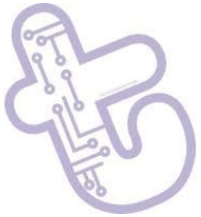
Northwestern
THE GRADUATE SCHOOL

Northwestern Summer Research Opportunity Program (2021)

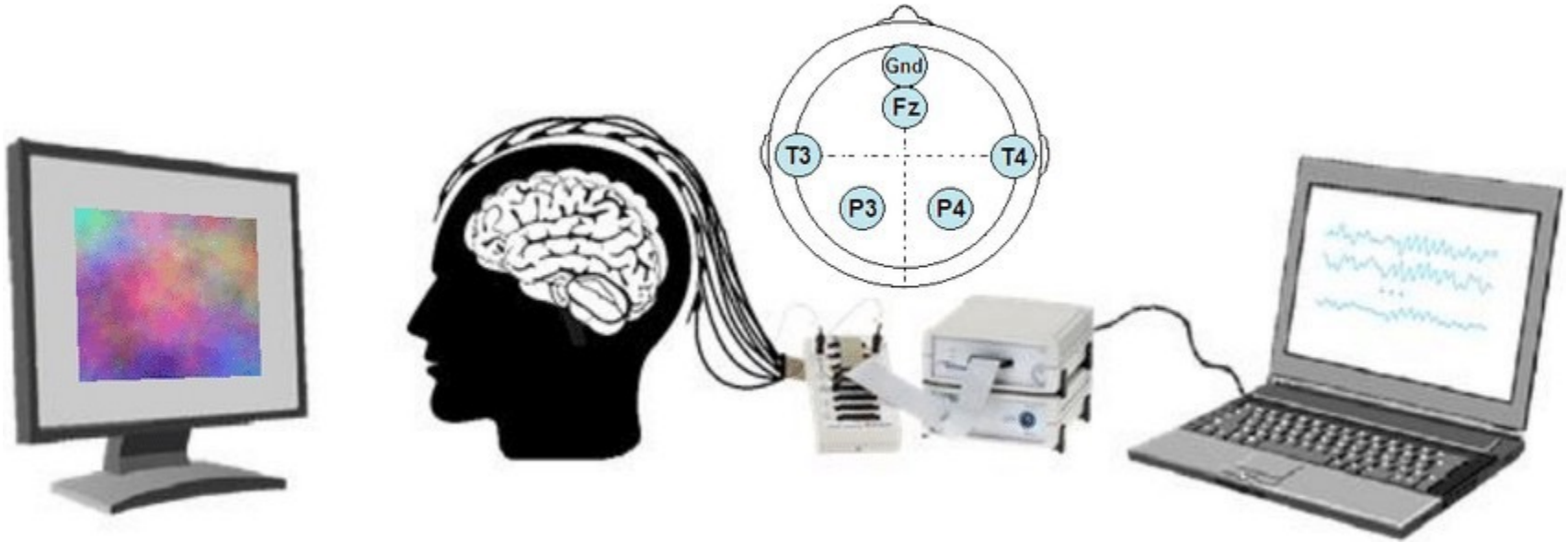
Tiilt Lab



Kyung Myung (Andy) Ko

Research Project

Brain-Computer Interface: EEG signal to initiate Minecraft playing command



https://www.researchgate.net/figure/Experimental-setup-Screen-participant-with-electroencephalography-EEG-headset-EEG_fig1_348013241

Outline

- Introduction
  - Project Description
  - My Role
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I. Introduction

