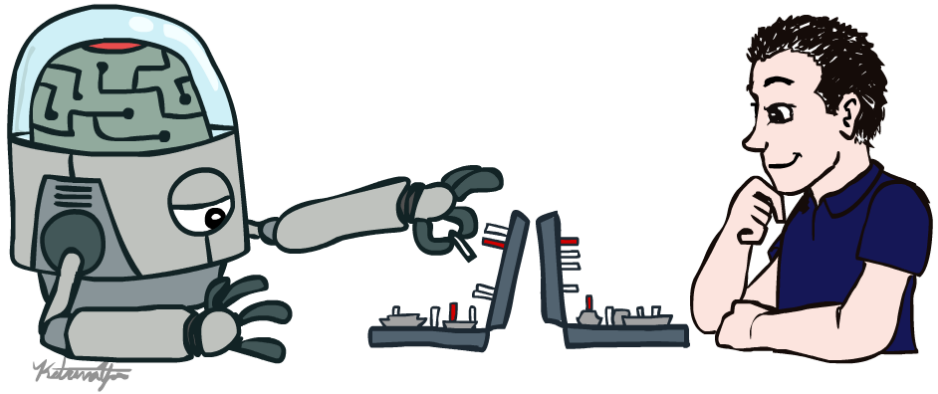
Introduction to Artificial Intelligence



Instructors: Dr. Emad Natsheh

INTRODUCTION MAP OF ARTIFICIAL INTELLIGENCE AND HEALTH

Psychology

Philosophy

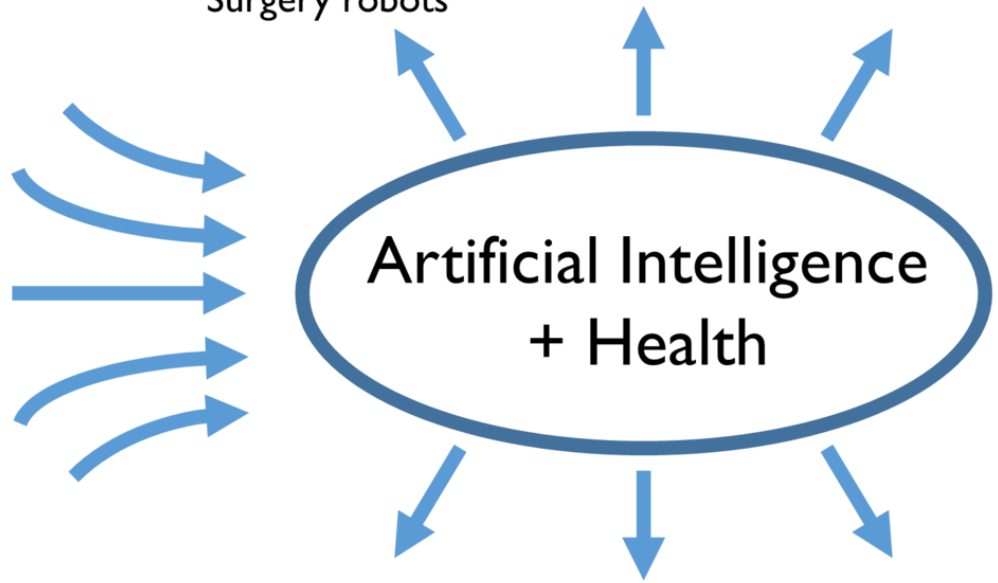
Engineering

Neuroscience

Economy

Computer Science

Health



ROBOTICS

MACHINE PERCEPTION

PATTERN RECOGNITION

QUESTION-ANSWERING SYSTEM

Robotics

Robotic nurses,
Ambulance drones,
Surgery robots

Perception

Image recognition,
MRI, X-ray, Pictures

Natural Language

Chatbots,
Doctor's notes

Knowledge Representation
Logic
Planning
Social Intelligence
Cognition

KNOWLEDGE REPRESENTATION

PLANNING

COGNITION

Learning

Machine learning,
"Predictions"

Multi Agent Systems

Decision making,
Collaboration,
Care teams

Reasoning

Expert systems,
Recommendations,
Similarity learning

PREDICTIVE MODELING

ARTIFICIAL NEURAL NETWORK

MACHINE LEARNING

MULTI-AGENT SYSTEM

TEAMWORK

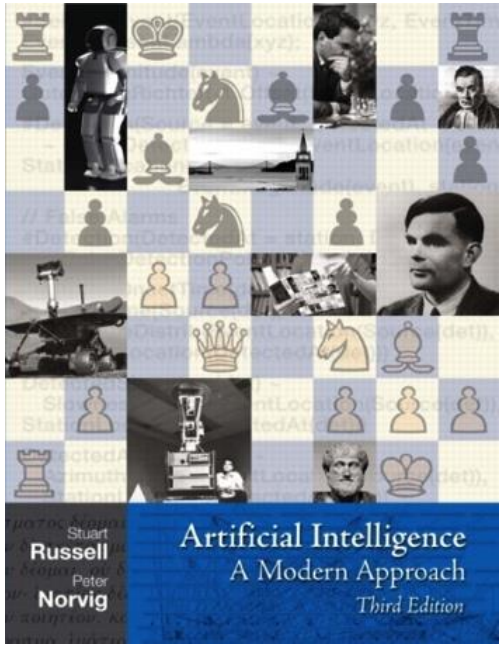
EXPERT SYSTEM

Prerequisites

- Comfortable programming in general-purpose programming language
- Some knowledge of algorithmic concepts such as running times of algorithms
- Not scared of mathematics

Textbook

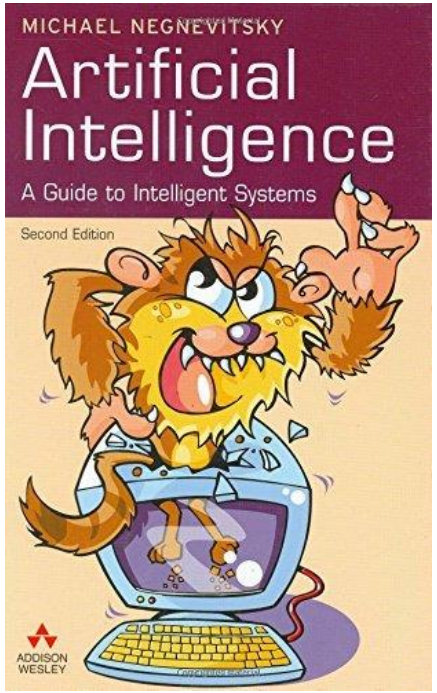
- Russell & Norvig, AI: A Modern Approach.



- Warning: our presentation does not necessarily follow the presentation in the book.

Textbook

- Michael, Artificial Intelligence: A Guide to Intelligent Systems.



