Artificial Intelligence

Lab 2 – State Space Model

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1. Depth-first search algorithms benefit most from detecting repeated states, becoming complete when they do check. For all the search algorithms the time and space complexities become bounded by the size of the state space, O(V+E), where V and E are the number of vertices and edges.

2. Hash maps are typically used to detect repeating states. They are indexed data structures that use unique and immutable keys. This means that the index access takes constant time and hashing takes constant time meaning that searching the hash map also takes constant time, O(1).

3. A state is determined by the agent's position in the grid, its orientation, if it is turned on or off and the number of dirt spots it has left to clean. The resulting data structure is:

```
state.agent_turned_on
state.agent_current_location
state.agent_orientation
state.dirts
```

   Legal actions are:

```
Turning the agent on when it’s turned off,     cost = 1
       Successor.agent_turned_on = True
Turning the agent off when it’s turned on,     cost 1+50xnum_of_dirt
                    If not at home cell,       cost 1+100xnum_of_dirt
       Successor.agent_turned_on = False
Suck the dirt if the agent is on cell containing dirt,      cost = 1
                    If the cell doesn’t contain dirt, cost = 5
       Successor.num_of_dirt = state.dirts.remove(agent_current_location)
Go forward if agent did not bump in previous action,  cost =1
       Succesor.agent_current_location = new location
Change orientation,        cost = 1
       Successor.agent_orientation = new orientation
```

4. For a grid of size W x H with D number of dirts for an upper bounds estimate we can make a general assumption that each cell in the grid can possibly have dirt or not. The agent can also be located in any cell, with any one of four available orientations and either turned on or off. The upper boundary can therefore be estimated to be:

   Boundary = 2x4x(WxH)^(2) = 8 x (W x H)^(2)

5. Implemented
6. It’s not good to always return 1 because there would be no way to differentiate between the items and all items would end in one useless bucket. If a hash value changes it cannot be found.

7. 24.0% index collisions and 0.0% hash collisions. Which means that all hash are unique, as all states are unique. It’s good to have few hash collisions and few index collisions are fine but it means that there will be more items in some buckets.

8. Since a hash collision means that two or more keys have mapped to the same value it is good that there be as few hash collisions as possible to be able to reliably detect states.