Project Description

My Role

Project Description

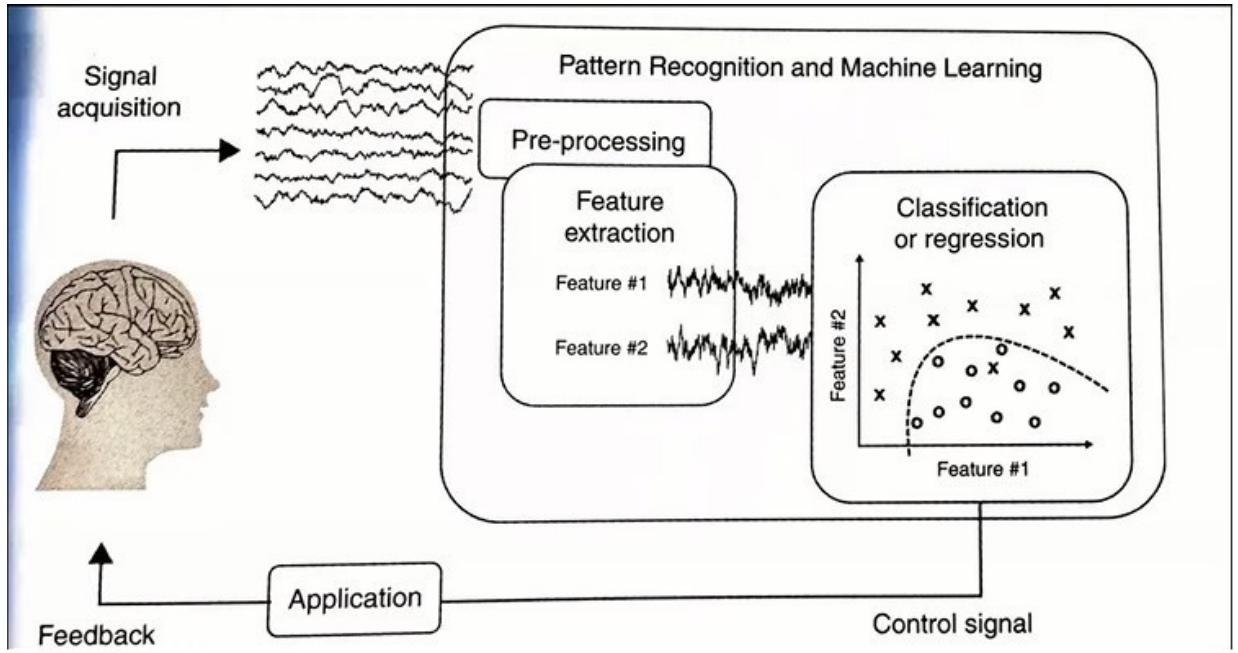
Multimodal

- Using multiple inputs for better interaction with the system
- Speech-based, eye tracking, object detection

Multicraft

- Multimodal input to control the Minecraft interface
- Support diverse learners in non-traditional learning environments.

My Role



Electroencephalography (EEG)

Measures electrical activity of a brain

Characteristics:

- Entails diverse and rich information

Challenges:

- Complexity in processing

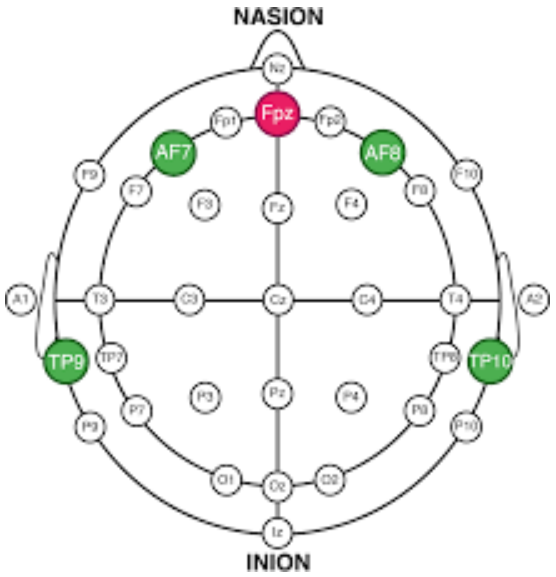
II. Methodology

Dataset

Feature Extraction

Model Description

Dataset



Muse S. (Headset)

- Has 4 sensors (dry electrodes): TP9, TP 10, AF7, AF8 to measure data from

Additional Tools

- muse-lsl: python package to access the EEG data
- BlueMuse: GUI to connect the headset to a PC

https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8513653,
Real-time Mental State Recognition using a Wearable EEG

