Karlsruhe Institute of Technology

INSTITUTE OF INFORMATION SYSTEMS AND MARKETING

Measuring Mental Workload using Machine Learning and Raw ECG data

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Motivation

IT supported acitivites

A growing number of professional activities are today IT-supported, and this trend will continue in the coming years [1,2].

Human Computer Interaction

Today humans and computers interact still in an asymmetrical mouse and keyboard dependent way [3].

Motivation

Physio-adaptive Systems

Physio-adaptive systems are a promising approach towards a more advanced interaction between humans and information systems that considers psychophysiological user states [4,5].
These approaches could help to support desirable states such as flow, or dynamically react to states such as mental workload [6].

[8]

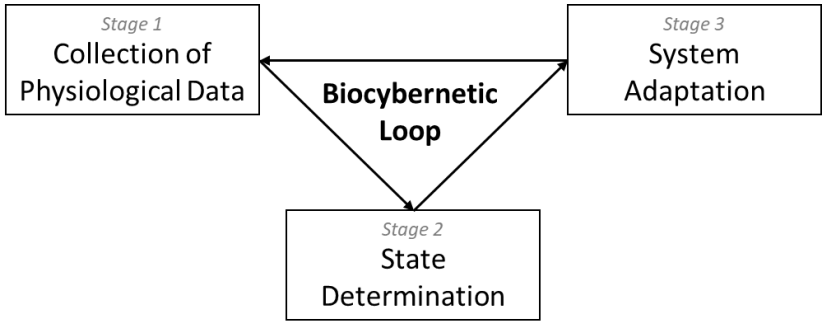
[7]

New Sensor Technology

Improvements in the field of wearable sensors hold the potential to use physio-adaptive systems in everyday life.

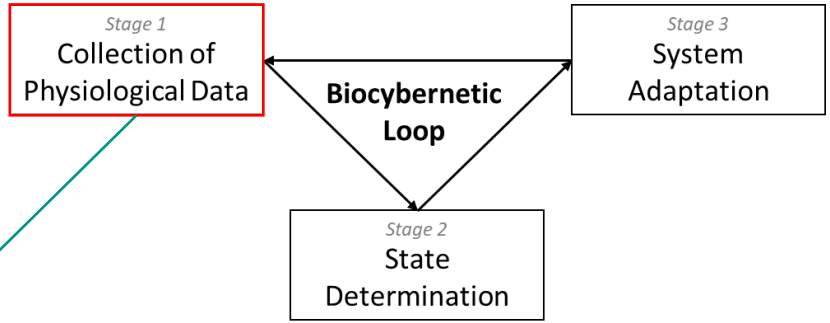
Physio-adaptive Systems

Core of physio-adaptive systems is the so-called biocybernetic loop [5]:



The Biocybernetic Loop I

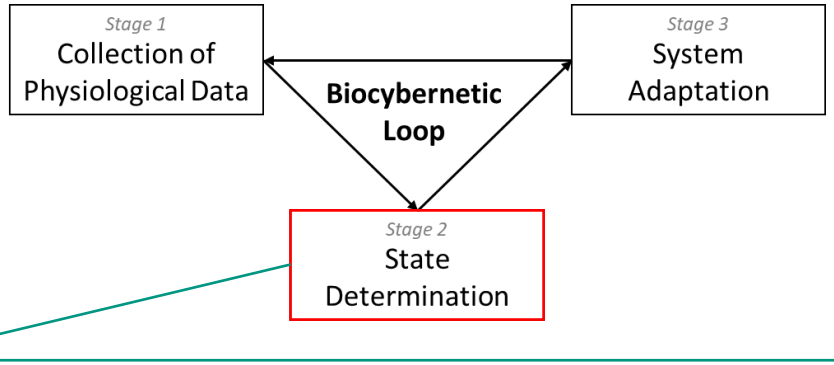
Core of physio-adaptive systems is the so-called biocybernetic loop [5]:



Collection of Physiological Data
Physiological Data (e.g., heart rate) has to be collected and combined with self-reported or observed data about the user's state.
This data represents the ground truth for Machine Learning (ML) or rule based approaches for State determination.

