BIOMEDICAL ENGINEERING

Predicting Mobility Status After Stroke Using Fitbit Data

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BACKGROUND

Fitbit data such as heart rate and step count are granular markers of status that can serve as indicators of mobility, which is an important marker of recovery after stroke. Their continuous measurement provide accurate assessments of mobility, and by extension, predictors of health and functional status. The goal of this work was to derive metrics from Fitbit data that could be used to replace in-clinic tests and serve as a more dynamic measure of mobility status.

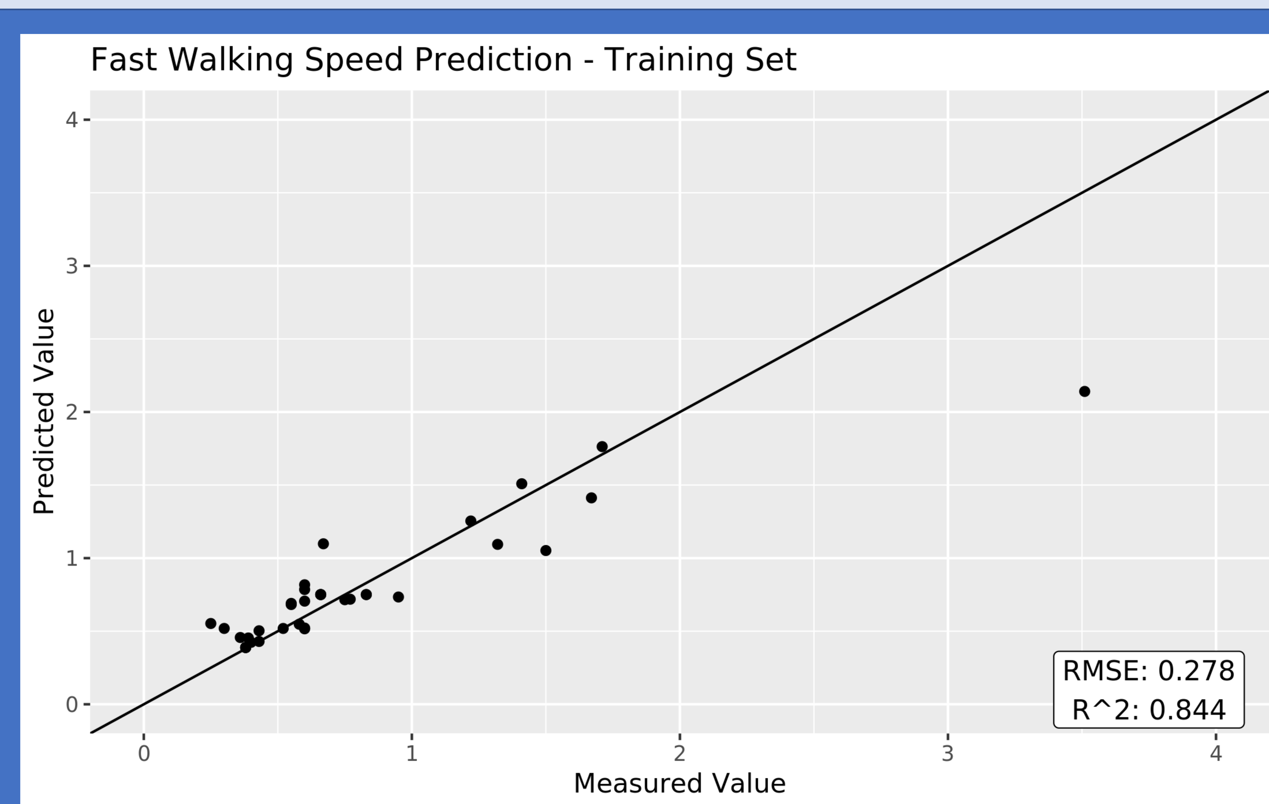
METHODS

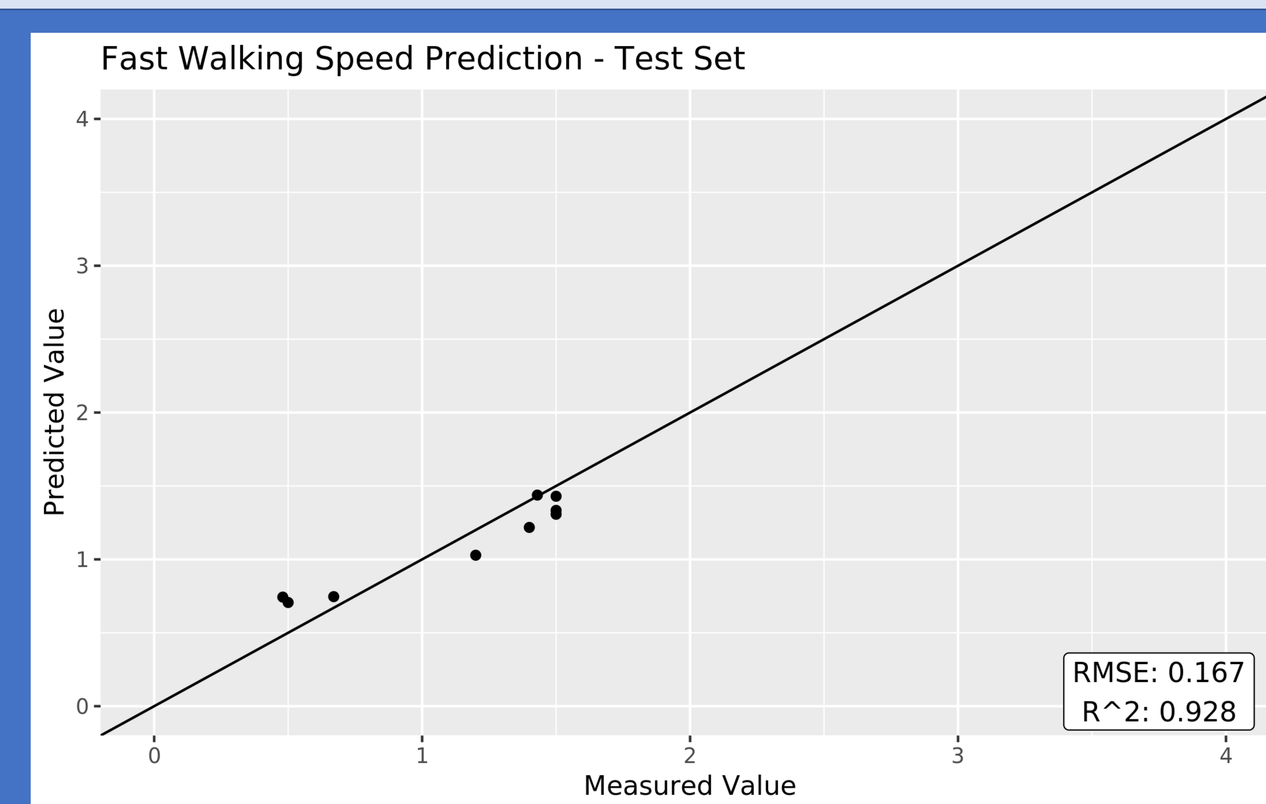
1. Collected minute-level Fitbit data, EHR data, cognitive, and psychosocial data from a cohort of post-stroke patients through the Rehabilitation Precision Medicine Center of Excellence
2. Performed quality filtering on data, removing infeasible heart rate and step count values.
3. Divided each participant's data into 2-week windows with valid windows have >=10 days of data and >= 18 hours of data each day. Missing heart rate values were imputed with the window mean.
4. Derived several health metrics across heart rate, activity level, and sedentary level domains. Metrics were calculated for each valid window.
5. Developed predictive models of clinic-based assessments of mobility, and adverse events.

