Introduction to Artificial Intelligence (AI)

Dr. Ganesh Bhutkar

VIT, Pune INDIA

ganesh.bhutkar@vit.edu

TY BTech Comp - 2020-21

Reference Books

- **Rich & Knight:** Artificial Intelligence, Third Edition, McGraw Hill.

- **Russell & Norvig:** Artificial Intelligence - A Modern Approach, Prentice Hall.

Applications - AI

- Autonomous cars & Flying cars
- Smart home appliances - TV & Refrigerator
- Chatbots - COVID19 & Customer care
- Robots - Home support & Pets
- Medical Devices - Patient Monitors & Ventilators
- Smart Cities - Dustbins & Surveillance

What is Intelligence?

- **Data** - Raw collection

- **Information** - Structured or labeled **Data**

- **Knowledge** - Inference drawn from **Information**

- **Intelligence** - Application of **Knowledge** to solve problem or implement a solution

Example - Data

15921	**1190**
13378	**1050**
13289	**0970**
13288	**0890**
12472	**0810**

Example - Information

15921	**1190**
13378	**1050**
13289	**0970**
13288	**0890**
12472	**0810**
Cricket	**Census**

AI - Some Definitions (I)

The exciting new effort to make
computers think …
machines with minds,
in the full literal sense.

Haugeland, 1985

(excited but not really useful)

AI - Some Definitions (II)

The study of mental faculties through the use of computational models.

Charniak and McDermott, 1985

A field of study that seeks to explain and emulate intelligent behavior in terms of computational processes.

Schalkoff, 1990

(Applied psychology & philosophy?)

AI - Some Definitions (III)

The study of how to make computers do things at which, at the moment, people are better.

Rich & Knight, 1991

(I can almost understand this one).

Dimensions in AI Definitions

- Build intelligent artifacts vs. understanding human behavior.

- Does it matter how I built it as long as it does the job well?

- Should the system behave like a human or behave *intelligently*?

What Does AI Really Do?

- Knowledge Representation
- Automated Reasoning
- Planning
- Machine Learning
- Natural Language Understanding
- Robotics and Machine Vision
- Speech Recognition
- Others

Brief History of AI

- The Dartmouth conference, Summer 1956
- Early enthusiasm 1952-59:
  - Puzzle solving with the General Problem Solver, Geometry theorem prover, Games,
  - LISP
- Reality strikes:
  - Programs don't scale up.
  - The problem is not as easy as we think.

  AI Researchers:

  John McCarthy - Father of AI

  Marvin Minsky

More AI History

- Knowledge-based Systems **(Expert systems)** 1969-1979:

    - **Ed Feigenbaum** (Stanford): *Knowledge is power!* (as opposed to weak methods)

        - MYCIN: Medical diagnosis of blood infections (Malaria, Hepatitis & Fever)

