Comparison of Machine Learning Methods to Predict Sleep Quality from Daytime Activity and Nightly Bedroom Environmental Conditions

Hagen Fritz, Congyu Wu, Kerry Kinney, and Zoltan Nagy | The University of Texas at Austin

Objective: Assess relationship between IAQ/activity with sleep by predicting 7 sleep metrics.

Methods

Smartphone

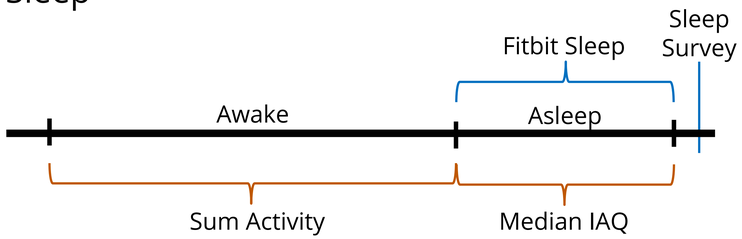
GPS | Self-report Sleep

BEVO Beacon

IAQ

Fitbit Inspire HR

Activity | Sleep



Features

$PM_{2.5}$	> 1000 Steps
CO_2	> 30 Minutes Activity
TVOCs	
CO	
T	
RH	

Targets

Fitbit
- Sleep Efficiency (SE)
- % Rapid-Eye-Movement (REM)
- Total Sleep Time (TST)

Survey
- TST
- Sleep Onset Latency (SOL)
- Number of Awakenings (NAW)
- Restfulness

Models

Logistic Regression

K-Nearest Neighbor
k=7, Euclidean

Random Forest
trees=10, depth=1

Results

	Model	Accuracy Train	Accuracy Test	Accuracy Dummy	F1 (threshold) Test	F1 (threshold) Dummy
SE	LR	**0.79**	0.78	0.79	**0.89** (0.45)	0.89
	kNN	**0.82**	0.74		**0.89** (0.26)	
	RF	**0.79**	**0.79**		**0.89** (0.71)	
% REM	LR	**0.64**	0.63	0.64	**0.54** (0.28)	0.53
	kNN	**0.69**	0.60		**0.53** (0.09)	
	RF	**0.64**	**0.64**		**0.53** (0.34)	
TST (Fitbit)	LR	**0.65**	0.64	0.65	**0.52** (0.25)	0.52
	kNN	**0.70**	0.59		**0.52** (0.17)	
	RF	**0.65**	**0.65**		**0.52** (0.32)	
SOL	LR	**0.60**	0.51	0.56	**0.71** (0.33)	0.71
	kNN	**0.67**	0.54		**0.72** (0.23)	
	RF	**0.58**	0.53		**0.71** (0.5)	
NAW	LR	**0.59**	0.43	0.52	0.67 (0.36)	0.69
	kNN	**0.69**	0.47		**0.69** (0.23)	
	RF	**0.57**	0.40		0.68 (0.48)	
Restful	LR	**0.83**	**0.82**	0.82	**0.9** (0.53)	0.90
	kNN	**0.83**	0.79		**0.9** (0.46)	
	RF	**0.82**	**0.82**		**0.9** (0.75)	
TST (Survey)	LR	**0.69**	0.61	0.64	**0.78** (0.42)	0.78
	kNN	**0.70**	0.61		**0.78** (0.26)	
	RF	**0.64**	**0.64**		**0.78** (0.56)	

Feature Importance

	LR (coefficient)	RF (impurity)
SE	RH, T	Steps, TVOC
% REM	Active, $PM_{2.5}$	Active, $PM_{2.5}$
TST (Fitbit)	Active, TVOC	Active, RH
SOL	T, Steps	Active, CO_2
NAW	CO, T	CO_2, CO
Restful	CO, RH	CO, RH
TST (Survey)	Active, RH	Active, RH

Conclusion: IAQ/activity are related to and can predict sleep quality better than a dummy model that assumes the majority outcome.