Current Topics in Brain-Computer Interfacing

Institute of Software Engineering and Theoretical Computer Science

winter term 2021/2022

Leonie Lübbing - February 1st, 2022

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EEG-Based Closed-Loop Neurofeedback for Attention Monitoring and Training in Young Adults

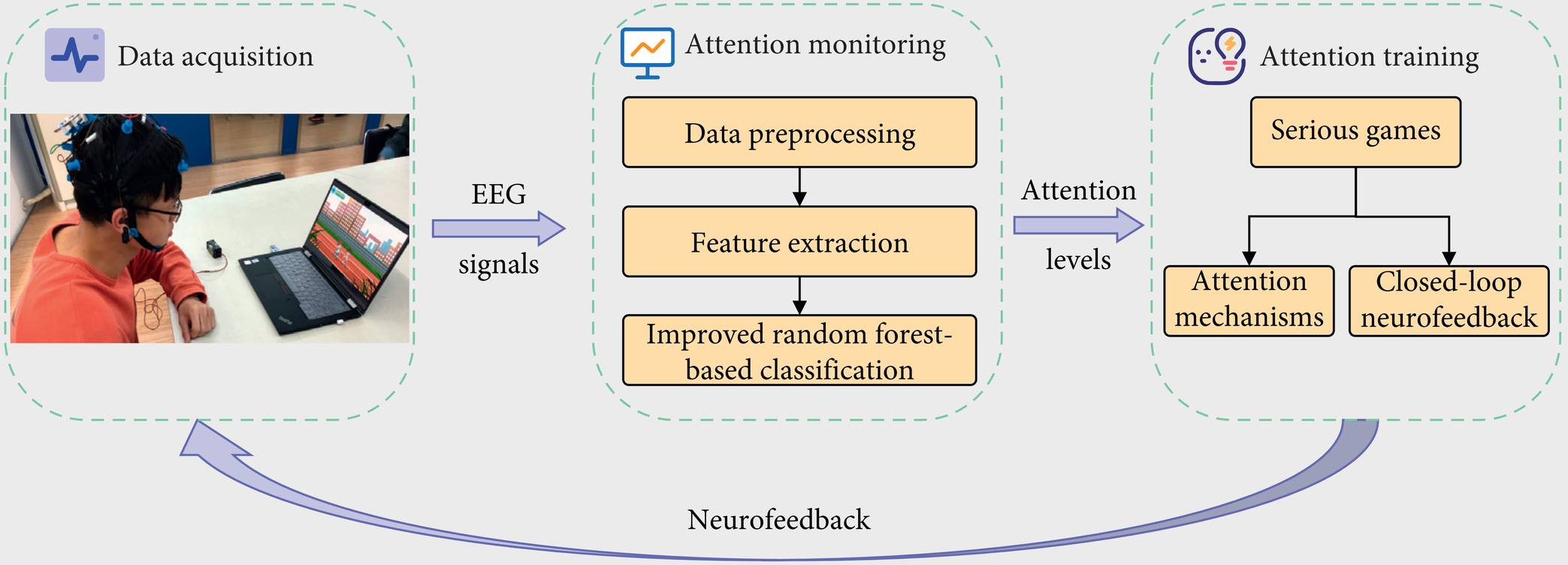
Bingbing Wang, Zeju Xu, Tong Luo, Jiahui Pan

Journal of Healthcare Engineering, Vol. 2021

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Attention monitoring

Architecture of attention monitoring and training modules



Attention monitoring

Feature extraction

- OpenBCI headset, channels TP9, AF7, AF8, TP10 based on previous studies
- Continuous wavelet transform (Daubechies coefficients) to extract power spectral density features
- SURE threshold to remove noise from EEG signal
- Inverse CWT to reconstruct signal