        - Dendral: Inferring molecular structure from a mass spectrometer

- AI becomes an industry:
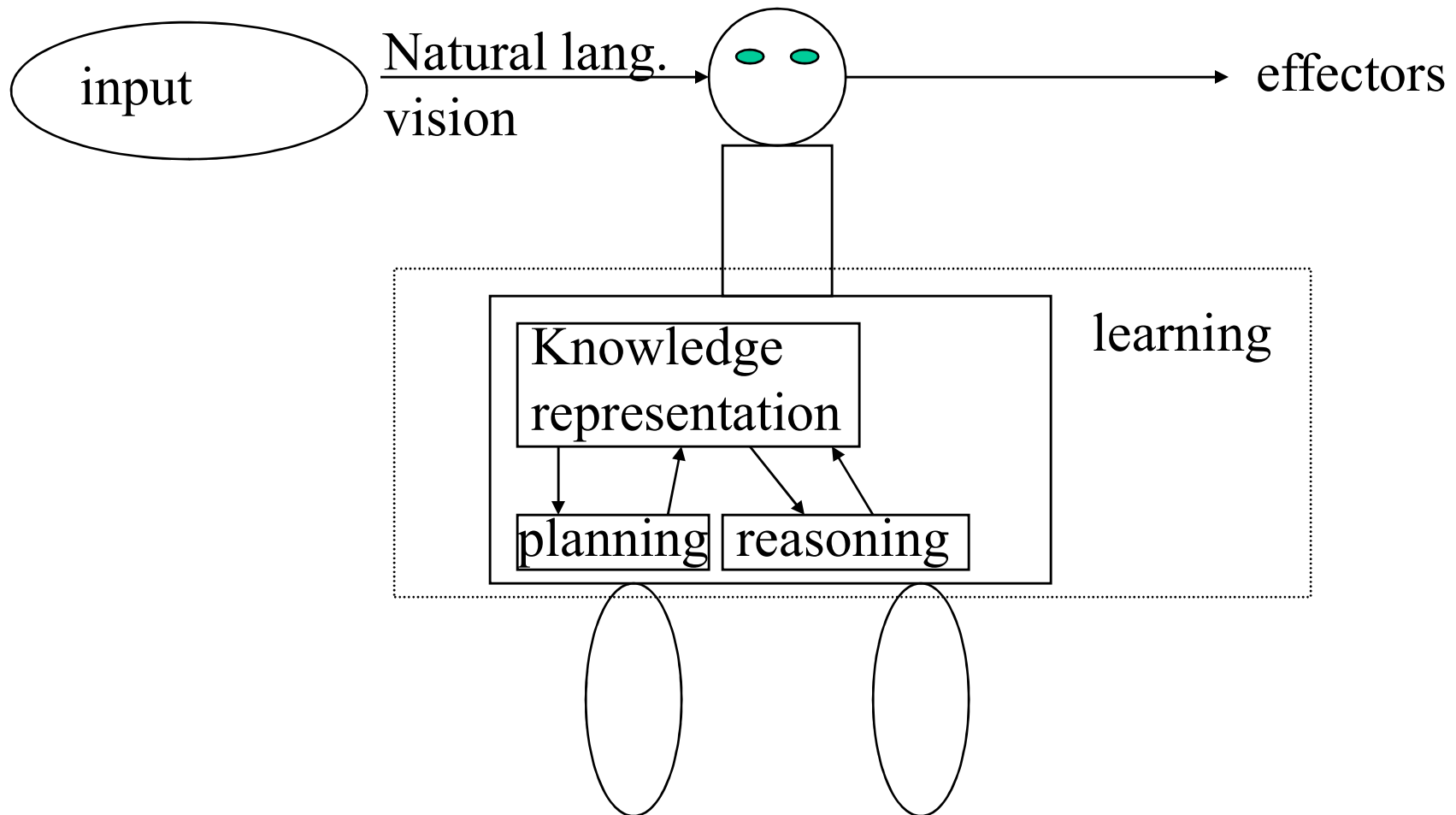
    - R1: Configuring computers for DEC

    - Robotics

Recent AI Developments

- AI turns *more scientific*, relies on more mathematically sophisticated tools:
  - Hidden Markov models
  - Belief networks
  - Genetic algorithms
  - Machine learning
- Focus turns to **building useful artifacts** as opposed to just solving the problems

Recent AI Successes

- **Deep Blue** beats Kasparov.
- **Theorem Provers** proved an unknown theorems.
- **Expert Systems:** Medical diagnosis, machine configuration & design
- **Speech Recognition Apps:** Google Assistant
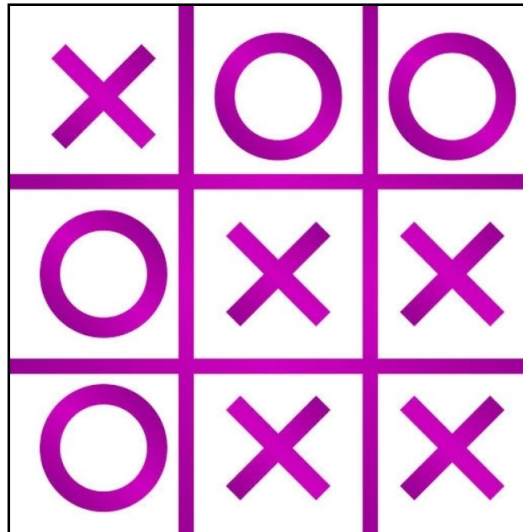- **Robots** controlling quality in factories

