Computer Science and Artificial Intelligence

KHOA CÔNG NGHỆ THÔNG TIN
TRƯỜNG ĐẠI HỌC KHOA HỌC TỰ NHIÊN

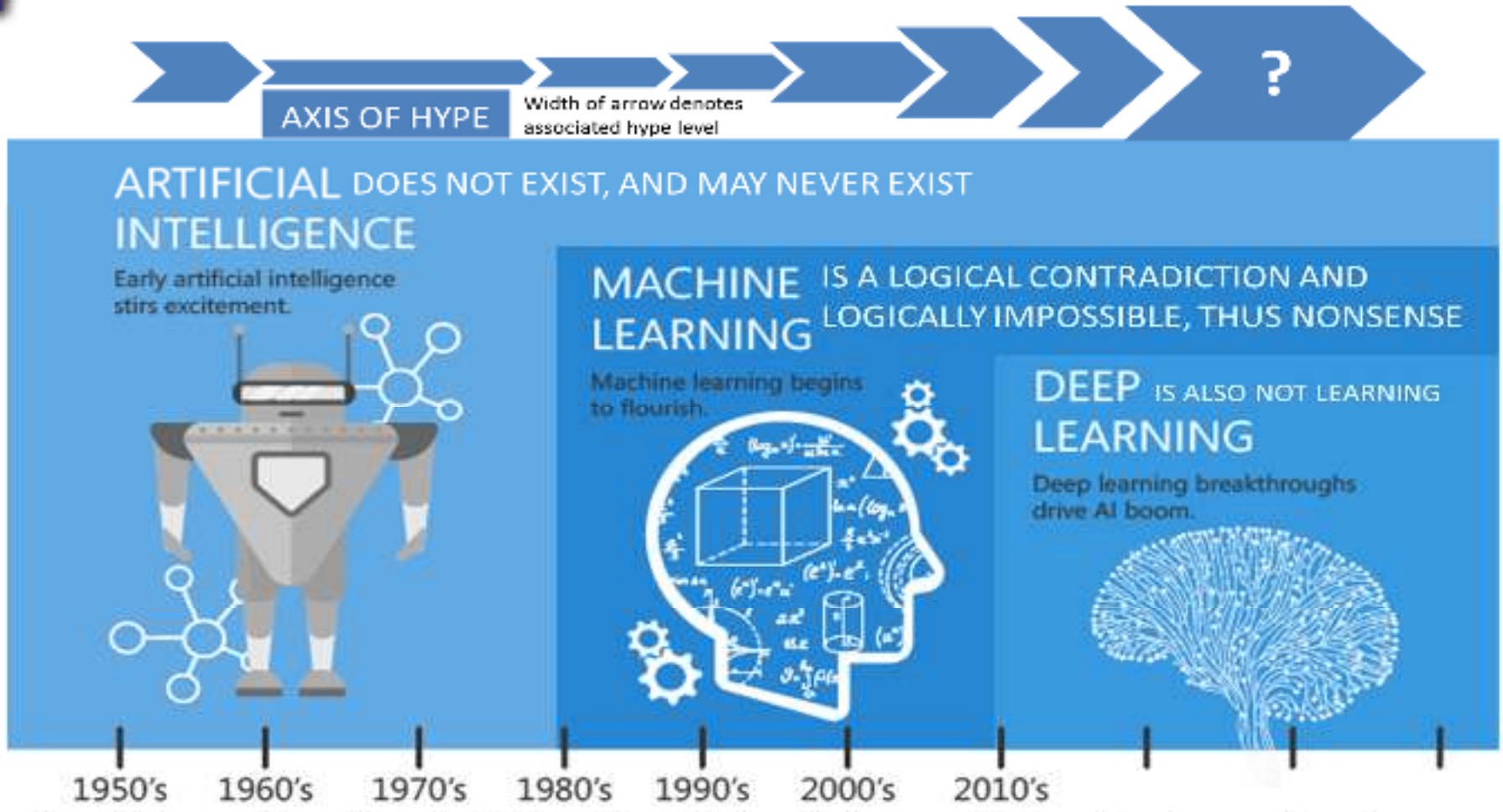
Content

- **Intelligence and Machines**
- Perception
- Reasoning
- Additional Areas of Research
- Artificial Neural Networks
- Robotics
- Considering the Consequences
- About Computer Science Department

What is AI?

- **Artificial intelligence** is the field of computer science that seeks to build autonomous machines
  - machines that can carry out complex tasks without human intervention.
  - machines be able to perceive and reason.
- The field of artificial intelligence is quite large and merges with other subjects such as psychology, neurology, mathematics, linguistics, and electrical and mechanical engineering.

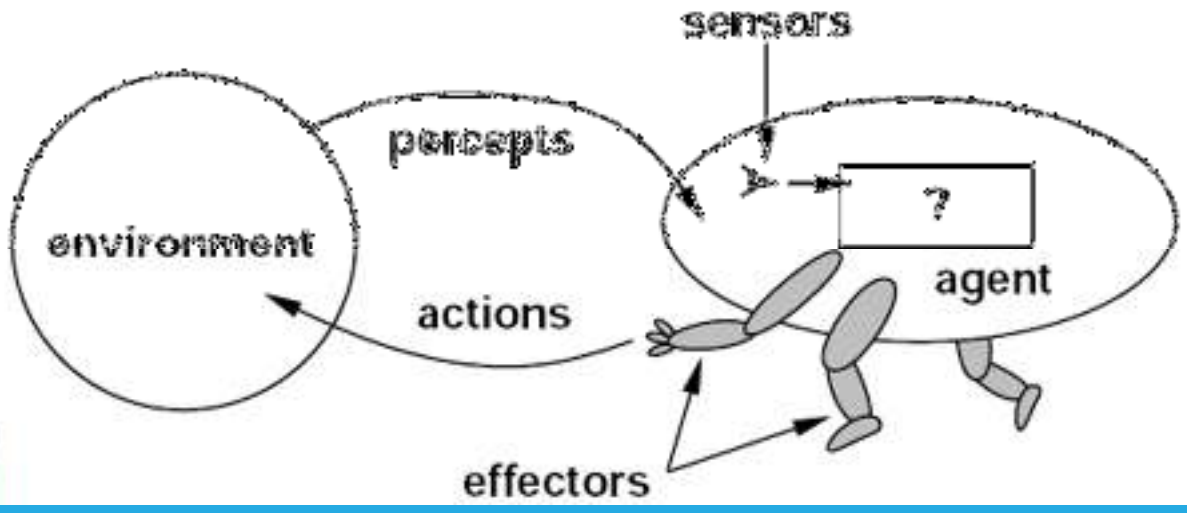
What is AI?



Since AI has continued to not exist since it was first posited as possible, hype has become the only means of maintaining interest and funding in AI. By creating smaller subsets of something that has continuously failed to materialize we confuse the public and maintain our positions of influence in academia and technology. Who knows what made up term we will think of next. My money is on systems of intelligence although data science has gotten off to a really strong start.

Intelligent Agents

- **Agent**: A "device" that responds to stimuli from its environment
  - Sensors (microphones, cameras, range sensors, and air or soil sampling devices, …)
  - Actuators (wheels, legs, wings, grippers, and speech synthesizers,…)
- Much of the research in artificial intelligence can be viewed in the context of building agents that behave intelligently



Intelligent Agents

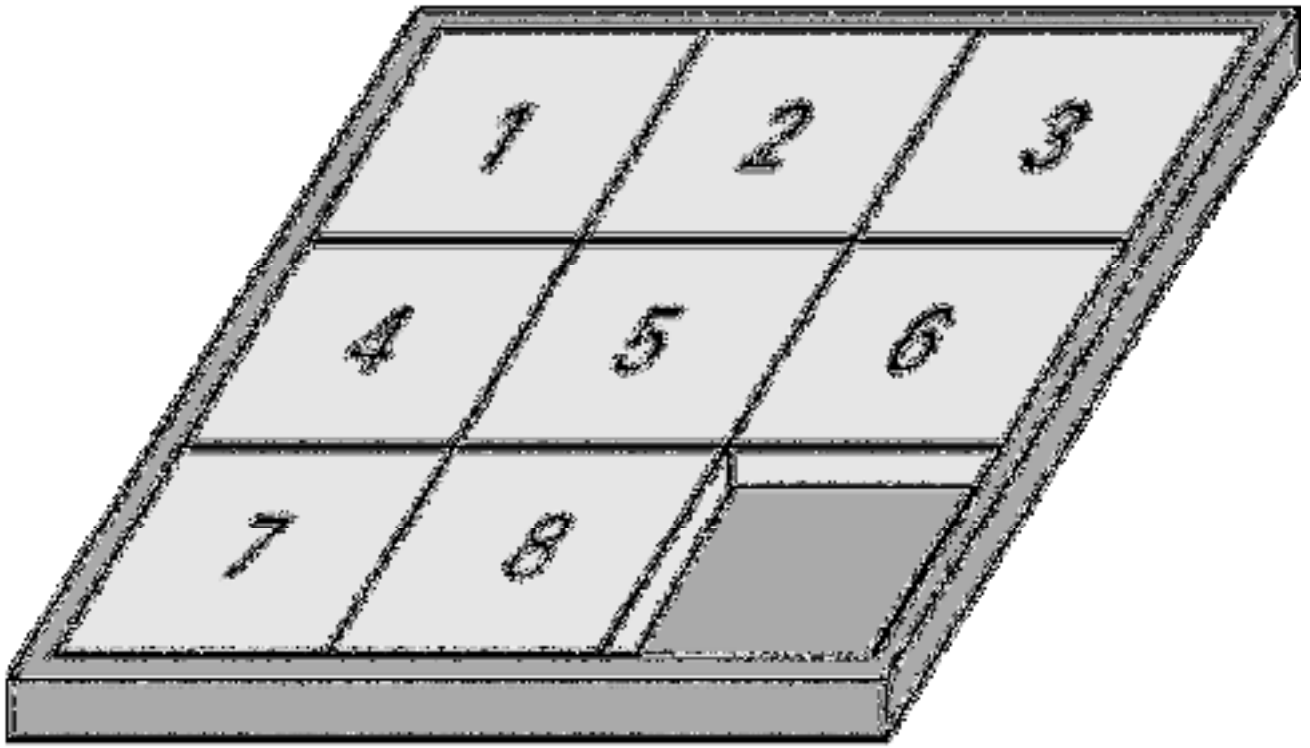
- An agent as an individual machine such as a robot.
- However, an agent may take other forms such as an autonomous airplane, a character in an interactive video game, or a process communicating with other processes over the Internet (perhaps as a client, a server, or a peer).

