Neuro-Symbolic Reinforcement Learning: Natural Language Driven Multi-Task Agents

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(ABSTRACT)

In recent years, neuro-symbolic learning methods have demonstrated promise in tasks requiring a semantic understanding that can often be missed by traditional deep learning techniques. By integrating symbolic reasoning with deep learning architectures the interpretability of the model's reasoning becomes more evident and can provide more control during deployment. This thesis aims to apply neuro-symbolic learning to the domain of reinforcement learning. First, a simulation environment for robotic manipulation tasks based on the Gazebo physics simulator and ROS2 middleware suite is presented. In this environment an analysis of policy-gradient based reinforcement learning algorithm is given. Then, by leveraging the performance of deep learning with the semantic reasoning and interpretability of symbolically defined programming, a novel neuro-symbolic learning method is proposed to generalize tasks and motion planning for robotics applications using natural language. The novel neuro-symbolic can be seen as an adaptation of the Neuro-Symbolic Concept Learner (Mao et. al) developed by IBM Watson, in which images and natural language are first processed by convolutional and residual neural networks, respectively and then parsed by a symbolically reasoned program. Where the architecture proposed in this paper differs, is in its use of the Neuro-Symbolic Concept Learner for preprocessing of a given input task, to then inform a reinforcement learning agent of how to act in a given environment. Finally, the novel adaptation of the Neuro-Symbolic Concept Learner is introduced as a method of controlling multi-task agents.

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(GENERAL AUDIENCE ABSTRACT)

You are also required as of Spring 2016 to include a general audience abstract. This should be geared towards individuals outside of your field that may be reading seeking information about your work. You should avoid language that is particular to your field and clearly define any terms that may have special meaning in your discipline.

Dedication

This is where you put your dedications.

Acknowledgments

This is where you put your acknowledgments.

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NLP is a field of computer science, artificial intelligence, and linguistics concerned with the interactions between computers and human (natural) languages.

σ is the eighteenth letter of the Greek alphabet, and carries the 's' sound. In the system of Greek numerals, it has a value of 200.

Chapter 1

Introduction

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1.1 Objectives

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1.1.1 A sub-section

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1.2 Applications

1.3 Challenges

1.4 Contributions

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Chapter 2

Background

2.1 Markov Decision Process

2.2 Reinforcement Learning

2.3 Neuro-symbolic Architectures

2.4 Sim-to-Real

2.4.1 Transfer Learning

2.4.2 Multitask Learning

Chapter 3

Neuro-symbolic Reinforcment Learning Model

Neuro

./images/architecture_overview.png

Figure 3.1: Overview of proposed architecture.

Chapter 4

Simulations

Chapter 5

Reality

Chapter 6

Discussion

Chapter 7

Conclusions