

# Diagnosing multiple sclerosis with a gait measuring system, an analysis of the motor fatigue, and machine learning

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## Background

Walking impairment is frequent and appears early in the disease course of MS Patients (MSP). Last year, a new gait measuring system well suited for the clinical routine (*GAIMS*) has been introduced [3]. The measures can be used to compute Gait Descriptors (GDs) averaging the gait characteristics, either over the total recorded test, or over any part of it. This allows to analyze the evolution of the gait over time, which is related to the motor fatigue. In [2], a statistical difference between MSP and Healthy People (HP) has been found on the walking speed evolution during a 500 *m* walk test, but the corresponding discrimination power has not yet been investigated. Moreover, *GAIMS* provides many more GDs than the speed, which opens new prospects.

## Objective

To show that the motor fatigue, given by the evolution of the gait characteristics measured by *GAIMS* during a single 500 *m* walk test, can be used to discriminate MSP and HP.

## Methods

115 HP and 59 MSP (median EDSS 3.26) walked 500 *m* (25 laps of an 8-shaped path) as fast as possible, and their gait was recorded with *GAIMS*. The measures taken over the total path, and 50 consecutive windows of 10 *m*, have been analyzed. This led to 26 GDs for the total path, and for each window. A machine learning algorithm, named *ExtRaTrees* [1], was used to predict if the observed person is a MSP or a HP. We tried to feed it with two sets of values. The first set gathers the GDs computed on the total path while the second one is populated with the subtractions between the GDs computed on each window and the GDs computed on the first, the middle and the last window. By proceeding in this way, the second set of values only takes into account the evolution of the GDs which is related to the motor fatigue.

## Results

The results are obtained by *leave-one-person-out*: the class (HP or MSP) of each person is predicted using a model learned only from the data related to the other people. We obtained a maximum balanced accuracy (*i.e.* the arithmetic mean of the sensitivity and the specificity) on predictions of 89.8% and 82% respectively for the first and the second set of values.

## Conclusions

Although the temporal evolution of the gait characteristics has a lower discrimination power than GDs averaged over the total test, the score obtained with the second set of values (82%) implies that the evolution of the gait characteristics, which is related to the motor fatigue, contains some useful information that can be taken into account for diagnosing MS.

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## References

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