

# Foundations of Artificial Intelligence

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Exercise Session  
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Registrations of the Exercise Sessions on **WeBeep**

Registration Links also available at

<https://albertometelli.github.io/teaching/2021-teaching-fai>

## Exercise 1.2

You have three containers that may hold **12 liters**, **8 liters** and **3 liters** of water, respectively, as well as access to a water **faucet**. You can **fill** a container from the faucet, **pour** it into another container, or **empty** it onto the ground.

The goal is to measure exactly **one liter** of water.

1. Give a precise specification of the task as a search problem.
2. Draw the search tree produced by **depth-limited search** with maximum depth equal to **three** and elimination of repeated states.

# Solution Proposal

**State:**  $[x, y, z]$  – contents of 12, 8 and 3 liters

**Initial state:**  $[0, 0, 0]$

**Goal test:**  $[1, y, z] \vee [x, 1, z] \vee [x, y, 1]$

**Path cost:** number of actions in path from initial state to goal state

# Solution Proposal

## Fill actions

- Fill12:  $[x, y, z] \Rightarrow [12, y, z]$
- Fill8:  $[x, y, z] \Rightarrow [x, 8, z]$
- Fill3:  $[x, y, z] \Rightarrow [x, y, 3]$

## Empty actions

- Empty12:  $[x, y, z] \Rightarrow [0, y, z]$
- Empty8:  $[x, y, z] \Rightarrow [x, 0, z]$
- Empty3:  $[x, y, z] \Rightarrow [x, y, 0]$

## Pour actions

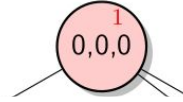
- Pour12-8:  $[x, y, z] \Rightarrow [x - \min(x, 8 - y), y + \min(x, 8 - y), z]$
- Pour12-3:  $[x, y, z] \Rightarrow [x - \min(x, 3 - z), y, z + \min(x, 3 - z)]$
- Pour8-12:  $[x, y, z] \Rightarrow [x + \min(y, 12 - x), y - \min(y, 12 - x), z]$
- Pour8-3:  $[x, y, z] \Rightarrow [x, y - \min(y, 3 - z), z + \min(y, 3 - z)]$
- Pour3-12:  $[x, y, z] \Rightarrow [x + \min(z, 12 - x), y, z - \min(z, 12 - x)]$
- Pour3-8:  $[x, y, z] \Rightarrow [x, y + \min(z, 8 - y), z - \min(z, 8 - y)]$

# Depth-Limited Search - DLS (max depth = 3)

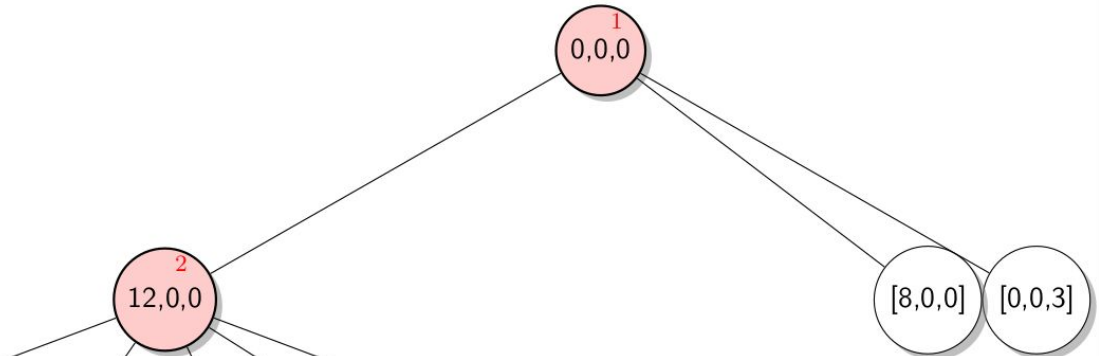
## Just for this exercise:

- Elimination of repeated states @ node creation
- Goal test @ node creation

DLS (max depth = 3)

