Artificial & Computational Intelligence

AIML CLZG557

M1 : Introduction
&
M2 : Problem Solving Agent using Search

Indumathi V

Guest Faculty,

BITS - WILP

BITS Pilani

Pilani Campus

Course Plan

M1	Introduction to AI
M2	Problem Solving Agent using Search
M3	Game Playing
M4	Knowledge Representation using Logics
M5	Probabilistic Representation and Reasoning
M6	Reasoning over time
M7	Ethics in AI

Traveller's Problem

S_1 : No data

$\boxed{P_1 \ P_2}$ → Utility < {Penalty, Reward & Performance me} ⇒ □ → Utility

KB: fl, WP, RR — P_1, P_2, P_3, P_4

T_2

T_1 — T_{1000}

Exploration

$\boxed{P_1, P_2, P_3, P_4}$ ⇓

T_{1001} $\boxed{P_2 \rightarrow}$ best

Traveller's Problem

S_2

$P_1 \boxed{P_2} P_3 P_4$

$3 \rightarrow \boxed{P_1 P_3 P_4}$

$\boxed{P_3}$

P_1 $\boxed{P_2}$ P_3 P_4

lev.

$\boxed{P_2 \rightarrow 0.01}$

Traveller's Problem

Exploration → learning from unknown envi

Exploitation → optimize the

Learning

Traveller's Problem

$S_3 \rightarrow$ weather condition
$\downarrow$
$A_1 \rightarrow$ car speed
$A_2 \rightarrow$

rational logic

innovate achieve lead

4 com

D1 D2 D3 D4 D5
R R R R R

Weather condn → observed even
Road condn → un " "
HMM

S_4 :: time orien

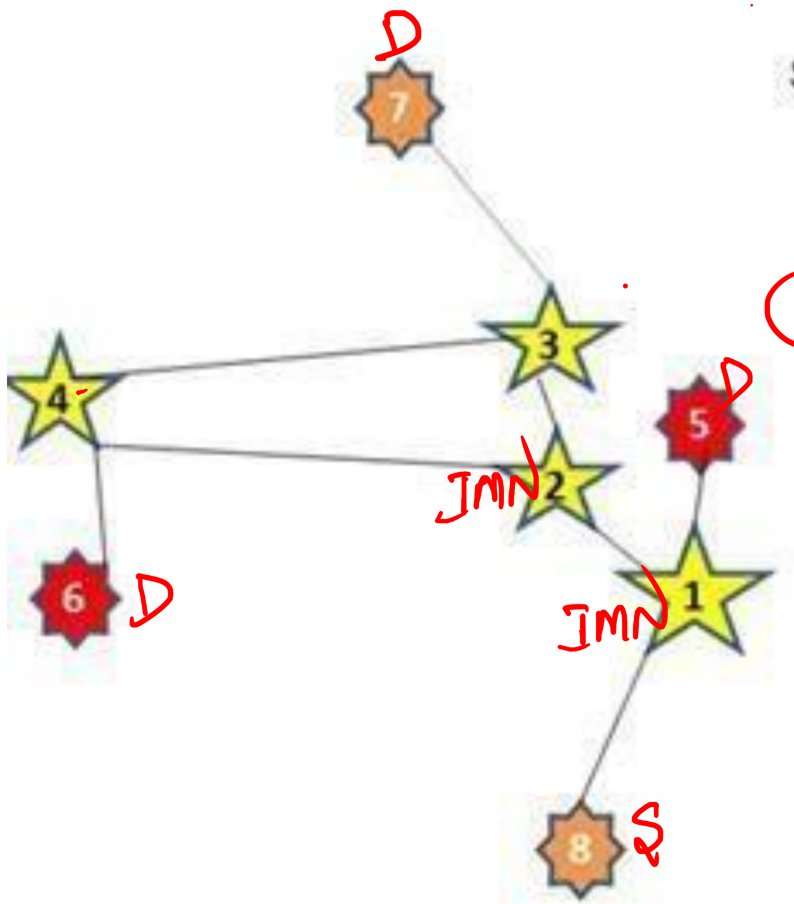
D_1	D_1	- - - -	D_2	D
R_1	R_2	- - - -	R_5	R
Sunny	S	- - - -	Ra	R

D_2
R_{15}
Rainy

Road condn?
$\downarrow$
can't observe dir.

