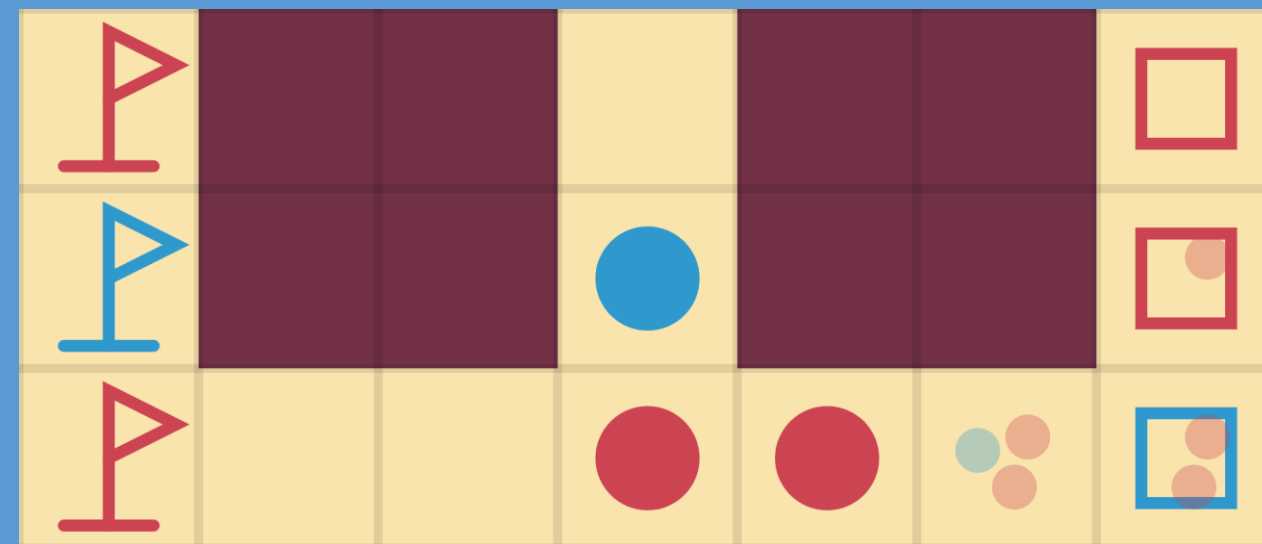


1. Introduction

Multi-Agent Pathfinding with Matching (MAPFM):

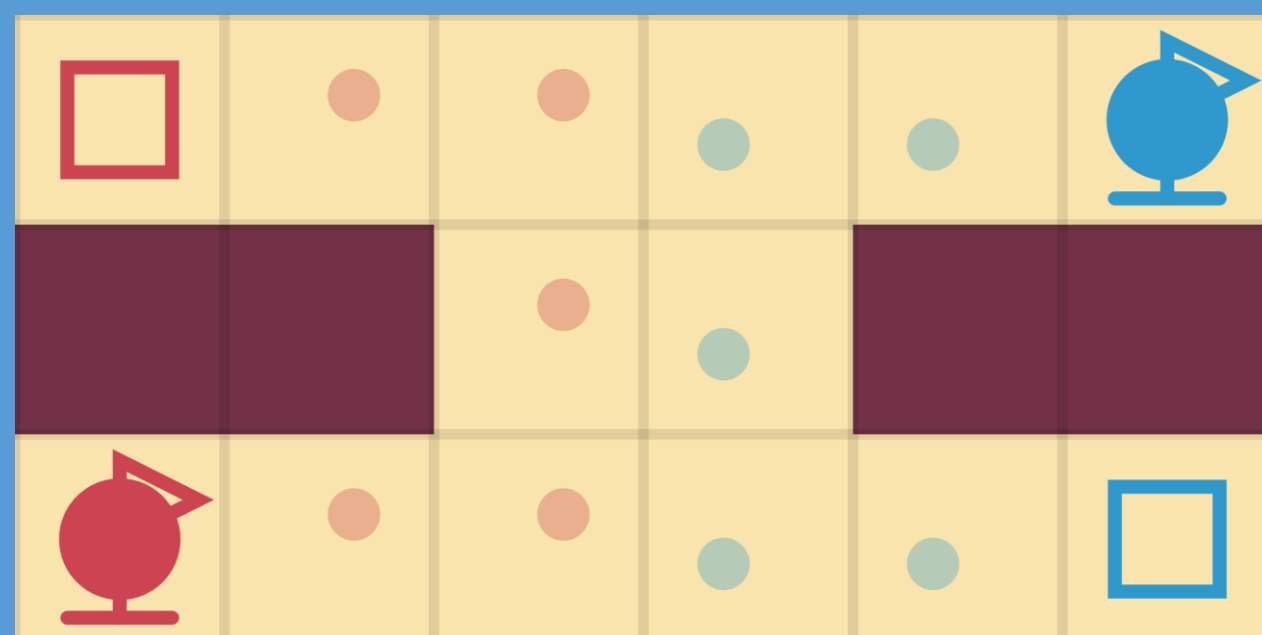
- For each agent find a route from their start to a goal belonging to the same team
- No collisions or swapping allowed
- Agents stay at their goal

The goal is to find the best solution according to the Sum of Individual Costs.



