The Tromsø Study

Machine learning to construct new types of algorithms to study physical activity

Shaheen Syed, PhD

THE ROADMAP

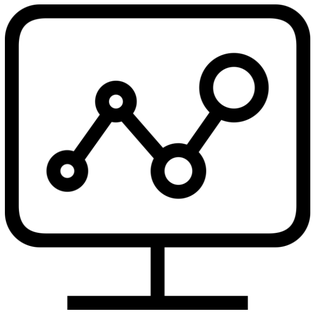
Data Extraction

Non wear time

PA Feature extraction

Sleep detection

Anomaly Detection



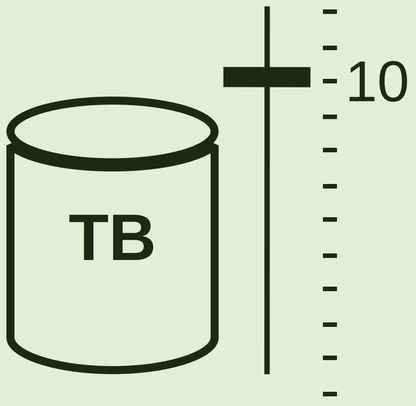
https://pypi.org/project/gt3x/

CHALLENGES ALONG THE WAY

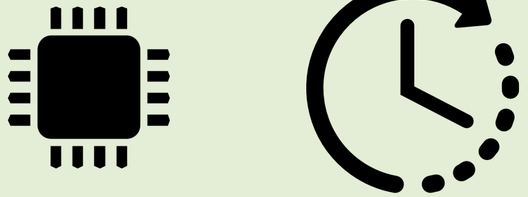
GT3X Proprietary format

6,500 Participants

10TB of Data



Low memory + computational time

