To appear in *Proceedings of the International Conference on Autonomous Agents & Multiagent Systems* (AAMAS-15), Istanbul, Turkey, May 2015.

The RoboCup 2014 SPL Drop-in Player Competition: Encouraging Teamwork without Pre-coordination

(Extended Abstract)

Katie Genter
Dept. of Computer Science
University of Texas at Austin
Austin, TX 78712 USA
katie@cs.utexas.edu

Tim Laue
Dept. of Computer Science
University of Bremen
28359 Bremen, Germany
tlaue@uni-bremen.de

Peter Stone
Dept. of Computer Science
University of Texas at Austin
Austin, TX 78712 USA
pstone@cs.utexas.edu

ABSTRACT

The Standard Platform League is a soccer league at the annual RoboCup world championships in which teams of five humanoid robots play against each other. In 2014, the Drop-in Player Competition was added to the league to serve as a testbed for cooperation without pre-coordination. Instead of homogeneous robot teams that are programmed by each team to implicitly work together, this competition features ad hoc teams, i. e. teams that consist of robots originating from different RoboCup teams and that are each running different software. In this extended abstract, we provide an overview of this competition, including its motivation and rules.

Categories and Subject Descriptors

I.2.11 [**Distributed Artificial Intelligence**]: Multiagent systems

General Terms

Documentation, Experimentation

Keywords

Ad Hoc Teamwork, Cooperation, Robot Soccer

1. INTRODUCTION

RoboCup is an annual international robotics competition in which teams from many universities, companies, and other organizations compete against each other in a variety of leagues. Since 1997, RoboCup has served as an excellent domain for testing teamwork, coordination, and cooperation. Most teams have successfully programmed their robots to work well as a team, coordinating which robot should go to the ball, which robot should play defense, and even what formation should be adopted by the team when facing various different opponent types.

There are many leagues in RoboCup — this abstract focuses on a new competition occurring in the Standard Platform League (SPL). The SPL is different from the other RoboCup leagues in that all teams must use the same robotic platform, making it essentially a software competition. SPL teams must play completely autonomously — no human input is allowed during games outside of game state signals sent by an official to communicate to the robots when a goal has been scored, when they have been penalized, and so on. The robots on each team are allowed to communicate with each other over a wireless network. See Figure 1 for a picture of a SPL game at RoboCup 2014.

Appears in: *Proceedings of the 14th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2015), Bordini, Elkind, Weiss, Yolum (eds.), May 4–8, 2015, Istanbul, Turkey.*

Figure 1: NAO robots playing in an SPL game during RoboCup 2014 in João Pessoa, Brazil.

This abstract presents the Drop-in Player Competition held in the SPL at RoboCup 2014 in which teams were encouraged to develop 'drop-in' soccer players that could be good teammates and play well within an ad hoc team composed of drop-in players from a variety of teams in the SPL. The teams were asked not to pre-coordinate, so that during games these agents had to reason about their teammates' abilities and intentions in real time and determine how to best assist their team. Each agent's goal was to win a soccer game by as much as possible, while being judged as a 'good teammate' by human officials who were watching the game.

2. COMPETITION DESCRIPTION

The Drop-in Player Competition is based on the main RoboCup SPL soccer competition. The 2013 drop-in player challenge across three RoboCup leagues [1] was one of the first organized efforts to evaluate a player's ability to coordinate with a set of teammates in an ad hoc manner, and the 2014 SPL Drop-in Player Competition discussed in this abstract greatly improved upon the 2013 challenge in both scale and participation.

In the remainder of this section, we discuss the SPL standard communication protocol as well as the scoring metrics and organization of the Drop-in Player Competition.

2.1 Communication

To enable communication among the players of a team, the SPL introduced a wireless standard communication protocol in 2014. This protocol is mandatory and no other wireless communication is allowed. Each robot is allowed to send up to five UDP broadcast messages per second to its team. Each message has a predefined format and includes information about the robot's position, walk target, shooting target, observed ball state, and intention. Intention is a state that could be *want to be goalkeeper*, *want to play defense*, *want to play the ball*, *I am lost*, or *nothing* (default). However, all communication is unidirectional and no negotiation mechanisms exists. Therefore, each robot can express its intention but there is no guarantee that its teammates will consider it in their own decisions.

