

# **Introduction to Computer Science & Engineering**

Lecture 10: Artificial Intelligence

Jeonghun Park

# Thinking Machines

- What computers do best?
  - ▶ Count the distribution of letters in a book
  - ▶ Add 4 digit numbers
  - ▶ Match finger print
  - ▶ Etc..

# Thinking Machines

- Artificial intelligence (AI)
  - ▶ The study of computer systems that attempt to model and **apply the intelligence of the human mind**
  - ▶ For example, writing a program to pick out objects in a picture



**FIGURE 13.1** A computer might have trouble identifying the cat in this picture  
Courtesy of Amy Rose

# The Turing Test

튜링 테스트

- Provide a rule for the perfect AI

※ 사람 이랑 대화를 하다  
AI로 대화상대를  
아낄때 구분할 수 있는가?

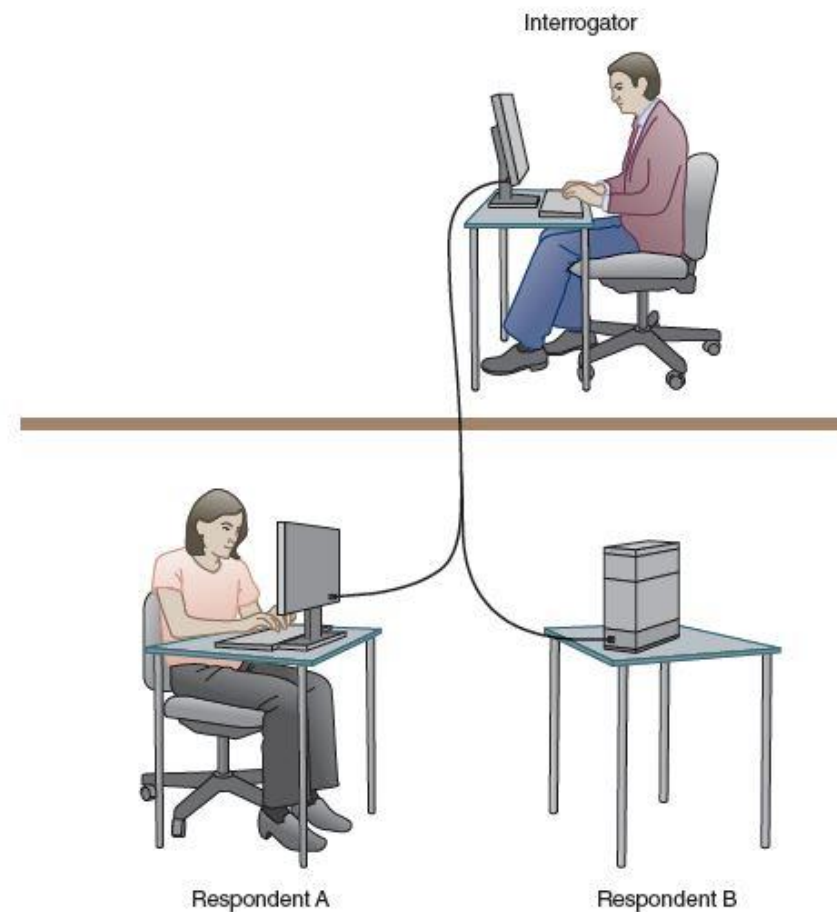


FIGURE 13.2 In a Turing test, the interrogator must determine which respondent is the computer and which is the human

# The Turing Test

- Weak equivalence  $\Rightarrow$  사람이 생각하는 것 처럼은 못하지만 원하는 결과는 얻어내줌
  - ▶ Two systems (human and computer) are equivalent in results (output), but they do not arrive at those results in the same way
- Strong equivalence  $\Rightarrow$  테미니아처럼 ( 사람이 하는 프로그래밍 동작)
  - ▶ Two systems (human and computer) use the same internal processes to produce results

개발자들은 weak equivalence 를 원하고 strong equivalence 를 하려했으나.

실제의 유한 정보처럼 strong equivalence 를 하니 어려웠다.

# The Turing Test

- Loebner prize
  - ▶ The first formal instantiation of the Turing test, held annually
- Chatbots  $\begin{pmatrix} 1 & 1 \\ 2 & 2 \end{pmatrix} 0$ 
  - ▶ A program designed to carry on a conversation with a human user

# Knowledge Representation

- How can we represent knowledge?

- ▶ We need to create a logical view of the data, based on how we want to process it

=> 데이터를 나타낼 새로운 방법이 필요.

