



Artificial and Computational Intelligence

AIMLCZG557

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M1 : Introduction &

M2 : : Problem Solving Agent using Search



BITS Pilani

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Presented by

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Artificial and Computational Intelligence

Disclaimer and Acknowledgement



- Few content for these slides may have been obtained from prescribed books and various other source on the Internet
- I hereby acknowledge all the contributors for their material and inputs and gratefully acknowledge people others who made their course materials freely available online.
- .I have provided source information wherever necessary
- This is not a full fledged reading materials. Students are requested to refer to the textbook w.r.t detailed content of the presentation deck that is expected to be shared over e-learning portal - taxilla.
- I have added and modified the content to suit the requirements of the class dynamics & live session's lecture delivery flow for presentation
- **Slide Source / Preparation / Review:**
 - From BITS Pilani WILP: Prof.Raja vadhana, Prof. Indumathi, Prof.Sangeetha
 - From BITS Oncampus & External : Mr.Santosh GSK

Course Plan

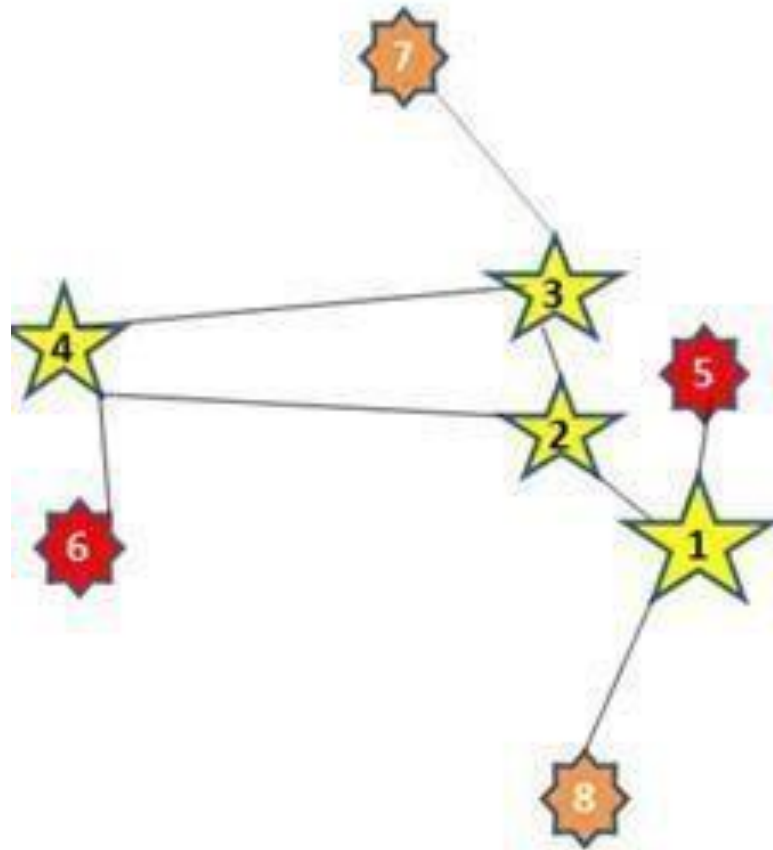


- M1 Introduction to AI
- M2 Problem Solving Agent using Search
- M3 Game Playing
- M4 Knowledge Representation using Logics
- M5 Probabilistic Representation and Reasoning
- M6 Reasoning over time
- M7 Ethics in AI

