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Novel Statistical Rule Discovery for Understanding Behaviours of Swarm Robots

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Abstract

In this poster, we present a novel statistical rule discovery for understanding behaviours of swarm robots. Swarm robots [Parker 08] are autonomous agents each of whom interacts with their environment locally based on a relatively simple program but as a system they exhibit complex collective behaviours. It has been shown that learning a model of the control program of a robot helps the designer to better understand the program, especially when the program is highly complex [Fox 06]. One of the essentials of statistical rule discovery is its ability to focus on the interesting aspects of the given data, which seems to fit the nature of the control programs of swarm robots. We should, however, point out that traditional statistical rule discovery which extracts a set of rules from data has several limitations for this new application. Firstly, it allows different discovered rules to cover an identical example, which makes it difficult for the designer to understand the controller. Secondly, it assumes that the discovered rules serve as hints to the user, which leaves the designer most of the work of understanding the program. Thirdly, it is typically evaluated based on a single trial, which prohibits us to discuss its robustness against misunderstanding and noise quantitatively. Statistical implicative analysis [Gras 08, 09] is a promising approach for overcoming these limitations, though to the best of the author’s knowledge, the countermeasures are found in various papers, showing the maturity of the research field but prohibiting the public to obtain a solution easily.

To overcome these limitations, we argue that [Suzuki 09a] is a promising candidate of a novel statistical rule discovery for the task. Firstly, it discovers a partial decision list, which consists of mutually exclusive rules, and thus the designer would just have to concentrate on a single rule for the corresponding set of examples. The point here is our modification of the hypothesis space so that a partial decision list is sought instead of a set of possibly overlapping rules. Secondly, it tries to recover the true partial concept that has generated the given data, and thus the designer would just have to understand the discovered hypothesis of the controller. Thirdly, it is evaluated based on a multiple trials in terms of the ratio of successful recoveries, which allows us to discuss its robustness against noise quantitatively. Moreover, since [Suzuki 09a] assumes that an initial hypothesis, which is typically approximate, is given in the input, we can also discuss its robustness against misunderstanding of the user quantitatively. The point here is our extension of the Minimum Description Length Principle [Rissanen 89], which is for evaluating a partial decision list in terms of the given data and the initial hypothesis. Our endeavour is ongoing with several kinds of swarm robots, which we call flies [Suzuki 09b], centipedes [Kouno 10], and ants.

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