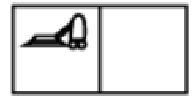
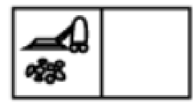
Show that the simple vacuum-cleaner agent function as described in lecture 1 is indeed rational.

It is sufficient to show that for all possible actual environments (i.e., all dirt distributions and initial locations), this agent cleans the squares at least as fast as any other agent.

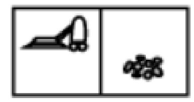
This is **trivially** true when there is no dirt.



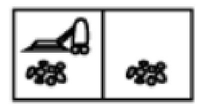
When there is dirt in the initial location and none in the other location, the world is clean after **one step**; no agent can do better.



When there is no dirt in the initial location but dirt in the other, the world is clean after **two steps**; no agent can do better.



When there is dirt in both locations, the world is clean after **three steps**; no agent can do better.



For each of the following assertions, say whether it is true or false and support your answer with examples or counterexamples where appropriate.

(a) An agent that senses only partial information about the state cannot be perfectly rational.
False.

The vacuum-cleaning agent from Section 2.2.1 is rational but doesn't observe the state of the square that is adjacent to it

(b) There exist task environments in which no pure reflex agent can behave rationally.
True.

The card game Concentration or Memory is one. Anything where memory is required to do well will thwart a reflex agent.

(c) There exists a task environment in which every agent is rational.

True.

Consider a task environment in which all actions (including no action) give the same, equal reward

(d) The input to an agent program is the same as the input to the agent function.
False.

The input to an agent function is the percept history. The input to an agent program is only the current percept; it is up to the agent program to record any relevant history needed to make actions.

(g) It is possible for a given agent to be perfectly rational in two distinct task environments.

True.

Consider two environments based on betting on the outcomes of a roll of two dice. In one environment, the dice are fair, in the other, the dice are biased to always give 3 and 4. The agent can bet on what the sum of the dice will be, with equal reward on all possible outcomes for guessing correctly. The agent that always bets on 7 will be rational in both cases.

(h) Every agent is rational in an unobservable environment.

False.

Built-in knowledge can give a rational agent in an unobservable environment. A vacuum-agent that cleans, moves, cleans moves would be rational, but one that never moves would not be.

For each of the following activities, give a PEAS description of the task environment and characterize it in terms of the properties listed in Section 2.3.2

• Playing soccer. لعب كرة القدم

P- Win/Lose

E- Soccer field

A- Legs, Head, Upper body

S- Eyes, Ears.

partially observable, multiagent, stochastic, sequential, dynamic, continuous, unknown 1

• Shopping for used AI books on the Internet.

P- Cost of book, quality/relevance/correct edition

E- Internet's used book shops

A- key entry, cursor

S- website interfaces, browser.

partially observable, multiagent, stochastic, sequential, dynamic, continuous, unknown

• Playing a tennis match.

P- Win/Lose

E- Tennis court

A- Tennis racquet, Legs

S- Eyes, Ears.

partially observable, multiagent, stochastic, sequential, dynamic, continuous, unknown

• Knitting a sweater. حياكة سترة

P- Quality of resulting sweater

E- Rocking chair كرسي هزاز

A- Hands, Needles

S- Eyes.

observable, single agent, stochastic, sequential, dynamic, continuous, unknown

• Bidding on an item at an auction. المزايدة على عنصر في مزاد

P- Item acquired, Final price paid for item

E- Auction House (or online)

A- Bidding

S- Eyes, Ears.

Partially observable, multiagent, stochastic (tie-breaking for two simultaneous bids), episodic, dynamic, continuous, known

Give the initial state, goal test, successor function, and cost function for each of the following. Choose a formulation that is precise enough to be implemented.

You have to color a planar map using only 4 colors, in such a way that no two adjacent regions have the same color.

Initial state: No regions colored.
Goal test: All regions colored, and no two adjacent regions have the same color.
Successor function: Assign a color to a region.
Cost function: Number of assignments.

A 3-foot-tall monkey is in a room where some bananas are suspended from the 8-foot ceiling. He would like to get the bananas. The room contains 2 stackable, movable, climbable 3-foot-high crates.

