Detection of cognitive and physical fatigue using physiological signals

Alessandra Fava, Marta Gabbi, Valeria Villani and Lorenzo Sabattini

***Abstract*— In recent decades, the detection of fatigue has been largely studied to improve safety and performance in various domains such as healthcare, transportation, and manufacturing. In fact, fatigue significantly affects cognitive and physical performance. There are numerous studies on the detection of fatigue, but most of them focus on binary classification (i.e., fatigue vs. resting state) or different levels of fatigue intensity, without distinguishing between specific fatigue types.**

This work aims to discriminate between cognitive and physical fatigue, and proposes the use of physiological signals to classify four distinct conditions: rest, cognitive fatigue, physical fatigue, and combined cognitive and physical fatigue. We analyze data from cardiac, eye, electrodermal, and electromyographic activity. We consider different feature selection methods, including correlation analysis, principal component analysis and sequential forward floating search method. Ultimately, we classify them using state-of-the-art machine learning methods.

The highest classification accuracy (86.823%) is obtained from a support vector machine method using a selection of the features extracted from cardiac and electromyographic sensors. This study highlights the potential for real-time fatigue classification, which can enhance the adaptability of automated systems to human needs, particularly in high risk environments like transportation and healthcare. Furthermore, the findings suggest that fatigue monitoring can be effectively conducted with minimal sensor requirements, contributing to the design of more efficient wearable sensor systems.