An Intelligent Agent

input

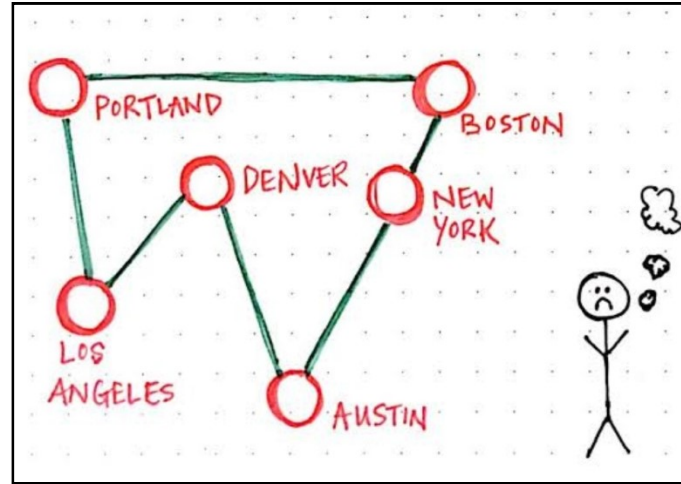Natural lang.
vision
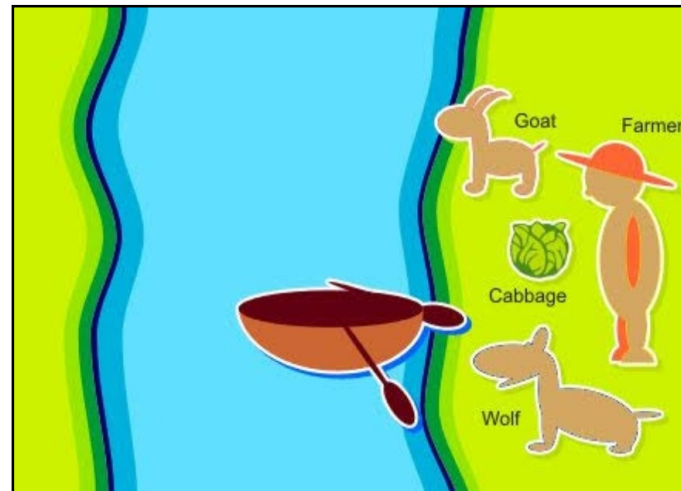
effectors

