SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
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DEPARTMENT OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

19AMB303-FULL STACK AI

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olving Problems by Searching

- Reflex agent is simple
  - base their actions on
  - a direct mapping from states to actions
  - but cannot work well in environments
    - which this mapping would be too large to store
    - and would take too long to learn
- Hence, goal-based agent is used

Problem-solving agent

- Problem-solving agent
  - A kind of goal-based agent
  - It solves problem by
    - finding sequences of actions that lead to desirable states (goals)
  - To solve a problem,
    - the first step is the ***goal formulation***, based on the current situation

Goal formulation

- The goal is formulated
  - as a set of states, in which the goal is satisfied
- Reaching from initial state → goal state
  - Actions are required
- *Goal formulation, based on the current situation and the agent's performance measure, is the first step in problem solving.*
- Actions are the operators
  - causing transitions between states
  - **Actions** should be abstract enough at a certain degree, instead of very detailed
  - E.g., turn left VS turn left 30 degree, etc.

Problem formulation

- The process of deciding
  - what actions and states to consider, given a goal
- E.g., driving Amman → Zarqa
  - in-between states and actions defined
  - States: Some places in Amman & Zarqa
  - Actions: Turn left, Turn right, go straight, accelerate & brake, etc.

Search

Because there are many ways to achieve the same goal

- Those ways are together expressed as a tree
- Multiple options of unknown value at a point,
  - the agent can examine different possible sequences of actions, and choose the best
- This process of looking for such a sequence is called ***search***
- A search algorithm takes a problem as input and returns a ***solution*** *in the form of an action sequence.*

Search algorithm

- Defined as
  - taking a *problem*
  - and returns a *solution*
- Once a solution is found
  - the agent follows the solution
  - and carries out the list of actions – execution phase
- Design of an agent
  - “Formulate, search, execute”

A simple problem-solving agent

```
function SIMPLE-PROBLEM-SOLVING-AGENT(p) returns an action
    inputs: p, a percept
    static: s, an action sequence, initially empty
            state, some description of the current world state
            g, a goal, initially null
            problem, a problem formulation
    state ← UPDATE-STATE(state, p)
    if s is empty then
        g ← FORMULATE-GOAL(state)
        problem ← FORMULATE-PROBLEM(state, g)
        s ← SEARCH(problem)
    action ← RECOMMENDATION(s, state)
    s ← REMAINDER(s, state)
    return action
```

ell-defined problems and solutions

- A problem is defined by 4 components:
  - The ***initial state***
    - that the agent starts in
  - The set of possible **actions**

Transition model: *description of what each action does.*

(***successor functions***): refer to any state reachable from given state by a single action

Initial state, actions and Transition model define the ***state space***

- the set of all states reachable from the initial state by any sequence of actions.

A ***path*** in the state space:

- any sequence of states connected by a sequence of actions.

Well-defined problems and solutions

- The ***goal test***
  - Applied to the current state to test
    - if the agent is in its goal

-Sometimes there is an explicit set of possible goal states. (example: in Amman).

-Sometimes the goal is described by the properties

- instead of stating explicitly the set of states

Example: Chess

- the agent wins if it can capture the KING of the opponent on next move (checkmate).
- no matter what the opponent does

Well-defined problems and solutions

- A ***path cost*** function,
  - assigns a numeric cost to each path
  - = performance measure
  - denoted by ***g***
  - to distinguish the best path from others
- Usually the path cost is
  - the sum of the **step costs** of the individual actions (in the action list)

