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Proceedings of the First Annual MIDCA Workshop

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Abstract

This report contains the proceedings of the First Annual MIDCA Workshop held at Wright State University on January 13th, 2017. MIDCA (Metacognitive Integrated Dual-Cycle Architecture) is an ongoing project of artificial intelligence research under Dr. Michael T. Cox of the Wright State Research Institute. MIDCA is a unique approach to artificial intelligence using explicit cognitive and metacognitive capabilities. The workshop included talks on getting to know the MIDCA architecture, research projects using MIDCA, and demonstrations of its capabilities. A primary objective of the workshop was to enable users to have a better understanding of MIDCA and discuss future improvements and research areas. More information about MIDCA can be found at the github page: https://github.com/mclumd/MIDCA

Introduction

The Metacognitive Dual-Cycle Integrated Architecture (MIDCA) project has seen an increase in recent activity and is being used in a number of different research projects involving goal reasoning, metacognition, and execution monitoring. This workshop is the first of hopefully many annual workshops on the progress of MIDCA. The aim of the workshop is to bring together those working on MIDCA (or interested in MIDCA) as well as review recent advancements and forecast future endeavors of the project. Specifically, the objectives for the workshop include:

- Sharing the current capabilities of MIDCA to current and new users.
- Collaboratively brainstorm improvements to the implementation and theory, as well as new research paths.
- Learning about MIDCA from a new user perspective.
- Continuing the establishment of a community around MIDCA.
- Strengthening the resources of the MIDCA project.

The workshop was live streamed via Youtube and the recording of each talk is publicly available. The link for each video can be found under the abstract in the sections below.

Schedule

Time	**Title**	**Speaker**
2:00 PM	Introduction to MIDCA	Dustin Dannenhauer
2:15 PM	The Origins of the MIDCA Architecture	Michael T. Cox
2:35 PM	Goal Graph and Goal Operations	Sravya Kondrakunta
2:55 PM	MIDCA and Baxter in Gazebo	Vahid Eyorokon
3:05 PM	Coffee Break 1	
3:15 PM	Collaborative Brainstorm	All
3:35 PM	Overview of Planning in MIDCA	Dustin Dannenhauer
3:55 PM	JSHOP: A New Planner for MIDCA	Zohreh A. Dannenhauer
4:00 PM	Perceive, Act and Plan in MIDCA	Zohreh A. Dannenhauer
4:20 PM	Metacognition in MIDCA	Dustin Dannenhauer
4:40 PM	New User Experience	Sam Schmitz
4:50 PM	Coffee Break 2	
5:00 PM	Working Session	All
5:40 PM	Closing Discussion and Final Thoughts	Dustin Dannenhauer

Abstracts

Introduction to MIDCA

Welcome to the First Annual MIDCA Workshop. The Metacognitive Dual-Cycle Architecture (MIDCA) is an ongoing project to create an artificial intelligent agent with explicit metacognitive capabilities. MIDCA has seen an increase in recent activity and number of people working on the project. The aim of this workshop is to strengthen the community around MIDCA, provide additional resources for those using MIDCA, and collaboratively brainstorm improvements and future research for MIDCA. This talk will introduce MIDCA from multiple angles including: review of MIDCA's theoretical model, review of the codebase at a high level, review of publications involving MIDCA, and a brief overview of an example script for running MIDCA (i.e. the entry point in the codebase).

Youtube Video URL:
https://www.youtube.com/watch?v=U4KudZ0aKVQ

The Origins of the MIDCA Architecture

Michael T. Cox

The MIDCA architecture has a rich history for its short lifetime, but a number of related projects preceded its development. We will examine a number of these precursors to place the cognitive architecture in context. In particular I will use the basic metareasoning model of Cox and Raja (2011) to illustrate this progression and to distinguish metacognitive from cognitive components in the all systems I discuss including those composing MIDCA.

Youtube Video URL:
https://www.youtube.com/watch?v=7S5bDRLO5P4

Goal Graph and Goal Operations

Sravya Kondrakunta

The goal graph is a tree structure which maintains all goals of the agent (i.e., user given and formulated goals). All the unique goals are partially ordered. Whenever goals are provided the agent checks if the provided goals are valid and then inserts them into the goal graph. The goal graph data structure contains three classes and they are the *goal*, *goal node* and *goal graph*. We also perform some goal operations such as goal formulation, delegation, selection, transformation and achievement. Currently our main focus is on transformation which is performed because of many reasons such as resource availability, emergencies, etc. All of the goal operations make the agent more flexible and self-reliant.

