Search with No/Partial Percepts

Outline

I. Searching with no observation

II. Searching in partially observable environments

* Figures are from the textbook site (or by the instructor) unless the source is specifically cited.

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Agent's precepts provide no information at all.

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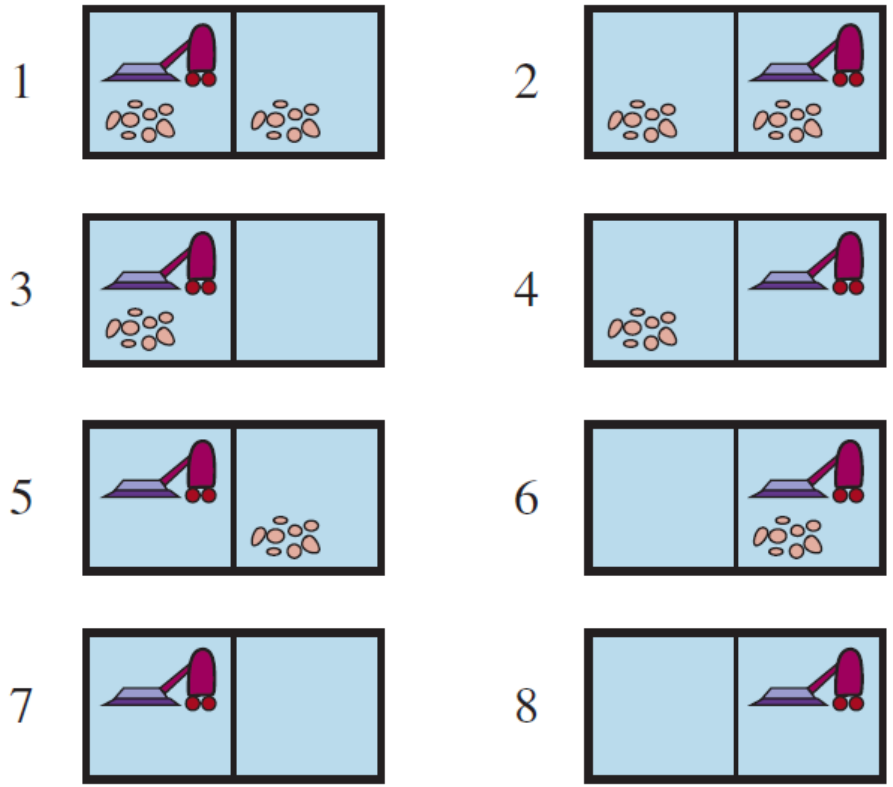

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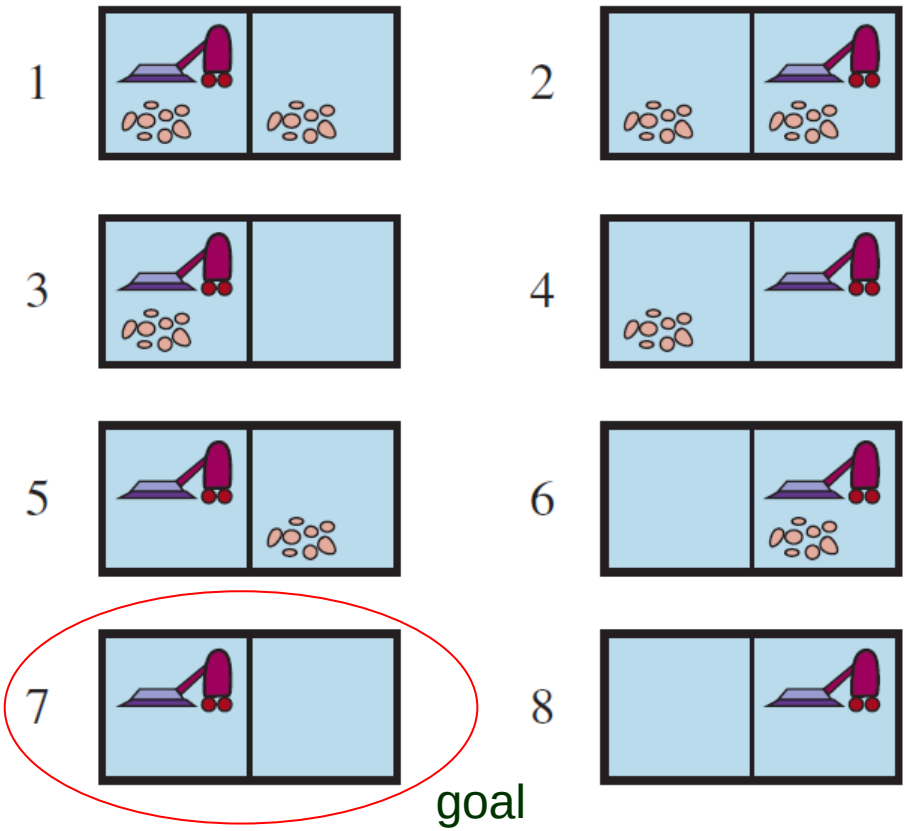

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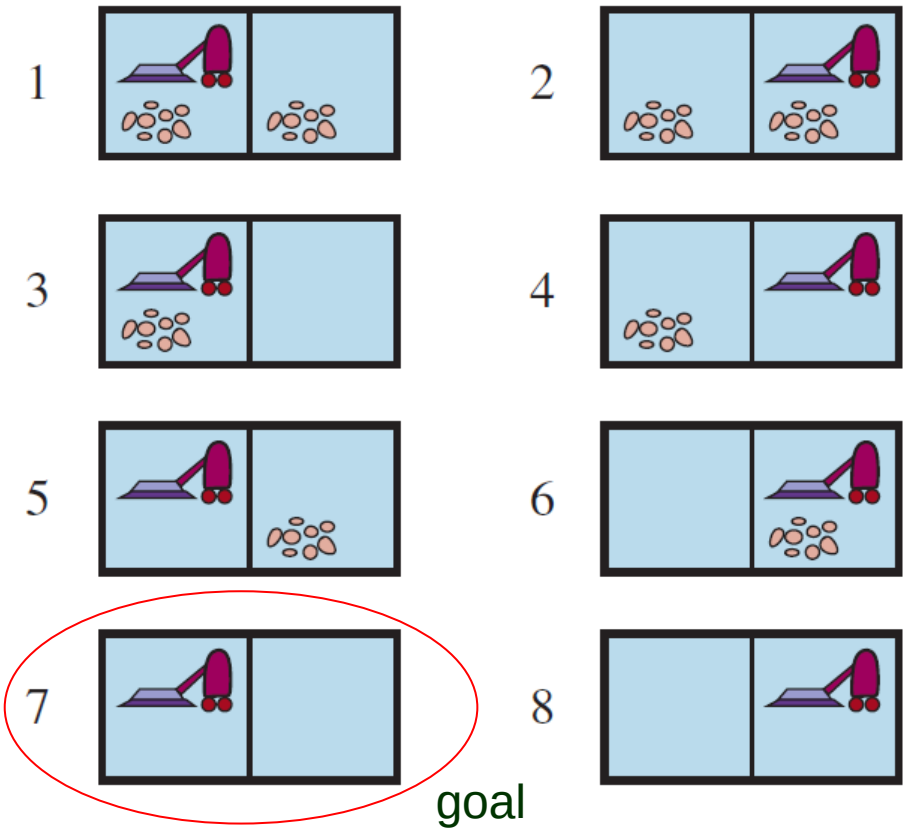