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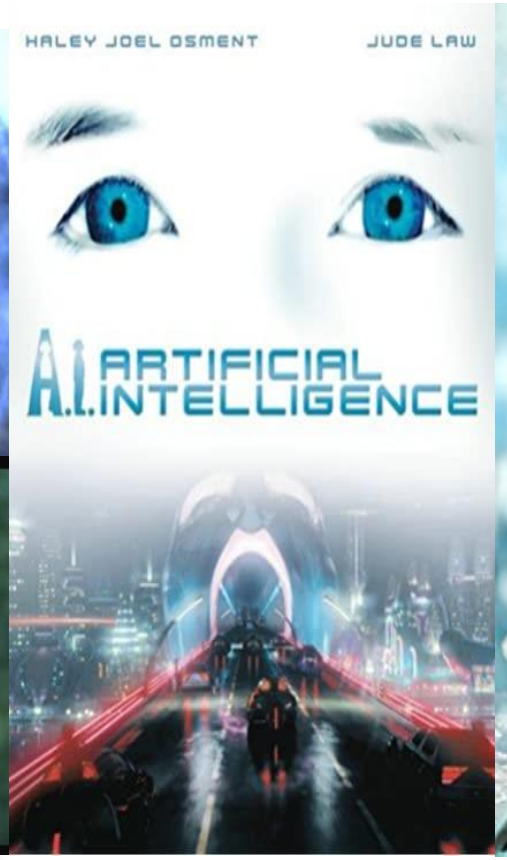
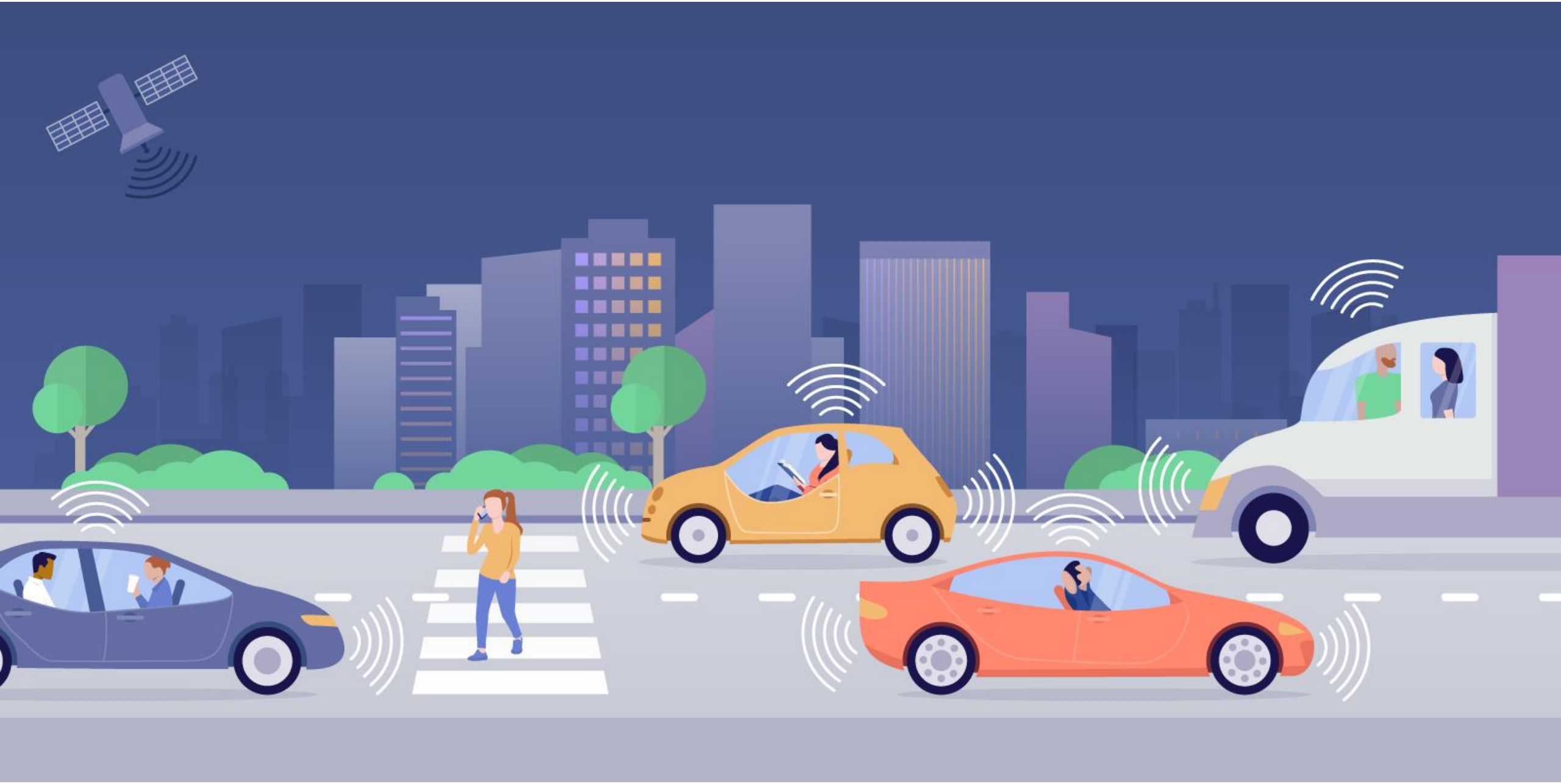
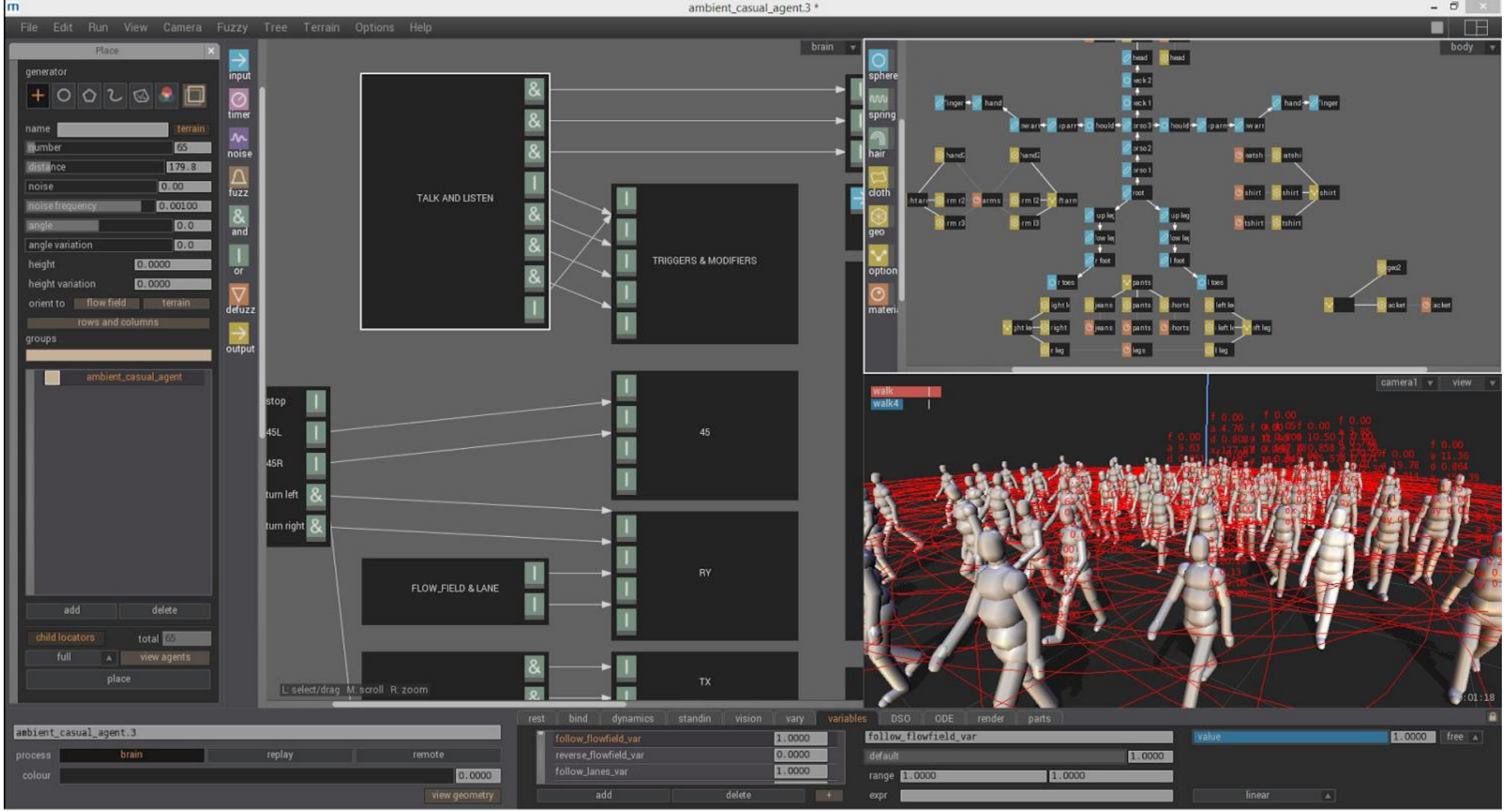
i,ROBOT


HALEY JOEL OSMENT
JUDE LAW
A.I. ARTIFICIAL INTELLIGENCE


HUMANITY'S LAST HOPE ISN'T HUMAN
REJECT
FROM THE DIRECTOR OF DISTRICT 9
CHAPPiE
MARCH 6
IMAX


TUG
CAUTION
MAY CONTAIN
CHEMOTHERAPY DRUG
CAUTION
MAY CONTAIN
CHEMOTHERAPY DRUG





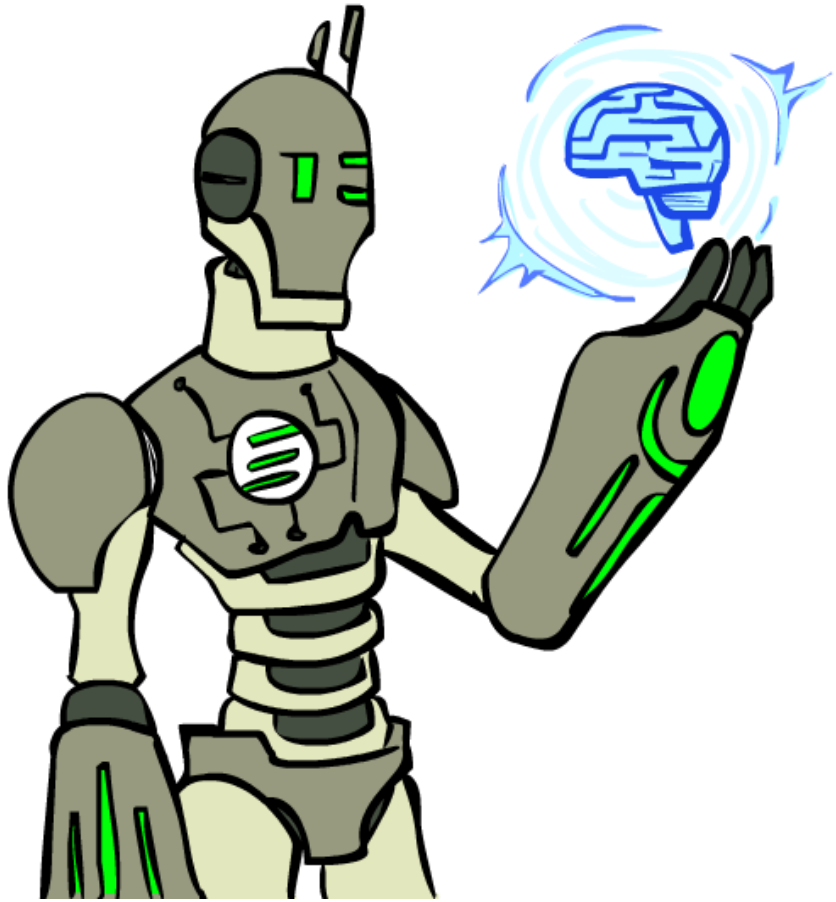
Massive Prime - Main Interface (3 vewports configuration)

What Can AI Do?

- Play a decent game of table tennis?
- Play a decent game of Jeopardy?
- Drive safely along a curving mountain road?
- Drive safely along Rafedia street?
- Buy a week's worth of food on the web?
- Converse successfully with another person for an hour?
- Perform a surgical operation?
- Translate spoken Chinese into spoken English in real time?
- Giving legal advice in a specialized area of law?
- Identifying objects in images?

This Chapter

- What is artificial intelligence (AI)?
- Look briefly about its history
- Talk about its branches and techniques
- What is this course?

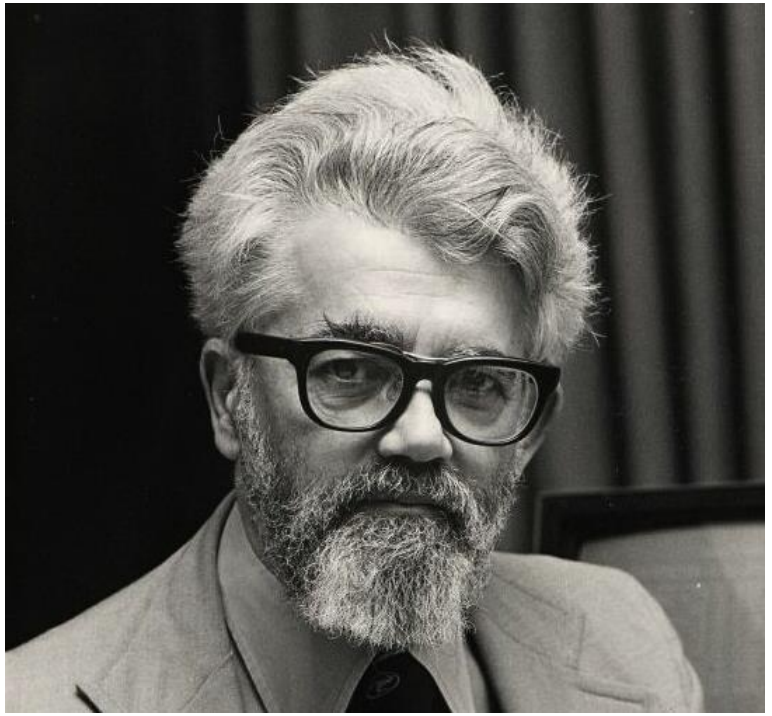


Definition

What is Artificial Intelligence ?

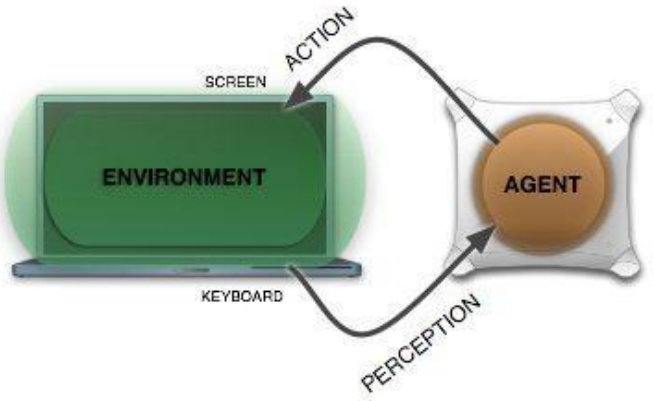
- John McCarthy, who coined the term artificial intelligence (AI) in 1955, define it as "**the science and engineering of making intelligent machines**".