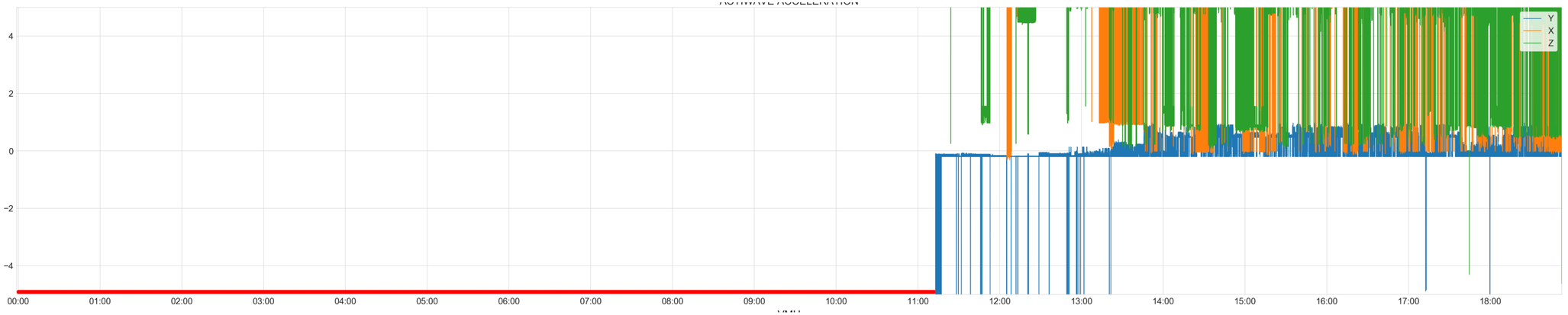


ANOMALY DETECTION

Visual Inspection

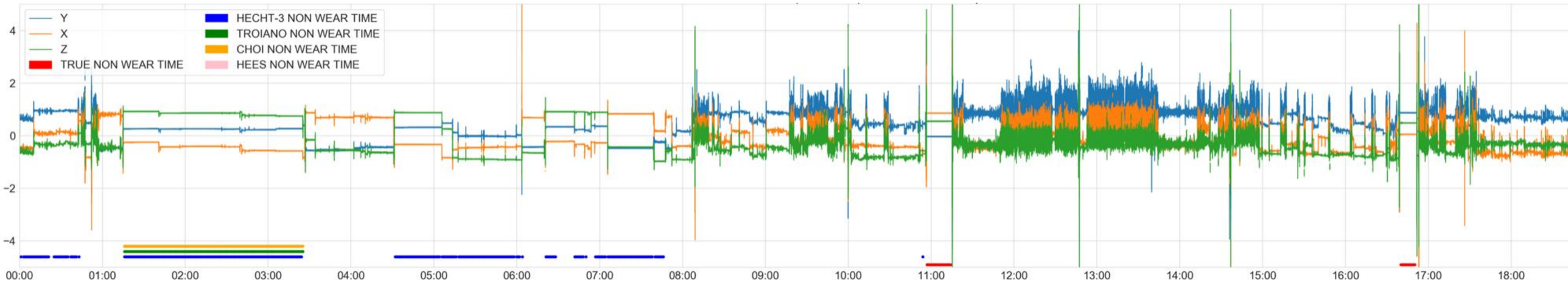
Outlier detection

- **Invalid ranges**
- **Unsupervised clustering**
- **Auto-encoders**



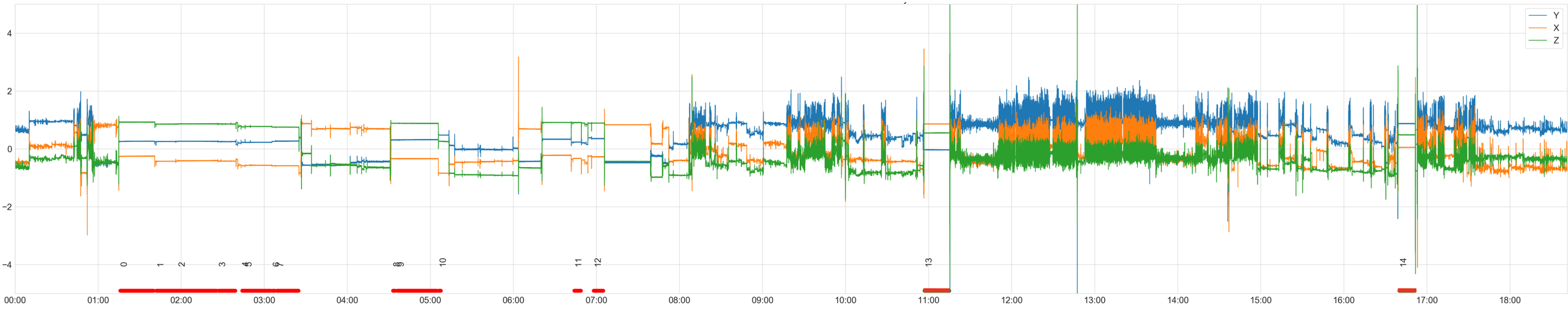
EXISTING ALGORITHMS TO DETECT NON-WEAR TIME

HECHT | **TROIANO** | **CHOI** | **v. HEES**



TRUE NON-WEAR TIME

Candidate non-wear episodes



Standard deviation of all axes <= threshold value

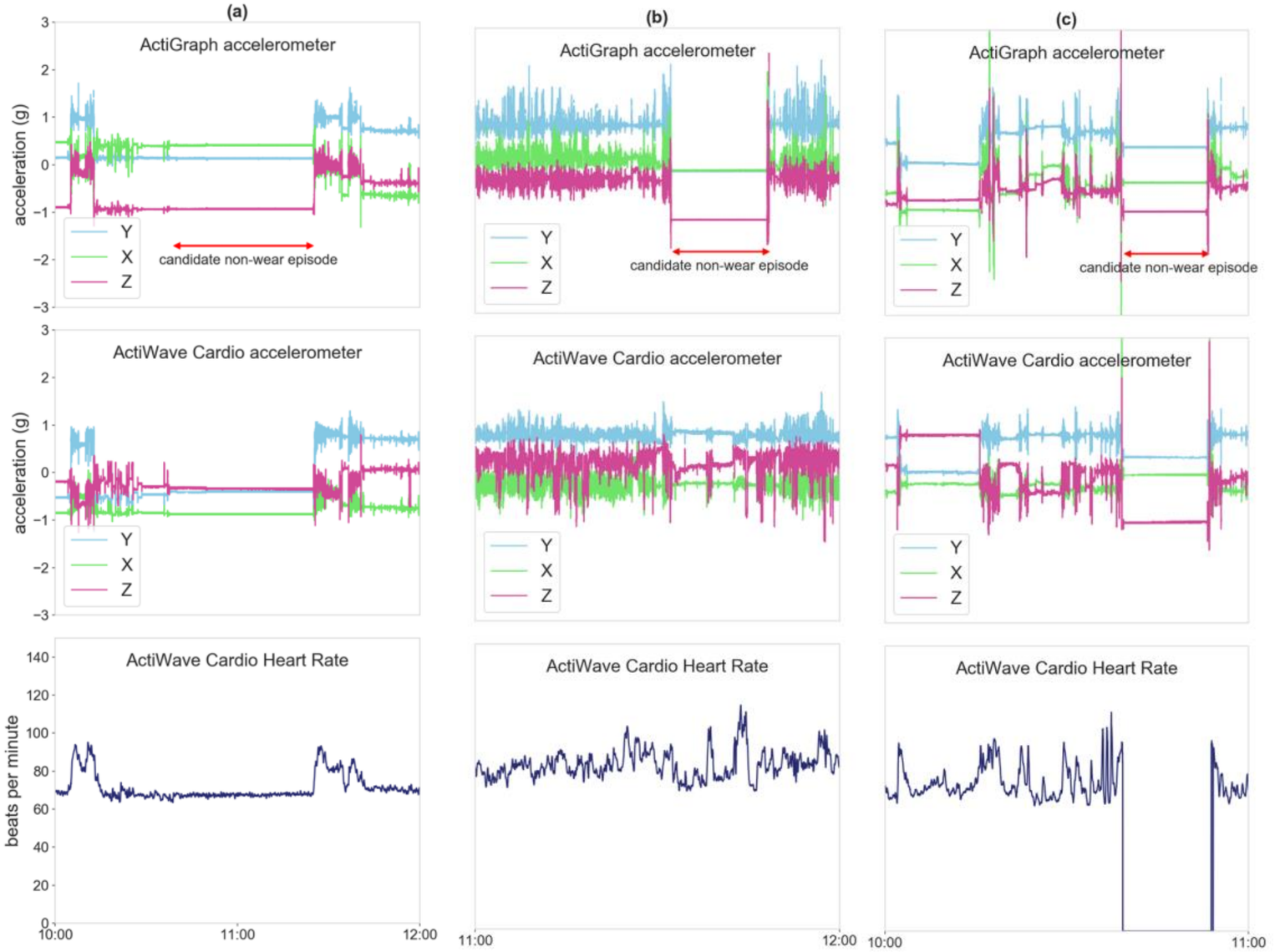
What happened during candidate non-wear episodes

