The Missing Neurocognitive and Artificial General Intelligence Bases of RoboCup Research: What still needs to be done before 2050?

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Abstract

There has been much recent interest in cognitively motivated paradigms for the design of humanoid soccer playing robots. In addition, some proto-attempts have been made to bring the 3D simulation and humanoid RoboCup leagues closer to each other. In the present paper, we outline the basic concepts of our Neurocognitive Artificial General Intelligence (NAGI) framework for the future 3D Soccer Simulation League. The aim of NAGI is to develop teachable AI soccer playing agents embodied in virtual environments such as *Second Life*. Once virtually embodied agents attain approximately human-like intelligence, the transfer of agent modeling knowledge to the humanoid robots should take place.

Keywords: Neurocognitive, Artificial General Intelligence, teachable AI agents, 3D Simulation League, Humanoid League, Novamente Cognition Engine, Second Life, t-pattern detection.

1 Introduction

Recently there has been much interest in cognitively based paradigms for the design of humanoid soccer playing robots [1], [2], [3]. In addition, some proto-attempts have been made to bring the 3D simulation [4], [5] and humanoid [6]

RoboCup leagues closer to each other with an objective to provide new insights and tools that would speed up the progress across both research areas [7]. In the present paper, we aim at re-defining the roadmap towards the ultimate goal of RoboCup research: To build a team of fully autonomous, humanoid soccer playing artificial agents capable of winning against a human world cup champion soccer team by 2050.

2 An Integrative Neurocognitive AGI Approach

We argue that this goal is reachable only via a successful integration of human-like neuro-cognitive architectures, adequate knowledge representation systems and feasible learning algorithms, or in other words, embodied and smarter-than-human Artificial General Intelligence (AGI) [8], [9]. The key ideas we propose here are as follows. First, we outline the basic concepts of our *Neurocognitive Artificial General Intelligence* (NAGI) design principle for the future 3D Soccer Simulation League. Here, we argue that the core of the design is representable through approaches such as the *Novamente Cognition Engine* [10], [11], [12], employing two distinct cognitive algorithms – probabilistic term logic (PTL) and Bayesian optimization algorithm (BOA) [12], [13], [14], [15].

3 Virtually Embodied Soccer Playing Agents

The main goal of NAGI is to develop teachable AI soccer playing agents living in virtual environments such as *Second Life* (SL). In a human-like manner, these agents would ascent through different stages of cognitive development, by interacting with both human avatars (users of SL) and artificial autonomous agents in virtual worlds. Once virtually embodied soccer playing agents attain approximately human-level intelligence, the transfer of agent modeling knowledge to the humanoid robots should take place. Thus, the major point of this proposal is that virtual worlds are an excellent benchmark for testing and maturation of AGI [11] necessary for the development of both digital and in silico human-like soccer players.

4 Alternative Approaches

The realization of our goal is not restricted to the outlined design; other candidate approaches that have the potential to develop AGI, such as adiabatic quantum computing [16], or emergent, content-addressable and associative quantum holographic neural-like network systems [17] and their recent implementations in humanoid robotics [18], are also discussed.

5 Future Directions

Since RoboCup research community aims at developing artificial agents that would be able to mimic human behavioral patterns during soccer games, there is a need for measuring and comparing the emerging behavior across populations (human vs. artificial). Moreover, it is important to develop and standardize a

particular pattern detection system that could be used by all research groups and that would further serve as a measure of efficiency of research improvements. For this purpose, we suggest the t-pattern detection approach [19], [20], which has already been successfully applied to the analyses of human-animal and human-robot interactions [21], and real-life human soccer matches [22], [23].

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