

Analysis and Automatic Detection of Fatigue using Smart Wearables in Elite Sports

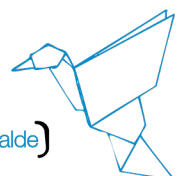
Job Offer

Topics:

The Basque Center for Applied Mathematics is offering an internship position within the Mathematical Design, Modeling and Simulations (MATHDES) research group led by Elisabetta de Giovanni.

The selected candidate will work on the Analysis and Automatic Detection of Fatigue using Smart Wearables in Elite Sports.

Physical fatigue is a critical physiological marker in sports, defined as exhaustion resulting from competition or prolonged, intense training. It is one of the primary factors impairing athletic performance and increasing the risk of overtraining or injury. Traditionally, fatigue is evaluated subjectively through the Rate of Perceived Exertion (RPE) on a Borg scale (0–10), which reflects incremental cardiorespiratory effort and maps to a percentage of maximal oxygen consumption (%VO₂max). Quantifying these parameters relies on expert analysis of gas-exchange measurements using bulky, expensive laboratory equipment. To overcome these constraints, non-invasive wearable devices enable indirect, automated fatigue estimation. While Heart Rate Variability (HRV) derived from Electrocardiograms (ECG) is the most established marker, other cardiorespiratory and physiological signals—such as Photoplethysmography (PPG), Respiration (RSP), Electrodermal Activity (EDA), and Skin Temperature (SKT)—can also model responses to high-intensity exercise. Because few studies capture these combined signals in real-world settings, this project aims to bridge the gap by acquiring multi-sensor data during team sports training to build robust, automated fatigue detection models.



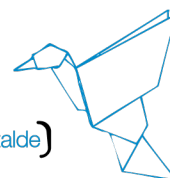
The main objective of this project is to develop automated algorithms for real-time and post-session fatigue detection by preprocessing and extracting meaningful features from multi-modal wearable signals (ECG, PPG, RSP, EDA, and SKT). Through statistical modeling and machine learning techniques, the project aims to estimate athletic fatigue levels against ground-truth physiological metrics (RPE scores and %VO2max) and ultimately identify the minimal, optimal combination of sensors and features required for accurate, non-invasive field monitoring in team sports.

The tasks to be carried out will be:

- **Literature Review** Analyze the state-of-the-art bibliography on automatic fatigue determination from gas-exchange measurements during maximal/submaximal tests and various wearable sensors during in-field exercise sessions.
- **Experimental Setup & Data Collection** Participate in setting up experiments and collecting new data using dedicated wearable devices on healthy team sports players (rugby, basketball, football) during regular training sessions and laboratory tests, organizing all records within the internal data management platform.
- **Signal Preprocessing & Feature Extraction** Clean and preprocess raw cardiorespiratory and physiological signals (**ECG, PPG, RSP, EDA, SKT**) from existing or newly collected datasets, and extract relevant features (starting with peak-to-peak RR intervals for HRV analysis).
- **Statistical & Machine Learning Modeling** Explore and apply suitable statistical modeling methods and machine learning algorithms to estimate fatigue levels during exercise and determine the optimal set of features and sensors.
- **Model Validation & Performance Benchmarking** Evaluate the performance metrics of the developed models against ground-truth indicators (RPE scores and %VO2max percentages).

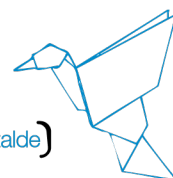
PI in charge:

Elisabetta de Giovanni



Salary and conditions:	• Living in the Basque Country: - Graduate students: net salary of 300 € monthly - Master's degree students/ PhD students: net salary of 350 € monthly. • Living in Spain: - Graduate students: net salary of 500 € monthly + 150 € for travel expenses - Master's degree students/ PhD students: net salary of 600€ monthly + 150 € for travel expenses • Living outside Spain: - No remuneration. - Accommodation and meals covered by BCAM* - Travel expenses are covered and to be reimbursed: - Up to 300 €, if the intern comes from the EU - Up to 1000 €, if the intern comes from outside of the EU (to be checked on each country)
Nº Positions offered:	1
Contract and offer:	6 months
Deadline:	31st October 2026, 14:00 CET (UTC+1)
How to apply:	Applications must be submitted on-line at: https://joboffers.bcamath.org

Scientific Profile Requested	
Requirements:	• Enrolled in a Bachelor's or master's degree in biomedical engineering or related fields
Skills and track-record:	Although the requirements can be adapted to the different candidate profiles, a strong candidate needs to possess the following skills: • Programming skills (Python) • Basical signal processing



Application and Selection Process	
Formal Requirements:	The selected candidate must have applied before the application deadline online at the webpage: https://joboffers.bcamath.org The candidates that do not fulfil the mandatory requirements will not be evaluated with respect to their scientific profile.
Application:	Required documents: • CV • Letter of interest in English describing which topics the candidate is interested in researching. • 2 recommendation letters • Academic record: including undergraduate and master-level courses attended and grades and scientific results achieved, and research statement is NOT required (leave blank in application form).
Evaluation:	Based on the provided application documents of each candidate, the evaluation committee will evaluate qualitatively: the adaption of the previous training and career to the profile offered, the recommendation letters, the main results achieved (papers, proceedings, etc.), the statement of past and proposed future research and other merits; taking in account the alignment of these items to the topic offered.

Incorporation:	1st November 2026
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