



Sleepify

There's a nap for that.

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At a glance...



- Sleepify improves sleep quality depending on temperature
 - App + the cloud + machine learning + web interface
 - Non intrusive – wearable
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- Industry / Our Promise / High Level Design / Backend / Web Interface / Machine Learning / Demo / Testing and Evaluation

The State of the Industry | Competitors



- Focused on sleep tracking
- None on temperature and heating

Our Promise



1. Better sleep quality can be achieved by sleeping in an ideal sleeping temperature; we want the environment to not be too cold nor too hot.
2. Through machine learning, prolonged usage of the app will improve performance and classification accuracy.
3. Provide a slick, and intuitive app and web interface for the user
4. The feeling of tiredness can be reduced by:
 - Reducing the effects of jet-lag by notifying the user to sleep
 - Setting the alarm to go off when the user is not in deep sleep

High Level Design



Backend / Web Interface



django-bootstrap3
django-rest-framework
django-sendfile
Sphinx

django-ical
django-cron
django-rest-auth
django-push-notifications

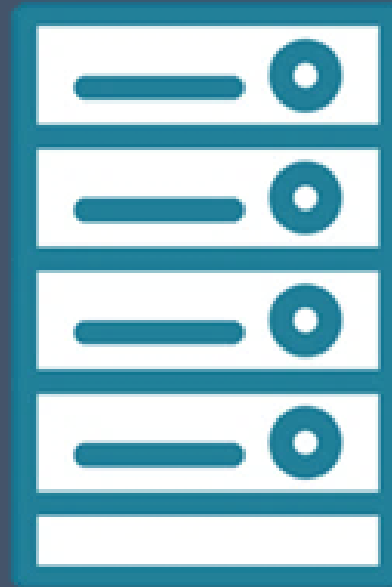
- Extremely fast development
- Tried, tested, scalable framework
- Security issues mostly taken care of



Bitbucket



RESTful API



- Empowers the other sections
- Raw data, graphs, machine learning results, calendar events, notifications
- Authentication using sessions/cookies

Machine Learning – Sleep Quality Classification



1. Polysomnography

- ✗ Requires EEG / ECG
- ✗ Expensive, and intrusive to the user

2. Pittsburgh Sleep Quality Index

- ✗ Suited for long term classification (1 week+)
- ✗ Requires constant user feedback via a questionnaire

3. Actigraphy

- Compromise between accuracy and resources

- Prioritize real-time aspect
- Reduce accuracy problems using machine learning





Machine Learning – Hardware

1. Microsoft Band 2

- Heartrate
- GSR
- Body Temperature
- Acceleration

2. Elgato Eve Room Smart Plug

3. iOS Device

- Existing sensors and hardware
 - +Temp, +GSR
- Smart plugs replace thermostat integration

Machine Learning – Software



1. MATLAB Benchmarking
2. Python scikit-learn
 - Extends RESTful API

Choose random forest
Fast training and testing times
Enables online training

Data Browser		
▼ History		
1.1 ☆ SVM	Accuracy: 96,4%	17/17 features
Last change: Linear SVM		
1.2 ☆ SVM	Accuracy: 97,6%	17/17 features
Last change: Quadratic SVM		
1.3 ☆ SVM	Accuracy: 98.8%	17/17 features
Last change: Cubic SVM		
1.4 ☆ SVM	Accuracy: 96,4%	17/17 features
Last change: Fine Gaussian SVM		
1.5 ☆ SVM	Accuracy: 98.8%	17/17 features
Last change: Medium Gaussian SVM		
1.6 ☆ SVM	Accuracy: 96,4%	17/17 features
Last change: Coarse Gaussian SVM		
2.1 ☆ Ensemble	Accuracy: 96,4%	17/17 features
Last change: Boosted Trees		
2.2 ☆ Ensemble	Accuracy: 98.8%	17/17 features
Last change: Bagged Trees		
2.3 ☆ Ensemble	Accuracy: 97,6%	17/17 features
Last change: Subspace Discriminant		
2.4 ☆ Ensemble	Accuracy: 97,6%	17/17 features
Last change: Subspace KNN		
2.5 ☆ Ensemble	Accuracy: 92,8%	17/17 features
Last change: RUSBoosted Trees		