Traveller's Problem



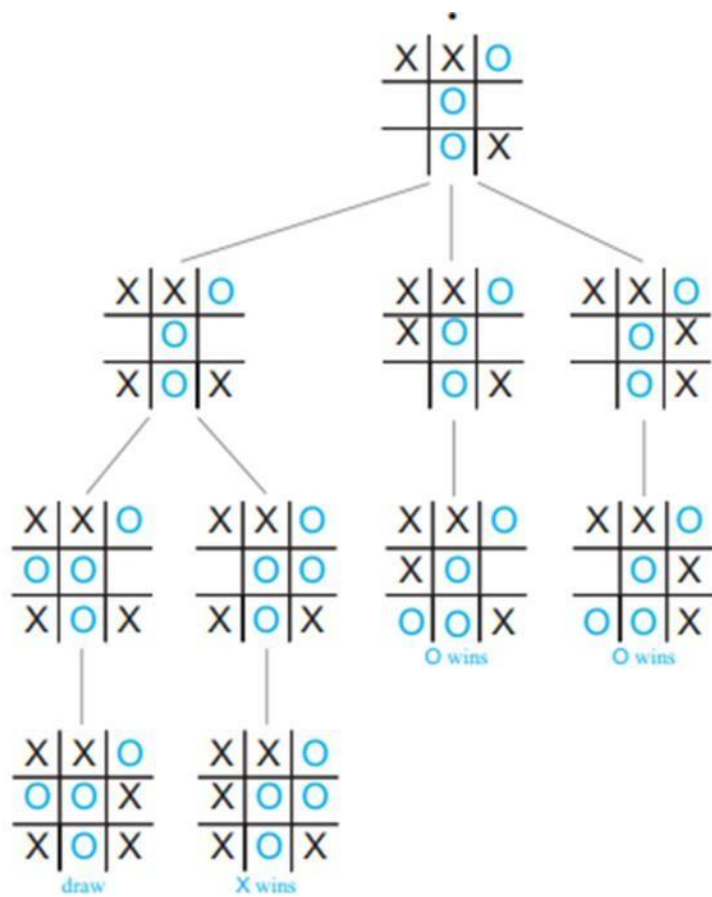
Traveller's Problem



Sensors → Environment → Actuators



Tic Tac Toe Problem



Rational Agents

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)

The Rational Agent Approach

- An agent is an entity that perceives and acts

This course is about designing rational agents

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

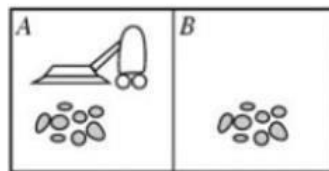
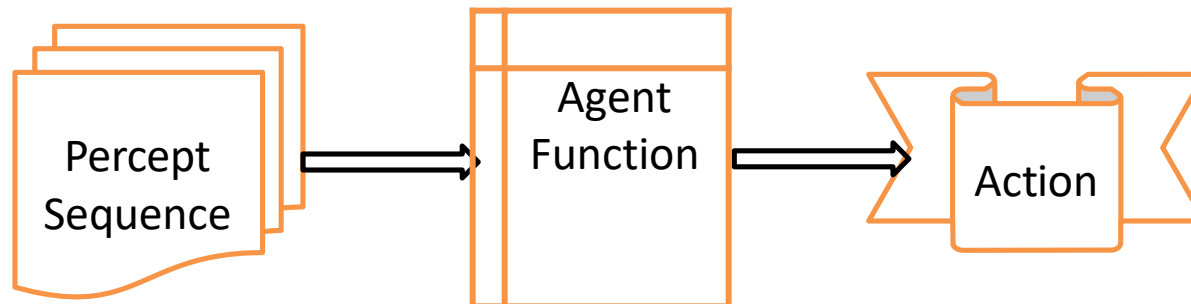
Properties of Rational Agent

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

Intelligent Agent

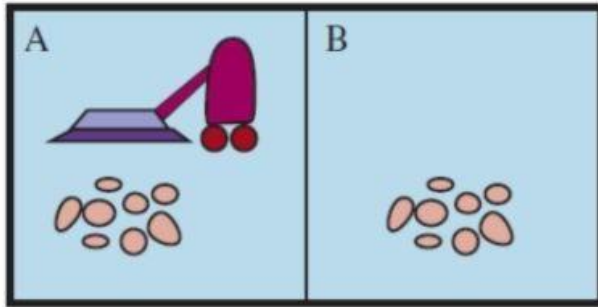
Rational Agent is one that acts to achieve the best outcome or the best expected outcome even under uncertainty

Maps / Tabulated / Programmed



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
...	...