4 consedn

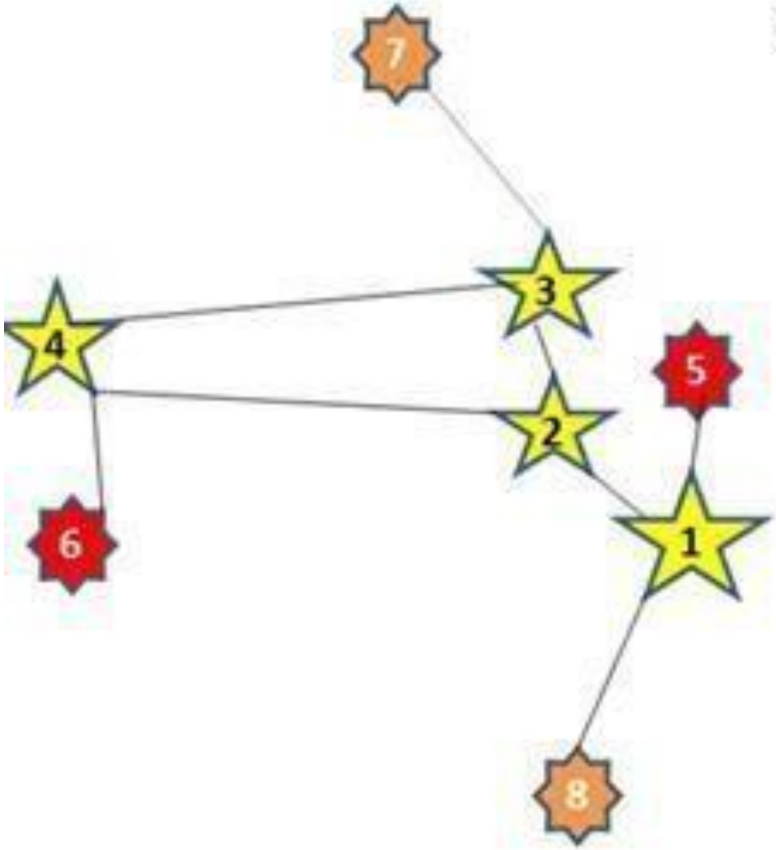
Traveller's Problem



Sensors → Environment → Actuators

1. Sketch the problem — objective
2. Searching Technique
3. Path Finding — $P_1 P_2 P_3 P_4$
4. Derive Solution/s — Exploration P_2
5. Improve Solution
6. Suggest or Act

