EMU: Early Mental Health Uncovering Framework and Dataset

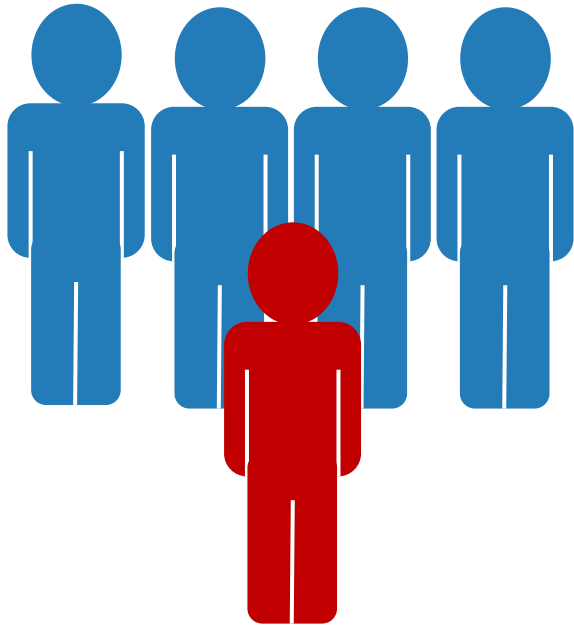**ML Tlachac**, Ermal Toto, Joshua Lovering, Rimsha Kayastha, Nina Taurich, Elke Rundensteiner

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Mental Illnesses are Prevalent and Costly

Annually, more than
1 in 5
U.S. **adults** experience mental illnesses

Depression and anxiety are the most prevalent mental illnesses

- Globally account for one trillion US dollars per year in lost productivity

- Treatment is effective

- There are long delays in diagnosis and treatment

[1] National Alliance on Mental Illness, "Mental health by the numbers," 2020. [Online]. Available: https://www.nami.org/mhstats

[2] K. Kroenke, R. L. Spitzer, and J. B. Williams, "The phq-9: validity of a brief depression severity measure," Journal of General Internal Medicine, vol. 16, no. 9, pp. 606–613, 2001.

[3] R. M. Epstein, P. R. Duberstein, M. D. Feldman et al., "I didn't know what was wrong: How people with undiagnosed depression recognize, name and explain their distress," Journal of General Internal Medicine, vol. 25, pp. 954–961, 2010.

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Mental Illness Detection
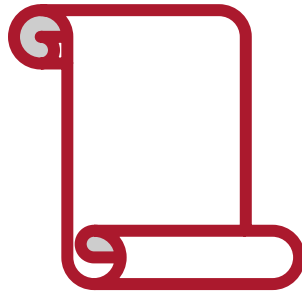
Interview → Survey → App

People are More Willing to Share Active Modalities

Modality	Willingness to Share
Voice Recordings	65%
Selfies	58%
GPS	48%
Twitter Tweets	44%
Call Logs	43%
Facebook Posts	42%
SMS Text Logs	41%
Browser History	36%

Active Modalities

Passive Modalities

Dogrucu, et al. "Moodable", Smart Health, 2020

Early Mental Health Uncovering (EMU) Framework
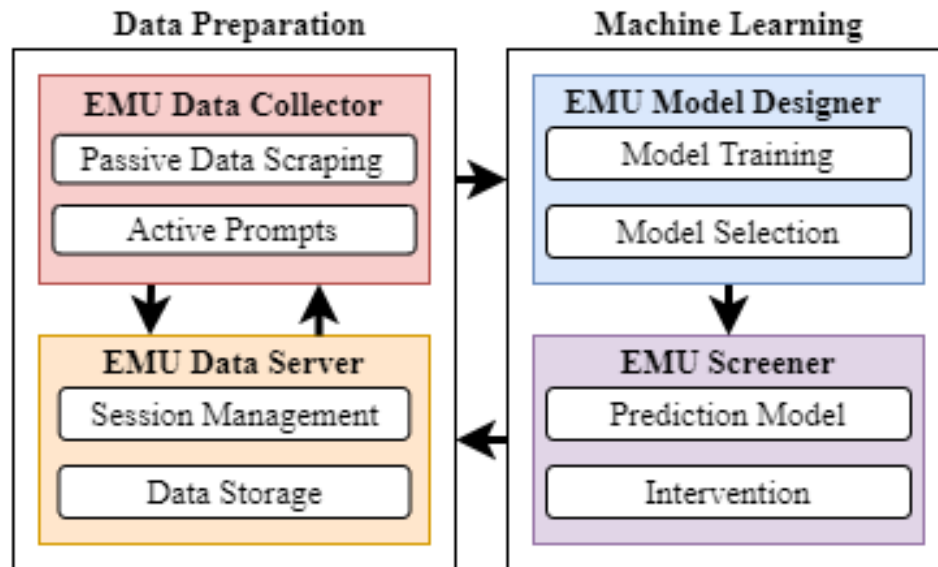
EMU seamlessly combines the collection of both active and passive modalities to maximize the data collected for near instantaneous screening of a variety of mental illnesses