The Biocybernetic Loop II

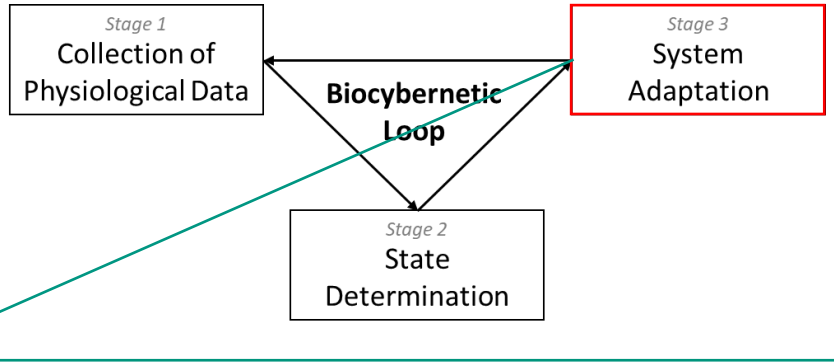
Core of physio-adaptive systems is the so-called biocybernetic loop [5]:



State Determination
Training supervised or unsupervised Machine Learning algorithms using (labeled) physiological data. The application of the Machine-Learning algorithms then only requires physiological data to measure psychophysiological state.

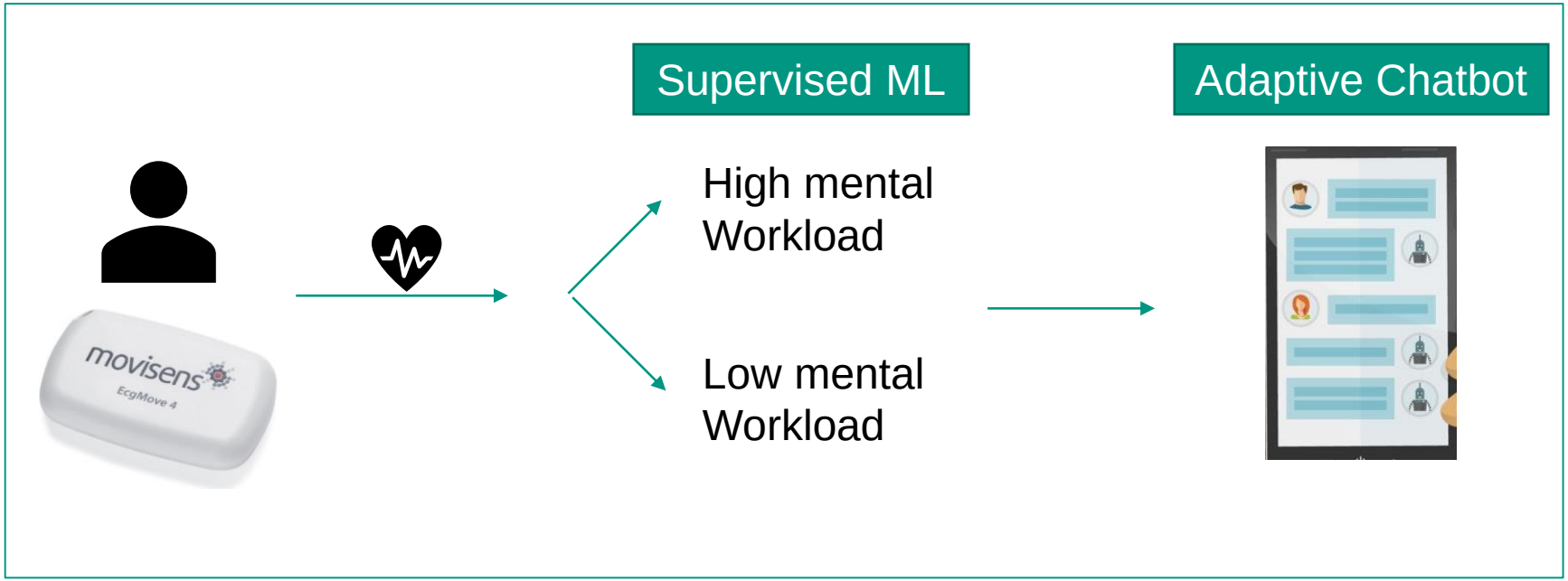
The Biocybernetic Loop III

Core of physio-adaptive systems is the so-called biocybernetic loop [5]:

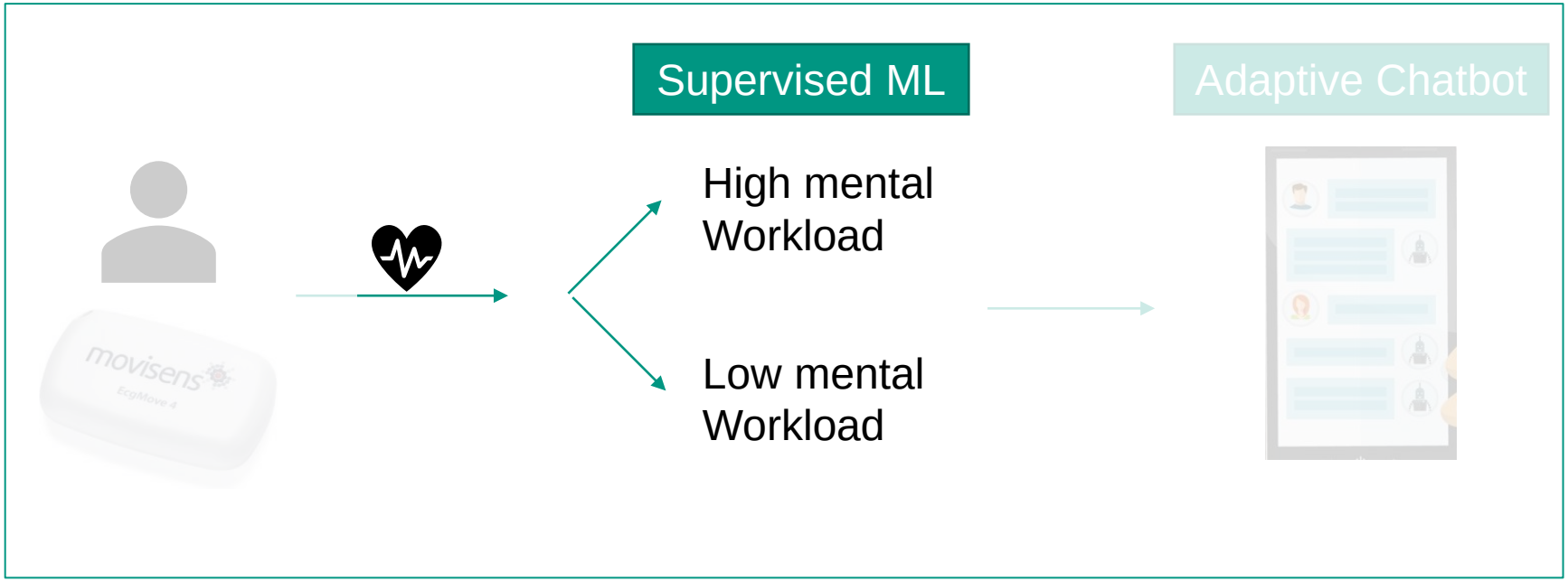


System Adaptation
The physio-adaptive system adapts itself reactively or pro actively to the determined psychophysiological state in order to stabilize the state (e.g., in case the state is desirable) or to manipulate the state (e.g., to get the user out of an an undesirable state).

Overarching Goal



Goal Interactive Analytics Seminar



Interactive Analytics Seminar

In order to build a mental workload adaptive system a deep-learning classifier is to be developed based on an existing raw ecg signals dataset.

Work packages

- Investigate a given dataset containing labeled ecg raw data.
- Develop ML-Pipeline and a LSTM based ML-Classifier for mental workload and optimize it according to state-of-the-art recommendations.

Requirements

- Practical and/or theoretical knowledge of supervised ML-algorithms ideally also with Deep Learning models like LSTM.
- Understanding of EKG, tachogram and the characteristics of these data desirable.

References

[1] Forrester Research Inc (2017). *Midyear Global Tech Market Outlook For 2017 To 2018*. URL: https://www.forrester.com/report/Midyear+Global+Tech+Market+Outlook+For+2017+To+2018/-/E-RES140272.

[2] van der Meulen, R. and W. Bamiduro (2018). *Gartner Says Global IT Spending to Grow 6.2 Percent in 2018*. URL: https://www.gartner.com/en/newsroom/press-releases/2018-04-09-gartner-says-global-it-spending-to-grow-6-percent-in-2018.

[3] Hettinger, L. J., P. Branco, L. M. Encarnacao and P. Bonato (2003). “Neuroadaptive technologies: Applying neuroergonomics to the design of advanced interfaces” *Theoretical Issues in Ergonomics Science* 4 (1-2), 220–237.

[4] Riedl, R. and P.-M. Léger (2016). *Fundamentals of NeuroIS*. *Information Systems and the Brain.* 1st ed. 2016. Berlin, Heidelberg: Springer.

[5] Fairclough, S. H. (2009). “Fundamentals of physiological computing” *Interacting with Computers* 21 (1-2), 133–145.

[6] Csikszentmihalyi, M. (1990). *Flow*. *The psychology of optimal experience.* New York: Harper and Row.

[7] Image by Polar Inc., https://polar.com.

[8] Image by movisens GmbH, https://www.movisens.com/.