



## **RESEARCH PROJECT.**

**3021 - Doctoral Program in Computer Engineering (RD. 99/2011)**

**30210003 - Computer Technology: Medical and Industrial Applications**

**Title:** Development and implementation of expert systems based on models for professional soccer teams, aimed at optimizing health and performance.



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## LIST OF PLANNED ORIGINAL PUBLICATIONS

1. **Detection of T-wave inversion with machine learning to prevent sudden death in professional soccer players** (T wave inversion detection with machine learning to prevent sudden death in professional football players.)
2. **Machine learning applied to biological parameters for control and advice in professional footballers** (Machine learning applied to biological parameters for control and advisory in professional football players.)
3. **Machine learning applied to sports geolocation systems for the prevention of injuries in professional soccer players** (Machine learning applied to sport geolocation systems for injury prevention in professional football players.)

### 1. Introduction

The approach of this project arises from the concern to use intelligence systems artificial intelligence and machine learning in professional sports as assistance for the optimization of the health and performance in professional soccer players. In professional sport, efforts are required increasing physical, biological and physiological conditions and we need help tools.

In this regard, the proposal of several publications within the project has been raised:

1. **Detection of T-wave inversion with machine learning to prevent sudden death in professional soccer players.**

Players undergo various pre-competitive screening tests to assess their status of health, specifically one of them is a resting 12-lead electrocardiogram. From the waveform findings in this complementary test, the risk of a professional athlete and the need for more complementary tests (Drezner et al., 2017). Our proposal is to reanalyze these tests and submit them to a mathematical model of machine learning that is capable of detecting inversions of the T wave in said leads and present the results and recommendations according to international study criteria electrocardiography in athletes.



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## **2. Machine learning applied to biological parameters for control and advice in professional footballers.**

During the season, routine analyzes are carried out to control biochemical parameters related to health and performance and fluctuating or changing throughout the season: vitamin D, vitamin B12, vitamin B9, ferritin, etc (Galan et al., 2012). These data will be submitted to a machine learning procedure that can notify us of alterations in the pattern habitual of the players and that can cause alterations in performance, even reaching generate pathologies.

## **3. Machine learning applied to sports geolocation systems for the prevention of injuries in professional soccer players.**

The data obtained during training sessions and matches regarding physical data such as duration, distance, distance at different speeds, training density, etc. What are provided by sports geolocation systems, are of great importance when studying the effort profile and performance of each player. Obtaining the performance profile of the player standardized according to On training day we can detect adverse situations such as: over-training or lack of physical condition. Warning and alarm systems can be designed aimed at the prevention of injuries. (Rossi, Pappalardo, Marcello, Javier, & May, 2017).

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To better understand the theoretical framework of the study and its background, we can highlight how in In recent years, soccer competitions have experienced a great boom worldwide (FIFA, 2006), which is also extrapolated to Spain (Consejo Superior de Deportes, 2015).

With regard to health and performance in football, multiple initiatives are emerging and carrying out different studies, on the one hand oriented to health and sudden death prevention (Drezner, Harmon, Asif, & Marek, 2016) and on the other hand performance-oriented and that relate the injury incidence (Hägglund, Waldén, & Ekstrand, 2005), injury load (Ekstrand, Waldén, &



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Hägglund, 2016), player availability (Bahr, Clarsen, & Ekstrand, 2017) and other parameters as possible factors that affect the final result of the teams, (Hägglund et al., 2013). For all Therefore, this project is of great interest to show a strategy that helps to improve these aspects.

To end this introduction and prior to explaining the description and objectives of the study it is interesting to reflect that integrating predictive systems with preventive orientation is not exempt from limitations (Bahr, 2016). Because of this and other factors that have been considered, it has been tried to develop models that, from the current point of view, tend towards an approximation oriented to the complexity of the causality of injuries. (Bittencourt et al., 2016)(Quatman, Quatman, & Hewett, 2009), and make a correct scale of the statistical weights as have been carried out by other authors. (López-Valenciano et al., 2017)

## **2. Description**

The studies will be carried out implementing artificial intelligence and machine learning systems machine on the physical, biological and physiological data collected during routine activity sports and health in professional football teams in the 2019-20 to 2023-24.

### **2.1 General Objectives**

- Evaluate the implementation of artificial intelligence systems such as machine learning to obtain models and results in the interpretation of physical, biomedical and physiological parameters of Players.
- Develop advisory/advisor systems in the area of health and performance based on the profiles.

## **3. Methodology**

### **3.1 Experimental Design**

- 1. Detection of T-wave inversion with Machine Learning to prevent sudden death in professional soccer players**



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Comparison study between results obtained in the electrocardiographic interpretation of qualified professionals and a machine learning system based on detection algorithm of the morphology of the T wave in electrocardiography.

## **2. Machine learning applied to biological parameters for control and advice in professional footballers**

Development of a machine learning system for the detection of abnormal deviations multiparametric variables in the biochemical profiles of the players.

## **3. Machine learning applied to sports geolocation systems for prevention of injuries in soccer players**

Development of machine learning for the detection of abnormal deviations multiparameters in the physical data profiles of the players during routine activity.

### **3.2 Intervention**

The procedure is based on the generation of mathematical models from the data obtained of the routine tests carried out on players during their usual work practice:

EKGs (monthly)

Blood and urine tests (monthly)

Sports geolocation systems (daily)

### **3.3 Sample/Participants**

Inclusion criteria:

Healthy, young players and professionals of legal age who perform their role in teams soccer professionals.