Traveller's Problem



Sensors → Environment → Actuators

Sketch the problem

↓

Searching Technique

↓

Path Finding

↓

Derive Solution/s

↓

Improve Solution

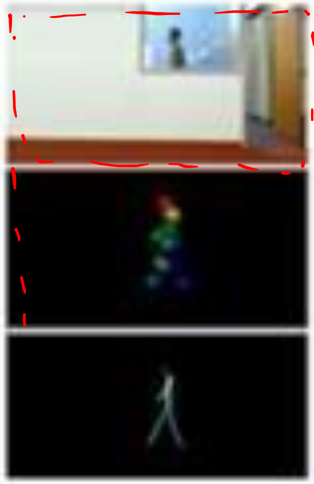
↓

Suggest or Act

AI in HealthCare

Lyrebird's Project Re-Voice

Voice cloning technology



AI in Culinary Field

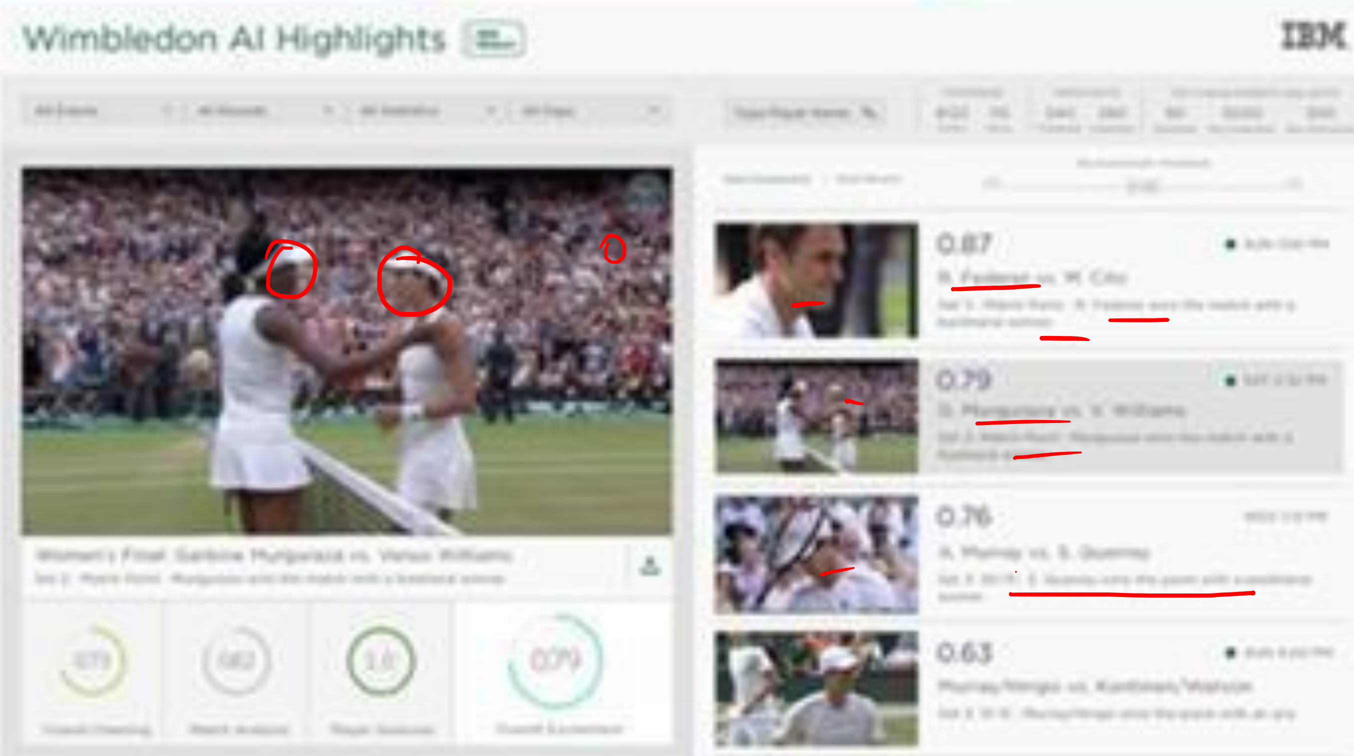
Spyce

AI in Transportation

AI in NLS

IBM Watson

NLP



- Computer Vision
- NLP
- ML
- Speech Recognition
- Automation

Rational Agents

Rational Agent

Design Principles & Techniques

	Thought / Reasoning	Acting
Human Performance	THINKING HUMANLY "[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning, … " (Bellman, 1978)	ACTING HUMANLY "The art of creating machines that perform functions that require intelligence when performed by people" (Kurzweil, 1990)
Rational Performance	THINKING RATIONALLY "The study of computations that make it possible to perceive, reason, and act" (Winston, 1992)	ACTING RATIONALLY "Computational intelligence is the study of the design of intelligent agents" (Poole et al., 1998)

Acting Rationally

The Rational Agent Approach

- An agent is an entity that perceives and acts i/p

This course is about designing rational agents doing right things $P_1 - - - P_5 -$

- Abstractly, an agent is a function from percept histories to actions: [f: P* →A]

P_2

- For any given class of environments and tasks, we seek the agent (or class of agents) with the best performance
- Computational limitations make perfect rationality unachievable
- Design best program for given machine resources

Properties of Rational Agent

- Omniscience : Expected Vs Actual Performance
- Learning Capability : Apriori Knowledge KB
- Autonomous in decision making: An agent is autonomous if its behaviour is determined by its own experience (with ability to learn and adapt)