Unmanned aerial vehicle

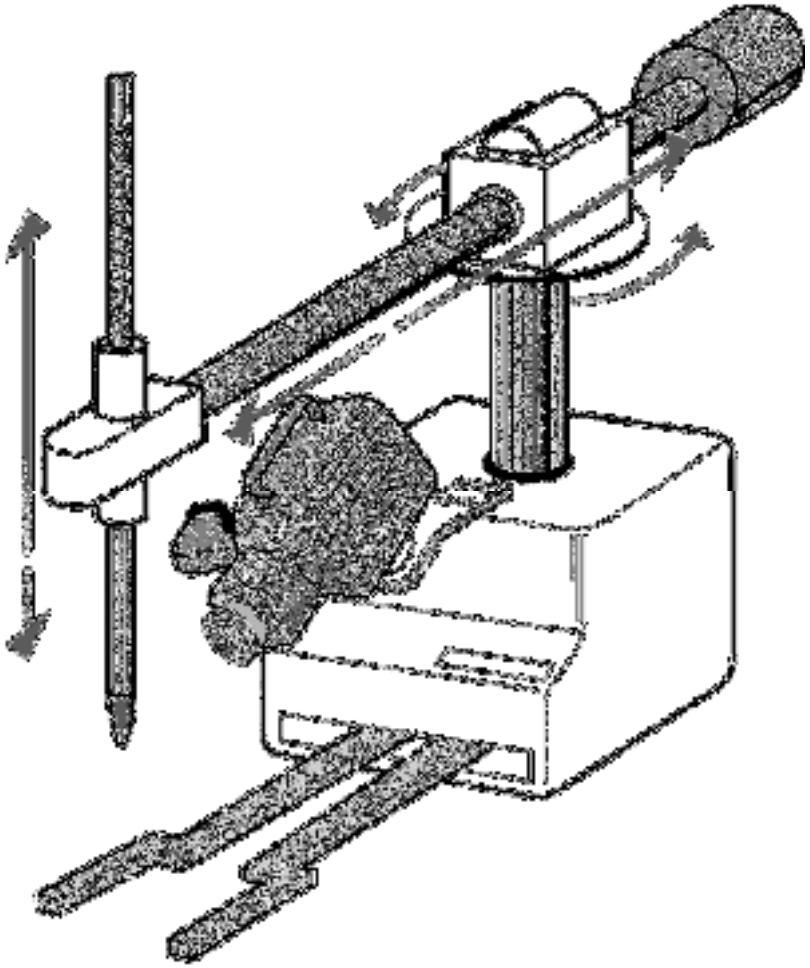
Levels of Intelligent Behavior

- Reflex: actions are predetermined responses to the input data
- More intelligent behavior requires knowledge of the environment and involves such activities as:
  - Goal seeking (such as winning a game of chess or maneuvering through a crowded passageway)
  - Learning (an agent's responses improve over time)

The eight-puzzle in its solved configuration



Our puzzle-solving machine

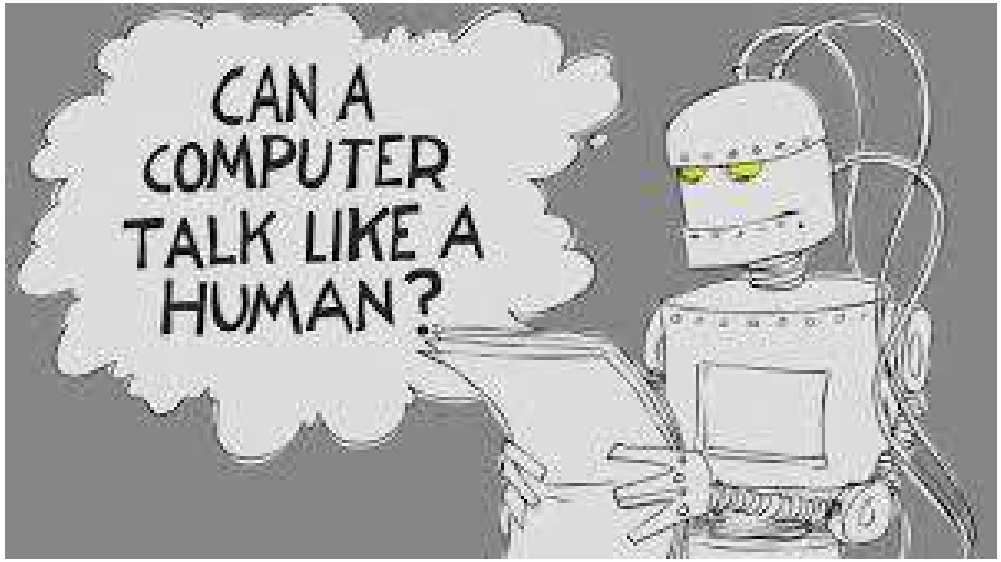


Approaches to Research in Artificial Intelligence

- Engineering track: develop systems that exhibit intelligent behavior.
  - Performance oriented (produce a product that meets certain performance goals)
- Theoretical track: develop a computational understanding of animal—especially human—intelligence.
  - Simulation oriented (expand our understanding of intelligence)

Turing Test

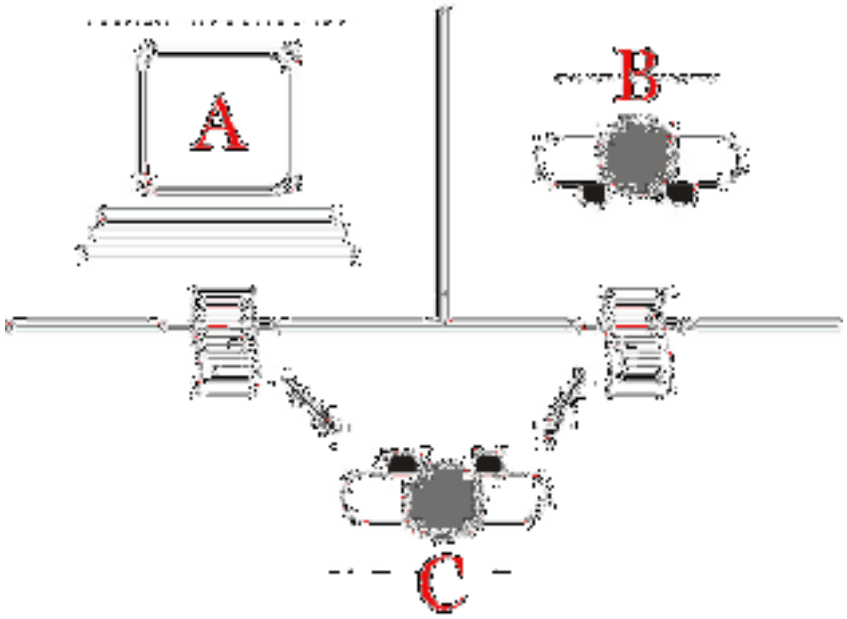
- **Turing test** (proposed by Alan Turing in 1950) has served as a benchmark in measuring progress in the field of artificial intelligence.



https://www.youtube.com/watch?v=3wLqsRLvV-c

Turing Test

- Test setup: Human interrogator communicates with test subject by typewriter.
- Test: Can the human interrogator distinguish whether the test subject is human or machine?

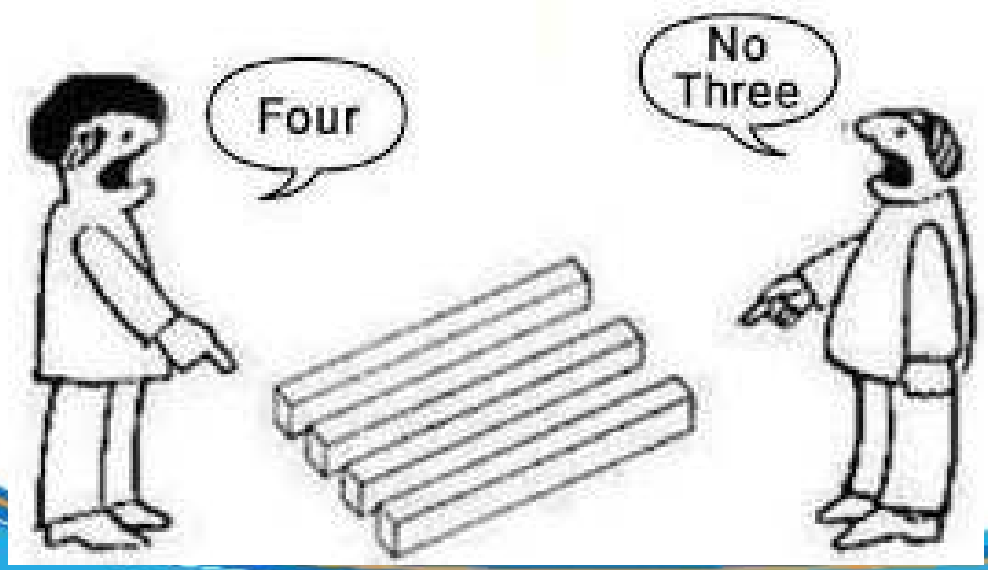


Content

- Intelligence and Machines
- **Perception**
- Reasoning
- Additional Areas of Research
- Artificial Neural Networks
- Robotics
- Considering the Consequences
- About Computer Science Department

Perception

- To respond intelligently to the input from its sensors, an agent must be able to understand that input (perceive).
- Two areas of research in perception that have proven to be especially challenging:
  - understanding images and language.



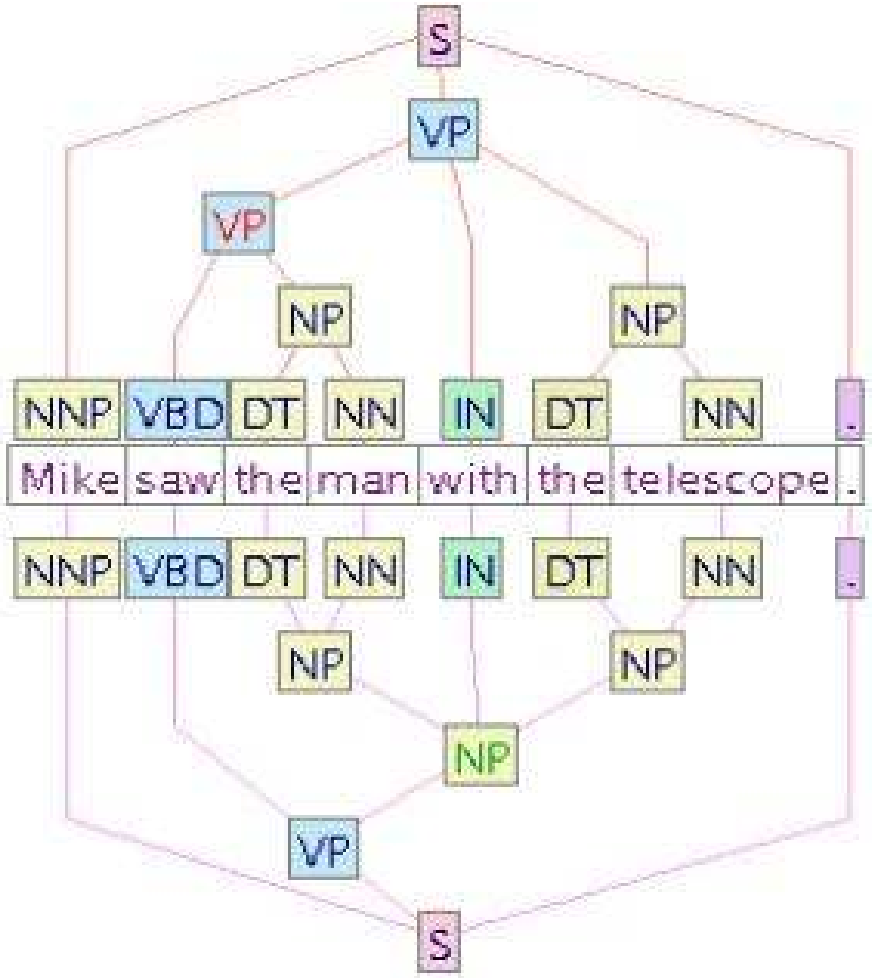
Techniques for Understanding Images

- Template matching
- Image processing (identifying characteristics of the image)
  - edge enhancement
  - region finding
  - smoothing

