Part I

Classical Planning

A *restricted state-transition system* is one that meets all of the restrictive assumptions A0 through A7 given in Chapter 1. It is a deterministic, static, finite, and fully observable state-transition system with restricted goals and implicit time. Such a system is denoted $\Sigma = (S, A, \gamma)$ instead of (S, A, E, γ) because there are no contingent events. Here S, A, and γ are finite, and $\gamma(s, a)$ is a single state when a is applicable to s.

A planning problem for a restricted state-transition system $\Sigma = (S, A, \gamma)$ is defined as a triple $\mathcal{P} = (\Sigma, s_0, g)$, where s_0 is an initial state and g corresponds to a set of goal states. A solution to $\mathcal{P}$ is a sequence of actions $(a_1, a_2, \ldots, a_k)$ corresponding to a sequence of state transitions $(s_0, s_1, \ldots, s_k)$ such that $s_1 = \gamma(s_0, a_1), \ldots, s_k = \gamma(s_{k-1}, a_k)$, and s_k is a goal state. The planning problem is to synthesize such a sequence of actions.

Classical planning refers generically to planning for restricted state-transition systems.[1] There are several motivations for studying classical planning problems.

- As usual in science when one is facing a very complex problem, it is very useful to make restrictive assumptions in order to work out well-founded models and approaches. In planning, assumptions A0 through A7 led to this baseline class. Classical planning is now a well-formalized and well-characterized problem. It is important, at least for pedagogical reasons, to have a good understanding of its representations and properties.
- Classical planning opened the way to algorithms and techniques that scale up reasonably well (presented in Parts II and III).

1. This class of planning problems is also referred to in the literature as *STRIPS planning*, in reference to STRIPS, an early planner for restricted state-transition systems [189].

- As long as one keeps in mind that this is a restrictive and unrealistic model that is not to be studied only for its own sake, many extensions to more realistic planning models can be studied from this baseline (Parts III and IV).

The main issues in classical planning are the following:

- How to represent the states and the actions in a way that does not explicitly enumerate S, A, and γ. Without such a representation, it is not possible to develop domain-independent approaches to planning.
- How to perform the search for a solution efficiently: which search space, which algorithm, and what heuristics and control techniques to use for finding a solution.

This part of the book is devoted to classical planning in two particular types of search spaces: state spaces (Chapter 4) and plan spaces (Chapter 5). Chapter 2 describes the representations used in classical planning. To explain why planning is a problem even in this restricted model, Chapter 3 analyzes the complexity of classical planning.