Intelligent Agent



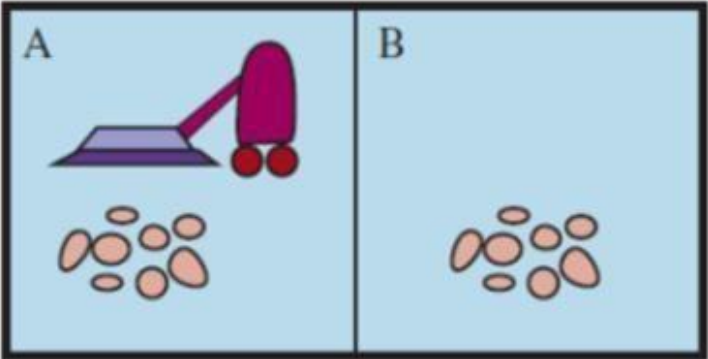
- Percepts: location and contents, e.g., [A , Dirty]
- Actions: *Left, Right, Suck, NoOp*

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

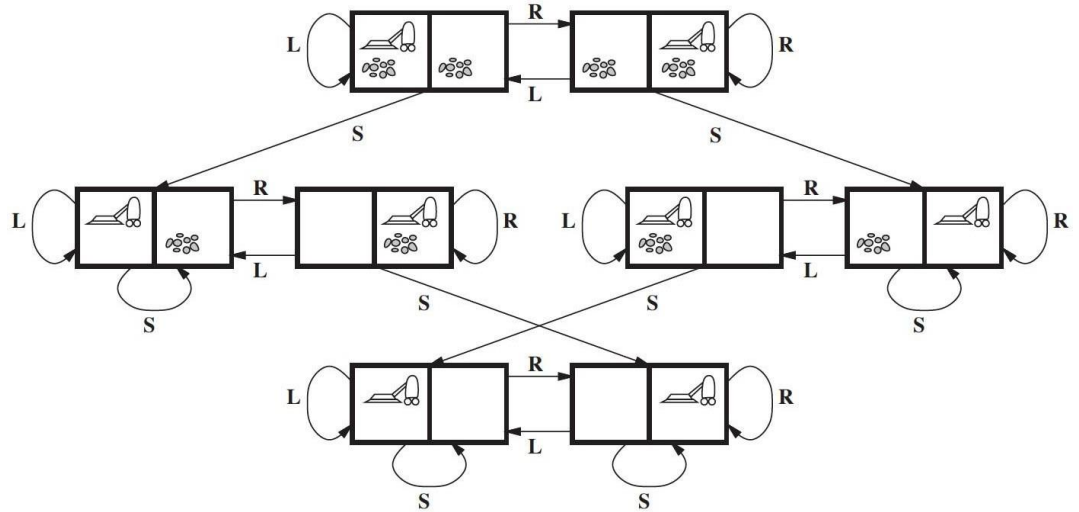
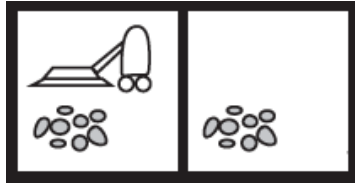
E.g., performance measure of a vacuum-cleaner agent

- » amount of dirt cleaned up
- » amount of time taken
- » amount of electricity consumed
- » amount of noise generated, etc.