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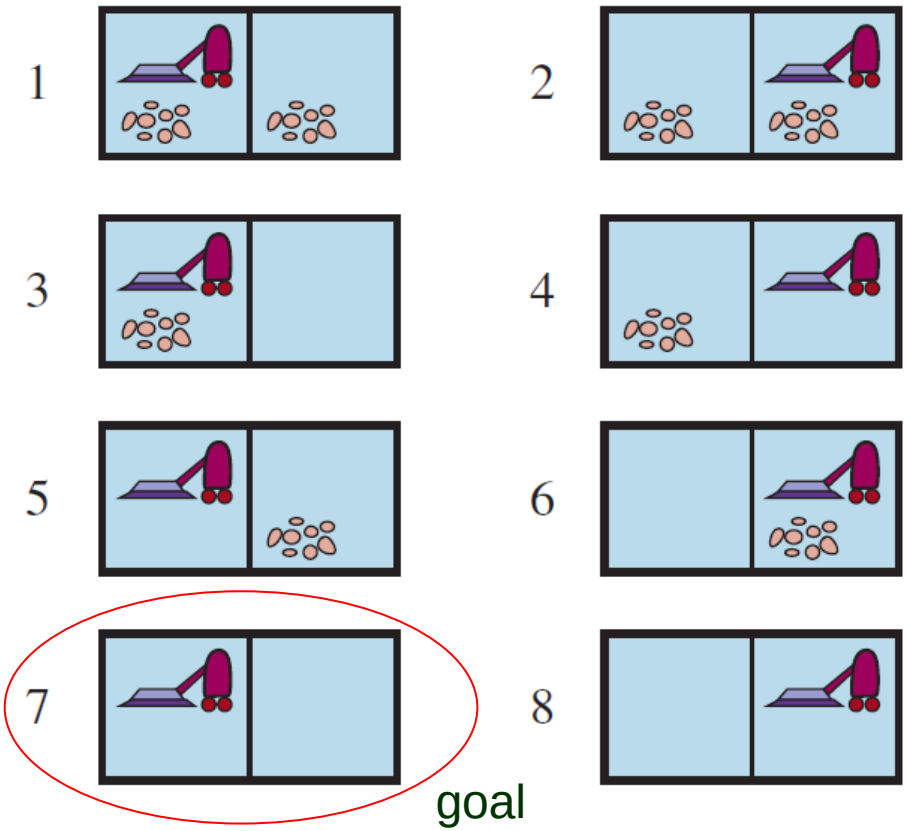

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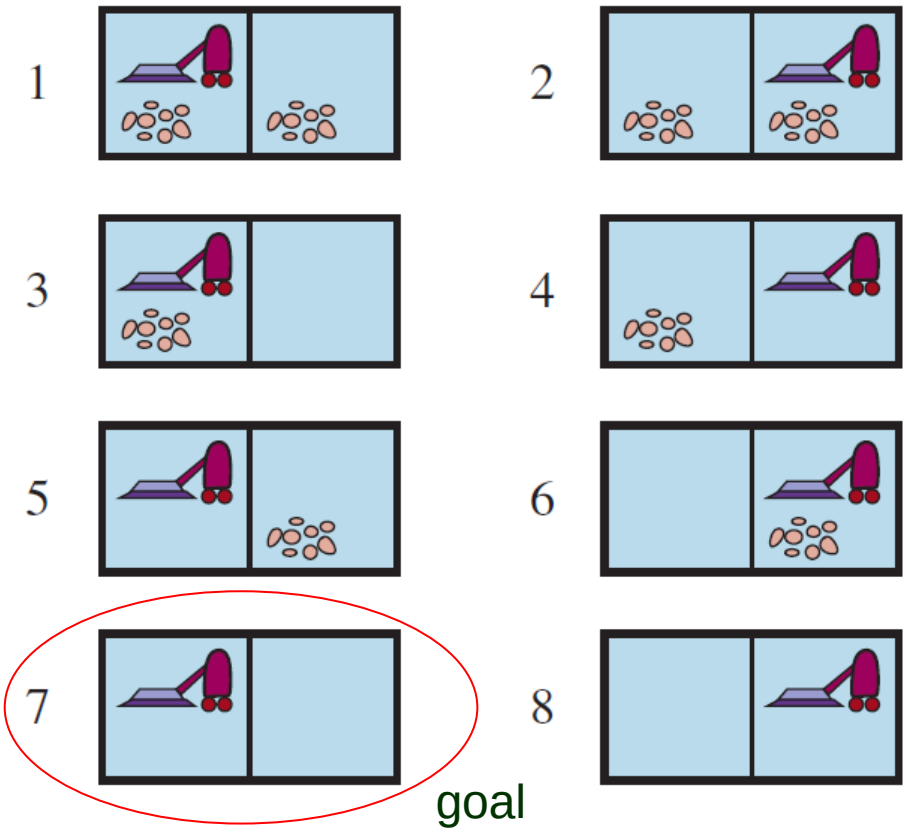

