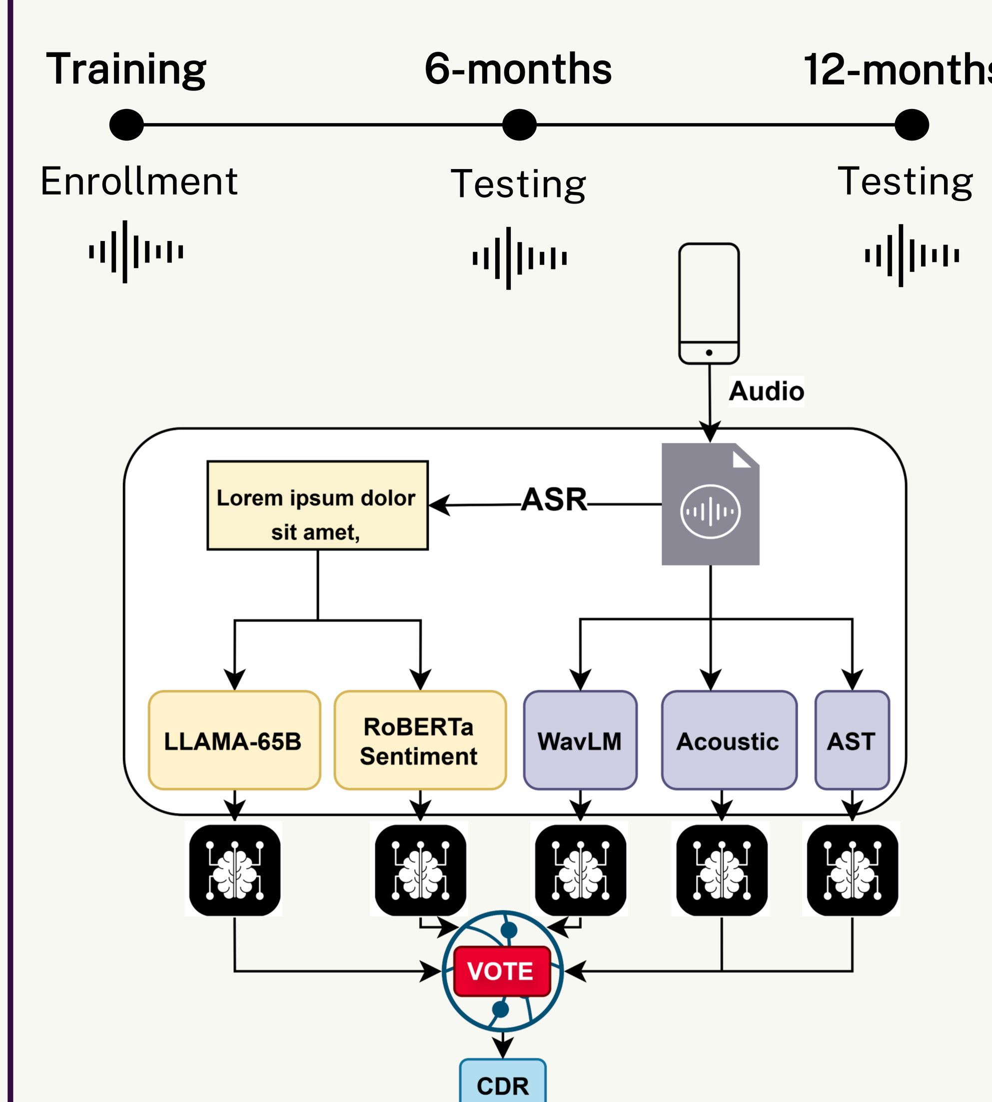
1 39 participants from the I-CONECT study[3] (www.i-conect.org) to predict CDR (20 with normal cognition /19 with MCI) and PWB (17 low, 20 high). This was followed by feature importance (SHAP[4]), bias analysis, and Equalized Odds post-processing[5] to mitigate bias.



2 31 participants with MCI from the Charlie and Harriet Shaffer Cognitive Empowerment Program (CEP) at Emory to predict depression (14 depressed, 17 not depressed) and anxiety (10 anxious, 20 not anxious).



