
# Multi Agent Pathfinding in Asprilo

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# The MAPF Problem - An Example

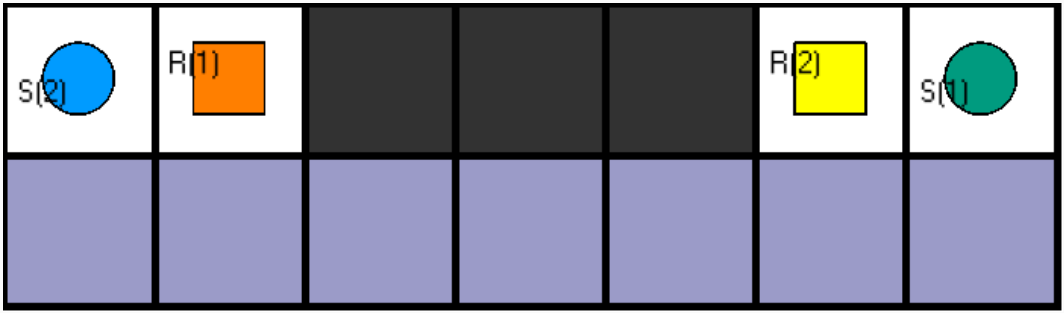


**Figure 1:** A first example of MAPF

Each square wants to go the circle with the same number.

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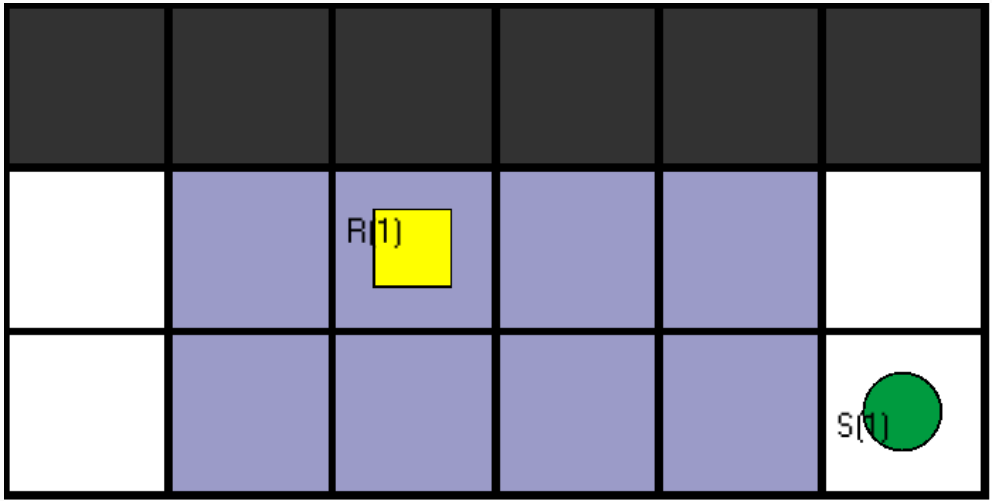
We want to move from a starting position to a goal.



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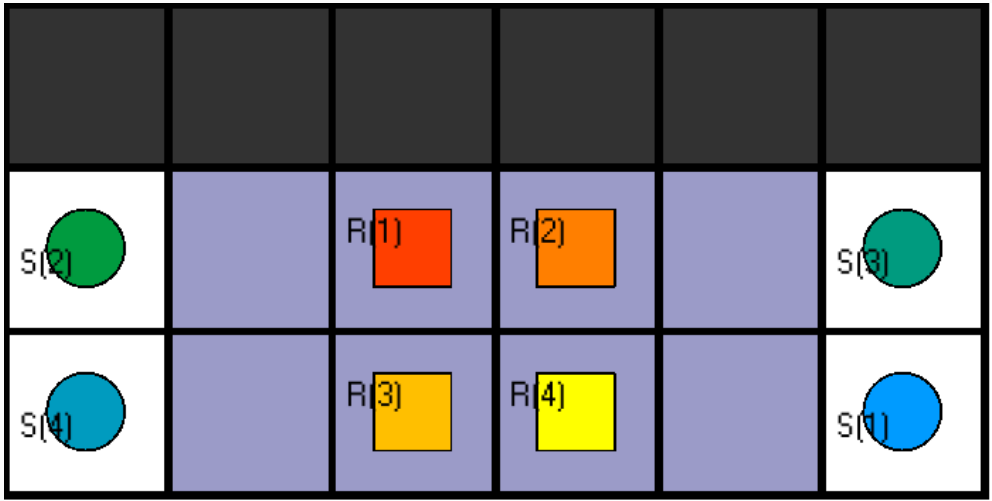

# MAPF in particular

Given

- A graph
- Starting positions for robots
- Goal positions for robots

Find path from start to goal for each robot.

