# Artificial & Computational Intelligence

## AIML CZG557

## M1 : Introduction
## &
## M2 : Problem Solving Agent using Search

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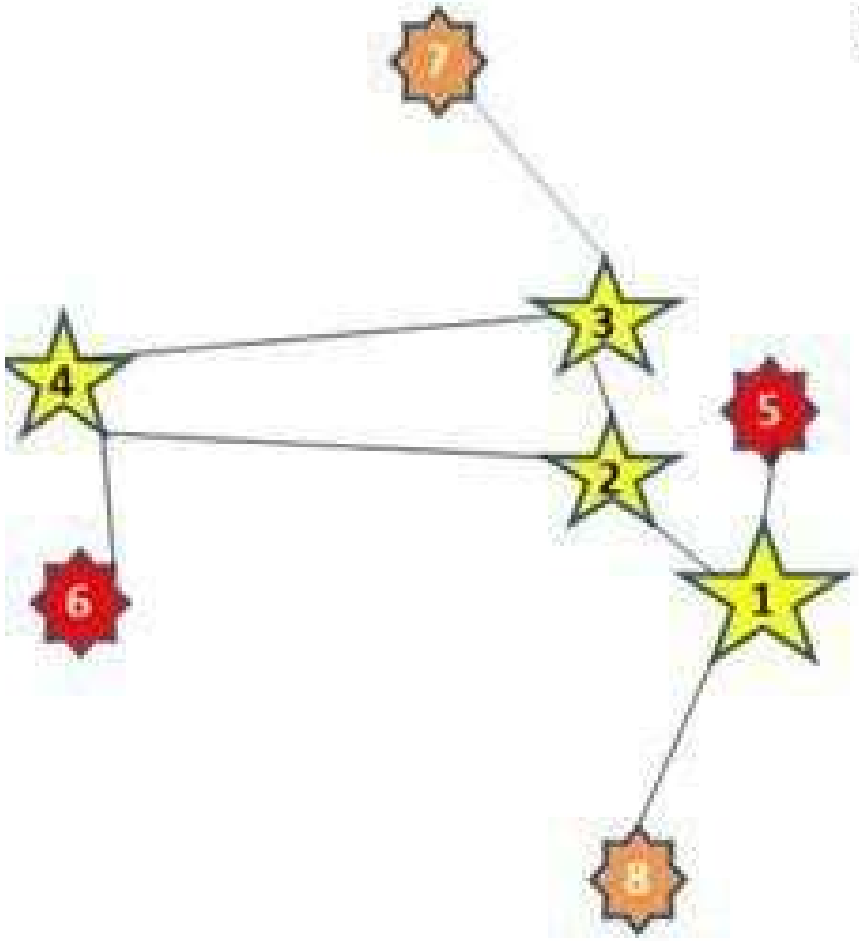
# Course Plan

