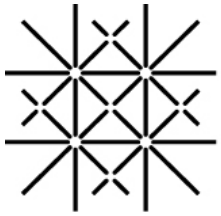
May 2nd 2018

Master Thesis

Using Value Abstraction for Optimal Multi-Agent Pathfinding with Increasing Cost Tree Search

Simon Wallny

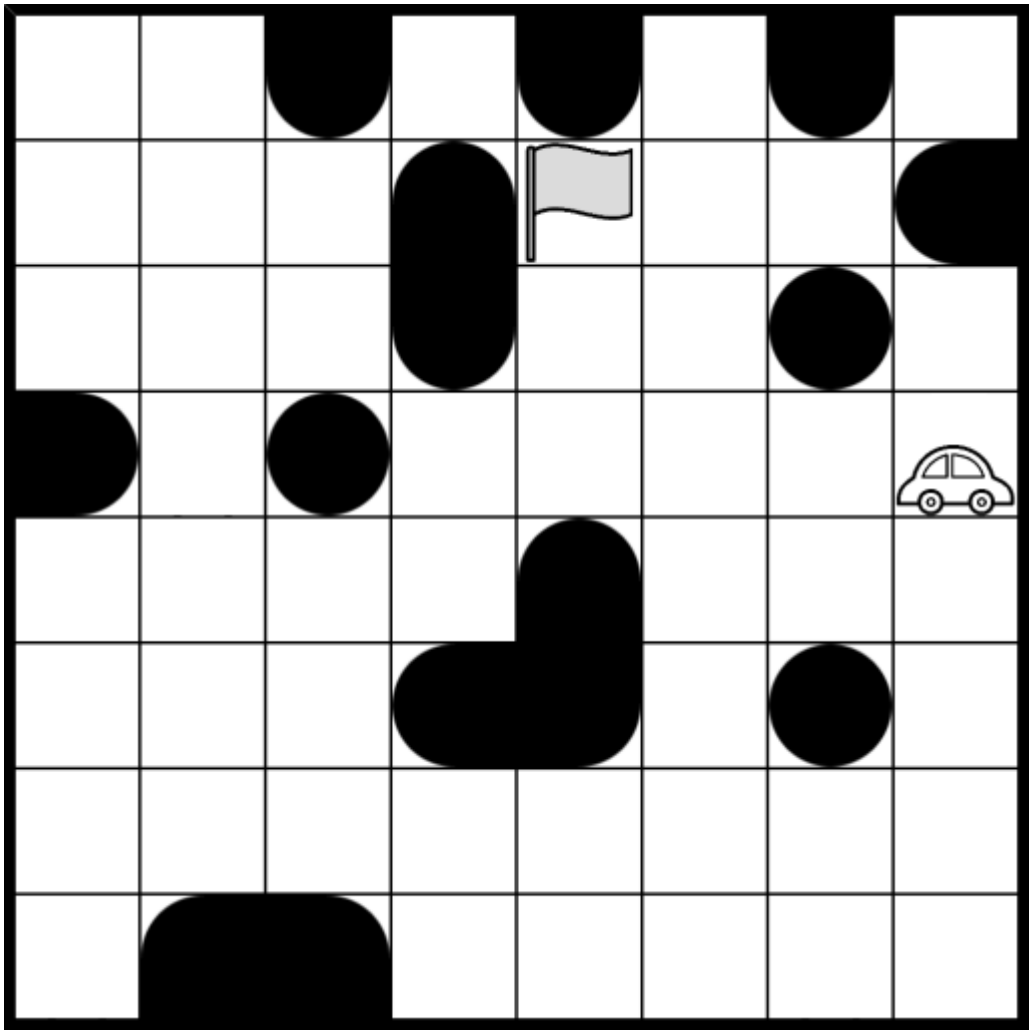


University of Basel

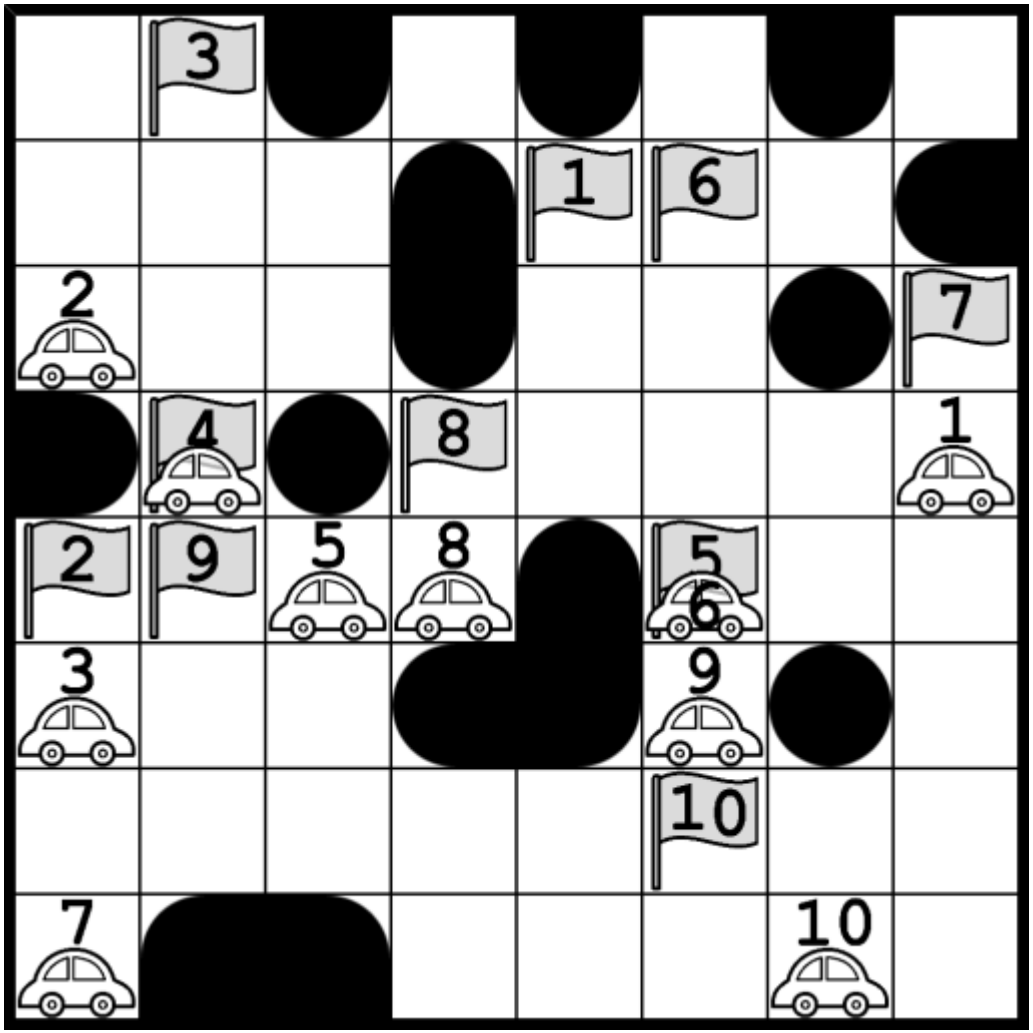
Structure

- Multi-Agent Path Finding
  - Independence Detection
- Increasing Cost Tree Search
  - MDDs for Encoding Paths
- Value Abstraction
  - Refinement
  - Path Reconstruction
  - Heat Map
- Empirical Results