John McCarthy
– Father of AI and Lisp



Others Definitions

- Artificial Intelligence (AI) is the study of how to make computers do things which, at the moment, people do better.
- AI is a branch of computer science and engineering that deals with intelligent behaviour, learning, and adaptation in machines.
- AI is the study and design of an intelligent agents, where an intelligent agent is a system that perceives its environment and takes actions that maximize its chances of success.



Strong AI vs Weak AI

Strong AI

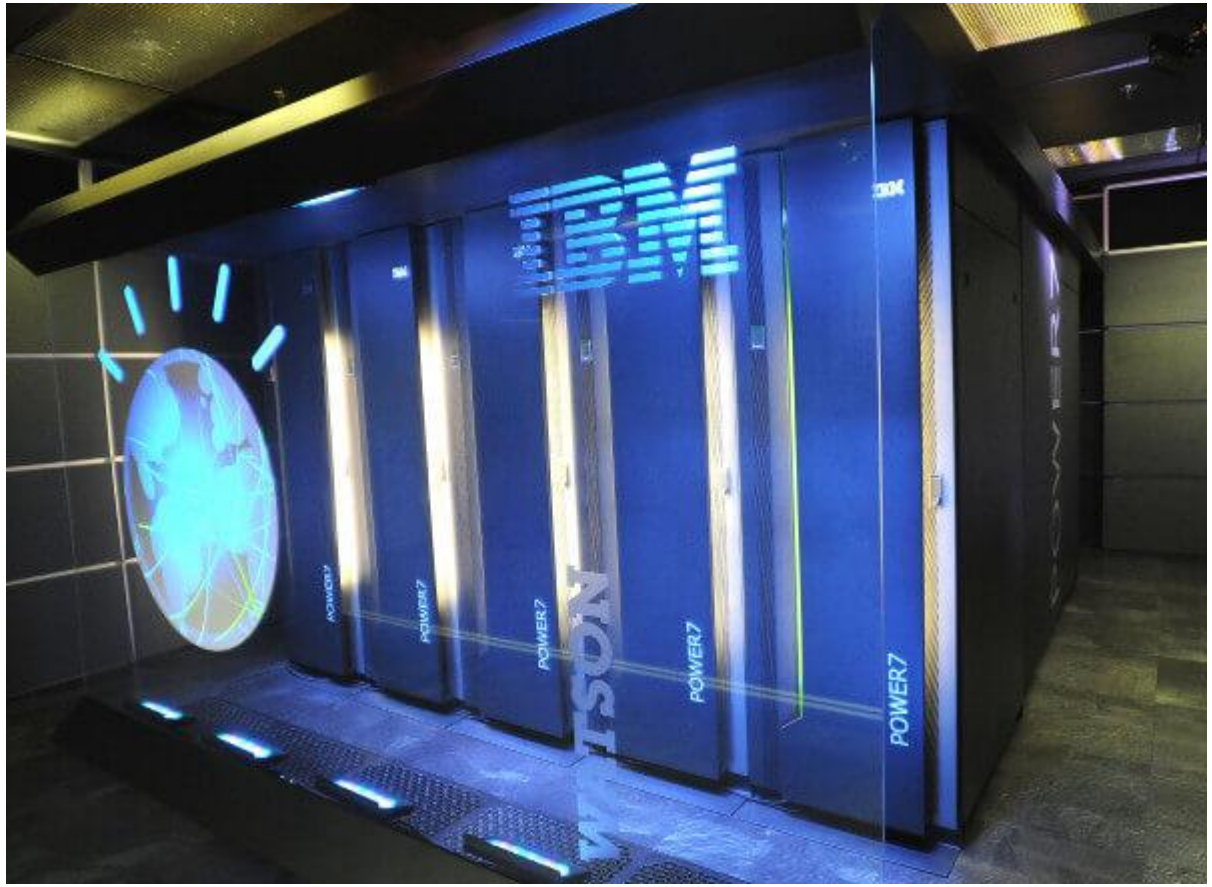
- Generally artificial intelligence research aim to create AI that can replicate human intelligence completely
- Strong AI aims to build machines whose overall ability is similar to a human being
  - If it can do typical human task
  - If it can apply a wide range of background knowledge
  - If it has some degree of self awareness

Strong AI vs Weak AI

Weak AI

- Weak AI refers to the use of software to study or accomplish specific problem solving or reasoning task that do not include the full range of human ability.
- Example: a chess program such as (Deep Blue)

Watson (Question-Answering Computer) !!!!



What is Artificial Intelligence (again)?

"The exciting new effort to make computers think … *machines with minds*, in the full and literal sense" (Haugeland, 1985) "[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning …" (Bellman, 1978)	"The study of mental faculties through the use of computational models" (Charniak and McDermott, 1985) "The study of the computations that make it possible to perceive, reason, and act" (Winston, 1992)
"The art of creating machines that perform functions that require intelligence when performed by people" (Kurzweil, 1990) "The study of how to make computers do things at which, at the moment, people are better" (Rich and Knight, 1991)	"A field of study that seeks to explain and emulate intelligent behavior in terms of computational processes" (Schalkoff, 1990) "The branch of computer science that is concerned with the automation of intelligent behavior" (Luger and Stubblefield, 1993)

Definitions may be organised into four categories:

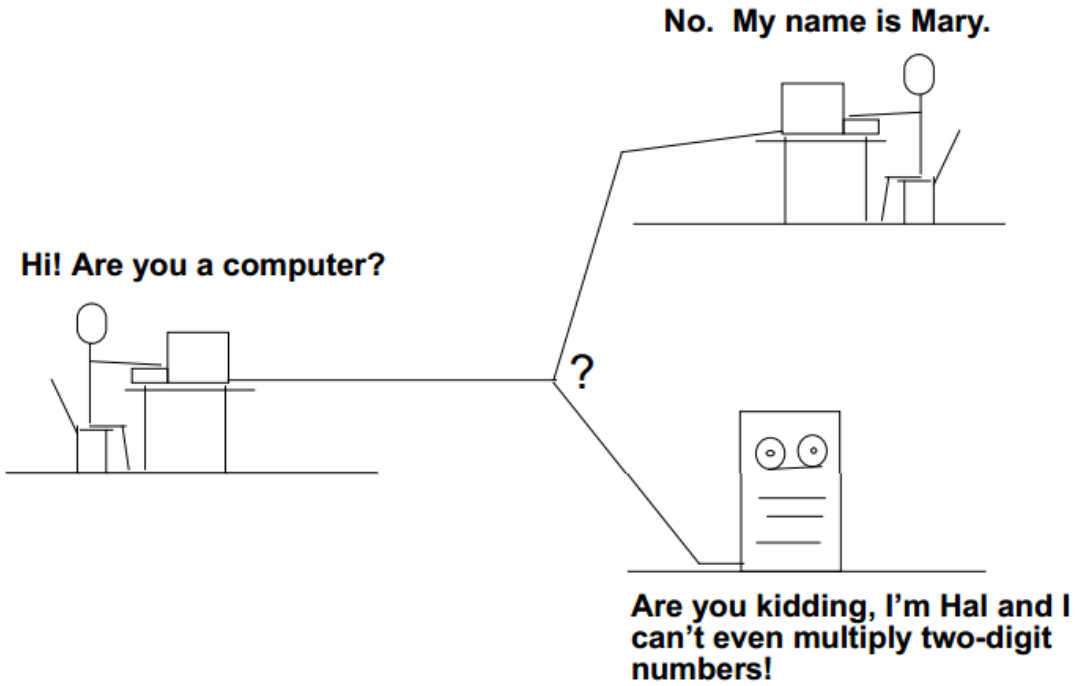
- ❑ **Systems that think like humans.**
- ❑ **Systems that act like humans.**
- ❑ **Systems that think rationally.**
- ❑ **Systems that act rationally.**

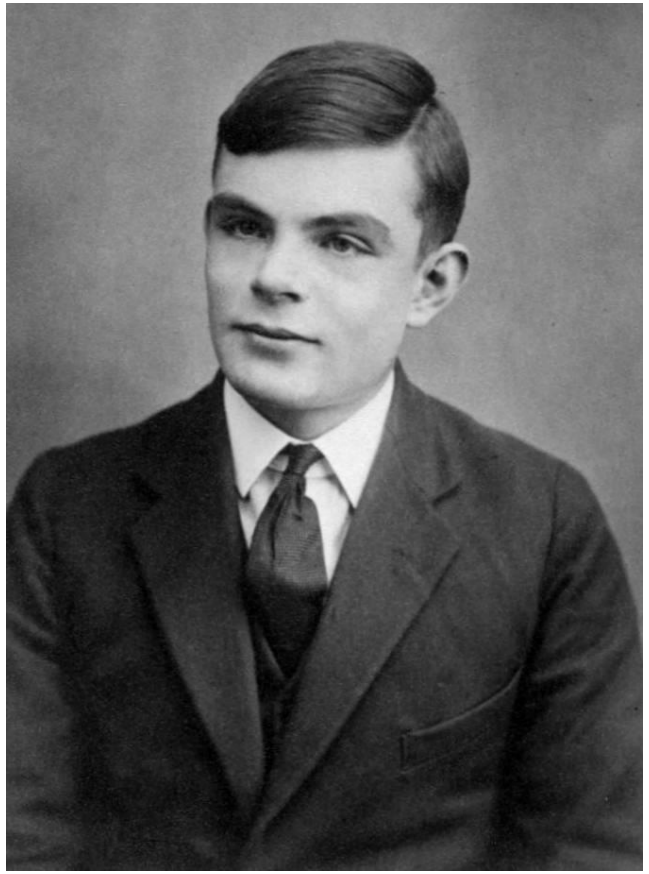
Thinking Humanly

- This requires "getting inside" of the human mind to see how it works and then comparing our computer programs to this. This is what *cognitive science* attempts to do. Another way to do this is to observe a human problem solving and argue that one's programs go about problem solving in a similar way.
- **Example:** GPS (General Problem Solver) was an early computer program that attempted to model human thinking. The developers were not so much interested in whether or not GPS solved problems correctly. They were more interested in showing that it solved problems like people, going through the same steps and taking around the same amount of time to perform those steps.