Youtube Video URL:
https://youtu.be/HQtNXMVqVpg

MIDCA and Baxter in Gazebo

Vahid Eyorokon

The accessibility of robotic systems plays a pivotal role in both their communal development and research as well as facilitating improved opportunities for educational exposure and commercial adoption. Improving research and development of these systems can reduce their costs. However, the prohibitive cost of these systems often proves to be a deterrent to their use thereby restricting cases of adoption. Simulations offer a more cost effective solution to promoting development of robotic systems. Gazebo is a free open source simulator with a built-in physics engine that facilitates development of robotic systems. By utilizing the Robot Operating System (ROS), Gazebo can take advantage of native ROS commands within each robot system to manipulate them within the simulated world. MIDCA is a cognitive architecture that takes advantage of ROS commands and can therefore be used to control a Baxter robot in simulation.

Youtube Video URL:
https://youtu.be/tS5H5TYG68M

Overview of Planning in MIDCA

Dustin Dannenhauer

The planning phase of the cognitive level of the MIDCA architecture has received considerable attention. MIDCA currently has three available planners: PyHop, JSHOP, and a HeuristicSearchPlanner. Which planner is best depends on the domain and choice of the MIDCA developer. PyHop and JSHOP both use Hierarchical Task Network (HTN) methodologies. The HeuristicSearchPlanner uses a state-space methodology, and has been used in situations involving updates to the planning operators, which are then immediately used during planning for the next goal. PyHop requires some translation functions from MIDCA's internal state representations to a representation to be used for states in the planning search. JSHOP also requires some translation, although considerably less then PyHop, and the HeuristicSearchPlanner requires no translation (it uses internal MIDCA states and operators). While the HeuristicSearchPlanner does not require translation, it requires good heuristics in order to be computationally efficient. Without good heuristics the HeuristicSearchPlanner may be intractable, particularly because search occurs over both actions and the variable-bindings of arguments to those actions. These issues should be kept in mind when working with planning in MIDCA.

Youtube Video URL:
https://youtu.be/zawQho-89Lg

JSHOP: A New Planner for MIDCA

Zohreh A. Dannenhaer

JSHOP is the implementation of the SHOP Planner in Java. MIDCA now uses JSHOP in the Plan phase. Using JSHOP has an advantage over the Pyhop planner in that there is no need to define the operators and methods in the code. Instead, the developer gives the domain and problem files as input to the planner. The domain file includes the definition of methods and operators, and the problem file includes the list of tasks to accomplish and the initial state. To use JSHOP in MIDCA you need to define a domain file and write a function to convert the goal(s) in MIDCA to the tasks for JSHOP.

Youtube Video URL:
https://youtu.be/h6hLWj9joJ0

Perceive, Act and Plan in MIDCA

Zohreh A. Dannenhauer

This talk begins with a demonstration of a Baxter humanoid robot with MIDCA in a blocksworld domain. Baxter is asked to stack the red block on the green block, but during planning time, a person puts another block on top of the red block. Baxter sees the change in the world state and modifies the plan under construction, and then it executes the valid plan to achieve the goal **on**(*redblock*, *greenblock*)).

The rest of the presentation covers the details of how this demonstration works. It starts with an overview of the Robot Operating System (ROS). Next, I discuss the interface between MIDCA and ROS that we developed. Then I show how predicates are extracted from the image received by Baxters camera. The presentation on the relationship between Plan and Perceive phases in MIDCA, and how an agent can respond to changes in the environment during planning time.

Youtube Video URL:
https://youtu.be/dDzlzbtYOw0

Metacognition in MIDCA

Dustin Dannenhauer

Metacognition in MIDCA is one of the two dual-cycles of the architecture. The metacognitive layer is analogous to the cognitive layer, with the primary difference being that it is concerned about the cognitive layer's activities as opposed to the world. Metacognition monitors the cognitive layer while the cognitive layer perceives the world. Metacognition control affects changes in cognition, while the cognitive layer acts to change the world. Metacognition in MIDCA currently has three implemented capabilities: dynamically removing and adding modules, transforming goals, and modifying planning domain knowledge, which all happen during runtime. MIDCA's metacognitive infrastructure runs one metacognitive cycle in between each phase of cognition. There are many potential areas for future work, including (1) viewing goal transformation as a planning problem and using planning based approaches and (2) modeling metacognitive goals such as desired mental states or modes of operating (i.e. agent operating urgently vs. accurately).

Youtube Video URL:
https://youtu.be/0U4wVBzbK24

New User Experience

Samuel Schmitz

The purpose of this presentation is to display the ease of downloading MIDCA by a new user and demonstrate some examples of MIDCAs scripts. At the end of this presentation, a new user to MIDCA will understand the effortlessness of its installation, setup, and execution. In addition, this presentation will demonstrate a detailed example script in MIDCA, illustrating its syntax, commands required to execute it, and illustrate through visual display the simplicity of the inner-workings of MIDCA.

Youtube Video URL:
https://youtu.be/MMz03WLz4co

Summary

The workshop was a huge success. We would like to thank all of the speakers and the following individuals for contributing to the discussions and brainstorming sessions: Matthew Paisner, Lauren Hoffman, and Uday Panjala. We felt all objectives were met and the brainstorming sessions were engaging and motivating. There is a bright future ahead for the MIDCA project!

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