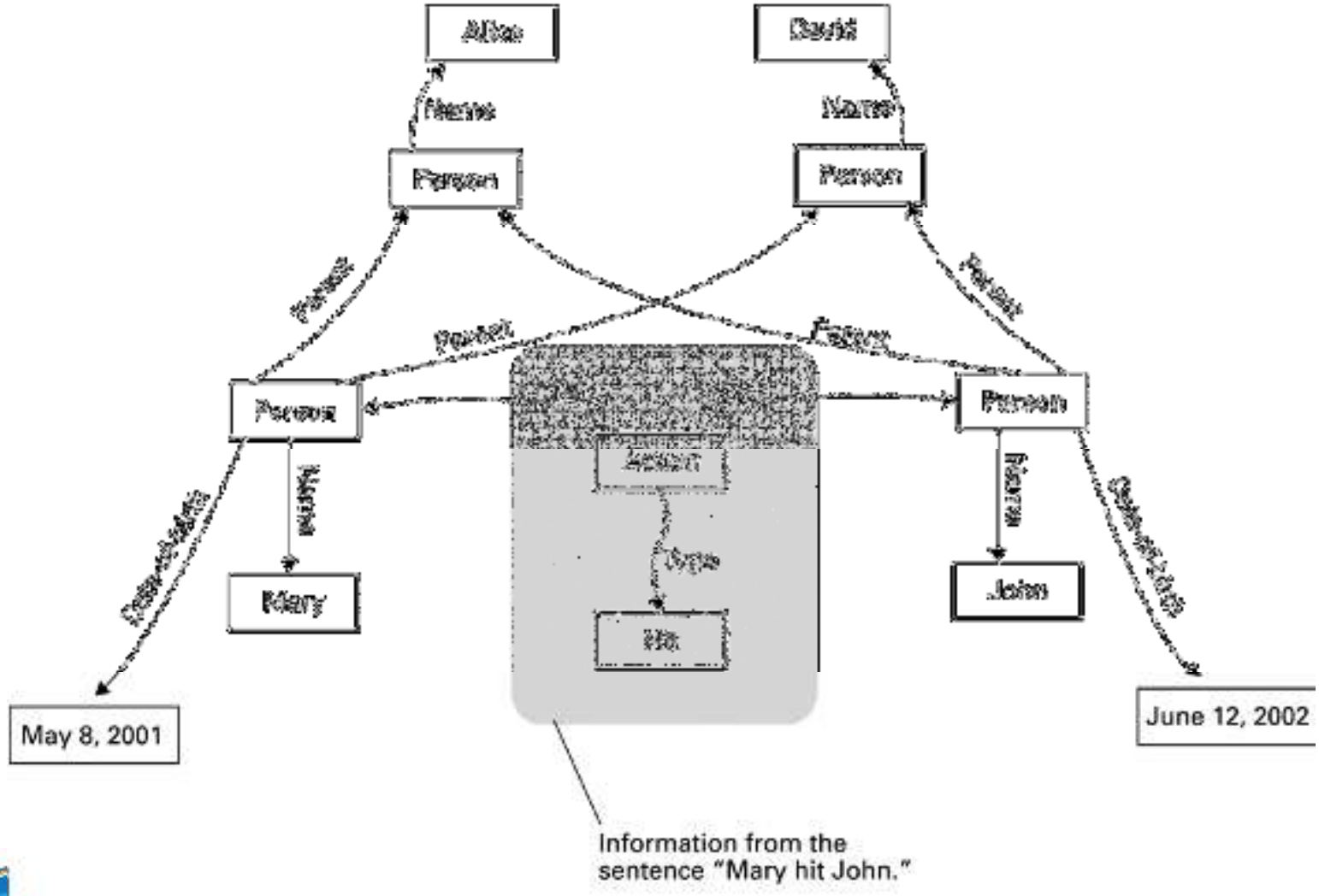
- Image analysis (the process of understanding what these characteristics mean)

Language Processing

- Syntactic Analysis
- Semantic Analysis
- Contextual Analysis



A semantic net



Content

- Intelligence and Machines
- Perception
- **Reasoning**
- Additional Areas of Research
- Artificial Neural Networks
- Robotics
- Considering the Consequences
- About Computer Science Department

Reasoning

- Reasoning is the act of deriving a conclusion from certain premises using a given methodology.
- Reasoning is a process of thinking.
- Reasoning is logically arguing.
- Reasoning is drawing inference.
- It must figure out what it needs to know from what it already knows

Reasoning Example

If we know :

Robins are birds, and

All birds have wings

Then if we ask:

Do robins have wings?

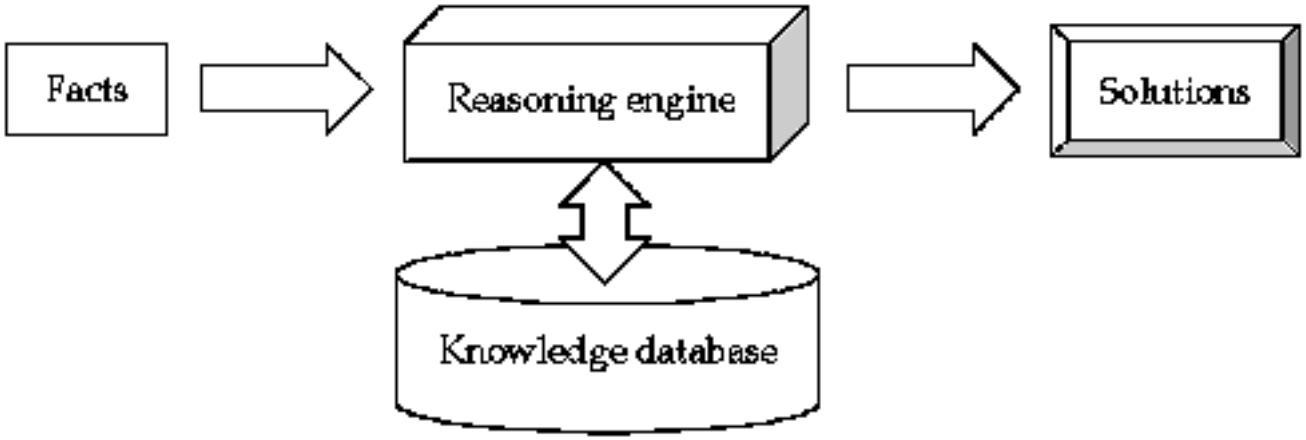
To answer this question - some reasoning must go.

Uncertainty in Reasoning

- The world is an uncertain place; often the Knowledge is imperfect (Incomplete, Inconsistent, Changing) which causes uncertainty.
  - Therefore reasoning must be able to operate under uncertainty.
- AI systems must have ability to reason under conditions of uncertainty.

Reasoning under uncertainty

- Many reasoning systems provide capabilities for reasoning under uncertainty.
- This is important when building situated reasoning agents which must deal with uncertain representations of the world.



Reasoning Systems

- Production systems
- Theorem provers
- Deductive retrieval systems
- Semantic networks
- …

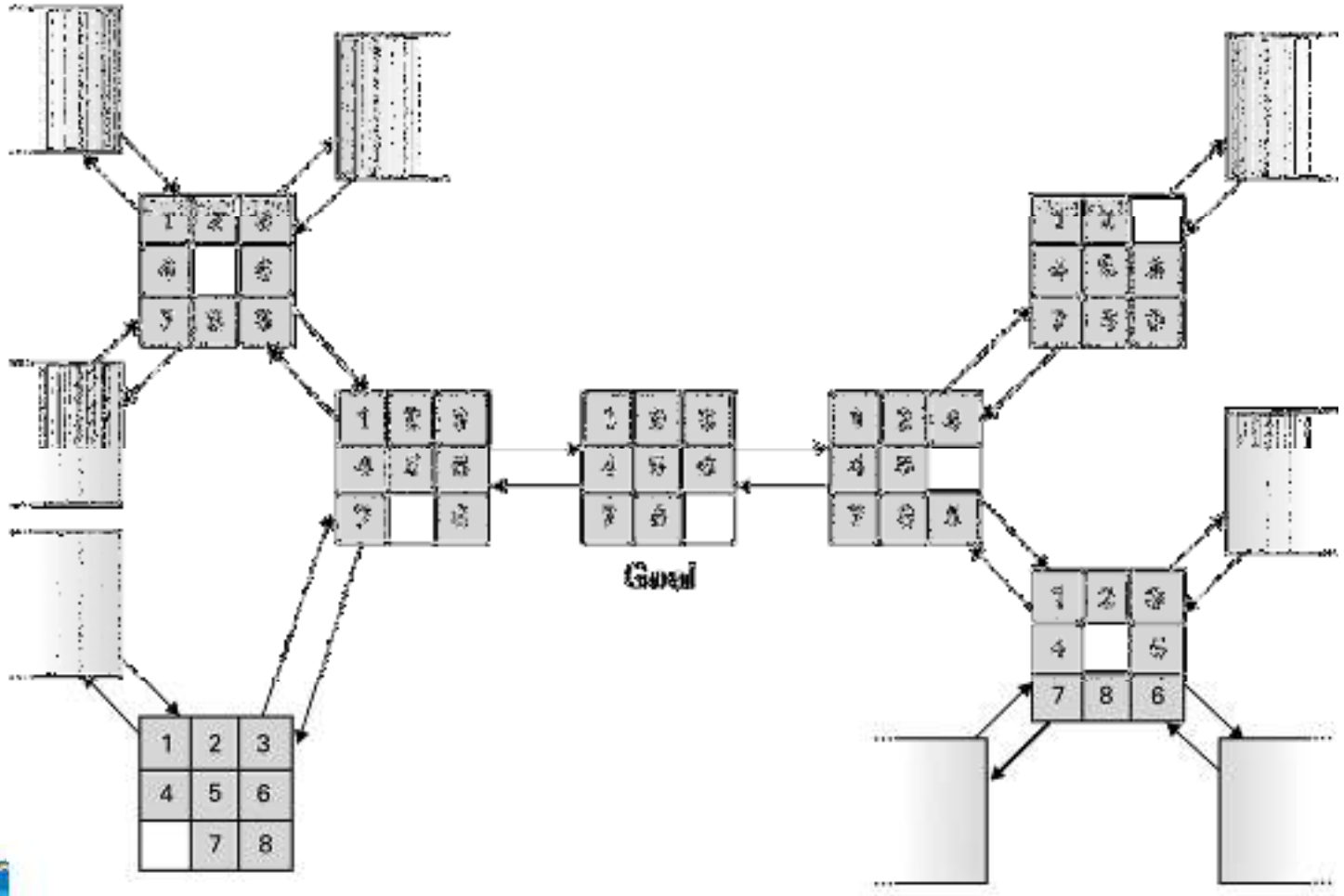
Production Systems

1. Collection of states
   - Start (or initial) state
   - Goal state (or states)
2. Collection of productions: rules or moves
   - A production is an operation that can be performed in the application environment to move from one state to another
   - Each production may have preconditions
3. Control system: decides which production to apply next