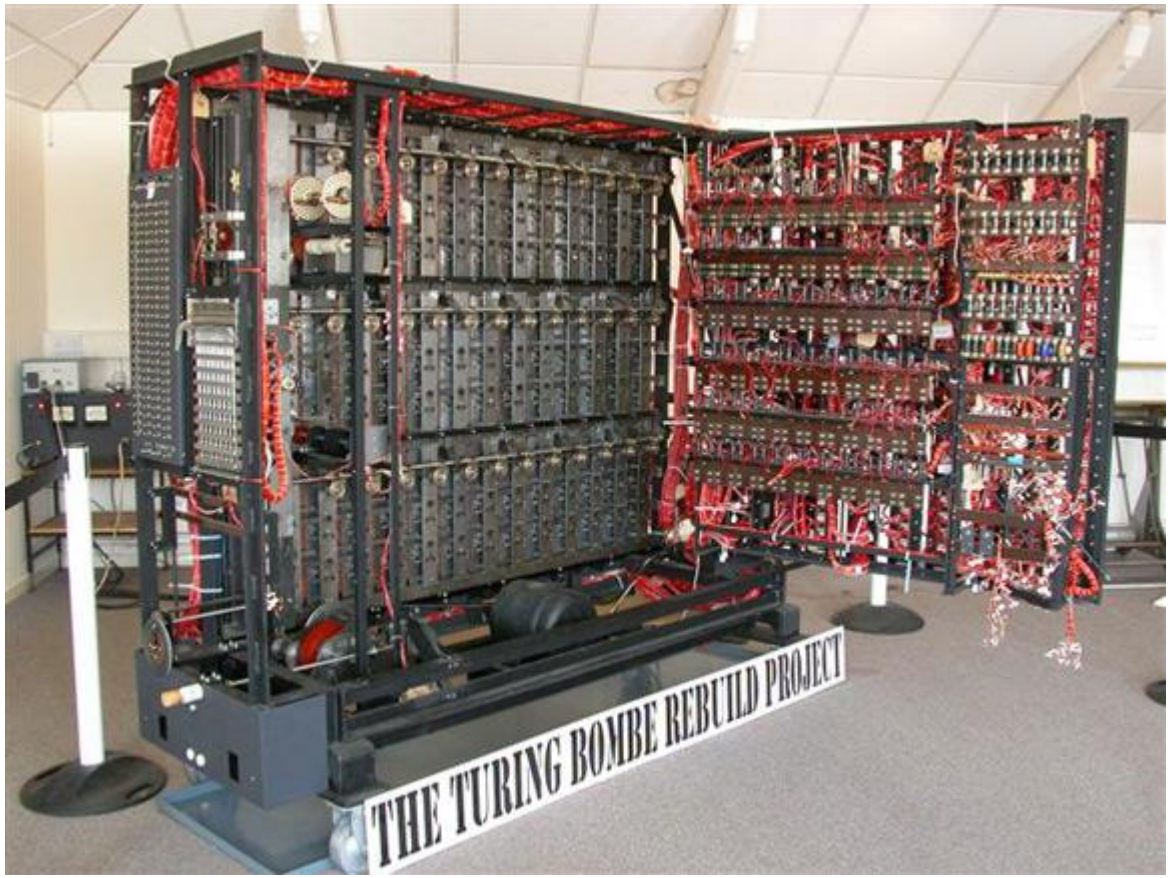
Acting Humanly

- The first proposal for success in building a program and acts humanly was the Turing Test.





The Imitation Game !!!



Turing Test

- To pass this test requires:
  - Natural language processing
  - Knowledge representation
  - Automated reasoning
  - Machine learning
  - Computer vision

John Searle (The Chinese Room)

Thinking Rationally.

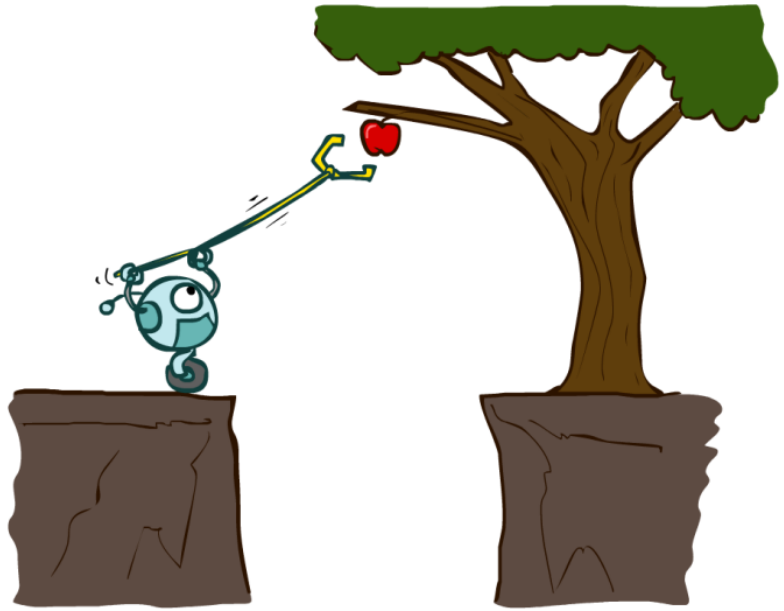
- Aristotle was one of the first to attempt to codify "thinking".
  His **syllogisms** provided patterns of argument structure that always gave correct conclusions, giving correct premises.
- This initiate the field of **logic**. Formal logic was developed in the late nineteenth century. This was the first step toward enabling computer programs to reason logically.
- **Example**: All computers use energy. Using energy always generates heat. Therefore, all computers generate heat.
- The goal is to formalize the reasoning process as a system of logical rules
- The problem not all problems can be solve by reasoning (logical rules)

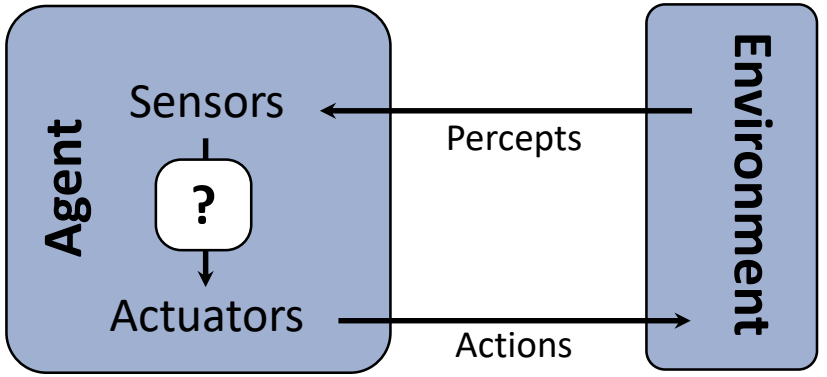
Acting Rationally: The rational agent approach

- The branch of computer science that is concerned with the automation of intelligent behaviour
- One way to act rationally is to reason logically and then act on ones conclusions. But this is not all of rationality because agents often find themselves in situations where there is no provably correct thing to do, yet they must do something.
- An **agent** is just something that perceives and acts.
- Goal is to develop system that are rational if not sufficient

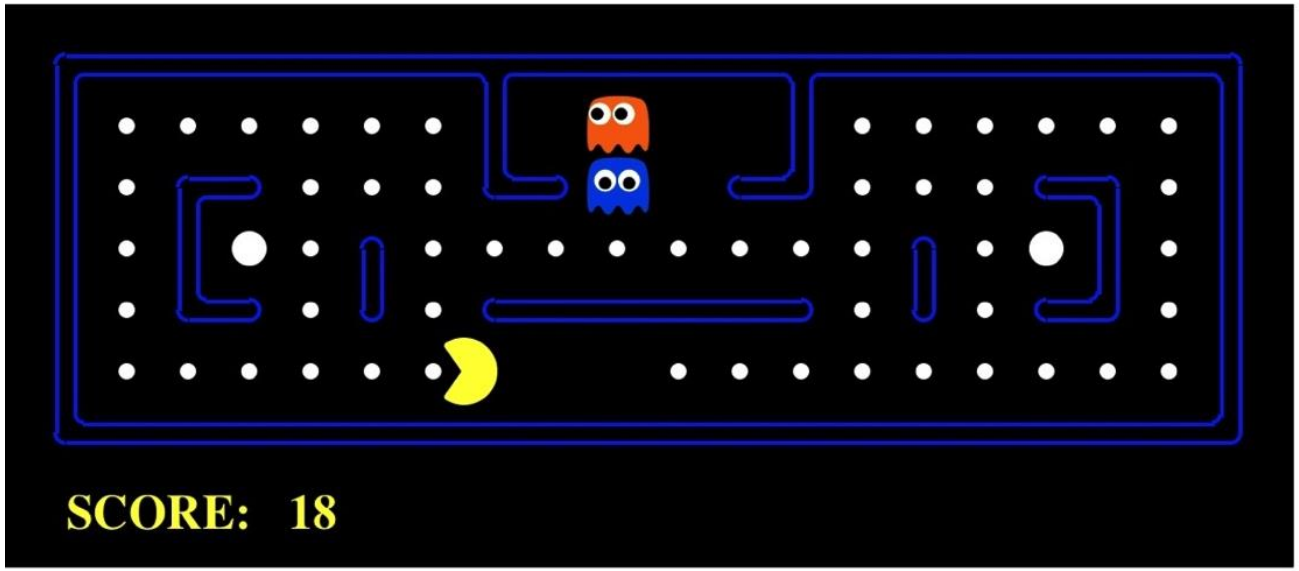
Rational Agents

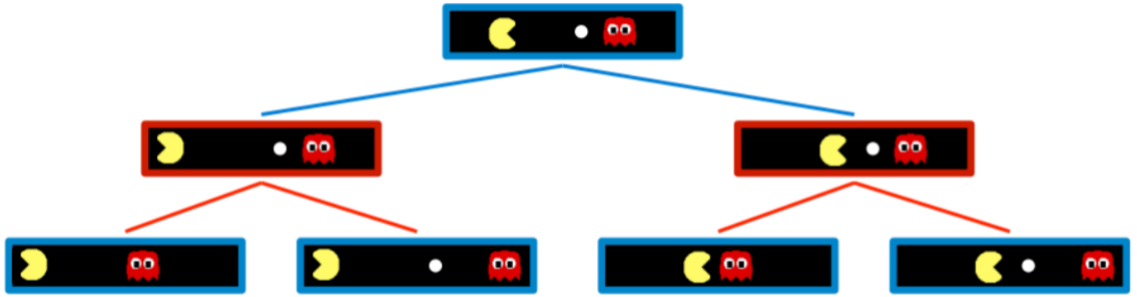
- An **agent** is an entity that *perceives* and *acts*.
- A **rational agent** selects actions that maximize its (expected) **utility**.
- Characteristics of the **percepts, environment,** and **action space** dictate techniques for selecting rational actions
- **In this course** we will learn general AI techniques for a variety of problem types

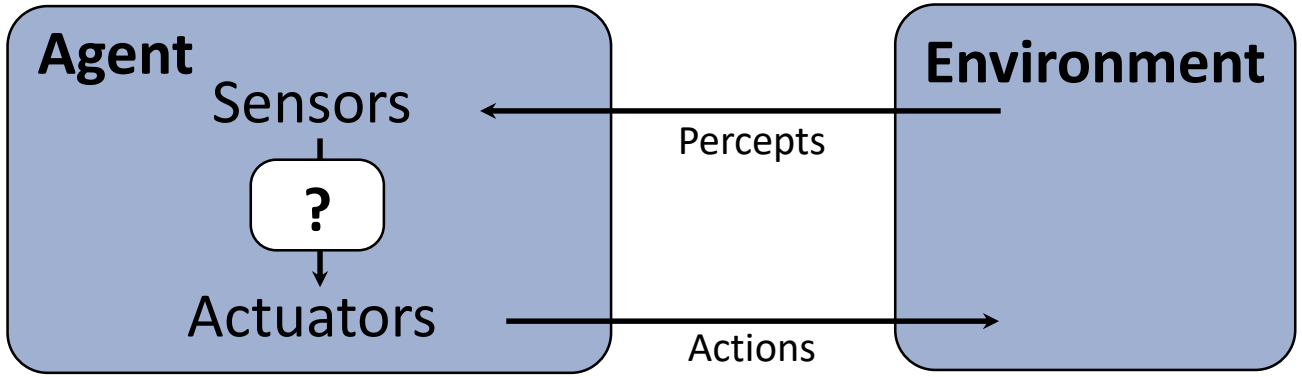




Pac-Man as an Agent







Russell and Norvig

“We should not expect computer intelligence to be the same as human intelligence anymore than we expect airplanes to fly the same as birds “

