MPSSDEGB
कौशल से रोजगार, समृद्धि अपार

FITT
Foundation For Innovation And Technology Transfer

SANKALP
Ministry of Skill Development & Entrepreneurship

DAY 1 - Introduction to AI.

Introduction to AI

Course Objectives:

- Develop a foundational understanding of Artificial Intelligence (AI).
- Explore the historical development and evolution of AI.
- Analyze the capabilities and limitations of different AI techniques.
- Identify real-world applications of AI across various domains.
- Discuss the ethical considerations and potential challenges associated with AI development and deployment.
- Cultivate critical thinking and problem-solving skills in the context of AI.
- Enhance communication and collaboration skills through group discussions and presentations.

Introduction to AI

Learning Outcomes:

By the end of this course, you will be able to:

- Define AI and explain its key characteristics.
- Identify different types of AI and their applications.
- Describe the historical development of AI and its major milestones.
- Explain the basic concepts of search, problem solving, and machine learning.
- Implement simple algorithms for search and classification tasks.
- Discuss the ethical implications and challenges of AI development and deployment.
- Analyze the impact of AI on various sectors and society as a whole.
- Communicate effectively about AI concepts and applications.
- Collaborate with others on AI-related projects and tasks.

Introduction to AI

Expectations:

- Active participation in class discussions and activities.
- Completion of all assigned readings and homework assignments.
- Interaction and engagement.
- Respectful and collaborative interaction.

Introduction to AI

What is AI?

Artificial intelligence (AI) is the simulation of human intelligence in machines.
AI is a field of study in computer science that develops and studies intelligent machines.
Artificial intelligence leverages computers and machines to mimic the problem-solving and decision-making capabilities of the human mind.
The goals of AI include:

- Computer-enhanced learning
- Reasoning
- Perception

Introduction to AI

Key Characteristics of AI:

• Intelligence ◦ Adapting to new situations ◦ Solving complex problems ◦ Understanding and responding to the environment ◦ Demonstrating creativity and problem-solving	• Learning ◦ Supervised Learning ◦ Unsupervised Learning ◦ Reinforcement Learning ◦ Transfer Learning
• Reasoning ◦ Deductive reasoning ◦ Inductive reasoning	• Automation ◦ Repetitive tasks ◦ Time-consuming

Intelligence = Knowledge + ability to perceive, feel, comprehend, process, communicate, judge, learn.

Introduction to AI

Different Definitions of AI by Different People:

Philosopher (John Searle): **"Artificial intelligence is the subfield of computer science that studies and creates intelligent agents, which are systems that can reason, learn, and act autonomously."**

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Entrepreneur (Elon Musk): **"AI is the most significant threat to humanity."**

Artist (Maryam Monalisa Gharavi): **"AI is a tool, like any other tool, that can be used for good or evil. It's up to humans to decide how we use it."**

Writer (Margaret Atwood): **"AI is a mirror reflecting back to us the best and worst of our own humanity."**

Introduction to AI

Different Definitions of AI by Different People:

Scientist (Stephen Hawking): **"AI has the potential to either be the best or worst thing ever to happen to humanity. We need to be careful about how we develop it."**
Technologist (Jaron Lanier): **"AI is not magic. It's just a bunch of algorithms and data. We need to be realistic about what it can and cannot do."**
Economist (Andrew Ng): **"AI is going to create a lot of new jobs, but it's also going to automate some existing jobs. We need to prepare for this now."**
Ethicist (Stuart Russell): **"We need to develop AI in a way that is safe, fair, and beneficial to all of humanity."**
Average Person: **"AI is that thing that can beat me at chess and recommend movies on Netflix."**

Introduction to AI

Different types of AI:

1. Narrow vs. General AI:

· Narrow AI (Weak AI): ○ Also known as "applied AI" or "specialized AI" ○ Designed to perform a specific task or set of tasks ○ Examples: ▪ Playing chess ▪ Recognizing faces ▪ Translating languages ▪ Recommending products ▪ Driving a car	· General AI (Strong AI): ○ Hypothetical type of AI that can perform any intellectual task that a human can ○ Does not currently exist ○ Potential benefits and risks ○ Subject of much debate and research

Introduction to AI

2. Symbolic vs. Connectionist AI:

Symbolic AI: ◦ Also known as "rule-based AI" or "logical AI" ◦ Uses symbolic representations of knowledge and rules to make decisions ◦ Examples: ▪ Expert systems ▪ Game-playing programs ▪ Knowledge graphs	Connectionist AI: ◦ Also known as "neural networks" or "deep learning" ◦ Inspired by the structure and function of the human brain ◦ Uses interconnected nodes (neurons) to learn and process information ◦ Examples: ▪ Image recognition ▪ Natural language processing ▪ Speech recognition

Introduction to AI

Here's a table summarizing the key differences:

Feature	Narrow AI	General AI	Symbolic AI	Connectionist AI
Capabilities	Specific tasks	Any intellectual task	Rule-based reasoning	Learns from data
Examples	Chess-playing AI, facial recognition	Hypothetical	Expert systems, game-playing programs	Image recognition, natural language processing
Underlying technology	Symbolic representations, rules	Neural networks	Rules, logic	Interconnected nodes (neurons)
Development status	Widely available	Hypothetical	Relatively mature	Rapidly evolving

Introduction to AI

AI Capabilities

- Automating complex tasks
- Enhancing human capabilities
- Solving challenging problems

AI Limitations

- Lack of common sense and reasoning skills
- Susceptibility to bias and errors
- Ethical considerations

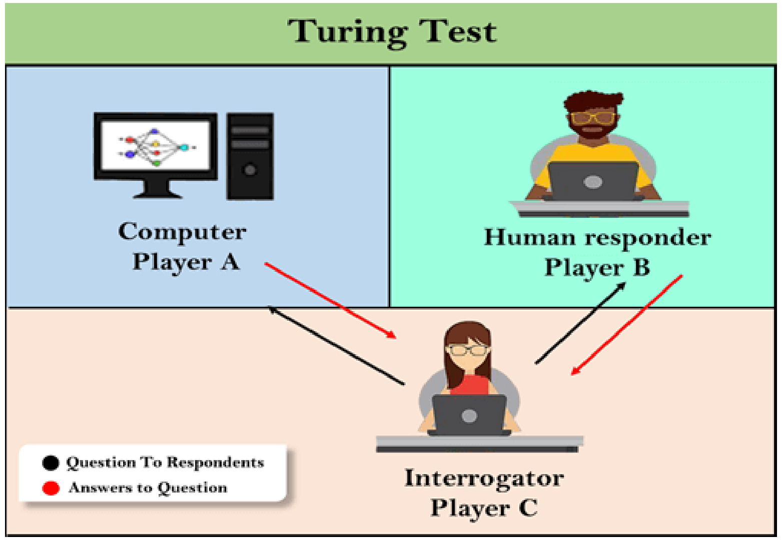
Introduction to AI

Turing Test

- In 1950, Alan Turing introduced a test to check whether a machine can think like a human or not, this test is known as the Turing Test.
- **Player A: computer**

  Player B: human

  Player C: an interrogator.



- Interrogator is aware that one of them is machine, but he needs to identify this based on questions and their responses.
- The conversation between all players is via keyboard and screen so the result would not depend on the machine's ability to convert words as speech.

Introduction to AI

Systems that act like humans

- *Natural language processing*

  for communication with human

- *Knowledge representation*

  to store information effectively & efficiently

- *Automated reasoning*

  to retrieve & answer questions using the stored information

- *Machine learning*

  to adapt to new circumstances

Related Concepts

Machine Learning (ML):

- Subfield of AI concerned with automated learning from data
- Types of ML: supervised, unsupervised, reinforcement

Deep Learning:

- Subset of ML inspired by the structure and function of the brain
- Applications in image recognition, natural language processing, etc.

Related Concepts

Historical Perspective of AI

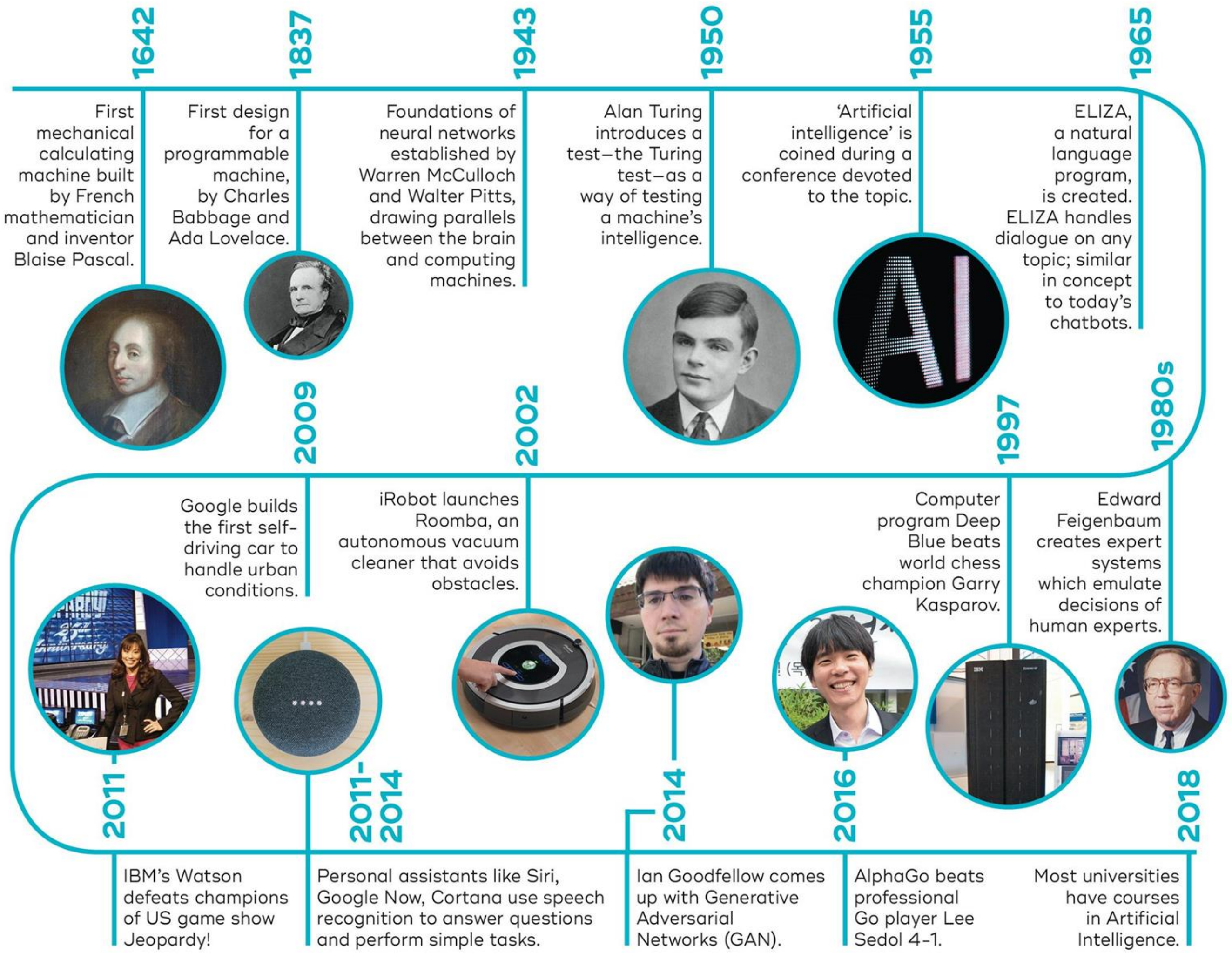
Early Beginnings
1950s: Birth of AI research
- Turing Test
- Dartmouth Workshop

1960s and 1970s: AI boom and bust
- Expert systems
- Natural language processing

1980s and 1990s: AI winter
- Limited progress
- Lack of funding

The Rise of Machine Learning
1990s and 2000s: Resurgence of AI
- Advancements in algorithms
- Availability of data and computational power
- Success of deep learning

Related Concepts



AI Today: Applications and Impact

Rapid Growth and Development of AI

The field of Artificial Intelligence (AI) is experiencing explosive growth, driven by several key factors:

Advances in Computing Power
Data Availability
Algorithmic Breakthroughs
Funding and Investment
Open-source Software
Cloud Computing
Societal Needs and Demands

AI Today: Applications and Impact

Widespread Applications

AI is finding applications in diverse domains, including:

- Healthcare
- Finance
- Transportation
- Retail
- Education
- Agriculture
- Manufacturing
- Energy
- Entertainment

AI Today: Applications and Impact

AI in the Modern World:

<table>
<tr>
<td>Healthcare
• Medical diagnosis and treatment assistance
• Drug discovery and personalized medicine
• Robotic surgery and rehabilitation</td>
<td>Finance
• Fraud detection and risk assessment
• Personalized financial advice and investment management
• Market analysis and prediction</td>
</tr>
<tr>
<td>Transportation
• Autonomous vehicles
• Traffic management and logistics optimization
• Planning and route optimization</td>
<td>Retail
• Personalized recommendations and product search
• Demand forecasting and inventory management
• Customer service and chatbots</td>
</tr>
<tr>
<td colspan="2">Education
• Adaptive learning platforms and virtual tutors
• Content personalization and skill assessment
• Educational game design and gamification</td>
</tr>
</table>

Impact of AI on Society and Future of Work

The rapid growth and development of AI are having a profound impact on society across various aspects. Here are some key areas of impact:

Employment:
- Job displacement
- New job creation
- Changing nature of work

Inequality
- Unequal access to benefits
- Bias in AI systems

Privacy and security:
- Data collection and analysis
- Security risks

Ethics and governance:
- Bias and fairness
- Transparency and explainability
- Governance and regulations

AI Today: Applications and Impact

Future of Work

- Lifelong learning: In the face of rapid technological changes, continuous learning and skill development will be crucial for individuals to remain competitive in the job market.
- Upskilling and retraining: Governments and educational institutions will need to provide training programs and resources to help workers develop the skills needed for AI-powered jobs.
- Human-AI collaboration: The future of work will likely involve humans and AI working together in collaborative teams, leveraging the strengths of both.

AI Today: Applications and Impact

The Future of AI:

Continued Growth and Development:

- AI research and development are expected to continue at an exponential rate.
- Advances in computing power, data availability, and algorithms will lead to even more powerful and sophisticated AI systems.
- Investment in AI is projected to continue increasing, fueling further innovation and advancements.

Emerging Applications in New Areas:

- AI is poised to transform new and existing domains, including:
  - Science: Drug discovery, materials science, climate change research.
  - Law: Legal research and analysis, automated legal services.
  - Arts and entertainment: Personalized content creation, interactive experiences.
  - Space exploration: Autonomous robots for space exploration, resource discovery.

AI Today: Applications and Impact

Potential Benefits and Challenges:

- Benefits:
  - Enhanced productivity and efficiency across various sectors.
  - Improved decision-making based on data analysis.
  - Personalized experiences and services tailored to individual needs.
  - Automation of dangerous and tedious tasks.
  - Advances in healthcare and scientific research.
- Challenges:
  - Job displacement and the need for reskilling and retraining.
  - Ethical concerns and potential for bias and discrimination.
  - Privacy and security risks associated with data collection and analysis.
  - The potential for misuse of AI for malicious purposes.

Problems in AI

A problem in AI refers to a situation where we need to find a sequence of actions that achieve a desired goal or outcome.

The problem can be defined by the following elements:

- Initial state: The starting point of the problem.
- Goal state: The desired outcome or solution.
- Operators: Actions that can be applied to the current state to transition to another state.
- State space: The set of all possible states that can be reached from the initial state.
- Transition model: Defines the effects of applying operators on states.
- Path cost: The cost associated with applying an operator.

Problem space

The problem space is a conceptual representation of all possible states, operators, and transitions that exist in a problem.
It can be visualized as a graph where states are nodes and operators are edges connecting those nodes.

Search in AI

Search is a core technique in AI used to find solutions to problems by systematically exploring the state space.

Search algorithms work by applying operators to the current state, generating new states, and evaluating them against the goal state.

Types of search:

Search algorithms can be broadly categorized into two types:

Uninformed search:

These algorithms explore the state space without any prior knowledge about the goal state.

Ex: Breadth-First Search (BFS) and Depth-First Search (DFS).

Inefficient for large state spaces.

Heuristic search:

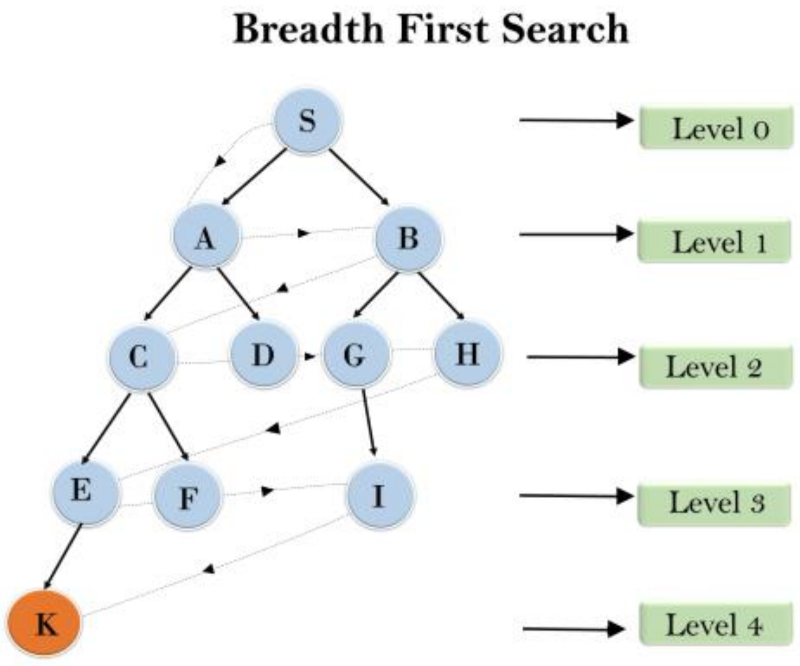
These algorithms utilize heuristics, which are estimates of the distance to the goal state, to guide the search process and focus on promising areas of the state space.

Ex: A* search, Hill Climbing, and Best-First Search.

Problems, Problem Spaces and Search in AI

Search in AI

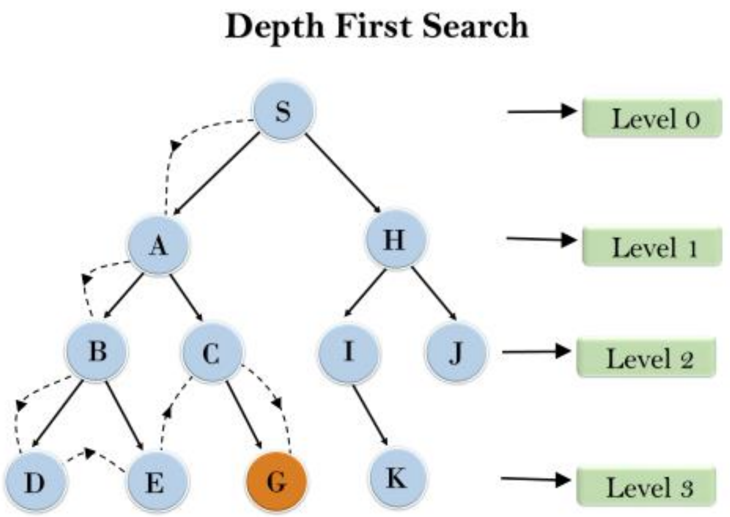
Uninformed search: Breadth-First Search



S---> A--->B---->C--->D---->G--->H--->E---->F---->I---->K

Uninformed search: Depth-First Search

Root node--->Left node ----> right node.



Problems, Problem Spaces and Search in AI

Search in AI

A* Algorithm

A Powerful Heuristic Search Technique

Combines the strengths of uninformed search (BFS, DFS) and heuristic search.

It efficiently finds the optimal path (shortest path, lowest cost) from an initial state to a goal state in a problem space.

$$f(n) = g(n) + h(n)$$

Estimated cost of the cheapest solution.

Cost to reach node n from start state.

Cost to reach from node n to goal node

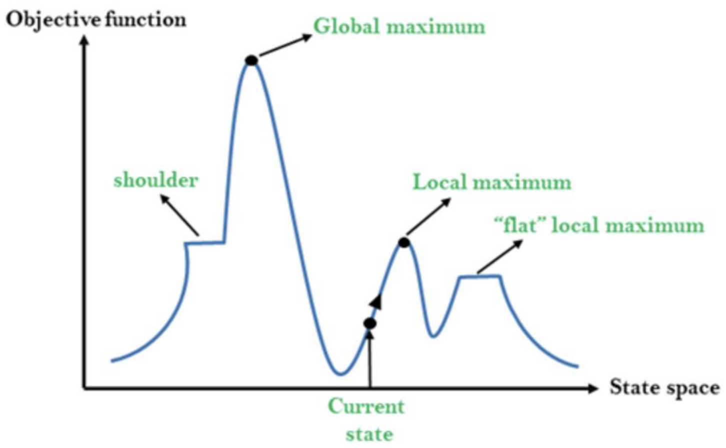
Search in AI

Hill Climbing Algorithm

to find optimal solutions

utilize estimates (heuristics) to guide the search process towards promising areas of the state space.