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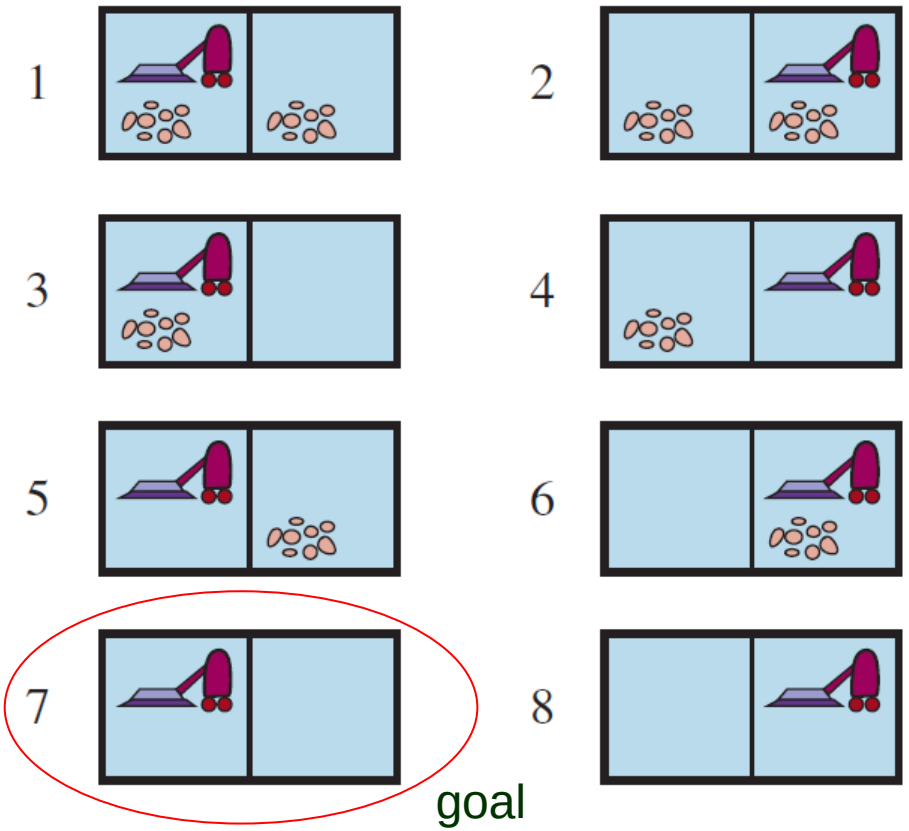

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Sensorless Manipulation - Tray Tilting

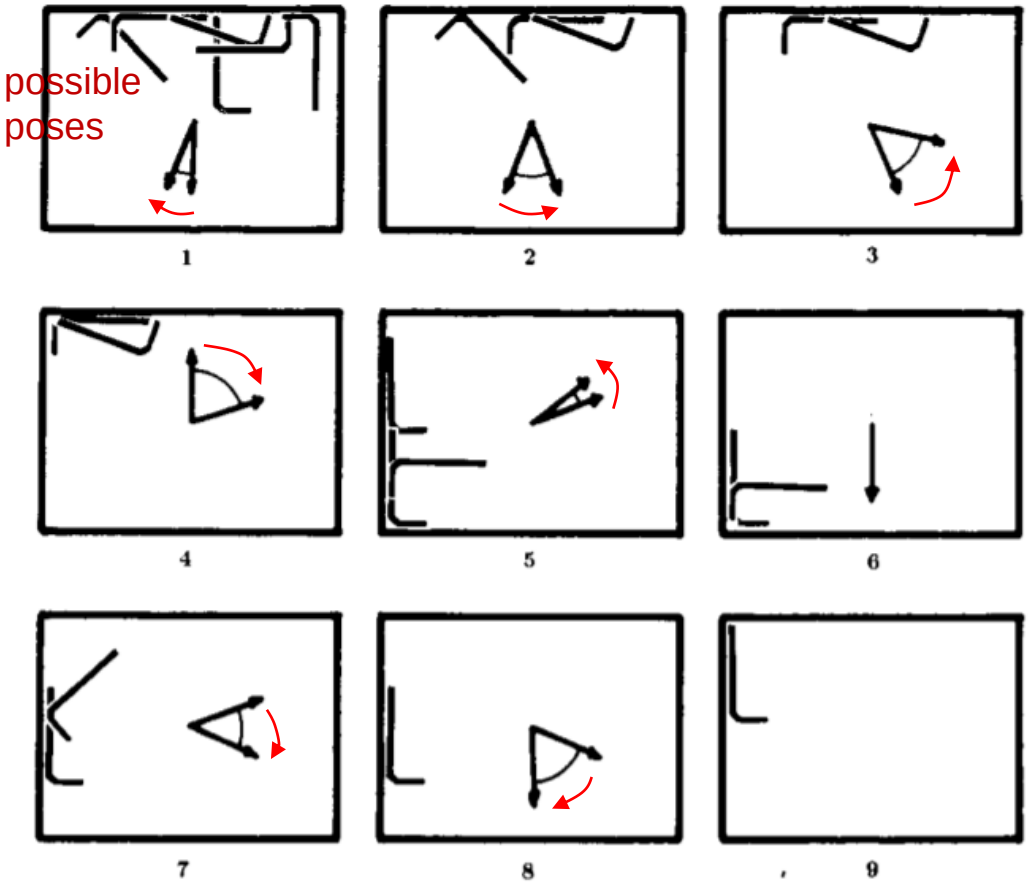

Fig. 2. Beginning at the upper left and moving from left to right, we can trace an automatically generated program that orients the wrench. Each frame shows the set of possible wrench contacts, and the operation to be applied. Each operation is represented by an interval of azimuths. The azimuth arrows indicate the tray's direction of steepest ascent; gravity acts in the opposite direction.

Erdmann & Mason (1988):

Orients the Allen wrench with eight tilts

- Slow planar motion
- Coulomb friction

IEEE Journal of Robotics and Automation, vol. 4, no. 4, pp. 369-379, 1988.