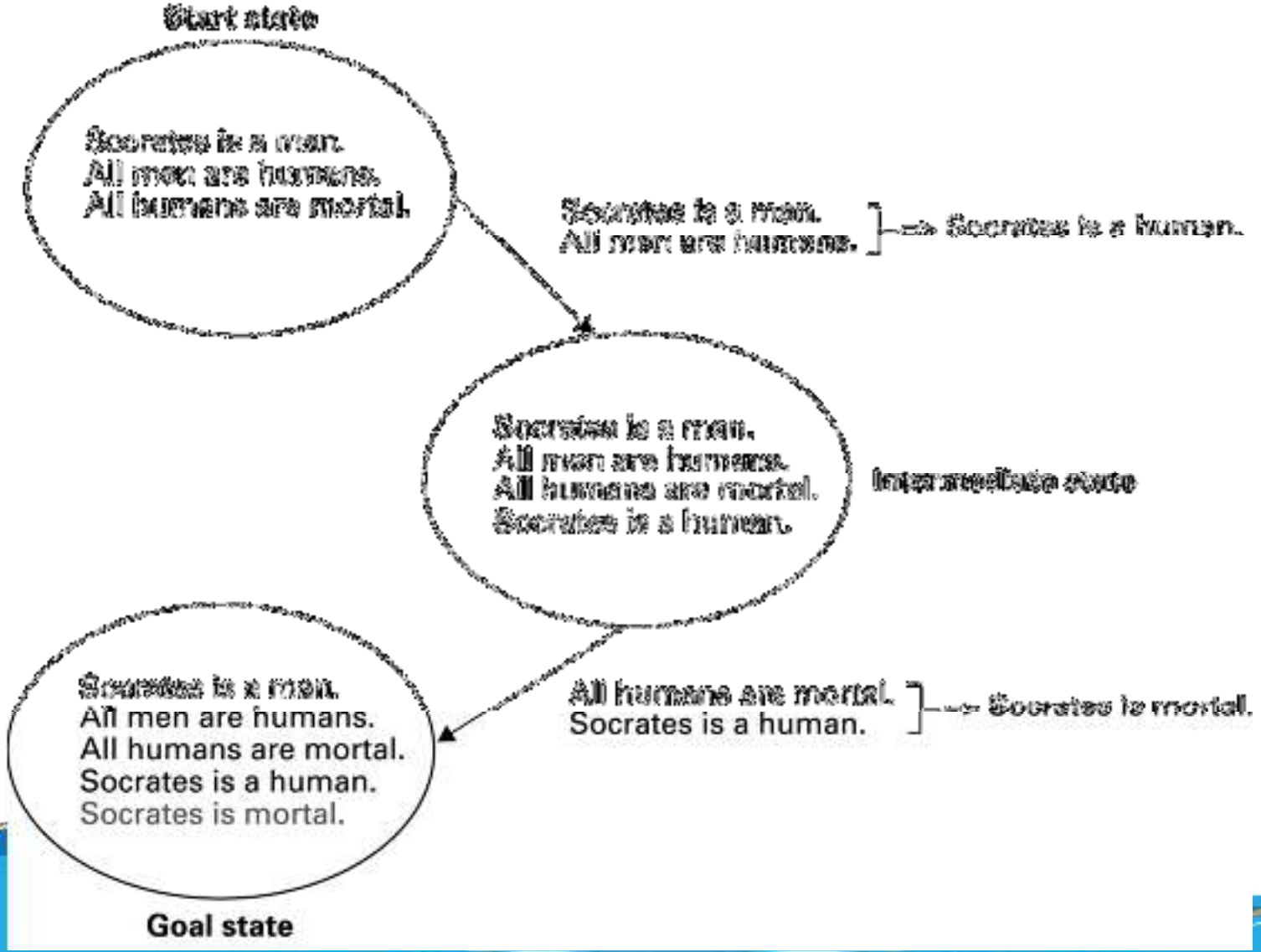
Reasoning by Searching

- **State Graph:** All states and productions
- **Search Tree:** A record of state transitions explored while searching for a goal state
  - Breadth-first search
  - Depth-first search

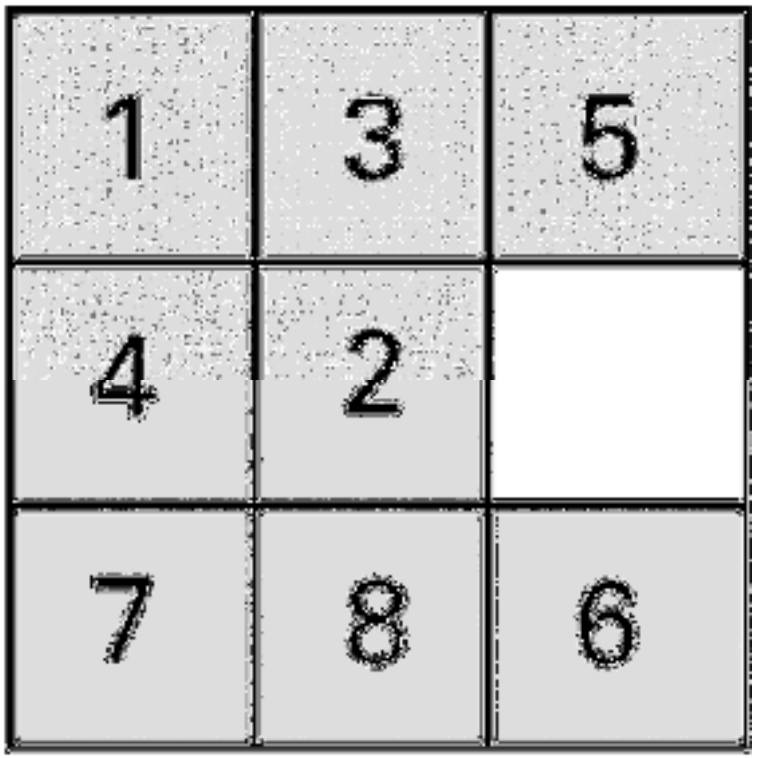
A small portion of the eight-puzzle's state graph



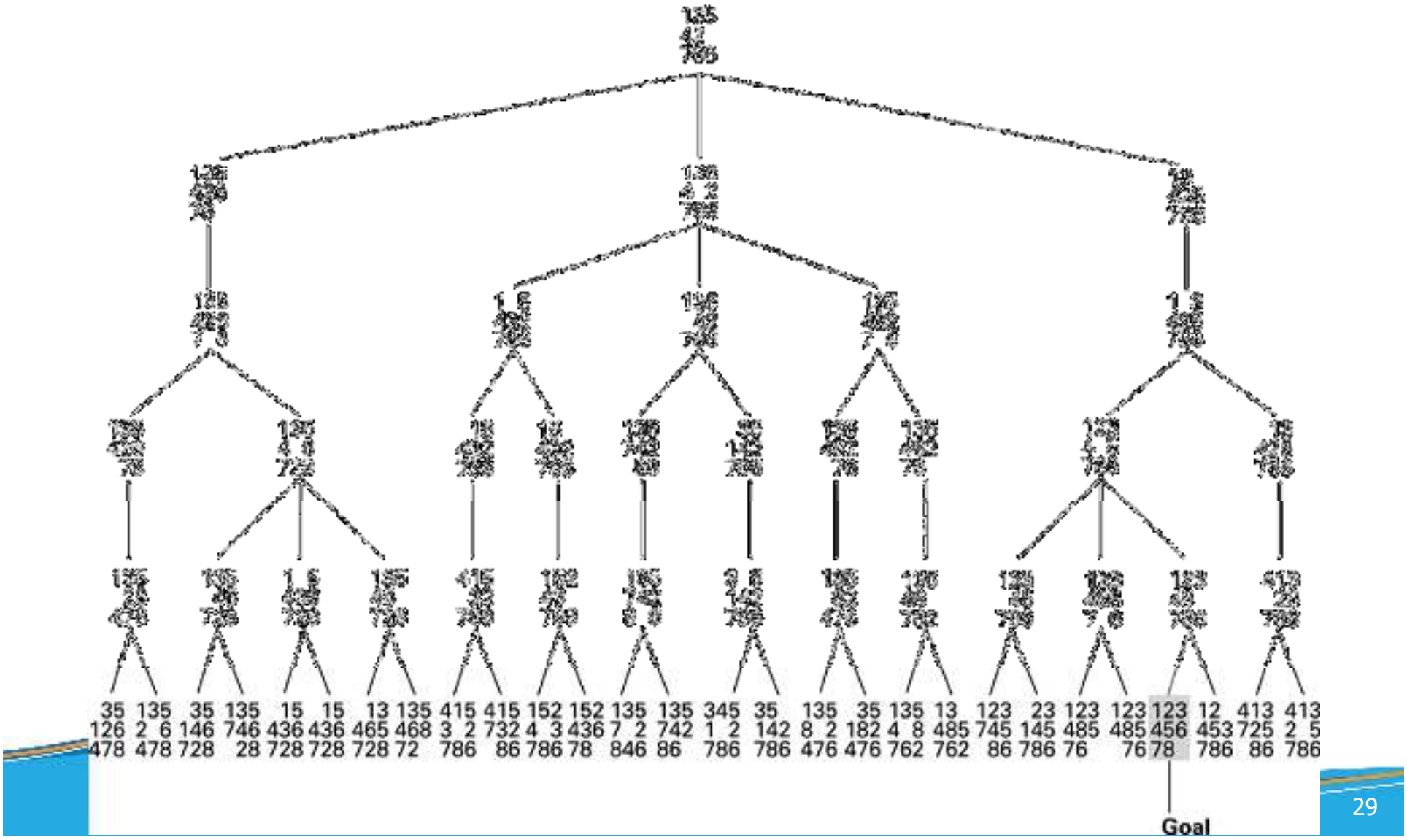
Deductive reasoning in the context of a production system



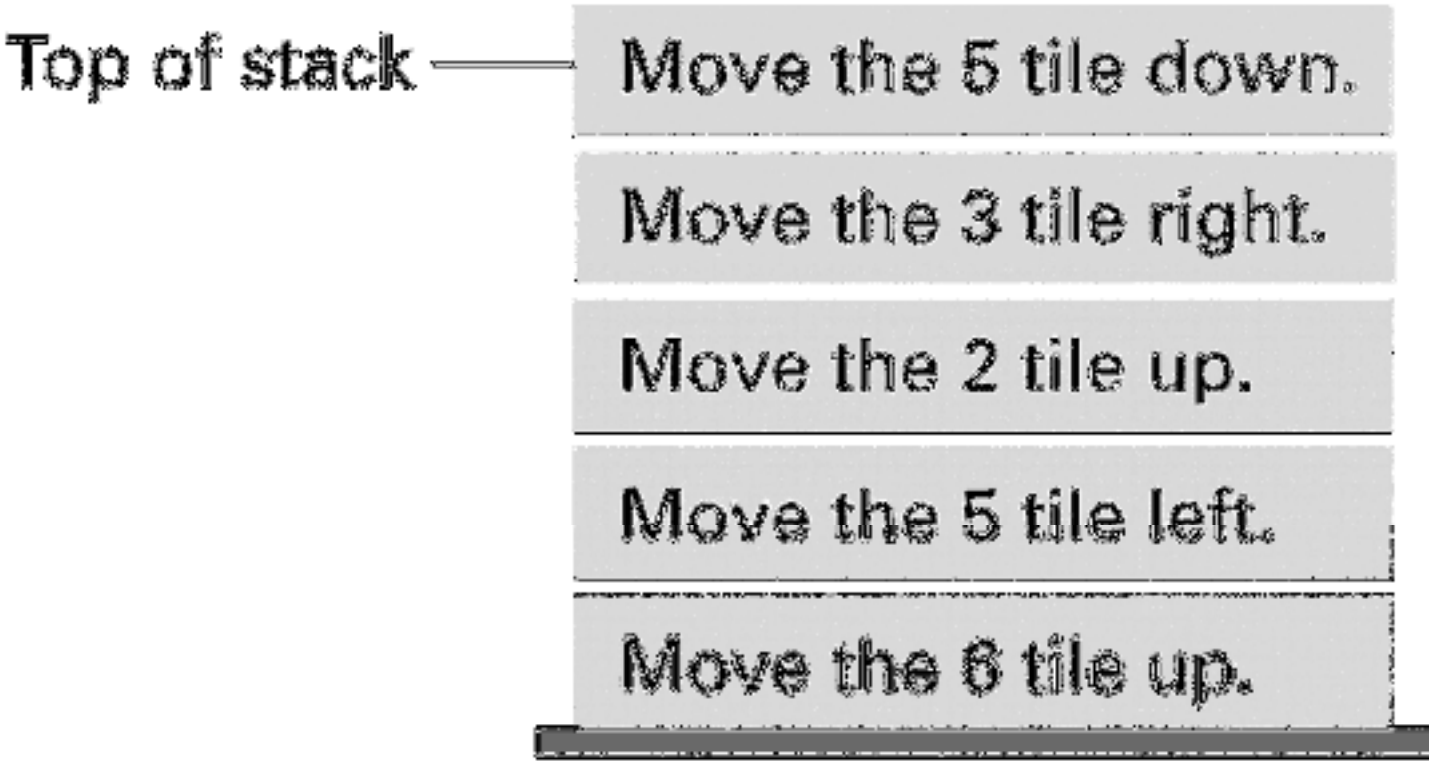
An unsolved eight-puzzle



A sample search tree



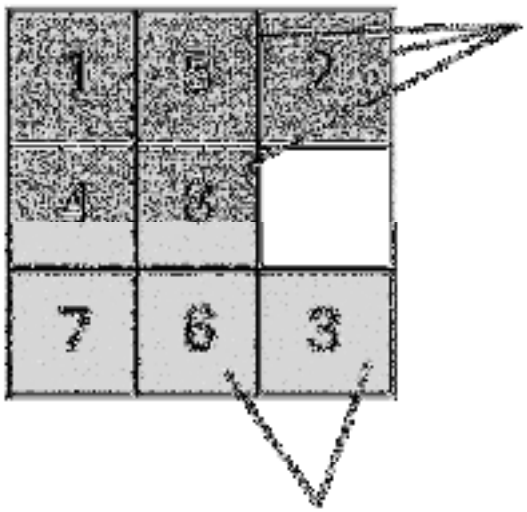
Productions stacked for later execution



Heuristic Strategies

- **Heuristic**: A “rule of thumb” for making decisions
- Requirements for good heuristics
  - Must be easier to compute than a complete solution
  - Must provide a reasonable estimate of proximity to a goal

