Smart Start

Sleep State Detection for your Personal Routine
&
Home Appliance Integration

About Us

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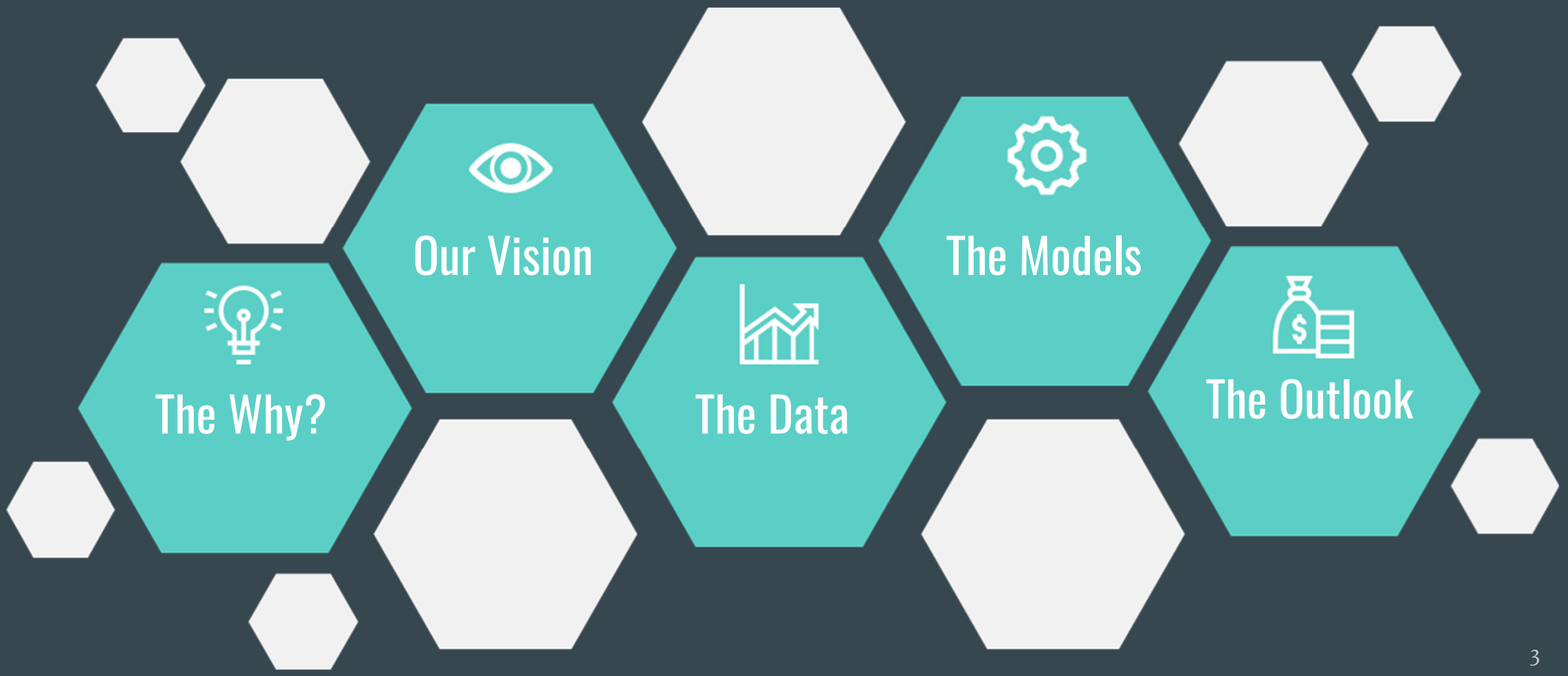
The Content



The Why?

Routines:

Many Individuals struggle with (morning) routines due to time constraints & health issues

Inefficient Energy Use:

Traditional methods of morning routines often lead to unnecessary energy consumption

Manual Tasks:

Routine tasks consume valuable time and energy first thing in the morning.