BUILDING A GROUND TRUTH DATASET

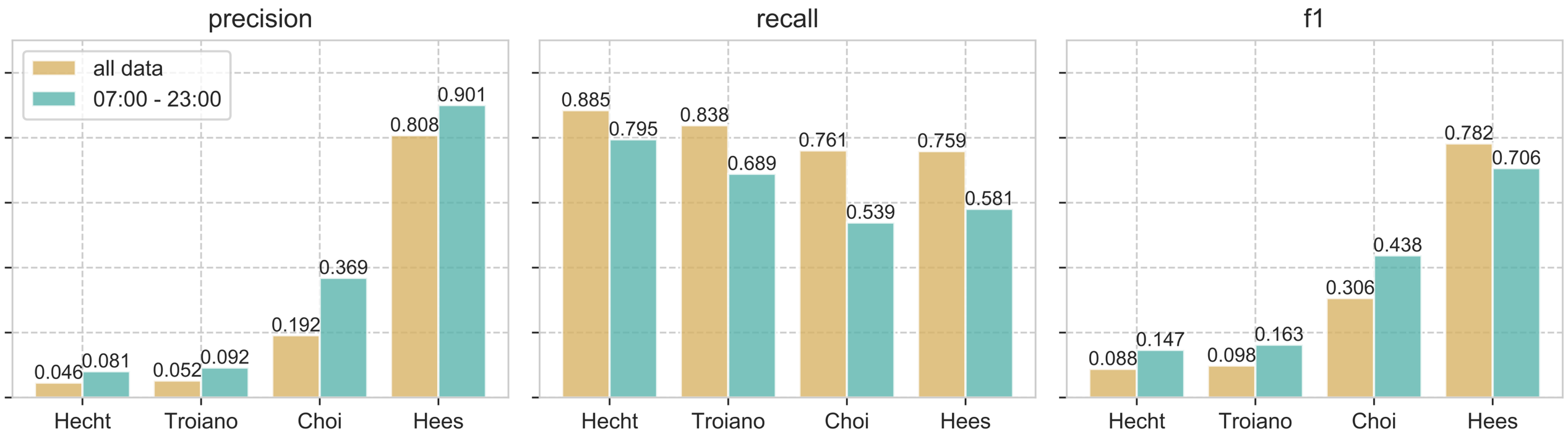
ACTIGRAPH

ACTIWAVE

HEART RATE



WHICH ALGORITHM TO USE?



Can we do better?
Hyperparameter Tuning

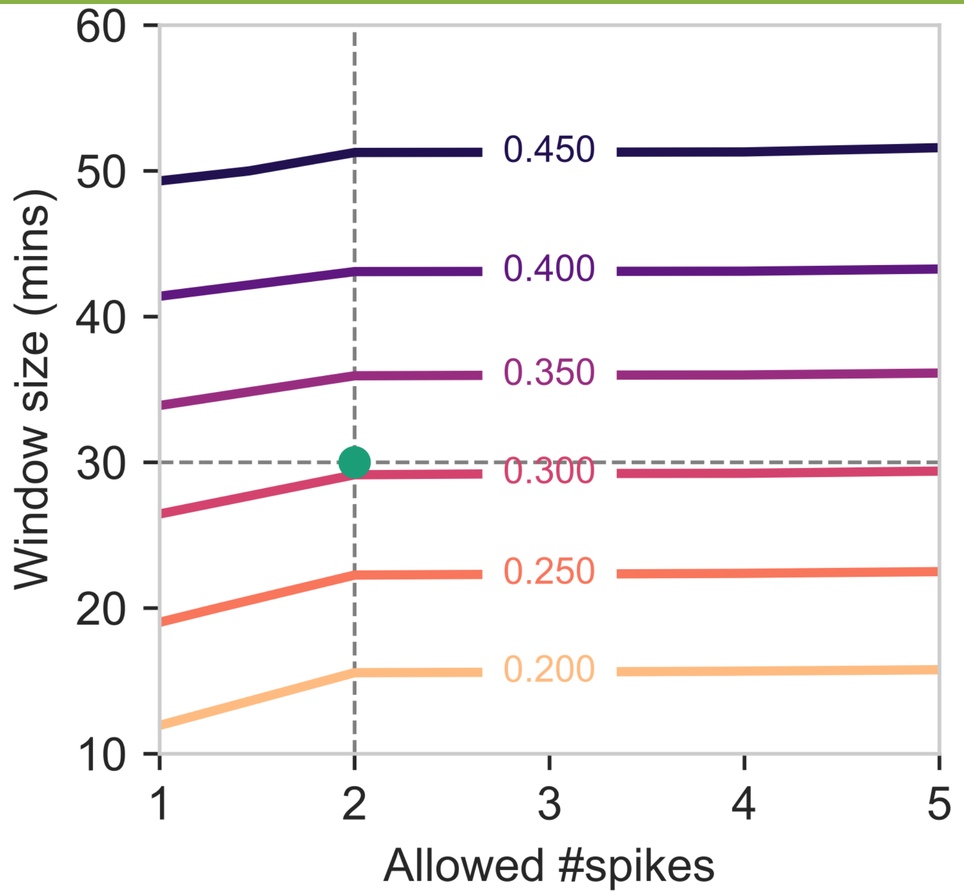
Troiano non-wear algorithm

The non-wear episodes were defined as intervals of at least 60 consecutive minutes of zero activity counts, with allowance for 1–2 minutes of counts between 0 and 100 (to allow for spikes or artificial movement).

