Unsupervised learning of myographic signals

Eduardo Coronado, Sebastian Knigge, Sam Voisin, Zheng Yuan

Duke University

Duke Statistical Science

Motivation

Recent advances in surface electromyographic signal (sEMG) recordingsystems and analytics methods have encouraged the use of sEMGs in human-machine interfaces to control exoskeletons and protheses; however, challenges remain. Accurate classification of user movements is highly variable given the inherent noise of sEMG recording systems and per-user variability. In turn, this leads to problems downstream when attempting to convert these classifications into spatial directions (e.g. up, down, right, and left). Here, we aim to address the former challenge specifically. Our goal is to design and implement an unsupervised learning model via a multi-layered neural network to accurately identify six distinct hand gestures from sEMG data.

Data

Raw sEMG signal data from 36 individuals was obtained from Lobov *et al* (2018). Two series were recorded per individual, each comprised of signals obtained via 8 equally spaced sensors around the forearm (i.e. channels). For each series, subjects were asked to performed a set of 6 basic hand gestures. Each gesture was performed for 3 seconds with a 3 second pause in between. Gestures classification scheme is shown in Table 1.

Table 1. sEMG gesture classifications

Gesture	1	2	3	4	5	6	7
	Hand at rest	Hand clenched in a fist	Wrist flexion	Wrist extension	Radial deviations	Ulnar deviations	Extended palm

Methods

Data Preprocessing

Filtering is a common technique is used to process signal data before analysis. Therefore, we implemented a root means squared (RMS) envelope of 200 ms overlapping time windows at 100 ms steps via the *biosignalEMG* R package to remove someof the noise generated during sEMG signal collection.

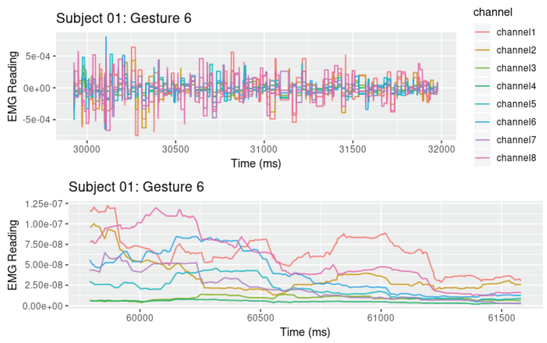


Figure 1. Caption

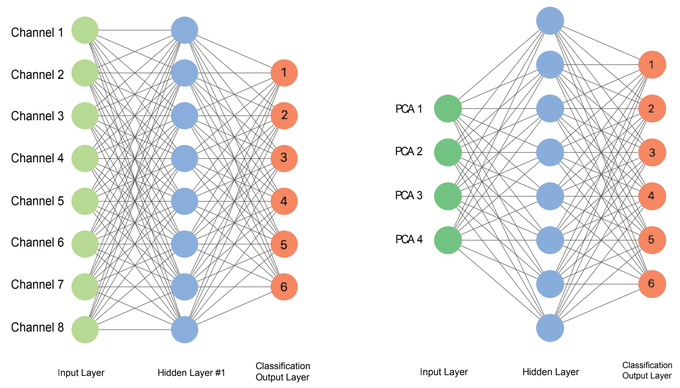
Dimension reduction/analysis

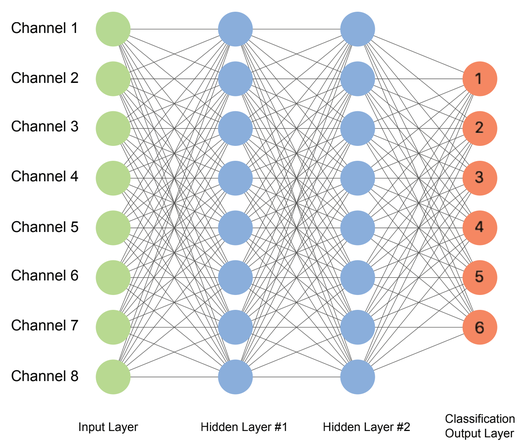
PCA methods description

Unsupervised Model Design

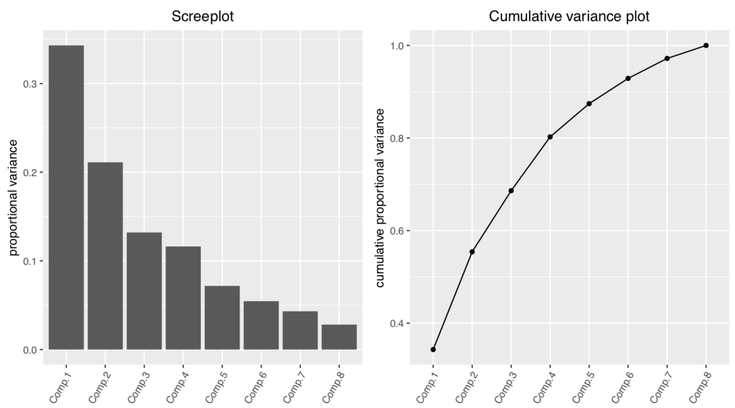
NN methods and description

Model Design continued





Results



Cross entropy high res image and analysis of results

Conclusions (Preliminary)

-
-
-

Discussion

References

- Daniel Falbel, e. a. Package ‘keras’

- J.A. Guerrero, J. M.-D. Package ‘biosignalEMG’.

- Sergey Lobov, Nadia Krilova, I. K. V. K. and V. A. Makarov (2018). Latent factors limiting the performance of semg-interfaces. Sensors 18(1122).