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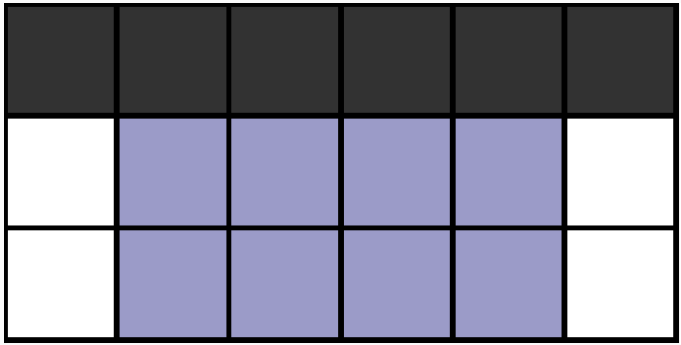
# Graphs

A graph is determined by vertices and edges.



In Asprilo Vertices are Nodes.

# MAPF in particular

Given

- A graph
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# MAPF in particular

Given

- A graph
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Find path from start to goal for each robot.

# Paths

Each robot has to move to a goal.
It moves step by step $\rightarrow$ we call these time steps
Each time step each robot takes an action.

## MAPF in particular

Given

- A graph
- Starting positions for robots
- Goal positions for robots

Find path from start to goal for each robot.

Constraints:

- No robots may share a position
- No robots may switch position

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# How do we find a path?

Naive:
Try out every possible move for every robot.

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Result:
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Naive:
Try out every possible move for every robot.

Result:
We have a solution.

Disadvantage:
It does not scale well.
It takes a exponential time to find it.

# How do we find a path?

Instead:

$k$ - Individual agent merger

# How do we find a path?

First generate individual plan per robot
Then “merge” these plans.

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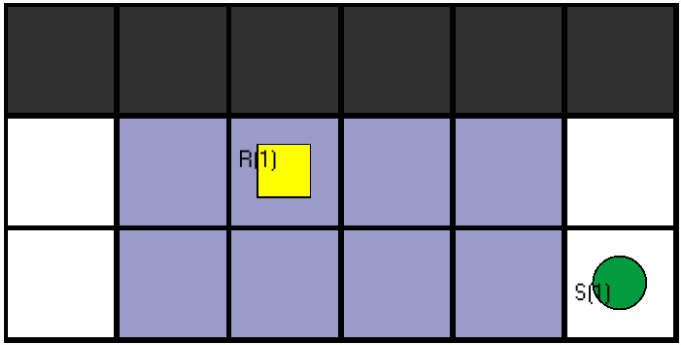
# How do we find a path? - individual plans

Generate individual plan per robot



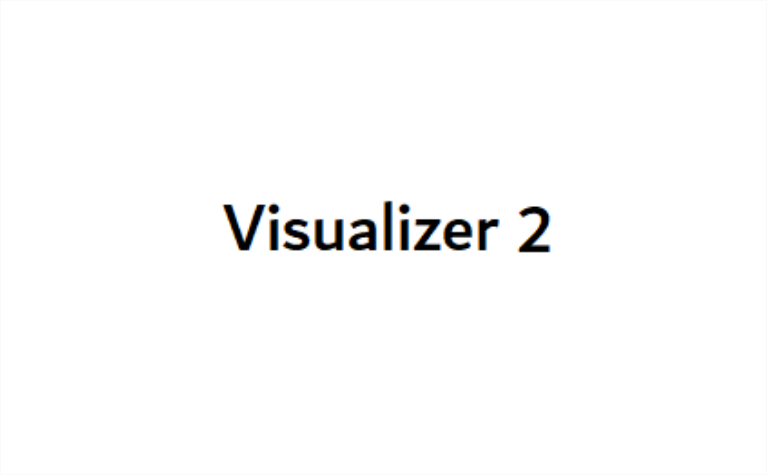

Find shortest path from start to goal.

# How do we find a path?

First generate individual plan per robot
Then “merge” these plans.

# How do we find a path? - Merging

Is ‘merging’ these plans difficult?



# How do we find a path? - Merging

Is ‘merging’ these plans difficult?

YES

Conflicts may arise.