Attention monitoring

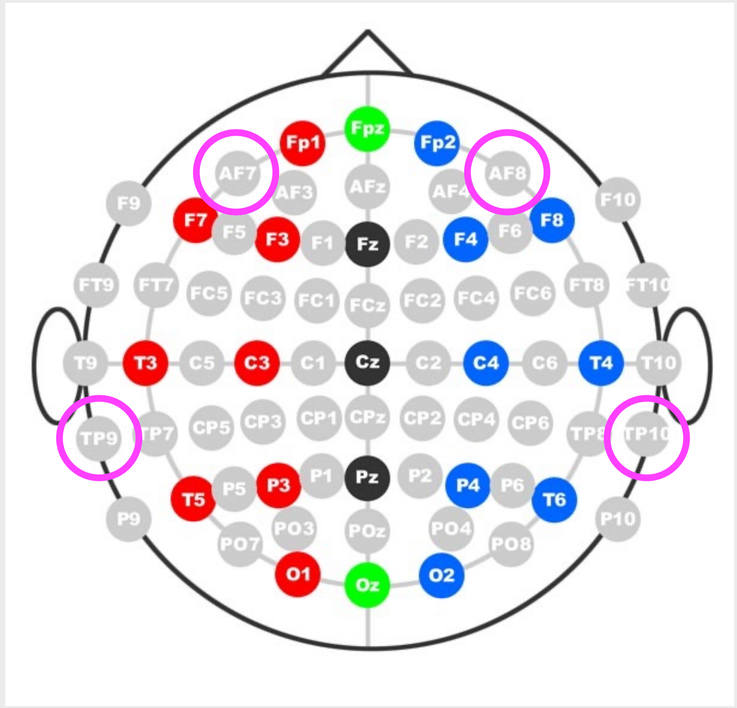


Fig. 1: 10 / 10 System Positions[1]

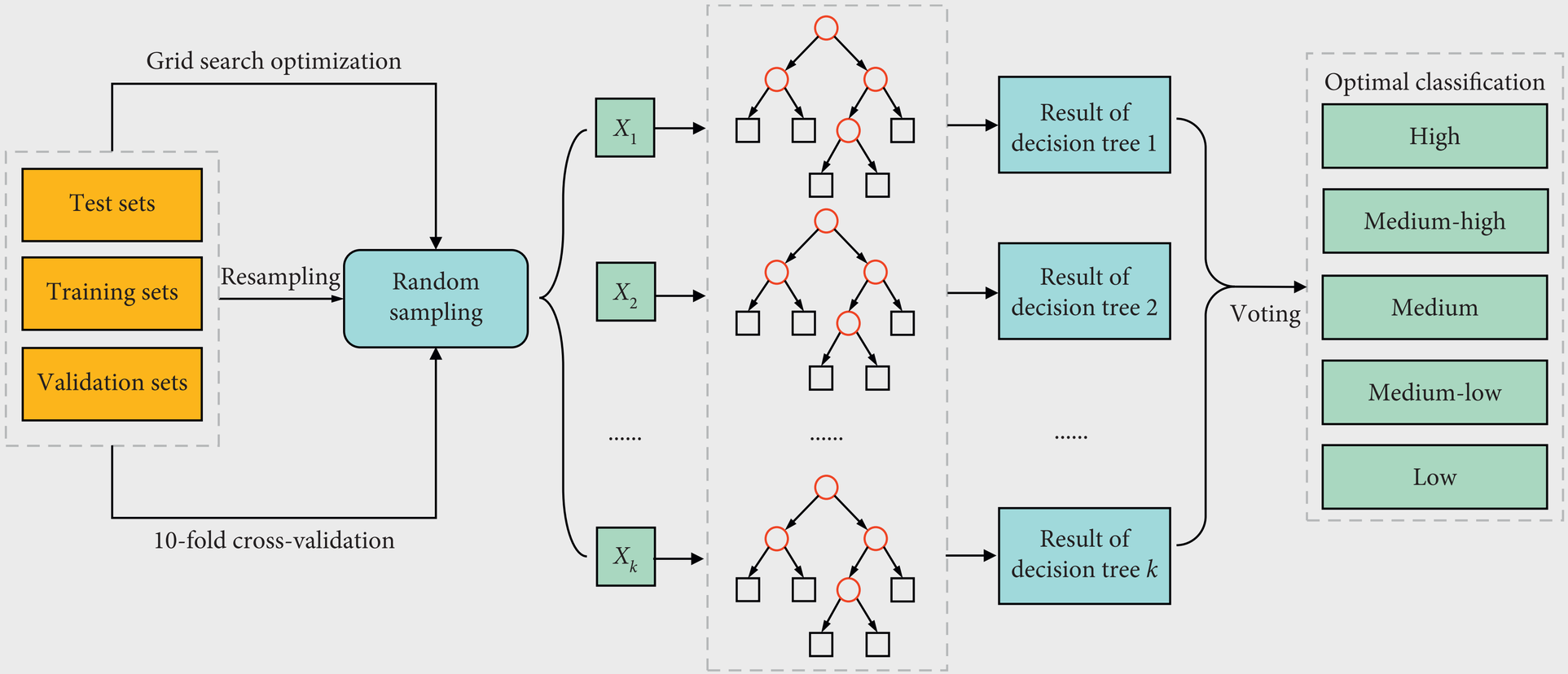
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Attention monitoring