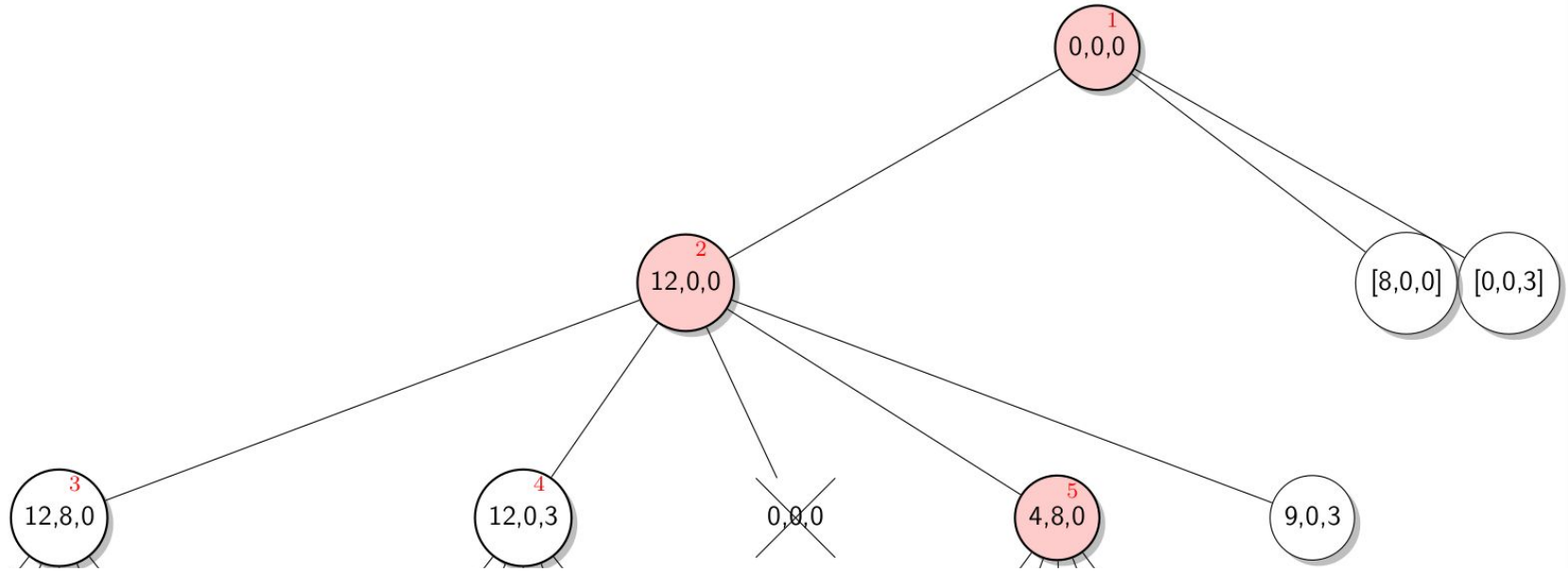


DLS (max depth = 3)

