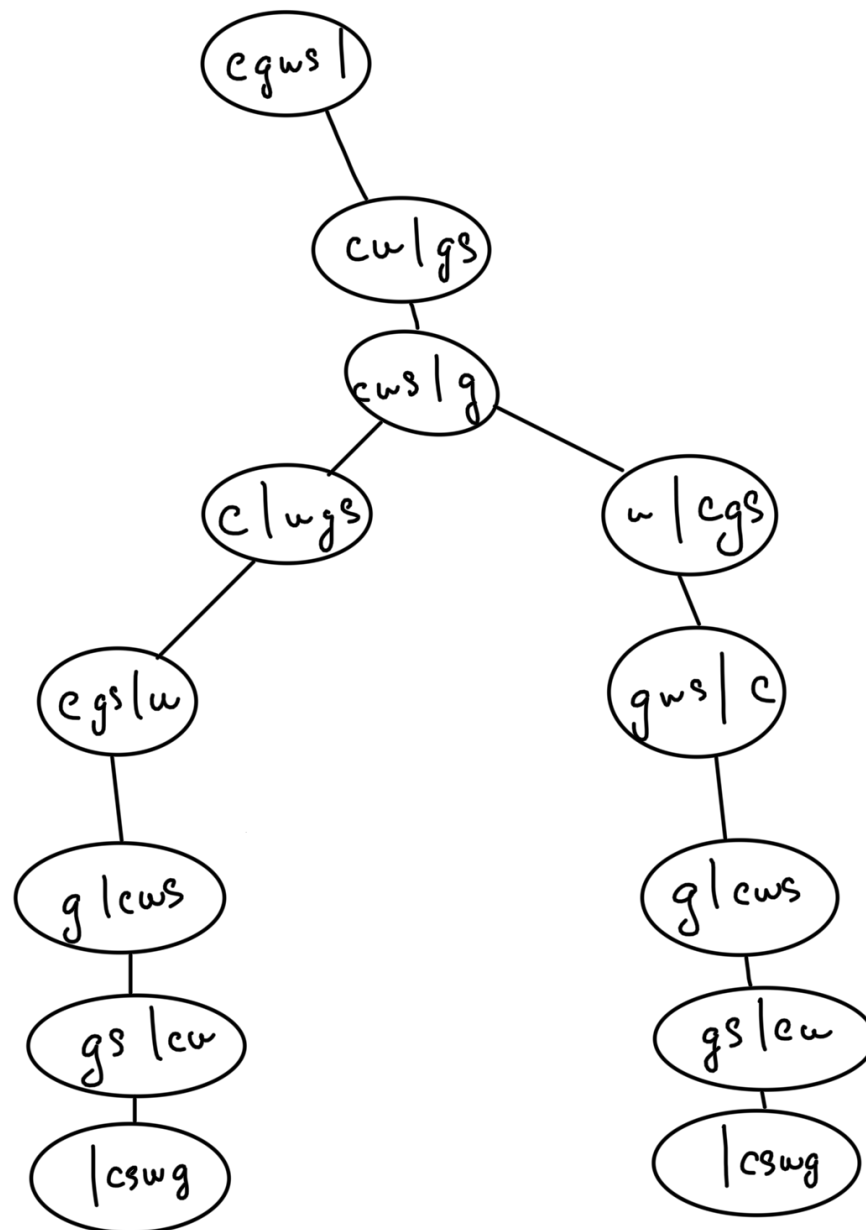


CHAPTER 3: PROBLEM SOLVING

Exercise 1

Consider the shepherd, goat, wolf, cabbage (s, g, w, c) problem

1.1. Tree of simplified state space



1.2. The maximum branching factor **b** is 2.

The depth of the least-cost solution **d** is 7.

The maximum depth of the state space **m** is 7 to avoid infinite loops.

1.3. Breadth-first search

- Steps:

Breadth-first search

Step	Node expand	Fringe
1	[cgws]	[cgws]
2	[cw gs]	[cw gs]
3	[cws g]	[cws g]
4	[c wgs]	[c wgs], [w cgs]
5	[w cgs]	[cgs w], [w cgs]
6	[cgs w]	[cgs w], [gws c]
7	[gws c]	[g cws], [gws c]
8	[g cws]	[g cws], [g cws]
9	[g cws]	[gs cw], [g cws]
10	[gs cw]	[gs cw], [gs cw]
11	[gs cw]	[cswg], [gs cw]
12	[cswg]	[cswg], [cswg]

- The space complexity in practice is 13, whereas it is $O(2^7) = O(128)$ in the worst case.
- The time complexity in practice is 13, whereas it is $O(2^7) = O(128)$ in the worst case.