- ▶ Natural language is very descriptive, but does not lend itself to efficient processing

=> 우리가 쓰는 말은 표현하기가 쉽지만  
프로그램이 이해하기 어렵다

- ▶ Semantic networks and search trees are promising techniques for representing knowledge

→ 지식을 표현하는 2가지 방법

# Semantic Networks

- Semantic network 개체와 개체사이의 관계에 초점을 맞춘 기술
  - ▶ A knowledge representation technique that focuses on the relationships between objects
  - ▶ A directed graph is used to represent a semantic network or net

그래프 방식  
(네트워크 같은)  
사용.



# Semantic Networks

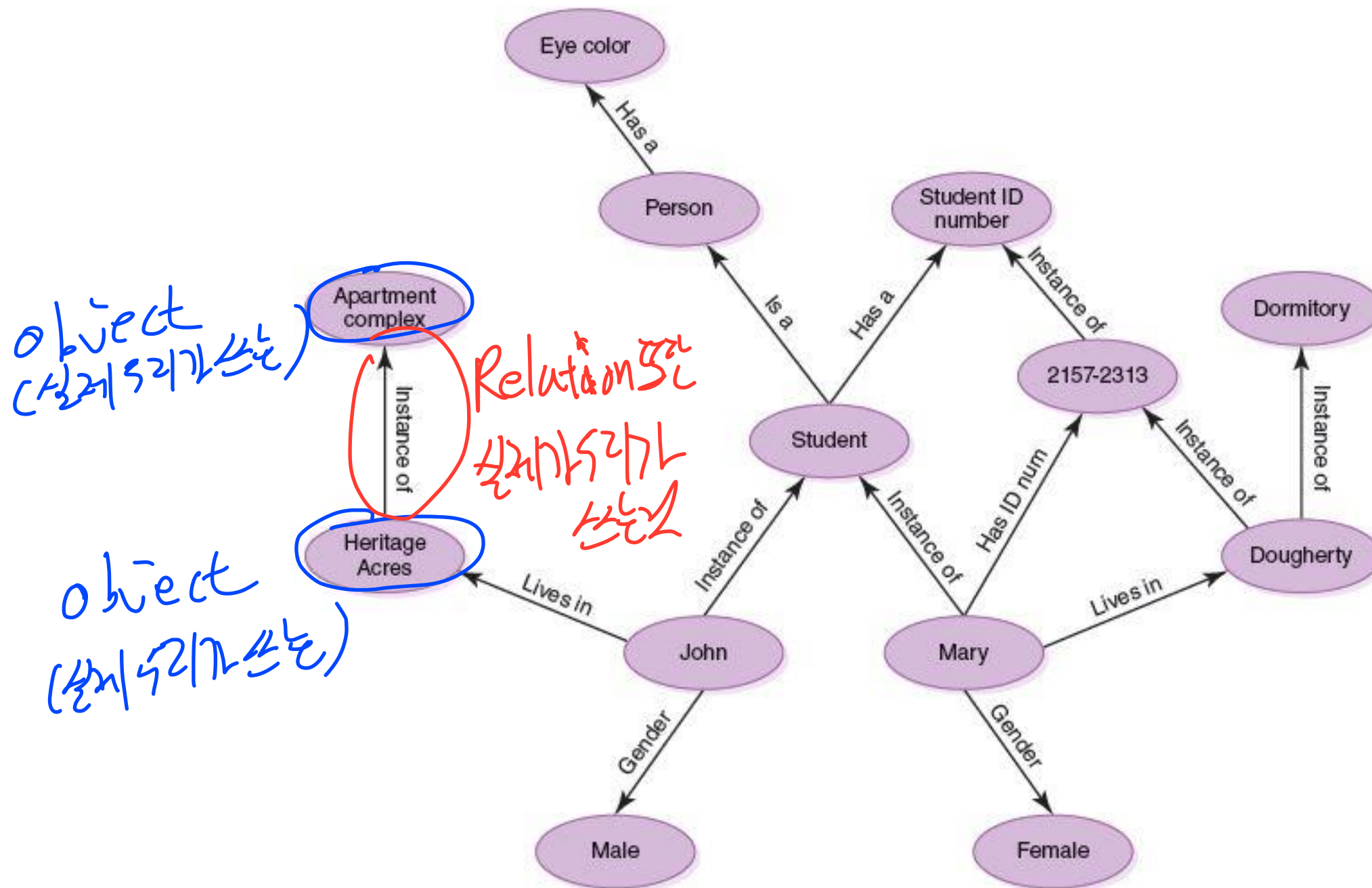


FIGURE 13.3 A semantic network

# Semantic Networks

① object 는 우리가 실제로 쓰는 것들로 함

② object와 object 관계에 대한 질문도 우리가 실제로 쓰는 것들로 함

## • Network Design

- ▶ The objects in the network represent the objects in the real world that we are representing
- ▶ The relationships that we represent are based on the real world questions that we would like to ask
- ▶ That is, the types of relationships represented determine which questions are easily answered, which are more difficult to answer, and which cannot be answered

