On the Benefits of Randomly Adjusting Anytime Weighted A*  

Abhinav Bhatia, Justin Svegliato and Shlomo Zilberstein

College of Information and Computer Sciences, University of Massachusetts Amherst  
{abhinavbhati, jsvegliato, shlomo}@cs.umass.edu

Abstract

- Anytime Weighted A* (Hansen and Zhou, 2007; Hansen, Zilberstein, and Daniilchenko, 1997) is an anytime heuristic search algorithm that uses a weight to scale the heuristic to manage the trade-off between solution quality and running time.
- We propose a randomized version of this algorithm, called Randomized Weighted A*, that randomly adjusts its weight at runtime.
- RWA* typically outperforms AWA* with static weights on a range of benchmark problems.

Introduction

- Contract setting: A fixed computation time is available to solve a problem.
- Trade-off: Higher weights lead to better solutions in short-term.
- Best weight: Depends on the characteristics of the domain, the details of the instance, and the available computation time (contract duration).
- Time best static weight for a problem (Hansen and Zhou, 2007).
- Time at runtime heuristically (Sun, Druzdzel, and Yuan, 2007; Thayer and Ruml, 2009, 2008).
- Adjust at runtime using deep-RL (Bhatia, Svegliato, and Zilberstein, 2021).
- Adjust at runtime randomly? Advantage: simplicity, no hyperparameters, no offline experimentation.

Randomized Weighted A*

- For each node expansion, RWA* samples a weight uniformly from a fixed set of weights e.g., \( w \sim W = \{1, 1.5, 2, 3, 4, 5\} \).
- RWA* maintains an open list corresponding to each \( w \). Same nodes, different priorities.
- Operate on the open lists in parallel for efficiency.
- Adjust at runtime randomly? Advantage: simplicity, no hyperparameters, no offline experimentation.

Experimental Setup

- RWA* \( w \sim \{1, 1.5, 2, 3, 4, 5\} \) vs AWA* with static weights 1, 1.5, 2, 3, 4, 5 (commonly used).
- Domains: Sliding-Puzzle (Sp), Inverse-Sliding-Puzzle (Isp), Travelling-Salesman-Problem (Tsp), City-Navigation-Problem (Cnp).
- 500 instances per domain of varying difficulty.
- Node-expansions budget (contract) of 6000 for Sp, Isp and 3000, 2400 for Tsp, Cnp.

Results

- RWA* computes solutions with a higher quality on average than any static weight.
- Has the highest probability of computing a solution that is at least as good as any other approach.
- Has the highest probability of computing at least one solution compared to any static weight.

Conclusion

- RWA* (i) computes better solutions on average, (ii) exhibits a higher probability of computing any solution at all, and (iii) exhibits a higher probability of computing a solution at least as good as any static weight of AWA* in a contract setting across a range of contract durations on our benchmark domains.
- RWA* is appealing because it is easy to implement and effective without any extensive offline experimentation or parameter tuning.

References