Brain-Controlled Virtual Instruments for Children

Ethan Dhanraj, Jenny Tou, Tom Chau

Background

Brain Computer Interface (BCI)

Machine Learning (ML) Classifier

Electrical activity in the brain is classified into commands for a computer

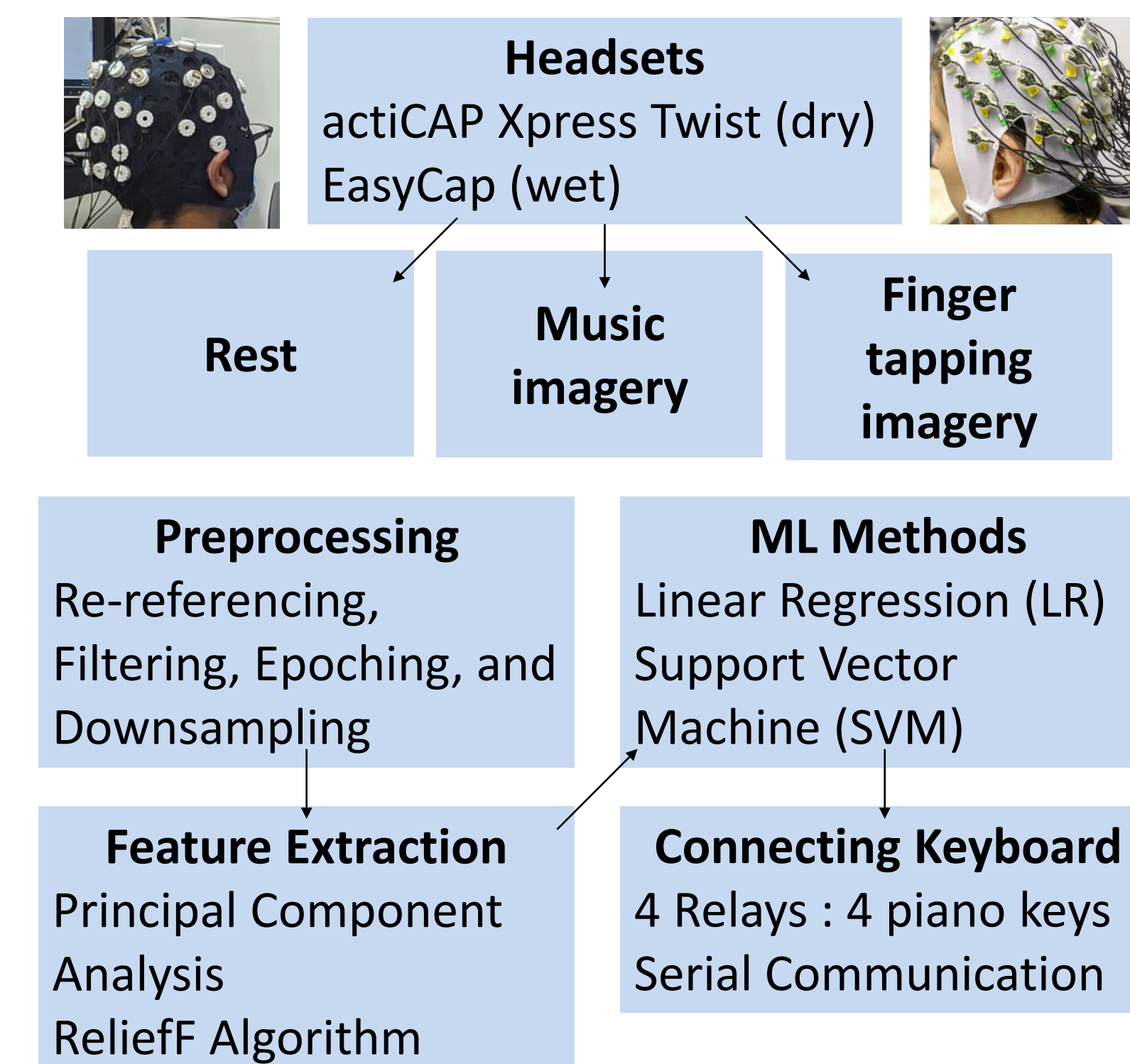The computer sends signals to play piano keys

Research Questions

Can music imagery and or motor imagery recorded using electroencephalography (EEG) be used in a BCI?

What are the best headsets, signal features, and machine learning methods for classification?