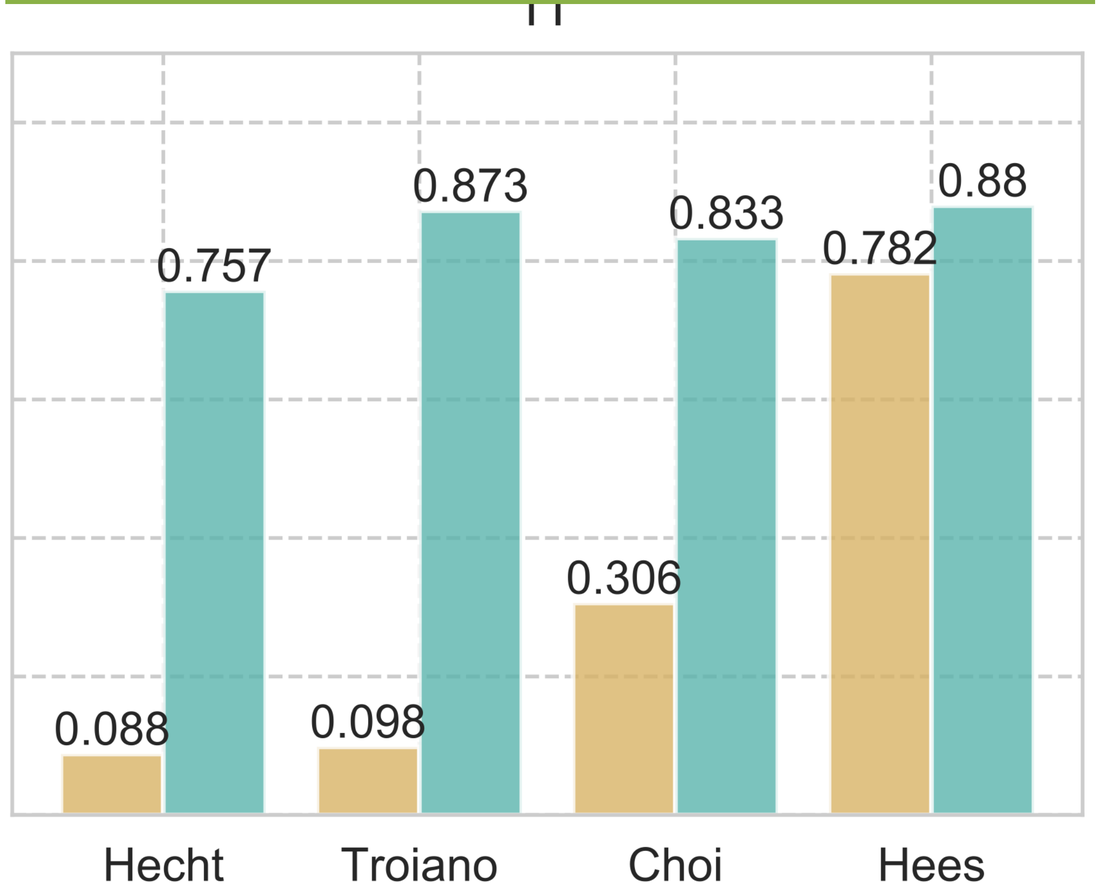
- The minimum length of the interval to classify an episode as non-wear time; defaults to 60 minutes.
- The number of spikes in the interval; defaults to 2.
- The lower bound of the spikes threshold within the interval; defaults to 0 counts.
- The upper bound of the spikes threshold within the interval; defaults to 100 counts.

What happens when we tweak the parameters?

Sensitivity analysis for Choi on F1



Default vs optimised F1



DATA DISTRIBUTION IMPORTANT !

Results published in SR

www.nature.com/scientificreports

SCIENTIFIC REPORTS

nature research

OPEN

Evaluating the performance of raw and epoch non-wear algorithms using multiple accelerometers and electrocardiogram recordings

Shaheen Syed[1*], Bente Morseth[2], Laila A. Hopstock[3] & Alexander Horsch[1]

Can we do *even* better?