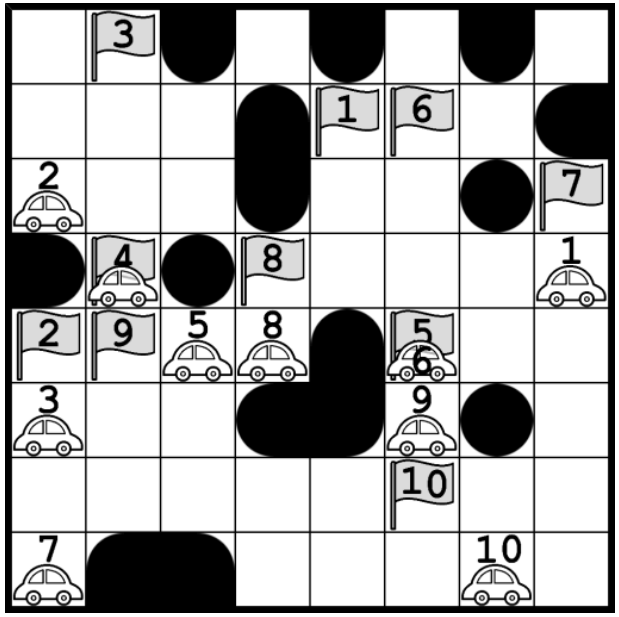
Multi-Agent Path Finding

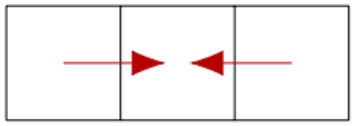


Multi-Agent Path Finding

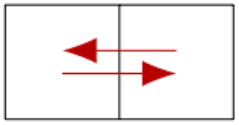


Multi-Agent Path Finding

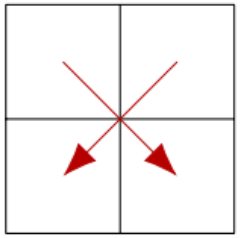




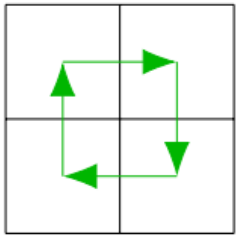
conflict



conflict

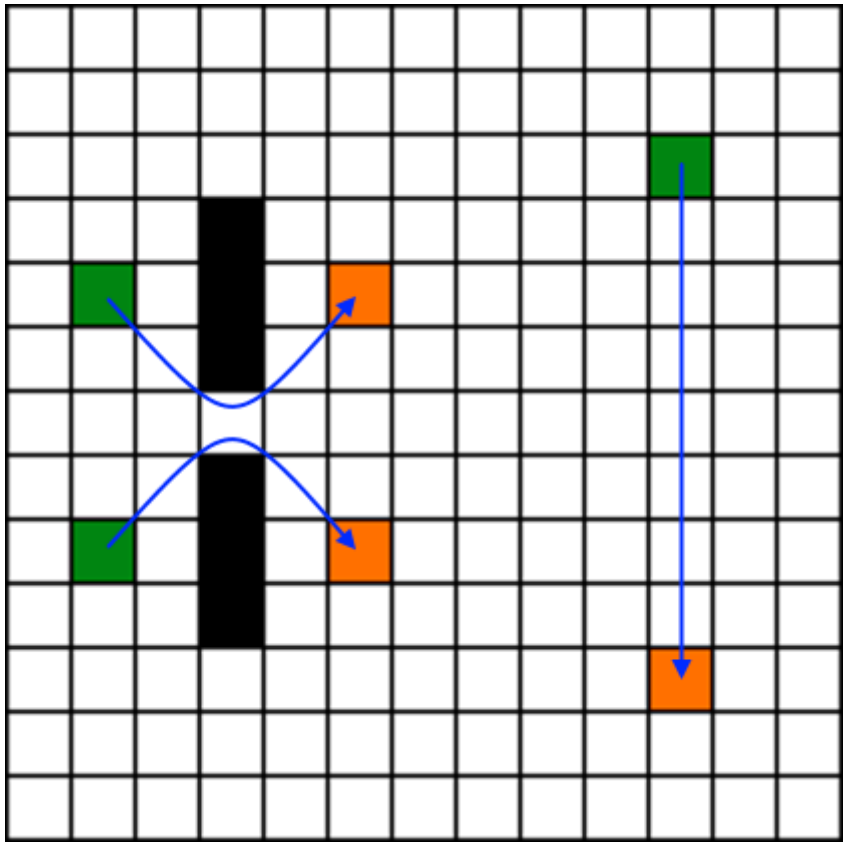


conflict

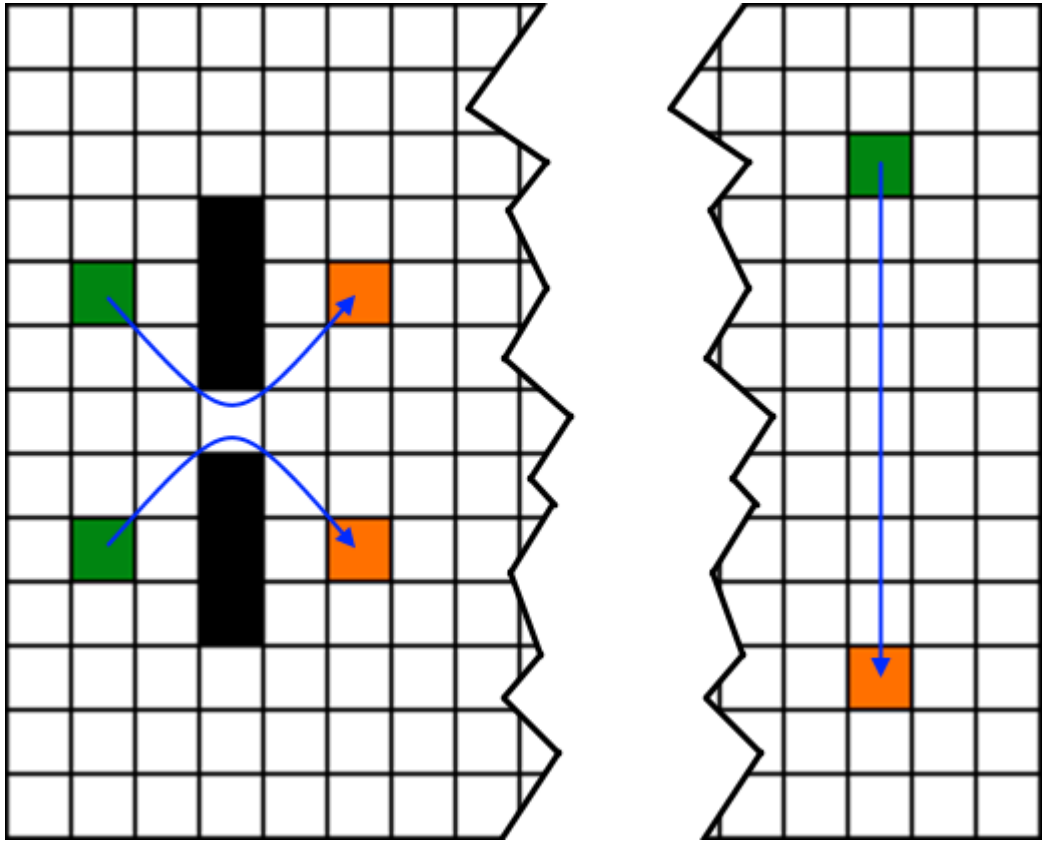


no conflict

Independence Detection



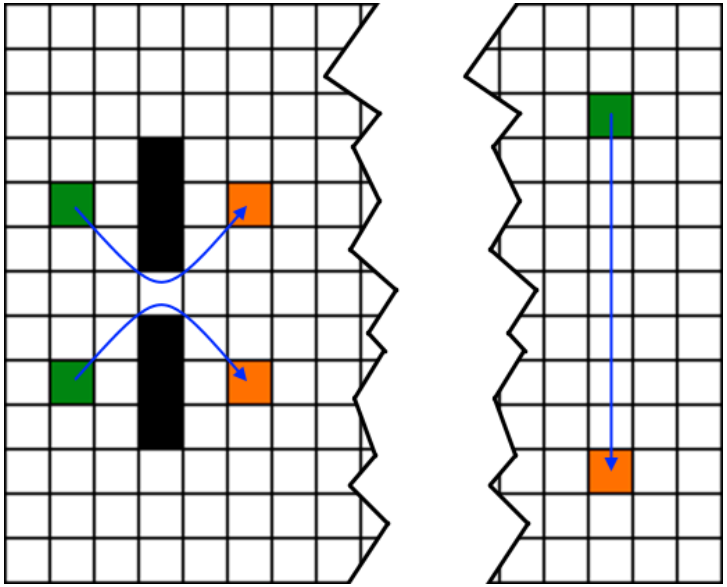
Independence Detection



Independence Detection

- General Framework
- Introduced in 2010