Dataset

State 1. Wandering

- Subjects were to move in any direction from the map

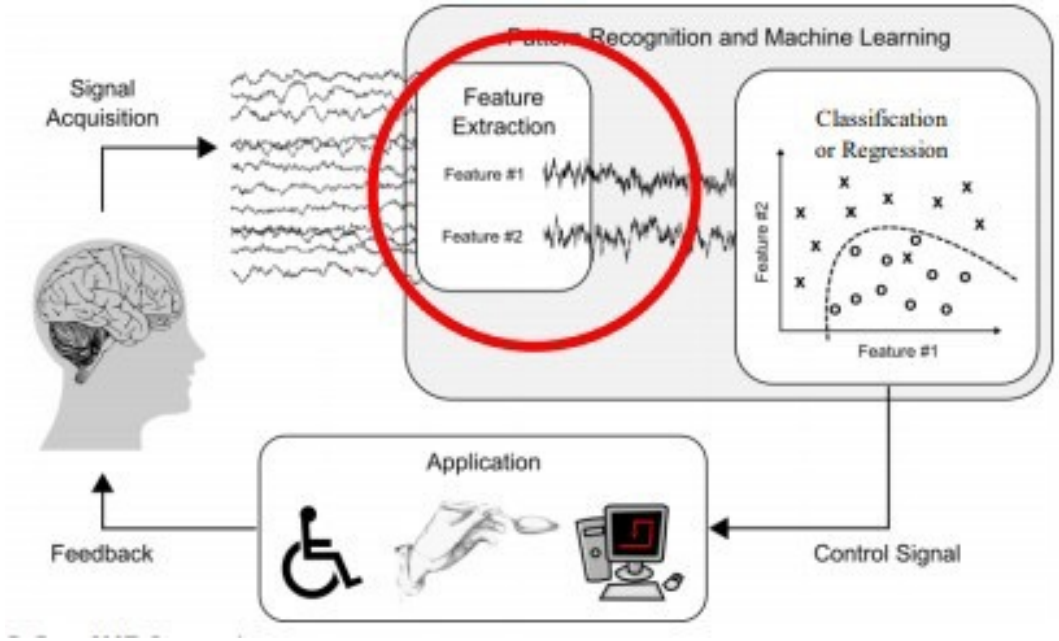
State 2. Mining

- Subjects were to simply mine with any tool

State 3. Building

- Subjects were to build anything (default to N x N shape) using any type of block

Feature Extraction



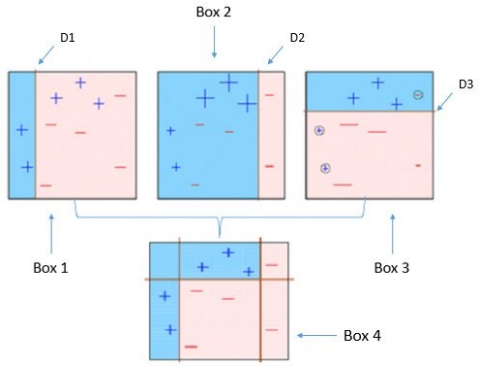
Short-time Windowing Technique

- Single-point features does not convey enough information for the models to learn
- Generates a total of 988 features + label = (989)
- Specific feature details could be found from *"Classification of EEG Signals Based on Image Representation of Statistical Features"* by J. Ashford, J. Bird, F. Campelo, and D. Faria

