A STATE-TRANSITION MODELING ON THE FOOTBALL PITCH AS A PERFORMANCE TOOL

André Luiz Santana[1,4], Luiz Fernando C. S. Durão [1,4], Rodrigo Monteiro de Aquino[3,4], Julia Taunay Perez[1,4], Vinícius Gusmão[4], Igor Vac Coelho[4], Paulo Taunay Perez[4], André Filipe de Moraes Batista[1,4], Helder Nakaya[2,4]

[1] Insper - Instituto de Ensino e Pesquisa, Rua Quatá, 300 - 04546-042, Vila Olímpia, São Paulo, SP, Brasil

[2] Hosp. Israelita Albert Einstein, Av. Albert Einstein, 627 - 05652-000, Morumbi, São Paulo, SP, Brasil

[3] ESEG, Rua Apeninos, 960 - 04104-000, Liberdade, São Paulo, SP, Brasil

[4] BioViz Sports, Rua Miguel Rodrigues, 94 - 05447-060, Vila Madalena, São Paulo, SP, Brasil

Introduction. A team's success depends not only on the individual quality of the players but on the strategy adopted against each opponent. A group of professionals usually perform player evaluation and strategy based on their expertise and experience. The use of data from observation of games and training favors notational and performance analysis, allowing an algorithm to suggest indicators that characterize the athlete's trajectory inside the football pitch, creating a representation of his in-game behavior [1]. Different researches highlight the role of computer vision and machine learning techniques in the decision-making process of choosing players and in the strategy adopted against a given opponent [2][3]. However, it needs to be clarified how to use this data to create a unique profile of the player to describe his behavior during the match. A State Machine is a mathematical modeling approach to describe state-dependent behavior for an object or entity, in this case, the player. A player responds differently to the same event (an action or an observer) depending on his current state. So, to describe a state machine, it's necessary to specify a set of states (how the player is at an instant of time) and a set of transitions (observational trigger to state change). This research proposes a mathematical and computational model capable of characterizing a player's State in different moments of a match or training. This model allows characterizing the player and his team at different time points, helping to select the proper strategy during a match or select the best set of players for a team during the season. In addition, the change between States and the connection between different possible States can represent a good proxy for identifying gaps in athletes' development and reveal room for improving their performance. Method. To reach this objective, we propose the characterization of an athlete through the use of finite-state machines. The idea is to elaborate a behavior profile for an athlete through a multivariable, dynamic, responsive, and structured approach based on the observations of their behavior. States are defined based on the player's position and the type of match analyzed (a friendly, a season match, or a playoff stage). This characterization considers the player's idleness on the pitch and the actions related to whether or not this player participates in offensive and defensive plays; which sector he is in; whether or not he has the ball; and whether or not other players are close to him. The model also considers traditional football statistical data (such as passes, shots on goal, fouls committed, and fouls suffered). Finally, the model was elaborated through a segmented analysis of one game to compare two players from different positions. The match was segmented into two timeslots (0-5 and 40-45 plus the extra time) and then analyzed. This data made it possible to identify the differences and potential action points. Results. Preliminary results exposed the difference between the player's representation of their State Machine models. By modeling the profile of each player, it is possible to identify the athlete's behavioral patterns, as well as to explain their interactions with other players or to recognize which actions or moves are being represented on the pitch. Still, it is possible to structure clippings of each instant of time, allowing the technical committees to have a more holistic view of what happens in a match when they realize which actions are being frequently recorded in the face of each critical

event of a game. For example, in retrospect, it is possible to observe details about how each team player is moments before a goal in favor or against, the suffering of a dangerous foul or a decisive play, even in a situation of pressure, in a match. Conclusions. This approach allows characterizing an athlete's profile and performance throughout a match. By identifying State machines capable of representing an athlete's behavior - with some degree of convergence - it is possible to develop tools and models that help a team create and test scenarios and simulations of plays based on the observed behavior of previous games. Future work can improve the model, increasing the convergence between the characteristics representing the player and his behavior and suggesting performance and indicators that demonstrate the most appropriate training to improve the player's performance.

References

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