  - by Trevor Standley

- Plan agents independently until they conflict



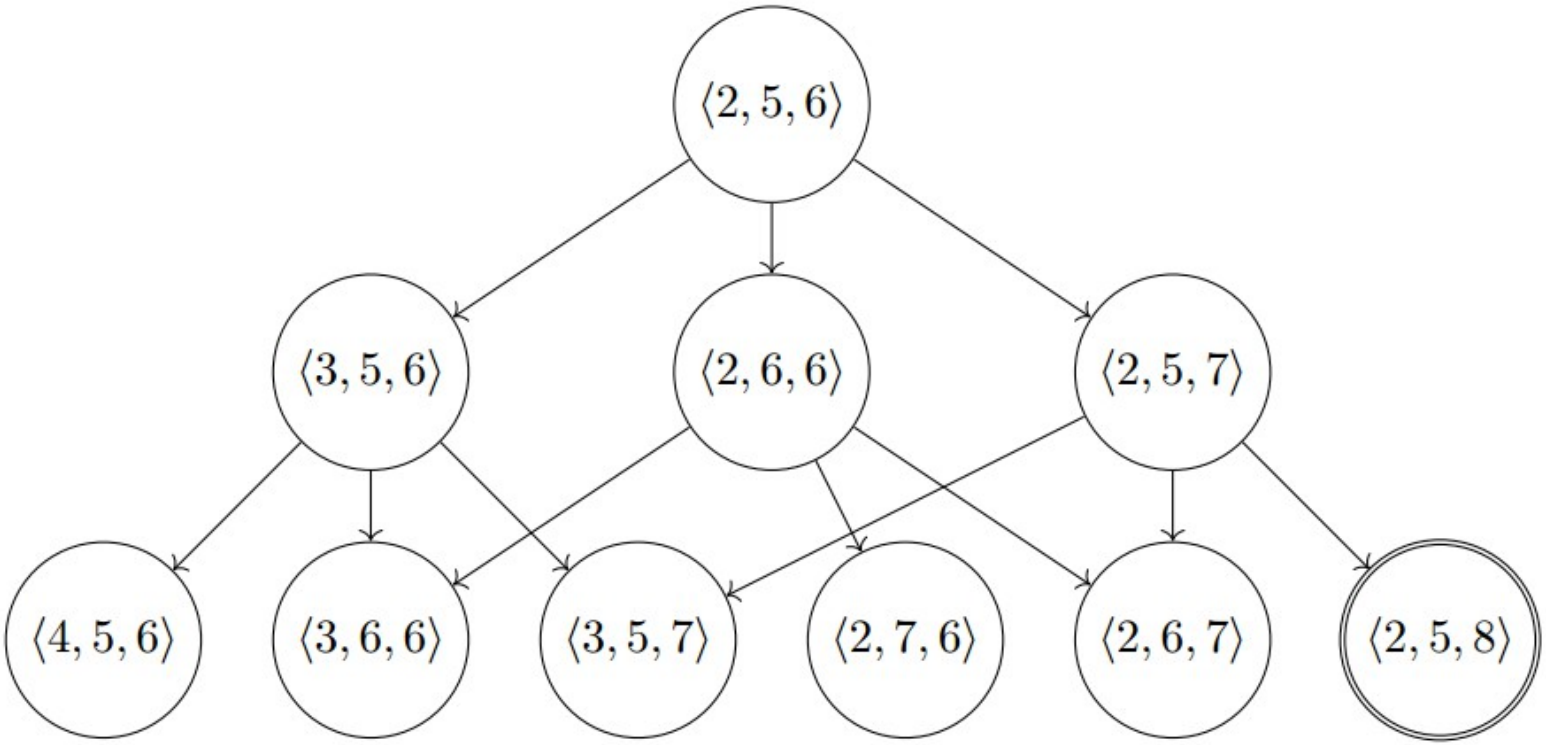
Increasing Cost Tree Search

- Optimal MAPF Solver
- Introduced in 2011
  - by Sharon et al.

- High-Level Search
  - Find lowest agent costs with valid solution.
- Low-Level Search
  - Find solution for given agent costs.

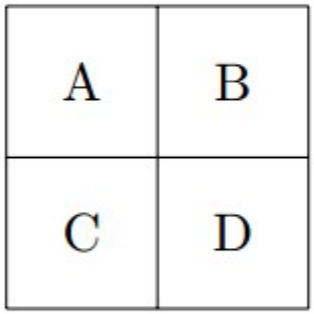
Increasing Cost Tree Search

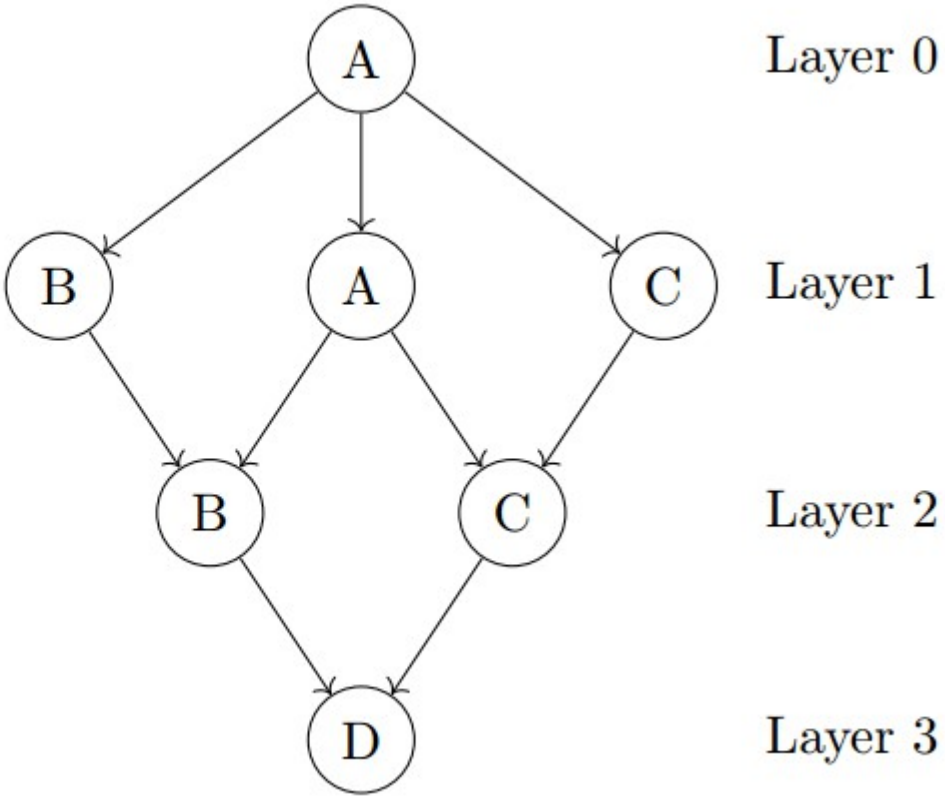
Increasing Cost Tree:



MDDs for Encoding Paths

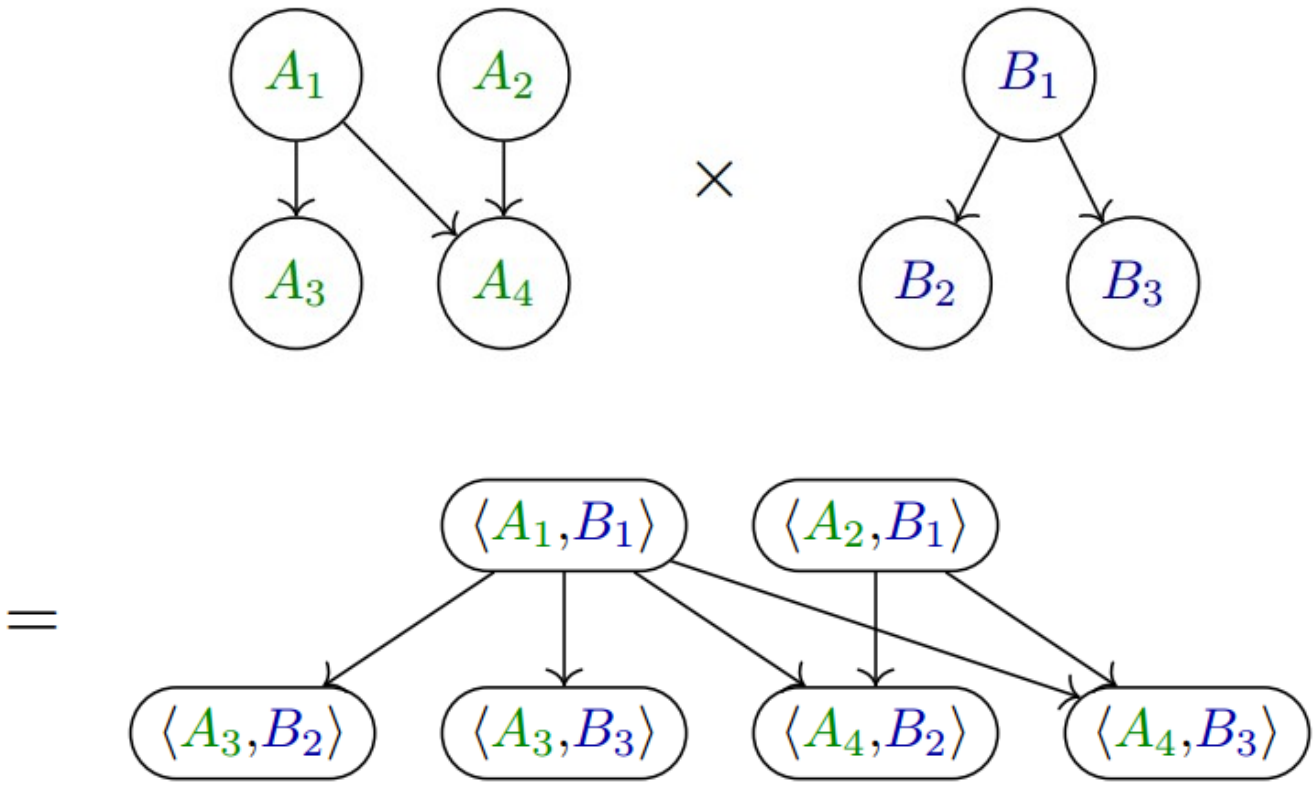
Multi-valued Decision Diagram (variant):



