

# **Problem-Solving Agents and Representation**

# Task: Problem Solving

- Formulate Goal
- Formulate Problem  
(i.e., choose representation)
- Generate Solution
- Execute Solution

# Goal Formulation

- Goal Representation
  1. Goal State or
  2. Goal Test Function
- Why are goals created?
  1. Subgoaling
  2. Interests
- In AI, goal formulation is often skipped as research topic (goals are given as input). But it is an important function of agent.

# Goal Formulation (cont.)

- Advantages of Goals
  1. Focus on what needs to be done
  2. Includes aspect of future state
  3. Adds level of abstraction
- Goal types:
  1. Achievement goals (often goals assumed to be achievement goals)
  2. Maintenance goals
  3. Prevention goals
- Examples:
  1. Achieve (winner(me, race))
  2. And (location(me, work),  
not(possess(me, speeding-ticket)))
  3. Forall A | (isa opponent A) ^  
(prevent (scores A soccer-goal))

# Formulate Problem

*Problem Formulation* = process of deciding what actions and states to consider

- Problem Representation

1. Initial State -  $s_0$
2. Operator (or successor function)
3. Goal State (or goal test function) -  $g$
4. Path Cost Function (but this could be in operator definition as with PRODIGY)

- State Space:

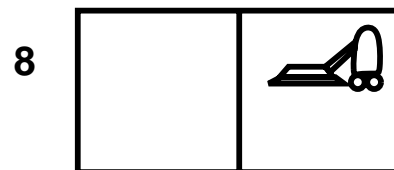
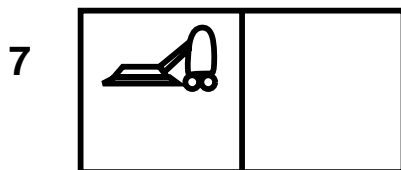
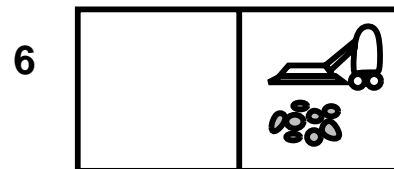
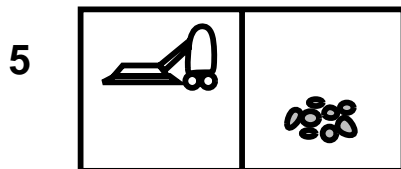
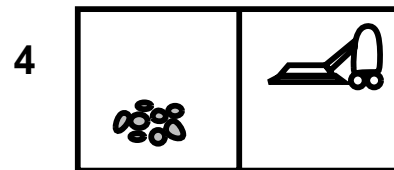
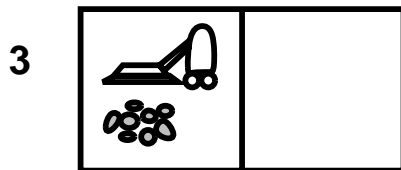
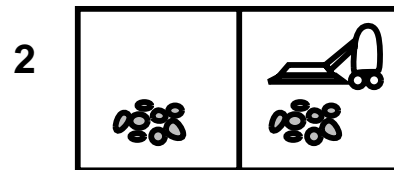
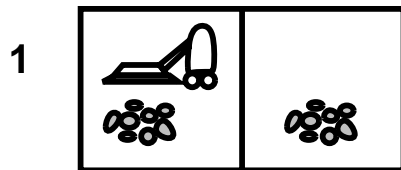
Set of all possible states reachable from the initial state.

World States  $\langle \rangle$  Problem-Solving States

# Formulate Problem (cont.)

- Example:

Vacuum Cleaner World



# Generate Solution

*Search:* Given alternative states with unknown value that are reachable from the current state, examine sequences of actions that lead to states of known value; choose best sequence.

- Solution Representation -

1. Path  $s_0\text{-op}_1\text{-}s_1\text{-op}_2\text{-}\dots\text{-op}_n\text{-}g_1$
2. or Action Sequence  $\text{op}_1\text{-op}_2\text{-}\dots\text{-op}_n$
3. In a Design Task, the solution might be description frame with attributes and components specified

- Alternative Generation Methods:

1. Search
2. MEA (Means-End Analysis)
3. CBR (Case-Based Reasoning)

# Solution Execution

- Procedure (1 and 2 assume a closed world):
  1. Assumed execution  
(Often not Addressed in AI Research)
  2. or Simple execution
  3. Interleaved planning and execution
- Uncertainty of action outcome -->  
Nondeterminism
- Exogenous events: e.g., hurricanes