Model Description

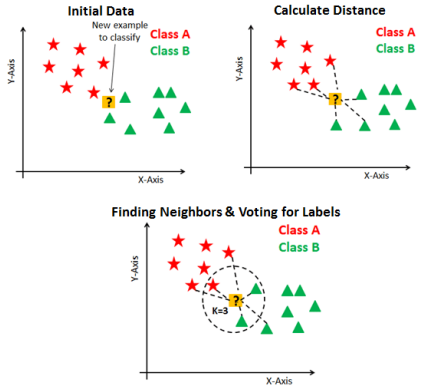
XGBoost

- Gradient Boosting technique



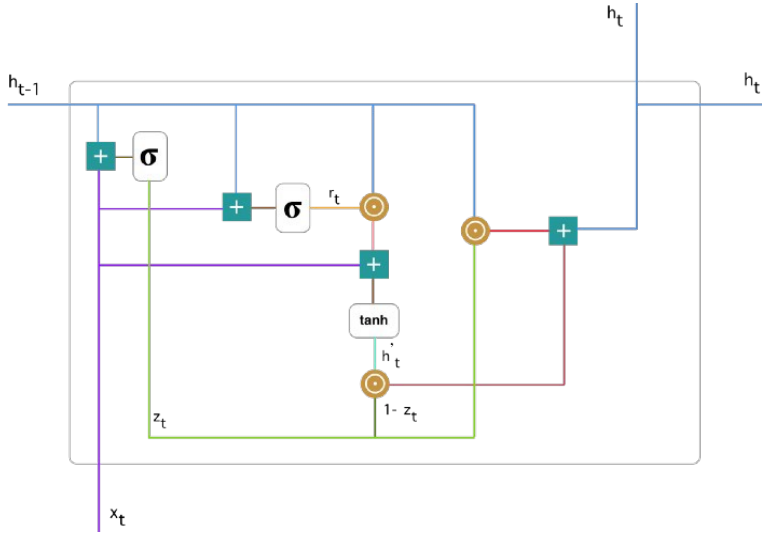
K-Nearest Neighbor (KNN)

- Uses Euclidean distance to determine the closest neighbors



Gated Recurrent Unit (GRU)

- Deep learning architecture
- Uses update and reset gate to determine what information to include/lose every time series