P → soln → Max achievable obj

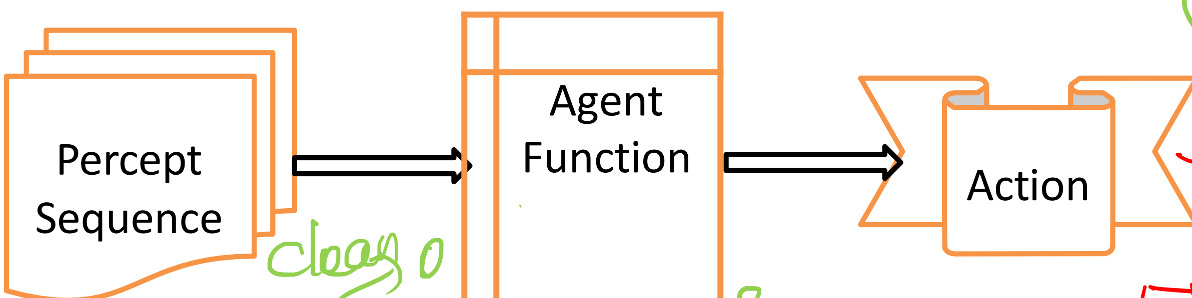
Intelligent Agent

Eg
Vacum cleaner Robot :-

① controlled environment
② Env : Room A & Room B
③ Obj :- clean both Room
④ 3 actions :-
↳ MR
↳ ML
↳ Suck

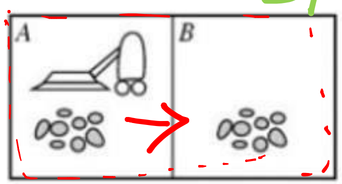
Rational Agent is one that acts to achieve the best outcome or the best expected outcome even under uncertainty

Maps / Tabulated / Programmed



clean 0

Status_A → Dirty → 1
Status_B → Dirty → 1
Loc_Robot → A → 1
B → 0



Percept sequence	Action
[A, Clean]	Right
[A, Dirty]	Suck
[B, Clean]	Left
[B, Dirty]	Suck
[A, Clean], [A, Clean]	Right
[A, Clean], [A, Dirty]	Suck
...	...

3 var

S_A	S_B	LR_a	LR_B
1	1	1	0
0	1	0	

Percept → Action

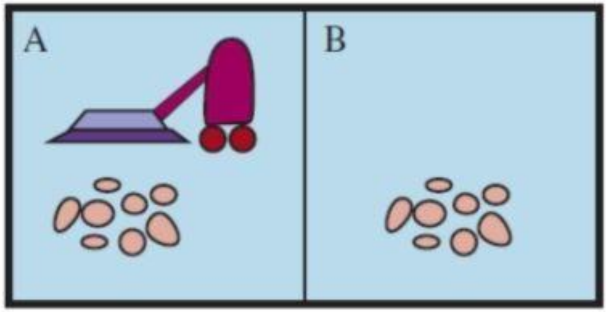
i/P

Intelligent Agent

Locn Stat

[A, Dirty] → Suck

Percept sequence



- Percepts: location and contents, e.g., [A , Dirty]
- Actions: *Left*, *Right*, *Suck*, ~~*NoOp*~~

$y = m_1 x + b$

Performance measure: An objective criterion for success of an agent's behaviour

E.g., performance measure of a vacuum-cleaner agent

1. » amount of dirt cleaned up
2. » amount of time taken
3. » amount of electricity consumed
4. » amount of noise generated, etc.

$PM_1 + PM_2 + PM_3 + PM_4$

P

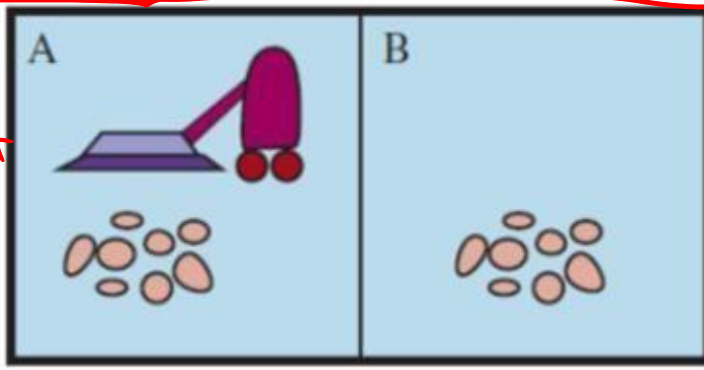
Utility

[PEAS Design]

Intelligent Agent

Percept sequence	Action
[A, Clean]	*Right*
[A, Dirty]	*Suck*
[B, Clean]	*Left*
[B, Dirty]	*Suck*
[A, Clean], [A, Clean]	*Right*
[A, Clean], [A, Dirty]	*Suck*
⋮	⋮
[A, Clean], [A, Clean], [A, Clean]	*Right*
[A, Clean], [A, Clean], [A, Dirty]	*Suck*
⋮	⋮

