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Multi-robot coordination using Setplays in the middle-size and simulation leagues

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ABSTRACT

Strategic planning and multi-agent coordination are major research topics in the domain of RoboCup. Innovations in these areas are, however, often developed and applied to only a single RoboCup league and/or one domain, without proper generalization. Moreover, the more technical leagues, like middle-size and humanoid, tend to focus development on low-level skills, that often suffice to gain a competitive edge over other teams. In these leagues, the development of high-level cooperation is secondary.

Although the importance of the concept of Setplay, to structure a robotic soccer team behaviour, has been acknowledged by many researchers, no general framework for the development and execution of generic Setplays has been introduced in the context of RoboCup. This paper presents such a framework for high-level Setplay definition and execution, applicable to any RoboCup cooperative league and similar domains. The framework is based on a flexible, standard and league-independent language, which defines Setplays that are interpreted and executed at run-time, using inter-robot communication.

An initial major step in the development of the Setplay framework was its usage and testing in the scope of the FCPortugal team, which participates in the RoboCup 2D-simulation and 3D-simulation leagues, where it won several titles both in the 2D and 3D leagues. This framework was also recently implemented in the middle-size team CAMBADA. This team has, in the recent past and with previous versions of the control software, ranked first and third in RoboCup's 2008 and 2009 editions. The implementation is described with concrete examples of Setplay definition and execution, which shows the usefulness of this approach and motivate its use as a major coordination tool for teams participating in the simulation, small-size, middle-size, standard platform and humanoid leagues of RoboCup.

1. Introduction

RoboCup[1] [4] is an international initiative to promote Artificial Intelligence, robotics, and related fields. It fosters research by providing a standard problem where a wide range of technologies can be integrated and examined. RoboCup uses the soccer game as a central topic of research, aiming at innovations to be applied for socially significant problems and industries. Research topics include design principles of autonomous agents, strategy acquisition, real-time reasoning, robotics, and multi-agent collaboration, which this paper aims at contributing to.

Robotic Soccer needs, as the research in the domain develops, coordination at team scope, which involves planning at many levels. This paper deals with representing and executing high-level, flexible plans for robots playing in different RoboCup leagues. A framework for representing, executing and evaluating such plans is presented, relying on a high-level Setplay definition language and inter-robot communication.

Setplays are commonly used in many team sports such as soccer, rugby, handball, basketball and baseball. There are surely several important differences between robot soccer and human sports, but Setplays are nonetheless a useful tool for high-level coordination and cooperation, since they allow the definition of how different players interact in key situations. In the sense employed in this article, a Setplay is a freely-definable, flexible and multi-step plan, which allows alternative execution paths, involving a variable number of robots.

1.1. Motivation and requirements

The CAMBADA team [2] has, in recent years, obtained very good results in the RoboCup competitions. The final ranks in the editions

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[1] http://www.robocup.org

[2] http://www.ieeta.pt/atri/cambada/

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