

*For Annette,  
Nicola, and Fabian*

# Preface

Robotic agents, such as autonomous office couriers or robot tourguides, must be both reliable and efficient. This requires them to flexibly interleave their tasks, exploit opportunities, quickly plan their course of action, and, if necessary, revise their intended activities. In this book, we describe how *structured reactive controllers* (SRCs) satisfy these requirements. The novel feature of SRCs is that they employ and reason about plans that specify and synchronize *concurrent percept-driven* behavior. Powerful control abstractions enable SRCs to integrate physical action, perception, planning, and communication in a uniform framework and to apply fast but imperfect computational methods without sacrificing reliability and flexibility. Concurrent plans are represented in a transparent and modular form so that automatic plan management processes can reason about the plans and revise them.

The book makes three main contributions. First, it presents a plan representation that is capable of specifying flexible and reliable behavior. At the same time, the plan representation supports fast and robust execution time plan management. Second, it develops *Probabilistic Hybrid Action Models* (PHAMs), a realistic causal model for predicting the behavior generated by modern concurrent percept-driven robot plans. PHAMs represent aspects of robot behavior that cannot be represented by most action models used in AI planning: the temporal structure of continuous control processes, their non-deterministic effects, and several modes of their interferences. Third, it describes XFRMLEARN, a system that learns structured symbolic navigation plans. Given a navigation task, XFRMLEARN learns to structure continuous navigation behavior and represents the learned structure as compact and transparent plans. The resulting plans support action planning and opportunistic task execution.

We present experiments in which SRCs are used to control two autonomous mobile robots. In one of them an SRC controlled the course of action of a museum tourguide robot that has operated for 13 days, more than 94 hours, and has performed about 3200 execution time plan management operations.

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