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Action on a physical state

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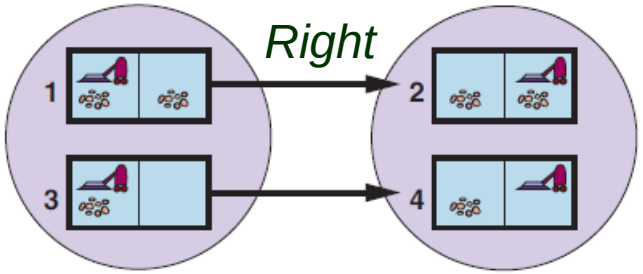

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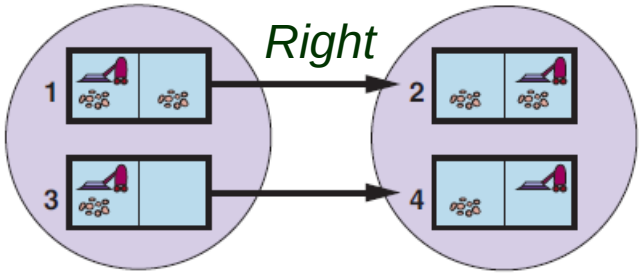

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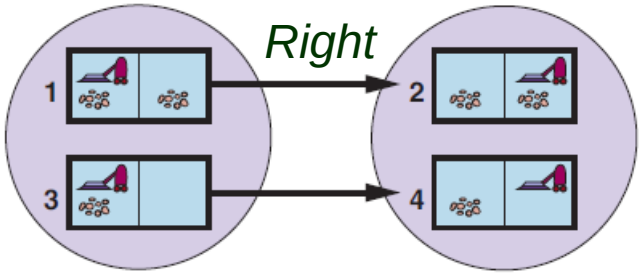

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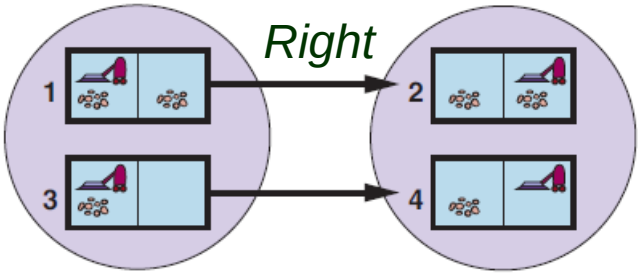

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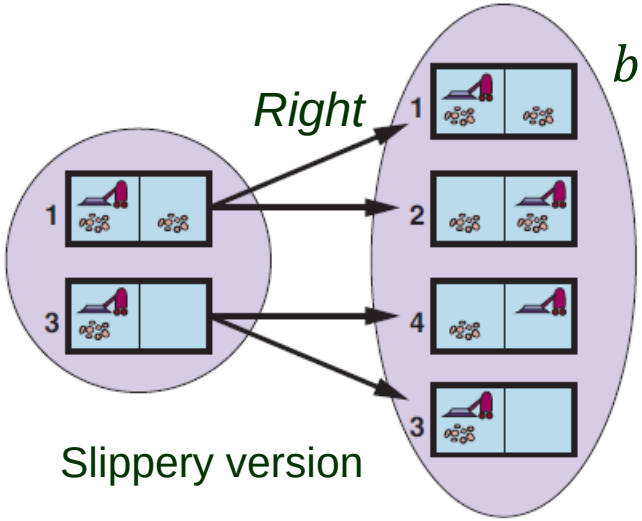

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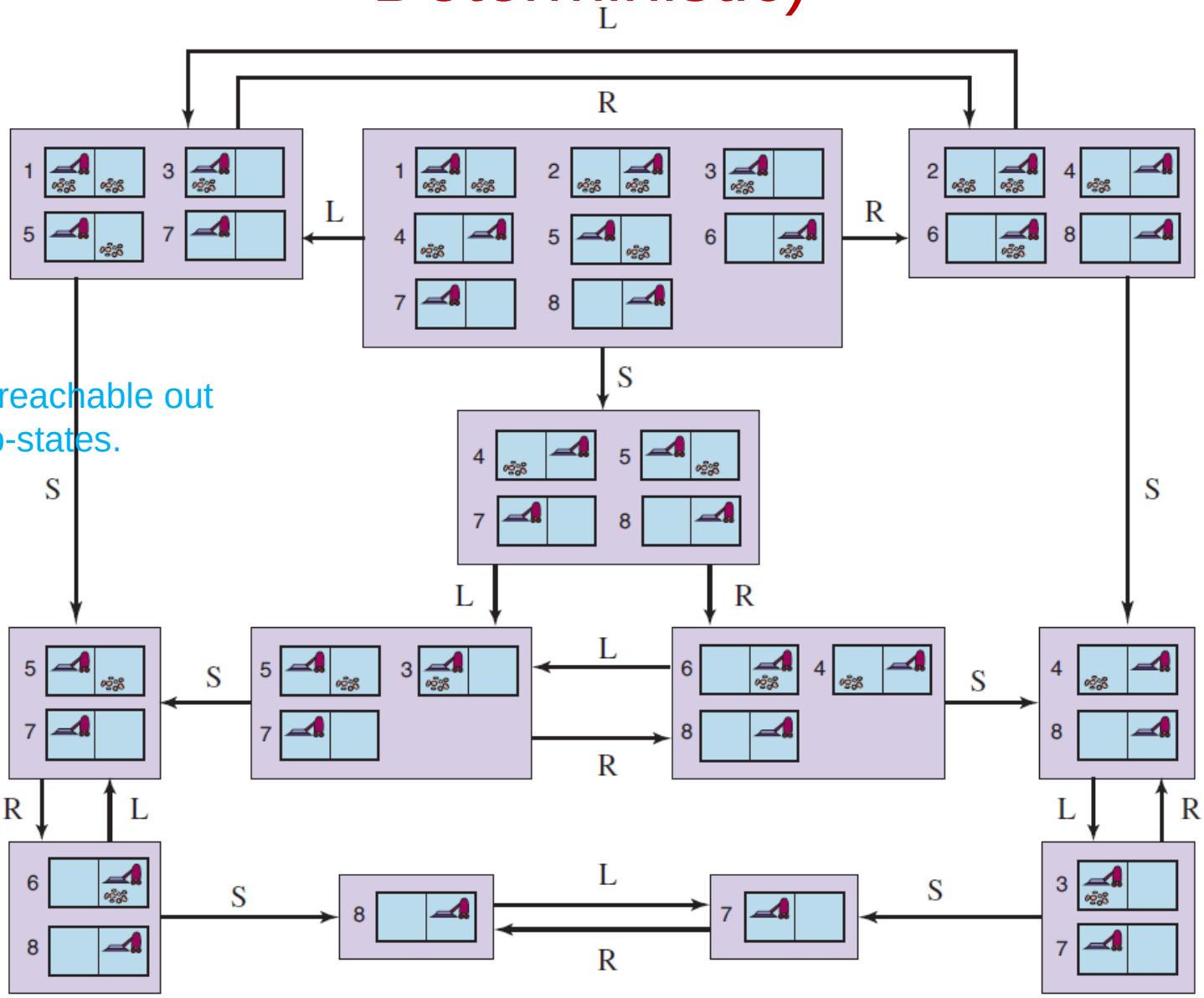
Goal & Cost of Action

- Goal test: The goal is achieved
  - ♣ *possibly* if one of the states $s \in b$ passes the test;
  - ♣ *necessarily* if every state $s \in b$ passes the test.

