Developing a Tool for Sensor Based Clinical Evaluation (SenBaCE)

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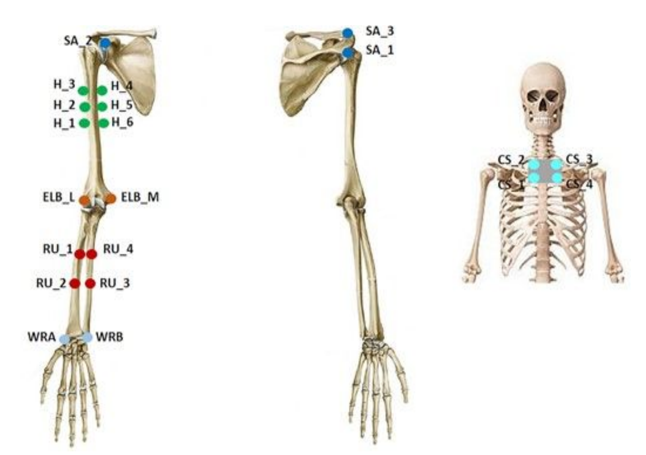
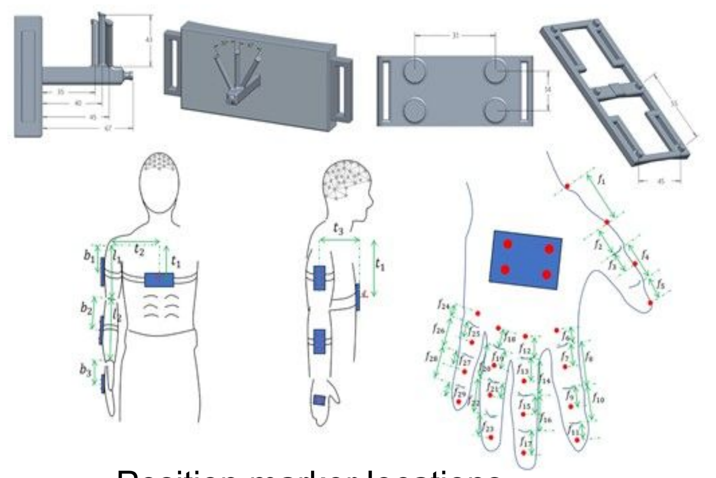
Introduction and Background

- Standard clinical practice involves visual assessments of motor tasks to clinically rate motor impairments.
- Sensor data (i.e. IMU, optical markers, electromyography (EMG)) help quantify motor activity, but there is a gap in making them clinically relevant.
- Here, we demonstrate the use of images generated from positional sensor data to train a convolutional neural network (CNN) to assign clinical scores and deploy it on Streamlit.


