

Helmert, M.**The fast downward planning system.** (English) Zbl 1182.68245
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Summary: Fast Downward is a classical planning system based on heuristic search. It can deal with general deterministic planning problems encoded in the propositional fragment of PDDL2.2, including advanced features like ADL conditions and effects and derived predicates (axioms). Like other well-known planners such as HSP and FF, Fast Downward is a progression planner, searching the space of world states of a planning task in the forward direction. However, unlike other PDDL planning systems, Fast Downward does not use the propositional PDDL representation of a planning task directly. Instead, the input is first translated into an alternative representation called multi-valued planning tasks, which makes many of the implicit constraints of a propositional planning task explicit.

Exploiting this alternative representation, Fast Downward uses hierarchical decompositions of planning tasks for computing its heuristic function, called the causal graph heuristic, which is very different from traditional HSP-like heuristics based on ignoring negative interactions of operators. In this article, we give a full account of Fast Downward's approach to solving multi-valued planning tasks. We extend our earlier discussion of the causal graph heuristic to tasks involving axioms and conditional effects and present some novel techniques for search control that are used within Fast Downward's best-first search algorithm: preferred operators transfer the idea of helpful actions from local search to global best-first search, deferred evaluation of heuristic functions mitigates the negative effect of large branching factors on search performance, and multi-heuristic best-first search combines several heuristic evaluation functions within a single search algorithm in an orthogonal way.

We also describe efficient data structures for fast state expansion (successor generators and axiom evaluators) and present a new non-heuristic search algorithm called focused iterative-broadening search, which utilizes the information encoded in causal graphs in a novel way. Fast Downward has proven remarkably successful: It won the "classical" (i.e., propositional, non-optimising) track of the 4th International Planning Competition at ICAPS 2004, following in the footsteps of planners such as FF and LPG. Our experiments show that it also performs very well on the benchmarks of the earlier planning competitions and provide some insights about the usefulness of the new search enhancements.

MSC:**68T20** Problem solving in the context of artificial intelligence (heuristics, search strategies, etc.) Cited in **60** Documents**Keywords:**

multi-valued planning tasks; Fast Downward's best-first search algorithm

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