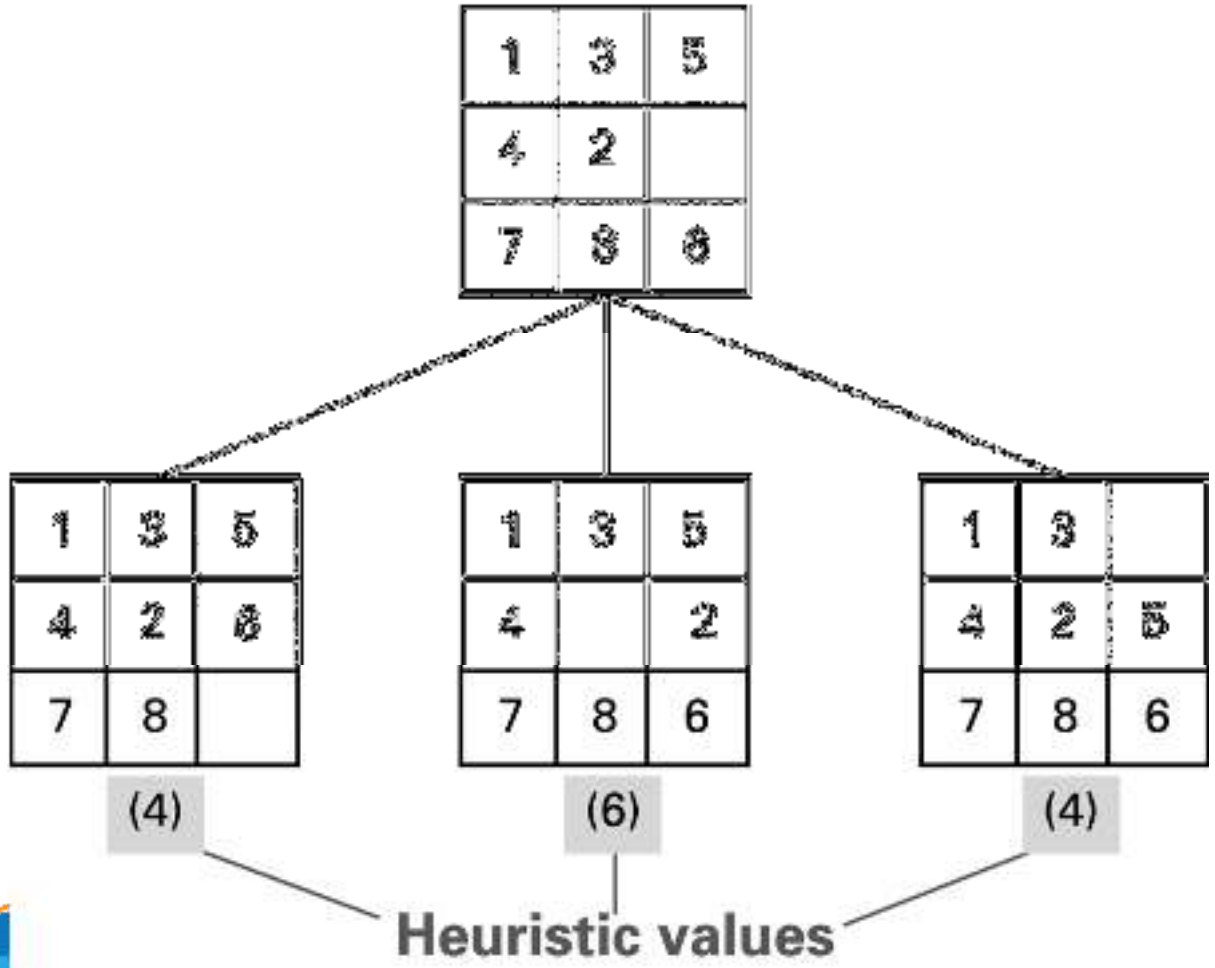
An unsolved eight-puzzle



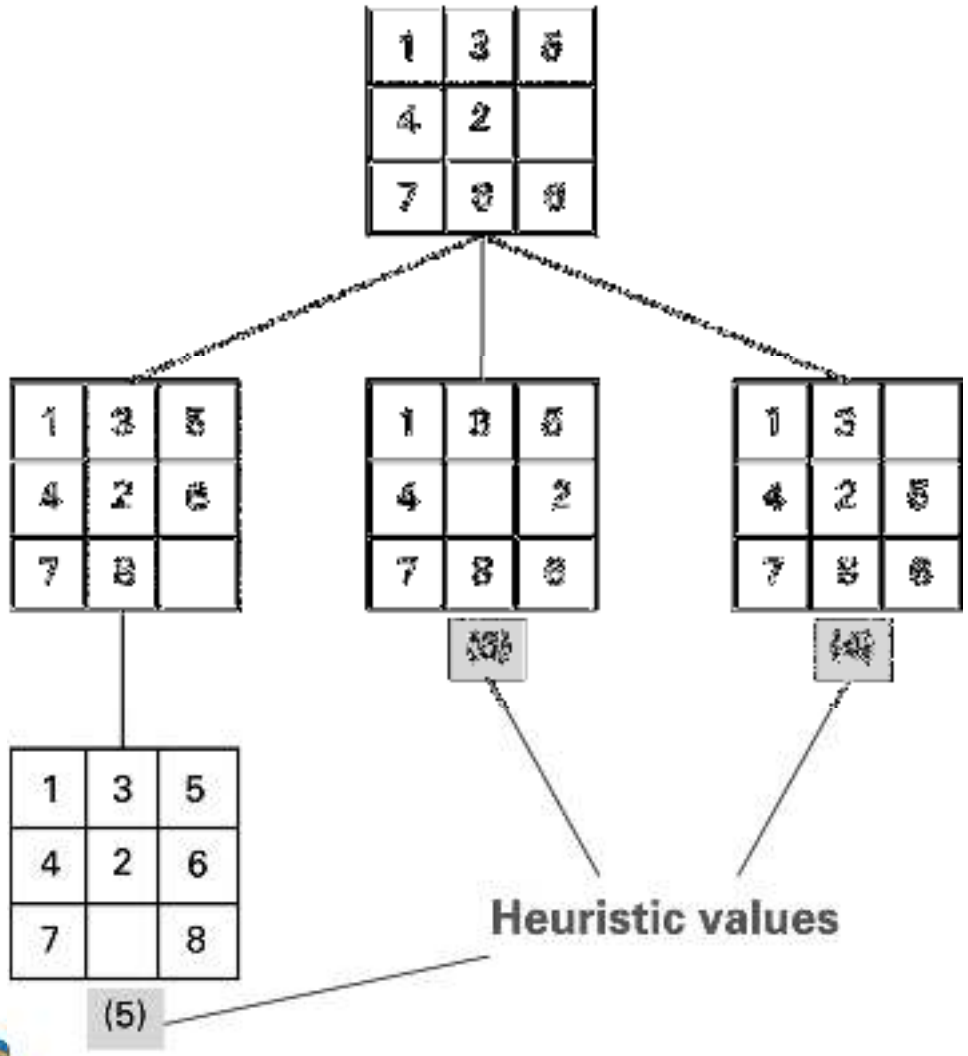
These tiles are at least one move from their original positions.

These tiles are at least two moves from their original positions.

