MI Sheet 1 Sol. (Part 1)

2.3)

a. An agent that senses only Partial info about the State cannot be Perfectly rational.

False, the definition of a rational agent only requires that expected utility is maximized given the Percept Sequence and the Prior Knowledge that the agent has.
(it does not constrain or restrict the Percepts themselves and whether they capture the full State of the environment)

b. There exist task environments in which no Pure reflex agent can behave naturally (Pure reflex means it can only use current Percepts — no memory)

True. We know that a Pure reflex agent would only be rational in a fully-observable environment. Hence, any Partially observable environment is a counter example:

Ex. 1) Task environment where

P E A S → Current location only

P → room cleanliness, energy

E → dirty room

A → it can move left or right or suck

S → A B

→ at anytime step, it would never know whether it should clean or move to the other cell; optimal behavior can't be guaranteed.

Ex. 2)

- Consider Chess Played via chat only (CorresPondence Chess)

P	E	A	S
whether it wins	Chess board	move a Piece validly	only the enemy's last move (e.g. 'a4' = move Pawn to a4)

→ In this case such agent's behavior maps each opponent move to it's next move.

- This means that regardless to the state of the board, it will make the same move 'Y' when the enemy has made move X. However, given any move 'X' by enemy there's no optimal move 'Y' that would work whatever was the state of the game.
→ it follows that the agent is hence not rational.

C. There exists a task environment in which every agent is rational.

True, in this case it must be that all actions contribute with the same improvement towards (P) all the time.
→ e.g., Consider if there's only one state (all actions must then lead to it)
→ e.g., Consider if there's only one action

→ Here we take P to be "maximizing a reward func. that's a function of State"

- Notice also that if the agent's reward doesn't depend on any ~~order of actions~~ specific sequence of actions (all possible sequences grant same reward) then such env. satisfies the property as well.

d. The input to the agent function is the same as the input to the agent program

False, Agent function
- Takes entire percept sequence each t_{step}

Agent program
- Takes only current percept (live state of the environ.)

→ it has memory to store previous ones so it can pass the entire sequence to the agent function.

e. every agent is implementable by some program / machine combination.

False, Consider an agent function that given a program decides whether it will halt or run forever

(Program at this current step is enough since diff. programs are independent)

- let's prove by contradiction that no program implements such agent function.

→ Suppose such program existed (call it X)

→ Then there's another program Y for which X can never classify correctly. (Concludes the proof)

Proof:

let Y be a program that

→ takes a program as input

→ feeds to an inner module that is 'X'

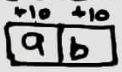
→ if X says the input program runs forever then Y halts and if it says that it halts then Y decides to run forever.

- In this case, if we input to 'Y' its own program then X will always be wrong.

→ Hence, such X cannot exist. □

f. Suppose an agent selects its action uniformly at random from the set of possible actions. There exists a task environment in which the agent is rational

. True, we've proven in C that there are task env. where every agent is rational (use multiple actions example)

e.g. 

g. It's possible for an agent to be perfectly rational in two distinct task environments

. True, consider task environment 'X' with the environment being a maze. Let 'A' be a rational agent.

→ Then, if we let 'Y' be another task environment such that it only differs from 'X' in the unreachable parts of the maze environment, it must be that 'A' is rational w.r.t 'Y' as well.
(the optimal mapping from state to action - policy - does not change)

h. Every agent is rational in an observable environ.

False

→ Such agent has no percepts and can only take actions

→ the agent may or may not take actions that maximize the expected utility given its prior knowledge of the environment.

e.g.,

P E A S

P ↓ whether it hit the front wall

E ↓  room (known)

A ↓ up, down, NoP

S ↓ none

. An agent that always goes down or does nothing is not rational.

i) A Perfectly rational Card-Playing agent never loses

False, the game involves uncertainty (dice rolls, opponent's cards). We can only hope that it doesn't lose on average (expected value of losses ≤ 0)

2.4.

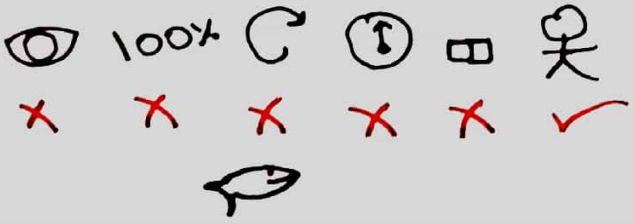
// Many of these can be argued either way (answers aren't cut & dried)

1. Playing Soccer

P	E	A	S
score, winning	ball, court, goals, other players	robot body (arms, legs, ...)	camera, IR sensor, location, ...

2. Exploring the subsurface oceans of Titan

P	E	A	S
energy, areas explored	ocean water, fish, coral reef, ..	robot body (robotic arm, fins, ..)	camera, IR sensor, location (GPS), ...



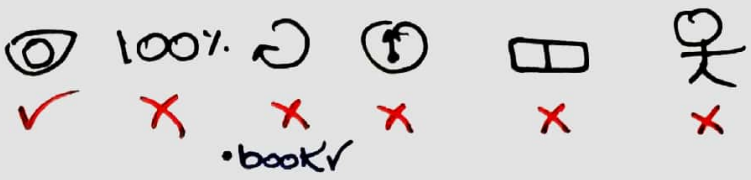
3. Shopping online

P	E	A	S
Price, Quality, relevance	websites, vendors, shippers	display to user, follow URL, fill form	HTML pages

- assume prices don't change & items don't run out of stock (☹, ☹) also no pages crashing (100%)

4. Playing Tennis

P	E	A	S
Score, Winning	other Player, Court, ball	robot body (arms, legs,..)	location of each Player, ball (GPS), Camera, IR,..

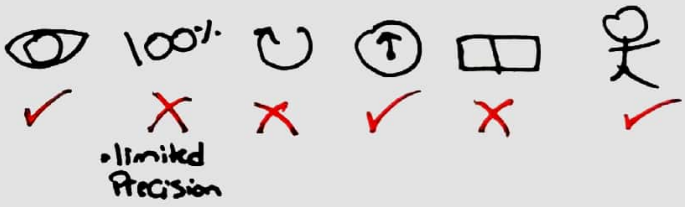


5. Playing Tennis against Wall

- No need to track other Player (Wall is const.)
- becomes Single agent

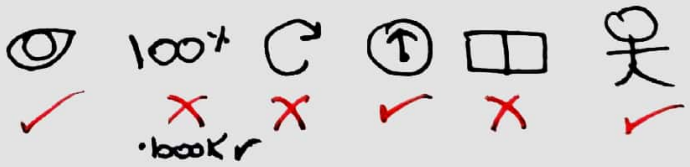
6. Performing a high Jump

P	E	A	S
height of Jump	Court, air	Legs, rest of robot body	altimeter, barometer



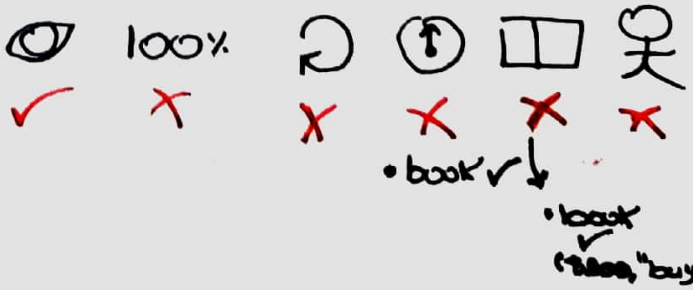
7. Knitting a Sweater

P	E	A	S
Speed, Wellness	Knitting needles, Knitting Yarns	hands	Camera, IR Sensor, ..



8. Bidding on an Item in auction

P	E	A	S
#items, cost	items, other bidders, auctioneer	mouth (Stickers), hands	Camera, microphone



2.10)

→ Consider a modified version of the vacuum environment where the agent is penalized for each movement.

a) Can a simple reflex agent be perfectly rational for this environment.

→ NO

→ Any simple reflex agent would process the current percept and either clean or move when it decides to move it is risking a penalty because the other □ might be already clean and it has not made use of its percept sequence to check.