3 103 participants (48 with normal cognition, 55 with MCI; aged ≥75) from the I-CONECT study[3] to predict CDR longitudinally.



RESULTS

F1 score ± 95% CI for all clinical outcomes

Goal	Clinical Outcome	F1 Score
(1) CDR & PWB in older adults	CDR	0.72 ± 0.008
	Social Engagement	0.71 ± 0.008
	Negative Affect	0.70 ± 0.006
(2) Depression & Anxiety in individuals with MCI	Depression	0.71 ± 0.186
	Anxiety	0.78 ± 0.236
(3) Longitudinal prediction of CDR	6-months	0.75 ± 0.024
	12-months	0.74 ± 0.020

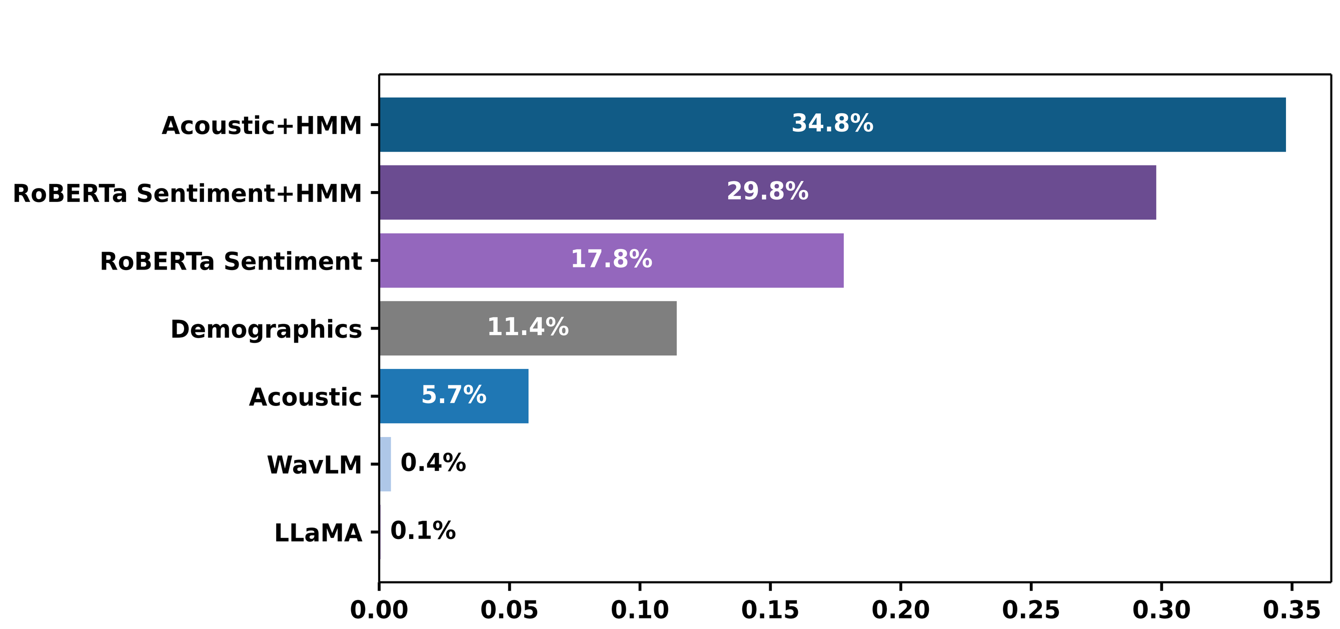
Equalized Odds Ratio (EOR) & F1 score (± 95% CI) before & after applying bias mitigation for assessing **CDR and PWB** in older adults