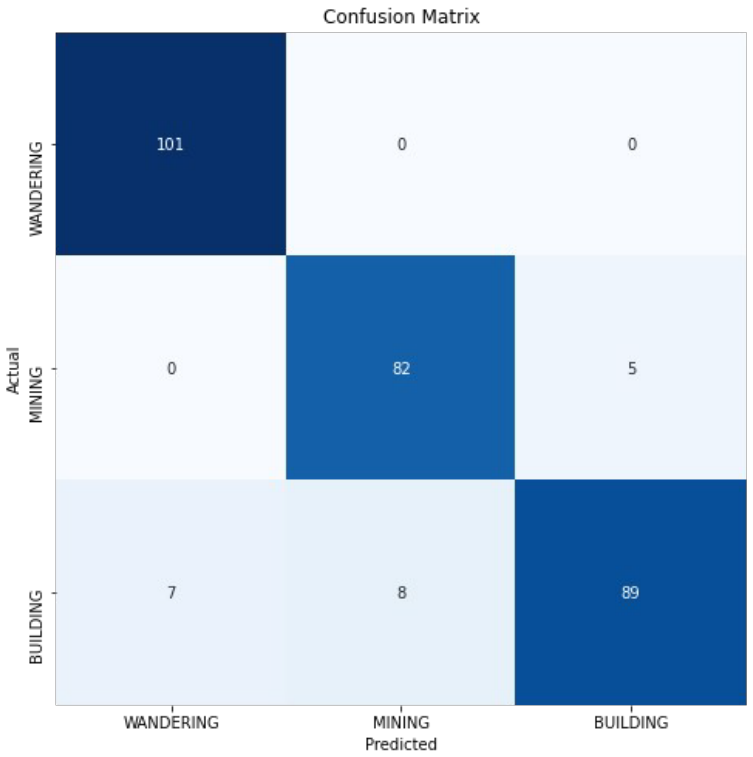


III. Results

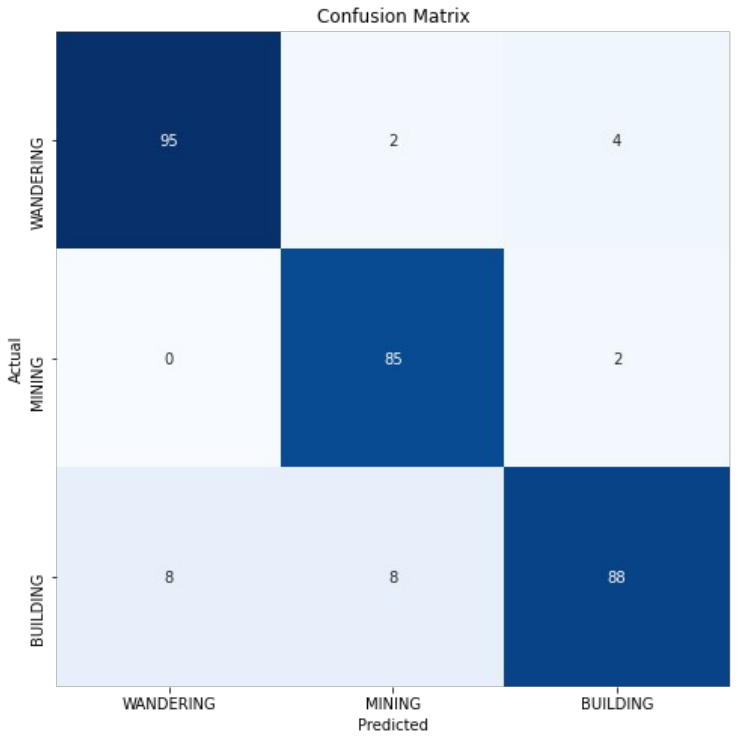
Model Evaluation Metrics

Discussion

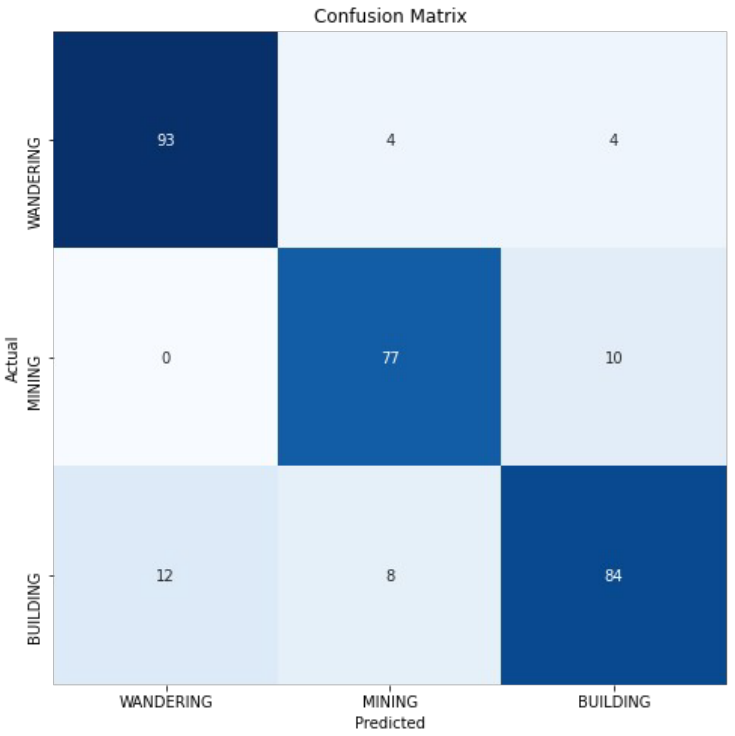
Model Evaluation Metrics



XGBoost: 93.15%



GRU: 91.78%



KNN: 86.99%

Discussion

Meaning of the Evaluation Metrics

- Use the trained model to predict at EEG state at real-time
- May even use more than one model for the classification task

Meaning of our Work

- Introducing EEG to accessible application
- Contribute to next level of interaction with machines

IV. Conclusion

Current Position

Future Goals

Current Position

Current Work

- Real-time Minecraft playing state classification using the trained models
- Developing a real-time task conversion based on the result of the EEG status

Current Models

- May need more dataset from more various users
- Still discovering optimal hyperparameter settings for the GRU model

Future Goals

Future Goals

- Incorporating eye gaze feature to perform more precise commands

Challenges

- Need more dataset to train the models
- Developing a real-time classification result conversion to appropriate Minecraft actions

Questions?

Thank You For Listening!

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https://github.com/andyko208/EEG_Classification