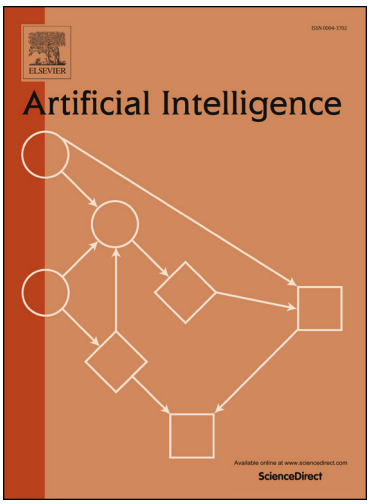
Accepted Manuscript



The MADLA Planner: Multi-Agent Planning by Combination of Distributed and Local Heuristic Search

Michal Štolba, Antonín Komenda

PII: S0004-3702(17)30104-2
DOI: http://dx.doi.org/10.1016/j.artint.2017.08.007
Reference: ARTINT 3034

To appear in: *Artificial Intelligence*

Received date: 21 January 2015
Revised date: 11 August 2017
Accepted date: 18 August 2017

Please cite this article in press as: M. Štolba, A. Komenda, The MADLA Planner: Multi-Agent Planning by Combination of Distributed and Local Heuristic Search, *Artif. Intell.* (2017), http://dx.doi.org/10.1016/j.artint.2017.08.007

The MADLA Planner: Multi-Agent Planning by Combination of Distributed and Local Heuristic Search

Michal Štolba[a] and Antonín Komenda[b]

[a] *Department of Computer Science, Faculty of Electrical Engineering, Czech Technical University in Prague*
Karlovo náměstí 13, Praha 2, 121 35, Czech Republic
michal.stolba@agents.fel.cvut.cz, *+420 22435 7693,* ***corresponding author***

[b] *Department of Computer Science, Faculty of Electrical Engineering, Czech Technical University in Prague*
Karlovo náměstí 13, Praha 2, 121 35, Czech Republic
antonin.komenda@agents.fel.cvut.cz

Abstract

Real world applications often require cooperation of multiple independent entities. Classical planning is a well established technique solving various challenging problems such as logistic planning, factory process planning, military mission planning and high-level planning for robots. Multi-agent planning aims at solving similar problems in the presence of multiple independent entities (agents). Even though such entities might want to cooperate in order to fulfill a common goal, they may want to keep their internal information and processes private. In such case, we talk about privacy-preserving multi-agent planning.

So far, multi-agent planners based on heuristic search used either a local heuristic estimating the particular agent's local subproblem or a distributed heuristic estimating the global problem as a whole. In this paper, we present the Multi-Agent Distributed and Local Asynchronous (MADLA) Planner, running a novel variant of a distributed state-space forward-chaining multi-heuristic search which combines the use of a local and a distributed heuristic in order to combine their benefits. In particular, the planner uses two variants of the well known Fast-Forward heuristic. We provide proofs of soundness and completeness of the search algorithm and show how much and what type of privacy it preserves. We also provide an improved privacy-preserving distribution scheme for the Fast-Forward heuristic.

We experimentally compare the newly proposed multi-heuristic scheme and the two used heuristics separately. The results show that the proposed solution outperforms classical (single-heuristic) distributed search with either one of the heuristics used separately. In the detailed experimental analysis, we show limits of the planner and of the used heuristics based on particular properties of the benchmark domains. In a comprehensive set of multi-agent planning domains and problems, we show that the MADLA Planner outperforms all contemporary state-of-the-art privacy-preserving multi-agent planners using a compatible