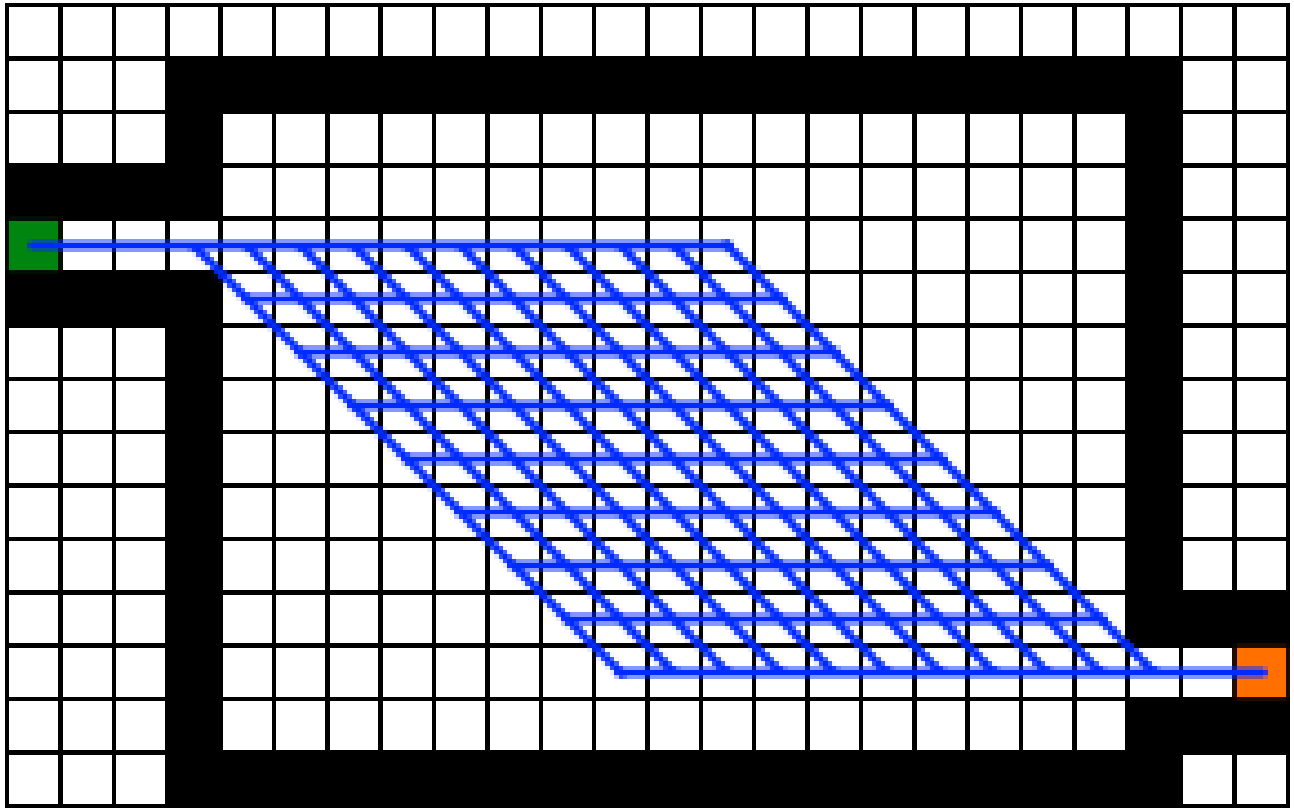


MDDs for Encoding Paths

Joint MDD:



Value Abstraction



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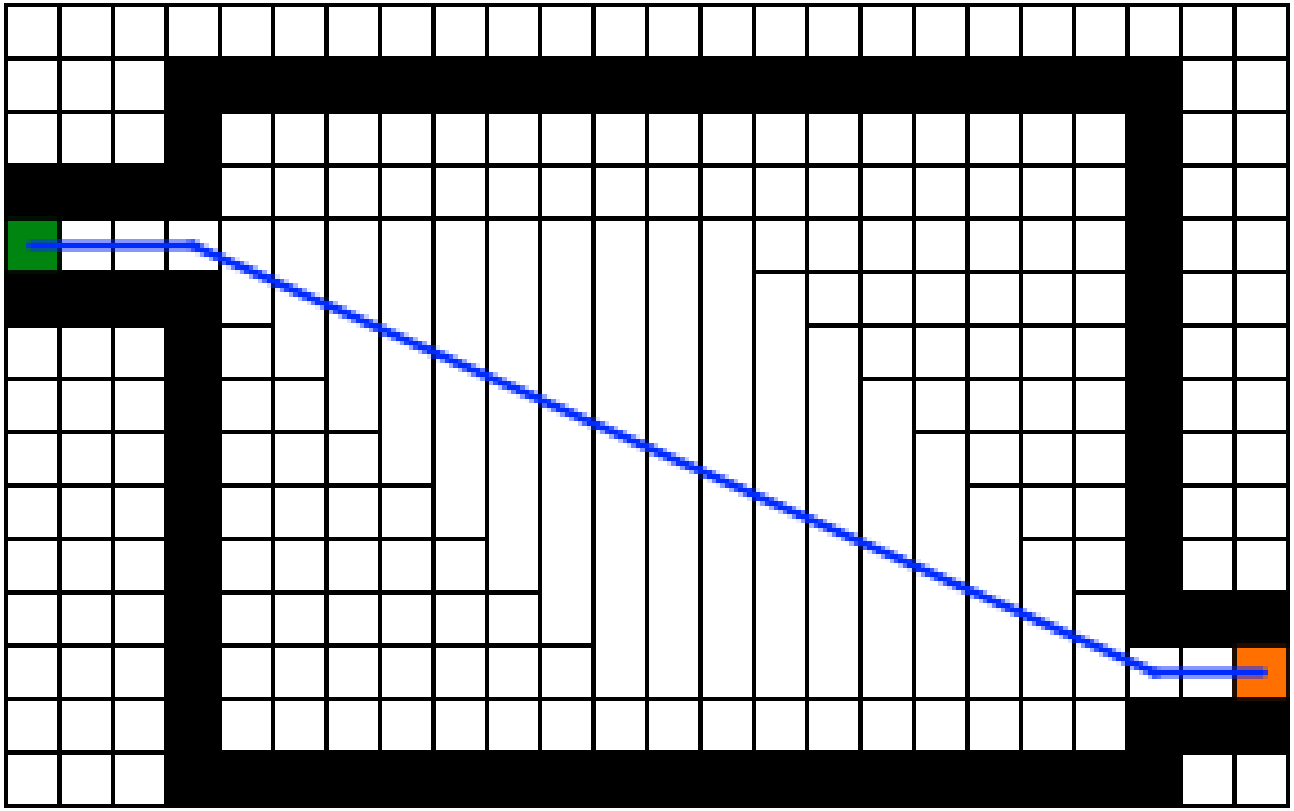
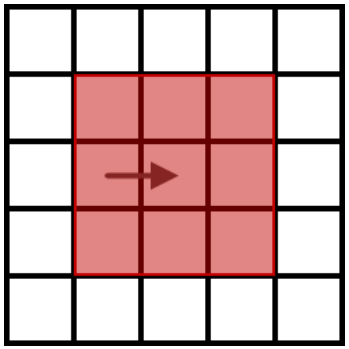
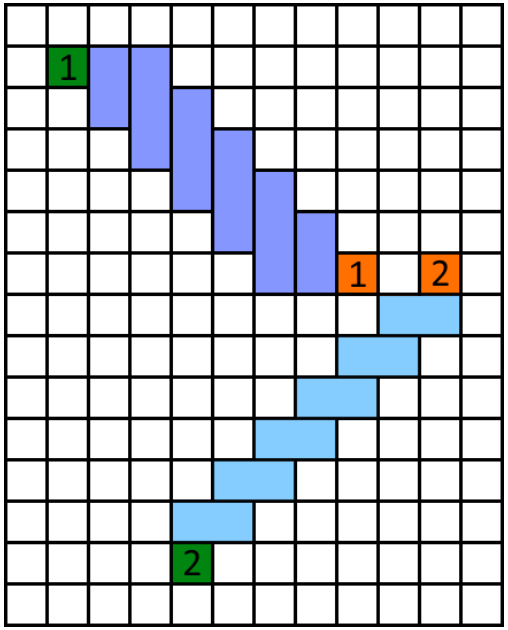


