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Machine-learning based electrical stimulation to assist neurological patients' gait

EvoCode Team: Elie Celnikier, George Durrant, Rongbo Zhou   **Advisors: Pierre Karashchuk, Aashyk Mohaiteen, Gabriel Gomes**

Neurological conditions reduce mobility

Over 33 million adults in the US suffer from a walking disability, with diseases such as stroke, multiples clerosis, and traumatic brain injury. Many victims need to use assistive devices to ever walk again, greatly reducing quality of life. Physicians characterize common mobility issues such as foot drop by how these issues affect the gait cycle, such as swinging legs and dragging feet.

Classifying gait abnormalities from an IMU

By inputting kinematic data into a neural network, we can classify a patient's gait using the Inertial Measurement Unit (IMU) on the EvoWalk device. We feed raw data from the IMU into a neural network to predict a gait pattern, verified by EvoVision and clinical standards. We can classify the gait pattern from a single IMU with 87% accuracy.

Confusion Matrix for Neural Net prediction on gait cycles

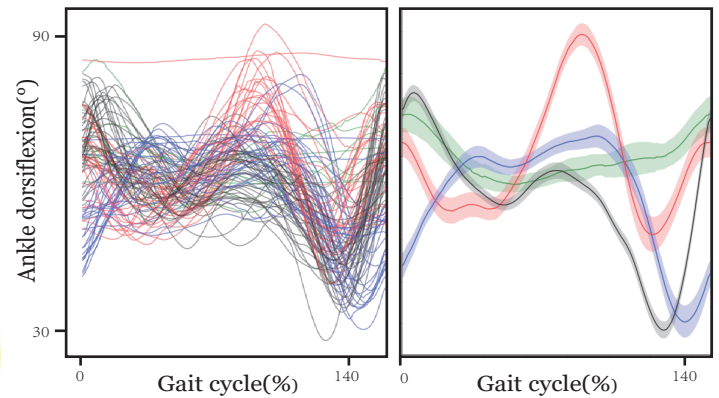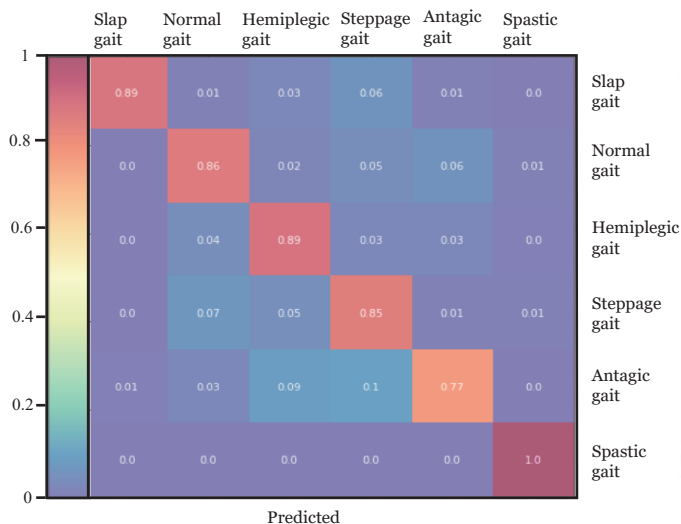
3D kinematic analysis with EvoVision

We must first find out what the gait abnormalities of patients are to improve them. So we look at 3D kinematic data to quantify the different gait patterns and abnormalities. A treadmill and camera setup uses neural networks to track 3D positions of joints during gait cycles. We use joint angle calculations and supervised learning techniques to classify kinematic data corresponding to gait abnormalities.

Angle of ankle dorsiflexion classification: K-means

Personalizing electrical stimulation

After comfirming a patient's gait pattern, we can personalize stimulation, helping the patient to walk. We apply functional electrical stimulation to the anterior tibialis muscle to assist patients with foot-drop in lifting their foot. By combining the kinematic analysis and gait classifier we can adjust the stimulation precisely for each patient.