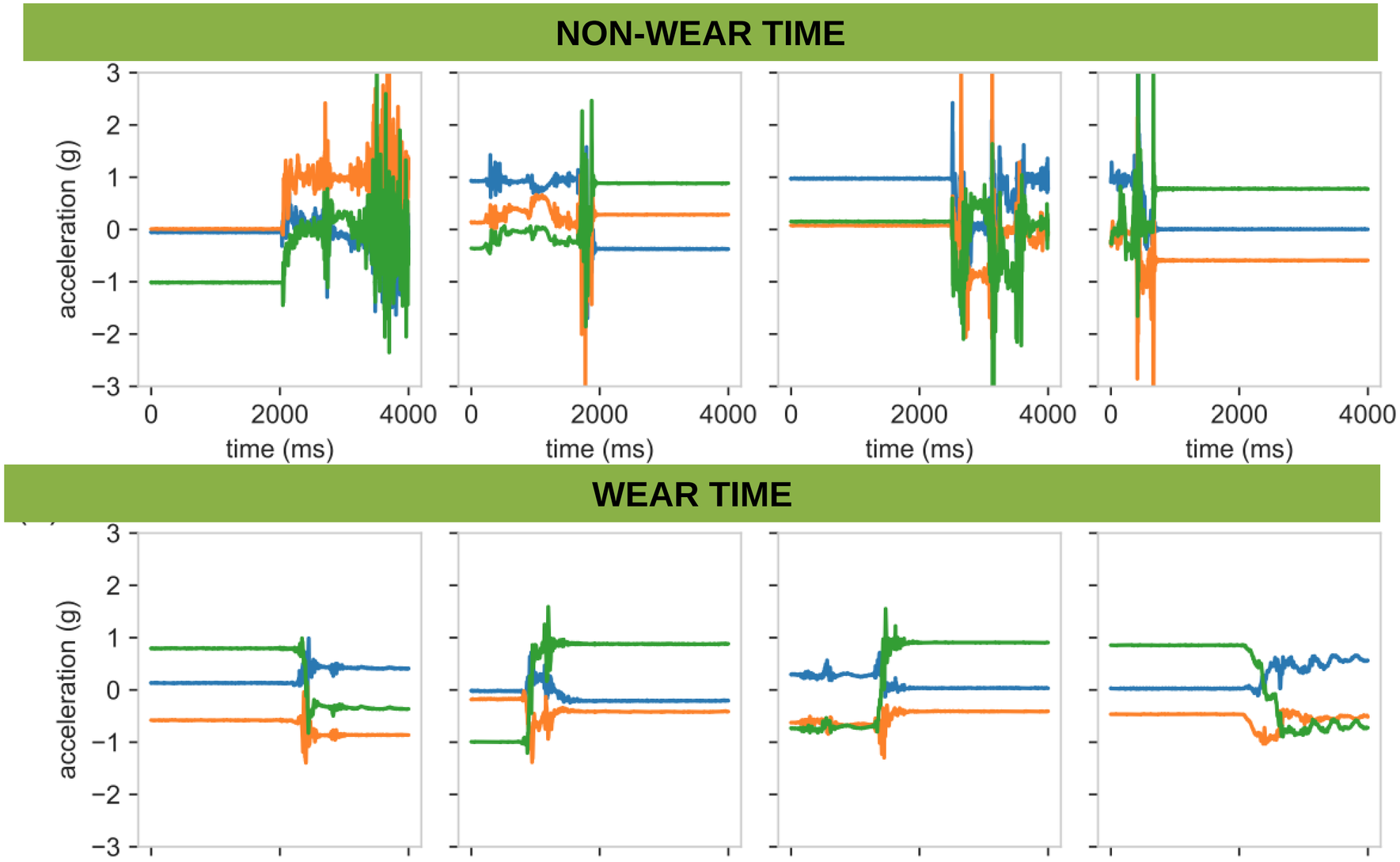
Deep Neural networks

Drawback current algorithms

Intervals need to be long enough to prevent false positives (type I errors),

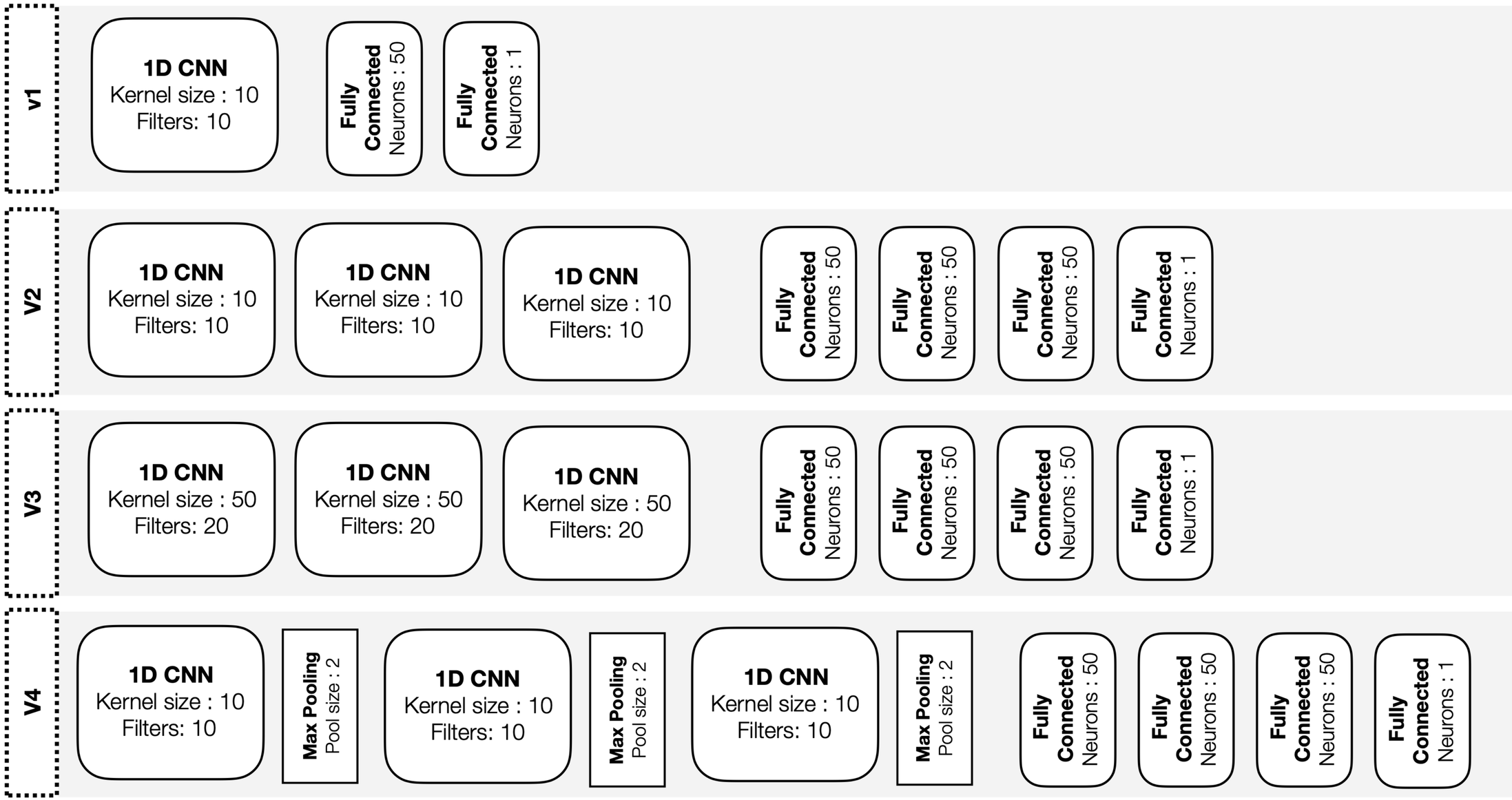
while short enough to prevent false negatives (type II errors)