A*+ID+OD:

- A*: Heuristic based optimal search
- Operator Decomposition (OD): Expand agents one by one instead of all at the same time. Reduces branching factor
- Independence Detection (ID): Solve paths individually when possible



2. Research question

How does A*+ID+OD extended with matching compare to other MAPFM algorithms?

Sub questions:

- Is exhaustive or heuristic matching better?
- Is the algorithm still optimal and complete?

3. Matching

Two matching methods have been implemented, both of which are optimal and complete:

- **Heuristic matching:**
Changes the original A* heuristic from giving the distance from an agent to their goal to giving the distance to the closest goal belonging to the same team.
- **Exhaustive matching:**
Tries all possible goal assignments and discards all A* nodes with a cost higher than the best solution so far.

4. Exhaustive matching improvements

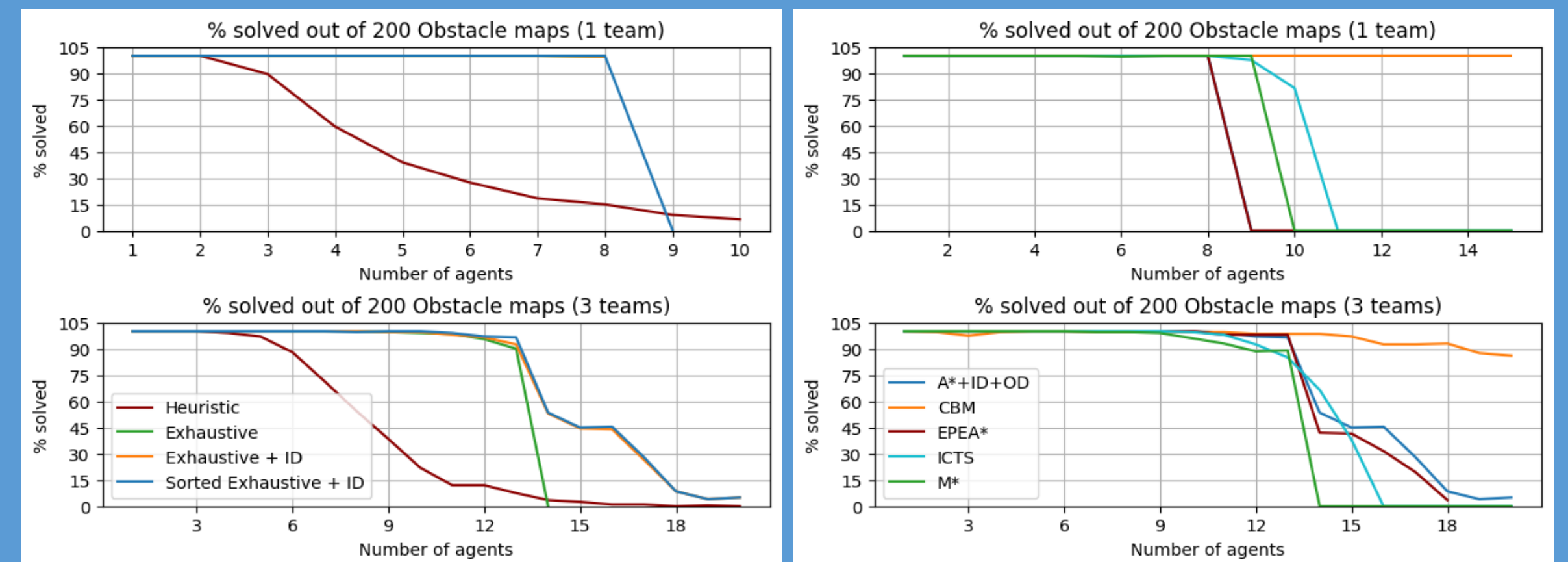
Exhaustive matching is further improved by two extensions:

- **Matching ID:**
Solves teams individually and only combines them when conflicts occur. This reduces the total number of goal assignments when successful.
- **Sorted goal assignments:**
By sorting the goal assignments based on the initial heuristic, the pruning efficiency can be improved significantly as the best solutions are found sooner.

5. Results

Algorithms were compared on a set of 200 20x20 maps for each set of parameters, with a 2 minute timeout per map. The maps were randomly generated with around 10% walls. Agents are either all in 1 team or divided over 3 teams.

All matching variants were compared and the best one was compared with various other algorithms. These algorithms are EPEA* with sorted exhaustive matching and matching ID. As well as ICTS and M* with sorted exhaustive matching and CBM which uses flow to solve the matching problem.



Percentage of solved maps for different solvers

6. Conclusions

Sorted exhaustive matching with ID performs the best of all the A*+ID+OD versions. Heuristic matching scales better with the number of goal assignments, however, it scales far worse with the number of agents.

On these maps, CBM performs the best as it is the only algorithm that does not use a version of exhaustive matching and as such it is not limited by the growing team size.