| | |
|---|---|
| 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

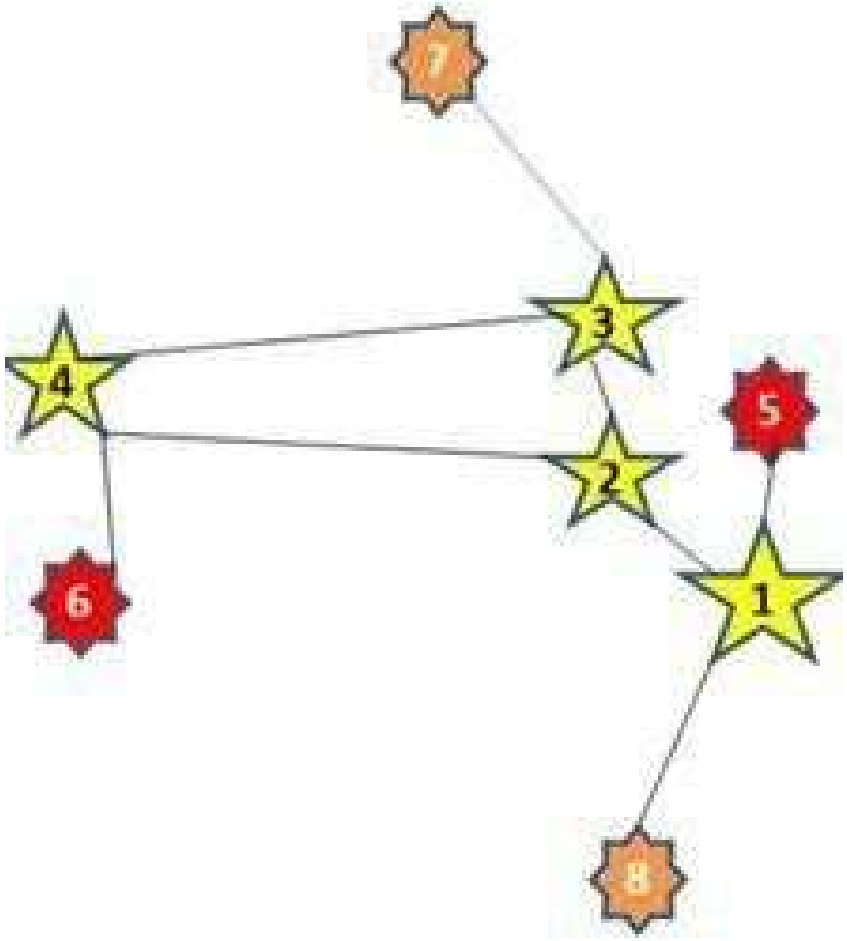
# Traveller's Problem

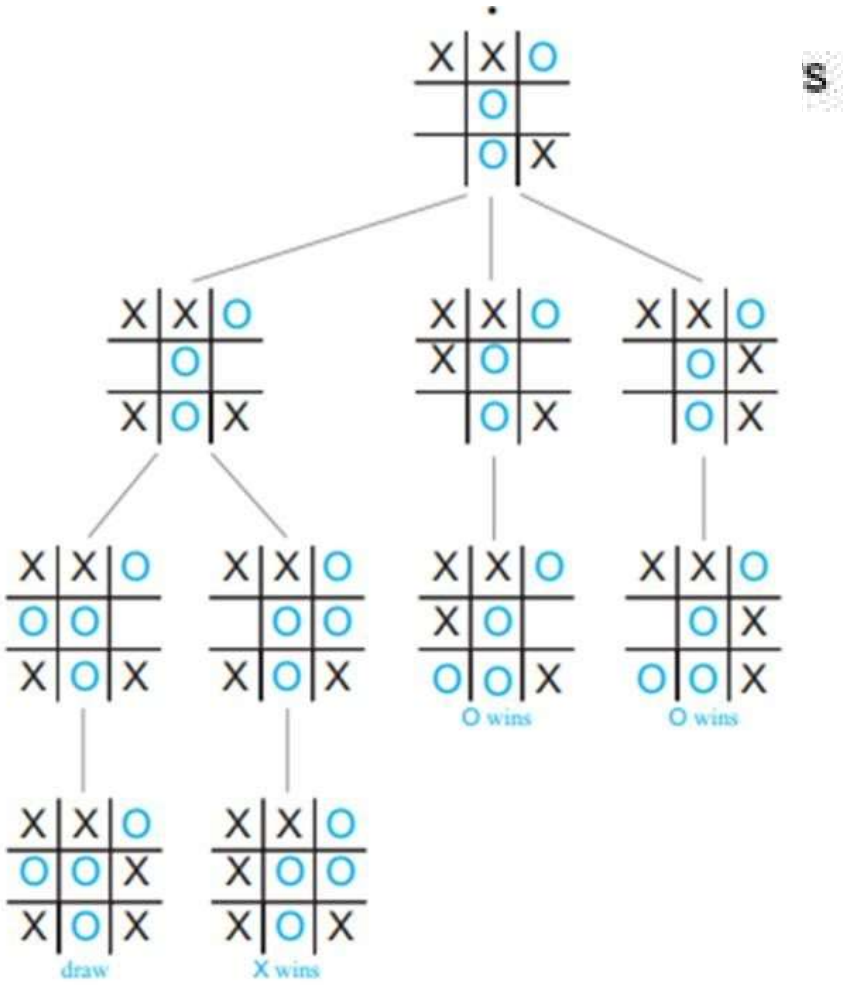



Sensors → Environment → Actuators

- Sketch the problem
- Searching Technique
- Path Finding
- Derive Solution/s
- Improve Solution
- Suggest or Act