Knowledge
representation

learning

planning   reasoning

AI Games

– Chess

– Tik-Tak-Toe
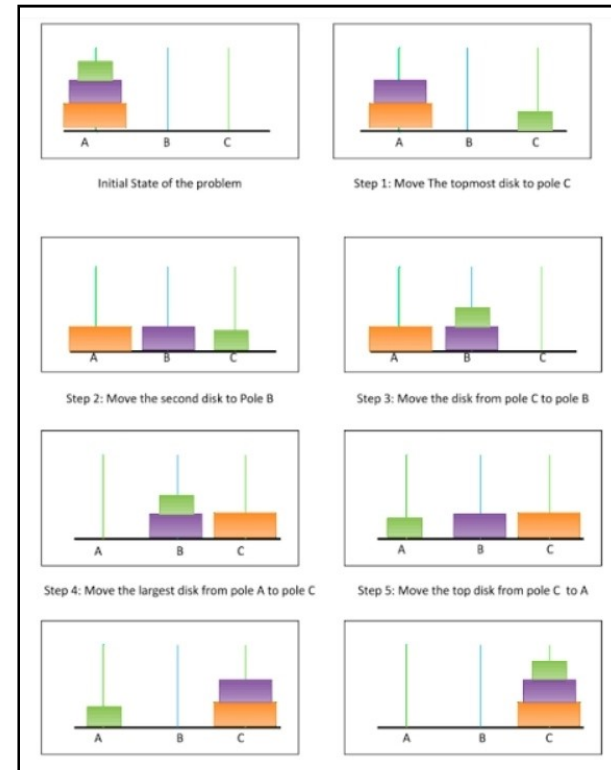
AI Problems

– Travelling Salesman Problem

– FCGW Problem

State, Action, Rule, Result, Cost…

AI Problems

Initial State of the problem

Step 1: Move The topmost disk to pole C

Step 2: Move the second disk to Pole B

Step 3: Move the disk from pole C to pole B

Step 4: Move the largest disk from pole A to pole C

Step 5: Move the top disk from pole C to A

– Tower of Hanoi Problem

– Monkey and Banana Problem

- A hungry monkey is in a room.
- Bananas have been hung from the center of the ceiling of the room.
- In the corner of the room there is a chair.
- The monkey wants the bananas but he can't reach them.
- What shall he do?

AI Problems

- Crypt Arithmetic Puzzle
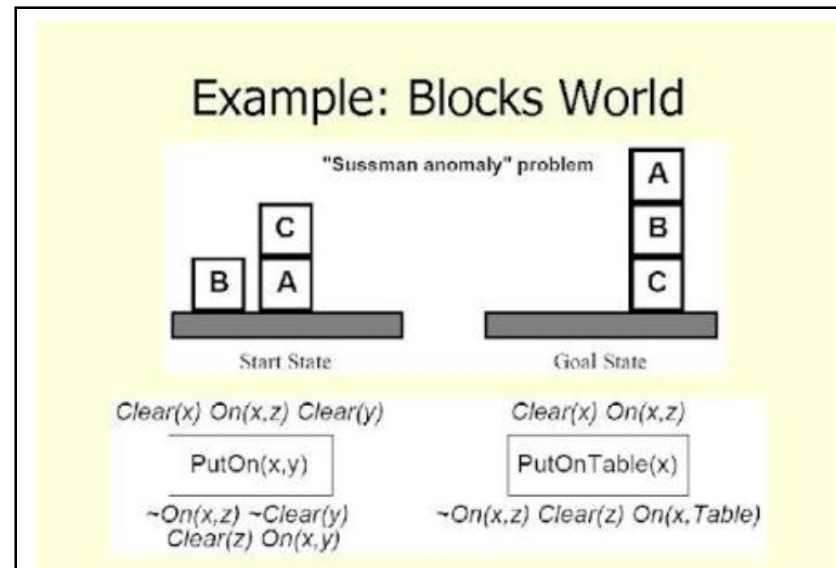

Cryptarithmetic / Verbal Arithmetic — Ravi Handa

$$E + 1 = N$$
$$1 + N + R = 10 + E$$
$$\Rightarrow 1 + E + 1 + R = 10 + E$$
$$\Rightarrow R = 8$$

- Block World Problem

Example: Blocks World

"Sussman anomaly" problem

Start State — Goal State

Clear(x) On(x,z) Clear(y)

PutOn(x,y)

~On(x,z) ~Clear(y)
Clear(z) On(x,y)

Clear(x) On(x,z)

PutOnTable(x)

~On(x,z) Clear(z) On(x,Table)