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# MAPF Mergers

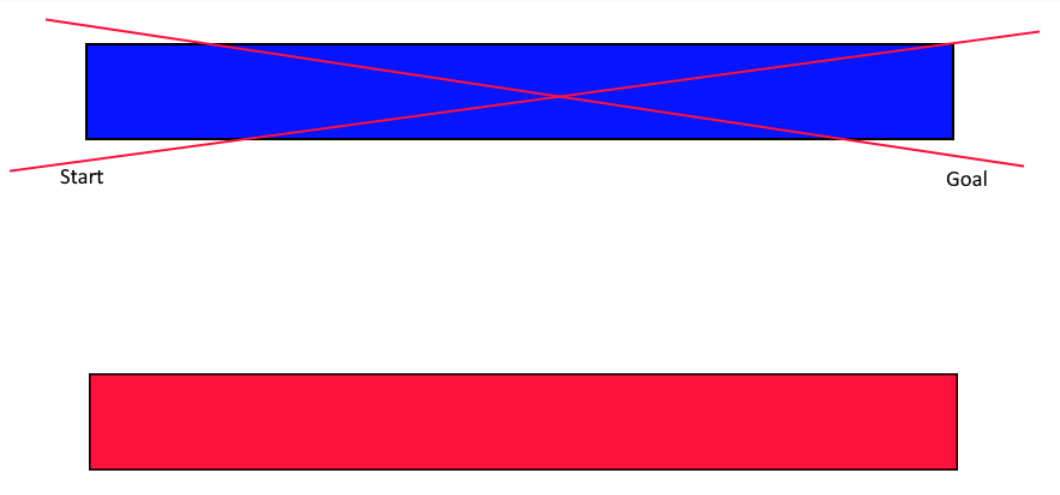
We need to modify the initial plans.
We created various plan mergers.

# Clean Plans

Here you can see the original plans

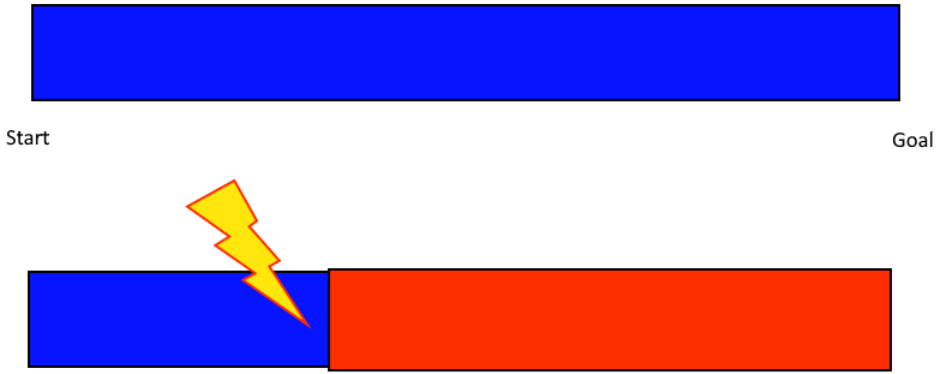
# Random Moves

Here you can see the ‘Random Moves’ merger
It throws away every original plan.



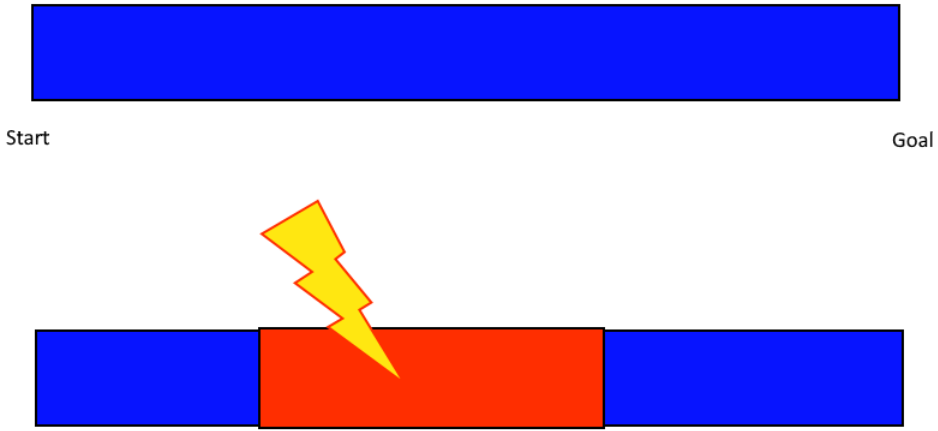
# Specific conflict

Here you can see the ‘Specific Conflict’ merger
It keeps the original plans until the first conflict