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Exclusion criteria:

Players who are not a regular part of these professional teams.

Players with known pathology.

Participant selection method and informed consent

The participating professional soccer players will be selected from the database of the Villarreal Club de Fútbol, from among teams A, B, C and Juvenil A. Once the participants have been selected according to the inclusion and exclusion criteria, they will be contacted to explain the objective of the research and development of the same (periods of realization, measures to be carried out, benefits and risks of the study). To finalize the selection process, participants will sign the consent informed (ANNEX I) so that there is a record of their acceptance to participate in the project.

### **3.4 Procedure**

To carry out the project, a procedure of low impact of presence has been followed, of so that the data could be obtained and the calculations carried out with the minimum presence and/or interference in the daily operation of the equipment.

### **3.5 Data analysis**

Within the methodology, depending on the article, an a priori study will be carried out to adjust the statistical parameters and the necessary sample with the statistical software GPower 3 (Faul, Erdfelder, Lang, & Buchner, 2007)(Erdfelder, Faul, Buchner, & Lang, 2009). This system allows determine the minimum sample for the study taking into account different parameters such as the type study, statistical power, effect size, and alpha significance level.

The studies that are going to be developed belong to experimental studies of the type pre-experimental tests in which we can have control groups or control databases to generate Confusion tables between actual and expected values. Normality criteria will be checked of the sample and the data will be processed through different statistical systems such as SPSS24. The systems for generating algorithms and programming systems are based on the language of



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Python programming and assistance software such as Anaconda Navigator and libraries of sports science like Pandas, Numpy, Matplotlib, Spider among others.

## **4. Results**

In this project we will try to obtain statistically representative results and significant for generating translational scientific results with a disruptive component. It is anticipated that the results of the project have a relevant scientific-technical impact that can be reflected in indicators such as scientific publications in widely distributed and recognized worth journals, presentations at congresses or presentations at scientific meetings. The data will be presented disassociated from the identity of the participants. In addition, the participants will be informed of the results of the study by sending the links corresponding to the publications obtained.

## **5. Discussion.**

In this section, the debate between the scientific articles published in this area and the results of this project. It will also try to argue and question the study in the face of possible limitations or improvements.

## **6. Ethical-legal and biosafety aspects.**

The project is based on the exploitation of data on physical, biological and physiological tests of routine developed in the sports field that could generate an exemption from passing through a committee of ethics (Winter & Maughan, 2009), even so, based on our concern to generate ethical and respectful research, it is sent to the biomedical research ethics portal of Andalusia for its approval and correct comparison.

The use of this material will comply with current international standards and will be complied with at all moment with the ethical principles established in the Declaration of Helsinki for research medical. All the information will be processed in a manner disassociated from the identity of the sources of information. data, in accordance with the provisions of Organic Law 15/1999, of December 13, on Data Protection of Personal Character and its updated supplement to the European Data Protection Regulation (EU) 2016/679, of April 27. In the procedures for collecting and transporting samples and analysis of





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laboratory, biosafety and personal protection standards will be applied, related to the level of WHO biohazard 2.

The project is of high interest due to its translational scope and it would not be possible to carry it out without data derived from the use of human samples. In addition, it is expected that the results of the research project can contribute to the improvement in the health and performance of the Professional sportsmen.

## 7. Practical application

The project has great potential for practical applicability and could generate a change of paradigm, since it is based on the generation of mathematical and/or programming models that They will help in the health controls and in the sports load controls that apply to professional soccer players. A notable aspect is the possible improvement of the calculation of the probabilistic weights of risk factors on health and performance.

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## 9. ANNEX I: Informed Consent

### INFORMED CONSENT FOR RESEARCH WITH BIOMEDICAL DATA.

Name	ID	Date of Birth	Date of Information

#### Project description.

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**Principal Investigator:**                      **mail:**

**Title:** *Development and implementation of expert systems based on models for professional soccer teams, aimed at optimizing health and performance.*

#### LIST OF PLANNED PUBLICATIONS:

4. Detection of T-wave inversion with Machine Learning to prevent sudden death in soccer players professional.
5. Machine learning applied to biological parameters for control and advice in professional soccer players.
6. Machine learning applied to sports geolocation systems for the prevention of injuries in soccer players professionals.

You are hereby informed that you are going to be included in the aforementioned research project. This implies that your biomedical and physiological data collected during your routine practice as a professional footballer will be processed for research purposes during the 2019-20 and 2020-21 seasons.

The treatment that will be made of them will be carried out in accordance with the general data protection regulation (RGPD) and its sole purpose being to generate algorithms or mathematical models aimed at optimizing health and performance. The data will remain anonymous, not being able to identify the experimental subject. You may deny or revoke permission to use the data by contacting the Principal Investigator by any written means.

The data on which the engineering analysis will be made primarily will be: electrocardiograms, blood tests, urine tests, sports geolocation data (GPSs), complementary imaging tests: DEXA, MRI, rx, CT scans and functional assessments.

**I declare that I have been informed by the Principal Investigator, and I am aware that, at any time, I can revoke my consent.**

**I am satisfied with the information received, I have been able to ask all kinds of questions that I have deemed appropriate and all the doubts raised have been clarified.**

**Accordingly, I consent to the use of my biomedical data.**

Signature of the experimental subject

Signature of Principal Investigator.

Signature

Signature



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REVOCATION OF INFORMED CONSENT

On date ..... I revoke the consent given for the use of my biomedical data for research.

Patient's signature

Signature of the research manager

Date: