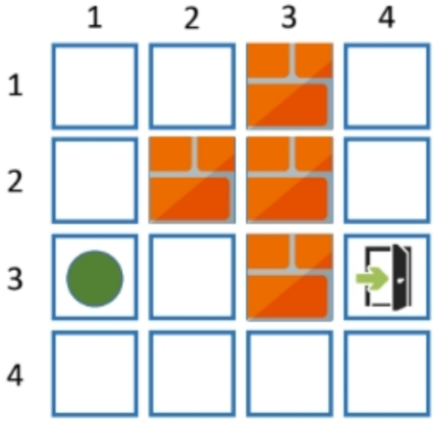
Exam 17/6/2015

An agent is posed at the entrance of the following labyrinth and, it has to traverse it to reach the exit . The symbol represents a wall



The **cost** for going **forward** or **up** is **1**, while for going **down** or **on diagonals** is **2**

The **state space** is the set of possible positions, that can be represented as a pair $\langle i, j \rangle$, with $\mathbf{0 < i < 5}$ and $\mathbf{0 < j < 5}$ and $\langle \mathbf{i}, \mathbf{j} \rangle \neq$

The **initial** state is in $\langle \mathbf{3}, \mathbf{1} \rangle$ while the **goal** state is in $\langle \mathbf{3}, \mathbf{4} \rangle$

At each step, the agent can move in every direction to one of the adjacent cells. It can perform an horizontal, vertical and diagonal move and, it can only advance from left to right, i.e. it cannot go from $\langle i, j \rangle$ to $\langle i, j-1 \rangle$, $\langle i-1, j-1 \rangle$ not $\langle i+1, j-1 \rangle$. Of course, the agent cannot traverse walls nor move out of the grid

1. Characterize the **state space**
2. Specify the **operators**

An agent is posed at the entrance of the following labyrinth and, it has to traverse it to reach the exit . The symbol represents a wall

- Is the **Manhattan distance** an appropriate **heuristic** function? Is it admissible?
- List the expanded nodes in the **order of expansion**
- Use **A*** with the above heuristic function to find a solution. **List all the generated nodes** with the order of generation and the values for g, h and f. **When more than one node has the same minimal value for f expand the most recently generated one**

Manhattan distance: distance between two points is equals to the sum of the absolute differences of their cartesian coordinates

$$d(p,q) = \|p-q\|_1 = \sum_{i=1}^{n} |p_i - q_i|$$

$$p, q \in \mathbb{R}^n \quad (p \text{ and } q \text{ are vectors})$$

Admissibility: the function never overestimate the cost to reach the goal

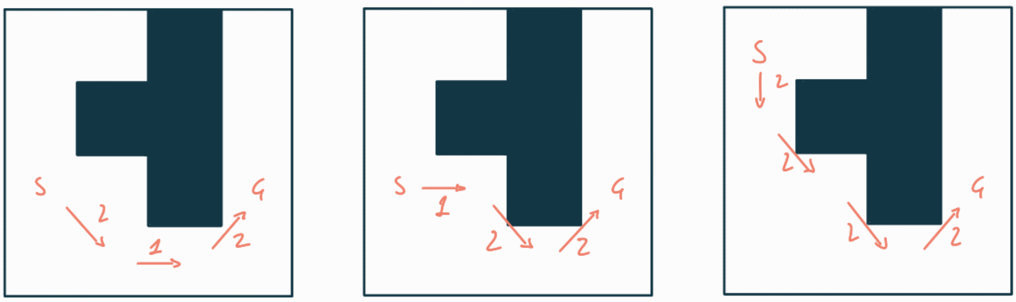
diagonal move: $d(\langle 3,1\rangle, \langle 4,2\rangle) = |3-4| + |1-2| = 1+1 = 2$

forward move: $d(\langle 3,1\rangle, \langle 3,2\rangle) = |3-3| + |1-2| = 0+1 = 1$

up move: $d(\langle 3,1\rangle, \langle 2,1\rangle) = |3-2| + |1-1| = 1+0 = 1$

down move: $d(\langle 3,1\rangle, \langle 4,1\rangle) = |3-4| + |1-1| = 1+0 = 1$

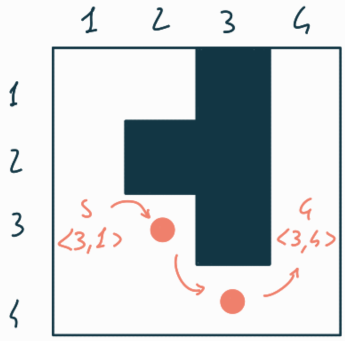
1. The manhattan distance is a valid heuristic function and it is admissible since it never overestimates the true cost function: it is always equal to it except in the case of a movement down (true cost = 2) in which case it underestimates the cost ($d = 1$). This procedure can be iterated for a full path



cost = 5   cost = 5   cost = 2+2+2+2 = 8 only

h = 5   h = 5   h = 1+2+2+2 = 7 underestimates

2. List the order of expansion



$g(s) =$

$h(s) =$ manhattan distance

① 3-1

$g = 0$

$h = |3-3| + |1-4| = 0 + 3 = 3$

$f = 0 + 3 = 3$

down → 4-1: $g = 2$, $h = |4-3| + |1-4| = 4$, $f = 2+4 = 6$

d-down → 4-2: $g = 2$, $h = |4-3| + |2-4| = 3$, $f = 2+3 = 5$

forward → ② 3-2: $g = 1$, $h = |3-3| + |2-4| = 2$, $f = 1+2 = 3$

up → 2-1: $g = 1$, $h = |2-3| + |1-4| = 1+3 = 4$, $f = 1+4 = 5$

From 3-2:

down → 4-2: $g = 1+2 = 3$, $h = |4-3| + |2-4| = 3$, $f = 3+3 = 6$

d-down → ③ 4-3: $g = 1+2 = 3$, $h = |4-3| + |3-4| = 2$, $f = 3+2 = 5$

From 4-3:

forward → 4-4: $g = 3+1 = 4$, $h = |4-3| + |4-4| = 1$, $f = 4+1 = 5$

d-up → ④ 3-4: $g = 3+1 = 4$, $h = |3-3| + |4-4| = 0$, $f = 4+0 = 4$

Order of expansion:

3-1

3-2

4-3

3-4