What happens before and after a candidate non-wear episode

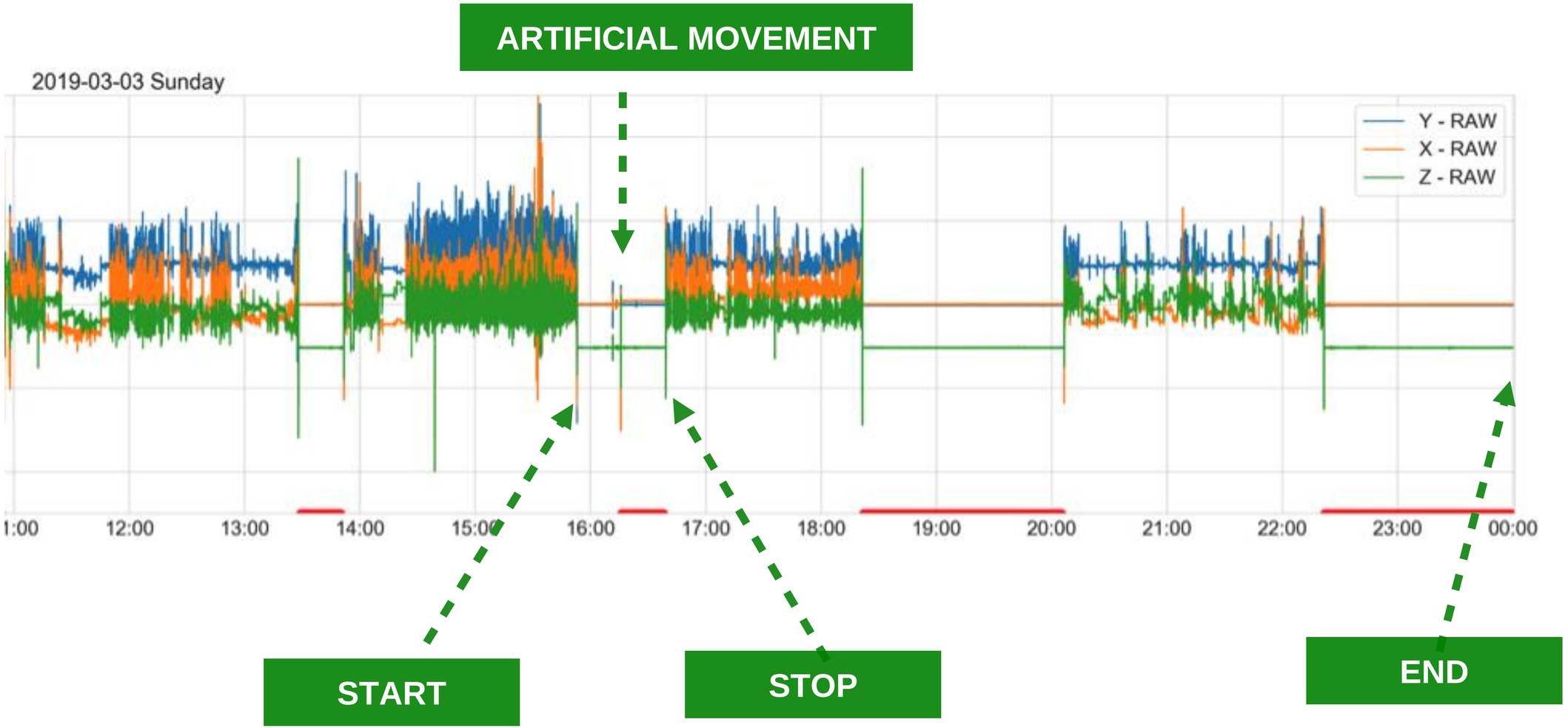


Using Convolutional Neural Networks (CNNs)