Well-defined problems and solutions

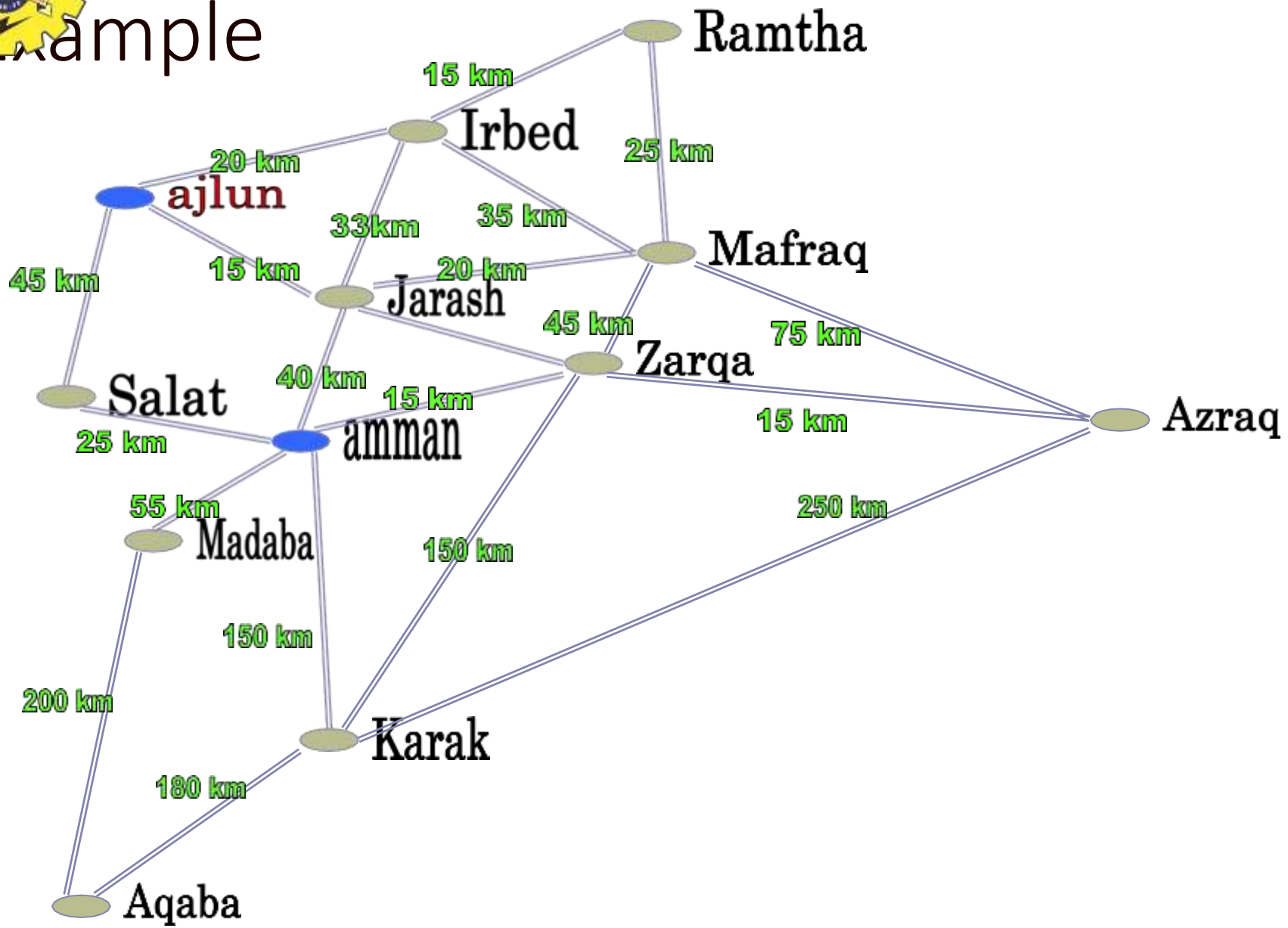
- Together a problem is defined by
  - Initial state
  - Actions
  - Successor function
  - Goal test
  - Path cost function
- The ***solution*** of a problem is then
  - *a path from the initial state to a state satisfying the goal test*
- ***Optimal*** solution
  - the solution with lowest path cost among all solutions

Formulating problems

- Besides the four components for problem formulation
  - anything else?
- ***Abstraction***
  - the process to take out the irrelevant information
  - leave the most essential parts to the description of the states

  (Remove detail from representation)
  - **Conclusion**: Only the most important parts *that are contributing to searching* are used

