SUMMER RESEARCH 2024/25
PROJECT ABSTRACT

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

PROJECT # 25

SUPERVISOR/S:	Dr Jemma König
PROJECT TITLE:	How tired are you? Using wearable devices to identify cognitive workload and cognitive fatigue
FIELD:	Software Engineering
DIVISION/SCHOOL:	HECS - Au Reikura School of Computing and Mathematical Sciences
PROJECT LOCATION:	Hamilton

PROJECT ABSTRACT:

This summer research scholarship will contribute to the SmartMind project. SmartMind centres on the identification of cognitive workload and cognitive fatigue using portable, non-intrusive, cost effective wearable devices. Cognitive workload and cognitive fatigue are typically measured using EEG data, which is only really suited to laboratory-based studies. Instead, the SmartMind project proposes the use of other physiological datapoints (ECG, EDA, and EMG) using portable, non-intrusive, and cost effective wearable devices.

As part of the larger SmartMind project, a dataset of physiological data was collected, both while participants were resting, and while participants undertook a cognitively intensive task. This data includes EEG as a cognitive baseline, alongside ECG, EDA, and EMG readings. This SRS project will involve the processing of this physiological data for workload and fatigue classification, contributing to the larger aims of the SmartMind project.

The objective of this scholarship is threefold: (1) to investigate different physiological readings (EEG, ECG, EDA, and EMG), (2) to investigate existing approaches for processing and categorizing physiological data, and (3) to apply the learnings from objectives 1 and 2 to the SmartMind dataset in order to obtain meaningful information about fatigue and workload.

For the first objective, the successful student will take time to learn about the different physiological datapoints (EEG, ECG, EDA, and EMG). They will investigate how this data is typically recorded (e.g. raw readings, sampling rates) and how it may be processed to extract meaningful information (e.g. extracting heart rate and heart rate variability from ECG data).

For the second objective, the successful student will learn about wearable IoT data and how physiological data is often approached. They will investigate approaches for handling different sampling rates (e.g. sliding windows) and investigate existing approaches for workload and fatigue classification.

For the third objective, the successful student will apply what they have learned during objectives 1 and 2. They will identify an appropriate approach for workload and fatigue classification with physiological data. They will implement this approach and evaluate its effectiveness. This may involve the use of Machine Learning algorithms and/or statistical analysis.

This SRS will provide the successful student with experience working on an active research project. It may also lead to further study including an Honors and/or Masters project.

The work completed during this scholarship will contribute to research that is currently being undertaken in cognitive workload and cognitive fatigue identification. It may be used, in conjunction with the Au Reikura School of Computing and Mathematical Sciences, to identify cognitive fatigue within the Forestry industry. It may also be used in conjunction with the Te Kura Mata Ao School of Engineering and the Te Huataki Waiora School of Health to investigate cognitive workload and cognitive fatigue for amputees and stroke patients. As such, this research has great relevance to New Zealand's primary industries and the wider community.

STUDENT SKILLS:

- Programming experience (required)
- Data processing (preferred but not required)
- Python programming (preferred but not required)
- Experience with large datasets (preferred but not required)
- Experience with machine learning classifiers (preferred but not required)

PROJECT TASKS:

1. Research on physiological data points (EEG, ECG, EDA, and EMG)
2. Research on processing heterogenous physiological data (e.g. variability in recording rates, sliding windows, variability in the metrics used to measure physiological data)
3. Research on existing approaches for cognitive workload and cognitive fatigue classification using physiological data.
4. Develop an application (likely in Python) for processing raw physiological data to extract meaningful measures (e.g. heart rate and heart rate variability)
5. Apply categorization methods to the data (likely in Python, Weka, and/or Moa)

EXPECTED OUTCOMES:

- Student's Research Poster (as per clause 6 of the Scholarship regulations)
- A brief report outlining objectives 1 and 2. This may include information about physiological data, handling heterogenous data, and approaches for classification.
- A Python application for processing physiological data
- A journal or conference publication (in the longer term)