

Tejasvi Nuthalapati

Artificial Intelligence Nano Degree at Udacity

10/14/2017

Historical Developments in the field of AI Planning and Search

During the past several years, AI planning progressed forward in size and difficulty of the set of problems that can be solved. Research on AI planning always took the route of non-linear planning algorithms until the **Graph plan algorithm** was introduced by Blum and Furst in 1995. This is regarded as the most influential breakthrough in the history of AI planning as it re-routed the research community from the traditional AI planning toolbox of techniques. It's ability to find plans of fixed length (increased incrementally) until a plan is found, and uses reachability information to prune a search tree separated it from the traditional methods. Very recently **HSP Planners** using forward or backward planners from Bonet and Geffner's 2001 research showed excellent results and increased interest in **heuristic search as planning technique**. Distance heuristics have recently caught the attention of the research community, it's basic idea is to derive an estimation function, heuristic that assigns to each search state how good the state is, then favor those states that seem best. The difficulty in applying this to domain independent planning lies in the derivation of heuristic. A straightforward way to relax a planning problem is to ignore the negative effects of all operators. This relaxation has been proposed by Bonet et al. [1997]. **Heuristic planners** based on ignoring negative effects have achieved extremely competitive runtime behavior on a lot of the commonly used benchmark planning domains. At the AIPS-2000 planning systems competition, four out of five awarded fully automatic planners were based on, or at least incorporating, that approach [Bacchus and Nau, 2001]. All of those planners use the same naive search paradigm, state space search. **Ordered binary decision**

diagrams (OBDD) [Bryant, 1992] have been extensively used in computer-aided verification, especially in symbolic model-checking, that is formal verification of transition systems (a communication protocol, a circuit, a program) with respect to correctness properties. Cimatti and Roveri [2000] proposed an **OBDD-based approach to conformant planning** (where none of the fluents are observable), plan construction is based on representing sets of possible current states (sets of belief states) as OBDDs. Each operator maps belief states to belief states, and plans are found by backward chaining from the goal states. The **Graphplan algorithm** has been generalized to **conformant planning** by Smith and Weld [1998]. The algorithm constructs a planning graph for every initial state, and during plan search the sub goals are compared to every planning graph. This guarantees the correctness of the plan for every initial state. Research on algorithms for conditional and probabilistic planning has also accelerated during the last decade. This research area has close connections to problems addressed in other areas in computer science, such as program synthesis, as well as to operations research and control theory.

Works Cited

Artificial Intelligence: A Modern Approach by Stuart J. Russell and Peter Norvig

Automated Planning and Acting by Malik Ghallab, Dana Nau, Paolo Traverso

An overview of recent algorithms for AI planning by Jussi Rintanen and Jorg Hoffmann