Refinement

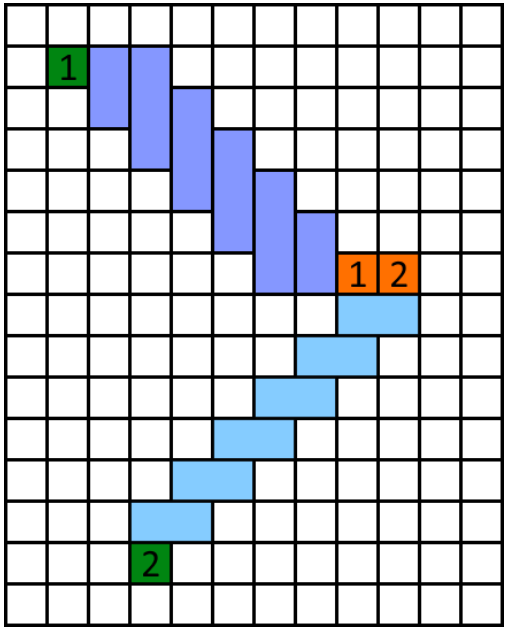
Transition 'Threat Range':



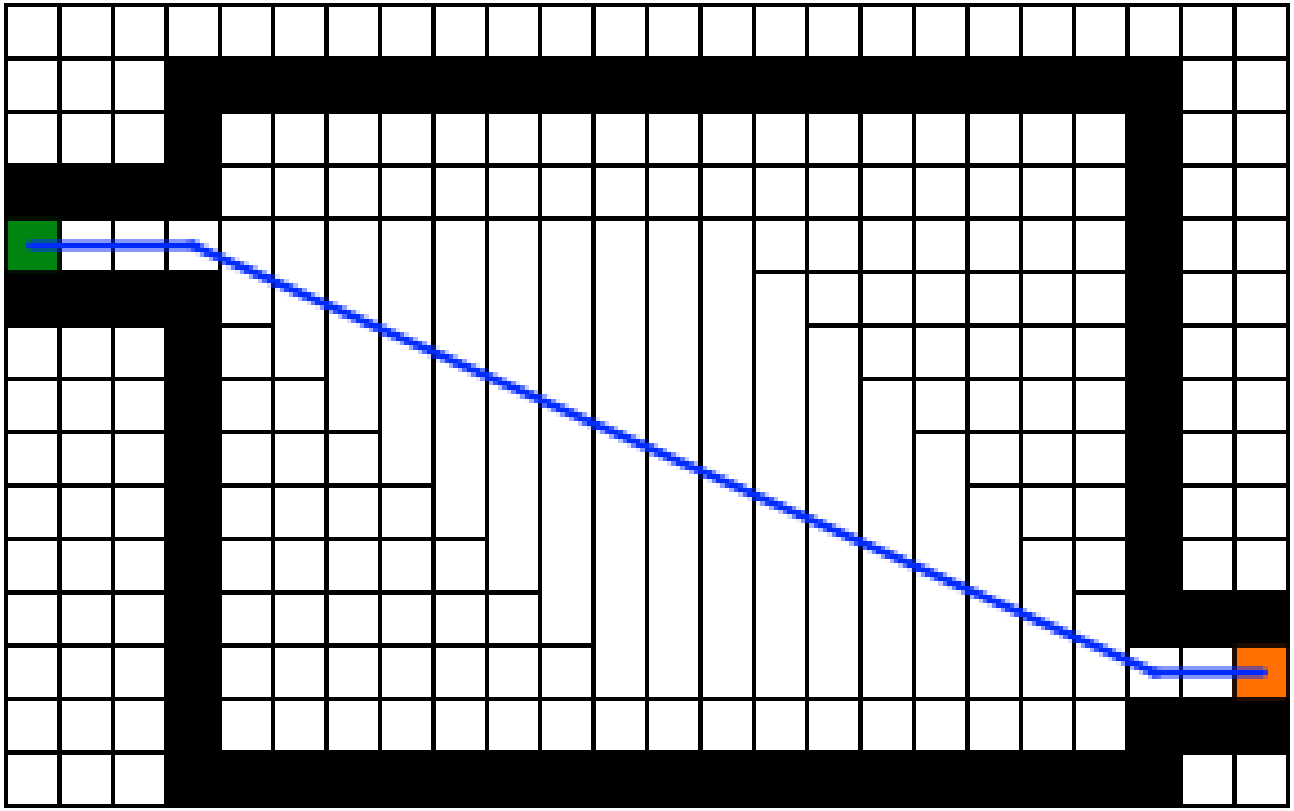
Safe Distance



Too Close



Path Reconstruction



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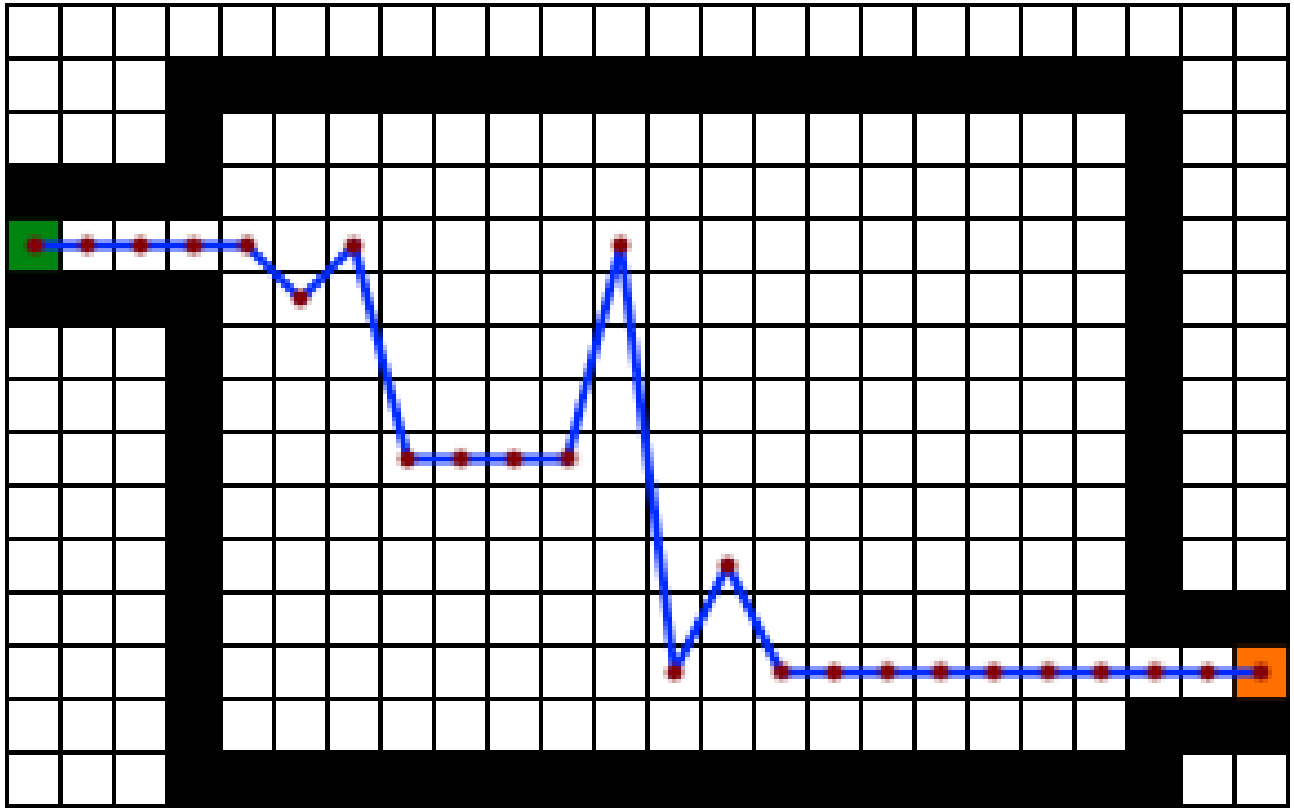