Lack of Personalization:

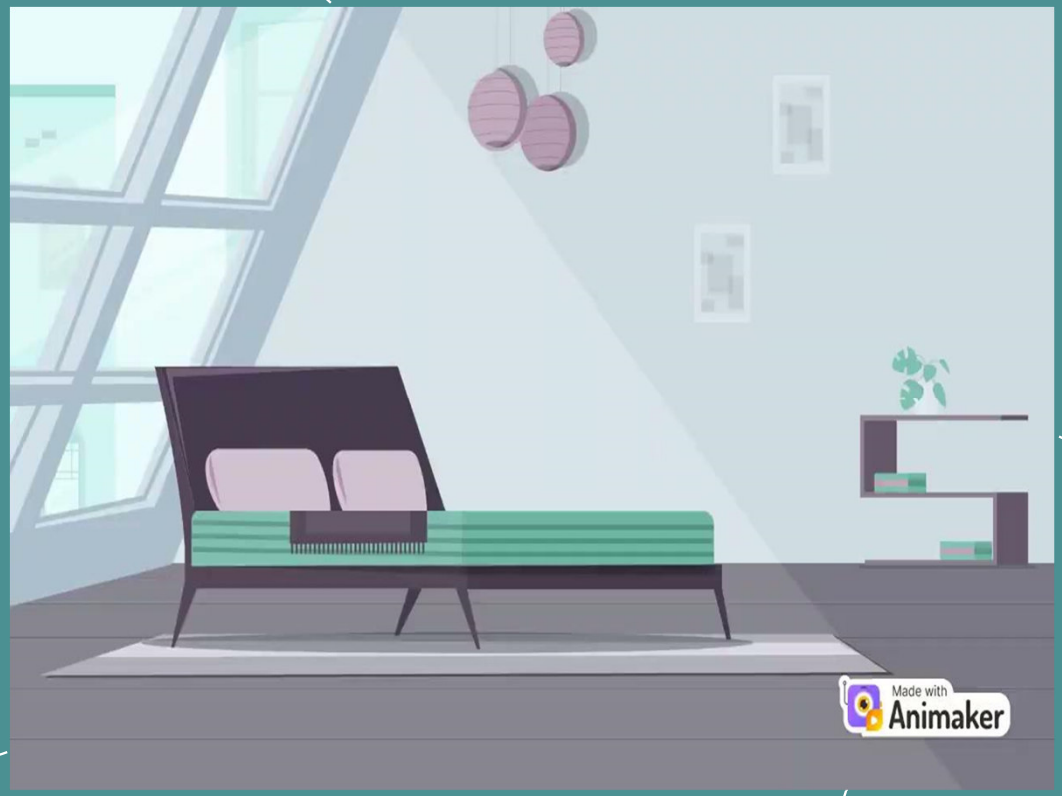
Current solutions do not adapt to individual preferences and needs, leading to less optimal start of the day

Our Vision

Revolutionizing Mornings with Smart Automation

Smart Start

Revolutionizing Mornings with Smart Automation



Link to the Movie

Smart Start

Concept Goals

- ➔ Detection of awake & sleep state
- ➔ Prediction of onset & wake-up time

- ➔ Data with only basic input
- ➔ Data privacy = no unnecessary sensor data recorded
- ➔ Slim models for small devices

- ➔ Whole day detection
- ➔ Universal application
- ➔ Tool for smart home implantation

