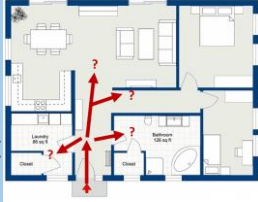


Solving the Watchman Route Problem on a Grid with Heuristic Search

Shawn Seiref, Tamir Jaffey, Margarita Lupatin and Ariel Felner

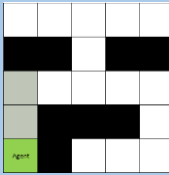
1 Problem Definition

Input: Grid-Map with an agent located in one of the cells.



Output: Minimal-cost valid path.

Valid path– Path that after traveling it, the agent has seen the whole map.



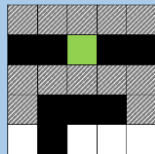
2 Background

Search Problem - Finding the path from a start node to a goal node.

A* - *Heuristic Search Algorithm* that achieves better performance by using heuristics to guide its search.

$$f(x) = g(x) + h(x)$$

Line-Of-Sight (LOS) – We use Bresenham LOS (*BresLos*): LOS function commonly used in computer graphics. Grey cells have LOS to the green cell. We keep the grey cells in the *Seen list*.



3 Main Method Definition as a Search Problem

Node: The current agent's position and the *Seen list*.

Start Node: The start position of the agent, *Seen list* containing the cells which have LOS to the start position.

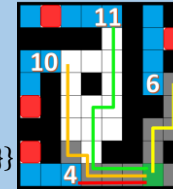
Operator: Move the agent to the neighbor positions (4-way movement) and add to the *Seen list* all the cells with LOS to the new position.

Goal Node: The *Seen list* contains all positions of the map.

4 We propose admissible heuristics in order to solve optimally with A* Singleton Heuristic

Our basic heuristic Compute for all the unseen cells the minimum distance to the agent.

$$h_{\text{singleton}}(n) = \max_{p \in P} \{ \min_{v \in \text{LOS}(p)} \{d(v, n.\text{position})\} \}$$



5 Graph Heuristics

Green cell is the Agent

Grey cells are Seen

Red cells are Pivots

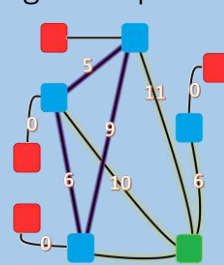
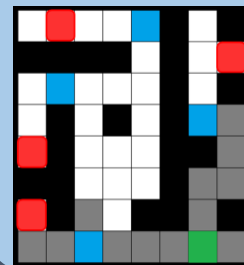
Blue cells are Watchers

Pivots - a set of cells with disjoint sets of watchers

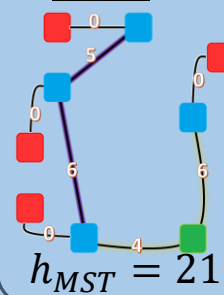
Watchers – a set of cells that have LOS to a pivot

In order to see the whole map, the agent must travel through all the vertices of the graph.

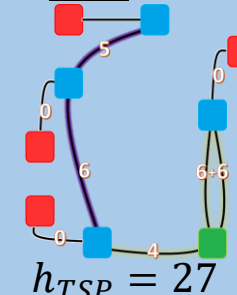
This graph is an abstraction of the grid map.



MST

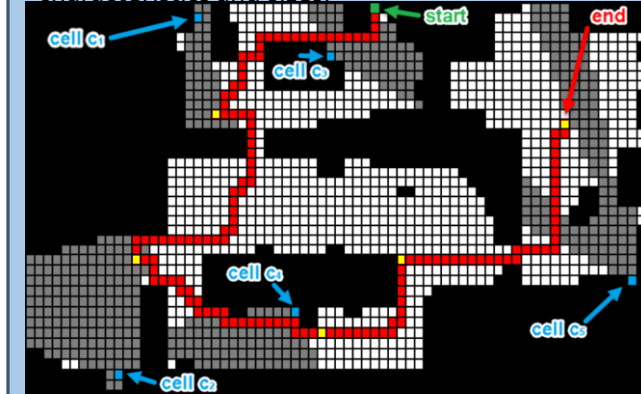


TSP



6 Experiments

We tested our problem on maps with variety of characteristics and sizes.



Map Size: 39×69

#Free cells: 1,360

Heuristic	Max _f	Expanded	Generated	Time(sec)
Optimal solvers				
BFS	66	>11,314	>50,000	>2,340
Singleton	103	>9,977	>45,000	>1,094
MST	137	>7,864	>28,500	>3,000
TSP	137	5,096	15,476	471

7 Conclusions

We introduced WRP and solved it with heuristic search.

Our most informed heuristic is TSP with preformed best.

Future and current work:

1. Developing suboptimal solvers.
2. Multi-Agent Watchman Route Problem.