Ie. Hill climbing algorithm is a local search algorithm which continuously moves in the direction of increasing elevation/value to find the peak of the mountain or best solution to the problem. It terminates when it reaches a peak value where no neighbour has a higher value.



Knowledge representation

Knowledge representation (KR) is a core area of artificial intelligence (AI) concerned with how to encode and store knowledge in a computer system for various applications.
Representing knowledge effectively is crucial for enabling AI systems to reason, learn, and solve problems.

Knowledge representation

Representation Knowledge using Rules:

Rules are a common and powerful way to represent knowledge in AI.

A rule typically consists of two parts:

- Premise (IF clause): Specifies the conditions that must be true for the rule to apply.
- Conclusion (THEN clause): Specifies the action or consequence that follows if the premise is true.

Example Rule:

IF the sky is cloudy AND the wind is strong THEN it will rain.

Languages used in Artificial Intelligence

Artificial Intelligence has become an important part of human life as we are now highly dependent on machines.

AI Programming Language

Case Studies Highlighting AI Impact:

1. Healthcare:

- Case Study: DeepMind's AI program AlphaFold predicts protein structures, accelerating drug discovery and development.
- Impact: Reduced time and cost of drug development, potentially leading to faster treatment for diseases like cancer and Alzheimer's.

2. Finance:

- Case Study: Robo-advisors use AI to manage investment portfolios automatically.
- Impact: Increased access to financial services for individuals who may not have access to traditional financial advisors, potentially leading to improved financial literacy and wealth management.

3. Transportation:

- Case Study: Tesla's Autopilot system uses AI to assist drivers with tasks like steering, acceleration, and braking.
- Impact: Improved safety and convenience for drivers, potentially reducing traffic accidents and fatalities.

Case Studies Highlighting AI Impact:

4. Retail:

- Case Study: Amazon's product recommendation system uses AI to suggest products to customers based on their purchase history and browsing behavior.
- Impact: Increased sales for retailers and a more personalized shopping experience for customers.

5. Education:

- Case Study: Duolingo uses AI to personalize language learning lessons for individual students.
- Impact: Improved learning outcomes for students and a more engaging learning experience.

6. Agriculture:

- Case Study: Blue River Technology developed an AI-powered robot that can selectively remove weeds in crops.
- Impact: Reduced herbicide use, leading to environmental benefits and increased crop yields.

Case Studies Highlighting AI Impact:

7. Manufacturing:

- Case Study: Siemens uses AI to predict and prevent machine failures in factories.
- Impact: Reduced downtime and increased efficiency in manufacturing processes.

8. Energy:

- Case Study: DeepMind's AI program AlphaZero developed a strategy for controlling energy grids that is more efficient and resilient than traditional methods.
- Impact: Reduced energy consumption and improved grid reliability.

9. Entertainment:

- Case Study: Netflix uses AI to recommend movies and TV shows to users based on their viewing history and preferences.
- Impact: Increased customer engagement and satisfaction, leading to higher retention rates.

10. Sports:

- Case Study: Stats Perform uses AI to analyze sports data and generate insights for teams and athletes.
- Impact: Improved decision-making and performance in sports.

Toy Problems vs Real-world Problems

- A **toy problem** is intended to illustrate or exercise various problem solving methods. It can be given a concise, exact description.

- A **real world problem** is one whose solutions people actually care about. Such problems tend not to have a single agreed-upon description, but we can give the general flavor of their formulations.

Toy Problems vs. Real-World Problems

Toy Problems/Puzzles
- concise and exact description
- used for illustration purposes (e.g. here)
- used for performance comparisons

Real-World Problems
- no single, agreed-upon description
- people care about the solutions

Summary of Problem Solving with AI – Toy Probl

1. 8 Puzzle
2. Water Jug
3. Block World
4. Tic Tac Toe
5. Missionaries and Cannibals

8- PUZZLE PROBLEM

The **8-puzzle**, an instance of which is shown below, consists of a 3×3 board with eight numbered tiles and a blank space. A tile adjacent to the blank space can slide into the space. The object is to reach a specified goal state, such as the one shown on the right of the figure.

1	2	3
7	8	4
6		5

Initial State

1	2	3
8		4
7	6	5

Goal State

8- PUZZLE PROBLEM

States: A state description specifies the location of each of the eight tiles and the blank in one of the nine squares.

Initial state: Any state can be designated as the initial state.

Successor function: This generates the legal states that result from trying the four actions (blank moves Left, Right, Up, or Down).

Goal test: This checks whether the state matches the goal configuration (Other goal configurations are possible.)

Path cost: Each step costs 1, so the path cost is the number of steps in the path.

8- PUZZLE PROBLEM

- **h_f= +1** for every correct position
- Solution of this problem is “movement of tiles” in order to reach goal state.
- The transition function or legal move is any one tile movement by one space in any direction.

1	2	3
7	8	4
6		5

1	2	3
7	8	4
	6	5

Move 1
h_f=6

1	2	3
7	8	4
6	5	

Move 2
h_f = 4

1	2	3
7		4
6	8	5

Move 3
h_f = 5

A Water Jug Problem: You are given two jugs, a 4-gallon one and a 3-gallon one, a pump which has unlimited water which you can use to fill the jug, and the ground on which water may be poured. Neither jug has any measuring markings on it. How can you get exactly 2 gallons of water in the 4-gallon jug?

WATER JUG PROBLEM

Solution:

The state space for this problem can be described as the set of ordered pairs of integers **(x,y)**

Where,

X represents the quantity of water in the 4-gallon jug **X= 0,1,2,3,4**
Y represents the quantity of water in 3-gallon jug **Y=0,1,2,3**

Note
$0 \leq X \leq 4$, and $0 \leq Y \leq 3$

Start State: (0,0)
Goal State: **(2, n)** for any n. Attempting to end up in a goal state.(since the problem doesn't specify the quantity of water in 3-gallon jug)

WATER JUG PROBLEM

Generate production rules for the water jug problem

Production Rules:

1. (x,y) -> (4,y) Fill x
2. (x,y) -> (x,3) Fill y
3. (x,y) -> (x-d, y) Pour water out from X
4. (x,y) -> (x,y-d) Pour water from y
5. (x,y) -> (0,y) Empty x
6. (x,y) -> (x,0) Empty y
7. (x,y) -> (4,y-(4-x)) Pour water from y into x until x is full
8. (x,y) -> (x – (3-y), 3) Pour water from x into y until y is full.
9. (x,y) -> (x+y, 0) Pour all water from y to x
10. (x,y) -> (0, x+y) Pour all water from x to y
11. (0,2) -> (2,0) Pour 2 Gallon of water from y to x
12. (2, y) -> (0,y) Pour 2 Gallon of water from x to ground.

WATER JUG PROBLEM

First solution

	4-g jug	3-g jug
Initial	0	0
R2	0	3
R9	3	0
R2	3	3
R7	4	2
R5	0	2
R9	2	0

Goal State

1. (x,y) -> (4,y) Fill x
2. (x,y) -> (x,3) Fill y
3. (x,y) -> (x-d, y) Pour water out from X
4. (x,y) -> (x,y-d) Pour water from y
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12. (2, y) -> (0,y) Pour 2 Gallon of water from x to ground.

BLOCK WORLD PROBLEM

What is the Blocks World? -- The world consists of:

- A flat surface such as a tabletop
- An adequate set of identical blocks which are identified by letters.
- The blocks can be stacked one on one to form towers of apparently unlimited height.
- The stacking is achieved using a robot arm which has fundamental operations and states which can be assessed using logic and combined using logical operations.
- The robot can hold one block at a time and only one block can be moved at a time.

Blocks world

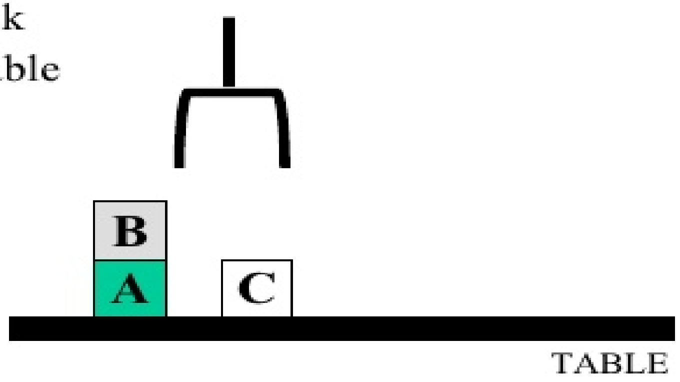
The **blocks world** is a micro-world that consists of a table, a set of blocks and a robot hand.

