

# An action language for set plays definition

Pedro Mota<sup>1</sup>, Miguel Abreu<sup>2</sup>, Luís Paulo Reis<sup>2</sup>, and Nuno Lau<sup>3</sup>

<sup>1</sup>LIACC/LASI, FCUP, University of Porto, Portugal, [pedndm@gmail.com](mailto:pedndm@gmail.com)

<sup>2</sup>LIACC/LASI, FEUP, University of Porto, Portugal, [{m.abreu,lpreis}@fe.up.pt](mailto:{m.abreu,lpreis}@fe.up.pt)

<sup>3</sup>IEETA/LASI, DETI, University of Aveiro, Portugal, [nunolau@ua.pt](mailto:nunolau@ua.pt)

## Abstract

Defining the global behavior of a team in soccer is a very complex task due to the multifaceted nature of the game. The sport requires a deep understanding and implementation of complex concepts such as tactics, formations, roles, and set plays. The latter encompasses pre-planned interactions between team members, a common strategy in collaborative sports like soccer, rugby, and handball. These set plays are deployed in specific situations to enhance scoring opportunities. Every interaction inherently influences the game dynamics and is only initiated when certain predefined conditions are fulfilled.

In previous years, a complete framework for the specification and execution of set plays was designed and developed in [1–3], for the 2D and 3D Simulation Leagues. In this framework, the set plays were expressed through a programming language based on S-expressions, which was cumbersome to write by hand. In light of this, we designed and implemented a new and more expressive language.

```
def setplay 'StartGame' with agents 'P1', 'P2', 'P3', 'P4':
{ game(play_mode='our_kickoff') and iam(agent='P1')
  and pos(agent='P2', xy=(-6, -5), tol=2)
  and pos(agent='P3', xy=(-11, 0), tol=2)
  and pos(agent='P4', xy=(-6, -5), tol=2.5) }

pass(agent='P1', to='P2') with AbortTime = 10
{ ball(agent='P2') }

move(agent='P1', xy=(3, -5), wait=false)
{ true }

pass(agent='P2', to='P3') with WaitTime = 1.25
{ ball(agent='P3') }

pass(agent='P3', to='P4') with WaitTime = 1.25
{ ball(agent='P4') }

pass(agent='P4', to='P1') with WaitTime = 1.25
{ ball(agent='P1') }

shoot(agent='P1') with AbortTime = 8
{ goal }
```

Figure 1: A kick-off set play

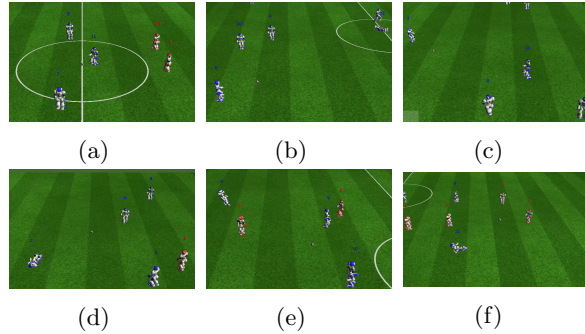


Figure 2: Execution of the kick-off set play

Every agent in our team is equipped with a suite of set plays, such as the one depicted in figure 1. A set play can be activated if the initial condition is met. Solely the agent in possession of the ball is capable of initiating a set play. If there are multiple set plays that could be initiated, the best evaluated is chosen. For the set play shown in figure 1, two agents (with names  $P1$  and  $P2$ ) will be involved. At the beginning of the set play, all agents are considered potential candidates for the set play roles, but they are progressively filtered out as additional restrictions come into play. For instance, the agent verifies if the current play mode is 'our kick-off' as the first step of this set play. Then, with the predicate  $iam(agent='P1')$ , it grounds the name  $P1$  to itself. With the condition  $pos(agent='P2', xy=(-6, 5), tol=2)$ , the candidates for the name  $P2$  are filtered to the agents that are within the circle with center  $(-6, 5)$  and radius 2, and so on. In case we get to the end of the condition and we have more than one possible agent for some names, a valid combination is chosen. Communication guarantees that all synchronisations are maintained while performing the set plays. Figure 2 shows the execution of the kick-off set play in figure 1. For our 2023 FC Portugal team the complete team's behavior is entirely dictated by our set play framework.

## References

- [1] Luís Mota, Paulo Luís, Luís Reis, and Nuno Lau. Multi-robot coordination using setplays in the middle size and simulation leagues. *Mechatronics*, 21, 03 2011.
- [2] Luís Paulo Reis, Fernando Almeida, Luís Mota, and Nuno Lau. Coordination in multi-robot systems: Applications in robotic soccer. In Joaquim Filipe and Ana Fred, editors, *Agents and Artificial Intelligence*, pages 3–21, Berlin, Heidelberg, 2013. Springer Berlin Heidelberg.
- [3] Simões, M. A. C., Nobre, J., Sousa, G., Souza, C., Silva, R. M., Campos, J., Nogueira, T. (2021). Generating a dataset for learning setplays from demonstration. *SN Applied Sciences*, 3(6), 608.