AI Problems

Rat in Maze

AI Problems

One solution to the eight queens puzzle
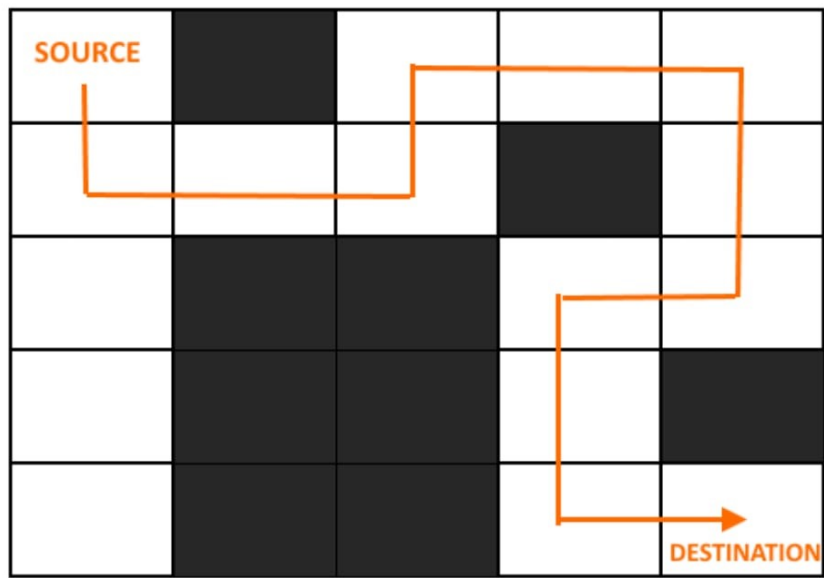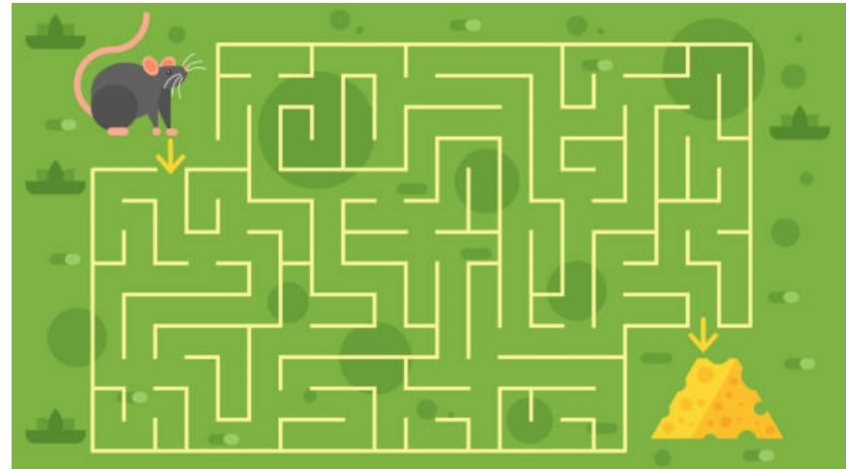
– 8 Queen Problem
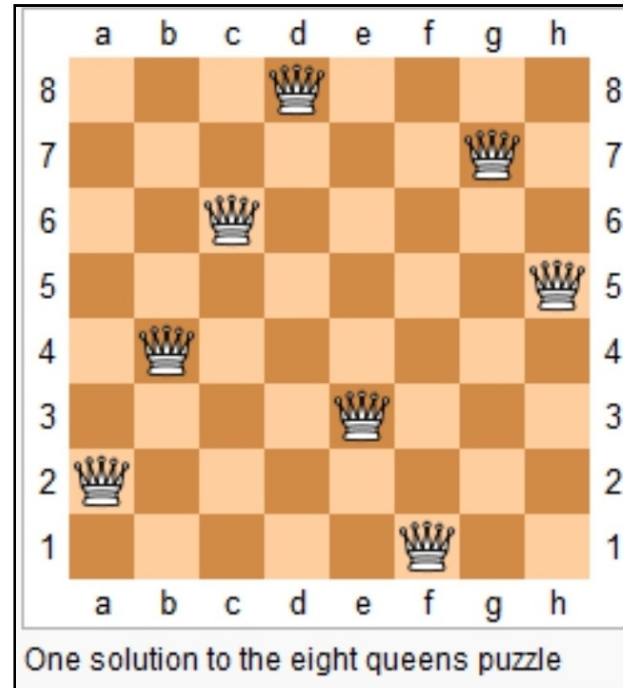
– Water Jug Problem