→ In other words, its not a rational because there exists another agent that maximizes the performance measure given the same actions, percept sequence and built in knowledge

- That agent is in particular that one which makes use of the last percept to know whether the other □ is clean or not.

b) What about a reflex agent with state? Design such agent.

→ yes, as described in (a)

→ We would modify the agent function so that if the previous state had [A, Clean] and the current state has [B, Clean] (or vice versa) A↔B then the agent would do nothing.

→ Otherwise, it follows the 3 rules as usual

c) How does your answer to (a), (b) change if the agent's Percepts give it clean/dirty status for each □

a) Yes, the environment now is fully observ. as no part of the world state that can help the agent maximize the Performance metric is unknown in the agents Percept
→ This means that the current Percept is sufficient for rationality.

- In other words, there's no agent that can perform better than one that
  → sucks current square if dirty
  → does nothing if both are clean
  → goes to the other square if it's dirty and current is clean.

b) Yes, an agent that stores the previous Percepts and follows the algo. above (that doesn't use them) would still be rational.
→ If we insist to use memory we can model this as a search problem with there being 8 nodes for the 8 states in a graph and the goal is to go from the given initial state (root node) (e.g., [A, dirty, dirty] to the goal states [A, clean, clean] or [B, clean, clean].
- In this case storing the path the search algo gives would be better than calling it everytime/step.

* The search algo would solve the problem in a more general way (w.r.t env. size) as well.

2.11) Consider a modified version of the vacuum environment where

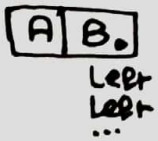
→ The geography (extend, boundaries and obstacles) are unknown

→ Initial dirt configuration is unknow

→ Agent can go LEFT, RIGHT, UP, DOWN

a) Can a simple reflex agent be Perfectly rational for this environment?

- Because its simple reflex, it can never learn the environment's geography and thus is not guaranteed to explore the whole map unless it randomizes.
  That is, location would have no meaning and the agent has to decide what to do based on status, it is prone to getting stuck forever for any specific action it chooses when Status = 'CLEAN'
  → In this case the answer is no.

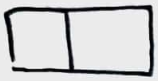


agent design for next Problem

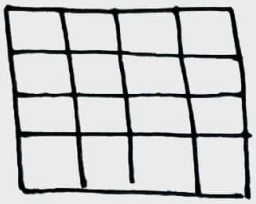
- Meanwhile, if the agent chooses a random action whenever Status = 'CLEAN' then we can be certain that after a very long time the agent will have eventually explored the whole map (hence cleaned it all)

Is it rational though?

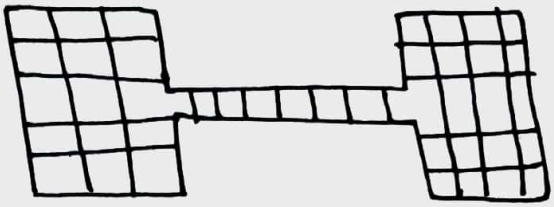
b) Yes, it solves the getting stuck problem as we have shown (has higher probability of cleaning the entire environment)



- Very simple environment (Probability of cleaning in a short time is high)