Workflow of improved random forest algorithm



Attention monitoring

Improved random forest algorithm

- Predictions of multiple uncorrelated Decision Trees
- Simple majority voting to determine optimal classification
- Grid Search Optimization
- 10-fold Cross Validation

Attention training

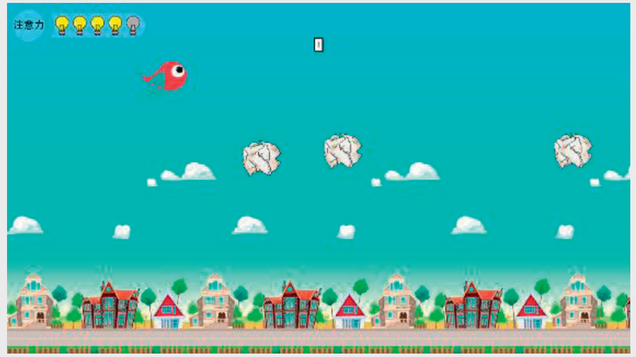
Serious Games with Closed-Loop Neurofeedback

Attention mechanisms by Sohlberg & Mateer 1978

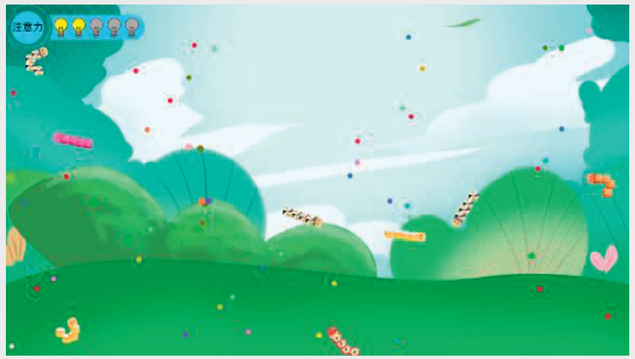
- (a) Sustained
- (b) Selective
- (c) focus



(a)



(b)



(c)

Experiments for Attention monitoring

- Offline Analysis with 80 participants to verify effectiveness
- Online Analysis headset at 256 Hz to record EEG data
- 5 male and 5 female healthy subjects
- Induced attention through specific tasks
- Self-Assessment Manikin (SAM) to evaluate attention

Experiments for Attention training

Serious Games with Closed-Loop Neurofeedback

- Online Analysis: OpenBCI headset at 256Hz to record EEG data
- 5 male and 5 female healthy subjects
- Calibration session and evaluation session
- Preparation phase, training phase & rest phase

