PROJECT VADER

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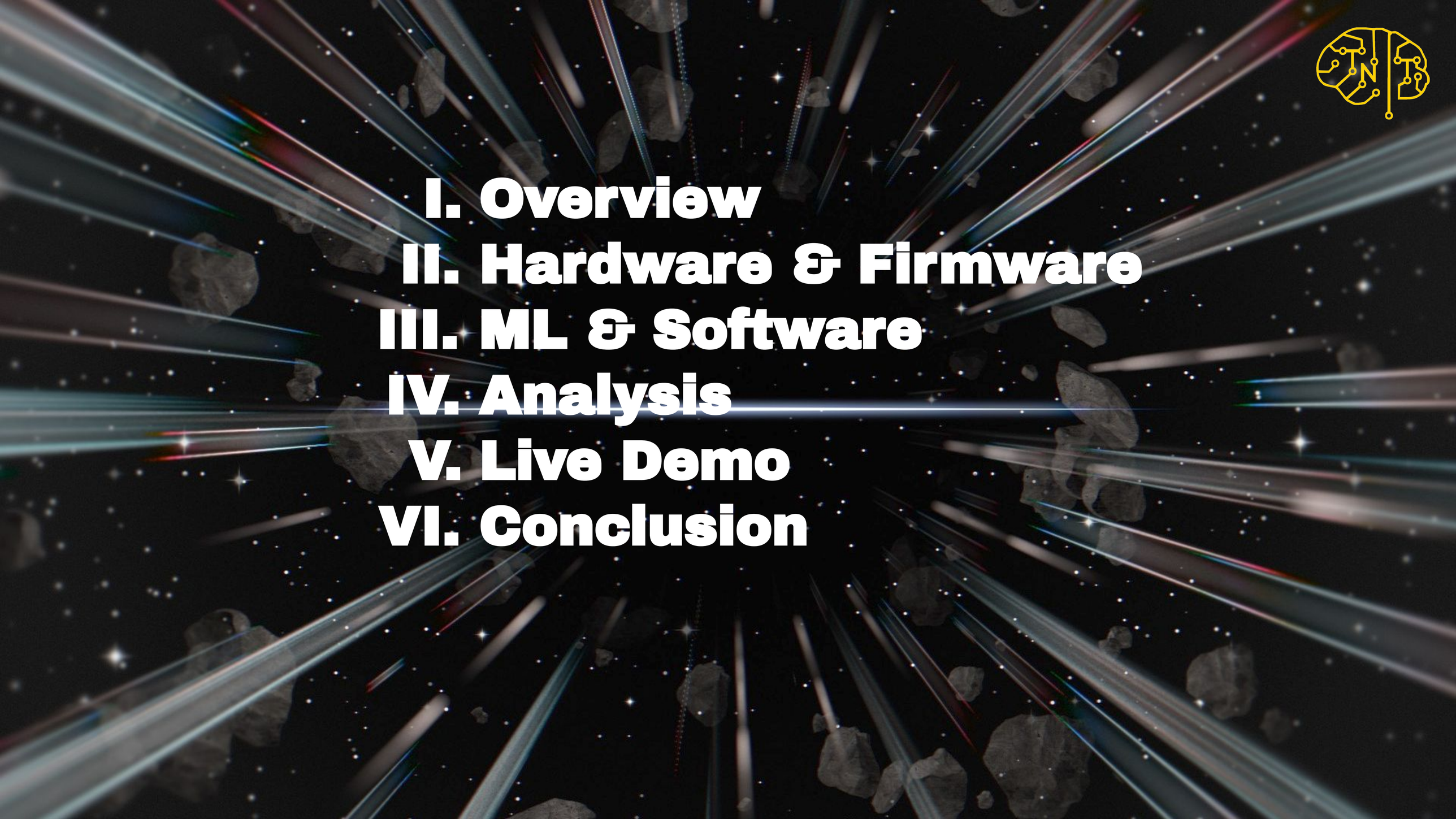