Example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From our Example

1. Formulate Goal

- **Be In Amman**

2. Formulate Problem

- **States : Cities**
- **actions : Drive Between Cities**

3. Find Solution

- **Sequence of Cities : ajlun – Jarash - Amman**

Our Example

1. **Problem : To Go from Ajlun to Amman**

2. **Initial State : Ajlun**

3. **Operator : Go from One City To another .**

4. **State Space : {Jarash , Salat , irbed,……..}**

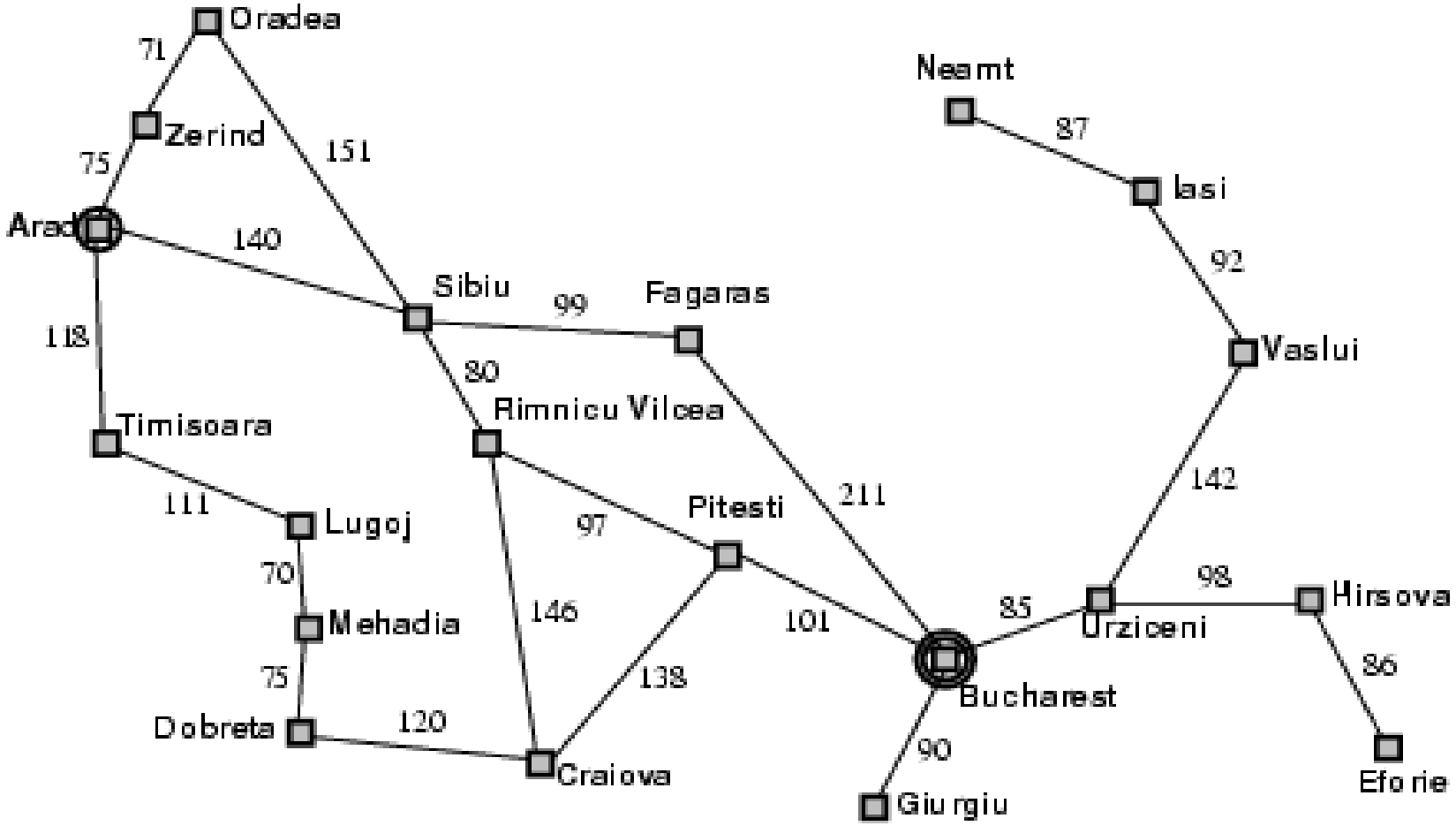
5. **Goal Test : are the agent in Amman.**