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
⋮		⋮

Vacuum World Problem



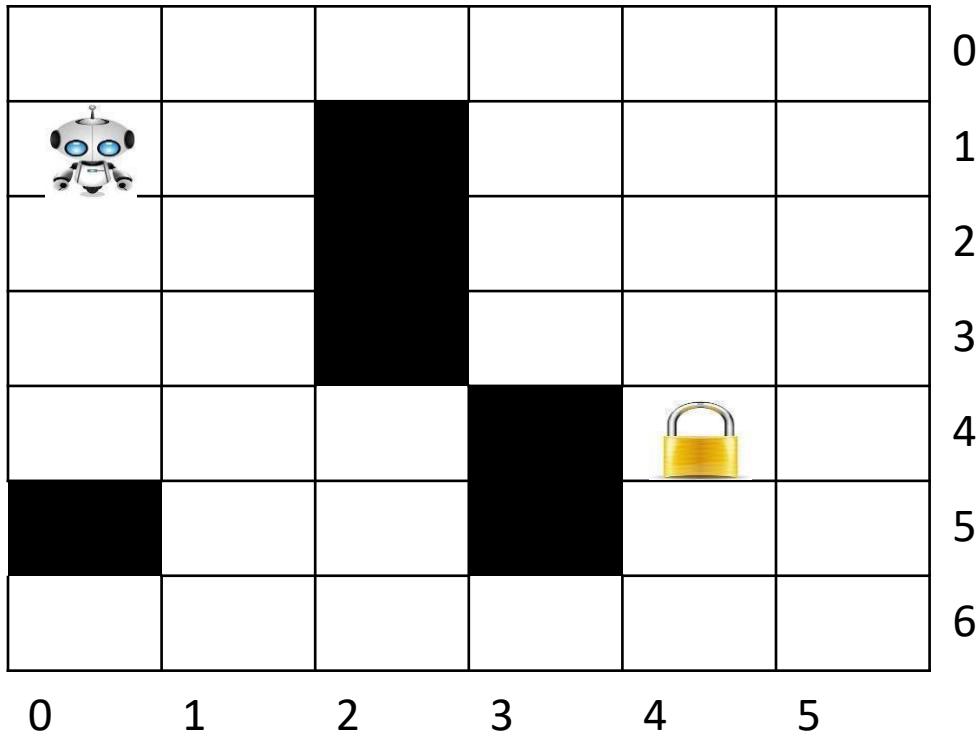


PEAS Environment

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

Agent	Performance	Environment	Sensors	Actuators
Medical diagnosis system	Healthy patient, reduced costs	Patient, hospital, staff	Keyboard entry of symptoms, findings, patient's answers	Display of questions, tests, diagnosis, treatments, referrals
Satellite Image analysis system	Correct image categorization	Downlink from orbiting satellite	Color pixel analysis	Display of scene categorization
Interactive English tutor	Student's score on test	Set of students, testing agency	Keyboard entry	Display of exercises, suggestions, corrections

Path finding Robot - Lab Example



PEAS Environment

Agent

Performance

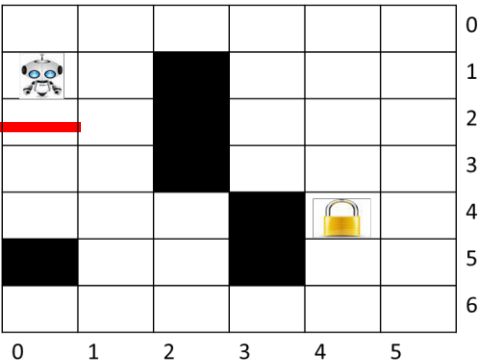
Environment

Sensors

innovate

achieve

lead



Dimensions of Task Environment

Sensor Based:

- Observability : Full Vs Partial

Action Based:

- Dependency : Episodic Vs Sequential

State Based:

- No.ofState : Discrete Vs Continuous

Agent Based:

- > Cardinality : Single Vs MultiAgent

Action & State Based:

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

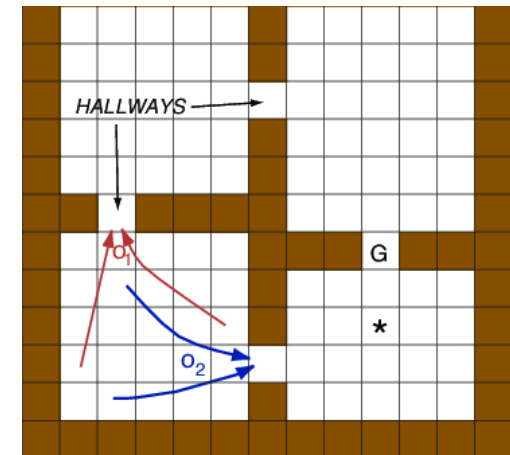
Task Environment

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

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

Sensor Based:

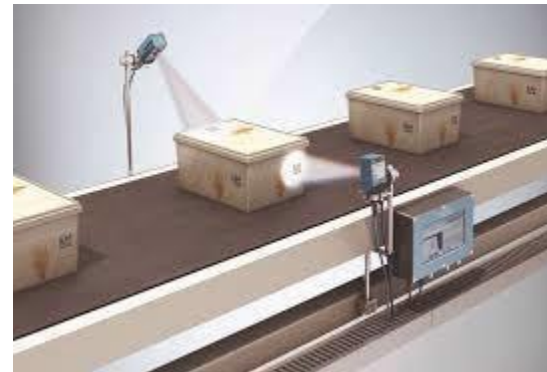
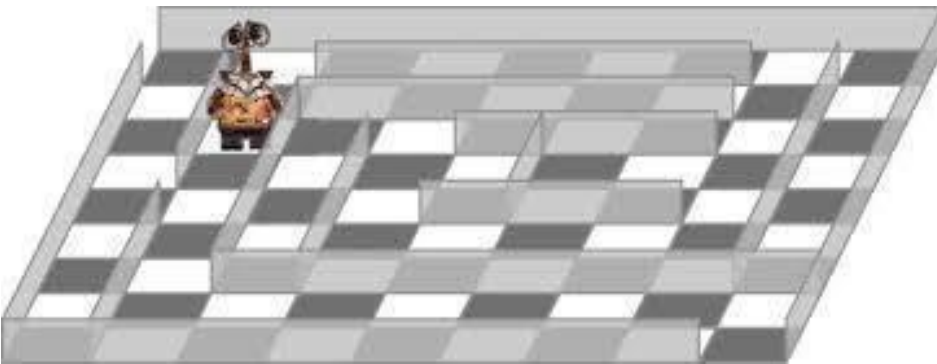
➤ Observability : Full Vs Partial



Task Environment

Action Based:

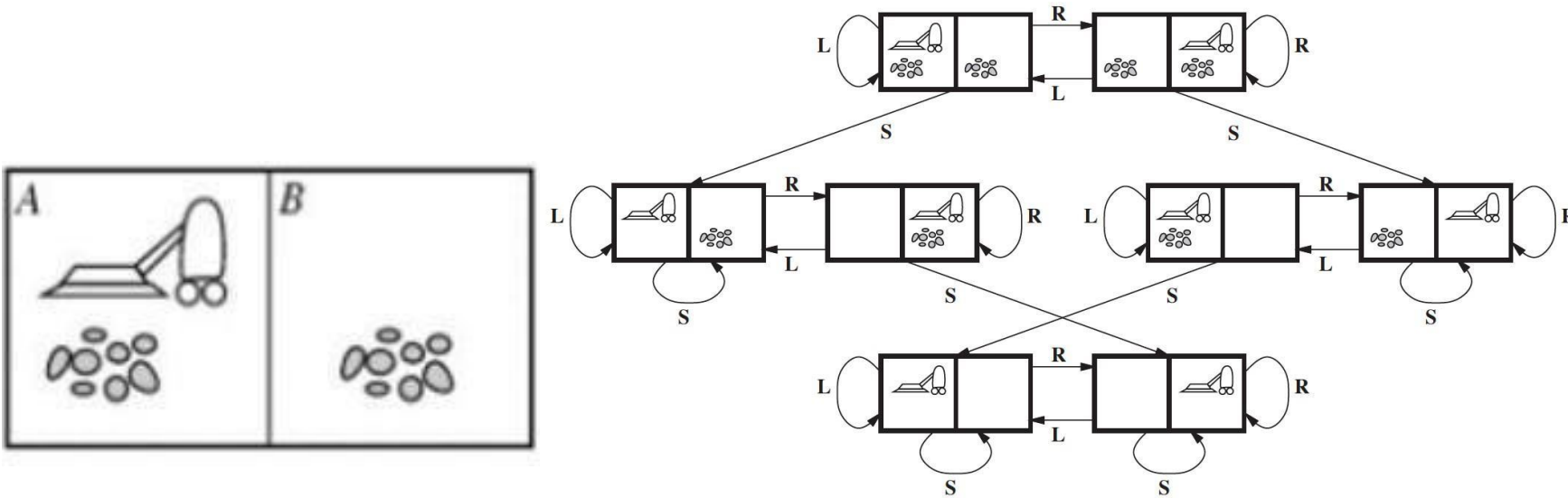
- Dependency : Episodic Vs Sequential



Task Environment

State Based:

➤ No.of.State : **Discrete** Vs Continuous



Task Environment



State Based:

- No.of.State : Discrete Vs Continuous



VS.

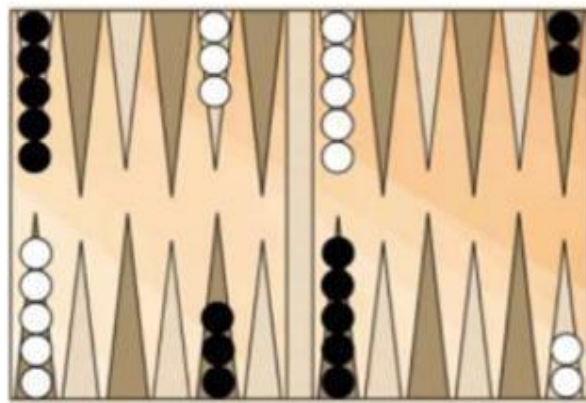


Task Environment

Action & State Based:

➤ State Determinism : Deterministic Vs Stochastic | Strategic

(If the environment is deterministic except for the actions of other agents, then the environment is strategic)



Task Environment

Agent Based:

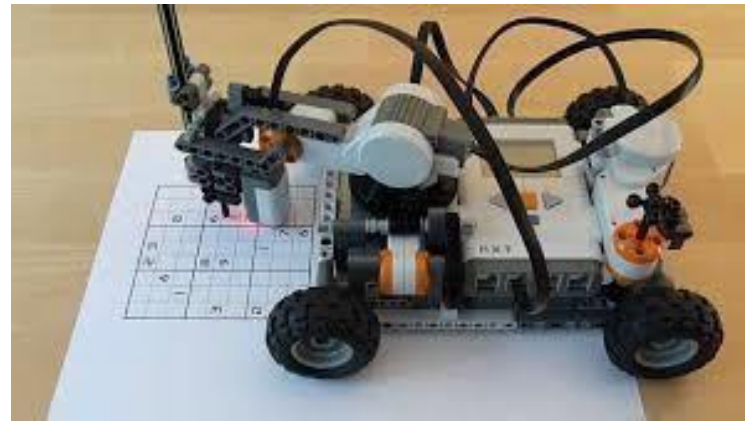
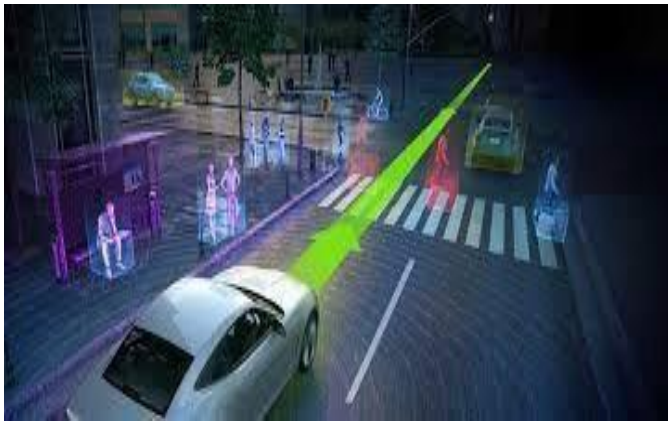
> Cardinality : Single Vs MultiAgent