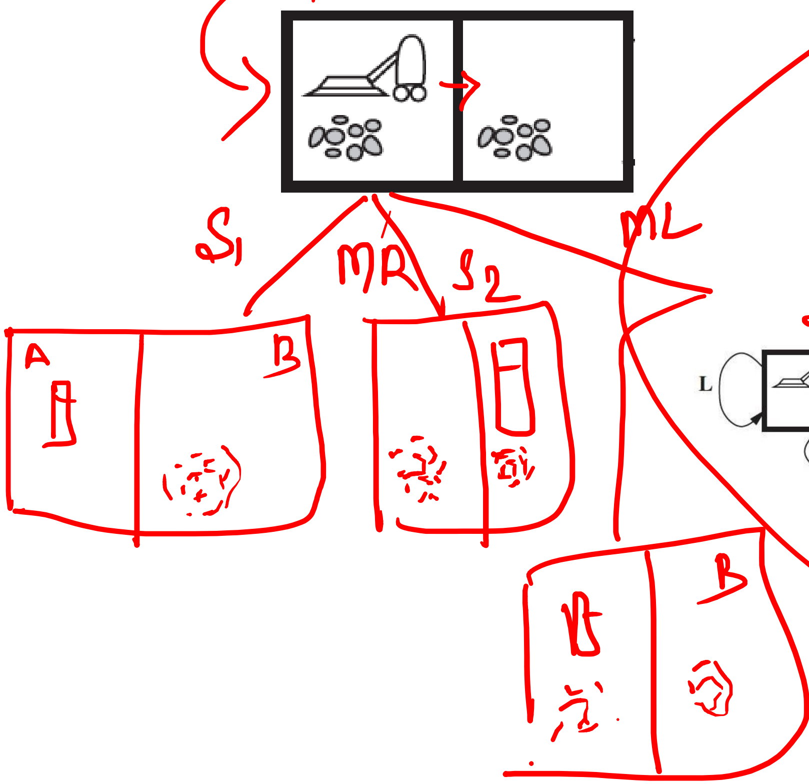
Current

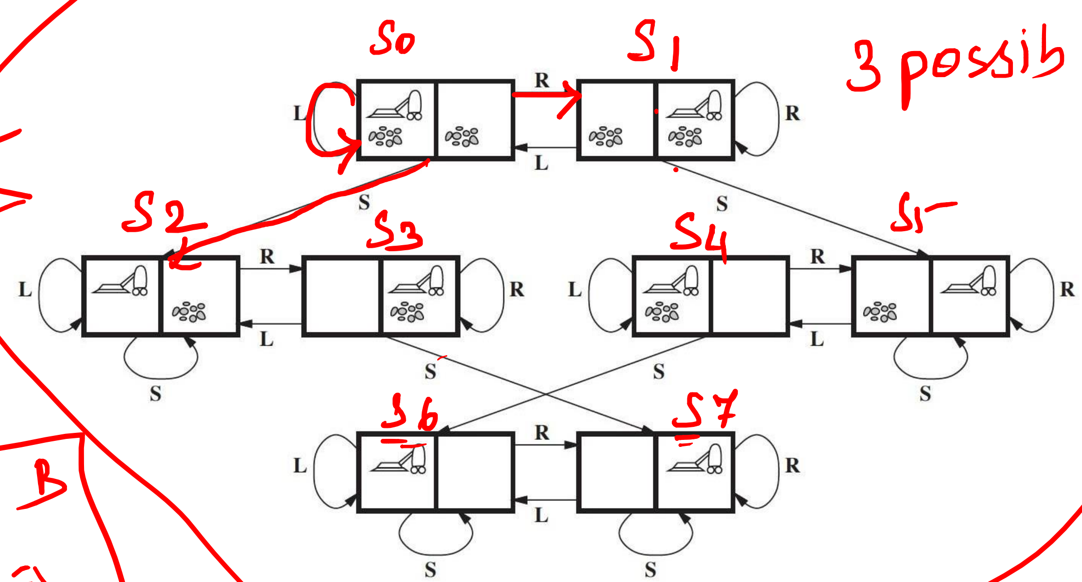


$S_0 \xrightarrow{Suck} S_1$

Vacuum World Problem

S0 Initial State





3 possib

State space environmental transition

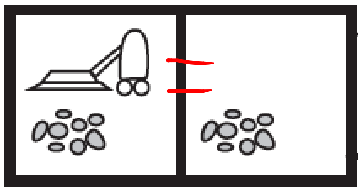
Vacuum World Problem

S/w agent → Chat

H/w agent → Movement

4 Parameters

PEAS

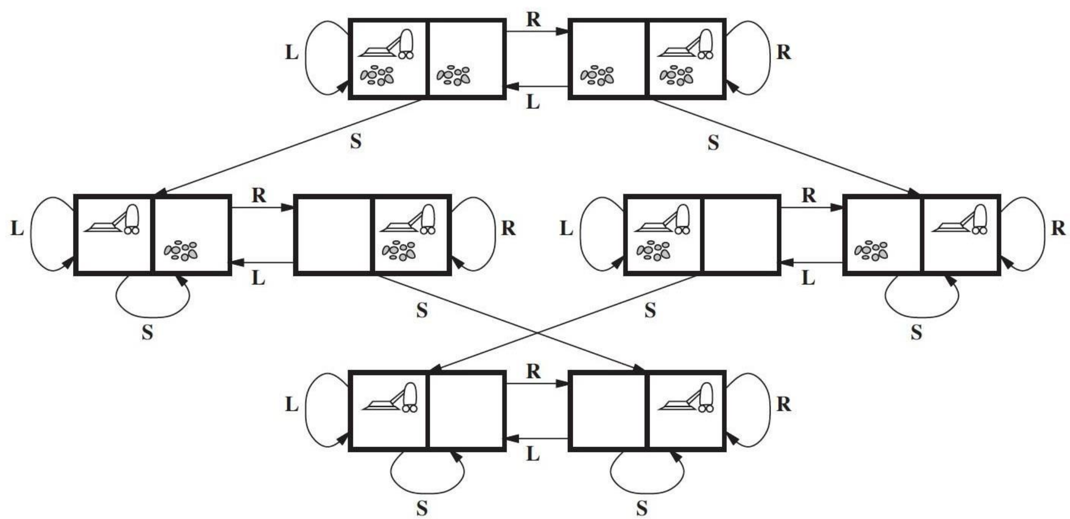


P → 4

E → Presence/absence of dirt

S → i/p → 3 vars

A → ML, MR, Suck



Status

Task environment

PEAS Environment

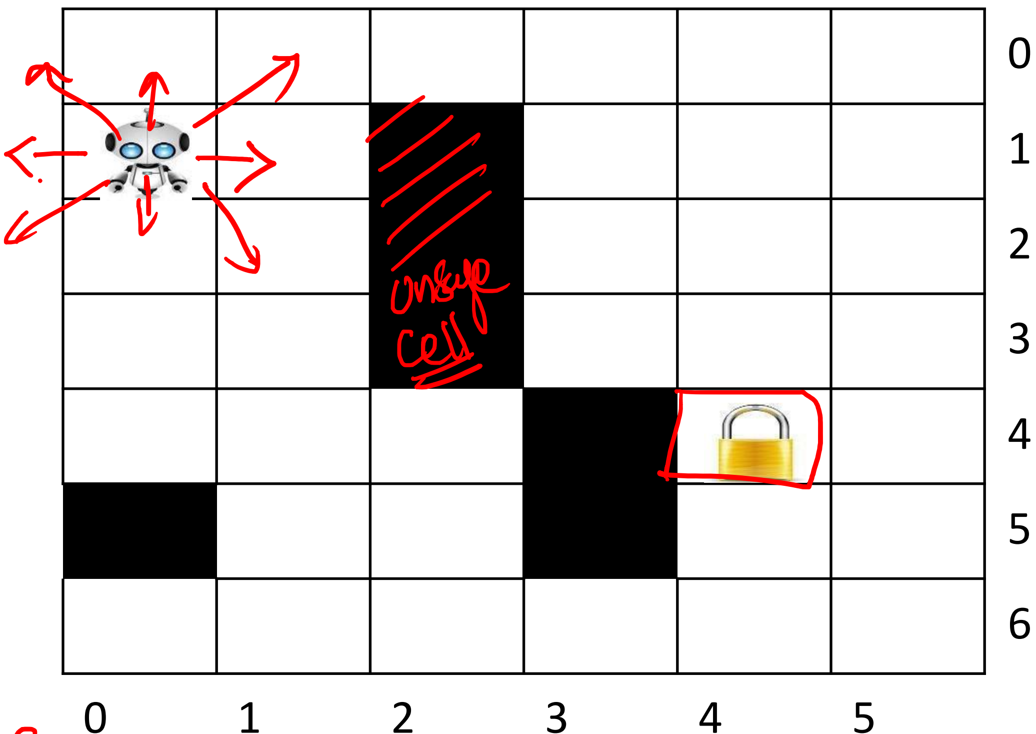
{P1 → q1, D → R1} {P → q1, D → R2}

Design on what an application wants the agent to do in the environment

Agent	P Performance	E Environment	S Sensors I/P	A Actuators O/P
(2) Medical diagnosis system chatbot	Healthy patient, reduced costs	Patient, hospital, staff	Keyboard entry of symptoms, findings, patient's answers	Display of questions, tests, diagnosis, treatments, referrals