6. **Path Cost Function : Get The Cost From The Map.**

7. **Solution :** { {Aj → Ja → Ir → Ma → Za → Am} , {Aj →Ir → Ma → Za → Am} … . {Aj → Ja → Am} }

8. **State Set Space :** {Ajlun → Jarash → Amman}

Example: Romania

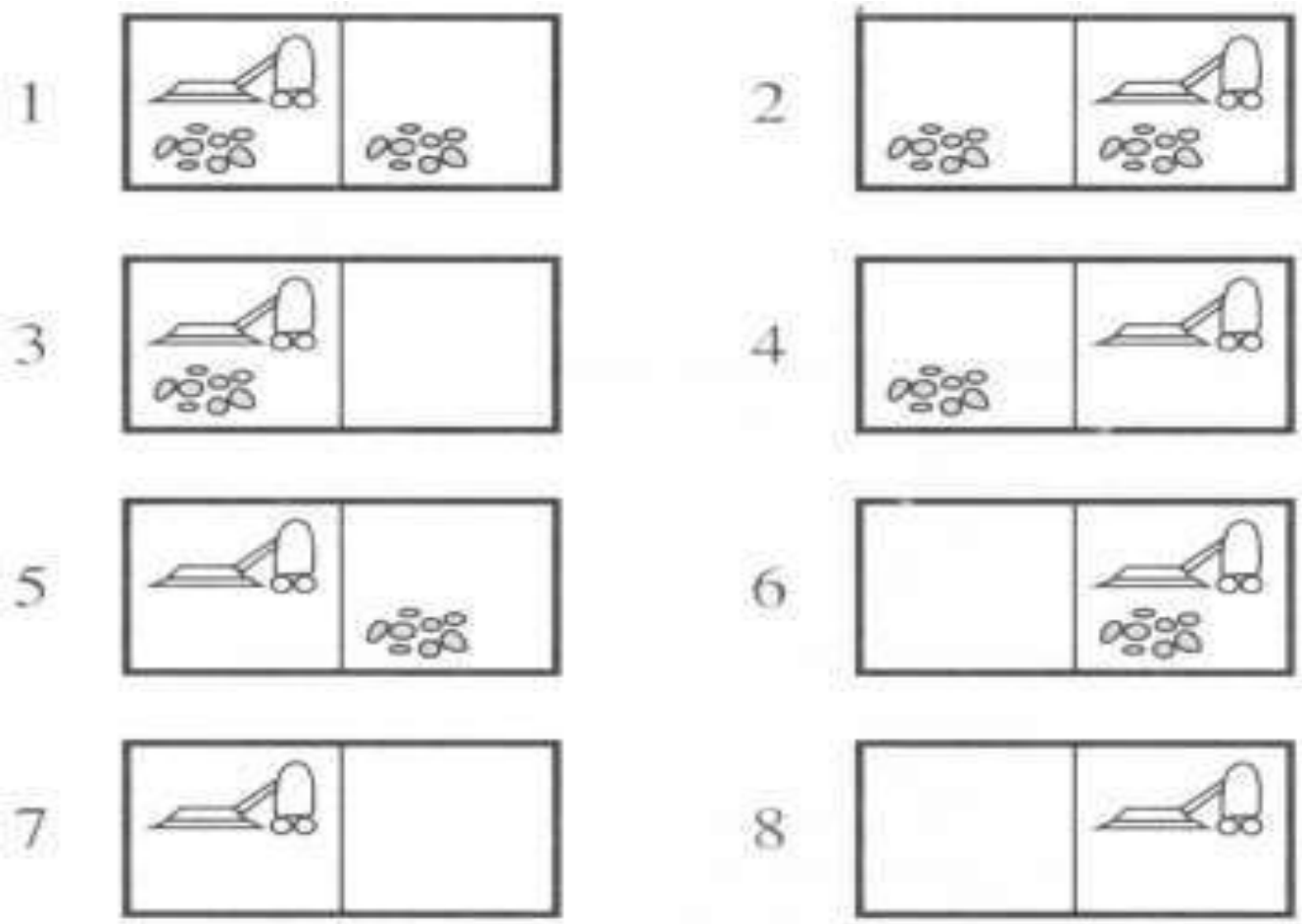


Example problems

- *Toy problems*
  - those intended to illustrate or exercise various problem-solving methods
  - E.g., puzzle, chess, etc.
- *Real-world problems*
  - tend to be more difficult and whose solutions people actually care about
  - E.g., Design, planning, etc.