Machine Learning – Software



App
sends
data using
API

API stores
as
features in
database

Train and
update
the model

Predict
based on
current
data

API sends
the result
back to
the app

- Frequent model updates
- Continuous learning

- Model is trained in batches
- Load the model as a binary file

- Initial prediction from user feedback
- Obtain optimum temperature from database

Demo



Modifications

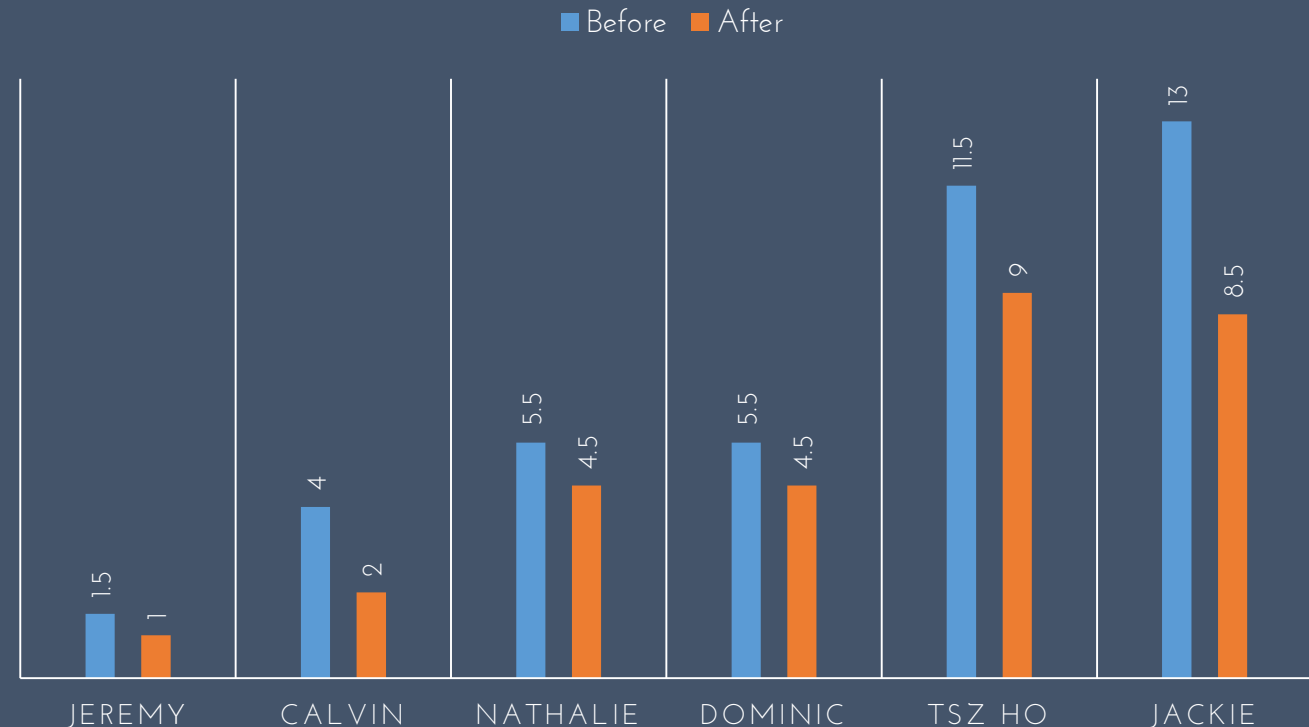
1. Refresh interval set from 10 minutes -> 10 seconds
2. Calendar 'time-to-sleep' push notification is manually sent.



Hypothesis Testing

1. Use the Pittsburgh Sleep Quality Index
2. Before and after a week's* usage
3. 6 differing subjects
 - 1x good sleeper
 - 3x mediocre sleepers
 - 2x bad sleepers

PSQI BEFORE AND AFTER



*) in cases where a full week wasn't done, the results are scaled accordingly
PSQI Questions - http://uacc.arizona.edu/sites/default/files/psqi_sleep_questionnaire_1_pg.pdf

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- ✓ 2. Through machine learning, prolonged usage of the app will improve performance and classification accuracy.
- ✓ 3. Provide a slick, and intuitive app and web interface for the user
- ✗ 4. The feeling of grogginess can be reduced by:
 - Reducing the effects of jet-lag by notifying the user to sleep
 - Setting the alarm to go off when the user is not in deep sleep

Give it a try!



<http://sleepify.zapto.org/download/>

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