- Will take some more time to completely clean

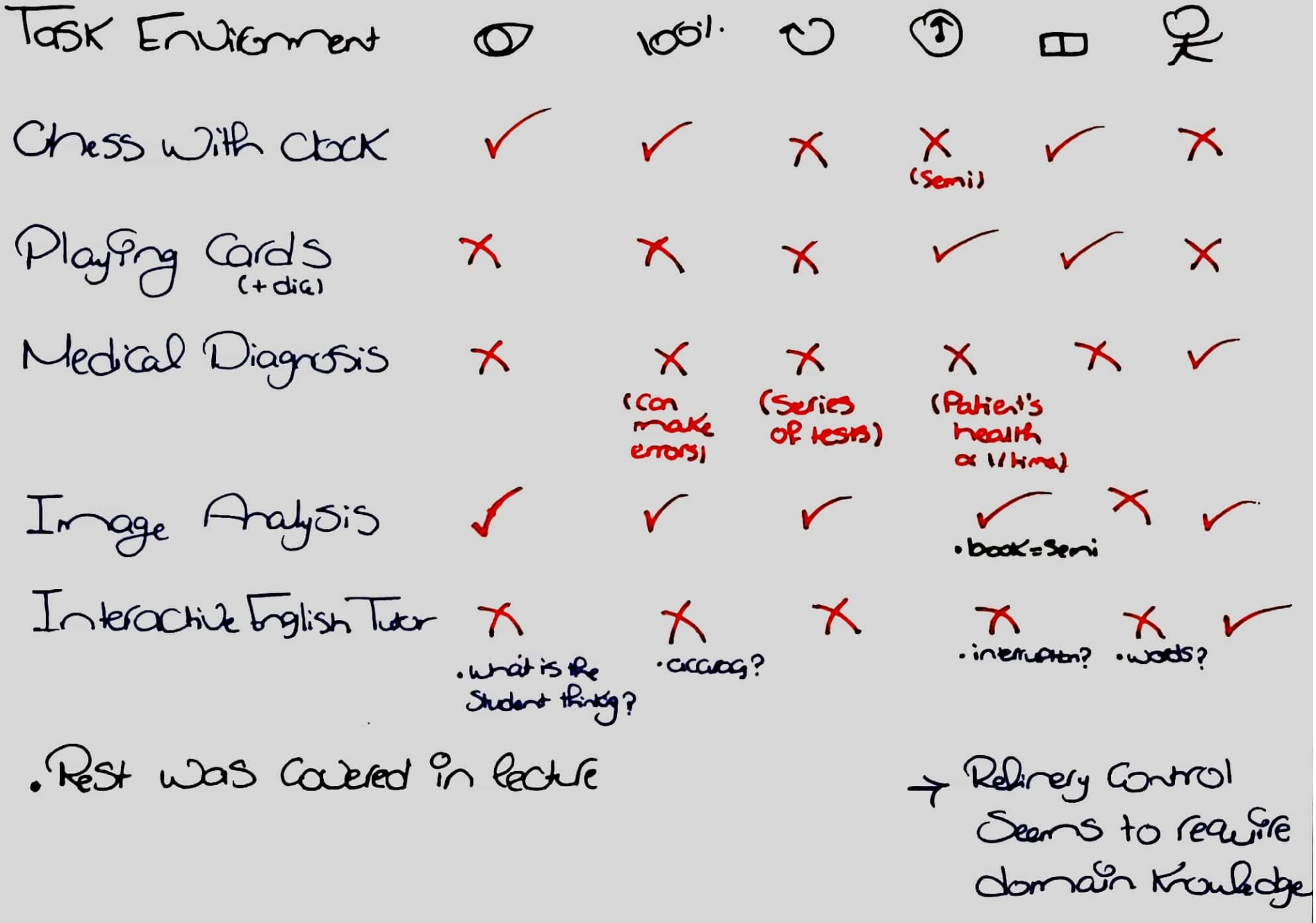


- Can take too long to completely clean (because it takes too many random actions to exit the corridor and get to the other side, not to mention entering it is not a high prob. event)

c) We've done that in (b) (any environment with tiny long connecting passages)

d) Definitely yes. Such agent would be able to build a map of the environment by recording the locations it visits. So it has a way to avoid going to locations it already cleaned (hence making a better agent) ☺

→ Designing such rational agent (and thus 'agent') is possible (perhaps under assumptions on the environment) and providing such design will perhaps be easier once we cover the relevant chapters (online search, reinforcement learning). ☺


Task Environment
Chess with clock
(Semi)
Playing Cards
(+ dice)
Medical Diagnosis
(Can make errors)
(Series of tests)
(Patient's health at a time)
Image Analysis
• book = Semi
Interactive English Tutor
• what is the student thinking?
• accuracy?
• intention?
• words?
• Rest was covered in lecture
→ Refinery Control Seems to require domain knowledge