Task Environment

Action & State Based:

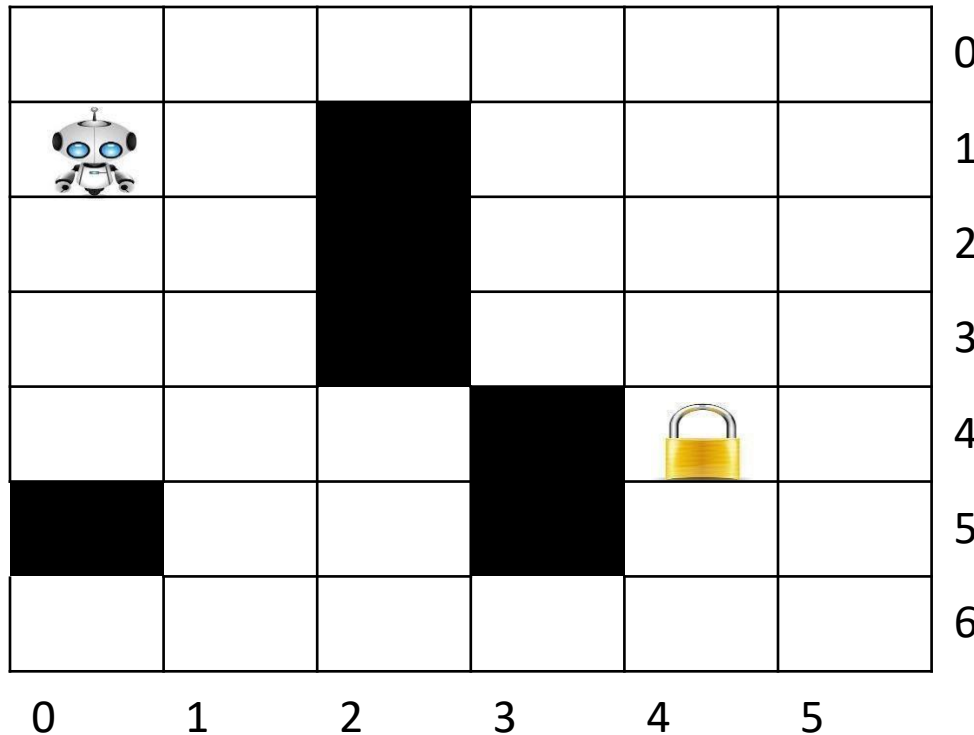
- Change in Time : Static Vs Dynamic
- (The environment is semi dynamic if the environment itself does not change with the passage of time but the agent's performance score does)



Task Environment

Task Environment	Fully vs Partially Observable	Single vs Multi-Agent	Deterministic vs Stochastic	Episodic vs Sequential	Static vs Dynamic	Discrete vs Continuous
Medical diagnosis system	Partially	Single	Stochastic	Sequential	Dynamic	Continuous
Satellite Image Analysis System	Fully	Single	Deterministic	Episodic	Static	Continuous
Interactive English tutor	Partially	Multi	Stochastic	Sequential	Dynamic	Discrete

Path finding Robot - Lab Example



Agent
Observability
No.of.Agents
No.of.States
Determinism
Dynamicity
Output Dependency



Learning Objective Achieved

At the end of this class , students Should be able to:

1. Identify the requirement for AI solutions for given problem
 2. Understand the significance of State based representations
 3. Design the PEAS (Performance, Environment, Actuators, Sensors) for given problem
 4. Identify dimensions of TASK environment
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Next Class Plan

Structure of Agents-Architectures

Problem Solving Agents

Problem Formulation

Uninformed Search Algorithms

Required Reading: AIMA - Chapter #2

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

Thank You for all your Attention