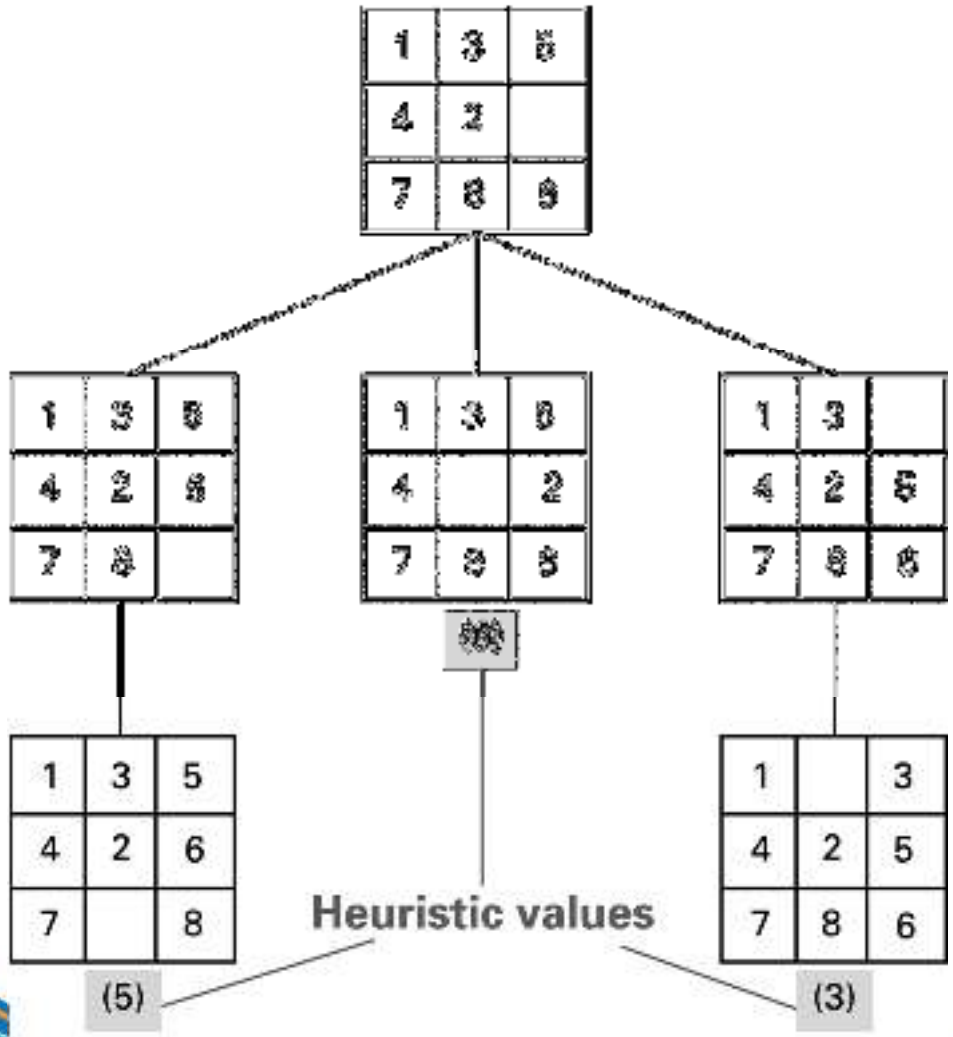
The beginnings of heuristic search

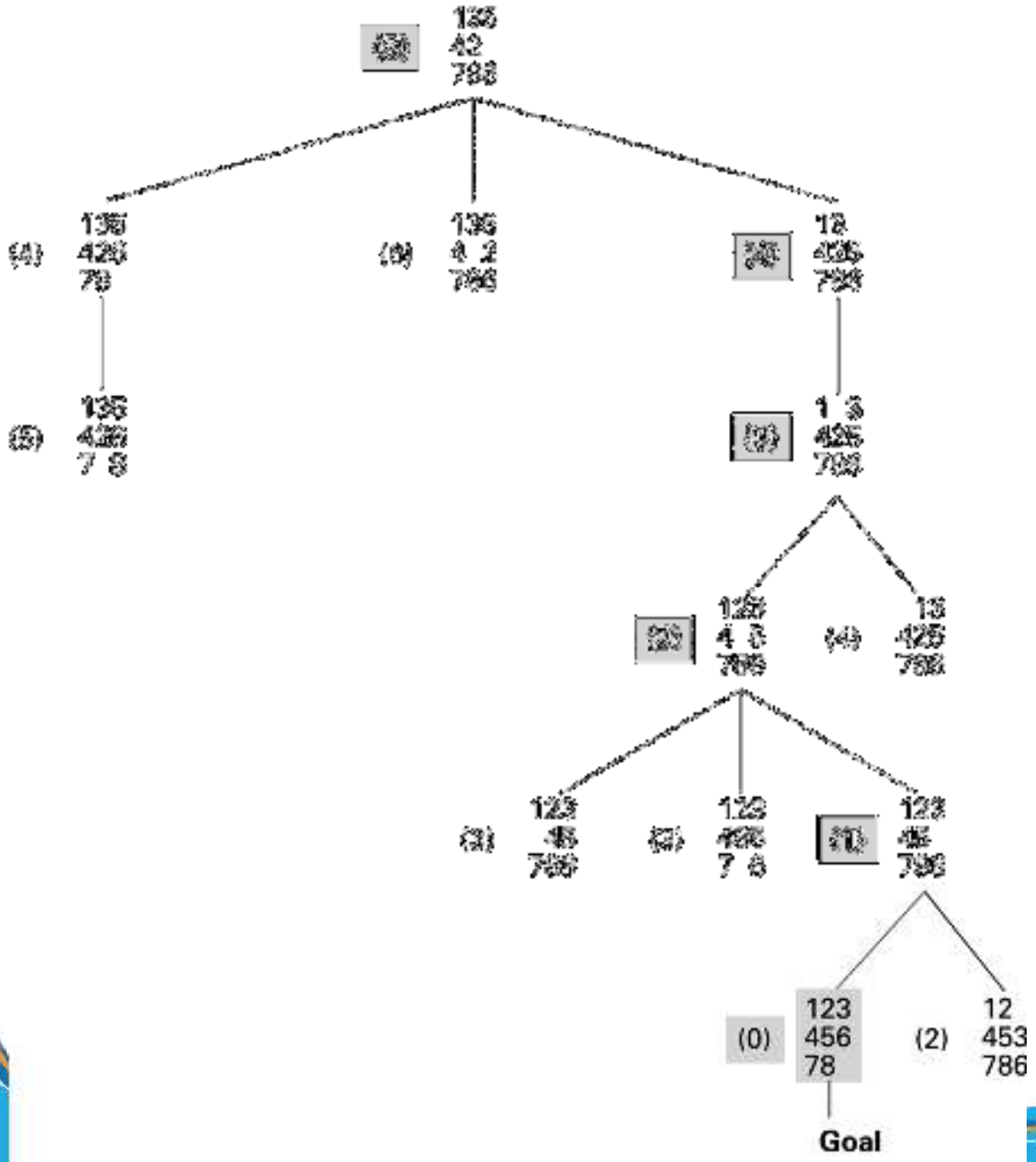


The search tree after two passes



The search tree after three passes




(0)
123
456
78
Goal
(2)
12
453
786

Content

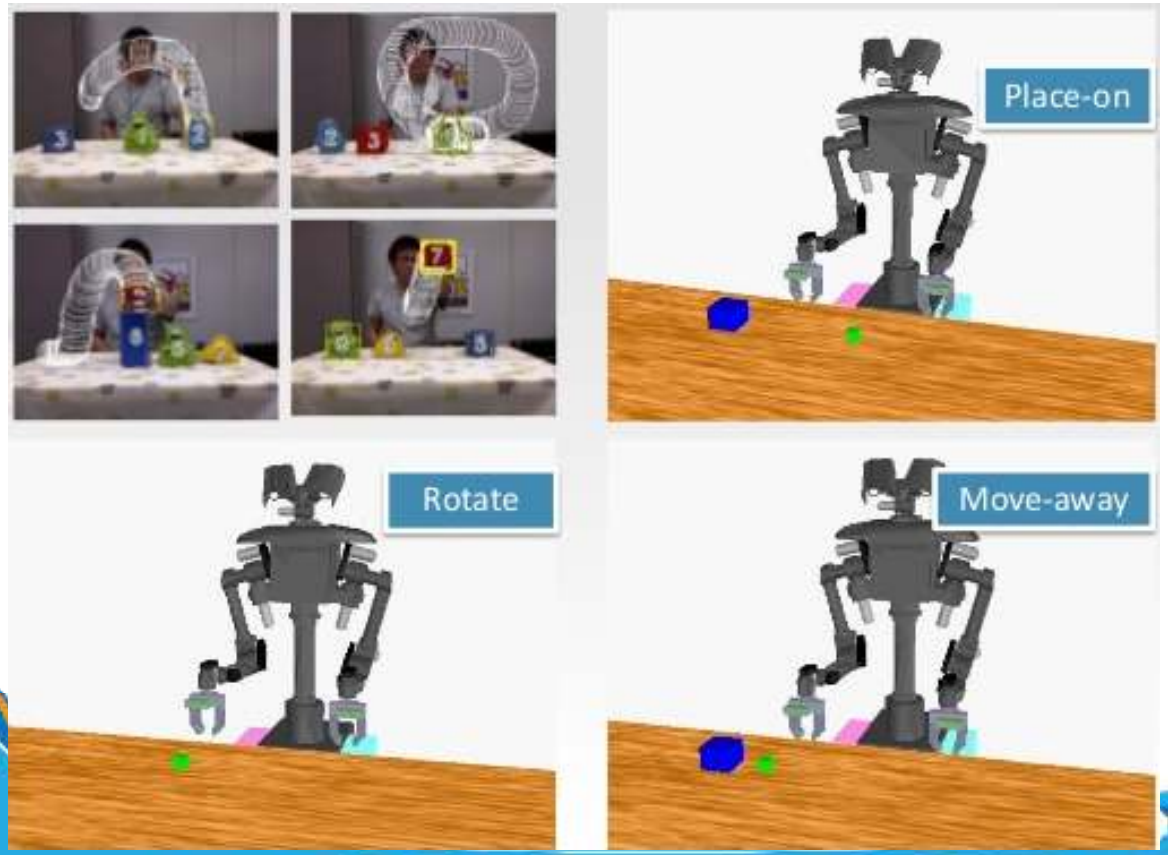
- Intelligence and Machines
- Perception
- Reasoning
- **Additional Areas of Research**
- Artificial Neural Networks
- Robotics
- Considering the Consequences
- About Computer Science Department

Handling Real-World Knowledge

- Representation and storage
- Accessing relevant information
  - Meta-Reasoning (reasoning about reasoning)
  - Closed-World Assumption
- Frame problem
  - Keeping stored knowledge up to date in a changing environment

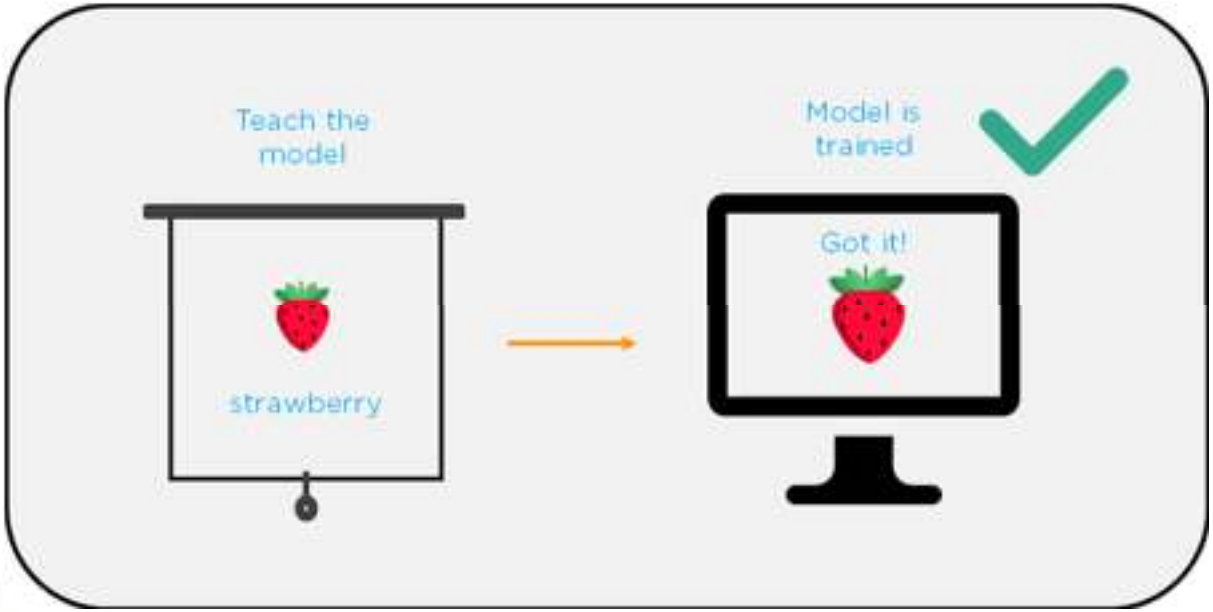
Learning

- Imitation
  - directly demonstrates the steps in a task and the computer simply records the steps.



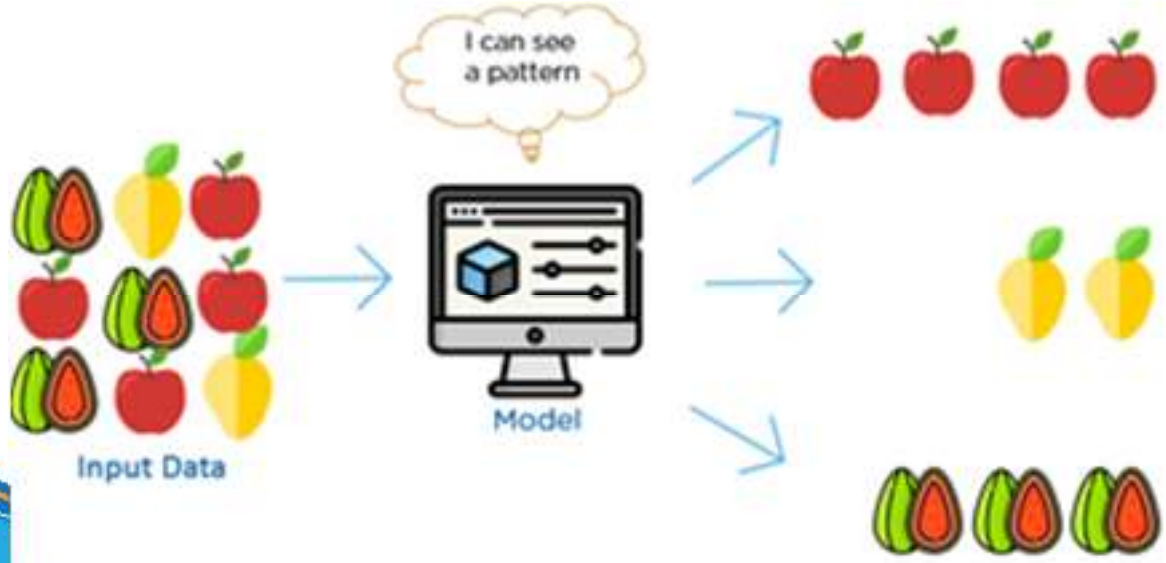
Learning

- Supervised learning
  - Task of learning a function that maps an input to an output based on example input-output pairs.