(2) Satellite Image analysis system D, R, Land for	Correct image categorization img → F → F	Downlink from orbiting satellite	Color pixel analysis	Display of scene categorization
(3) Interactive English tutor MS teams, canvas	Student's score on test	Set of students, testing agency	Keyboard entry	Display of exercises, suggestions, corrections

Path finding Robot - Lab Example

4° degree 8°



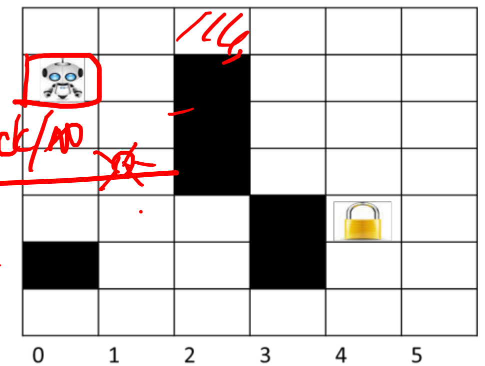
S (0,1)

Goal (4,4)

PEAS Environment

Agent
Performance
① Shortest path
Environment
Presence of block " " free cell " " monster. " " pit
Sensors
Actuators
4 freedom MN, MS ME, MW

x	y	is_safe	Lock/No
0	1	0 → unsafe 1 → safe	1



x,y	is_safe	is_goal

Dimensions of Task Environment

Sensor Based:
- Observability : Full Vs Partial

Action Based:
- Dependency : Episodic Vs Sequential

State Based:
- No.of State : Discrete Vs Continuous

Agent Based:

> Cardinality : Single Vs MultiAgent

Action & State Based:
- State Determinism : Deterministic Vs Stochastic | Strategic
- Change in Time : Static Vs Dynamic

Task Environment

A rational agent is built to solve a specific task. Each such task would then have a different environment which we refer to as Task Environment 5

Based on the applicability of each technique for agent implementation its task environment design is determined by multiple dimension

Sensor Based:

- Observability : Full Vs Partial

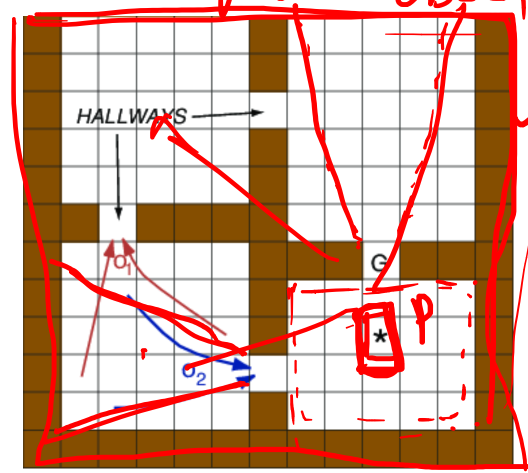
eg 1

1 → $s_1 \xrightarrow{a_1} s_2$

2

eg 2

Partial obser



Required Reading: AIMA - Chapter #2

Thank You for all your Attention

Note : Some of the slides are adopted from AIMA TB materials