School of Computer Science (BICA)
Monash University

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Review of optimal multi-agent Pathfinding algorithms and usage in warehouse automation

Phillip Wong

Supervisors: Daniel Harabor,
Pierre Le Bodic

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1 Introduction

In our multi-agent pathfinding problem, we have an environment containing a set of k agents on a grid-map. Each agent aims to find a path to their goal without colliding with another agent (a path collision).

Hence we have a centralized agent coordinator which aims to resolve path collisions.

2 Resolving conflicts

1. Given a set of paths, S which contains all agent's path, find a new path for each agent their goal and add it to S
2. Detect any path collision for each path
3. Convert the paths to MIP variables and path collisions to constraints
4. Repeat 1. if there is not a valid solution found i.e the optimal solution contains a path collision

3 Master problem formulation

Each agent is given *one or more* paths to their goal. The master problem aims to assign one path to every agent while minimizing the path distance and avoiding path collisions.

- **Potential paths**: A set of paths from an agent's position to their goal. We generate a variable for each path and the cost is set to the path length.
- **Penalty**: A penalty variable is added for every agent in the case that all the agent's paths are in collision. The cost of the penalty is set to be larger than the expected maximum path length (here it is 1000).

We specify an agent's path as p_{ij}. Penalty q_i. Path collision as c_{nm}.

$$\min \sum_{j \in (i \in A)} d_{ij} + p_{ij} + \sum_{i \in A} q_i \tag{1}$$

$$\text{subject to} \sum_{j \in (i \in A)} p_{ij} + q_i = 1 \tag{2}$$

$$\sum_{j \in (i \in A)} p_{ij} = 1 \tag{3}$$

For example **?**, our generated variables are: $5a_0p_0 + 5a_0p_1 + 1000q_0 + 2a_1p_0 + 2a_1p_1 + 1000q_1$.

Agents are assigned

References