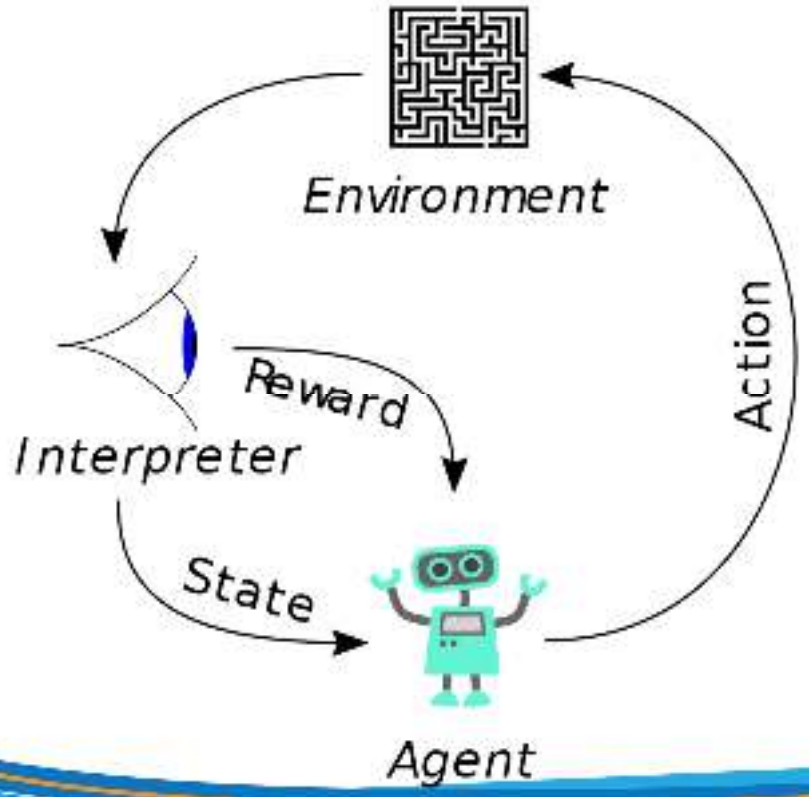
Learning

- Unsupervised Learning
  - learns from test data that has not been labeled, classified or categorized
  - Instead of responding to feedback, unsupervised learning identifies commonalities in the data and reacts based on the presence or absence of such commonalities in each new piece of data.



Learning

- Reinforcement learning
  - refers to goal-oriented algorithms, which learn how to take actions in an environment so as to maximize some notion of cumulative reward.



Genetic Algorithms

- There are some problems that are too complex to be solved such as:
  - execution exceeds available memory or
  - cannot be completed within a reasonable amount of time.
- A solution can sometimes be discovered through an evolutionary process involving many generations of trial solutions.
  - This strategy is the foundation for what is called genetic algorithms.

Genetic Algorithms

- Begins by generating a random pool of trial solutions:
  - Each solution is a **chromosome**
  - Each component of a chromosome is a **gene**
- Repeatedly generate new pools
  - Each new chromosome is an offspring of two parents from the previous pool
  - Probabilistic preference used to select parents
  - Each offspring is a combination of the parent's genes

Content

- Intelligence and Machines
- Perception
- Reasoning
- Additional Areas of Research
- **Artificial Neural Networks**
- Robotics
- Considering the Consequences
- About Computer Science Department

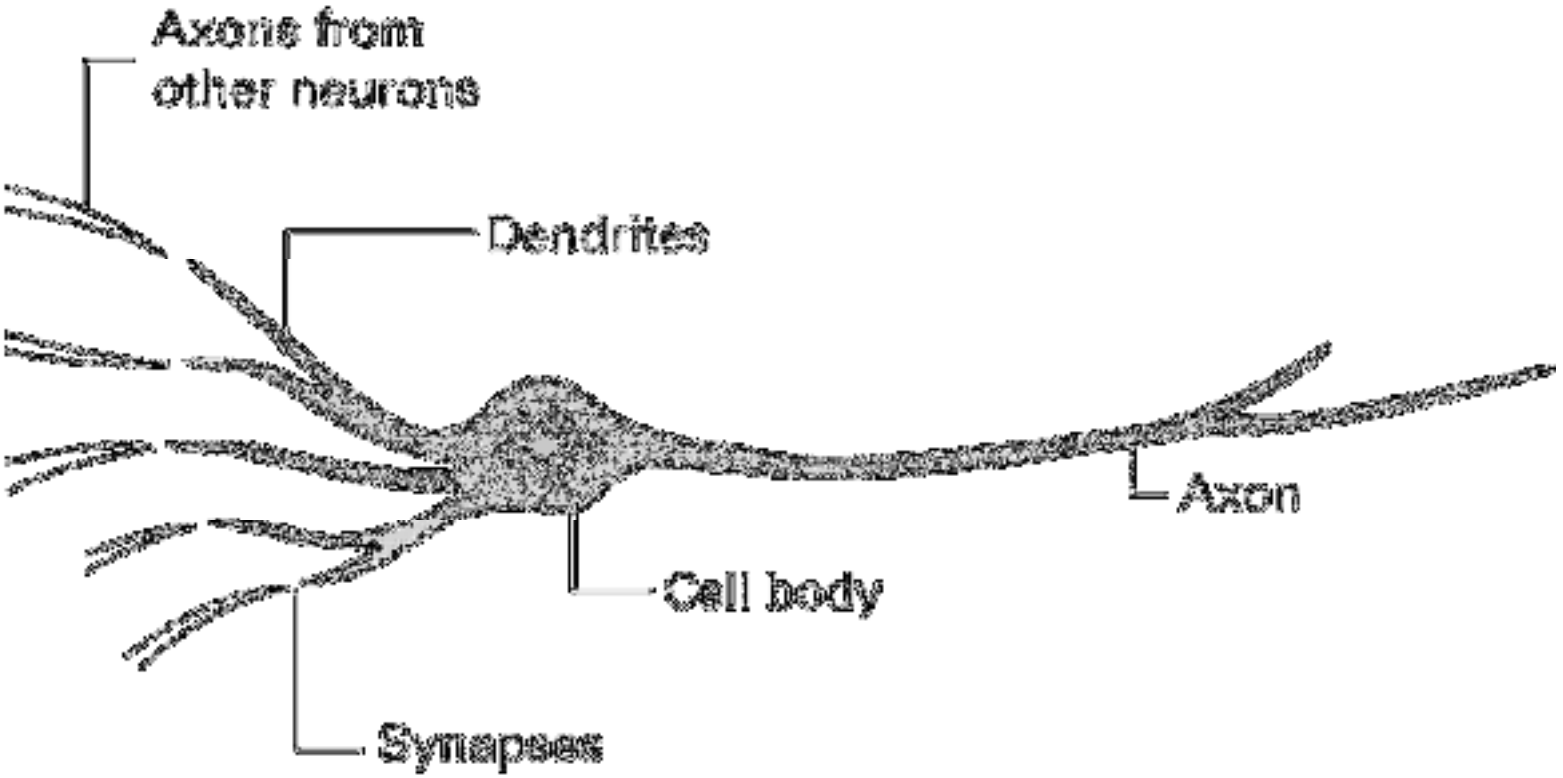
Artificial Neural Networks

- Many researchers are turning to approaches that leverage phenomena observed in nature.
  - One such approach is genetic algorithms presented in the previous section.
  - Another approach is the artificial neural network (human mind)

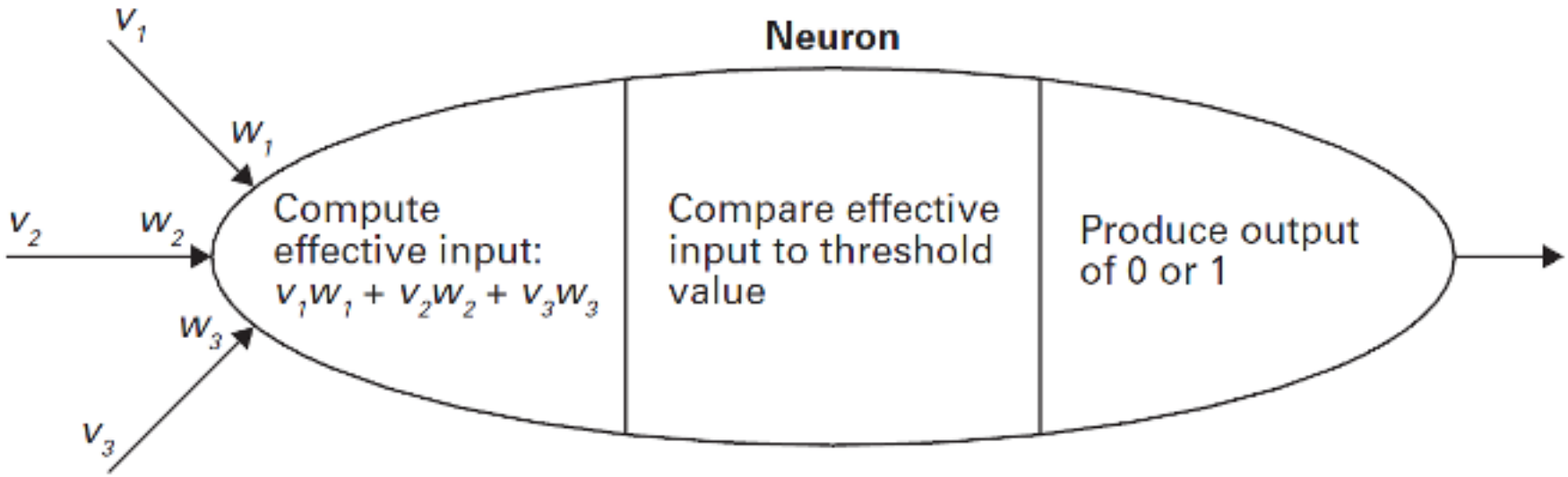
Artificial Neural Networks

- Artificial Neuron
  - Each input is multiplied by a weighting factor.
  - Output is 1 if sum of weighted inputs exceeds the threshold value; 0 otherwise.
- Network is programmed by adjusting weights using feedback from examples.