# Traveller's Problem



# Rational Agents

# Rational Agent





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

*This course is about designing rational agents*

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

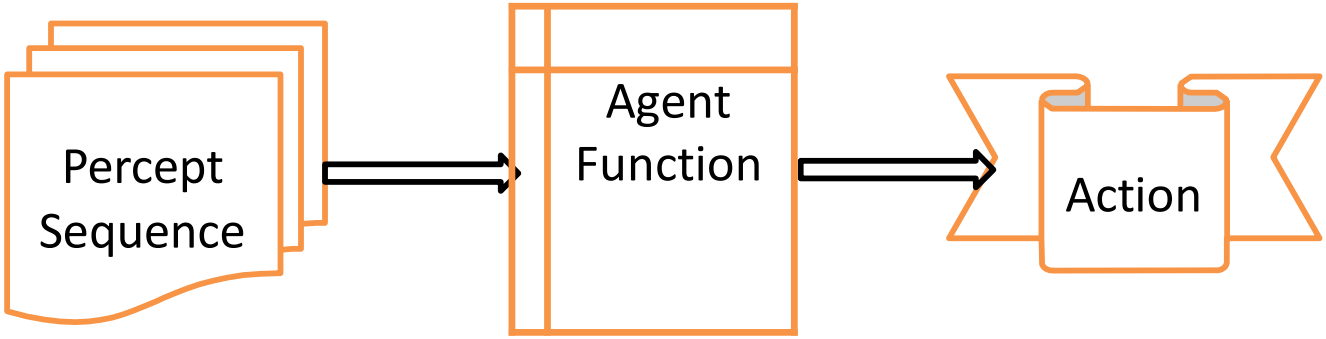
# Properties of Rational Agent

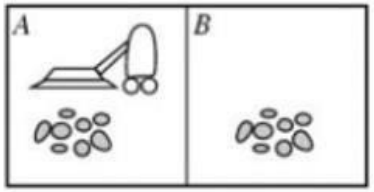
- Omniscience : Expected Vs Actual Performance
- Learning Capability : Apriori Knowledge
- Autonomous in decision making: An agent is autonomous if its behaviour is determined by its own experience (with ability to learn and adapt)

# Intelligent Agent

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

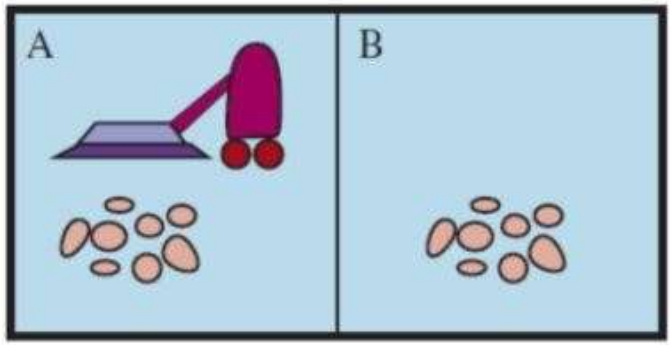
Maps / Tabulated / Programmed




| 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



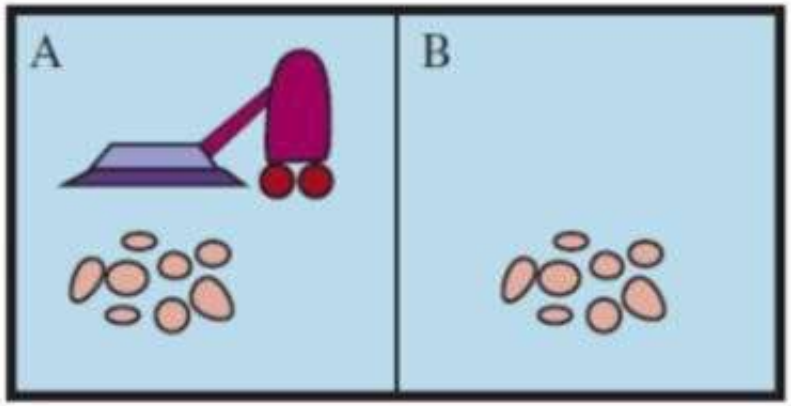

- Percepts: location and contents, e.g., [A , Dirty]
- Actions: *Left*, *Right*, *Suck*, *NoOp*

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

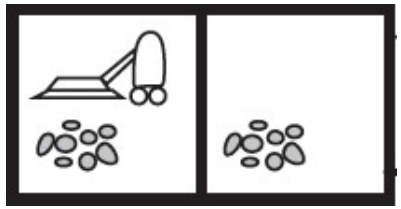
E.g., performance measure of a vacuum-cleaner agent
» amount of dirt cleaned up
» amount of time taken
» amount of electricity consumed
» amount of noise generated, etc.