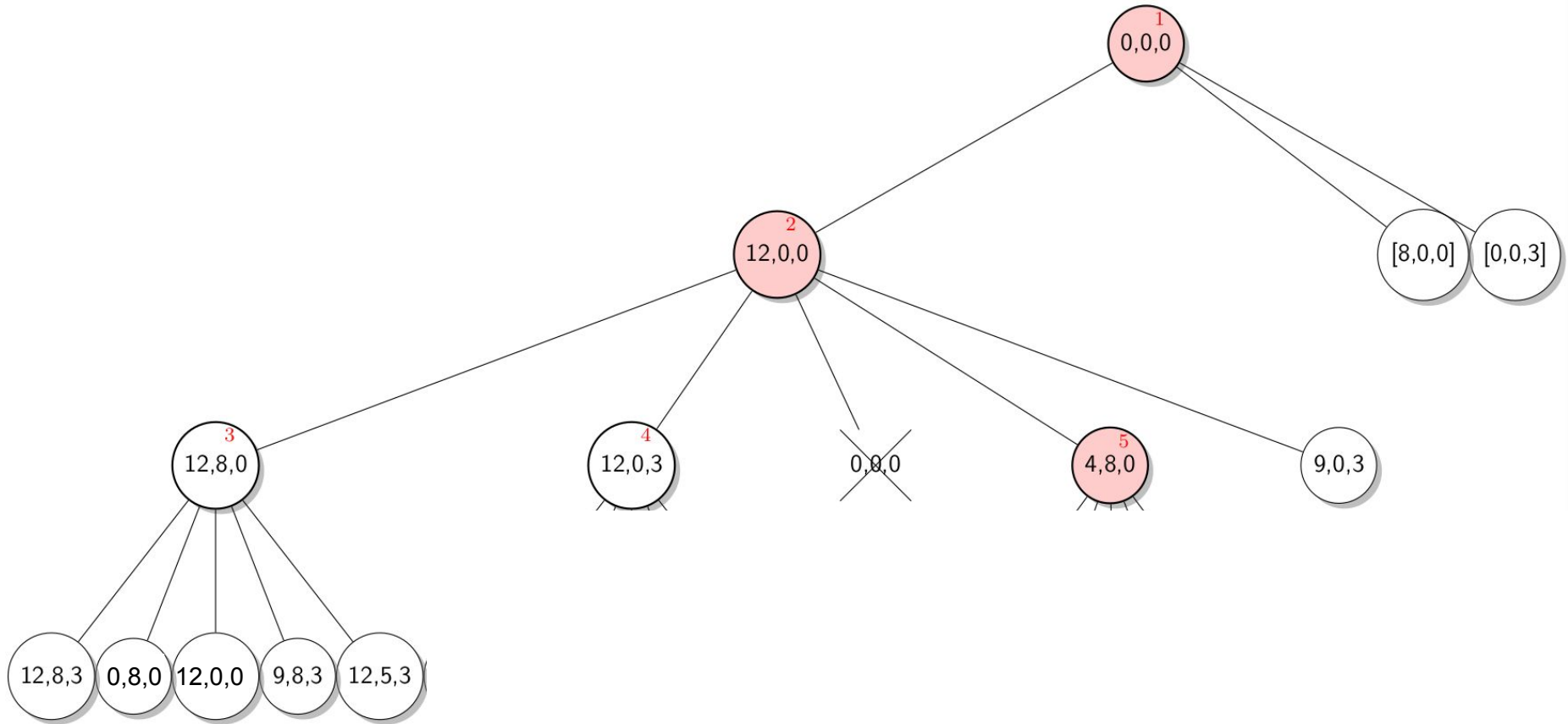




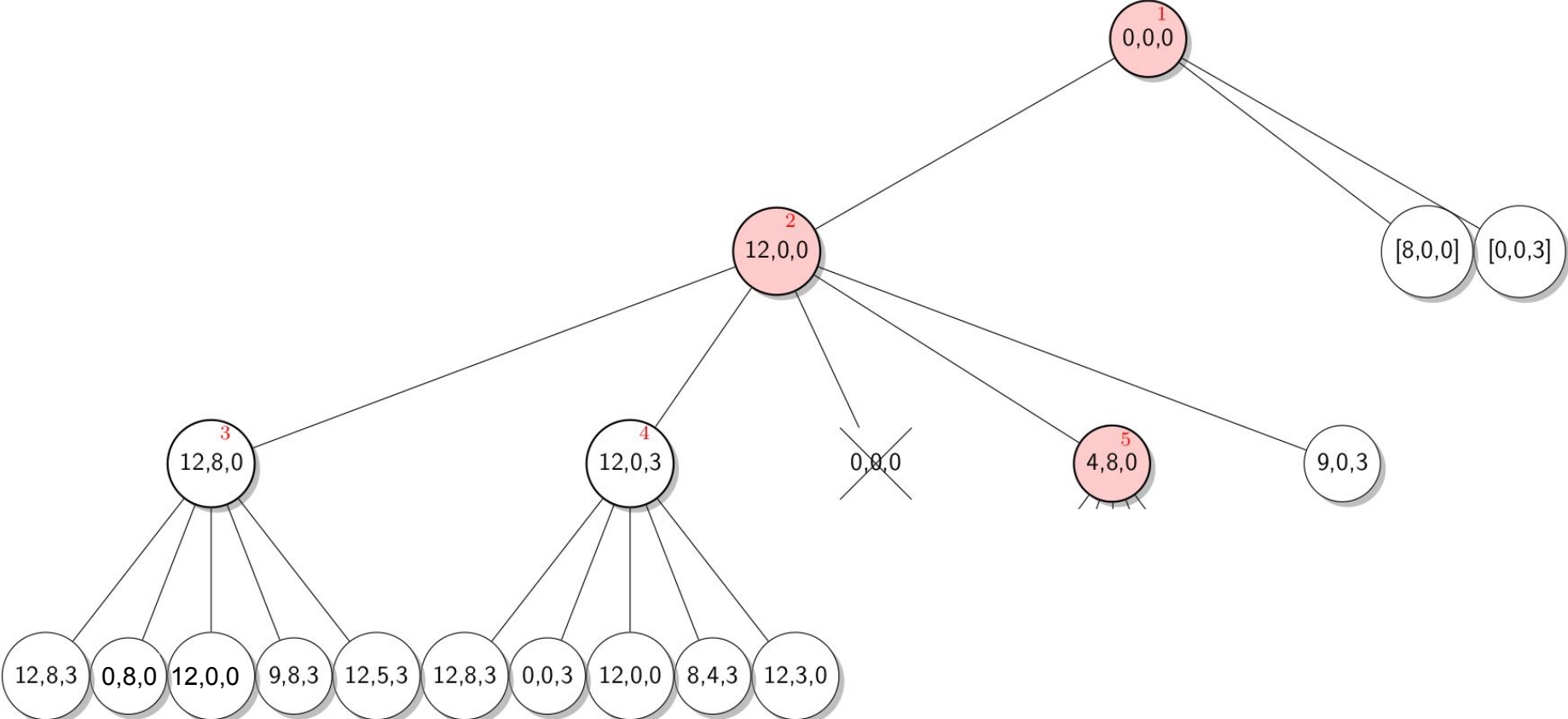
# DLS (max depth = 3)



# DLS (max depth = 3)



# DLS (max depth = 3)



# DLS (max depth = 3)