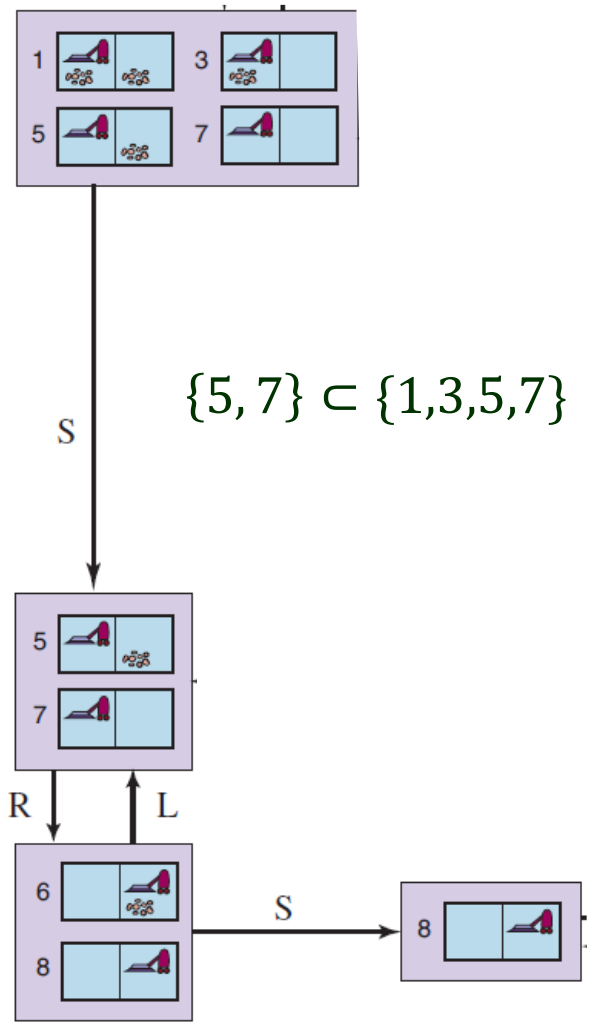
- Action cost: Could be one of several values if the same action has different costs in different states.

Reachable Belief States (Sensorless & Deterministic)

Only 12 are reachable out of 256= 2^8 b-states.



Subset and Superset States



$\{5, 7\} \subset \{1,3,5,7\}$

- Prune a superset b-state to concentrate on solving the easier subset b-state.
- Prune a subset b-state if a superset b-state has been found to be solvable already.

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Partially Observable Environments

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A little sensing (e.g., only one visible square in the 8-puzzle) can go a long way.

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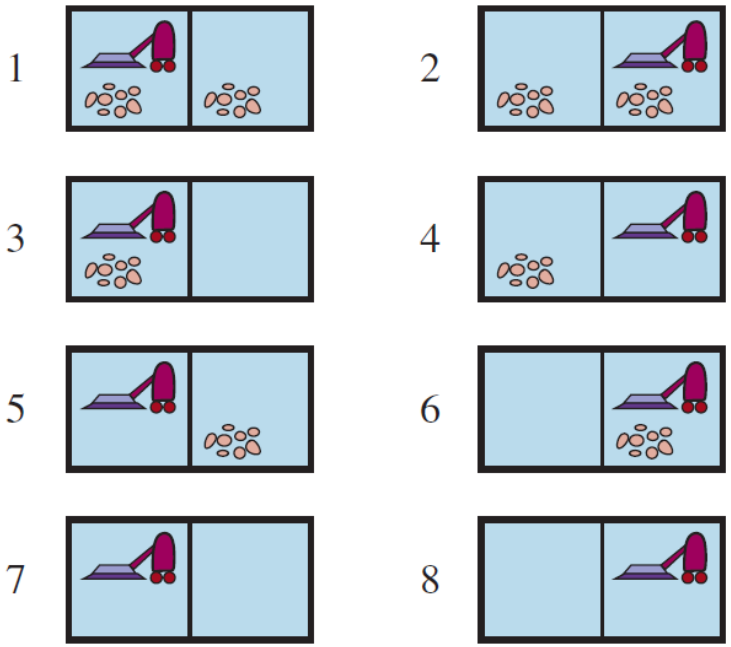

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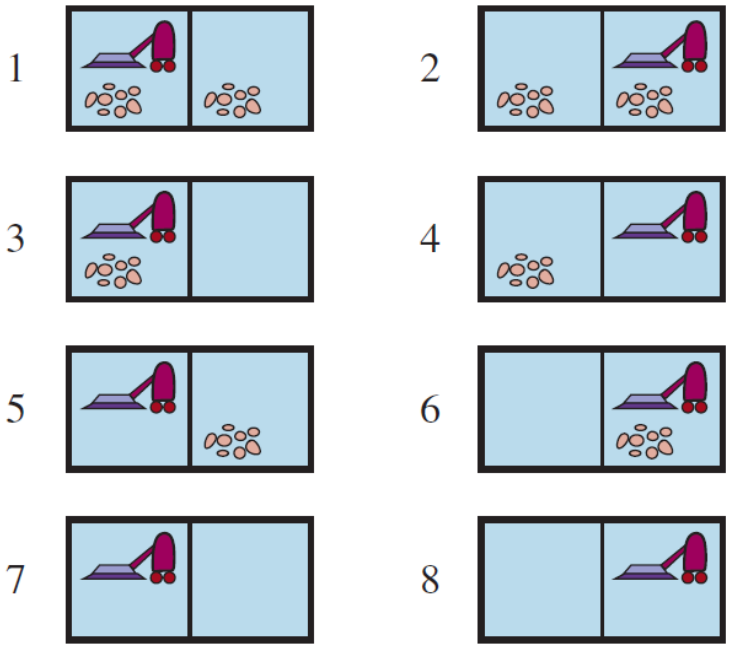

