

Introduction to Reasoning about Action and Change

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Many of the domains about which we wish to reason are dynamic in nature. That is, the world is subject to change due to the performing of actions in the world. Such domains exhibit a number of challenges when it comes to representation and reasoning.

In such environments, we firstly need to be able to describe the nature of the world in which we find ourselves (or our reasoner finds itself). A *state description* (or simply *state*) provides a snapshot of the world at particular moment in time. We also need to describe the *actions* that can be performed. Actions bring about changes to the state of the world. In describing legal states of the world there may be certain (state-independent) conditions or restrictions that are known to be true in every state of the world (e.g., an object is clear if and only if there is no other object on top of it). Such restrictions are referred to as *domain constraints* (also *state constraints*) and can prove quite valuable in reasoning.

Briefly then, the problem that confronts us in reasoning about action and change is to determine the nature of the world (i.e., what holds true in the world state) after performing a given action in a known world state(s).

Apart from the ubiquitous problems associated with the representation of knowledge we can identify a number of problems that relate to reasoning in a changing world:

Frame problem which characteristics of a state are not changed by the performing of an action?

Ramification problem what are the effects (direct and indirect) of an action?

Qualification problem what are the conditions (qualifications) under which an action is applicable?

Often, all these problems are collectively studied under the umbrella of the *frame problem* [8, 3, 10].

A variety of formal frameworks have been proposed to deal with these problems. Among the most common in the literature are the following:

- Situation calculus [7, 8, 1]
- Features and fluents [9]
- \mathcal{A} languages [2]
- Event calculus [5, 10]

In this talk we shall examine the general issues involved in representing and reasoning about dynamic domains. We will also take a brief look at some of the proposed frameworks for dealing with these problems (time does not allow us to investigate them all, however the list of references below will serve as a good starting point for further study).

The problem of reasoning about action and change has been around since the early days of artificial intelligence (if not earlier!). In more recent times it has led to the emergence of the field of *cognitive robotics* as the emphasis moves to putting formal theories of action to the test. However, the frame and associated problems remain a topic of discussion in artificial intelligence today.

Recent work has also concentrated on the rôle and nature of *causality* in reasoning about action. Such notions allow us to move away from problems associated with traditional (logical) domain constraints and arguably provide concise solutions to the frame problem.

Presenter

Maurice Pagnucco joined Macquarie University as a lecturer in Computing in 1998. Prior to that he held postdoctoral positions at the University of Sydney and at the University of New South Wales. He completed his doctoral studies in Computer Science at the University of Sydney in early 1996 on the role of abductive reasoning within the process of belief revision. He also undertook his undergraduate studies at the University of Sydney culminating in an Honours degree in Computer Science and including one year at the Department of Computer Science at the University of Milan, Italy. His research interests lie in logic-based approaches to artificial intelligence; in particular, belief revision, logics of action, abductive reasoning, nonmonotonic inference, and knowledge representation.

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