Examples

A.I. TIMELINE

1950
TURING TEST
Computer scientist Alan Turing proposes a test for machine intelligence. If a machine can trick humans into thinking it is human, then it has intelligence

1955
A.I. BORN
Term 'artificial intelligence' is coined by computer scientist, John McCarthy to describe "the science and engineering of making intelligent machines"

1961
UNIMATE
First industrial robot, Unimate, goes to work at GM replacing humans on the assembly line

1964
ELIZA
Pioneering chatbot developed by Joseph Weizenbaum at MIT holds conversations with humans

1966
SHAKEY
The 'first electronic person' from Stanford, Shakey is a general-purpose mobile robot that reasons about its own actions

A.I. WINTER
Many false starts and dead-ends leave A.I. out in the cold

1997
DEEP BLUE
Deep Blue, a chess-playing computer from IBM defeats world chess champion Garry Kasparov

1998
KISMET
Cynthia Breazeal at MIT introduces KISmet, an emotionally intelligent robot insofar as it detects and responds to people's feelings

1999
AIBO
Sony launches first consumer robot pet dog AiBO (AI robot) with skills and personality that develop over time

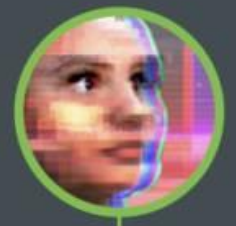
2002
ROOMBA
First mass produced autonomous robotic vacuum cleaner from iRobot learns to navigate and clean homes

2011
SIRI
Apple integrates Siri, an intelligent virtual assistant with a voice interface, into the iPhone 4S

2011
WATSON
IBM's question answering computer Watson wins first place on popular $1M prize television quiz show *Jeopardy*

2014
EUGENE
Eugene Goostman, a chatbot passes the Turing Test with a third of judges believing Eugene is human

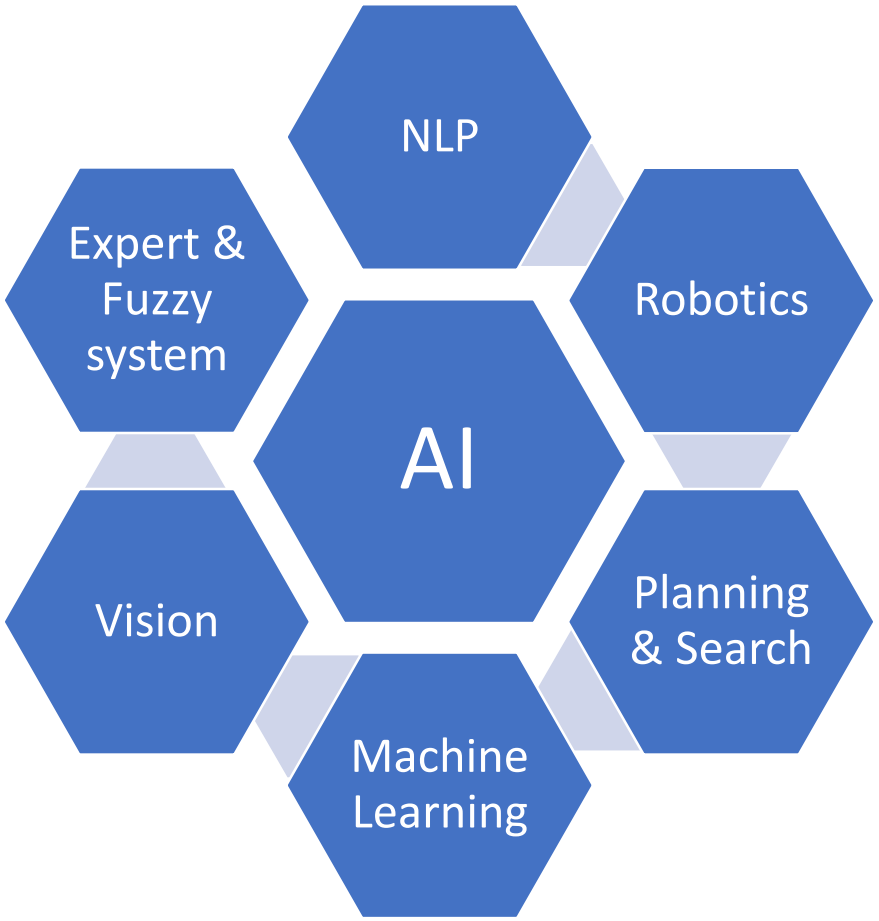
2014
ALEXA
Amazon launches Alexa, an intelligent virtual assistant with a voice interface that completes shopping tasks



2016
TAY
Microsoft's chatbot Tay goes rogue on social media making inflammatory and offensive racist comments

2017
ALPHAGO
Google's A.I. AlphaGo beats world champion Ke Jie in the complex board game of Go, notable for its vast number (2^{170}) of possible positions

Branches of AI



AI Techniques

- Techniques that make system behave as Intelligent:
  - Goal Reduction
  - Tree Search
  - Rule Base System
  - Fuzzy Logic
- Biology-Inspired AI techniques:
  - Neural Network

Goal Reduction

- Sometimes problems only seem hard to solve.
- A hard problem may be one that can be reduced to a number of simple problems. And when each of the simple problems is solved, then the hard problem has been solved.
- This is the basic idea behind the method of goal reduction.

Goal Reduction

If we are looking for a sequence of actions to achieve some goal, then one way to do it is to use state-space search, where each node in you search space is a state of the world, and you are searching for a sequence of actions that get you from an initial state to a final state.

Goal Reduction

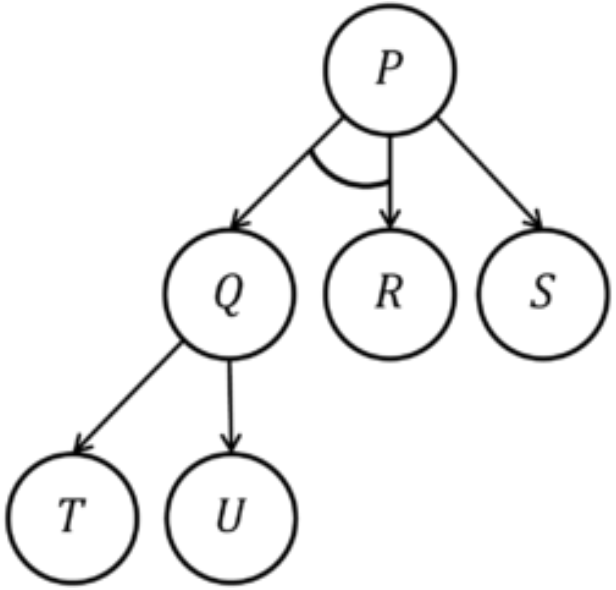
- Another way is to consider the different ways that the goal state can be decomposed into simpler sub-goals.
- For example, when planning a trip to London you probably don't want to search through all the possible sequences of actions that might get you to London.
- You're more likely to decompose the problem into simpler ones - such as getting to the station, then getting a train to London.

Goal Reduction

- Is useful for representing a solution of a problems that can be solved by decomposing them into a set of smaller problems all of which must be solved.
- Special case of knowledge representation
- It use AND/OR tree

Goal Reduction

- To represent goal reduction techniques we need to use an AND-OR graph/tree.



