



Chapter IV

On IETAL, Algebraically

Abstract

In this chapter, we formalize the Interactivist-Expectative Theory of Agency and Learning (IETAL) agent in an algebraic framework and focus on issues of learnability based on context.

Introduction

Accurate and reliable modeling of the environment is essential to its performance. It is conceptually easier to talk in terms of agents moving in 2D or 3D environments, we will speak of the agents as of mobile autonomous robotic agents, and thus connect our research to the field of navigational map learning (Kuipers, 1978). In many cases, due to the limitations of the agent's perceptual abilities, the agent can end up in a situation where it cannot distinguish between two locally distinct places that are perceived as the same (refer to comment on

Figure 1, for example). If the reason for this uncertainty is of a perceptual nature, we talk of *perceptual aliasing*. Then the only way a node can be recognized as different is to examine its *context*.

Context of a vertex in a graph is a tree-like data structure rooted at the vertex and defined recursively to include all the *reachable* vertices and their contexts. A sink vertex's context is that vertex itself. Dean, Basye, and Kaelbling (1992) give algorithms for learning models of such graphs while considering different types of uncertainties. In other papers, (Stojanov, Stefanovski, & Bozinovski, 1995), for example, learning algorithms inspired by biological systems have been presented. Here, we are concerned whether an agent can learn a given graph based on its context, in an environment where perceptual aliasing is present.

Basics of the Algebraic Formalization

In this section, we give a mathematical, graph-theory-based model of agent and related terms (Trajkovski & Stojanov, 1998). Bear in mind Figure 1 (graph Γ) while reading this section, as we will be referring to it and illustrating theoretical concepts with examples based on it.

From the perspective of the designer, Γ is a graph, and as such consists of vertices (or nodes) and edges. It is a directed graph, as the edges denote the direction in which an action can take the agent when the agent executes this action. Therefore, let:

$$V = \{v_1, v_2, \dots, v_n\}$$

be a finite nonempty set of vertices and

$$A = \{s_1, s_2, \dots, s_m\}$$

a finite nonempty set of actions with implicit ordering induced by the indexing.

So, if we use the designer's convention on Γ in naming the vertices in Figure 1, and the acronyms N, S, E and W for north, south, east and west respectively for the actions of the agent,

$$V = \{11, 12, 13, 22, 23, 31, 32, 33\},$$

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