1.4. Depth-first search

- Steps:

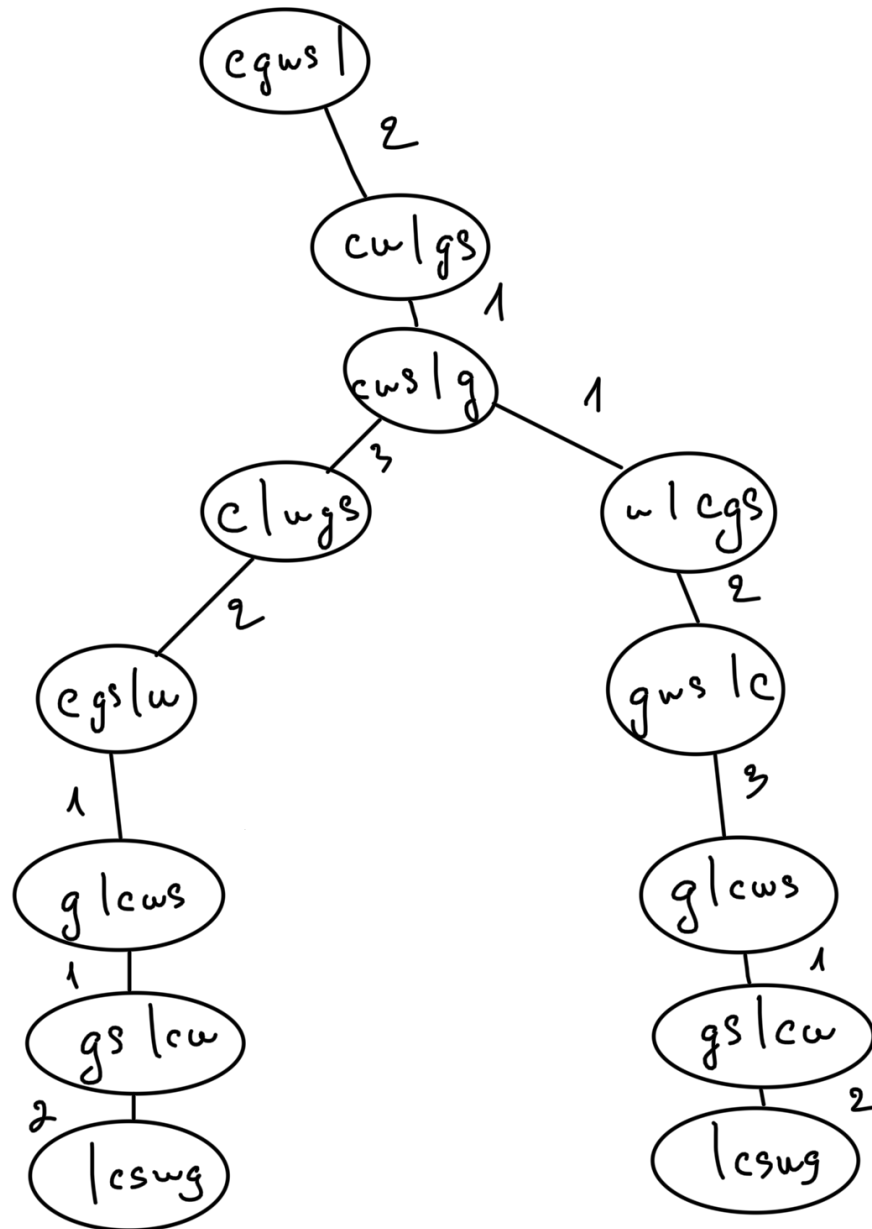
Depth-first search

Step	Node expand	Fringe
1	[cgws]	[cgws]
2	[cw gs]	[cw gs]
3	[cws g]	[cws g]
4	[c wgs]	[c wgs], [w cgs]
5	[cgs w]	[cgs w], [w cgs]
6	[g cws]	[g cws], [w cgs]
7	[gs cw]	[gs cw], [w cgs]
8	[cswg]	[cswg], [w cgs]

- The space complexity in practice is 9, where it is $O(2 \cdot 7) = O(14)$ in the worst case.
- The time complexity in practice is 9, where it is $O(2^7) = O(128)$ in the worst case.

Exercise 2

Consider the new shepherd, goat, wolf, cabbage (s, g, w, c) problem, with the associated cost for each step as below.



2.1. Uniform-cost search

- Steps:

Uniform-cost search

Step	Node expand	Fringe
1	[cgws]	([cgws], 0)
2	[cw gs]	([cw gs], 2)
3	[cws g]	([cws g], 3)
4	[w cgs]	([c wgs], 6), ([w cgs], 4)
5	[c wgs]	([c wgs], 6), ([gws c], 6)
6	[gws c]	([cgs w], 8), ([gws c], 6)
7	[cgs w]	([cgs w], 8), ([g cws], 9)
8	[g cws]	([g cws], 9), ([g cws], 9)
9	[g cws]	([gs cw], 10), ([g cws], 9)
10	[gs cw]	([gs cw], 10), ([gs cw], 10)
11	[gs cw]	([cswg], 12), ([gs cw], 10)
12	[cswg]	([cswg], 12), ([cswg], 12)

- C* is cost of the optimal solution: 12, and epsilon is 1 (the lowest cost for a step).
- Space complexity: 13 in practice and $O(2^{12}) = O(4096)$ in the worst case
- Time complexity: 13 in practice and $O(2^{12}) = O(4096)$ in the worst case.