Muscles recorded during experiments

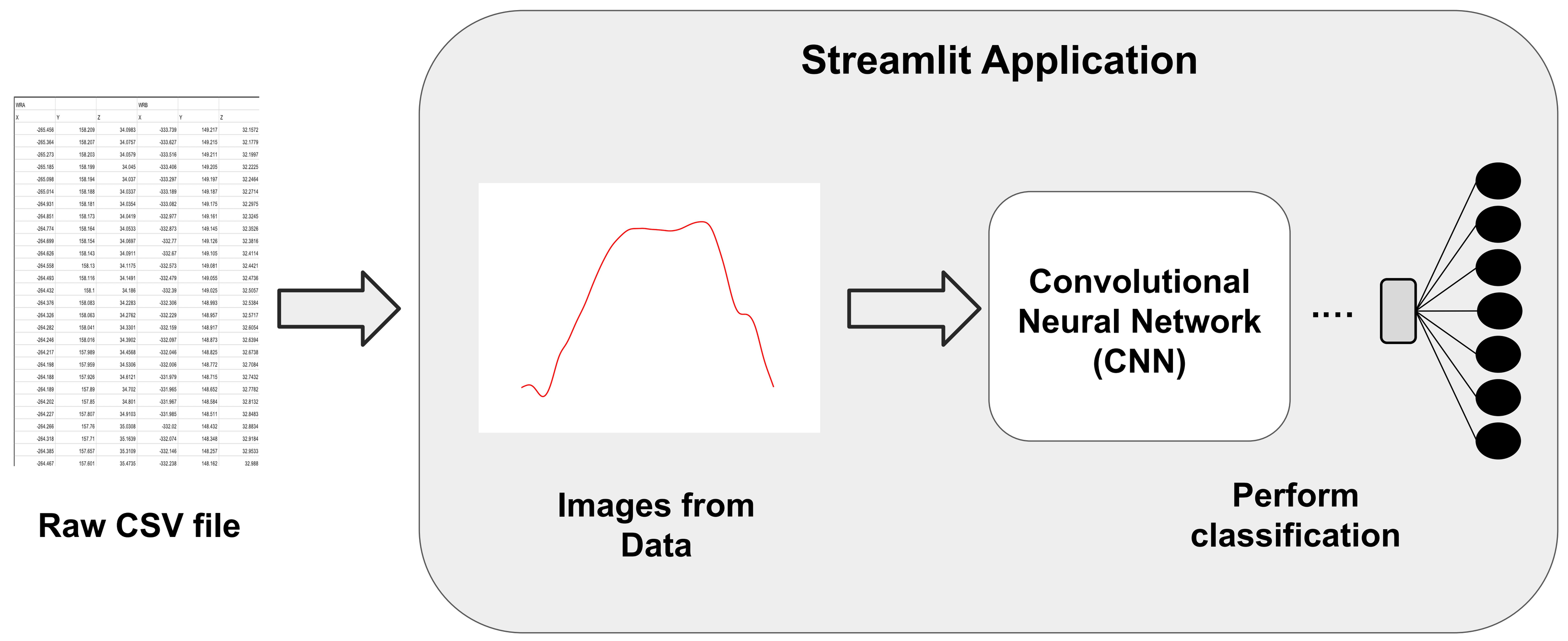

Position marker locations

Data and Design

- Dataset
  - U-Limb: large, multimodal, multi-center dataset on human upper-limb movements.
  - Kinematic data - with position data of thorax, upper-and forearm markers.