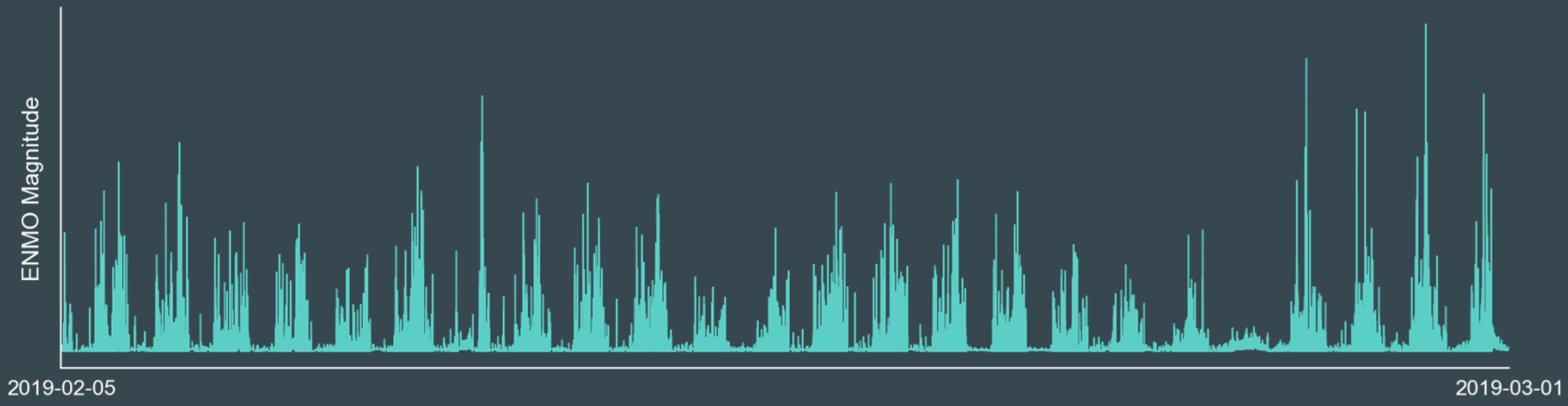
The Data

STAVROS NIARCHOS FOUNDATION
Global Center for Child & Adolescent Mental Health
AT THE CHILD MIND INSTITUTE

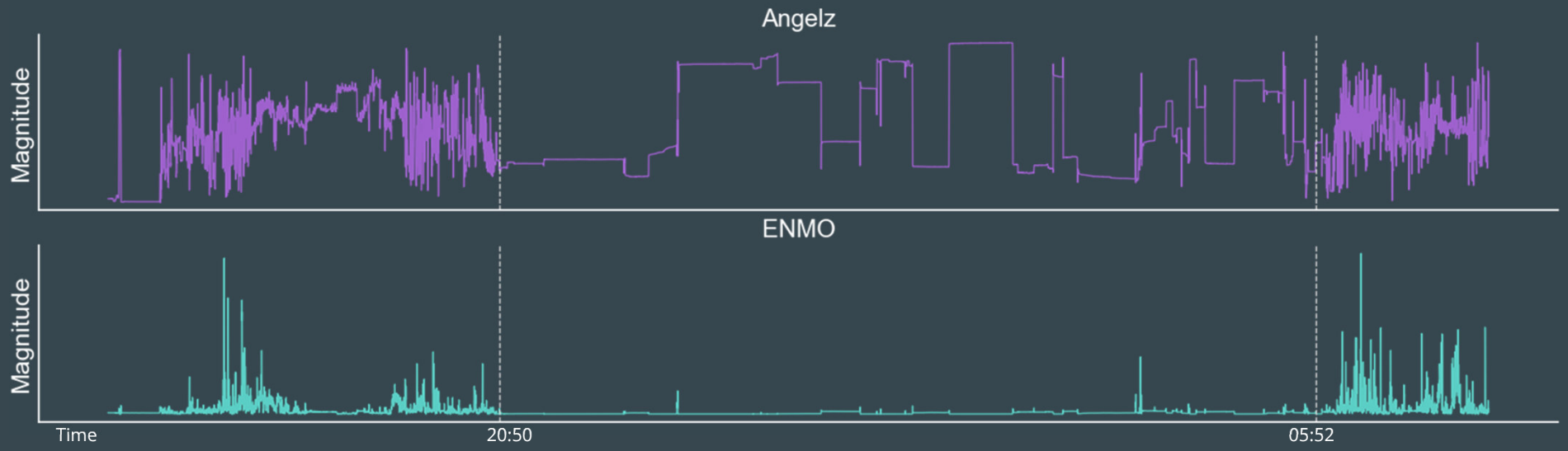
The Data

- Wrist-worn accelerometers acquire movement data of every 5 sec
- Sleep periods of 270 individuals and a total of ~5000 nights
- Each series comprises nights of one individual
- **Time series:**
  - ENMO
  - Angle z

Accelerometer



The Data

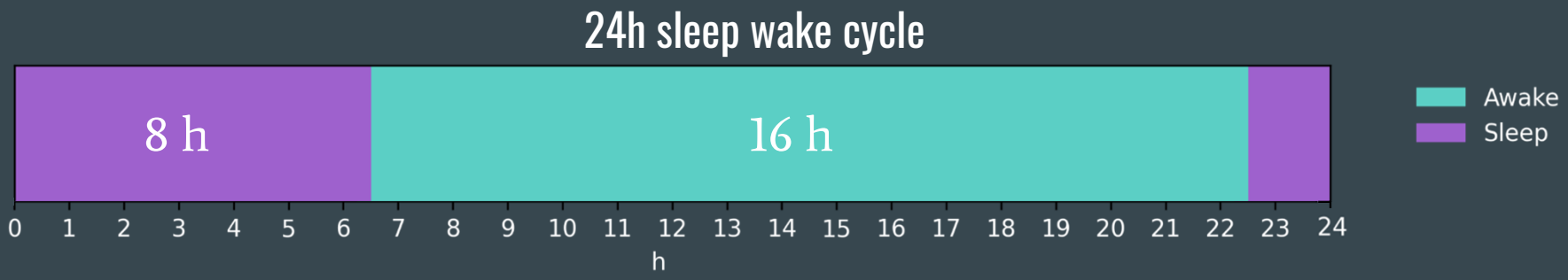


Night contains :