		Before		After	
		EOR	F1 Score	EOR	F1 Score
CDR	Years of Education (YoE)	0.04 ± 0.04	**0.74 ± 0.03**	0.51 ± 0.12	**0.30 ± 0.09**
	Age	0.24 ± 0.04	0.75 ± 0.01	0.37 ± 0.05	0.51 ± 0.04
Social Engagement	YoE	0.06 ± 0.04	0.70 ± 0.04	0.33 ± 0.09	0.43 ± 0.08
	Age	0.18 ± 0.03	0.71 ± 0.01	0.32 ± 0.04	0.57 ± 0.03
Negative Affect	YoE	0.08 ± 0.05	0.73 ± 0.04	0.40 ± 0.10	0.37 ± 0.08
	Age	0.19 ± 0.04	0.73 ± 0.02	0.32 ± 0.05	0.56 ± 0.04

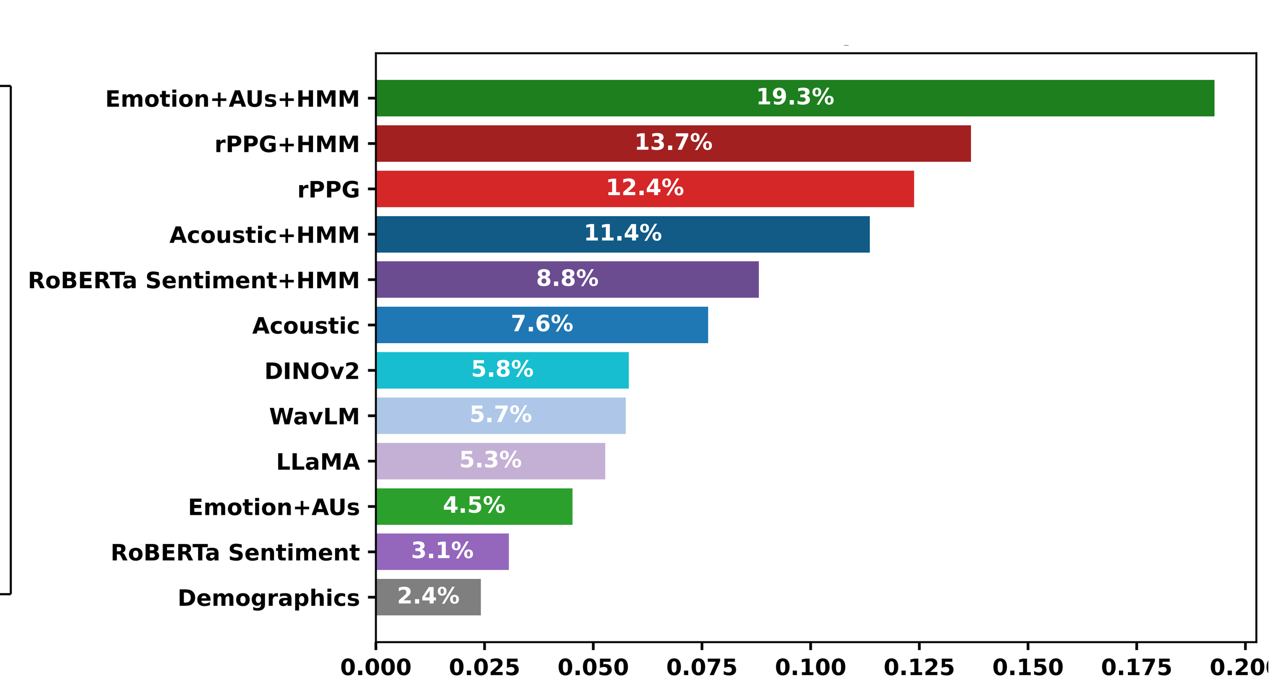
Feature importance analysis (SHAP) plots for assessing **CDR and PWB** in older adults

HMM stand for Hidden Markov Model and rPPG stands for remote Photoplethysmography

SHAP plot for CDR



SHAP plot for Negative Affect



CONCLUSION

1. **CDR & depression**: Acoustic features performed best (for CDR, adding language performed best).
2. **PWB & anxiety**: Video features performed best.
3. **Fairness:** All models showed significant biases. Post-processing mitigation greatly reduced F1.

FUTURE WORK

- Advanced multimodal time-series fusion methods.
- Test-time adaptation for longitudinal predictions.

ACKNOWLEDGMENTS

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