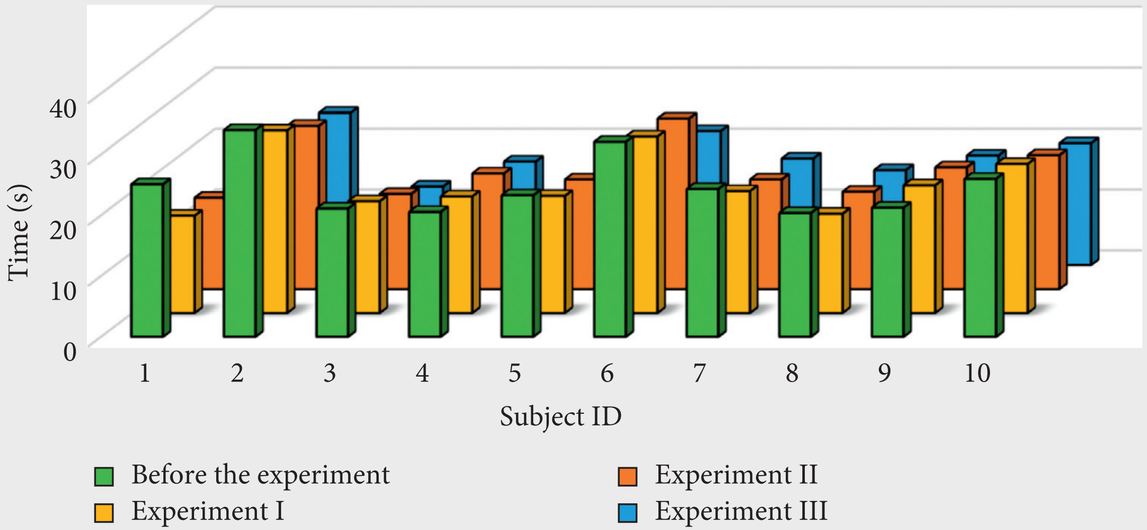
Experiments for Attention training

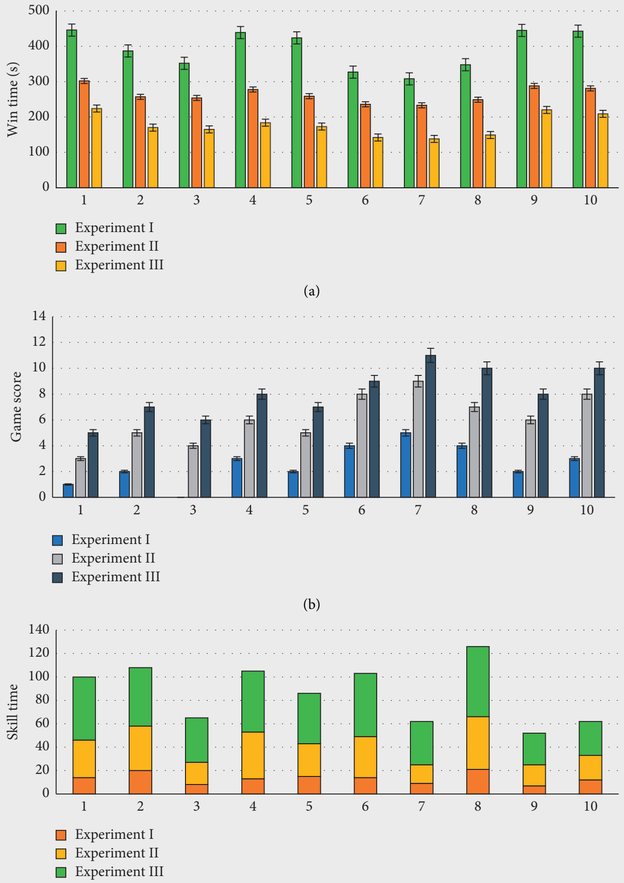
Serious Games with Closed-Loop Neurofeedback

- Each subject performed 3 experiments
- Effectiveness scored by Schulte times, win times, game scores and skill times
- Attention was influenced by familiarising with game, but much lower without neurofeedback

Experiments for Attention training

Serious Games with Closed-Loop Neurofeedback





Experiments for Attention training

Serious Games with Closed-Loop Neurofeedback

Other attention training studies focused mostly on

- EEG without neurofeedback
- Only one attention mechanism

Article showed that combination can significantly improve attention

- Limitation in small number of participants
- External factors not considered

[1] 2012 Trans Cranial Technologies ldt. 2410 Fortis Tower, 77-79 Gloucester Road, Wanchai , Hong Kong