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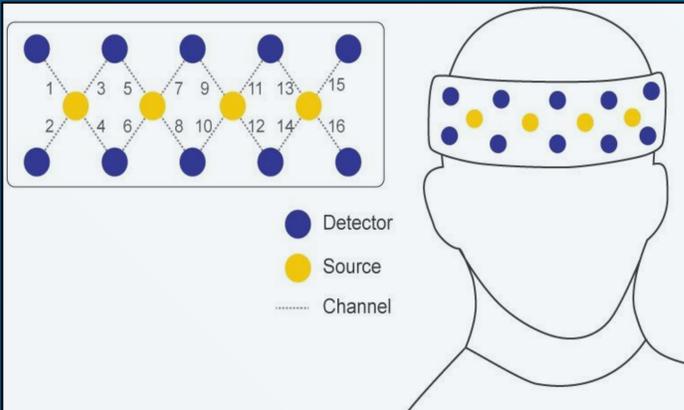
Max L. Wilson

Abstract



We compared different supervised machine learning approaches at classifying mental workload from functional Near InfraRed Spectroscopy (fNIRS) data collected during a computer-based task. We examined logistic regression, SVM, and CNN, personalised and generalised models with adapted feature selection to take advantage of each model.

- generalised models performed as good as personalised ones enabling to avoid the training phase for new participants
- deep learning was a suitable approach for medium size fNIRS datasets



Dataset

- **fNIRS data** collected while participants performed a **computer-based task** designed to impose different levels of mental demand.
It consisted of aiming at target balls using a joystick and shooting them within a time window using a button on the joystick. The number of balls varied during the task to elicit different levels of mental workload. This task was performed three times.
- **fNIRS**: measure of **blood oxygenation** in the prefrontal cortex: focus on **working memory**
- Labels: **Instantaneous Self Assessments (ISA)** throughout the tasks (Low vs High mental workload: 2 classes, or Low vs Medium vs High mental workload: 3 classes).

Pipeline

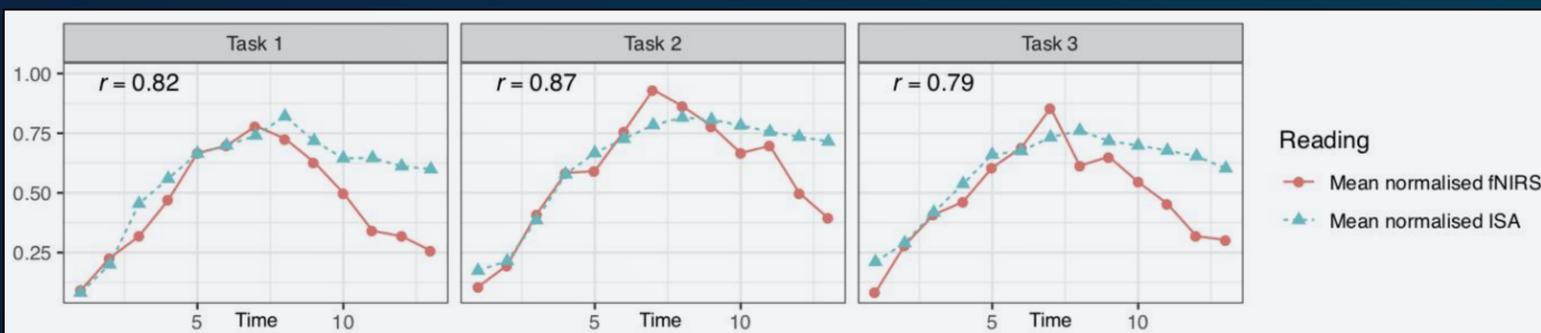


Personalised learning for the logistic regression and the SVM:
→ training on 2 tasks and testing on 1 for each participant

Generalised learning for the logistic regression, the SVM and the CNN:
→ training on 8 participants and testing on 1

Features		
Logistic regression	Support vector machine	Convolutional neural network
<i>mean</i>	<i>mean</i> <i>standard deviation</i> <i>gradient</i>	<i>mean</i> <i>standard deviation</i>

Findings



The normalized fNIRS data before the feature selection, averaged across the participants, were already quite correlated to the ISA ratings

- **Personalised** models outperformed generalised models for **2 classes** of mental workload
- **Generalised** models outperformed personalised models for **3 classes** of mental workload
- The best model for **2 classes** classification was a **personalised logistic regression**
- The best model for **3 classes** classification was a **generalised SVM**
- A **CNN** was suitable for mental workload classification even with a **limited dataset** (8 participants for the training set)

Classes	Approach	Personalised	Generalised
2 classes	Logistic regression	75.21 %	68.09 %
	SVM	72.81 %	71.27 %
	CNN	N/A	72.77 %
3 classes	Logistic regression	46.15 %	50.99 %
	SVM	48.56 %	53.90 %
	CNN	N/A	49.53 %

Future work

- Collect more labeled data
- More complex approaches specifically designed for small datasets
- Combination of generalised and personalised to reduce the training time for each participant
- Application to real-time classification

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