

Multi-agent pathfinding with waypoints using Branch-Price-and-Cut

1 MAPFW

In **Multi-Agent Pathfinding** (MAPF), agents have to move to a location without bumping into each other.

In **Multi-Agent Pathfinding with Waypoints** (MAPFW), they also have to pass waypoints on their way there.

MAPFW is important for:

- Warehouse navigation;
- Airport traffic;
- Train scheduling.

Finding the shortest paths through waypoints is similar to solving the Traveling Salesman Problem (TSP).

2 Branch-Price-and-Cut

- Branch-Price-and-Cut (BPC) is a technique for solving Integer Linear Programming (ILP) problems.
- A reduction from MAPF to ILP has been found (BCP), of which the implementation is the current state of the art for solving MAPF problems.
- BPC consists of 3 main parts:
 - **The Master problem:** Solves the current linear minimization problem with a subset of all the variables.
 - **The Pricer:** Generates new variables (in this case, paths) for the master problem to use.
 - **The Separators:** Add constraints to the master problem that are violated by the current solution.

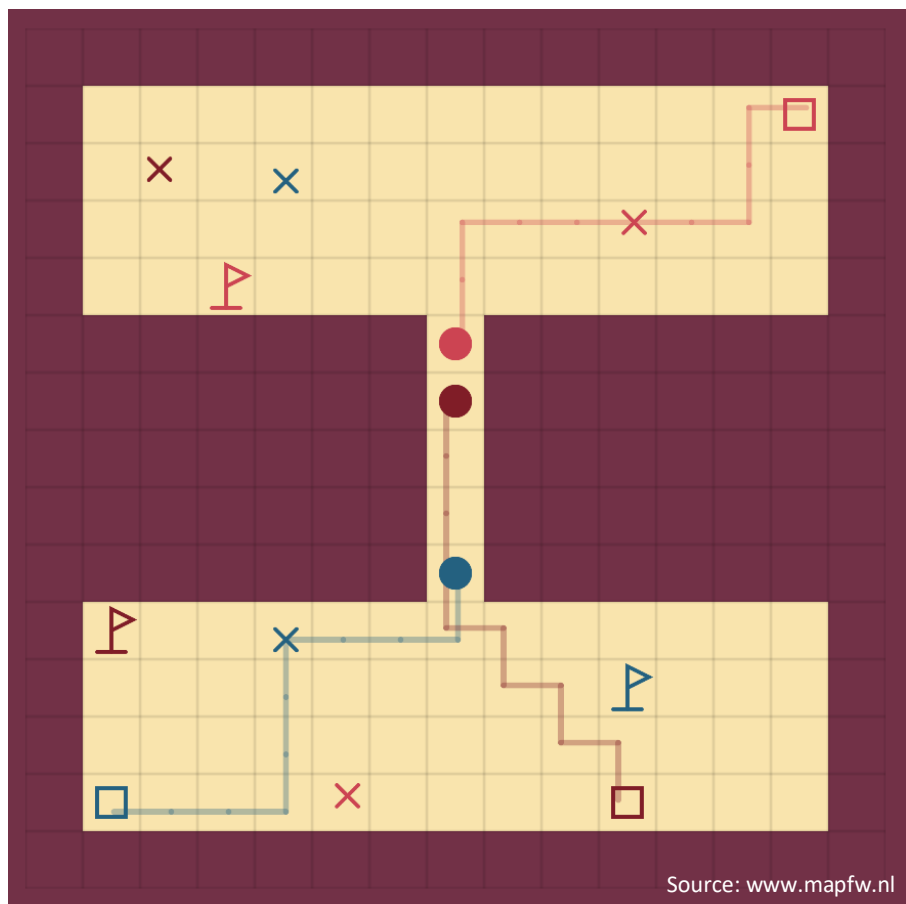
4 Results

Both algorithms have their strengths and weaknesses. BCP-A* has:

- **High** waypoint scalability
- Low mapsize scalability

BCP-TSP has:

- Low waypoint scalability
- **High** mapsize scalability



Source: www.mapfw.nl

3 Algorithms

Analysis shows that it is more viable to solve TSP in the **pricer**, rather than in the master problem or in the separators.

Developed algorithms:

- BCP-A*:
Runs A* using a heuristic that steers towards the unvisited waypoints.
- BCP-TSP:
Uses a modified TSP solving algorithm to find the optimal order of waypoints and runs A* with ordered waypoints.

5 Varying #Agents

Varying #Waypoints