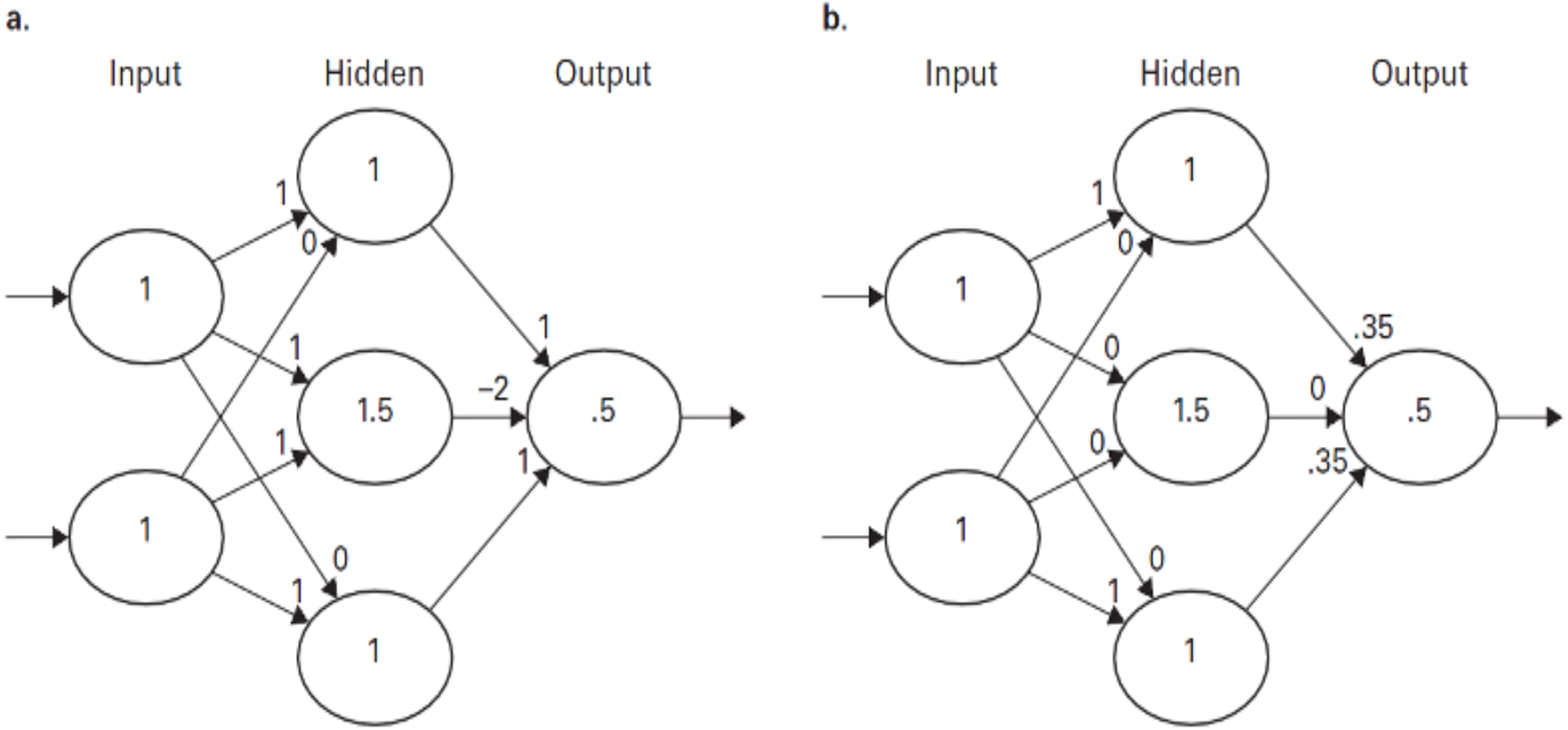
A neuron in a living biological system



The activities within a processing unit



A neural network with two different programs



Content

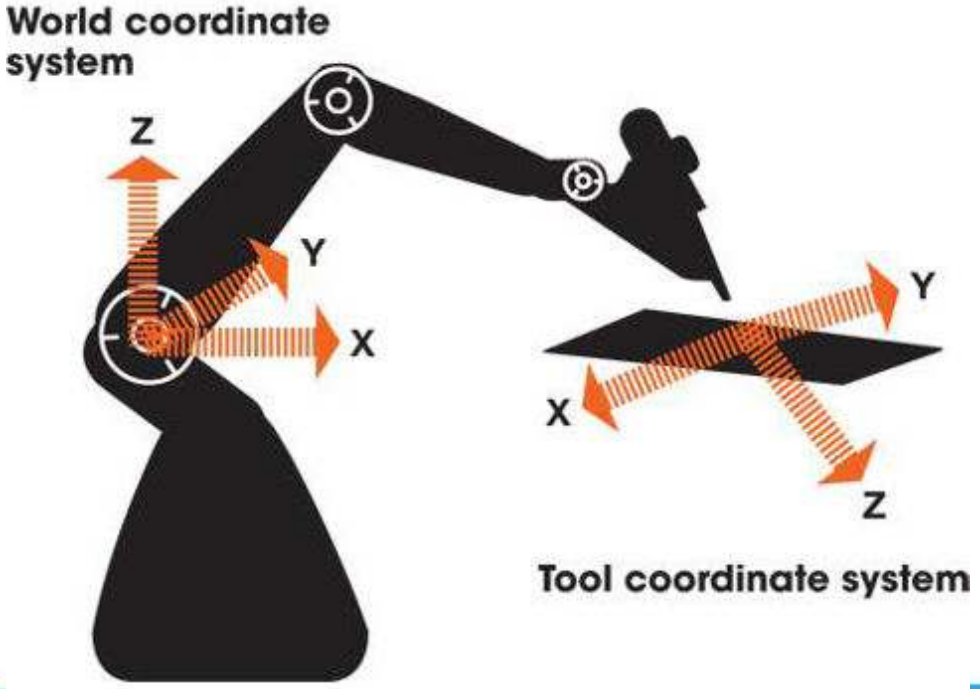
- Intelligence and Machines
- Perception
- Reasoning
- Additional Areas of Research
- Artificial Neural Networks
- **Robotics**
- Considering the Consequences
- About Computer Science Department

Robotics

- Truly autonomous robots require progress in perception and reasoning.
- To interact with the world, robots need mechanisms to manipulate objects and to move about.
- In the early days of robotics, the field was closely allied with the development of manipulators, most often mechanical arms with elbows, wrists, and hands or tools.

Robotics

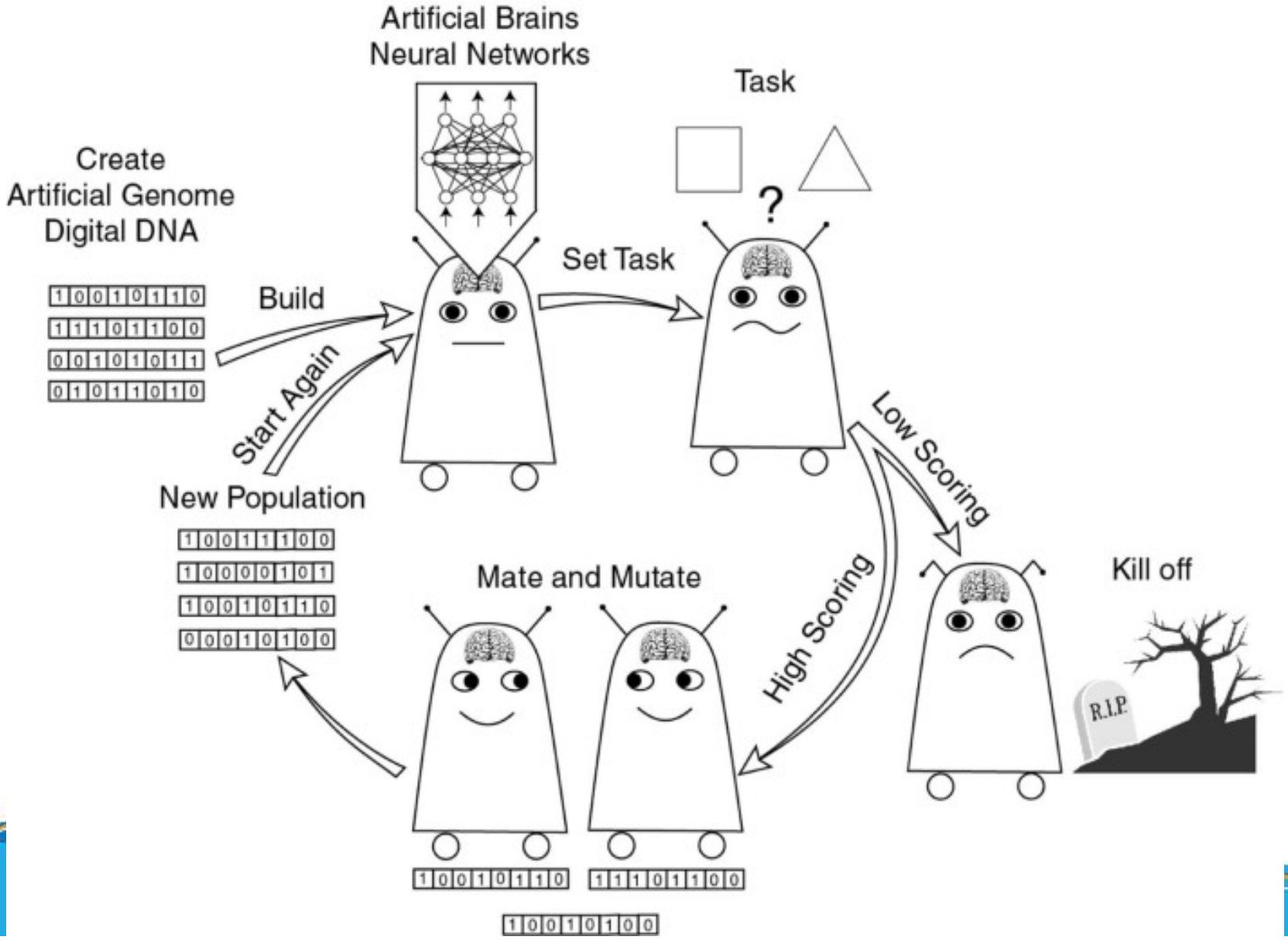
- Research dealt not only with how such devices could be maneuvered but also with how knowledge of their location and orientation could be maintained and applied.



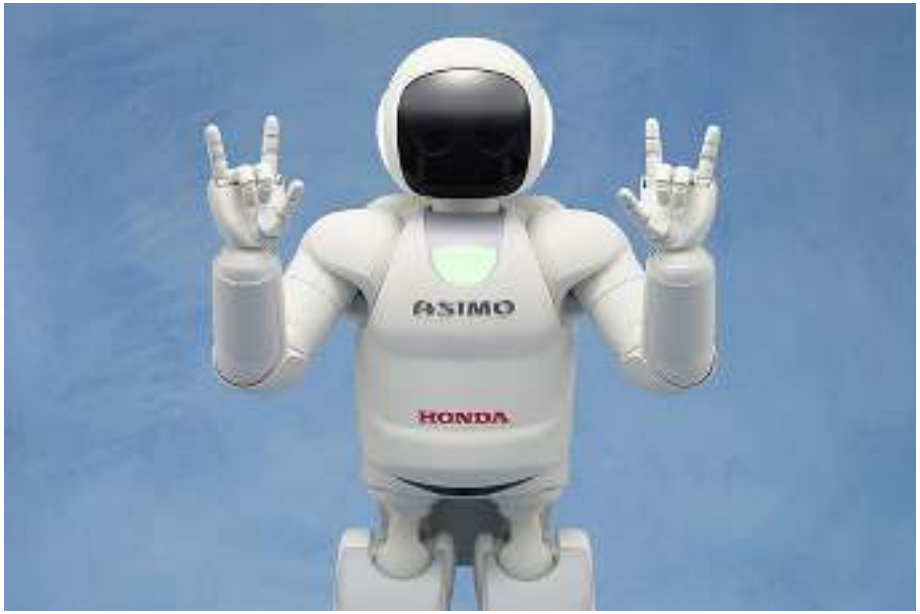
Evolutionary robotics

- Evolutionary robotics (ER) is a methodology that uses evolutionary computation to develop controllers and/or hardware for autonomous robots.
  - Algorithms in ER frequently operate on populations of candidate controllers, initially selected from some distribution.
  - This population is then repeatedly modified according to a fitness function.

Evolutionary robotics



Evolutionary robotics



asimo

Tartan Racing

Content

- Intelligence and Machines
- Perception
- Reasoning
- Additional Areas of Research
- Artificial Neural Networks
- Robotics
- **Considering the Consequences**
- About Computer Science Department

Issues Raised by Artificial Intelligence

Discuss about:

- When should a computer's decision be trusted over a human's?
- If a computer can do a job better than a human, when should a human do the job anyway?
- What would be the social impact if computer "intelligence" surpasses that of many humans?

Content

- Intelligence and Machines
- Perception
- Reasoning
- Additional Areas of Research
- Artificial Neural Networks
- Robotics
- Considering the Consequences
- **About Computer Science Department**

Department of Computer Science

- Since 2006
- Room I81
- Email: khmt@fit.hcmus.edu.vn
- Head: Prof. Le Hoai Bac
- Vice Head: Msc. Le Ngoc Thanh

CS Educational Objectives

- Provide students with knowledge in soft computing, data mining, biometrics, machine learning and pattern recognition, parallel programming, data hiding and some other field of computer science.
- Researching skills

Computer Science Sub Majors