- Varying time period before sleep onset
- Actual sleep period => 30 min
- Inconstant time period after wakeup

Heuristic Model

Heuristic Model

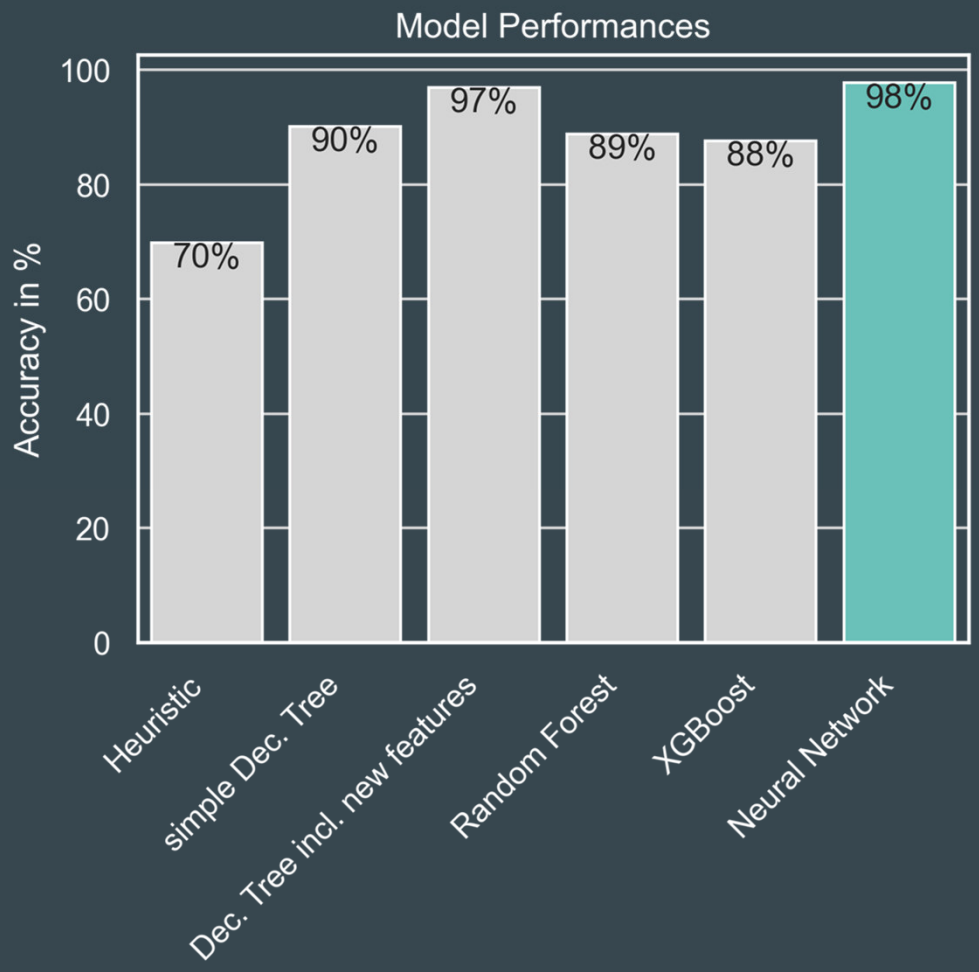


- Average wake-up time 6:30 & onset time 22:30
- Recommended sleep per day: 8:00 h
- 70% Accuracy