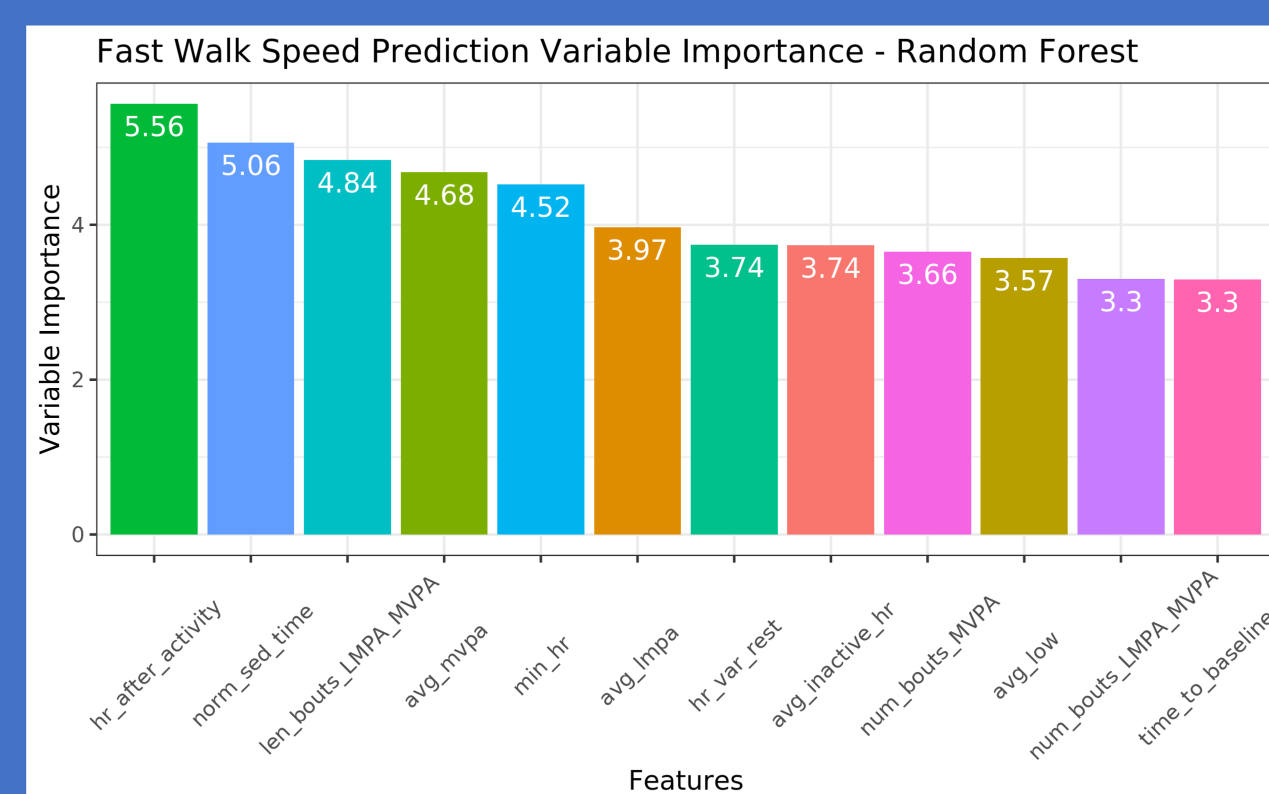
FEATURES

Heart Rate	Activity	Sedentary
Rolling max	Time in each PA level (low, light, light-moderate, moderate-vigorous)	Total sedentary time
Rolling min	Length of activity bouts	Length of sedentary bouts
Resting HR	Number of bouts	Number of bouts
Sedentary HR		
Resting HR variability		
Return to baseline after activity		

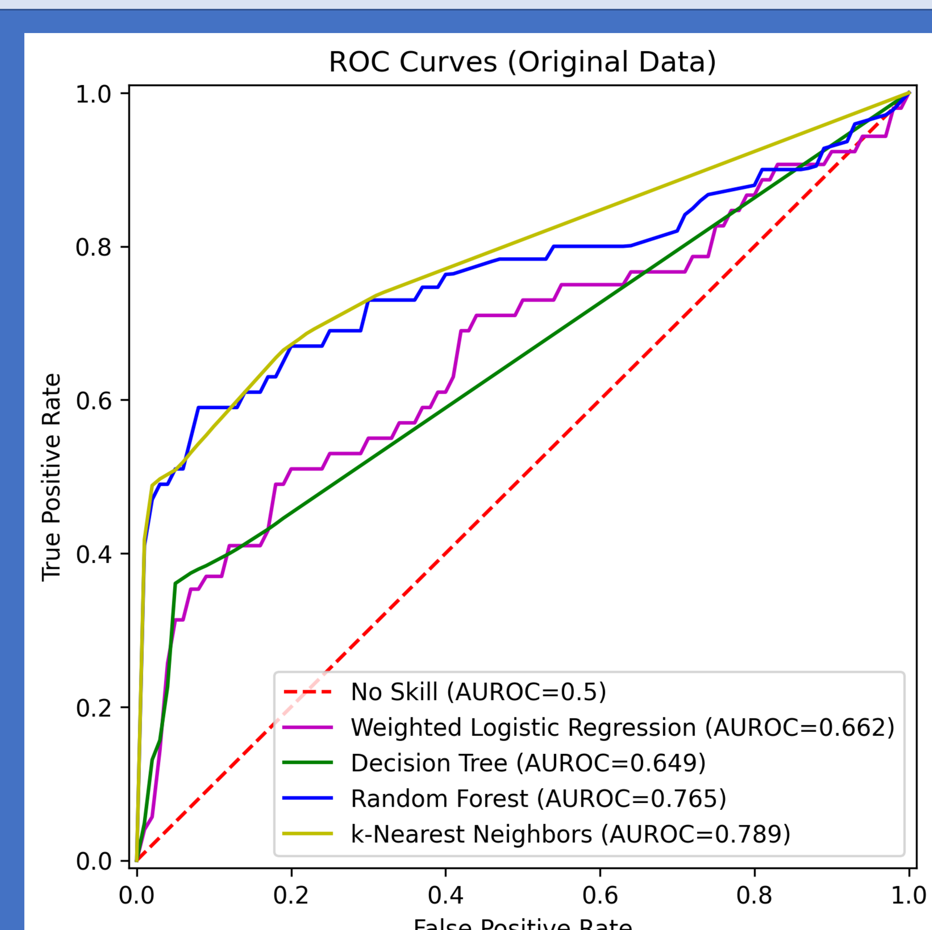
Fitbit-derived metrics can be used to determine health status outside of the clinic