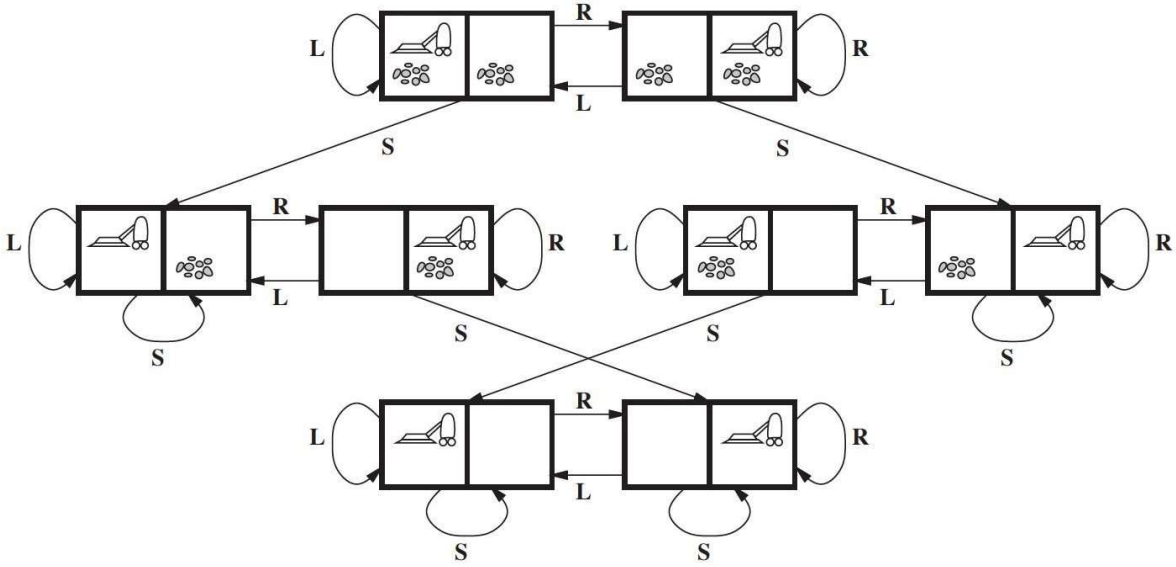
# Intelligent Agent

| 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



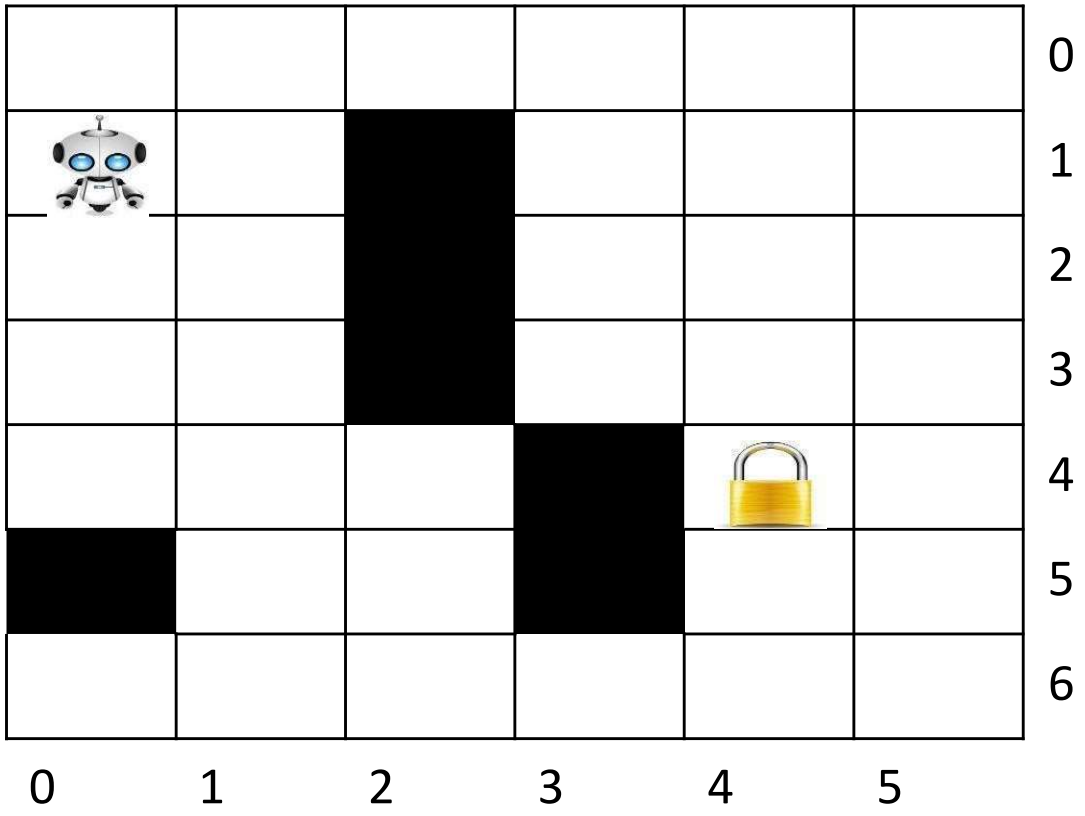


# PEAS Environment

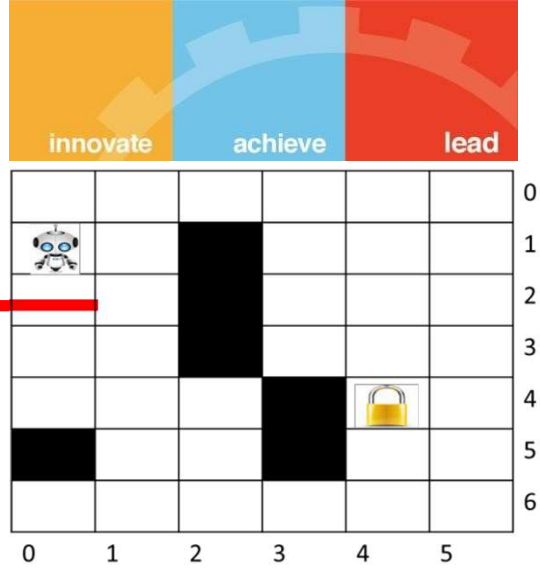
Design on what an application wants the agent to do in the environment

| 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**

**Actuators**

# 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

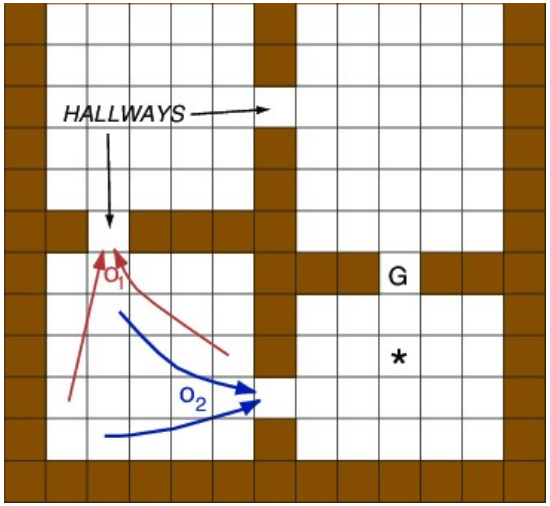
# Task Environment

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:**

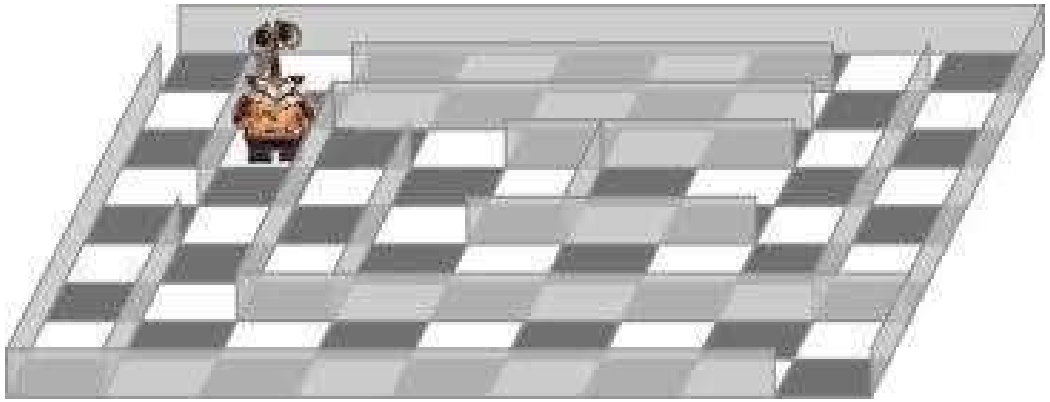
- Observability : Full Vs Partial

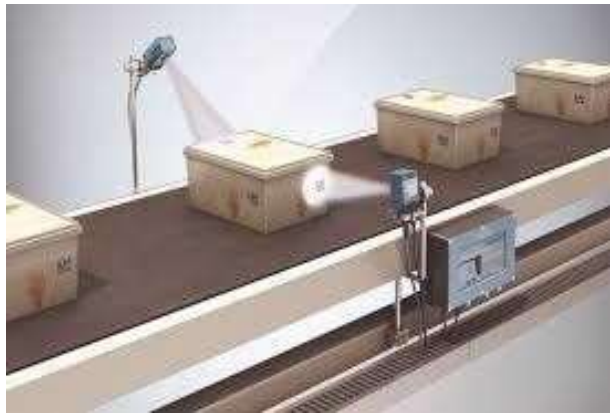


# Task Environment

**Action Based:**

- Dependency : Episodic Vs Sequential

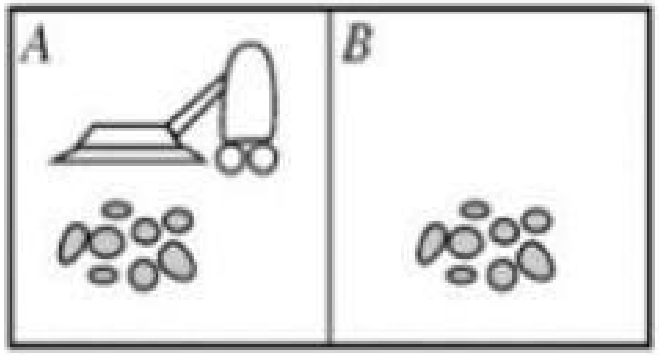


