



Computational intelligence in sports: Challenges and opportunities within a new research domain



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ABSTRACT

Computational intelligence is a branch of artificial intelligence that comprises algorithms inspired by nature. The common characteristics of all these algorithms is their collective intelligence and adaptability to a changing environment. Due to their efficiency and simplicity, these algorithms have been employed for problem solving across social and natural sciences. The aim of this paper is to demonstrate that nature-inspired algorithms are also useful within the domain of sport, in particular for obtaining safe and effective training plans targeting various aspects of performance. We outline the benefits and opportunities of applying computational intelligence in sports, and we also comment on the pitfalls and challenges for the future development of this emerging research domain.

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1. Introduction

Computational intelligence (CI) represents algorithms for solving real-world problems somewhat intelligently as similar problems are solved by natural systems. However, while intelligence by humans refers to a mental adaptation to new circumstances [18], artificial intelligence is based on an intelligent algorithm's capability of adapting to changing environment.

This class of CI algorithms encompasses algorithms like artificial neural networks (ANN), evolutionary algorithms (EA), swarm intelligence (SI), artificial immune systems (AIS) and fuzzy systems (FS). A commonality of all these algorithms is that the principles for their operations are borrowed from natural systems. For instance, the inspiration for artificial neural networks (ANN) is the human brain [19]. Evolutionary algorithms (EA) are inspired by the Darwinian struggle for existence, where only the fittest individuals can survive in nature [3,5,7]. The swarm intelligence (SI) based algorithms mimic the behavior of social living insects (e.g., ants, bees, termites) and animals (e.g., birds, dolphins, bats) [2]. Artificial immune systems (AIS) are based on natural immune systems (NIS), which are characterized by an amazing pattern matching ability [13]. Fuzzy systems use an approximate reasoning in place of exact reasoning and this incorporates a certain degree of uncertainty during a reasoning process.

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The purpose of this paper is to initiate the new research domain of applying the CI algorithms in sports. To date, these algorithms have been mainly applied to the domain of sports' training, especially in endurance sports' disciplines [20] like triathlons and marathons. Here, we would like to classify the performed work within the context of sports' training theory. Those areas of sports' training should be searched for that have been left uncovered in previous research studies. Finally, an integration of the results obtained for different areas of sports' training should enable the creation of an artificial personal trainer. This could be helpful for athletes who cannot afford coaches because of the high cost. Although the first steps in this direction have been made for individual sports, it is also possible to upgrade the acquired knowledge with expert knowledge of coaches for team sports. Thus, the universal or specialized artificial personal trainer for all sports' disciplines should be gained.

The structure of this paper is as follows. Section 2 introduces the basic theory of sports' training. Section 3 proposes a programming model of sports' training. In Section 4, the existing applications that are arisen within this domain are reviewed. Section 5 proposes the possible directions for future work, while a summary of the performed work is presented in Section 6.

2. Background information

CI algorithms in sports can primarily be used in different phases of training especially because of the huge amount of data produced by various devices during tracking the sports activities. Typically, the sports' training sessions are planned, analyzed and monitored by coaches. Obviously, coaches have a great influence on the quality of training as well as on the achieved results of trainees in competitions. The main tasks of an effective coach are [22]:

- to establish trust in a relation with his/her trainees,
- to manage the person (trainee) to become a personality,
- not to hurt trainees either physically or psychologically.

In order to harness the best abilities, the coach needs a knowledge from broad areas, like anatomy, physiology, biomechanics, psychology, sociology, and didactics. Obviously, sports' training is a very complex task.

The purpose of sports' training is to achieve maximal performance from an athlete or a team within selected sports' disciplines. Sports performance in selected sports discipline is evaluated with the achieved results of trainees by considering rules known in advance. The efficiency of an athlete is an ability to achieve targeted performances repeatedly. The sports' performance of athlete depends on the following types of sports' training (Fig. 1) [22]:

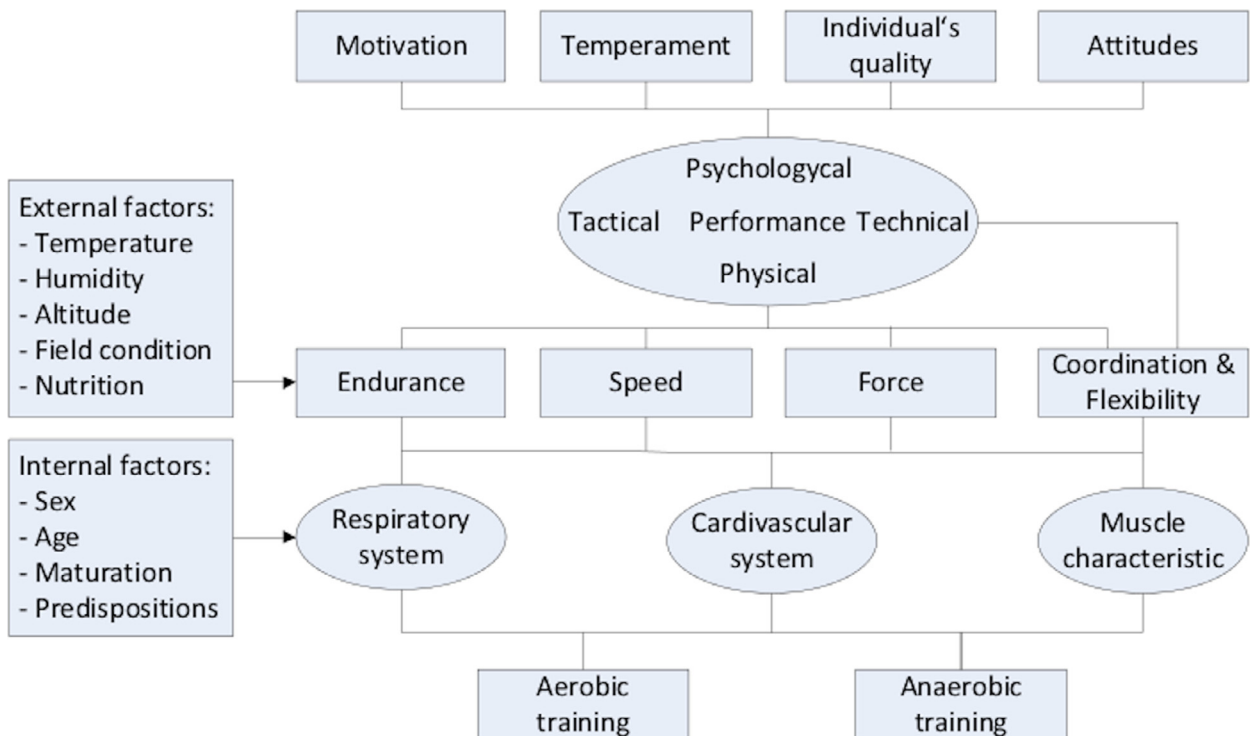


Fig. 1. Key components of sports' training. The core of tactical, psychological, technical and physical skills branches out as depicted schematically to determine the overall performance of the athlete.

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