Some domain constraints:

- Only one block can be on another block
- Any number of blocks can be on the table
- The hand can only hold one block

Typical representation:

ontable(a)
ontable(c)
on(b,a)
handempty
clear(b)
clear(c)



BLOCK WORLD PROBLEM

$h_f = -10$

Start	Goal	
a	e	+4
e	d	+3
c	c	+2
b	b	+1
d	a	0

Heuristic

For each block that has the correct support structure: +1 to every block in the support structure.

For each block that has a wrong support structure: -1 to every block in the support structure.

BLOCK WORLD PROBLEM

- STRIPS - an action-centric representation ,for each action , specifies the effect of an action.

A **STRIPS planning problem** specifies:

1) an initial state *S*
2) a goal *G*
3) a set of STRIPS actions

BLOCK WORLD - STRIPS
(STanford Research Institute Problem Solver)

BLOCK WORLD PROBLEM

- STRIPS - an action-centric representation ,for each action , specifies the effect of an action.

The STRIPS representation for an action consists of three lists,

- Pre_Cond list contains predicates which have to be true before operation.
- ADD list contains those predicates which will be true after operation
- DELETE list contain those predicates which are no longer true after operation

TIC TAC TOE PROBLEM

The game **Tic Tac Toe** is also known as **Noughts** and **Crosses** or **X**s and **O**s ,the player needs to take turns marking the spaces in a 3x3 grid with their own marks,
if 3 consecutive marks (**Horizontal**, **Vertical**,**Diagonal**) are formed then the player who owns these moves get won.

Assume ,

Player 1 - X
Player 2 - O

So,a player who gets 3 consecutive marks first,they will win the game .

1	2	3
4	5	6
7	8	9

2-D game-board

1	2	3	4	5	6	7	8	9

1-D Vector

MISSIONARIES AND CANNIBAL PROBLEM

Let Missionary is denoted by 'M' and Cannibal, by 'C'.
These rules are described below:

Rule 1 :	(0, M)	:	One missionary sailing the boat from bank-1 to bank-2
Rule 2 :	(M, 0)	:	One missionary sailing the boat from bank-2 to bank-1
Rule 3 :	(M, M)	:	Two missionaries sailing the boat from bank-1 to bank-2
Rule 4 :	(M, M)	:	Two missionaries sailing the boat from bank-2 to bank-1
Rule 5 :	(M, C)	:	One missionary and one Cannibal sailing the boat from bank-1 to bank-2
Rule 6 :	(C, M)	:	One missionary and one Cannibal sailing the boat from bank-2 to bank-1
Rule 7 :	(C, C)	:	Two Cannibals sailing the boat from bank-1 to bank-2
Rule 8 :	(C, C)	:	Two Cannibals sailing the boat from bank-2 to bank-1
Rule 9 :	(0, C)	:	One Cannibal sailing the boat from bank-1 to bank-2
Rule 10 :	(C, 0)	:	One Cannibal sailing the boat from bank-2 to bank-1

All or some of these production rules will have to be used in a particular sequence to find the solution of the problem.

MISSIONARIES AND CANNIBAL PROBLEM

Rules applied and their sequence in Missionaries and Cannibals problem

After application of rule	persons in the river bank-1	persons in the river bank-2	boat position
Start state	M, M, M, C, C, C	0	bank-1
5	M, M, C, C	M, C	bank-2
2	M, M, C, C, M	C	bank-1
7	M, M, M	C, C, C	bank-2
10	M, M, M, C	C, C	bank-1
3	M, C	C, C, M, M	bank-2
6	M, C, C, M	C, M	bank-1
3	C, C	C, M, M, M	bank-2
10	C, C, C	M, M, M	bank-1
7	C	M, M, M, C, C	bank-2
10	C, C	M, M, M, C	bank-1
7	0	M, M, M, C, C, C	bank-2

MISSIONARIES AND CANNIBAL PROBLEM

State space: triple (x,y,z) with $0 \le x,y,z \le 3$, where x,y, and z represent the number of missionaries, cannibals and boats currently on the original bank.
Initial State: (3,3,1)
Successor function: From each state, either bring one missionary, one cannibal, two missionaries, two cannibals, or one of each type to the other bank.
Note: Not all states are attainable (e.g., (0,0,1)), and some are illegal.
Goal State: (0,0,0) Path Costs: 1 unit per crossing

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THANKS