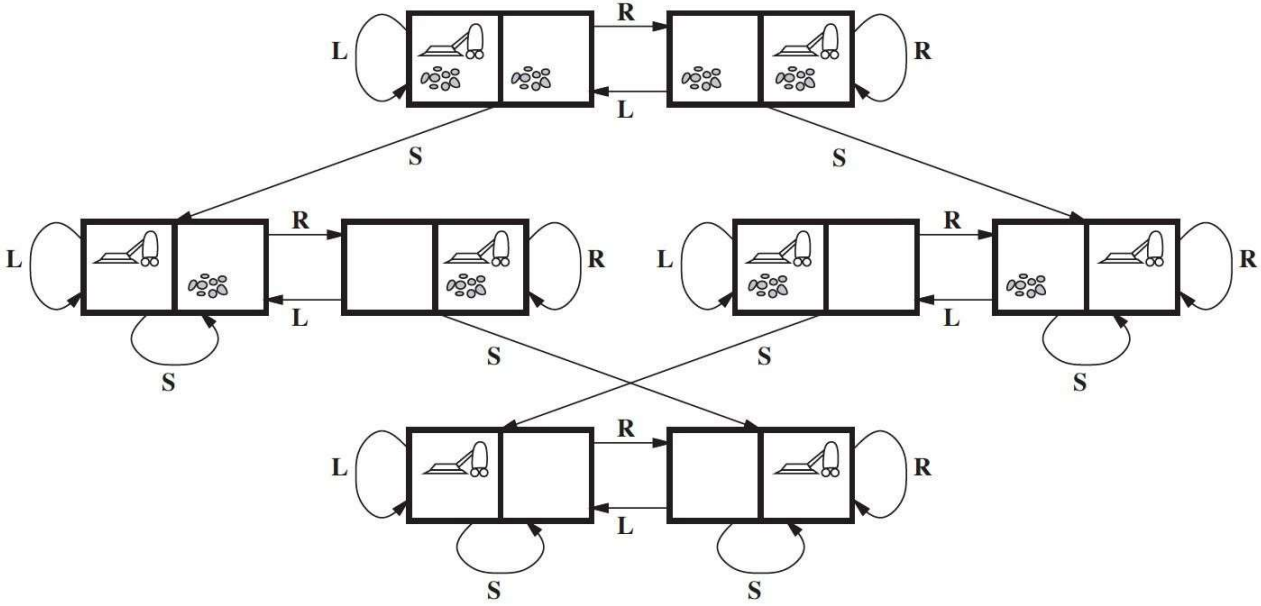


# Task Environment

**State Based:**

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



# Task Environment

**State Based:**

- No.of.State : Discrete Vs Continuous

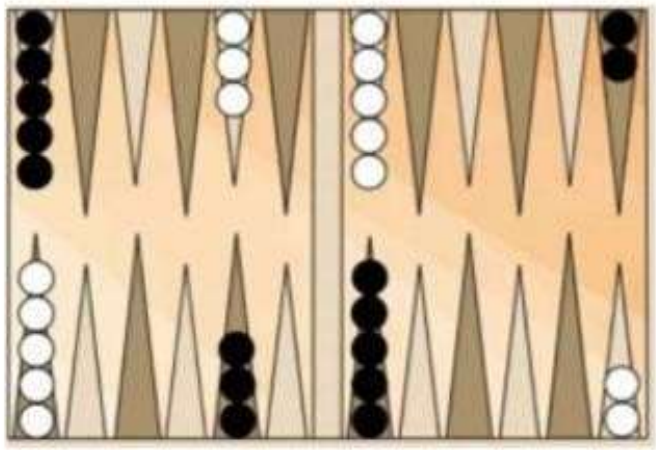
VS.

# Task Environment

**Action & State Based:**

- State Determinism : Deterministic Vs Stochastic | Strategic

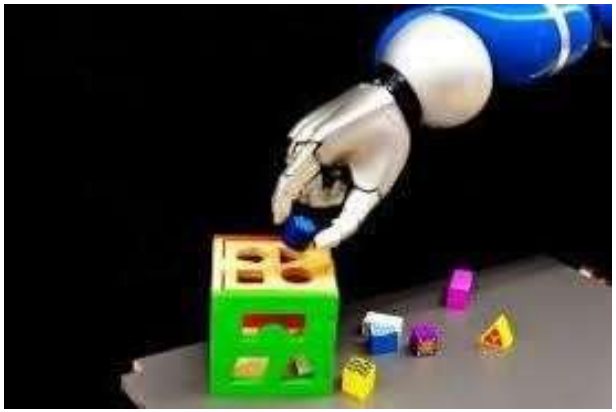
(If the environment is deterministic except for the actions of other agents, then the environment is strategic)