EMU Mobile Application

Upload Phone Data | Depression Survey | Anxiety Survey | Scripted Audio | Unscripted Audio

Mental illness labels for the data

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EMU Dataset Participants

Collected data from Mturk workers for three weeks in early 2019
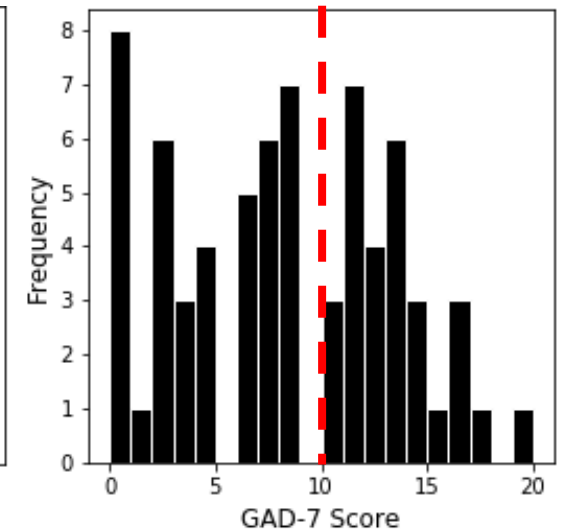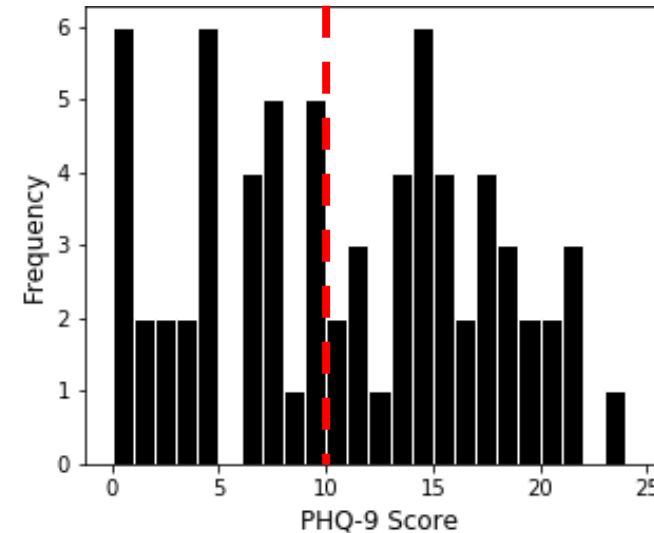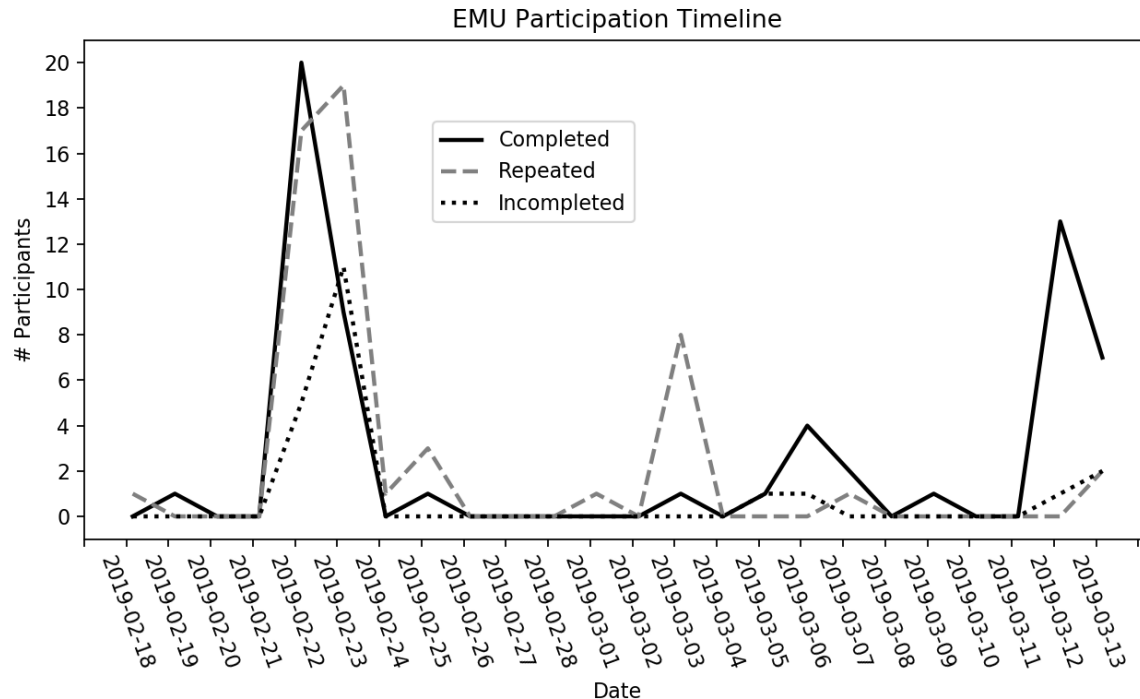
Most of the **70** participants were 23 to 38-year-old men with college degrees

Modalities Shared by EMU Participants

Modality	Participants	mean PHQ-9	mean GAD-7
PHQ-9	70	10.37	7.77
GAD-7	69	10.43	7.77
Demographic	70	10.37	7.77
Scripted Audio	63	10.08	7.63
Unscripted Audio	55	10.04	7.71
Text Messages	31	10.29	8.20
Calendar	28	10.89	8.18
Call Log	25	10.88	8.04
GPS	14	9.29	7.36
Twitter Username	14	8.50	7.21
Twitter Posts	11	6.91	6.00
Instagram	0	0	0

Screening Results with Audio Recordings

Mental Illness	Audio	Audio Recordings			Voice Recordings		
		$F1$	AUC	Acc	$F1$	AUC	Acc
Depression	Scripted	0.746	0.729	0.730	0.746	0.735	0.732
Depression	Unscripted	0.691	0.691	0.691	0.667	0.675	0.673
Anxiety	Scripted	0.655	0.696	0.683	0.667	0.733	0.750
Anxiety	Unscripted	0.625	0.681	0.673	0.636	0.695	0.673
Suicidal Ideation	Scripted	0.706	0.752	0.762	0.648	0.729	0.768
Suicidal Ideation	Unscripted	0.627	0.667	0.655	0.629	0.714	0.735

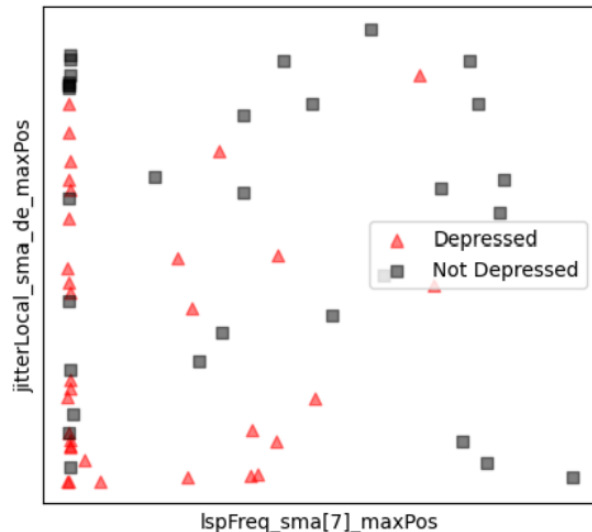**Leave-one-out** evaluation strategy to maximize training data

The most effective models were **Support Vector Classifiers**
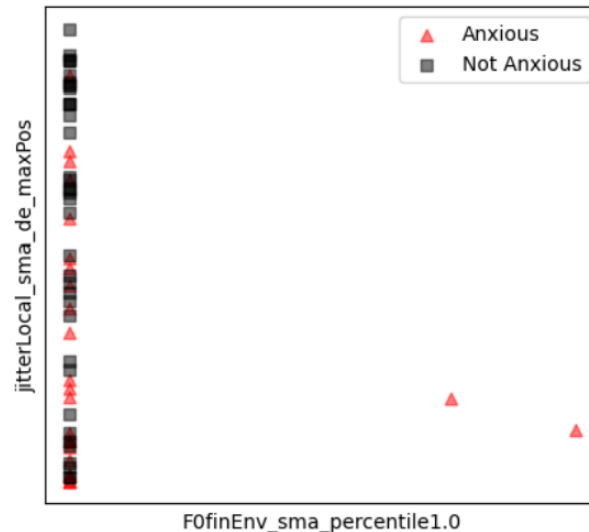
Screening Results with Transcripts

Mental Illness	Data	$F1$	AUC	Acc
Depression	Audio	0.600	0.633	0.628
Depression	Transcript	0.538	0.489	0.442
Depression	Both	0.600	0.633	0.628
Anxiety	Audio	0.600	0.693	0.721
Anxiety	Transcript	0.629	0.706	0.698
Anxiety	Both	0.545	0.639	0.651
Suicidal Ideation	Audio	0.667	0.754	0.767
Suicidal Ideation	Transcript	0.545	0.649	0.651
Suicidal Ideation	Both	0.621	0.718	0.744

Important Screening Features

Jitter
is important for
scripted audio

Mel-frequency Cepstral Coefficient
is important for
unscripted audio

Takeaways

- The **EMU framework** for mental illness screening integrates both passive and active modalities

- The **EMU dataset** is a valuable community data resource composed of digital phenotype and audio features labeled with mental illness screening scores: *https://github.com/mltlachac/EMU*

- The **EMU participants** were more willing to share active than passive modalities

- Future work involves combining existing datasets in this domain for multimodal models that can use both active and passive modalities

Thank You. Questions?

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