I. Overview
II. Hardware & Firmware
III. ML & Software
IV. Analysis
V. Live Demo
VI. Conclusion

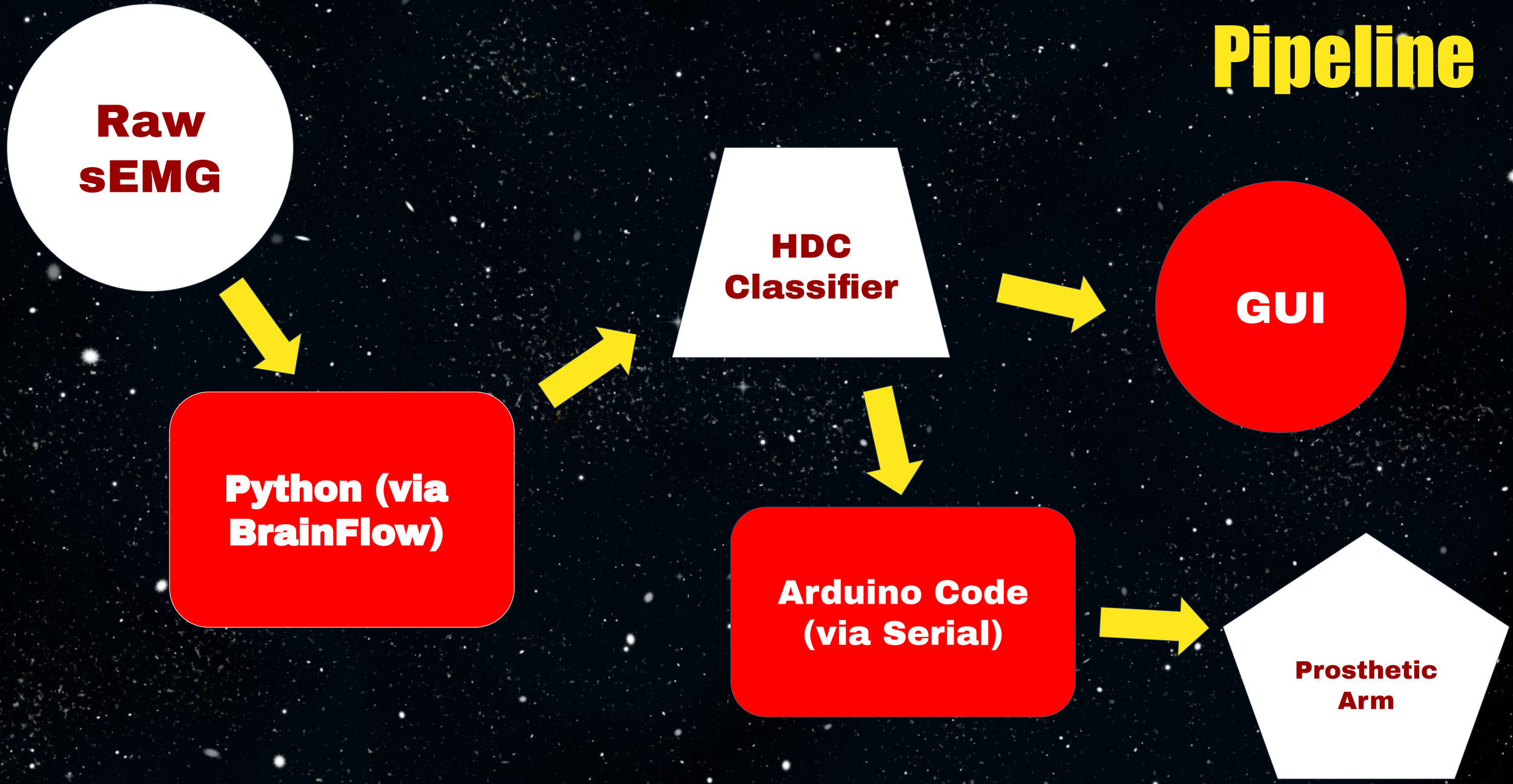
Overview

01 1.7 million people just in the U.S. alone with limb loss

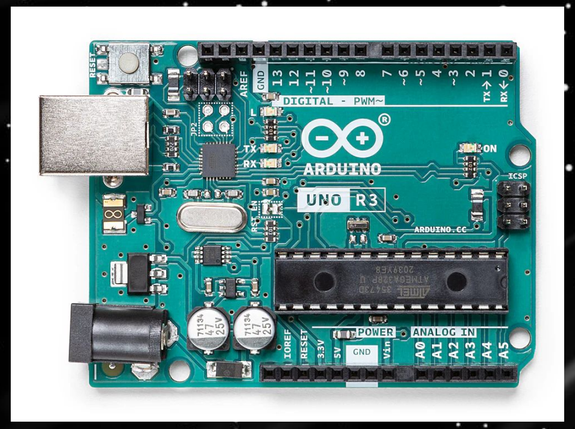
02 Prosthetic arms are very costly (easily in the thousands of dollars)