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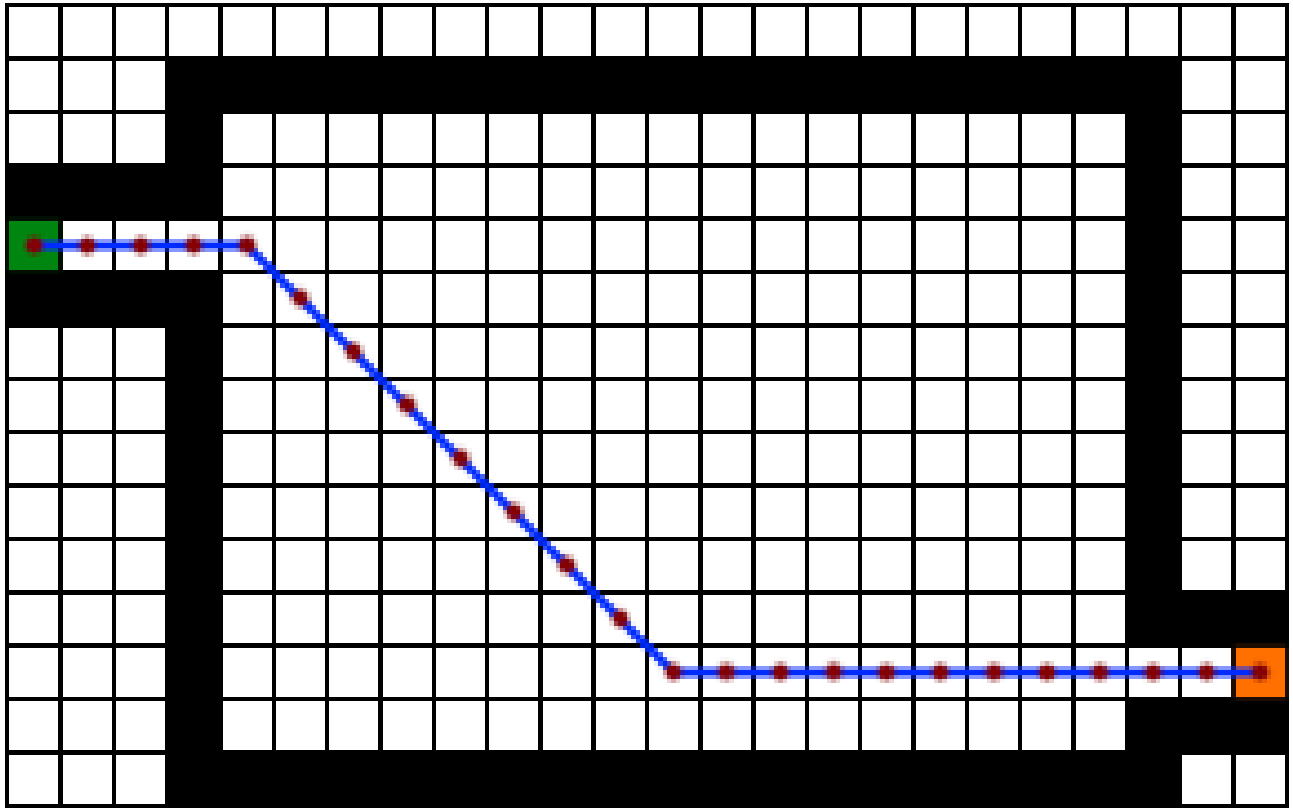

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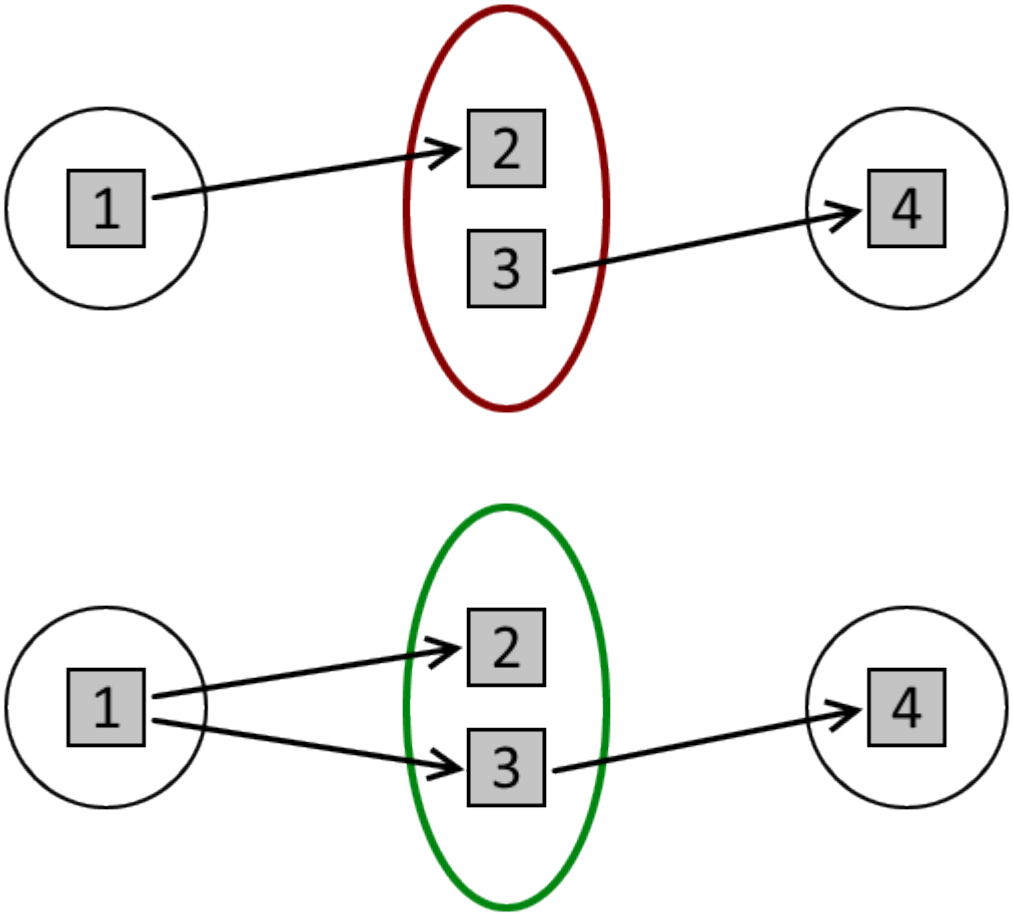
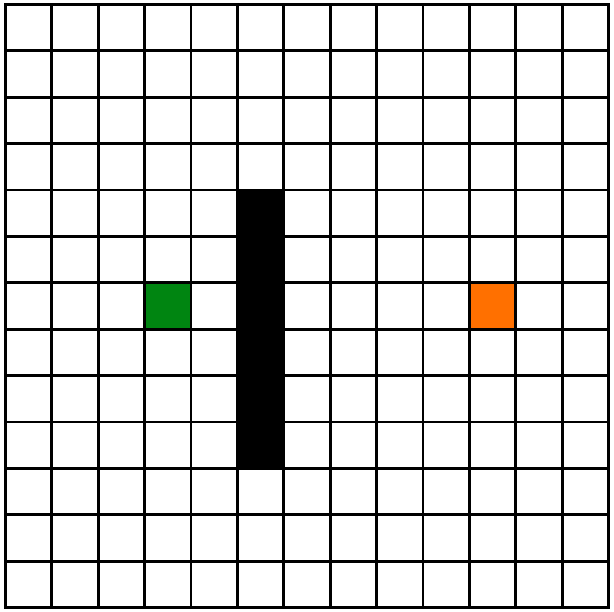
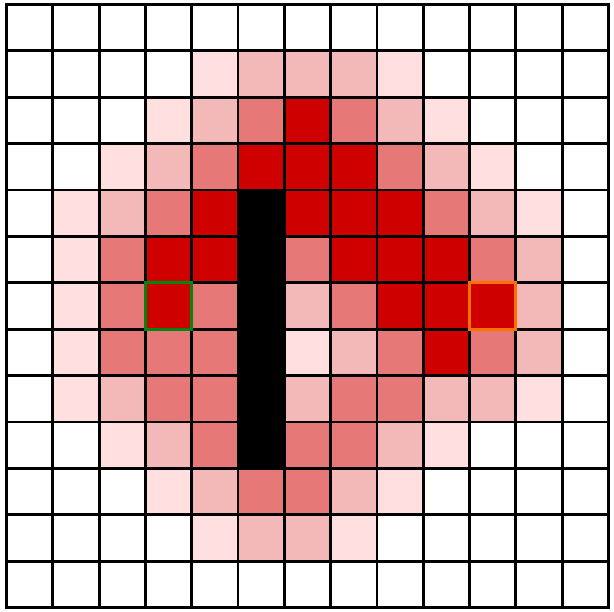


Heat Map

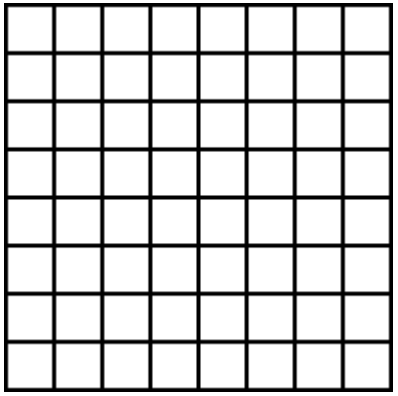
- Heuristic estimate of how 'busy' a tile is.
- Each agent assigns heat along optimal path.