Production Rules & States (WJP)

Rule No	Production Rule	Action
1	(i, j) —— (4,j) if i<4.	Fill the 4-liter jug, if 4-liter jug is not full.
2	(i, j) —— (i,3) if j<3.	Fill the 3-liter jug, if 3-liter jug is not full.
3	(i, j) ——(i-s,j) if i>0.	Pour some water our of the 4-liter jug, if 4-liter jug is not empty.
4	(i, j) —— (i,j-s) if j>0.	Pour some water out of the 3-liter jug, if 3-liter jug is not empty.
5	(i, j) —— (0,j) if i>0.	Empty the 4-liter jug on the ground, if 4-liter jug is not empty.
6	(i, j) —— (i,0) if j>0.	Empty the 3-liter jug on the ground, if 3-liter jug is not empty.
7	(i, j) ——(4,j-(4-i)) if (i+j)>=4 & j>0.	Pour water from the 30-liter jug into the 4-liter jug until the 4 liter jug is full, if the combined content is >= 4 and 3-liter jug is not empty.
8	(i, j) ——(i,(3-j),3) if (i+j) >= 3 & i>0.	Pour water from the 4-liter the into the 3 liter jug until the 3-liter jug is full if the combined content is >=3 and 4-liter jug is not empty.
9	(i, j) —— (i+j,0) if (i+j)<=4 and j>0.	Pour all the water from the 3-liter jug into the 4-liter jug if the jug, combined content is <=4 and 3-liter jug is not empty.
10	(i, j) ____ (0,i+j) if i+j)<=3 and i>0	Pour all the water from the 4-liter jug into the3-liter jug, if the combined content is <=3 and 4-liter jug is not empty

Search Graph

Water jug problem.
- Cycle
- When will the search terminate?
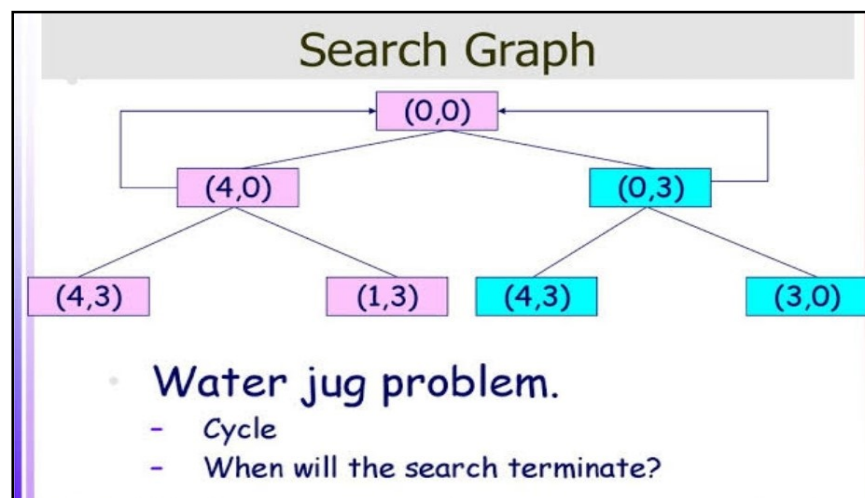
Solutions (WJP)

Liters in the 4-liter jug	Liters in the 3-liter jug	Rule applied
0	0	
4	0	1
1	3	8
1	0	6
0	1	10
4	1	1
2	3	8

	8 Liter Jar	5 Liter Jar	3 Liter Jar
Current State	8	0	0
Step 1	3	5	0
Step 2	3	2	3
Step 3	6	2	0
Step 4	6	0	2
Step 5	1	5	2
Step 6	1	4	3
End Result	4	4	0