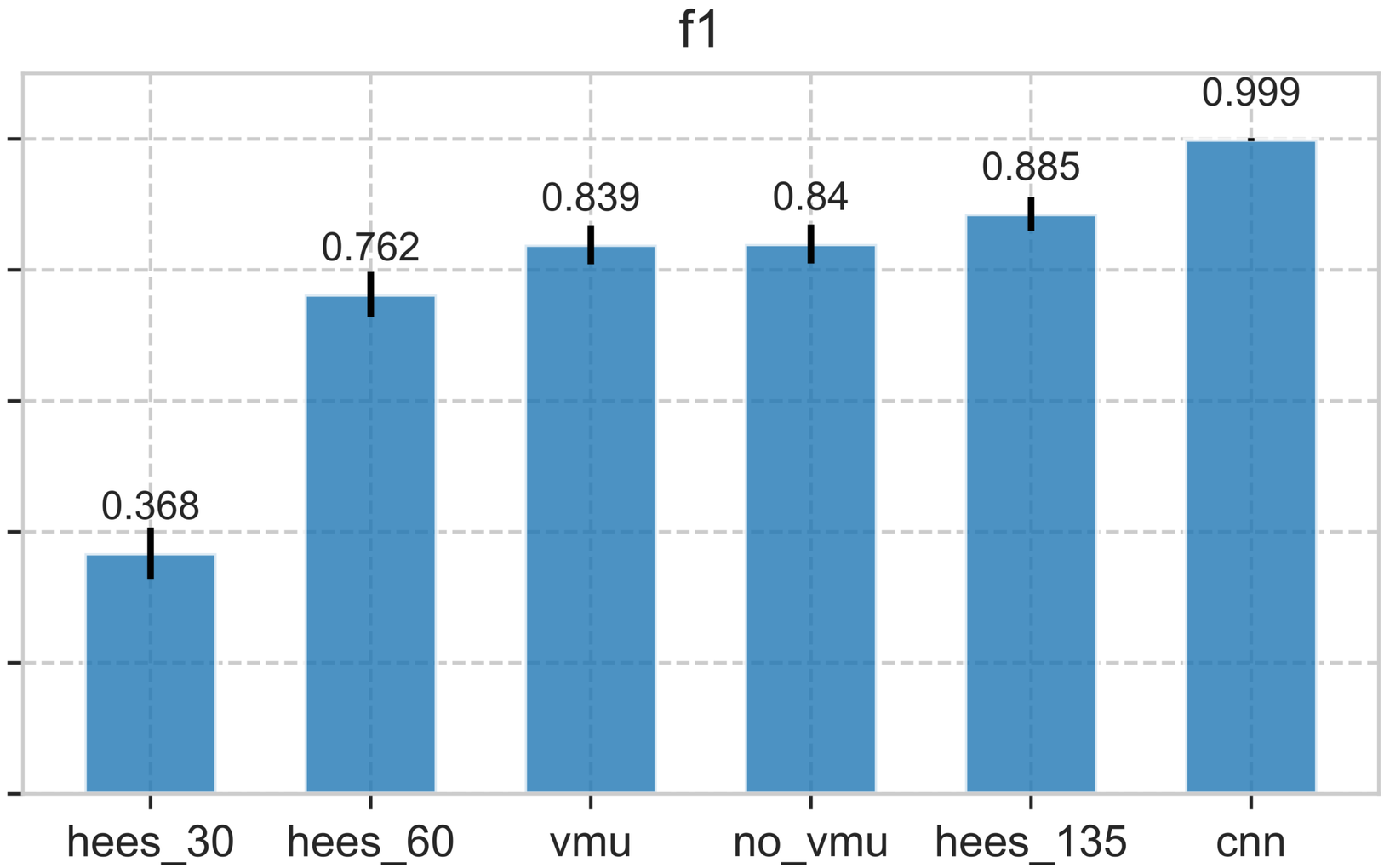
INPUT
3-10 sec segments



CREATING THE ALGORITHM



Classification Results on gold-standard dataset



DATA DISTRIBUTION IMPORTANT !

PATTERNS MIGHT NOT TRANSLATE

SAMPLE FREQUENCY

ORIENTATION

PUBLISHED IN SR

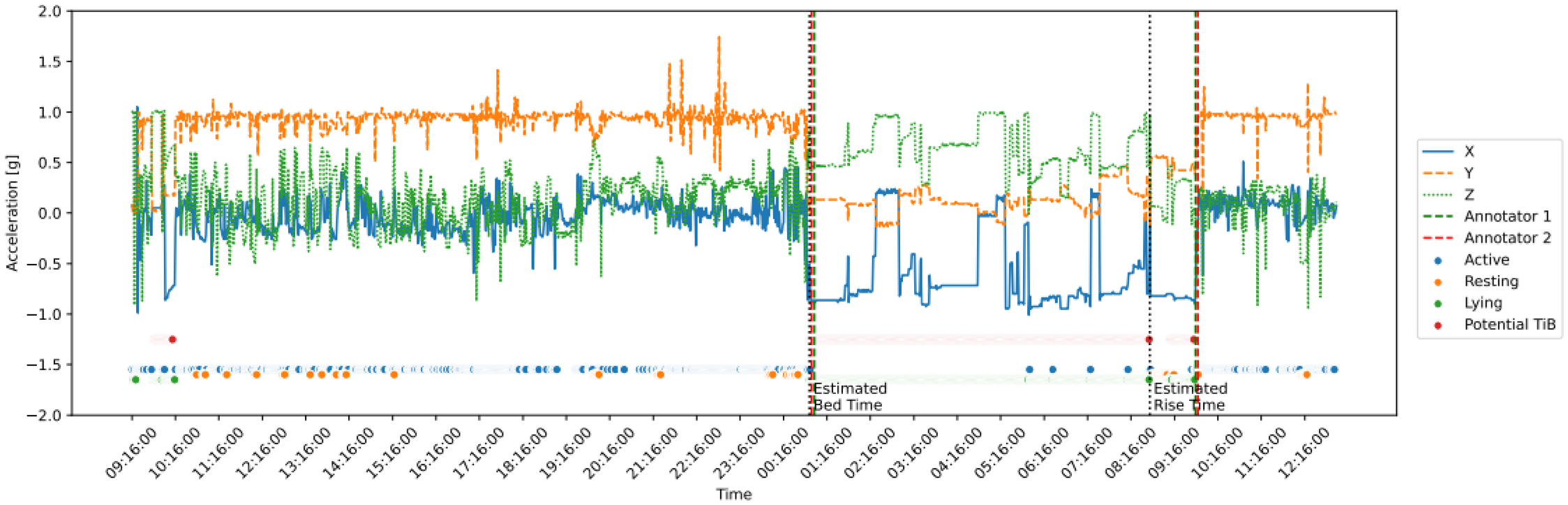
scientific reports

OPEN

A novel algorithm to detect non-wear time from raw accelerometer data using deep convolutional neural networks