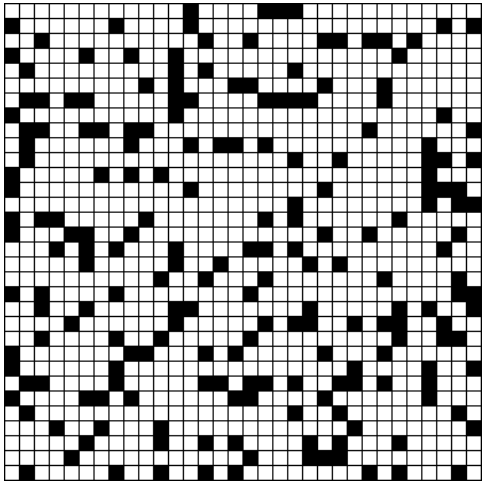


Empirical Results

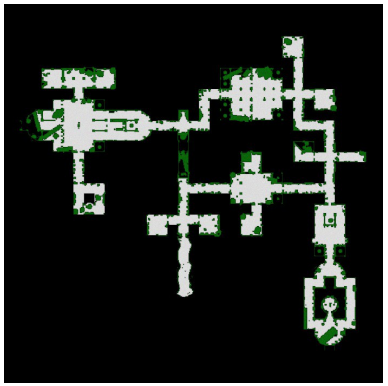
8x8 grid

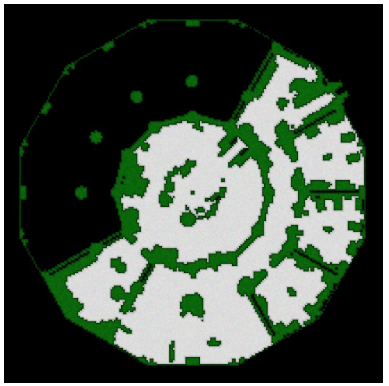


Obstructed 32x32 grids



Dragon Age Origins Maps





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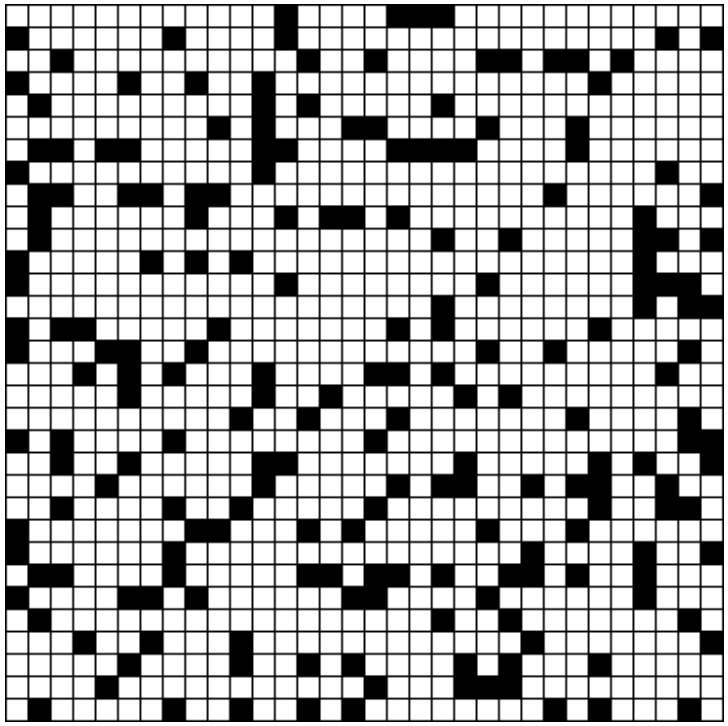

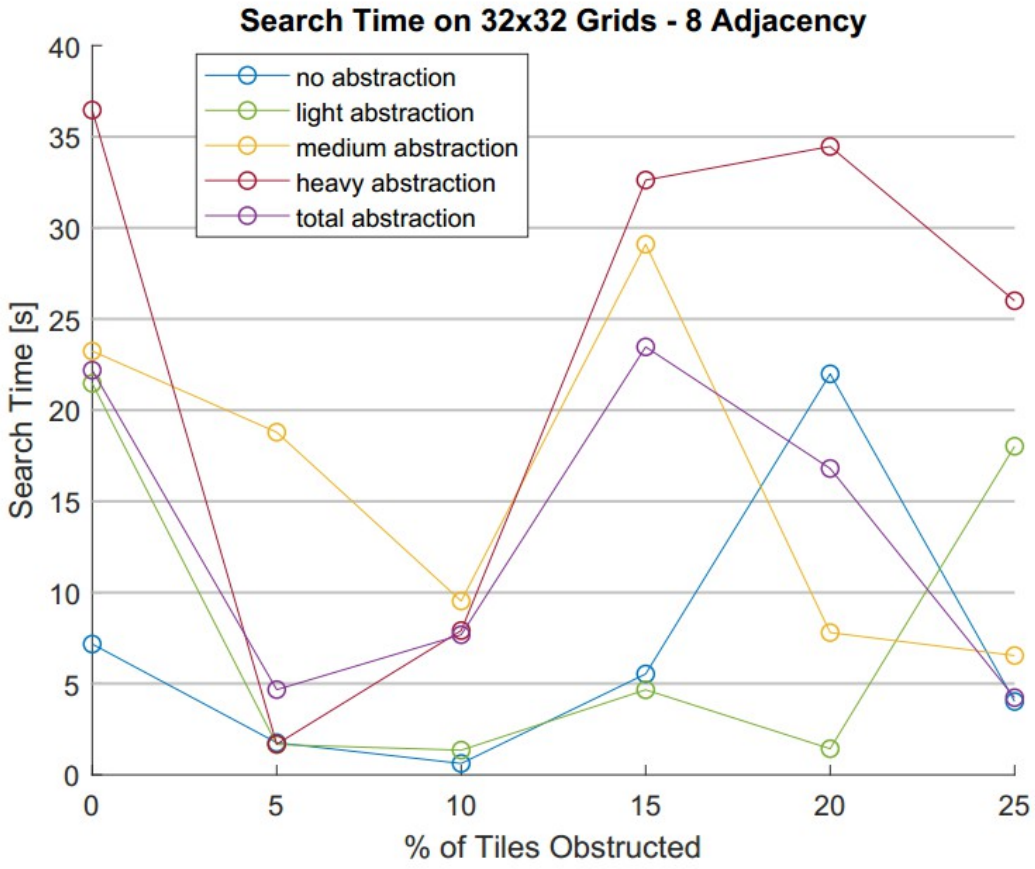

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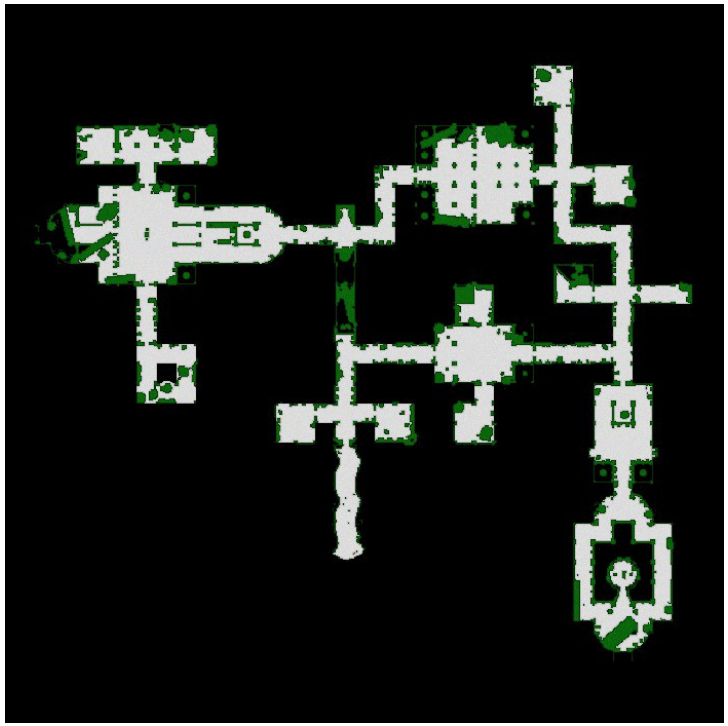