State Space Search

Initial State

1	2	3
8		4
7	6	5

Goal State

2	8	1
	4	3
7	6	5

8		6
5	4	7
2	3	1

	1	2
3	4	5
6	7	8

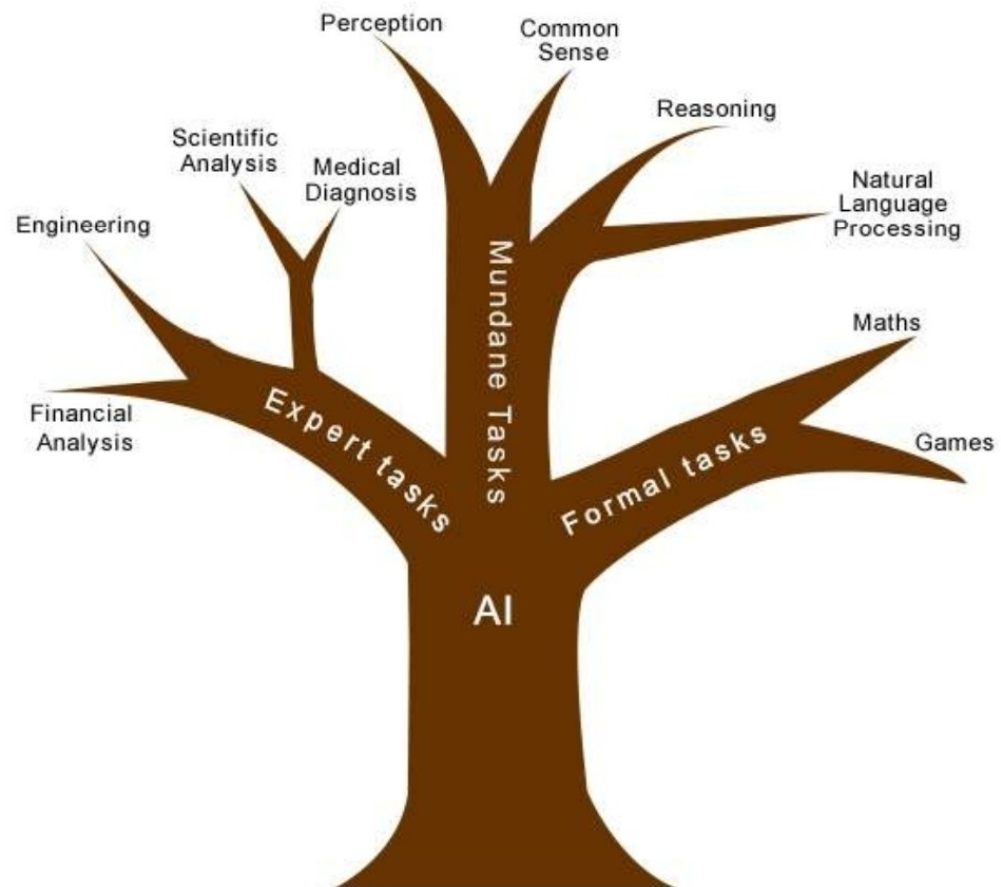**State, Action, Rule, Result, Cost…** **8 Puzzle Problem**