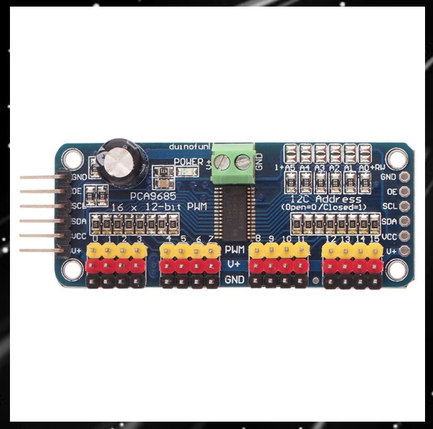
03 Goal: Provide a high number of gesture classifications at a low cost (less than $500)

Pipeline


Raw sEMG
Python (via BrainFlow)
HDC Classifier
GUI
Arduino Code (via Serial)
Prosthetic Arm

Hardware & Firmware





- Servos
- Arduino Uno
- PCA 9685
- Springs
- 200 lb Fishing Line

Hardware & Firmware

Armband

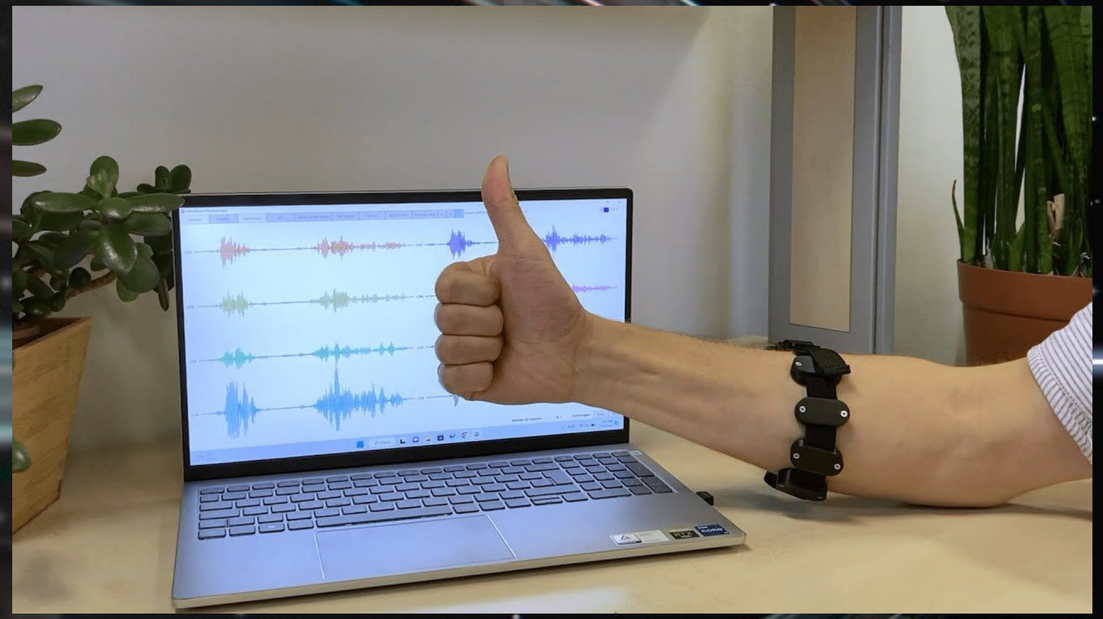
- Electrodes for sEMG Data
- Receive Data via BrainFlow
- Gyroscope Data

