SUMMER RESEARCH 2024/25
PROJECT ABSTRACT

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

PROJECT # 63

SUPERVISOR/S: Dr. Mitchell Head & Dr. Anany Dwivedi

PROJECT TITLE: Decoding Minds: Using Deep Learning to Classify Brain Signals from EEG Data

FIELD: Computer Science, Neuroscience, Engineering

DIVISION/SCHOOL: Te Mata Punenga o Te Kotahi | Te Kotahi Research Institute (TKRI)

PROJECT LOCATION: Hamilton

PROJECT ABSTRACT:

In this project, we aim to decode human brain signals from wearable electroencephalogram (EEG) data through advanced deep learning techniques. Our approach involves cleaning and pre-processing raw EEG data to ensure its quality, followed by experimenting with various deep learning models, including Convolutional/Recurrent Neural Networks (CNN/RNNs), and LSTMs, to classify human brain signals accurately. We evaluate these models using comprehensive metrics such as accuracy, precision, recall, and F1-score, and employ cross-validation to ensure robust performance. To enhance the interpretability of our models, we focus on methods like SHapley Additive exPlanations (SHAP) , Local Interpretable Model-agnostic Explanations (LIME), and Grad-CAM, providing insights into the decision-making process.
EEG dataset will be provided, having been collected with appropriate ethics approvals from our earlier study using consumer wearable devices.
Join us to build the cool tech of the future!

STUDENT SKILLS:

- Experience with Python
- Experience with Pytorch
- An interest/previous experience in using deep learning models ideal.

PROJECT TASKS:

1. Understand Data Preprocessing and Exploration
    - Task: Clean and preprocess the provided EEG dataset.
    - Deliverable: A cleaned and preprocessed dataset ready for model training.
2. Building and Training Deep Learning Models
    - Task: Develop and train several deep learning models (e.g., CNNs, RNNs, LSTMs) for brain signal classification using raw EEG data.
    - Deliverable: Trained deep learning models with performance metrics (accuracy, precision, recall, F1-score).
3. Model Evaluation and Validation
    - Task: Evaluate the trained models on a validation set and perform cross-validation.
    - Deliverable: A comprehensive evaluation report, including confusion matrices and cross-validation results.
4. Implementing Explainability Methods
    - Task: Apply explainability methods such as SHAP (SHapley Additive exPlanations), LIME (Local Interpretable Model-agnostic Explanations) and Grad-CAM to interpret the deep learning models' predictions.
    - Deliverable: Visualizations and explanations of the model's decision-making process. Include a report detailing the interpretability findings.
5. Documentation and Presentation
    - Task: Document the entire project process and prepare a presentation/poster.
    - Deliverable: A well-documented project report and a presentation/poster to be shared with the team or at a final review meeting.

EXPECTED OUTCOMES:

- Student's Research Poster (as per clause 6 of the Scholarship regulations)
- Develop processing pipeline for pre-processing EEG signal analysis
- Benchmark different machine learning models for the available dataset