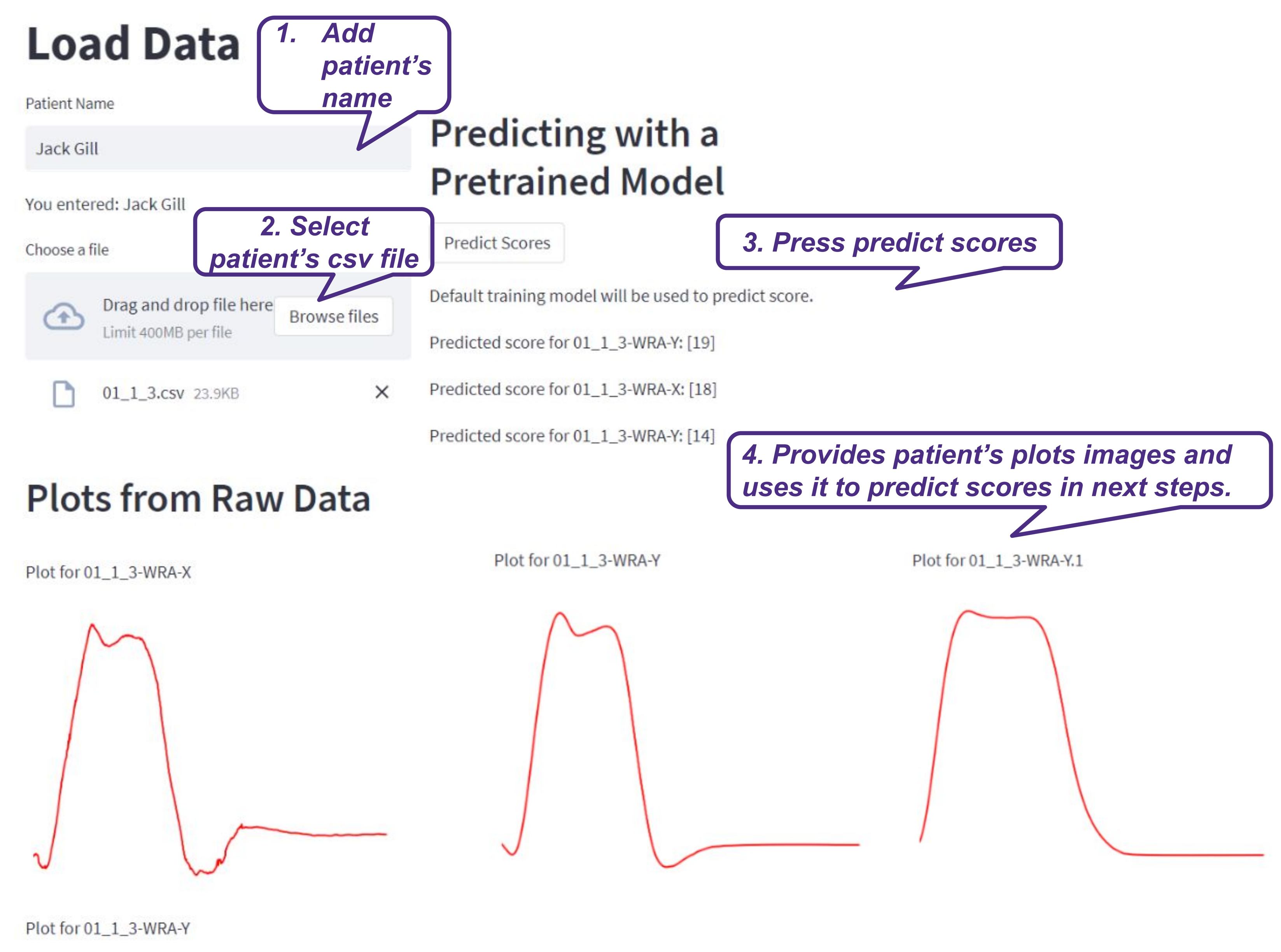
- User Interface (Streamlit Web App)
  - Primary users - Clinician and Researcher/ML
    - Enable prediction of scores (Clinician)
    - Enable training (Researcher/ML)
    - Allow for data import and export