State Space Search - Example
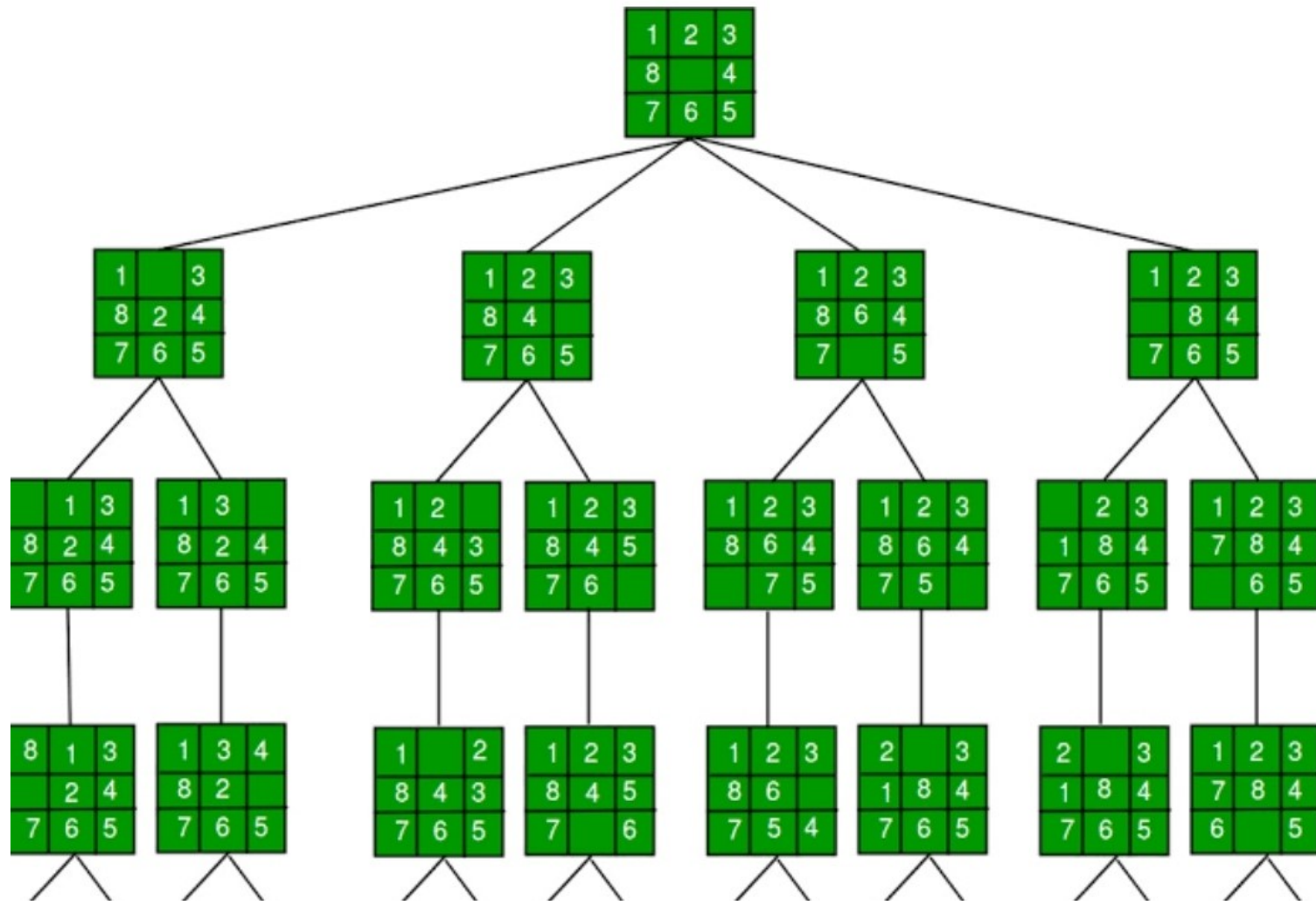
AI Tasks

Task Classification of AI

The domain of AI is classified into **Formal tasks, Mundane tasks,** and **Expert tasks.**

AI Tasks (Conti…)

Task Domains of Artificial Intelligence		
Mundane (Ordinary) Tasks	**Formal Tasks**	**Expert Tasks**

Perception
  □ Computer Vision
  □ Speech, Voice
	□ Mathematics
	□ Geometry
	□ Logic
	□ Integration and Differentiation
		□ Engineering
		□ Fault Finding
		□ Manufacturing
		□ Monitoring

Natural Language Processing
  □ Understanding
  □ Language Generation
  □ Language Translation
	Games
	  □ Go
	  □ Chess (Deep Blue)
	  □ Ckeckers
		Scientific Analysis

Common Sense	Verification	Financial Analysis
Reasoning	Theorem Proving	Medical Diagnosis
Planing		Creativity
Robotics □ Locomotive		

Thank You !