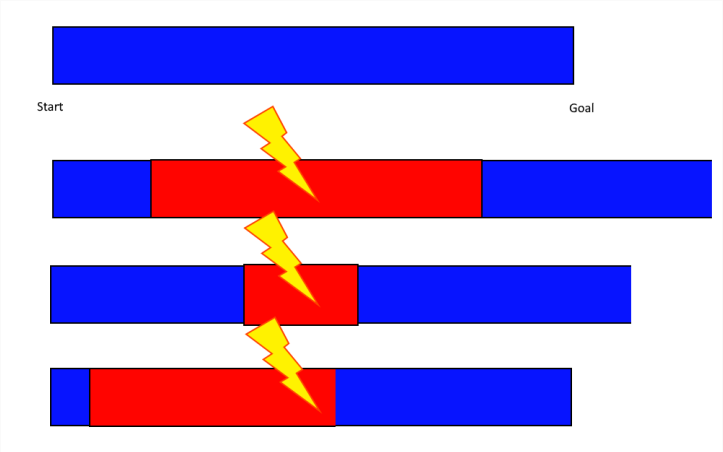
# Change Time

Here you can see the ‘Change Time’ merger
It cuts out the original plans around a conflict.



# Dynamic Time

Here you can see the ‘Dynnamic Time’ merger
It cuts the original plans before a conflict.
However it keeps the moves after a conflict. It may delay these moves.



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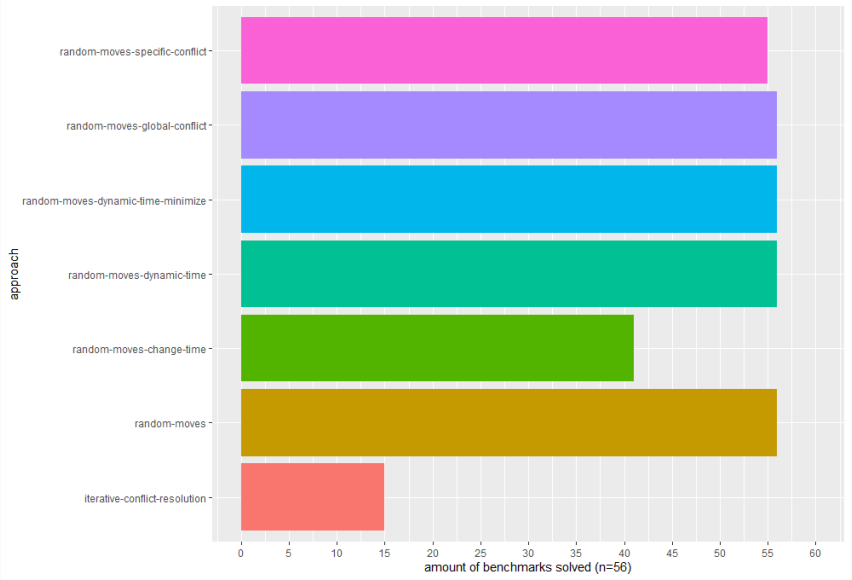
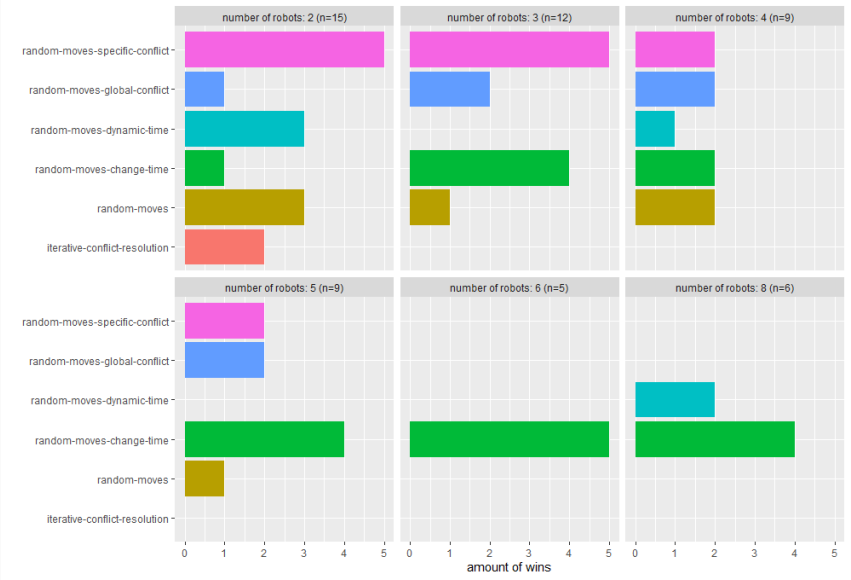
# Amount of Solvable Benchmarks



# Amount of Wins per Approach grouped by the number of robots



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# Conclusion

There is no perfect approach.
It is a trade off between performance and solving ‘power’.

Thank you for your attention

Any Questions?