Methods & Analysis

Headsets
actiCAP Xpress Twist (dry)
EasyCap (wet)

Rest

Music imagery

Finger tapping imagery

Preprocessing
Re-referencing, Filtering, Epoching, and Downsampling

ML Methods
Linear Regression (LR)
Support Vector Machine (SVM)

Feature Extraction
Principal Component Analysis
ReliefF Algorithm

Connecting Keyboard
4 Relays : 4 piano keys
Serial Communication

Music Imagery Can be Used to Control a Piano Keyboard

Results

The **ML classifier** can discern **music imagery** from **rest**
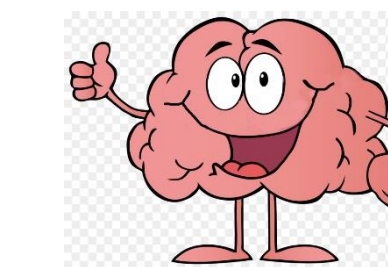
Dry headset   Wet headset
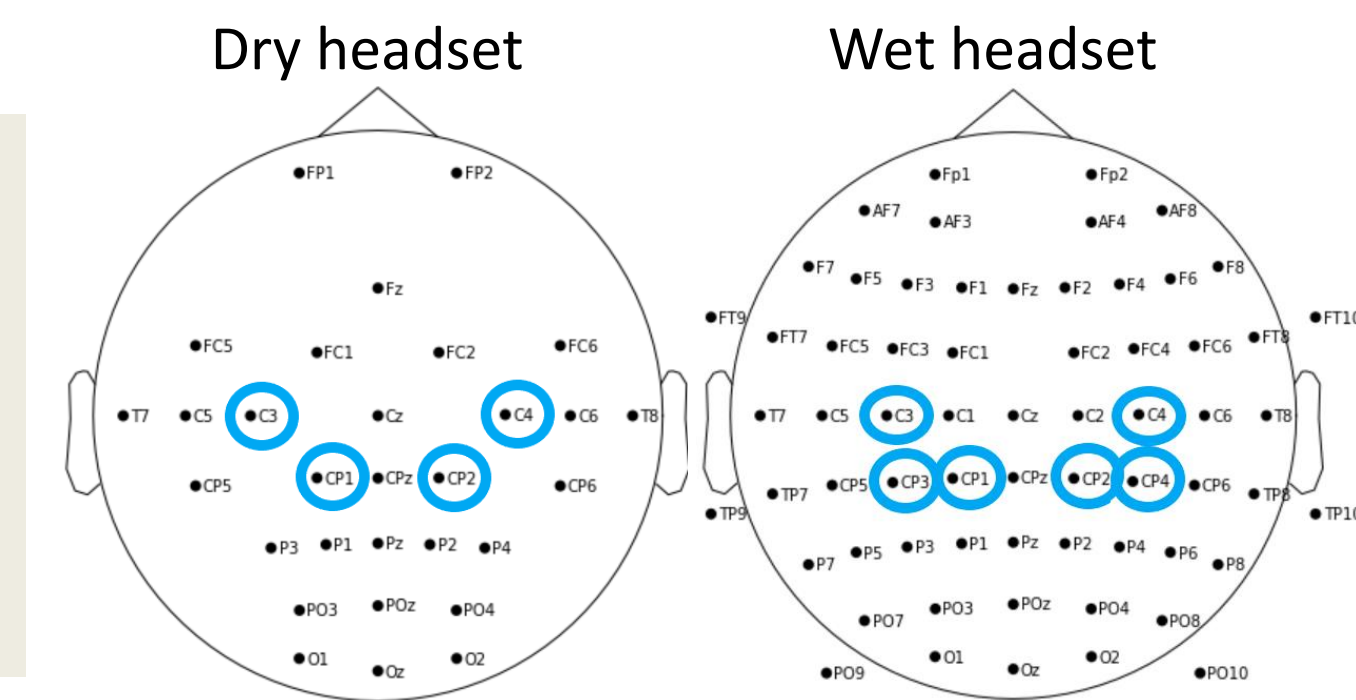
Uses select channels (dry: 4, wet: 6) from the central and central-parietal regions of the brain

Uses **ReliefF** to extract **60 features** from time series
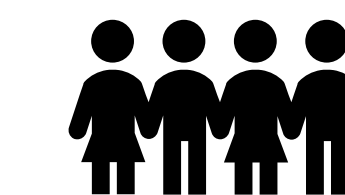Uses **SVM** for classification

Classifier output used to control 4 keys (C, D, E, G)

Conclusion & Next Steps

The BCI shows promise in distinguishing EEG recordings of music imagery from rest to control a piano keyboard.

The music imagery BCI will be used and evaluated in children with diverse physical abilities in a future study.

Relevance to Holland Bloorview

BCIs can provide an alternative pathway for communication and external interactions (1). This can benefit children with complex communication needs such as:
- Locked-in syndrome (LIS)
- Cerebral Palsy (CP)
- Spinal cord injury

This research can improve the accessibility of music training and its benefits.

References
1. Zhang J, Jadavji Z, Zewdie E, Kirton A. Evaluating If Children Can Use Simple Brain Computer Interfaces. Frontiers in Human Neuroscience. 2019;13.