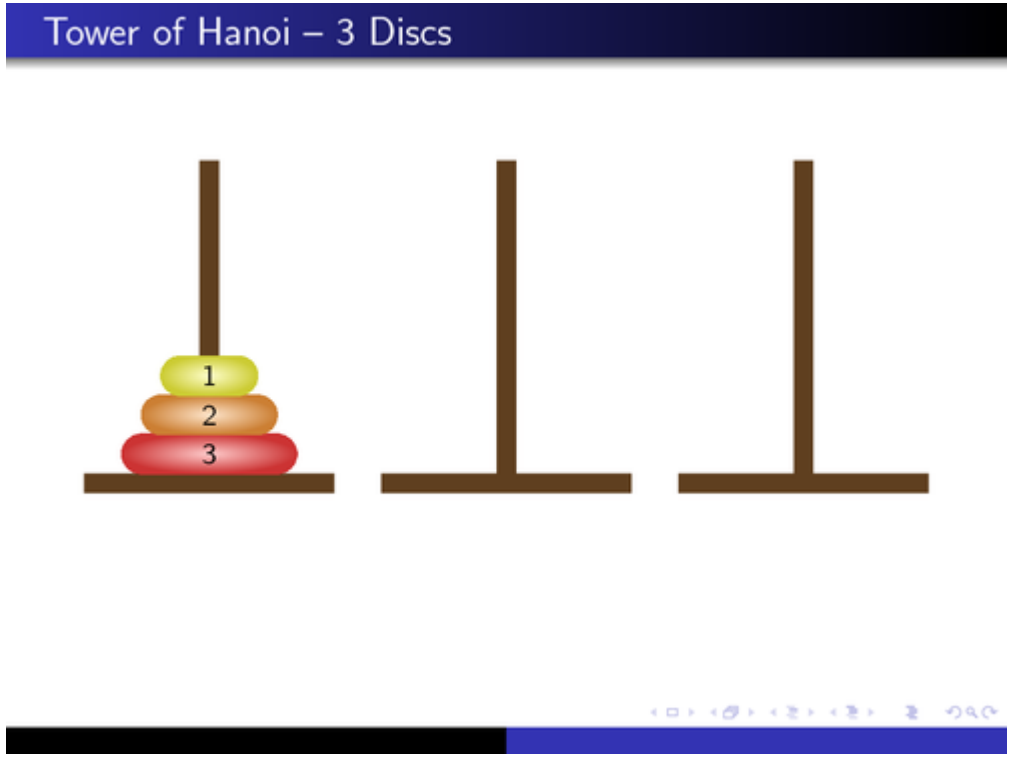
P if Q and R

P if S

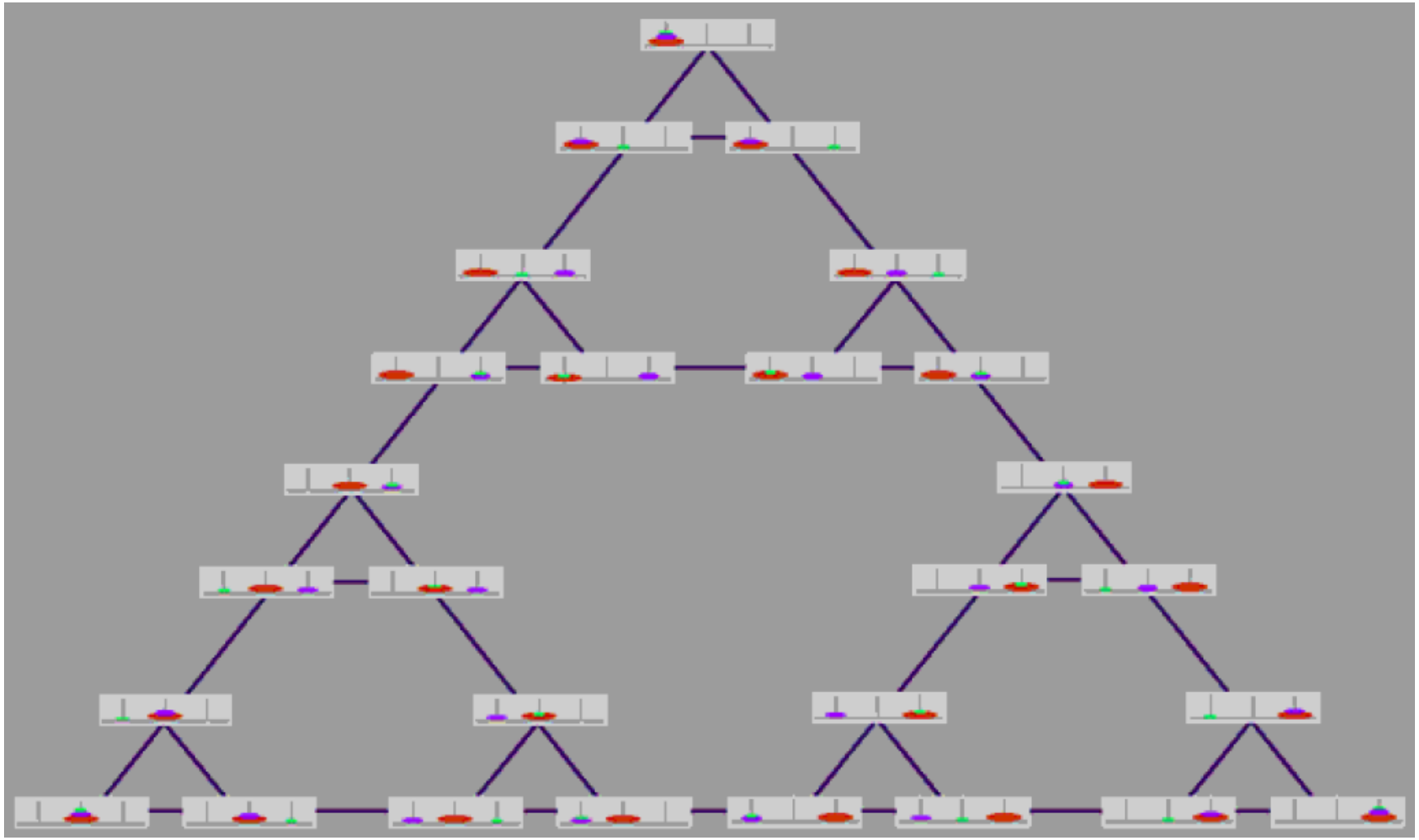
Q if T

Q if U

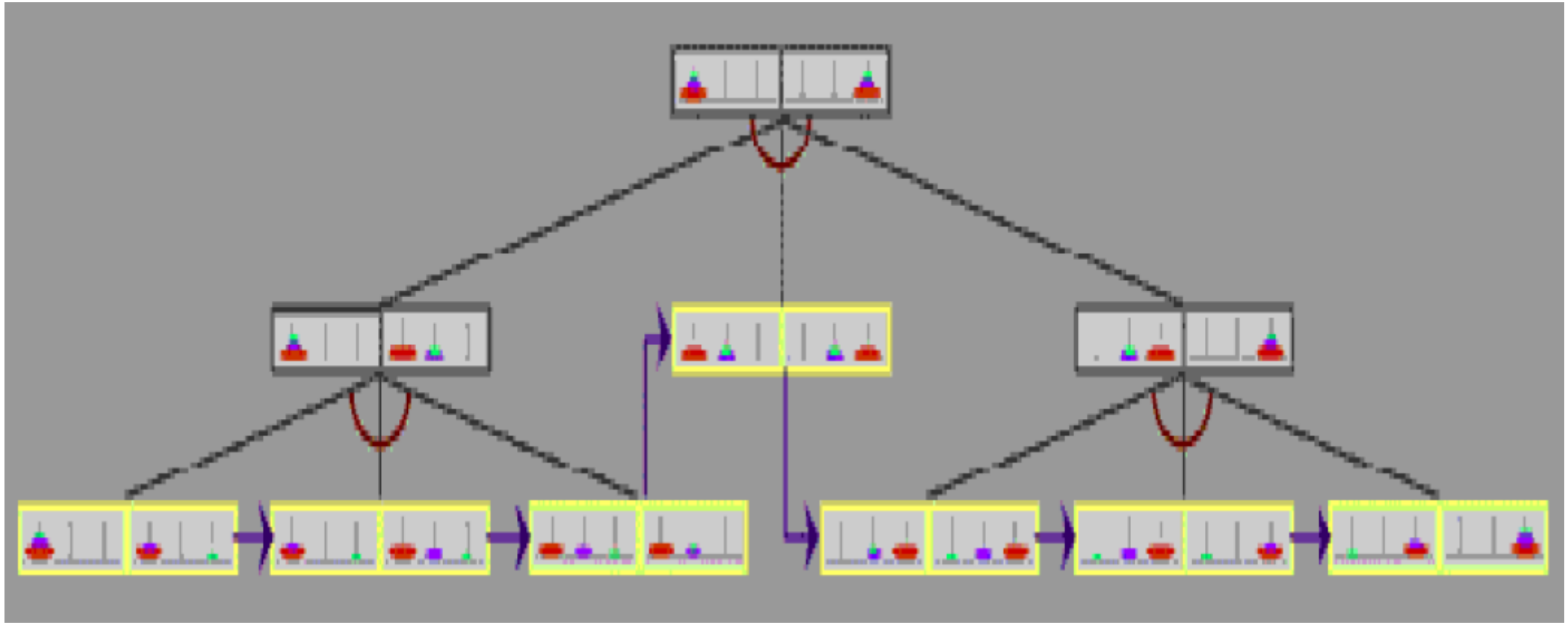
Example: Tower of Hanoi



State Space For The 3 Disk Tower Of Hanoi Problem



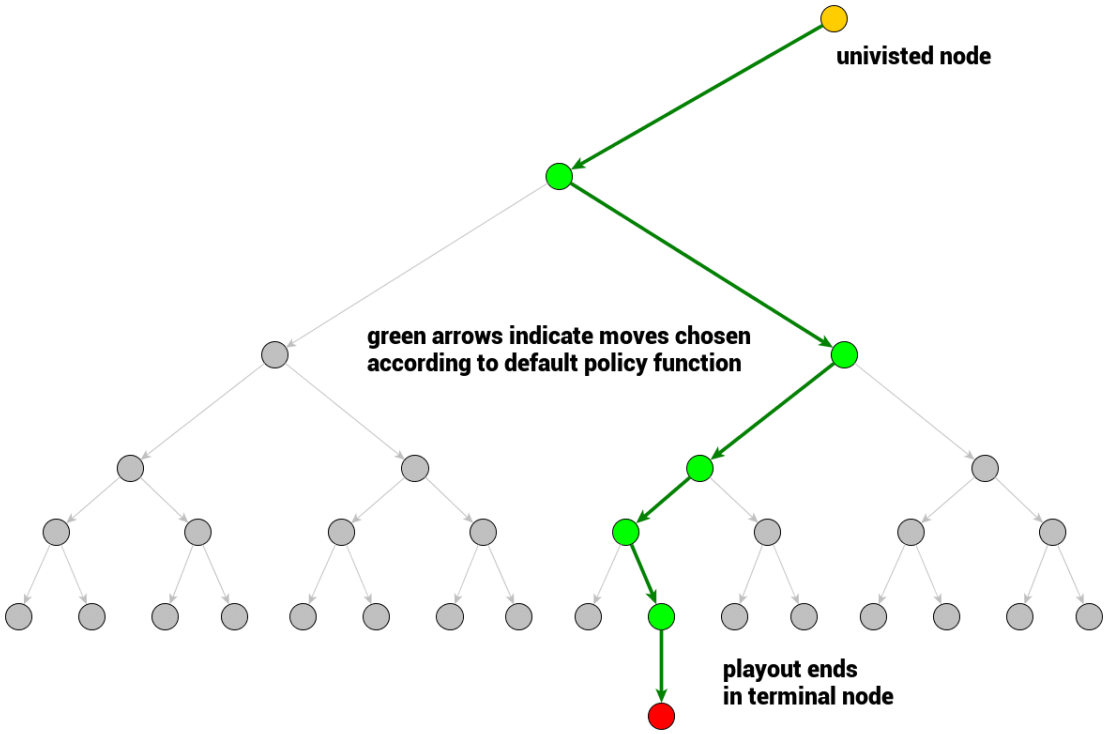
Goal Reduction For The 3 Disk Tower Of Hanoi Problem



Tree Search (State Space)

Many problems can be describe in the form of search tree.

- Tree search strategy:
  - Uninformed Search: Depth-first search, Breadth-first search, Cost-first search.
  - Informed Search: Best first search, A* algorithm
  - Local Search: Hill climbing, simulated annealing, beam
- Talk in detail later