Shaheen Syed[1]✉, Bente Morseth[2], Laila A. Hopstock[3] & Alexander Horsch[1]

SLEEP - WAKE DETECTION USING RNNs



SLEEP - WAKE DETECTION USING RNNs

Discrimination of sleep and wake periods from a hip-worn raw acceleration sensor using recurrent neural networks

Marc Weitz[1,*], Shaheen Syed[1], Laila A. Hopstock[2], Bente Morseth[3], Dilip K. Prasad[1], and Alexander Horsch[1]

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[2]Department of Community Medicine, Faculty of Health Sciences, UiT The Arctic University of Norway, Tromsø, Norway
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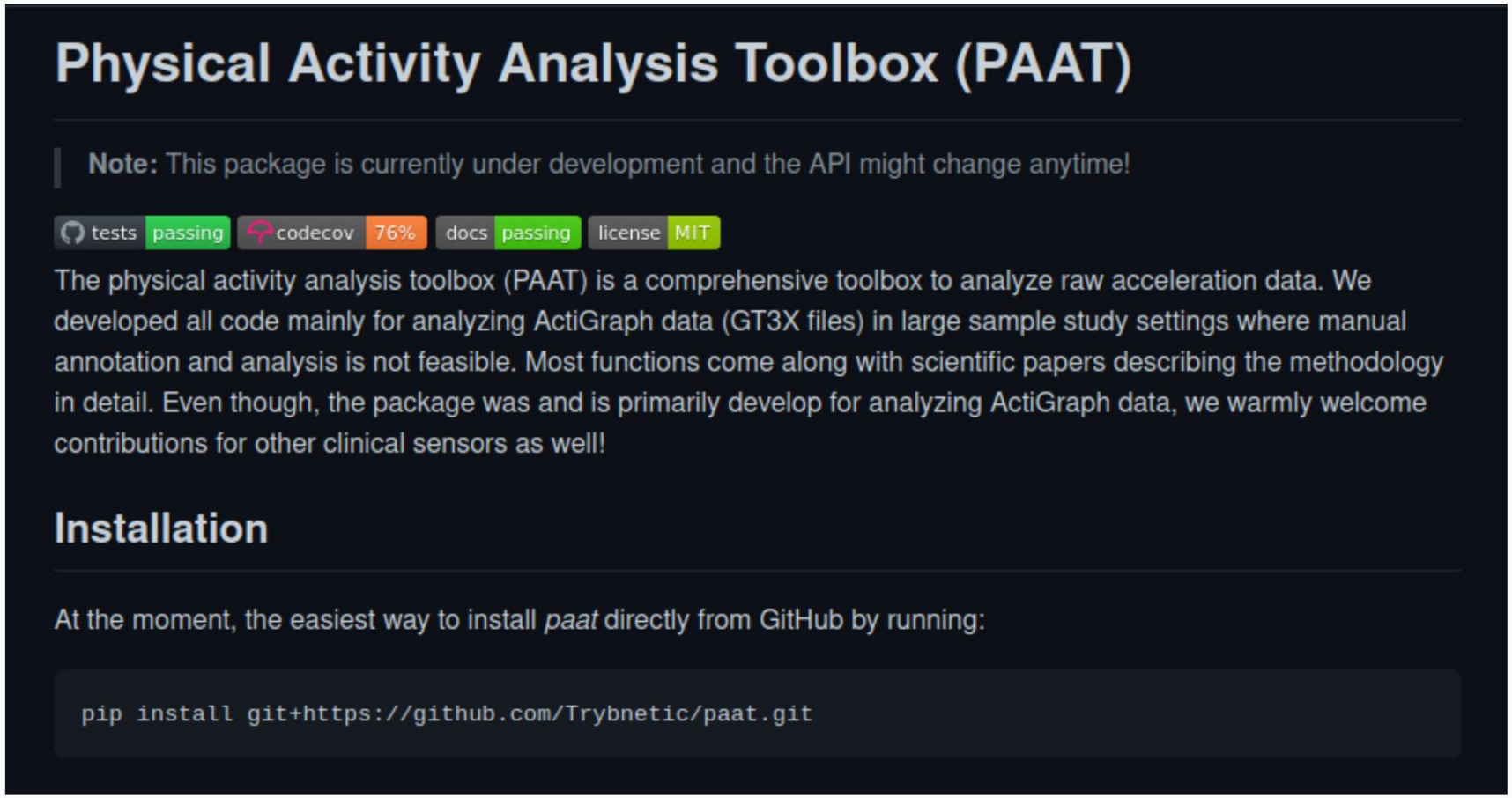
[*]marc.weitz@uit.no

PYTHON TOOLBOX



Physical Activity Analysis Toolbox (PAAT)

> **Note:** This package is currently under development and the API might change anytime!

tests passing | codecov 76% | docs passing | license MIT

The physical activity analysis toolbox (PAAT) is a comprehensive toolbox to analyze raw acceleration data. We developed all code mainly for analyzing ActiGraph data (GT3X files) in large sample study settings where manual annotation and analysis is not feasible. Most functions come along with scientific papers describing the methodology in detail. Even though, the package was and is primarily develop for analyzing ActiGraph data, we warmly welcome contributions for other clinical sensors as well!

Installation

At the moment, the easiest way to install *paat* directly from GitHub by running:

```
pip install git+https://github.com/Trybnetic/paat.git
```

https://github.com/Trybnetic/paat

THANK YOU

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https://github.com/shaheen-syed