

Chapter 10

Applying Lakatos–Style Reasoning to AI Problems

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ABSTRACT

One current direction in AI research is to combine different reasoning styles such as deduction, induction, abduction, analogical reasoning, non-monotonic reasoning, vague and uncertain reasoning. The philosopher Imre Lakatos produced one such theory of how people with different reasoning styles collaborate to develop mathematical ideas. Lakatos argued that mathematics is a quasi-empirical, flexible, fallible, human endeavour, involving negotiations, mistakes, vague concept definitions and disagreements, and he outlined a heuristic approach towards the subject. In this chapter the authors apply these heuristics to the AI domains of evolving requirements specifications, planning and constraint satisfaction

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problems. In drawing analogies between Lakatos's theory and these three domains they identify areas of work which correspond to each heuristic, and suggest extensions and further ways in which Lakatos's philosophy can inform AI problem solving. Thus, the authors show how they might begin to produce a philosophically-inspired theory of combined reasoning in AI.

INTRODUCTION

The philosophy of mathematics has relatively recently added a new direction, a focus on the history and philosophy of informal mathematical practice, advocated by Lakatos (1976, 1978) Davis & Hersch (1980), Kitcher (1983), Corfield (1997), Tymoczko (1998), and others. This focus challenges the view that Euclidean methodology, in which mathematics is seen as a series of unfolding truths, is the bastion of mathematics. While Euclidean methodology has its place in mathematics, other methods, including abduction, scientific induction, analogical reasoning, visual reasoning, embodiment, and natural language with its associated concepts, metaphors and images play just as important a role and are subject to philosophical analysis. Mathematics is a flexible, fallible, human endeavour, involving negotiations, vague concept definitions, mistakes, disagreements, and so on, and some philosophers of mathematics hold that this actual practice should be reflected in their philosophies. This situation is mirrored in current approaches to AI domains, in which simplifying assumptions are gradually rejected and AI researchers are moving towards a more flexible approach to reasoning, in which concept definitions change, information is dynamic, reasoning is non-monotonic, and different approaches to reasoning are combined.

Lakatos characterised ways in which quasi-empirical mathematical theories undergo conceptual change and various incarnations of proof attempts and mathematical statements appear. We hold that his heuristic approach applies to non-mathematical domains and can be used to explain

how other areas evolve: in this chapter we show how Lakatos-style reasoning applies to the AI domains of software requirements specifications, planning and constraint satisfaction problems. The sort of reasoning we discuss includes, for instance, the situation where an architect is given a specification for a house and produces a blueprint, where the client realises that the specification had not captured all of her requirements, or she thinks of new requirements partway through the process, or uses vague concepts like “living area” which the architect interprets differently to the client's intended meaning. This is similar to the sort of reasoning in planning, in which we might plan to get from Edinburgh to London but discover that the airline interpret “London” differently to us and lands in Luton or Oxford, or there may be a strike on and the plan needs to be adapted, or our reason for going to London may disappear and the plan abandoned. Similarly, we might have a constraint satisfaction problem of timetabling exams for a set of students, but find that there is no solution for everyone and want to discover more about the students who are excluded by a suggested solution, or new constraints may be introduced partway through solving the problem. Our argument is that Lakatos's theory of mathematical change is relevant to all of these situations and thus, by drawing analogies between mathematics and these problem-solving domains, we can elaborate on exactly how his heuristic approach may be usefully exploited by AI researchers.

In this chapter we have three objectives:

1. to show how existing tools in requirements specifications software can be augmented

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