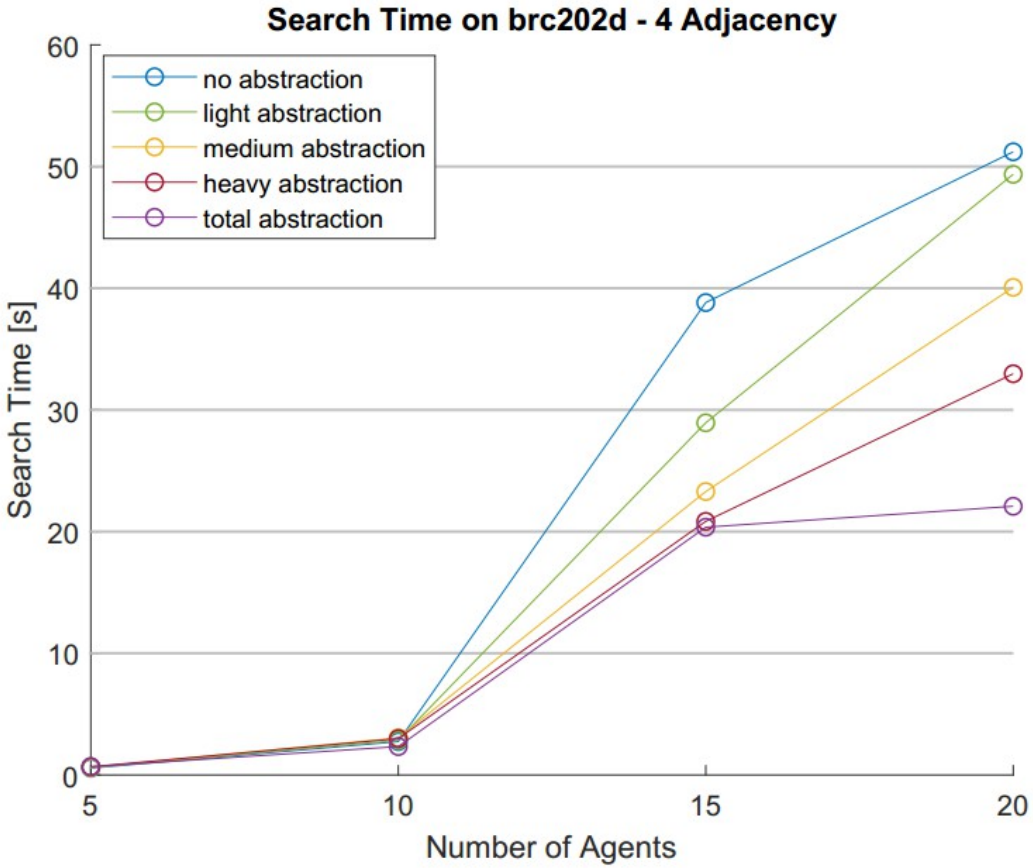

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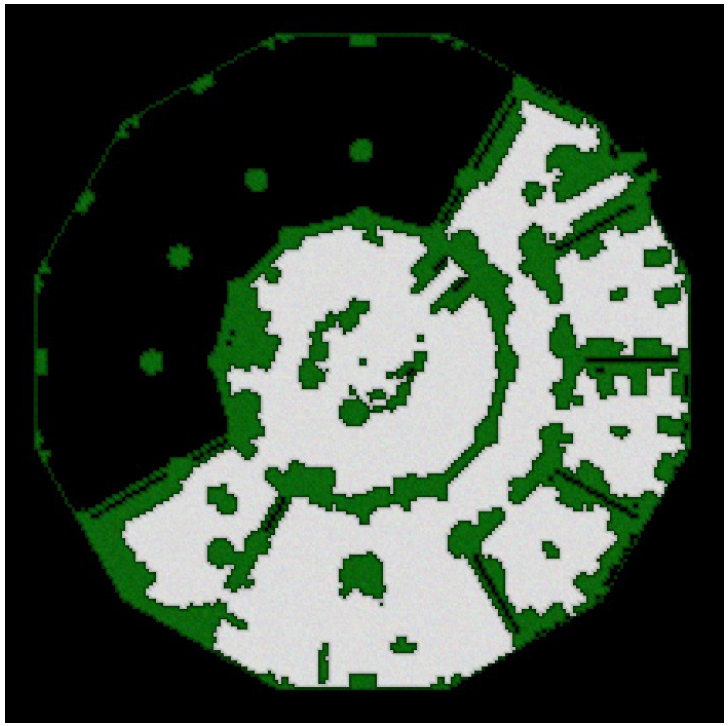

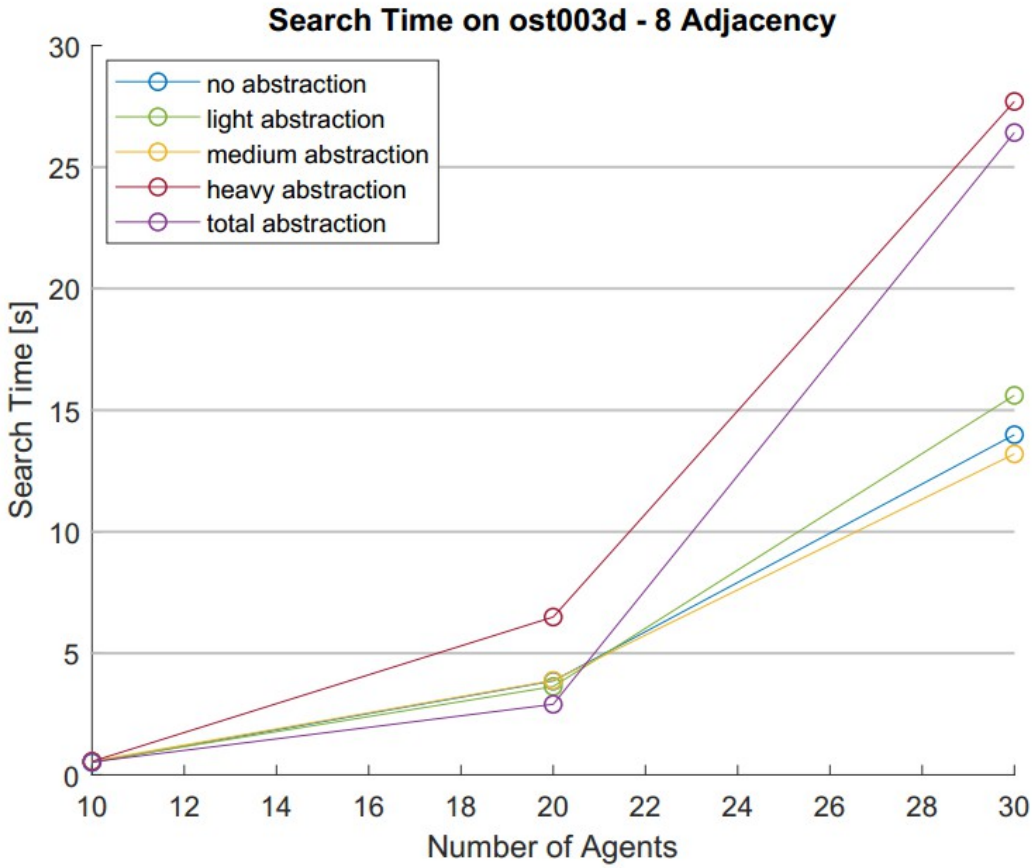

Empirical Results

Average Search Time:

Adjacency	none	light	med	heavy	total
8-adjacency	27.93	29.23	28.32	24.32	**17.60**
4-adjacency	16.81	16.96	19.45	17.23	**13.71**

- Good for large maps with sparse agents.
- Bad for small maps with dense agents.

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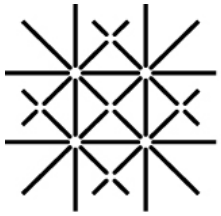

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