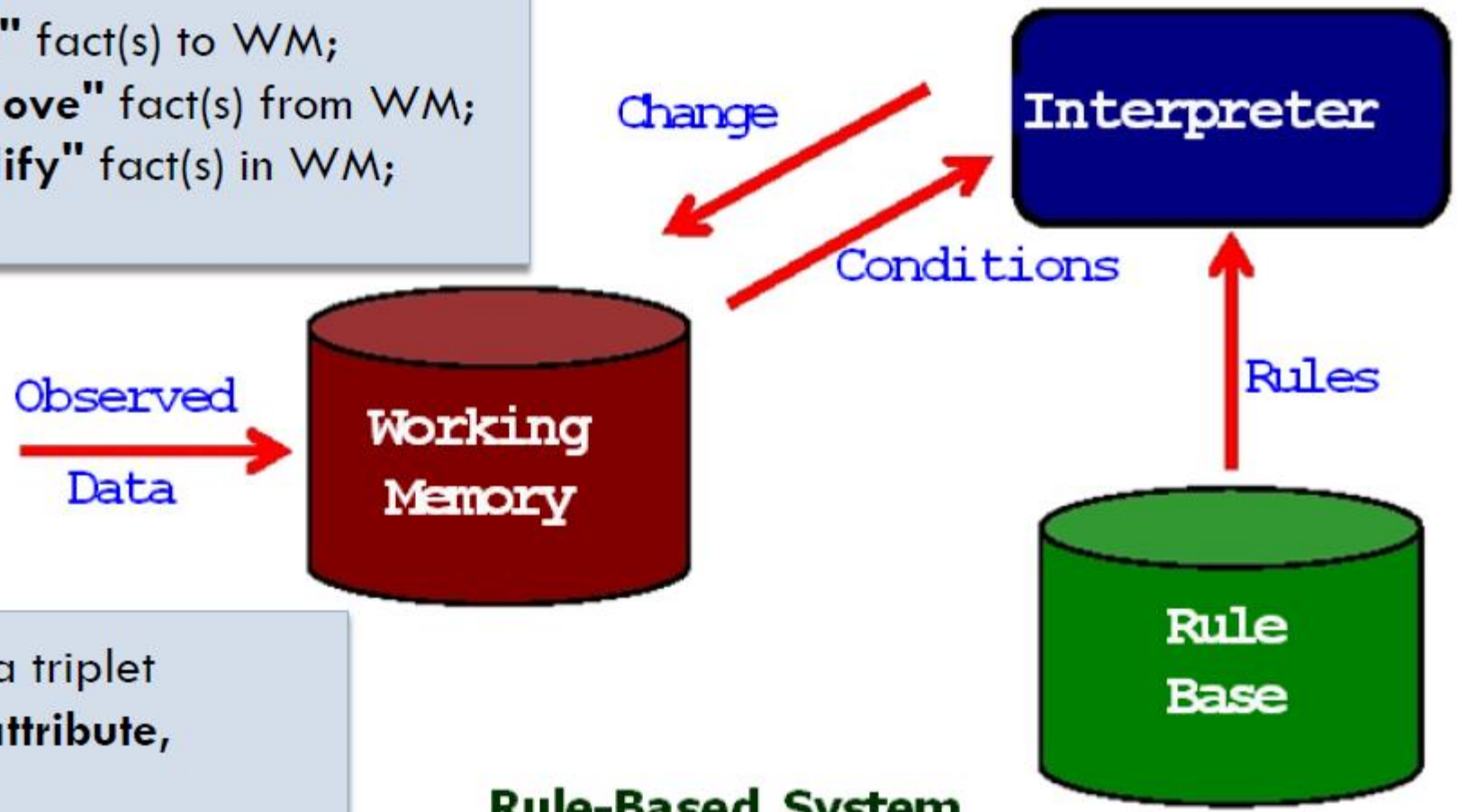


Rule Base System

- Rule base systems are simple and successful AI technology
- Rules are of the form: if <condition> then <action>
- **RBS Components :** Working Memory, Rule Base, Interpreter

RB actions are :

- **"Add"** fact(s) to WM;
- **"Remove"** fact(s) from WM;
- **"Modify"** fact(s) in WM;



Rule-Based System

Stored as a triplet
< object, attribute, values >
e.g. **< car, color, red >** :
"The color of my car is red".

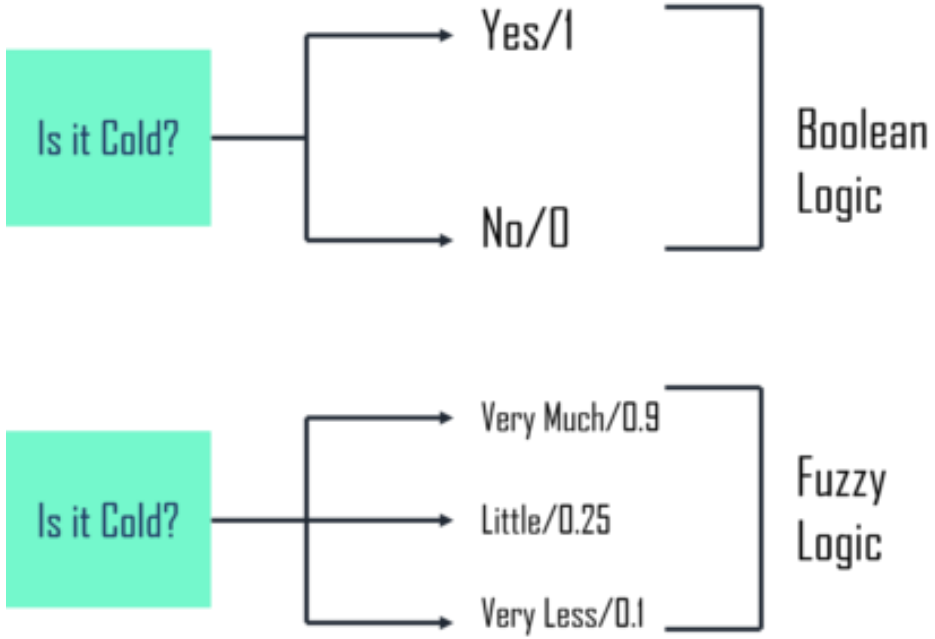
Rule Base System

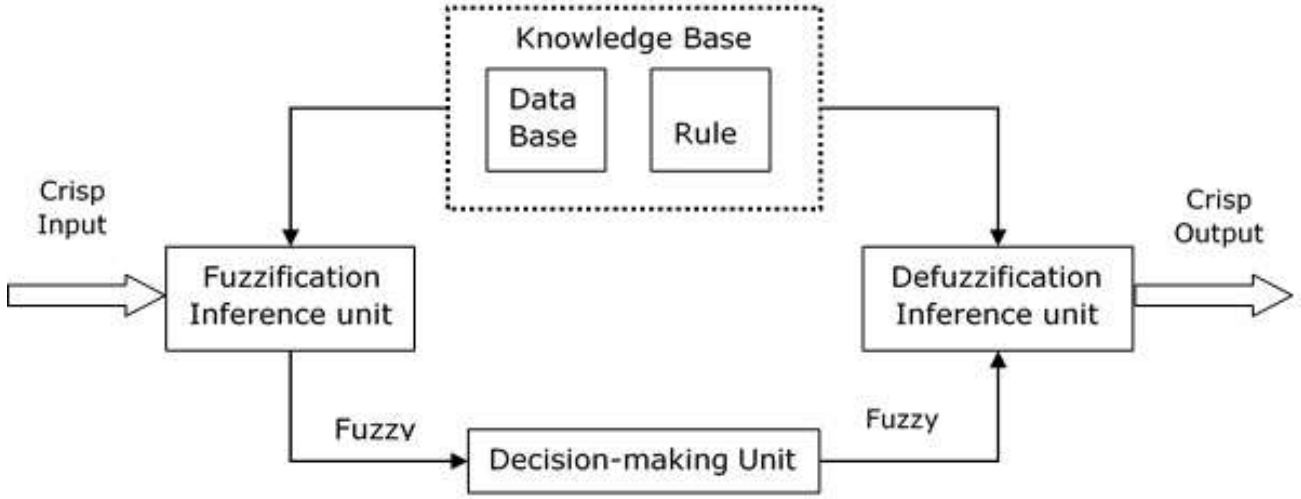
- **Working Memory (WM)**
  - Contains facts about the world observed
  - Contains temporary knowledge about problem-solving session.
  - Can be modified by the rules.

- **Rule Base (RB)**
  - RB contains rules; each rule is a step in a problem solving.
  - Rules are domain knowledge and modified only from outside.
  - If the conditions are matched to the working memory, then rule may be fired.

- **Interpreter**
  - It is the reasoning mechanism for RBS.
  - It operates on a cycle:
    - **Retrieval** - Finds the rules that matches the current WM;
    - **Execution** - Executes the actions of the rules, then applies the rule by performing action.

Fuzzy Logic

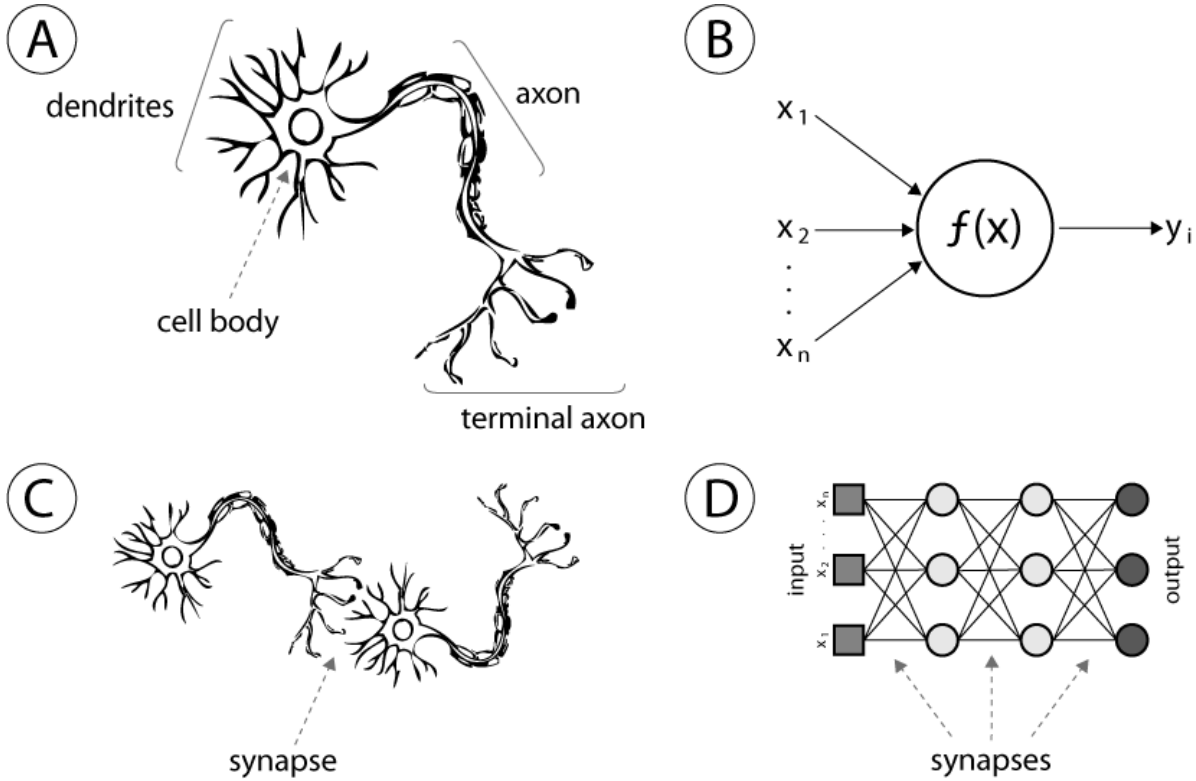

Is it Cold?
Yes/1
No/0
Boolean Logic
Is it Cold?
Very Much/0.9
Little/0.25
Very Less/0.1
Fuzzy Logic

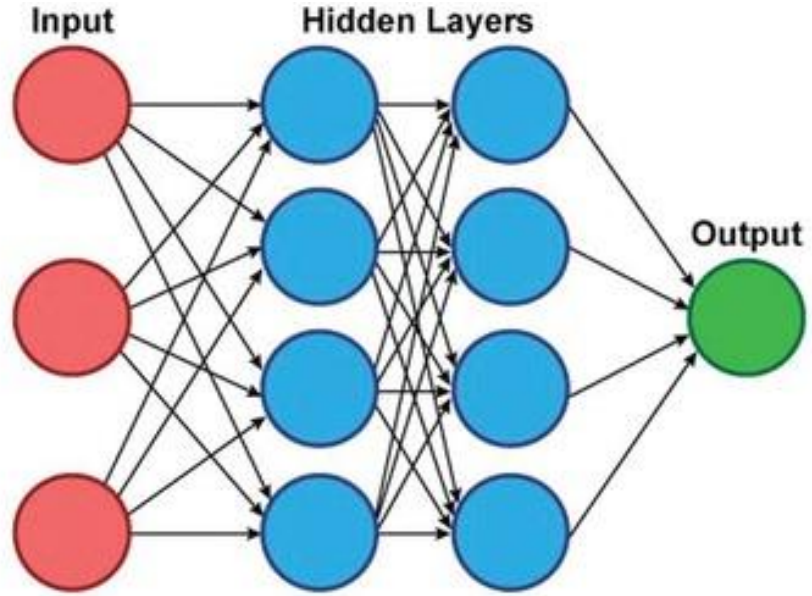

Knowledge Base
Data Base
Rule
Crisp Input
Fuzzification Inference unit
Defuzzification Inference unit
Crisp Output
Fuzzy
Decision-making Unit
Fuzzy