# Task Environment

**Agent Based:**

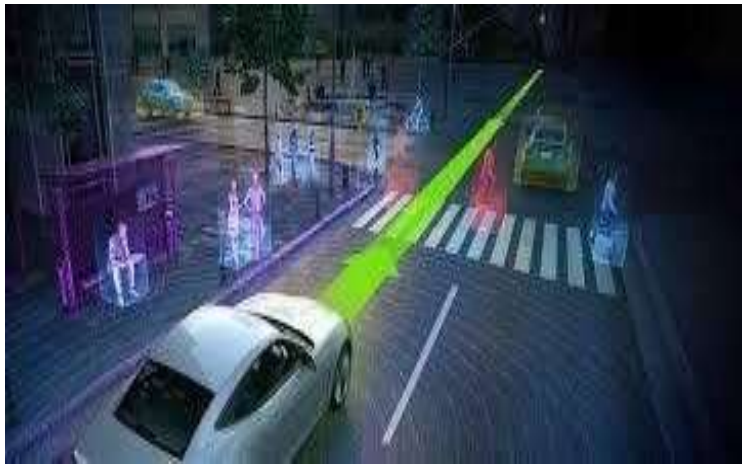
> Cardinality : Single Vs MultiAgent

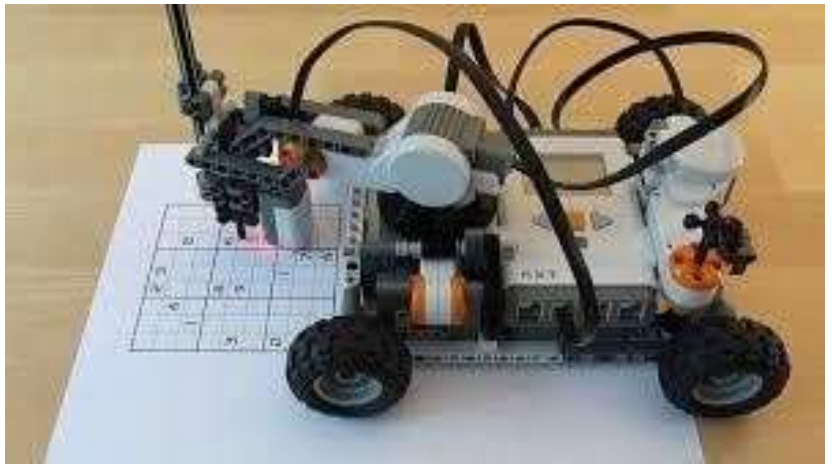


# Task Environment

**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)

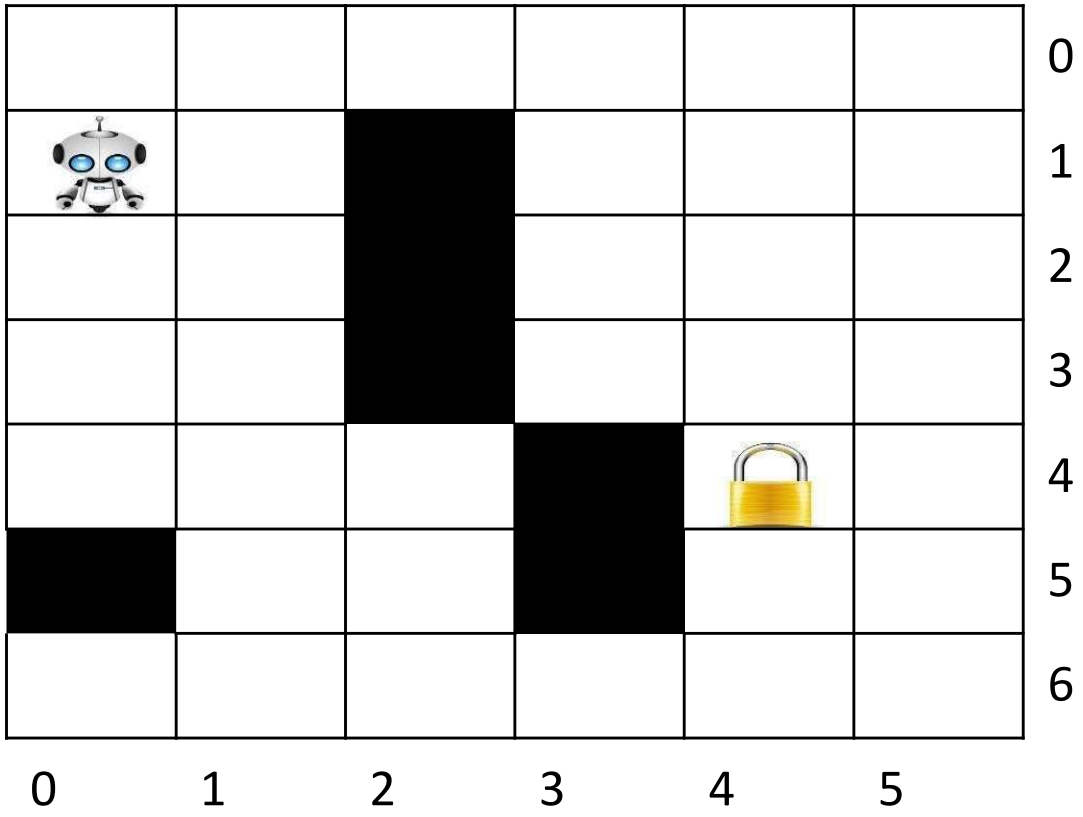




# Task Environment

| 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

# Next Class Plan

Structure of Agents-Architectures

Problem Solving Agents

Problem Formulation

Uninformed Search Algorithms

**Required Reading:** AIMA - Chapter #2

Thank You for all your Attention

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