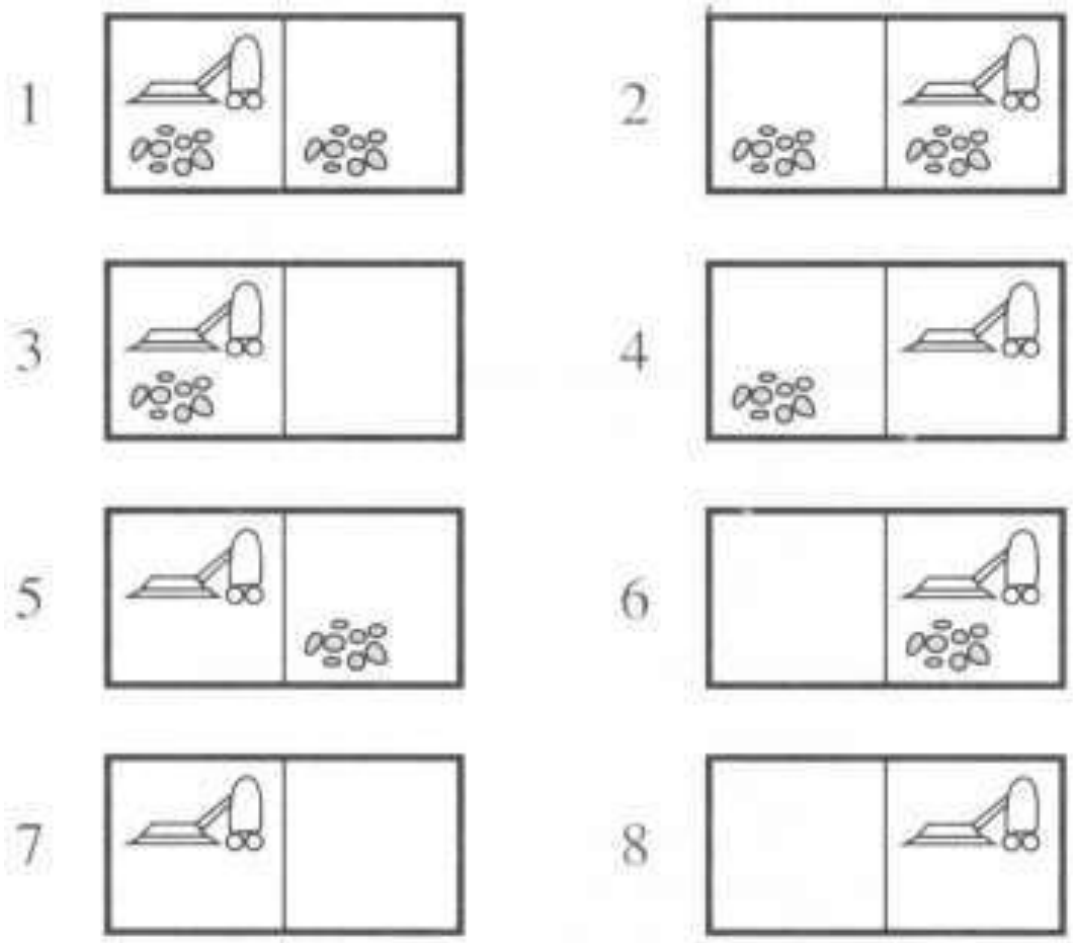
Toy problems

- Example: vacuum world

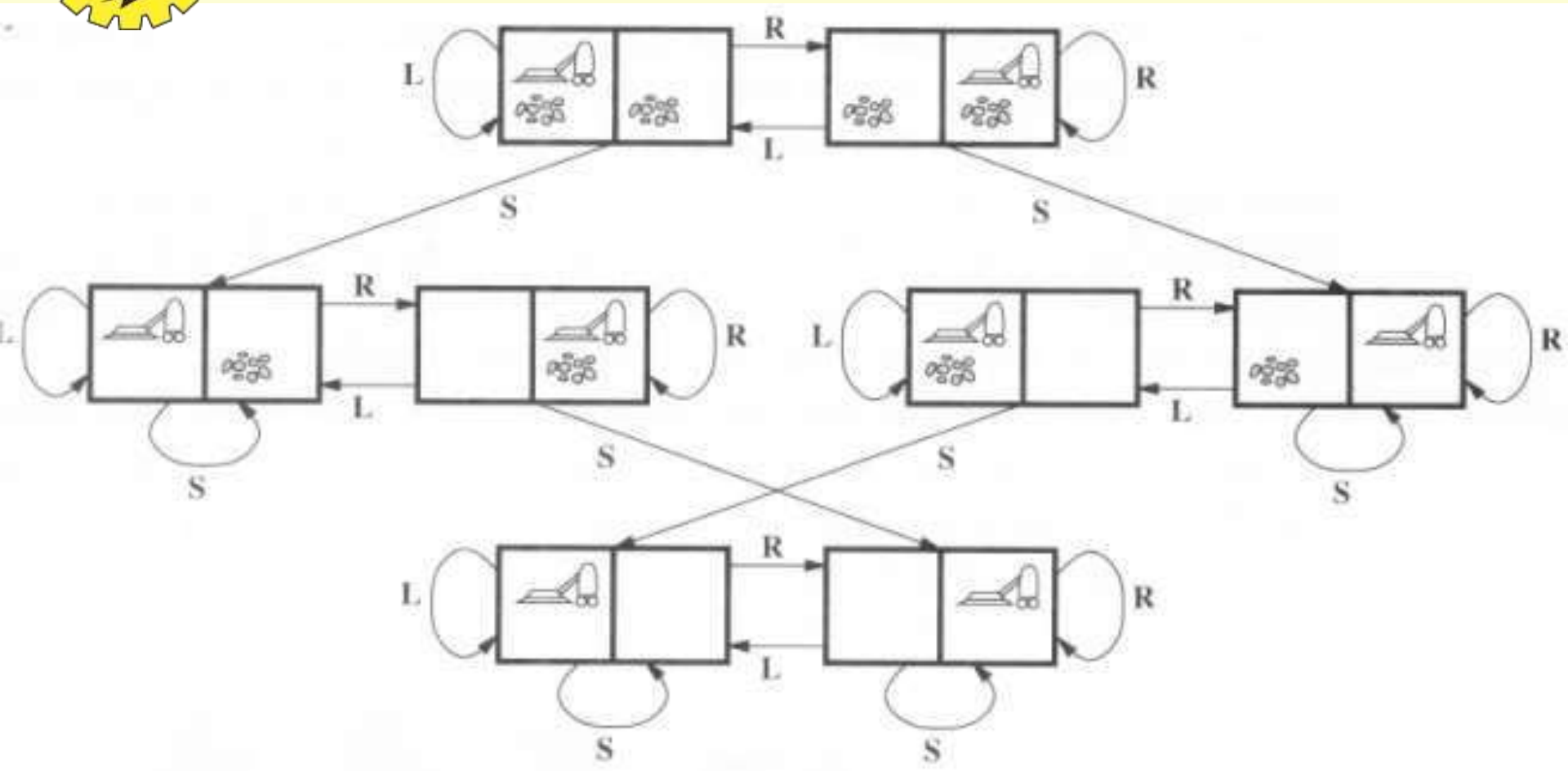


Toy problems

- Example: vacuum world



- Number of states: 8
- Initial state: Any
- Number of actions: 4
  - *left, right, suck, noOp*
- Goal: clean up all dirt
  - Goal states: {7, 8}
- Path Cost:
  - Each step costs 1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