Limite 1000 parole

The main part of the movements of everyday life embodies a cyclical nature. Some examples are walking, running, cycling, stair climbing, and swimming. Gait analysis is broadly used for the clinical assessment of patients. The acquisition of sEMG (surface Electromyography) during walking is used for assessing muscular functionality. From the sEMG is possible, using specifically developed methods [@bonato\_knaflitz; @ghislieri\_lstm], to identify the intervals when the muscle can be considered active or not. But, muscular activity, even during the performance of cyclical movements, such as walking, shows high intra-subject variability [@agostini\_1] both in the number of activation intervals (also called modality) and in their length. Recently Statistical Gait Analysis (SGA) [@SGA] has been recently proposed. The SGA consists of a "statistical" description of gait Spatio-temporal parameters and parameters derived from EMG signals. The purpose of this approach is to describe gait functionality in a condition like everyday walking. From the SGA methods, the CIMAP (Clustering for Identification of Muscle Activation Pattern) [@cimap1; @cimap2] algorithm was developed to perform pattern analysis on the activation profiles extracted from the sEMG recording of walking.

CIMAP [@cimap1; @cimap2] is an algorithm based on agglomerative hierarchical clustering that groups together gait cycles that show similar onset-offset intervals to form clusters. First the algorithm Each cluster identifies a particular pattern and characterizes the muscular behavior during the cyclical movement. Even though the algorithm was developed for gait analysis, its application is not limited to that field, and it can be applied to all sorts of cyclical movements.

# Statement of Need

Traditional gait analysis most frequently analyses only a few cycles of a subject. However, this procedure does not allow for capturing the natural behavior of a subject and its cycle-to-cycle variability, especially in gait analysis. To address the issue, the practice is leaning towards the acquisition of high numbers of gait cycles when performing gait analysis, and new methods, like SGA [@SGA], have been developed. CIMAP algorithm [@cimap1; @cimap2] has been developed to help clinicians with the interpretation of EMG data in gait analysis highlighting with clustering the relevant activation patterns that characterize a subject while walking. Even though the algorithm was developed for gait analysis, it can be applied to all sorts of cyclical tasks. The CIMAP Package was developed based on [@cimap1; @cimap2] published articles and is freely available.

The CIMAP package is a framework that provides users with methods that allow them to process their data and visualize the results of the application of the algorithm to their data. Briefly, what the CIMAP allows the users is:

1. the extraction of relevant information such as the number of modalities and the distribution of the cycles in the different modalities.
2. The automatic identification of the optimal cutting point of the hierarchical tree through the analysis of both the intra-cluster variability and the variability among the formed clusters.
3. The visualization of the clustering results for an easy interpretation of results.
4. The automatic saving of easy-to-read results in an open-source format.

The CIMAP package also allows the customization of results with the possibility of coloring the graphical results for a more in-depth analysis of the results. To the authors’ knowledge, there are no publicly available packages that implement the algorithm.

# Documentation

The documentation with all the information regarding the usage and the data preparation for the usage of CIMAP is available at the following URL:

[CIMAP Documentation](link documentation)

A complete description of [data formatting](link data formatting) for the application and an [example of usage] (link jupyter) can be found. Also, an [example dataset](link ex data) is given to try the algorithm.

# References