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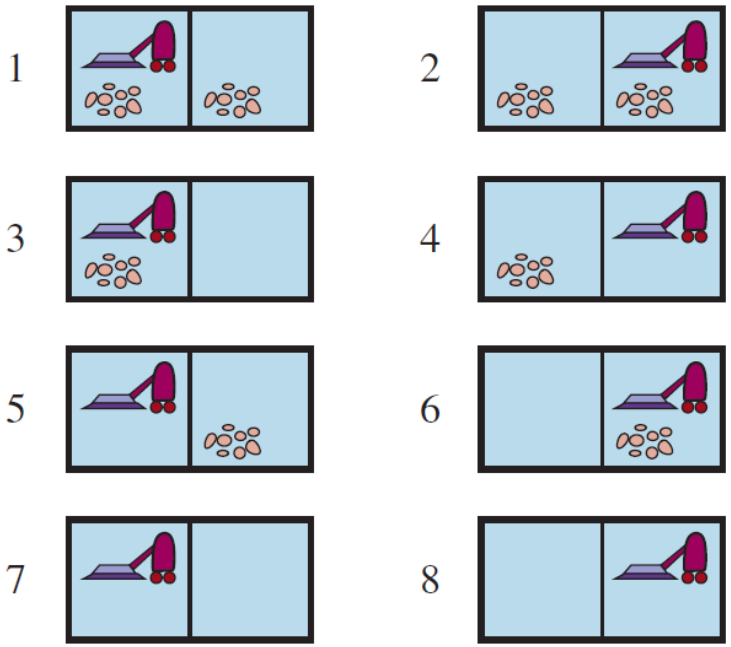

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$\{L, Dirty\} \longrightarrow$ b-state {1, 3}

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- Update: computes the set of states in $\hat{b}$ that could have produced the percept.

$$b_o = \text{UPDATE}(\hat{b}, o) = \{s \mid o = \text{PERCEPTS}(s) \text{ and } s \in \hat{b}\}$$

Possible B-states from an Action

$$\text{RESULTS}(b, a) = \{b_o \mid b_o = \text{UPDATE}(\text{PREDICT}(b, a), o) \text{ where}$$

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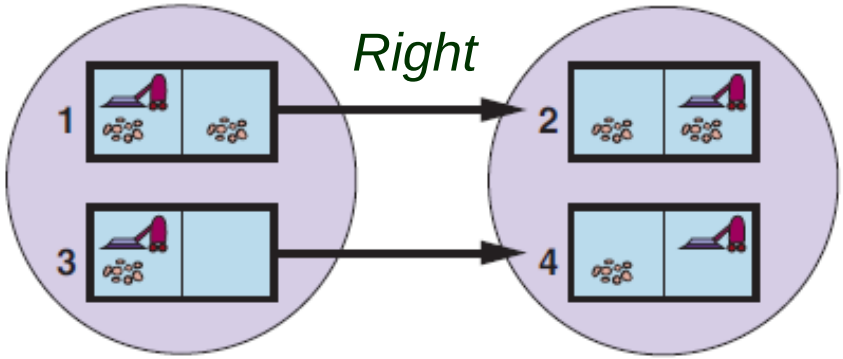

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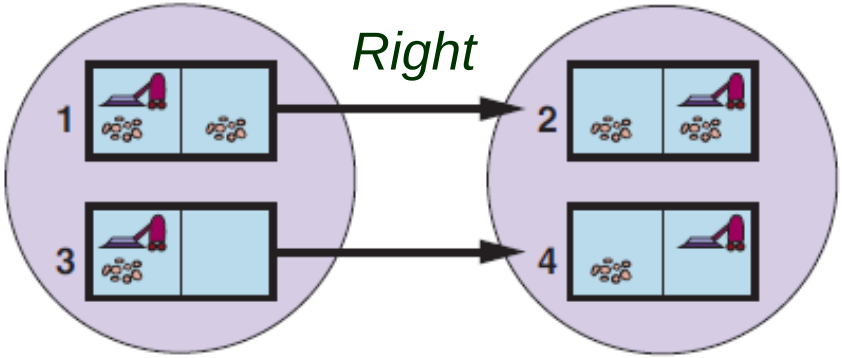

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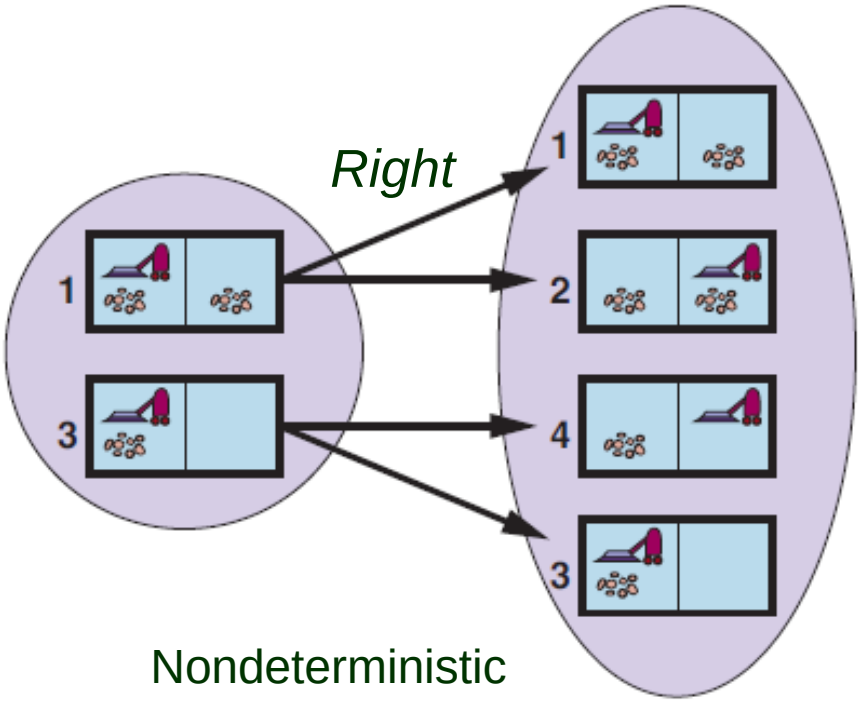
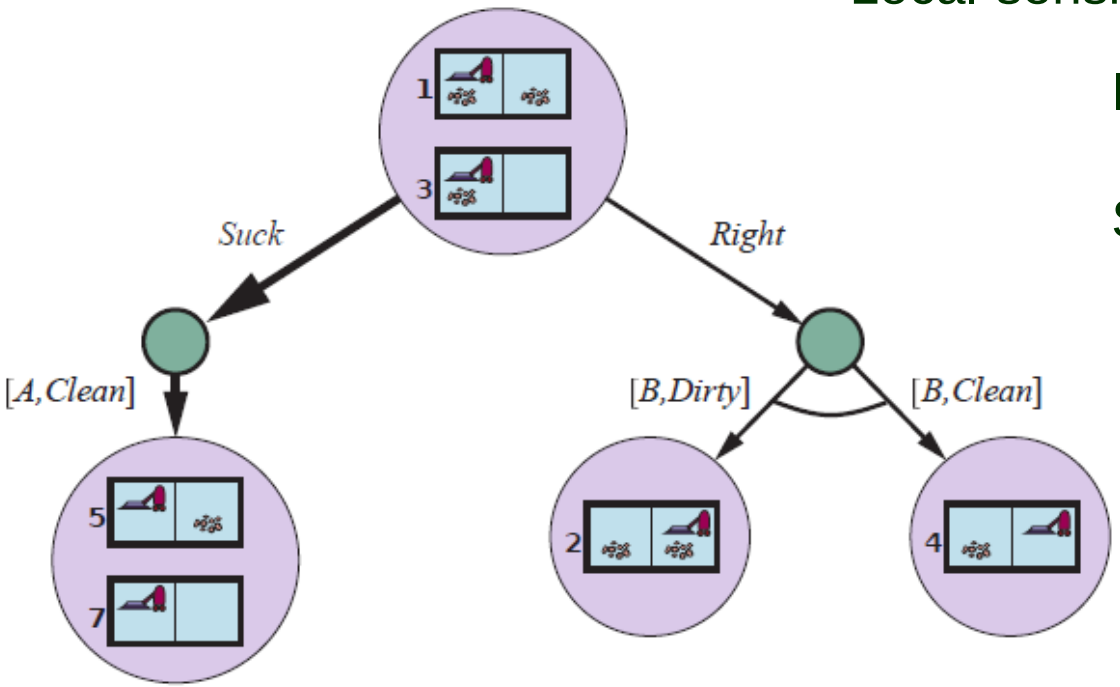


