Overview

- Non-cooperative multi-agent pathfinding (MAPF) problems can be solved by a combinatorial auction.
- These approaches incentivise participation from competing agents, while preserving their individual autonomy.
- Agents submit bids for paths, and a central auctioneer allocates paths to maximise social welfare.
- Total number of paths in a graph scales exponentially with graph size, so agents must be selective about the paths they submit as bids.

Agent Bid Generation Goals

- Systematically generate a fixed number of paths that give the auctioneer sufficient flexibility to find a good path allocation for all agents.
- Resulting paths should maximise likelihood that the auctioneer can find a feasible allocation, while still producing low-cost solutions.

Contributions

- An algorithm for systematic generation of dissimilar paths which provide demonstrable benefits for MAPF by combinatorial auction.
- Experimental evaluation shows improved performance over $k$-shortest paths baselines.

Path Generation Algorithm

- Adaptation of work from Jeong et al. (2011) on dissimilar path generation for the MAPF context.
- Starts by selecting the shortest path as the first bid.
- Iteratively generates a set of candidate paths by incrementally modifying the last selected path.
- Selects the next path from the candidates based on a dissimilarity metric designed to produce paths that do not have the agent at the same place at the same time:

$$p_{k+1}^s = \arg \max_{p \in C_s} \frac{1}{k} \sum_{j=1}^k \frac{|p_j^l \cap P|}{|p_j^l \cup P|}$$

Experimental Evaluation

- Evaluation over 50 trials on a small warehouse map.
- In high congestion scenarios, the algorithm significantly increases the chances of the auctioneer finding a feasible allocation.
- The algorithm allows lower-cost solutions to be found on average in all scenarios.

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Number of agents</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Iterative iBundle</td>
<td>48 (6.47)</td>
</tr>
<tr>
<td>VCG simple</td>
<td>48 (6.42)</td>
</tr>
<tr>
<td>VCG dissimilar</td>
<td>45 (5.52)</td>
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</tbody>
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Future Work

- Improvements to scalability for larger maps:
  - Random thinning of candidate set.
  - Online optimisation based on available computation time.
- Modelling of regions that are likely to act as bottlenecks.
- Further experiments using other algorithms for non-cooperative MAPF.