Three Years of the RoboCup Standard Platform League Drop-In Player Competition: Creating and Maintaining a Large Scale Ad Hoc Teamwork Robotics Competition

(JAAMAS Extended Abstract)

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ABSTRACT

The Standard Platform League is one of the main competitions at the annual RoboCup world championships. In this competition, teams of five humanoid robots play soccer against each other. In 2013, the league began a new competition which serves as a testbed for cooperation without pre-coordination: the Drop-in Player Competition. Instead of homogeneous robot teams that are each programmed by the same people and hence implicitly pre-coordinated, this competition features ad hoc teams, i.e. teams that consist of robots originating from different RoboCup teams and as such running different software. In the article advertised by this extended abstract, we provide an overview of this competition, including its motivation, rules, and how these rules have changed across three iterations of the competition. We also present and analyze the strategies utilized by various drop-in players as well as the results of the first three competitions. The article concludes by suggesting improvements for future competitive evaluations of ad hoc teamwork. To the best of our knowledge, the three Drop-in Player Competitions described in the article are the largest annual ad hoc teamwork robotic experiment to date. Across three years, the competition saw 56 entries from 30 different organizations and consisted of 510 minutes of game time that resulted in approximately 85 robot hours.

Keywords

ad hoc teamwork, coordination, drop-in player competition, multiagent teamwork, RoboCup, robot soccer

1. INTRODUCTION

As robots become more prevalent in the world, they are increasingly being designed to work in teams to accomplish tasks. One such example is delivery robots utilized in hospitals, such as the Aethon TUG robot.[1] Another example is the Amazon Robotics Kiva robots that move products to and from box packers in warehouses [4]. Usually, all of the robots on a team are programmed by one organization, and hence are implicitly designed to work together. RoboCup, an annual international robotics competition, features many such teams that are programmed by universities, companies and other organizations to play soccer [2]. The JAAMAS article [1] advertised by this extended abstract presents a specific competition held in the RoboCup Standard Platform League (SPL), namely the Drop-in Player Competition.

In the Drop-in Player Competition, each team programs a robot to coordinate with unknown teammates. The teams are asked to not pre-coordinate, so that during games these agents have to engage in *ad hoc teamwork* in order to reason about their teammates' abilities and intentions in real time and determine how to best assist their team. Each agent's goal should be to win the soccer game while being judged as a 'good teammate' by human observers.

It is often challenging when working with teams of real robots to gather extensive experimental data. Over three years, the SPL Drop-in Player Competition has seen 56 entries from 30 organizations, involved at least 50 human participants, and consisted of 38 games for a total playing time of 510 minutes. With 10 robots scheduled to participate in each game, this totals to an experiment utilizing roughly 85 robot hours. Hence, the three Drop-in Player Competitions described in our JAAMAS article proved to be the largest ad hoc teamwork experiment on robots that the authors are aware of to date, and is likely one of the largest robotic experiments involving 30 different organizations across three years.

The SPL Drop-in Player Competition grew from a technical challenge held at RoboCup 2013 in three different leagues [3]. The 2013 SPL technical challenge was optional for teams participating in the SPL, and hence only saw six SPL teams participate. Furthermore, the 2013 challenge was announced with little advance notice so many teams did not have time to tailor their strategies to the ad hoc setting. The authors of this extended abstract — and the JAAMAS article advertised by this extended abstract — helped plan, organize, and run the 2013 technical challenge as well as the substantially larger SPL Drop-in Player Competitions at RoboCup 2014 and RoboCup 2015. Both of these larger SPL Drop-in Competitions were mandatory for teams participating in the SPL and announced well in advance. Our JAAMAS article de-

[1] http://www.aethon.com/

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Figure 1: SoftBank NAO robots playing in an SPL game during RoboCup 2014.

tails all three SPL Drop-in Player Competitions, highlights the advances in each year of the competition, and discusses various drop-in player strategies utilized in the competition. An image displaying a SPL game at RoboCup 2014 is shown in Figure 1.

Our JAAMAS article makes two major contributions by (1) presenting the SPL Drop-in Player Competition's setup, rules, and scoring metrics across three iterations of the competition and (2) summarizing and analyzing the participating teams' strategies and comparing their performance in multiple Drop-in Player Competitions with their performance in multiple main competitions. The article also helps future organizers and participants of ad hoc teamwork competitions by detailing the lessons we learned while running and observing three years of the SPL Drop-in Player Competition.

2. LESSONS LEARNED

One contribution of our JAAMAS article [1] that is broadly relevant to the AAMAS community is Section 7: Lessons Learned. Section 7 suggests improvements for subsequent ad hoc teamwork competitions. Specifically, Section 7 provides insights regarding (1) how to set up a similar competition, (2) strategy improvements that would likely be beneficial to teams competing in such competitions, (3) improvements organizers can make in subsequent competitions, and (4) how experiences from the Drop-in Player Competition can apply to general ad hoc teamwork research. Although our experience is from organizing the SPL Drop-in Player Competition, most of the insights discussed in Section 7 apply to any competitive ad hoc teamwork evaluation. In this section, we quickly overview some of the insights presented in Section 7 of our JAAMAS article.

Suggestions for organizing a similar competition:

1. Introduce the competition as a 'challenge' event in a larger competition.
2. Ensure adequate participation — perhaps by requiring mandatory participation in early years.
3. Motivate teams to perform well in the competition — perhaps by tying award money or future qualification to performance.
4. Require successful teams to report their strategies publicly.
5. Check compliance of teams on critical components (in the Drop-in Player Competition, adherence to a standard communication packet).
6. Include elements that allow agents to determine the trustworthiness of teammates.
7. Test — through simulation or preliminary competitions — scoring metrics to make sure they reward and penalize behaviors as desired.

Open areas of research for ad hoc teamwork competitions:

1. Estimating the trustworthiness of teammates. This could mean tracking communicated information over time in order to learn a model of each teammate and calculate estimates of their trustworthiness and ability.
2. Determining when teammates are willing to coordinate. In the Drop-in Player Competition, a robot may indicate willingness to coordinate through intelligent positioning, passing, or adaptive role suggestions.
3. Seeking out teamwork opportunities. This could mean determining when it is appropriate and worthwhile to coordinate with a teammate.

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