- Processing and ML Pipeline (PyTorch, Pandas, Pillow)



Dashboard and Deploying ML model

1. Load data page



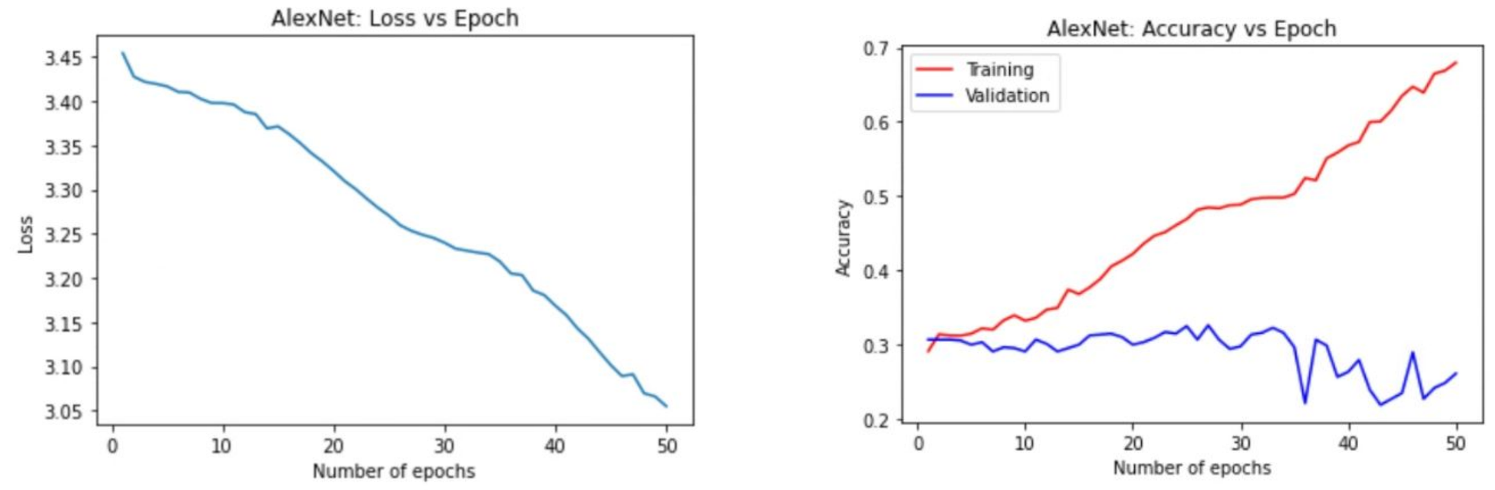
2. Training and prediction page

Challenges/Limitations

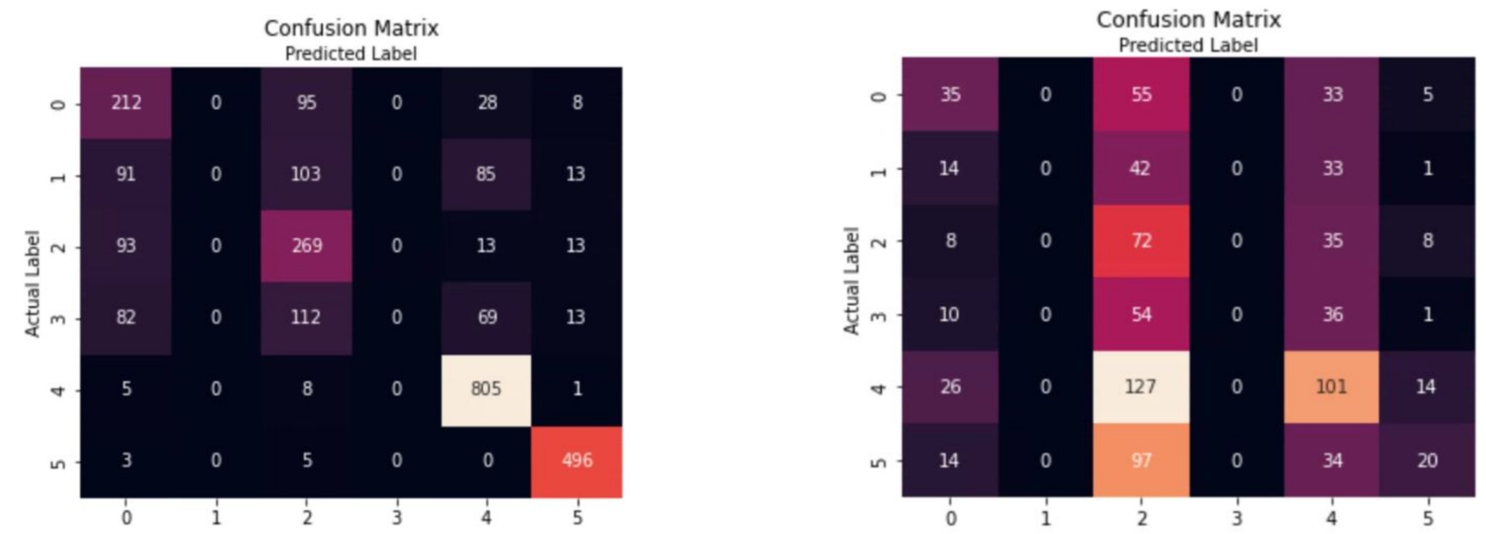
- Lower Accuracy: despite image size (227x227), very simple features (just red line) to train with.
- Many image files to load and train the data competed with limited resources.
- Uneven distribution of data, even within more severely impaired patients.

Machine Learning Results

AlexNet:

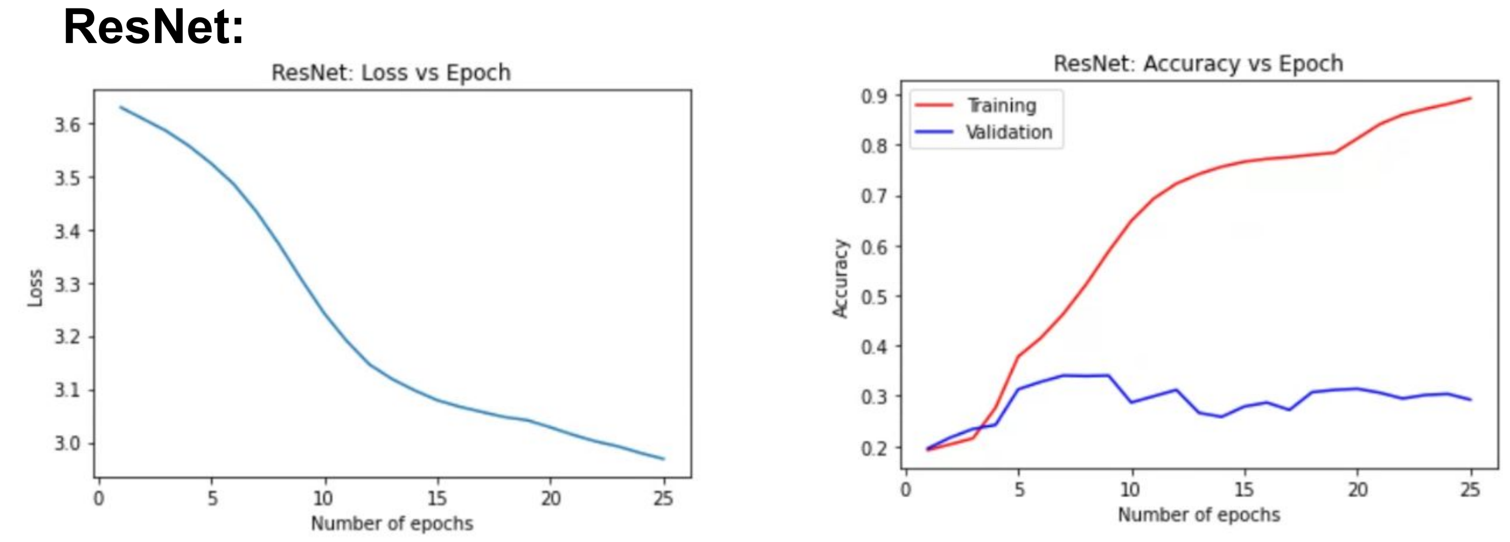


Performance of an AlexNet model trained for 50 epochs with a learning rate = 5e-6 and L2 regularization penalty = 1e-4, yielding a test accuracy of 33.98%.

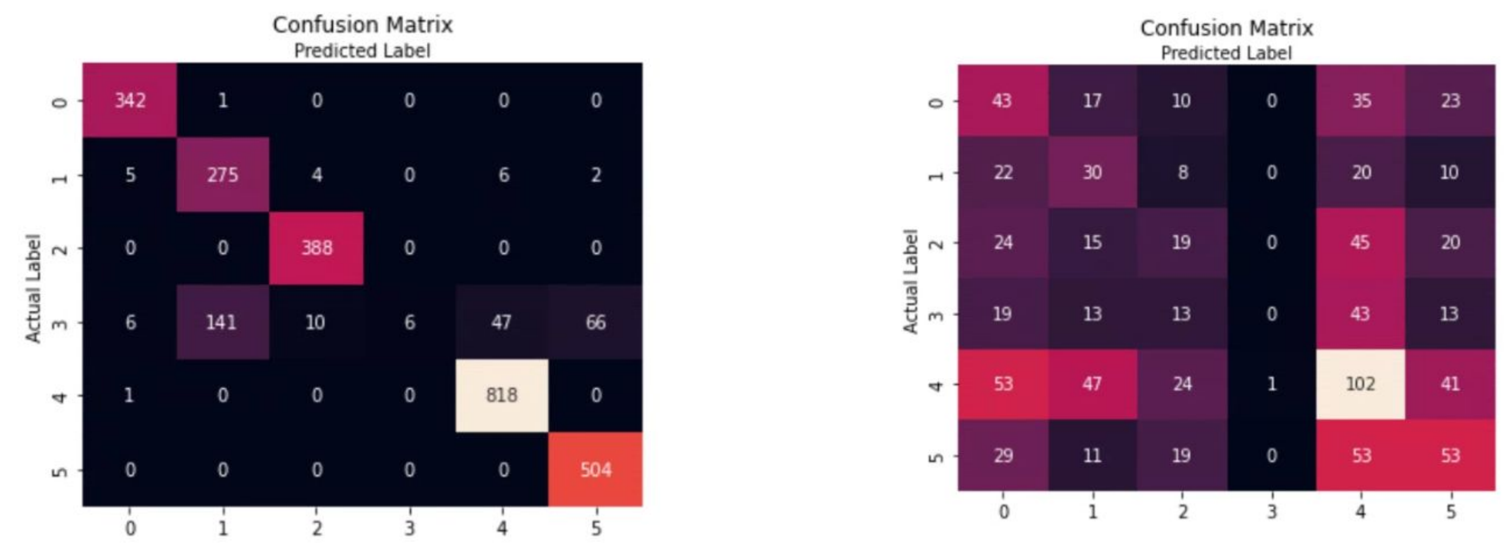


Confusion matrices for training (left) and validation (right) datasets with AlexNet.

ResNet:



Performance of an ResNet model trained for 25 epochs with a learning rate = 5e-6 and L2 regularization penalty = 1e-4, yielding a test accuracy of 33.52%.



Confusion matrices for training (left) and validation (right) datasets with ResNet.

Future Work

- Additional data for more equally distributed dataset.
- Expand data processing pipeline (i.e. EMG).
- Explore simpler models to decrease complexity and improve accuracy.
- Incorporate additional features through Streamlit interface (e.g., UI modification).