2.2 Scoring

Each player's score in the Drop-in Player Competition consists of two equally weighted components computed over all of the player's games: average goal difference and average judge score.

The average goal difference is calculated over all games that a robot is scheduled to play in the Drop-in Player Competition. Therefore, the intention of each robot should always be to score goals as well as prevent the opponent from scoring. The competition does not involve any individual rewards for scoring goals to make both types of role – offensive and defensive – equally attractive within a team.

Similarly to human soccer, important aspects of good team play, such as passing and good position, are not necessarily reflected by a game's final score. Therefore, each match is observed by six human judges that award positive scores for actions that positively affect team play and negative scores for actions that negatively affect team performance. Positive judge scores can be earned by actions such as passing the ball to a teammate or receiving a pass from a teammate. Negative judge scores can be earned by actions such as pushing teammates or stealing the ball from a teammate. Players also receive a positive or negative judge score for their game participation each half.

In each half, the six judges are divided into two groups of three with one group observing each team. At halftime, the judges switch teams. This procedure results in six scores from six different judges per robot per game. Each judge has to observe a maximum of five robots at any point of time and fill out a score sheet.[1] The possible ranges of scores that can be given by judges are listed in Table 1.

After all drop-in games are complete and the average goal differential and average judge score have been computed for each drop-in player, the two scoring metrics are normalized and added up to determine the overall winner of the Drop-in Player Competition.

2.3 Organization

Drop-in Competition games are played 5 vs. 5 just like main competition SPL games. In each game, all 10 robots on the field originate from different teams to avoid any biases in the overall scores. To achieve meaningful scores that reliably reflect the drop-in capabilities of a single robot, it is best to play as many games as possible with as many different teammates and opponents as possible. The involved judges and referees originate from teams different from those that provide the robots.

Observed Behavior	**Score Range**
Pass to a teammate	+1 – +4
Receiving a pass	+1 – +4
Pushing a teammate	-2
Unclassified bonus or penalty	-2 – +2
Game participation (once per half)	-10 – +10

Table 1: Possible scores (and their ranges) that can be awarded by judges. The *Unclassified bonus or penalty* is capped at -10/+10 per half.

3. COMPETITION AT ROBOCUP 2014

For the RoboCup 2014 Drop-in Competition, our schedule allowed us to organize 15 drop-in games. As 25 teams registered for the Drop-in Competition at RoboCup 2014, every robot was scheduled to participate in 6 different matches. The pairings were randomly generated by a computer program that was also used for 3D Soccer Simulation League drop-in games (Algorithm 1 in [1]). The overall tight schedule of RoboCup 2014 did not allow pairings in which every player plays at least once with every other player, as this would require at least 27 drop-in matches. However, for the creation of the pairings, a focus was for every player to have as many different teammates as possible. In this vein, each player had at least 18 and up to 22 different teammates, did not play with any specific teammate more than 3 times, and had at least 17 and up to 20 different opponents.

Subsequent to the competition, a friendly 'all-stars' vs. world champion game was held. The all-stars, consisting of the top five players in the Drop-in Competition, lost 2:4 against the 2014 world champion *rUNSWift*. This documents the potential strength of ad hoc teams, as this was the best result that any team achieved against *rUNSWift* during RoboCup 2014.

4. CONCLUSION

The Drop-in Player Competition in the SPL matured at RoboCup 2014 into a useful testbed for cooperation without pre-coordination. With the SPL being a standard platform league, and with options existing for teams to just compete in the SPL Drop-in Competition at RoboCup, this testbed is open and approachable for multiagent systems researchers looking to work on ad hoc teamwork in a robotics domain.

Acknowledgments

Katie Genter and Peter Stone are part of the Learning Agents Research Group (LARG) at UT Austin. LARG research is supported in part by NSF (CNS-1330072, CNS-1305287), ONR (21C184-01), and AFOSR (FA8750-14-1-0070, FA9550-14-1-0087).

REFERENCES

[1] P. MacAlpine, K. Genter, S. Barrett, and P. Stone. The RoboCup 2013 drop-in player challenges: Experiments in ad hoc teamwork. In *IROS'14*, September 2014.

[1] `https://www.informatik.uni-bremen.de/spl/pub/Website/Downloads/dropInScoreSheet2014.pdf`