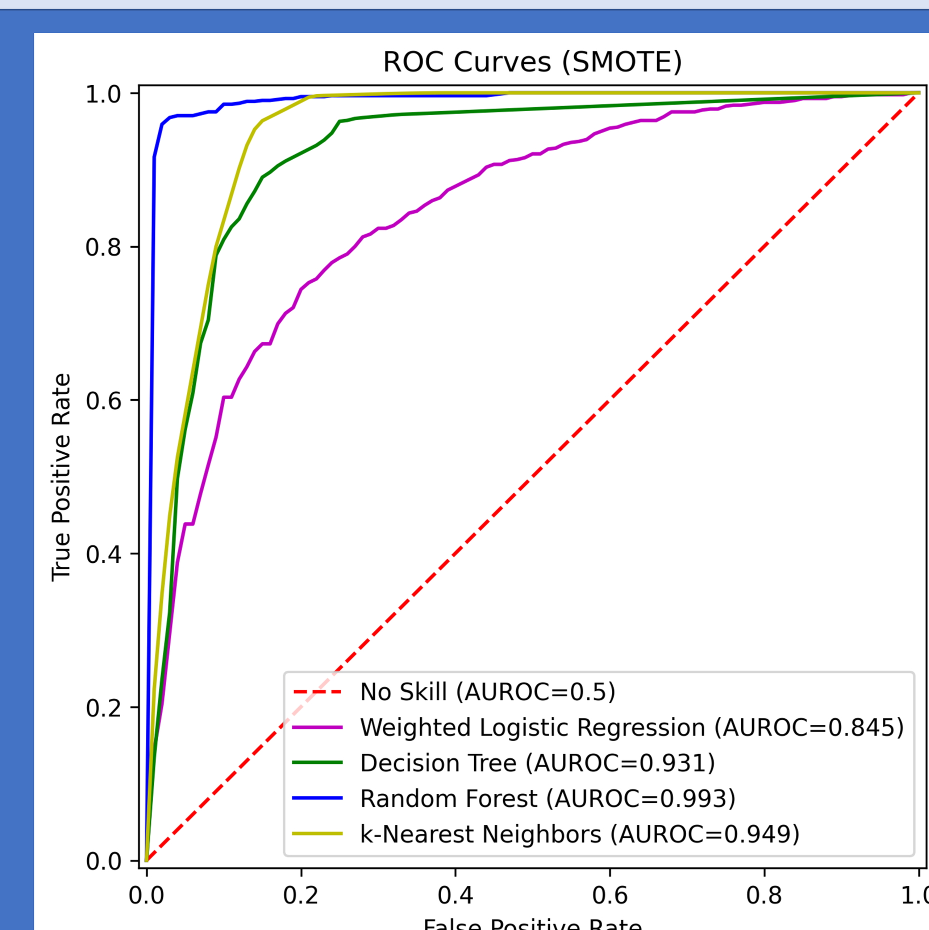




These metrics could be used to predict who is **at risk for an adverse event**



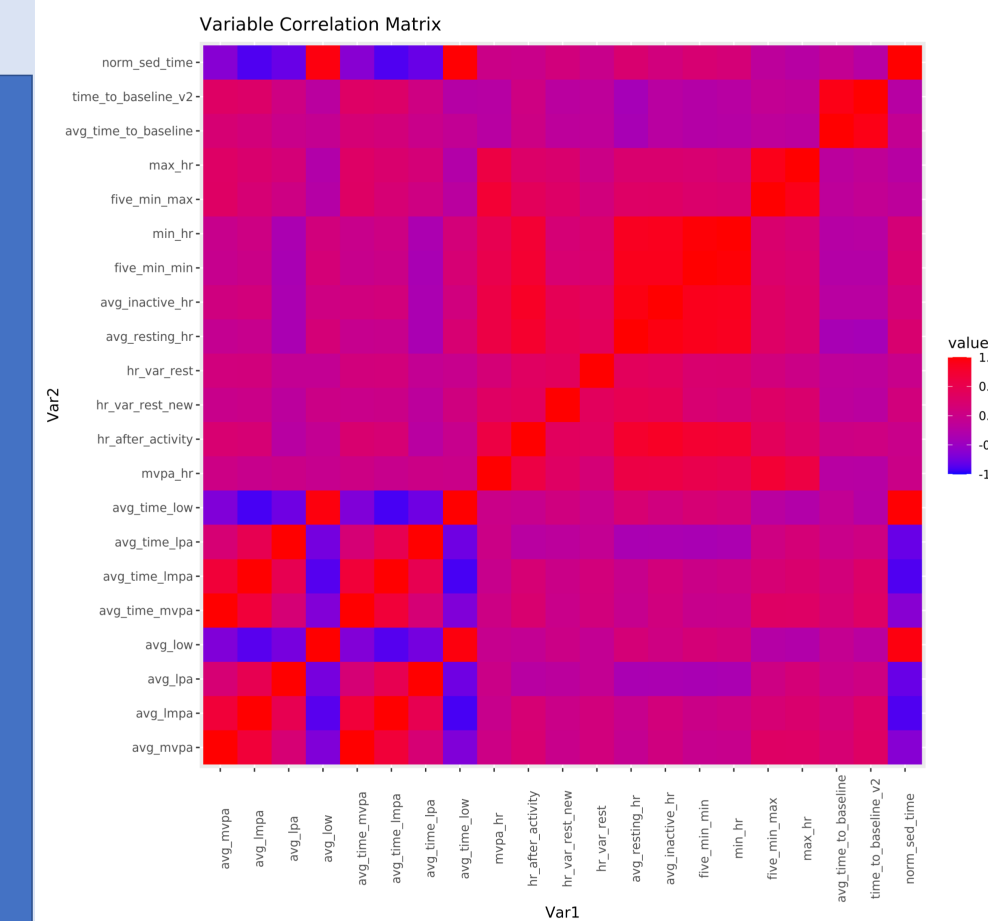
	Original Dataset			
	LR	DT	RF	**kNN**
AUC	0.662	0.649	0.765	**0.789**
F1	0.167	0.28	0.427	**0.492**



	Data with SMOTE			
	LR	DT	**RF**	kNN
AUC	0.845	0.931	**0.993**	0.949
F1	0.760	0.91	**0.96**	0.89

RESULTS

Feature Correlations



Clinic Tests

	Comfortable Walking Speed		Fast Walking Speed	
	RF (Train, Test)	LM	RF	LM
RMSE	0.130, 0.201	0.277, 0.455	0.278, 0.167	0.497, 0.529
R^2	0.897, 0.452	0.374, 0.455	0.844, 0.928	0.308, 0.102

Adverse Event Statistical Analysis

Feature	T-test	LR
Heart rate	0.024	0.003
Sedentary time	0.466	0.062
Activity level	LPA: 0.737 LMPA: 0.300 MVPA: 0.133	LPA: 0.006 LMPA: 0.014 MVPA: 0.543

FUTURE WORK

Although the power of many analyses is limited by small sample sizes, the feature extraction and modeling pipelines developed can be used to offer continuous monitoring of mobility status outside of the clinic, while still offering similar information. Future work will aim to further refine feature selection for modeling and calculate these metrics against a healthy baseline to offer an overall score of mobility. This work could also further explore time-based prediction of when an adverse event is likely to occur.