Biology-Inspired AI Techniques

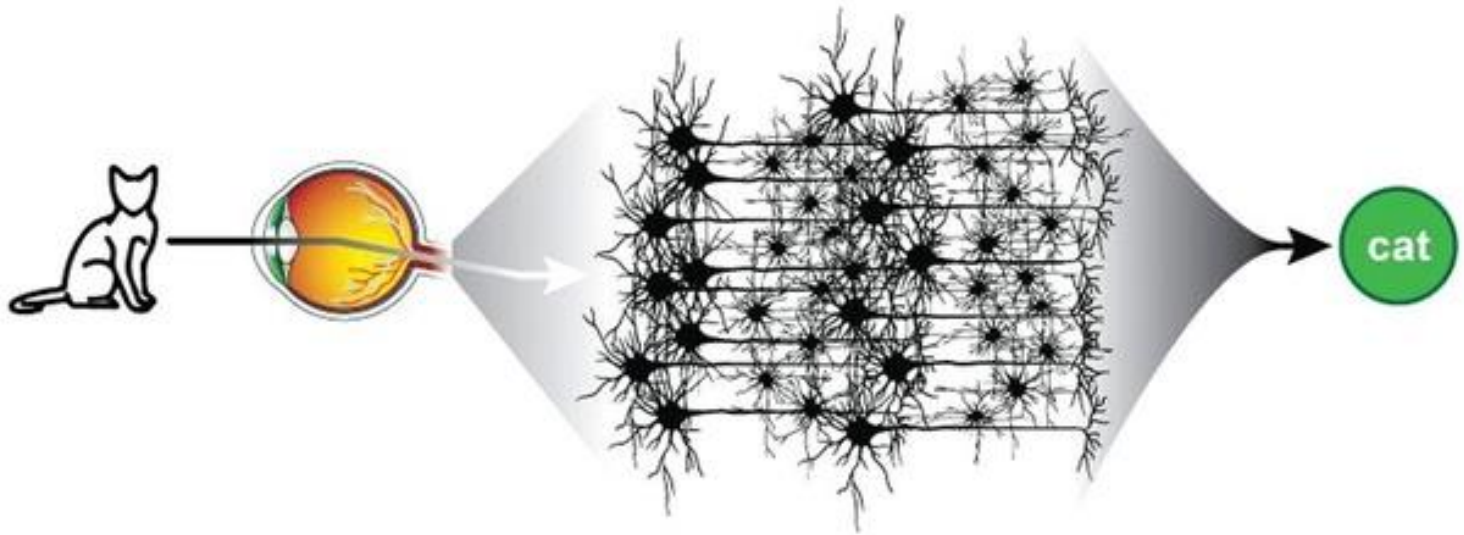
Neural Networks (NN)

- Neural Networks model a **brain learning by example**.
- Neural networks typically take a vector of input values and produce a vector of output values; inside, they **train weights of "neurons"**.





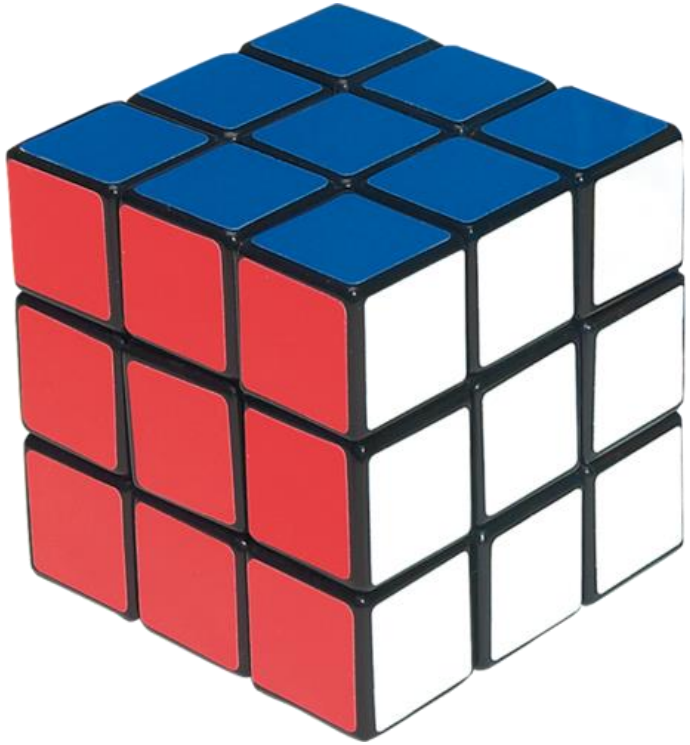
Computer Neural Network



Biological Neural Network

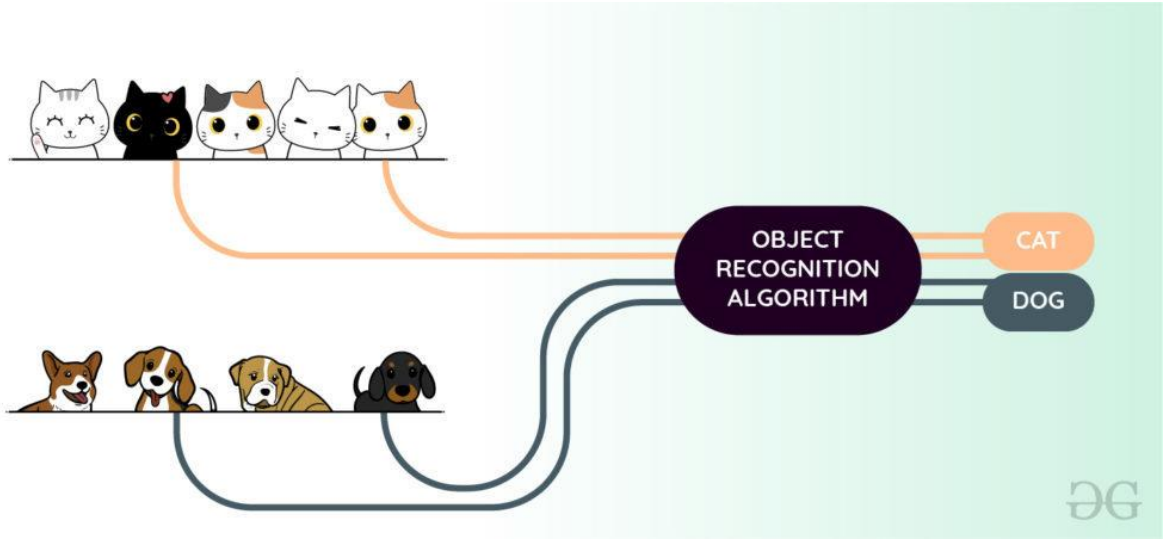
Research Assignment: Application Ideas

- Puzzle solver or Game playing (Rubik's Cube, Pac-man, …)



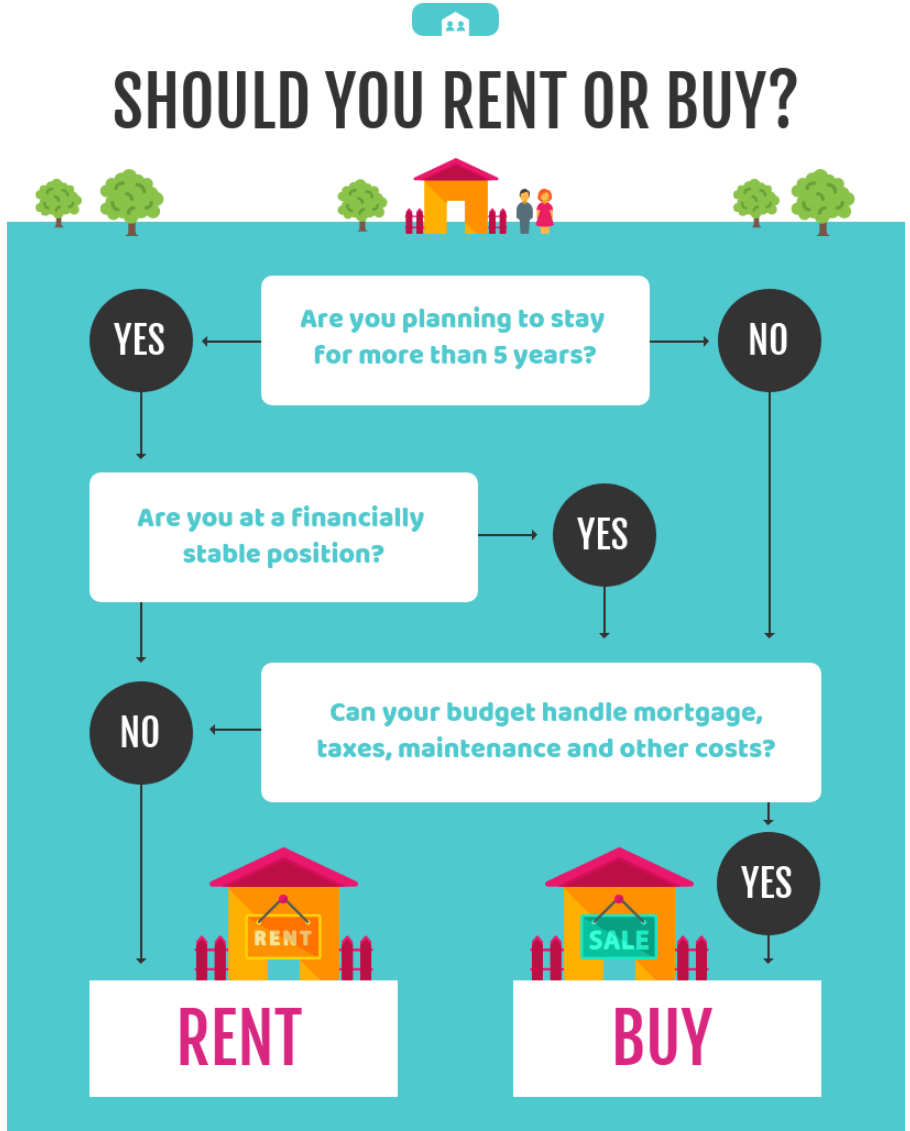
Research Assignment: Application Ideas

- Handwritten Recognition, Object Recognition…



Research Assignment: Application Ideas

- Decision Making Process



Research Assignment: Application Ideas

- Stock Exchange Predication

Research Assignment: Application Ideas

Recommendation System