ML Models

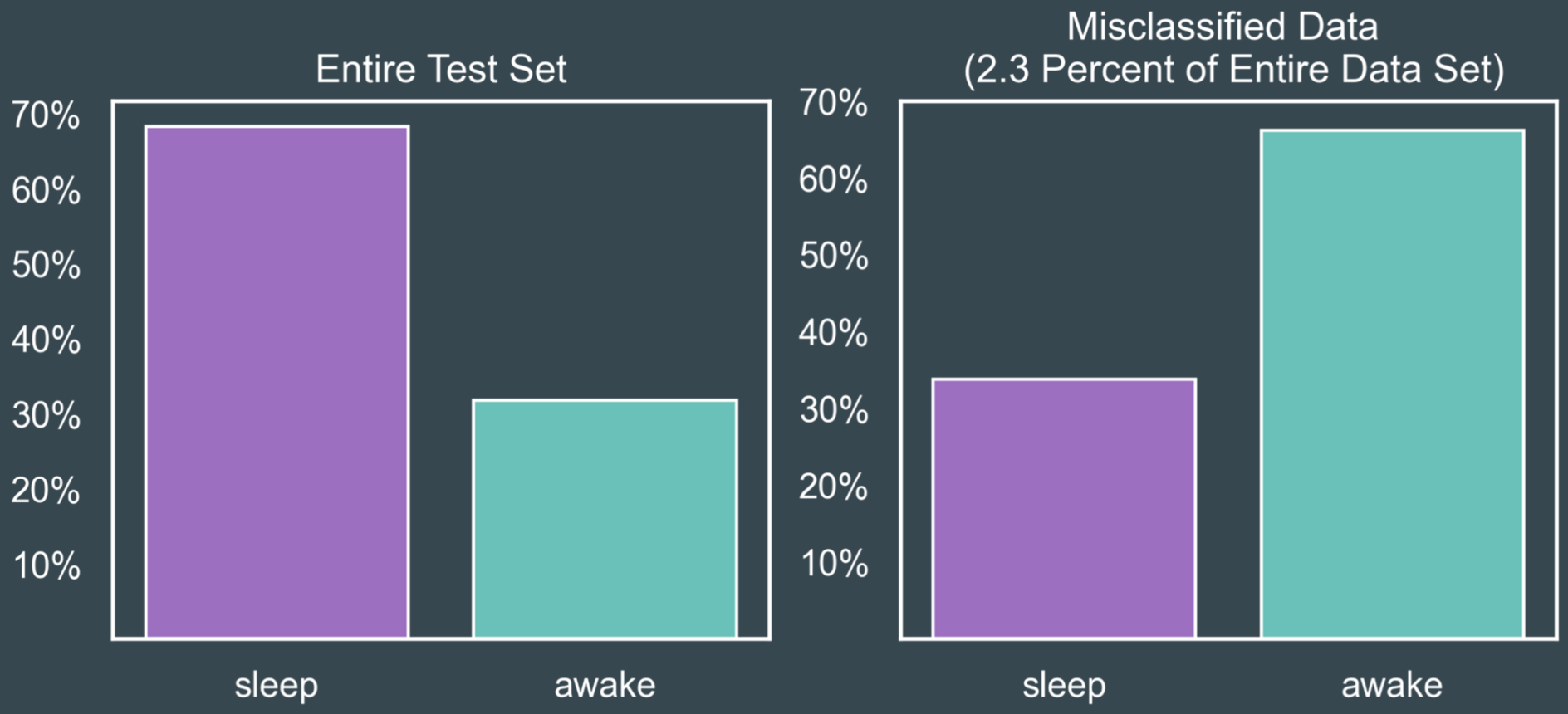
The Models

- ➔ Feature engineering:
  - ◆ different statistic values over time (mean, std., ...)
  - ◆ improvement: +7%
- ➔ Ensemble methods showed no improvement



Model Evaluation

Model Evaluation



Error Analysis

★ = misclassified timepoints

Outlook

Outlook

Improvement

- ➔ Feature engineering
- ➔ Sensor data (heart beat rate, body temp, skin conductance, ...)

Refinement

- ➔ Personal ‘awake’ time window

Focus shift

- ➔ Model recognizing potential patterns specific for ‘wakeup’

Conclusion

Conclusion

- ➔ Prediction of awake & sleep state
- ➔ 98 % Accuracy
- ➔ Detection of wake-up less accurate

- ➔ Data with only basic input
- ➔ Our model outperforms published Random Forest model

- ➔ Live prediction of current sleep / wake state
- ➔ Model can be integrated in smart home app

Thank you!

Smart Start

Resources

- Short Movie: Animaker
- Presentation Slides : Slidesgo and Freepik
- Data: Kaggle / Child Mind Institute
- Accelerometer Image: Cole et al. doi: 10.2196/mhealth.9035
- Cited Study: K. Sundararajan *et. al.*: Sleep classification from wrist-worn accelerometer data using random forests (https://www.nature.com/articles/s41598-020-79217-x)