Nondeterministic
(local sensing + slippery world)

Solution with Partial Observation

Apply the AND-OR search algorithm.



...

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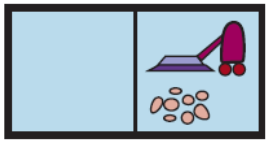
Initial percept: [*A*, *Dirty*]

Solution:

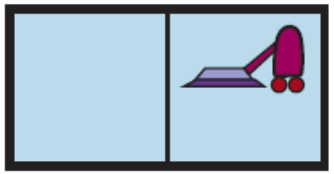
Suck, *Right*,
if b-state={6}
then *Suck*
else []

6



Goal:

8



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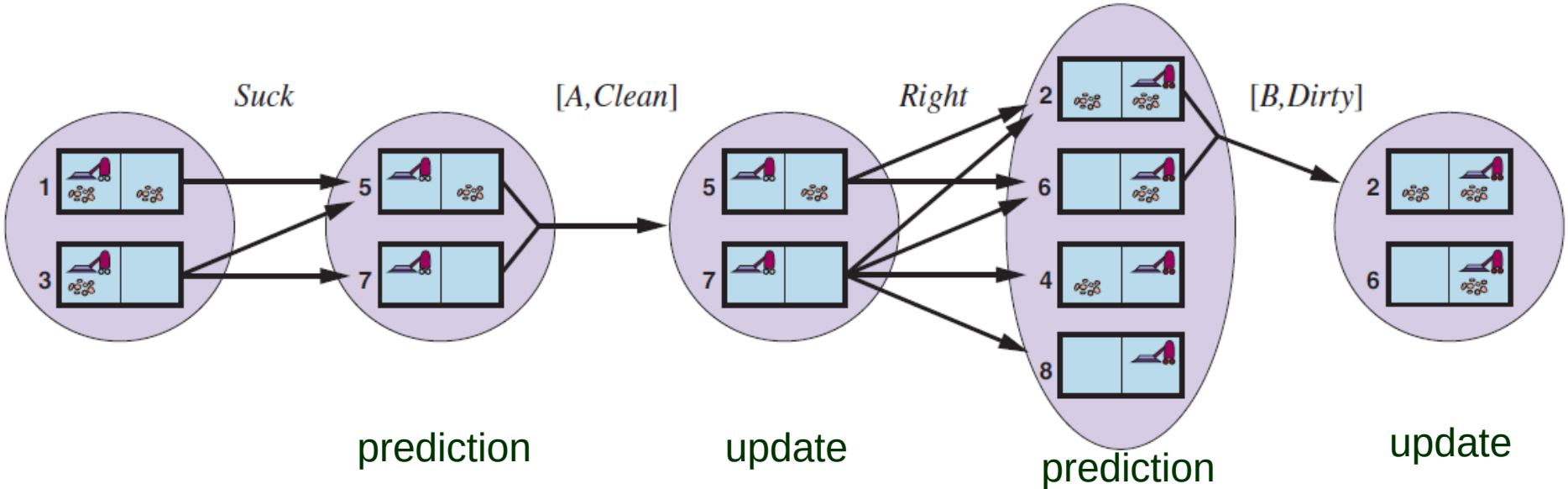