Initial state: Same as problem definition.
Goal test: Monkey has bananas.
Successor function: Hop on crate قفص ; Hop off crate; Push crate from one spot to another; Walk from one spot to another; Grab bananas (if standing on crate).
Cost function: Number of actions.

You have 3 jugs, measuring 12 gallons, 8 gallons, and 3 gallons, and a water faucet. You can fill the jugs up or empty them out from one to another or onto the ground. You need to measure out exactly one gallon.

Initial state: jugs إبريق have values [0, 0, 0]
Goal test: jugs have values [i, j, k], where one of i, j, k is 1.
Successor function: given values [x, y, z], generate [12, y, z], [x, 8, z], [x, y, 3] (by filling);
[0, y, z], [x, 0, z], [x, y, 0] (by emptying);
Cost function: Number of actions.

The missionaries and cannibal's problem are as follows. Three missionaries and three cannibals are on one side of a river, along with a boat. The boat can hold one or two people (and obviously cannot be paddled to the other side of the river with zero people in it). The goal is to get everyone to the other side, without ever leaving a group of missionaries outnumbered by cannibals. Your task is to formulate this as a search problem.

(a) Define a state representation.

missionaries => M

cannibals => C,

boat => B.

Each state can be represented by the items on each side,

e.g. S1{M, M, C, C}, S2{M, C, B}.

(b) Give the initial and goal states in this representation.

Initial state: S1{M, M, M, C, C, C, B}, S2{}

Goal state: S1{}, S2{M, M, M, C, C, C, B}

(c) Define the successor function in this representation.

A set of missionaries and/or cannibals (call them Move) can be moved from Side a to Side b if:

- The boat is on Side a.
- The set Move consists of 1 or 2 people that are on Side a.
- # missionaries in the set formed by subtracting Move from Side a = 0 OR >= # cannibals.
- # missionaries in the set formed by adding Move to Side b = 0 OR >= # cannibals.

(d) What is the cost function in your successor function? .

Each move has unit cost.

(e) What is the total number of reachable states?

S1{M, M, M, C, C, C, B},	S2{}
S1{},	S2{M, M, M, C, C, C, B}
S1{M, M, M, C, C, B},	S2{C}
S1{M, M, M, C, C},	S2{C, B}
S1{M, M, M, C, B},	S2{C, C}
S1{M, M, M, C},	S2{C, C, B}
S1{M, M, C, C, B},	S2{M, C}
S1{M, M, C, C},	S2{M, C, B}
S1{M, C, B},	S2{M, M, C, C}
S1{M, C},	S2{M, M, C, C, B}
S1{C, C, C, B},	S2{M, M, M}
S1{C},	S2{M, M, M, C, C, B}
S1{C, C, B},	S2{M, M, M, C}
S1{C, C, B},	S2{M, M, M, C}
S1{M, M, M},	S2{C, C, C, B}
S1{C, B},	S2{M, M, M, C, C}

The last one is only reachable through the goal state, but it is still technically reachable

(e.g. if you are just exploring the state space instead of searching for a goal).

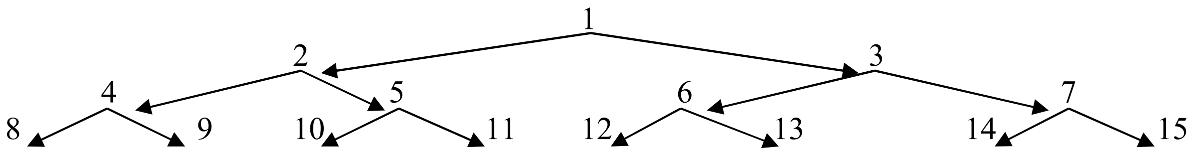
These two are not reachable because the preceding state must have had more cannibals than missionaries on one side of the river:

S1{C, C, C}, S2{M, M, M, B}

S1{M, M, M, B}, S2{C, C, C}

Consider a state space where the start state is the number 1 and each state k has two successors: numbers 2k and 2k+1.

a. Draw the portion of the state space for states 1 to 15.



b. Suppose the goal state is 11.
List the order in which nodes will be visited for breadth-first search, depth-limited search with limit 3, and iterative deepening search.

Breadth-first: 1 2 3 4 5 6 7 8 9 10 11

Depth-limited: 1 2 4 8 9 5 10 11