Multi-Agent Pathfinding

Till Zemann

2022-10-20 15:57:00 +0200

- TOC {:toc}

The Multi-Agent Pathfinding Problem

Multi-Agent Pathfinding (**MAPF**) is the problem of planning paths for multiple agents without colliding.

Assumptions

We assume that the environment is **discrete** and **2-dimensional**, e.g. robots moving in a warehouse are modelled as points in a grid. There probably are good algorithms for finding solutions in more complex scenarios, such as:

- 3d spaces
- continuous environments
- probabilistic environment dynamics

but we will stick to the easier problems in our MAPF course.

Input

The input to a MAPF problem is a triple $< G, s, t >$ consisting of:

- an undirected graph $G = (V, E)$
- a mapping s to source vertices with $s : [1, \dots, k] \to V$
- a mapping t to target vertices with $t : [1, \dots, k] \to V$

Solution

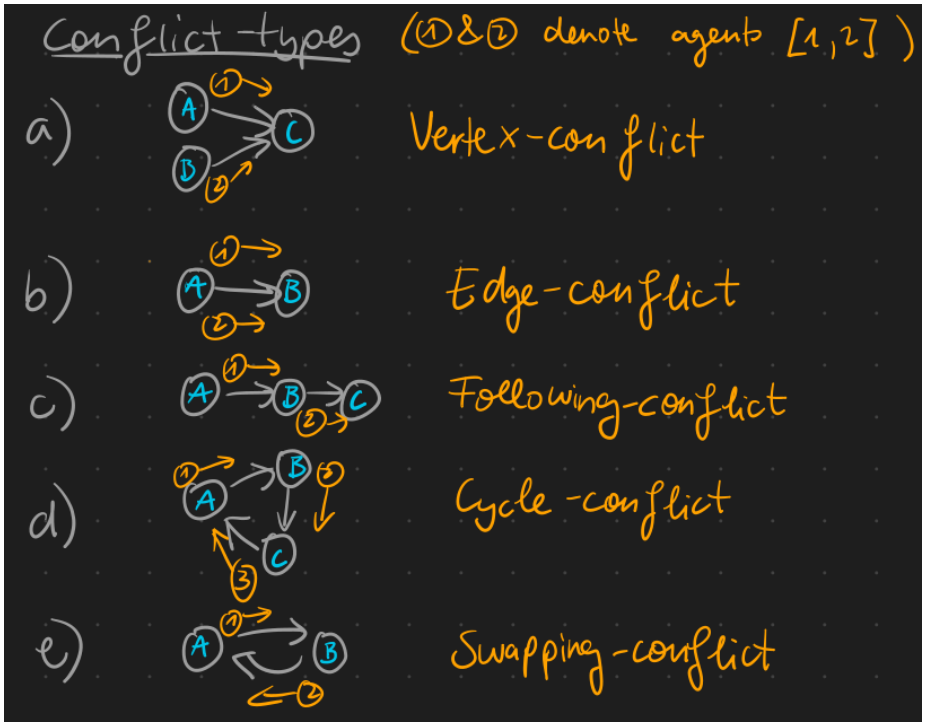
The solution of a MAPF problem is a set π of single-agent plans without conflicts: $\pi = \{\pi_1, \pi_2, \dots, \pi_k\}$ where π_i denotes the single-agent plan for agent i. A single-agent plan is an action mapping π (careful: notation overload!) that results in the agent being their target state. We can write this constraint as $\pi_i[|\pi|] = t(i)$.

Note, that π does **not** include the starting position $s(i)$. Instead, the first entry in π is the action that performed on the first timestep.

We can also ask, where an agent i is positioned after timestep x (equivalent to asking which node an agent occupies). We would write this as $\pi_i[x]$.

Conflict types

To properly define a MAPF problem, the definition should cover which of the following situations are considered to be conflicts and theirfore can not appear in a solution π:



Commonly used Algorithms

References

1. Kaduri, Omri: From A* to MARL (5 part blogpost series)