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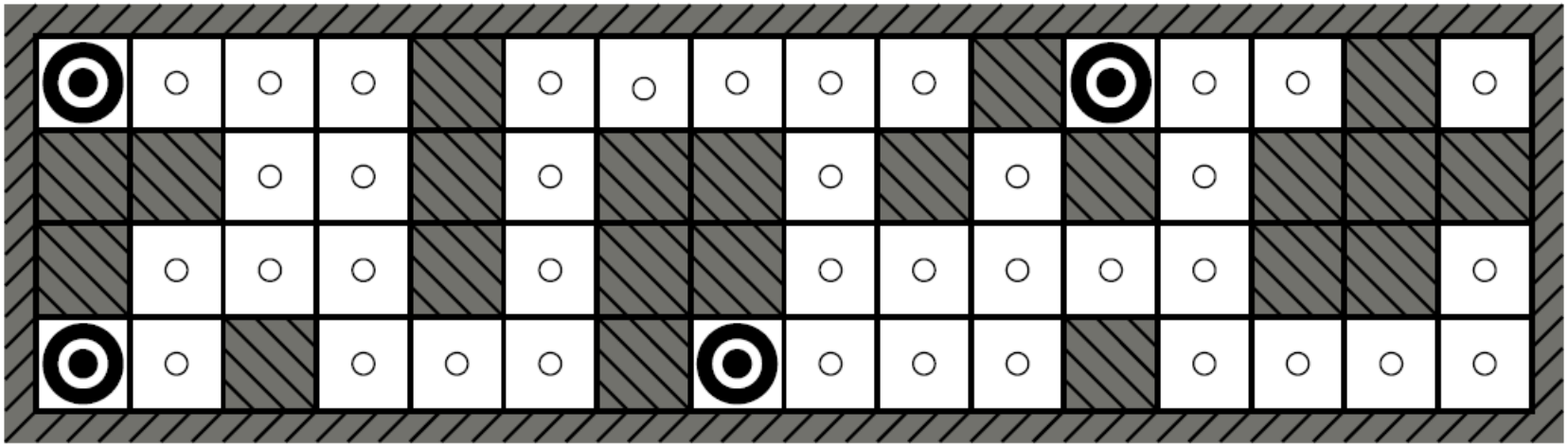


Robot Localization

Problem Use a map to determine where a robot is located with respect to its environment.

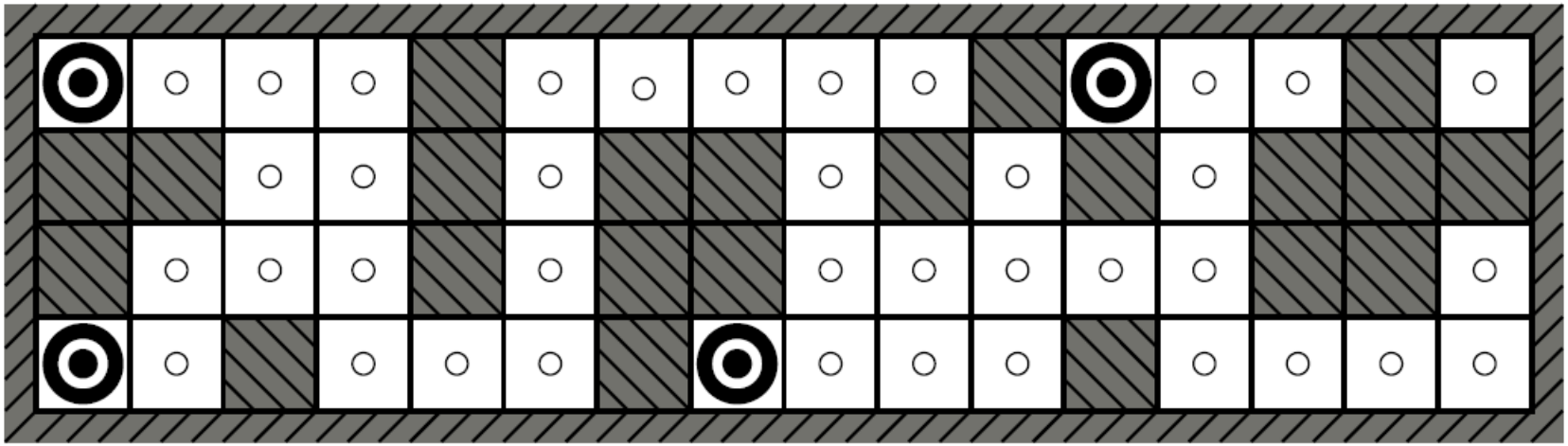
- Perfect sensing (by four sonar sensors)

Percept: 4 bits *NESW* (obstacle in the north, east, south, and west?)

b: set of all locations

⇩ *NESW* = 1011 (obstacles in *N*, *S*, *W*)

b_0 =Update$(b, 1011)$ // only four possible locations



Robot Localization

- Broken navigation: Action *Right* takes the robot randomly to one of the four adjacent squares.

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$\Downarrow$ *NESW* $= 1010$

b_1 =Update$(b_a, 1010)$

Robot Localization

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Next, the robot executes a *Right* action.

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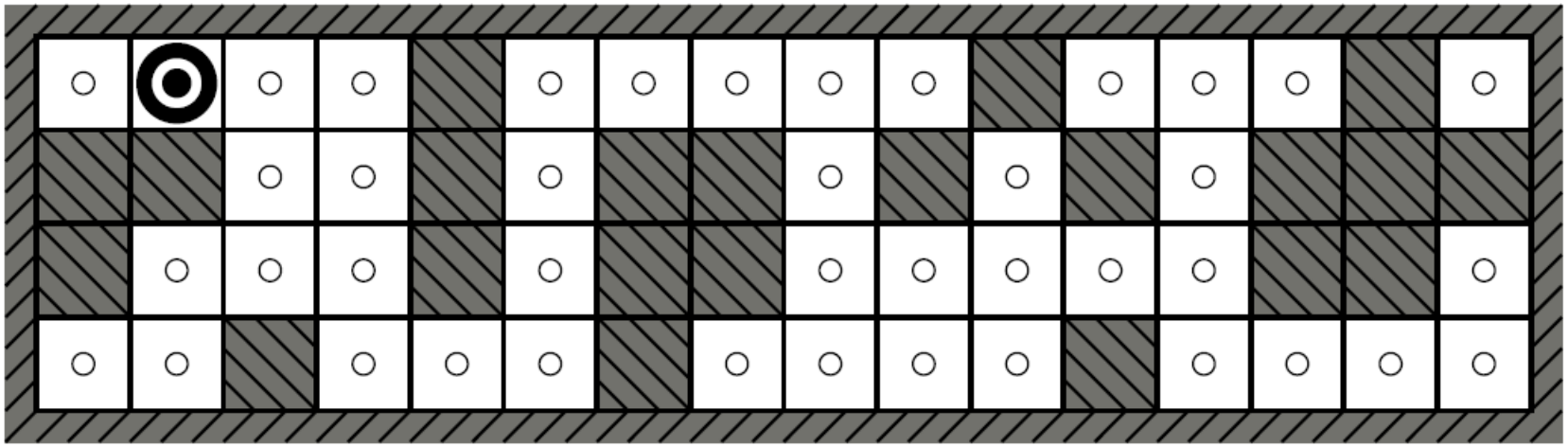
$\Downarrow$ $NESW = 1010$

b_1 =Update$(b_a, 1010)$ // One possible location!



Robot Localization

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