Arduino

- Receive Data via Serial
- Posture Alignment
- Signaling to PCA 9685

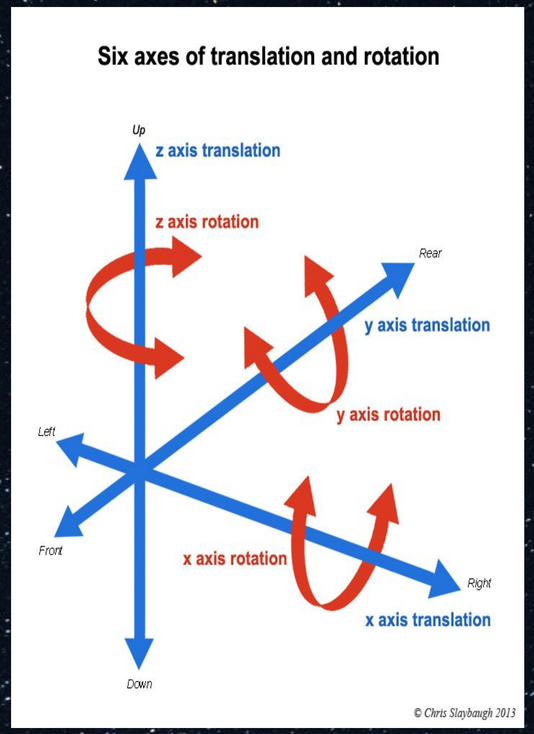
ML & Software

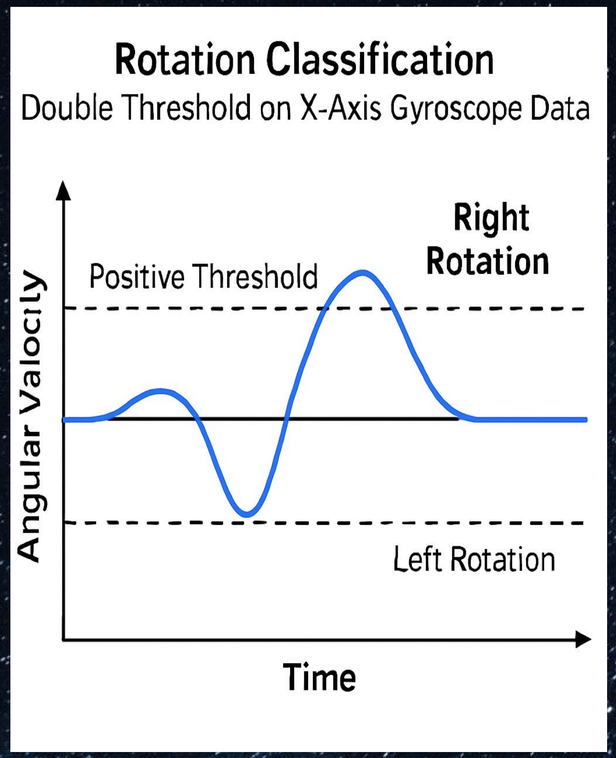
Data Acquisition and Preprocessing



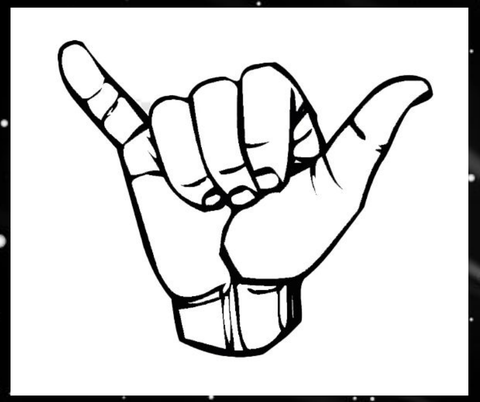
- 4 Channels
- 500 Hz Sampling Rate
- Label Synchronization
- Bandpass + Notch

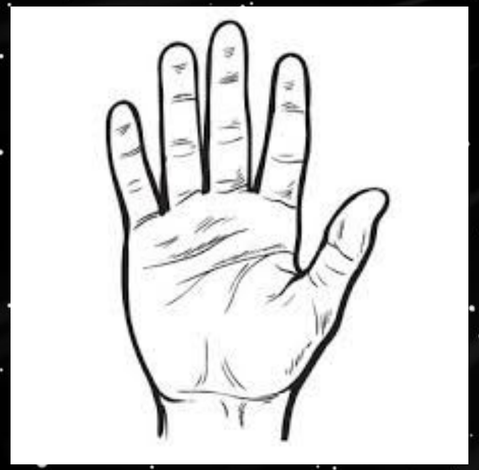
Rotation Classification





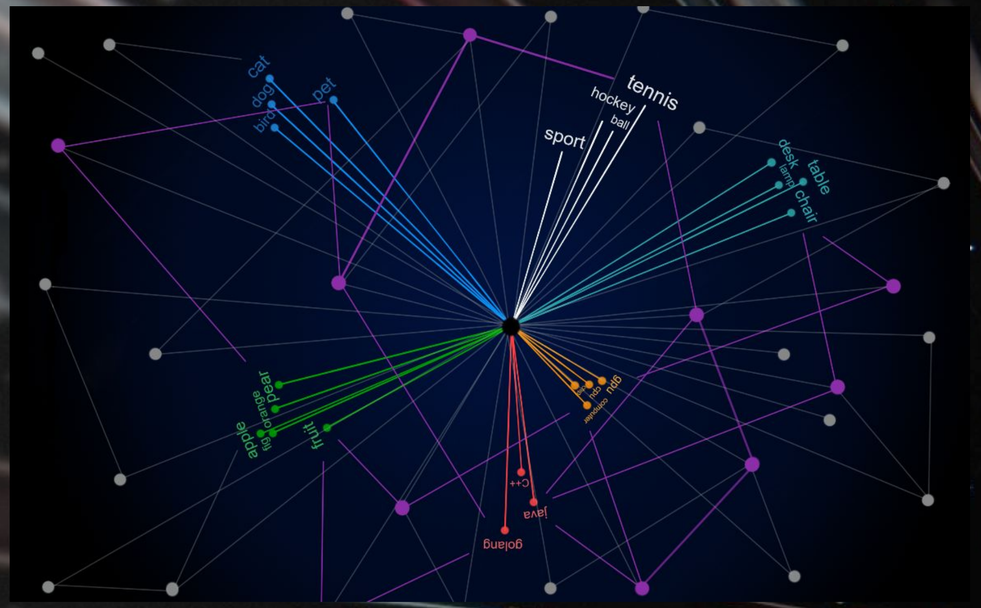
- Angular Velocity
- X-Axis Rotation
- Double Threshold
- 3 Rotational States





Gesture Classification

- Training Data
- 5 Classes
- Hyperdimensional Computing

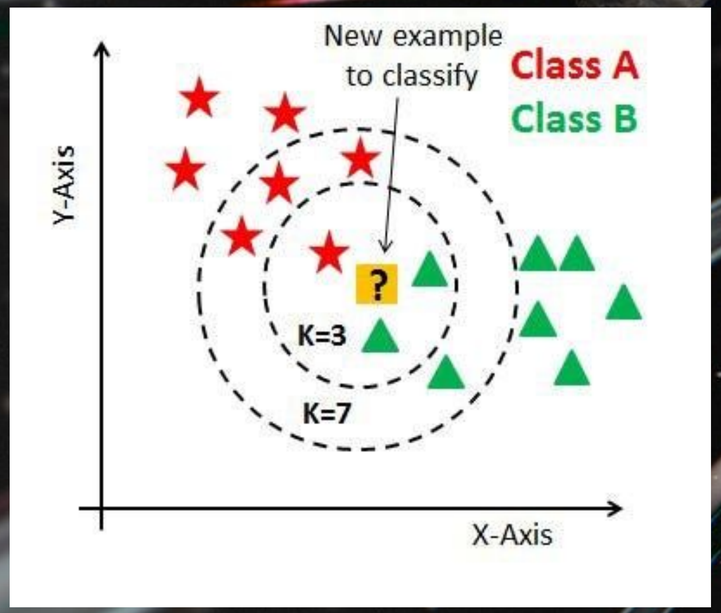


Brain-Inspired Computing

- Flexible, noise-tolerant representation
- Very large, high-dimensional patterns ("hypervectors")
- Robustness through redundancy and randomness

How we use it

- Centroid-based
- Few-shot learning



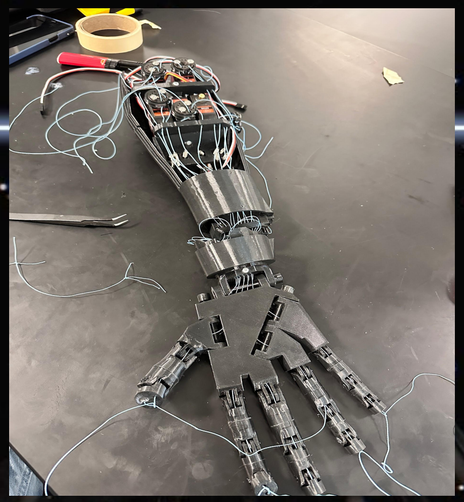
Limitations:

- Classification, not regression

Preliminary Results

- 80 training samples per class:
  - Test Accuracy:
    - 4 classes: ~95%
    - 5 classes: ~89%
    - 6 classes ~80%

LIVE DEMO



Future Directions

- **Custom Armband**
- **Bio-Feedback**
- **Regression-Based Clenching**