③ 어느 질문이 답하기 쉬우니  
어느 질문이 답하기 어려우니  
어느 질문이 답할수 없으니

} Type 결정

# Search Trees

- Search tree
  - ▶ A structure that represents alternatives in adversarial situations such as game playing  
대립적인
  - ▶ The paths down a search tree represent a series of decisions made by the players

# Search Trees

누가 이길 것인가

5판 3인승의 경우

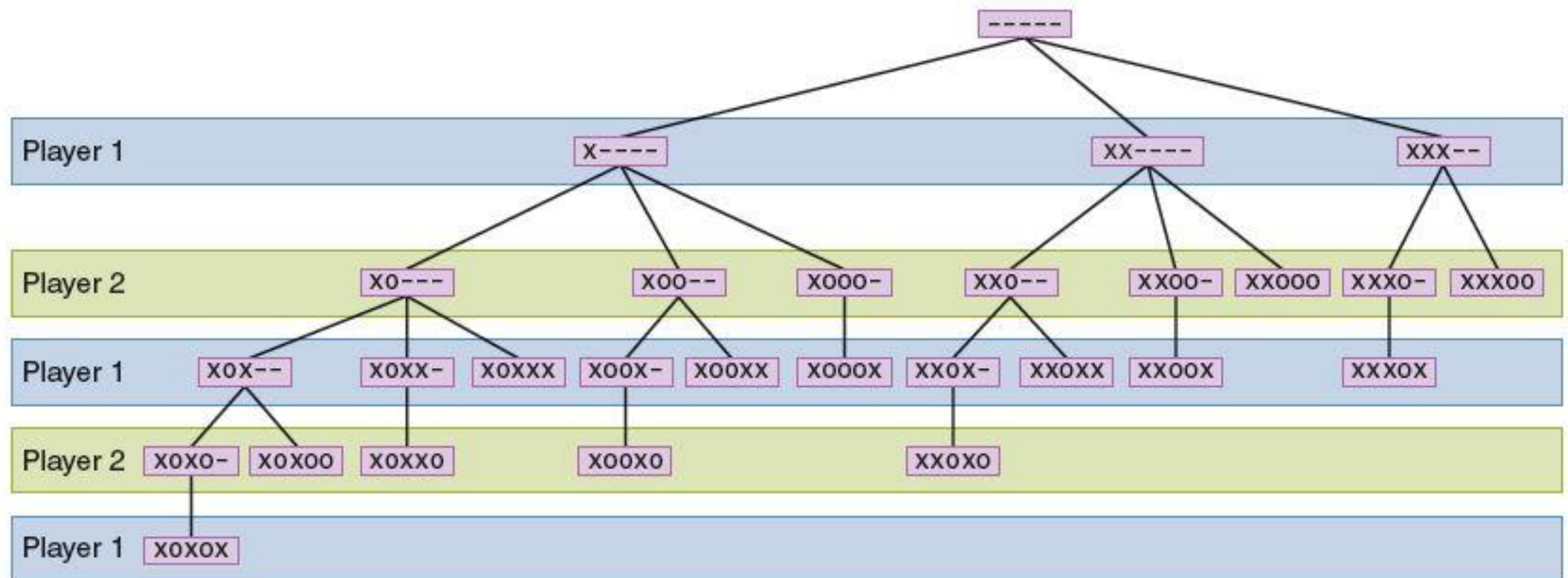


FIGURE 13.4 A search tree for a simplified version of Nim

\* 결과를 미리 보는 것 나타냄

# Search Trees

- Search tree analysis can be applied to other, more complicated games such as chess
- However, full analysis of the chess search tree would take more than your lifetime to determine the first move
- Because these trees are so large, only a fraction of the tree can be analyzed in a reasonable time limit, even with modern computing power
- Therefore, we must find a way to prune the tree

그냥 다 분석해볼 수 없지

# Search Trees

- Techniques for pruning search space

↳ 검색공간을 파르는 기술

- Depth-first

① 먼저 한 상황을 끝까지 깊이 파고 나머지를 때려눕히는 것

- ▶ A technique that involves searching down the paths of a tree prior to searching across levels

- Breadth-first ② 다음 경로를 찾기엔 싹다 훑은 채로 되는 것  
방위 퍼스트

- ▶ A technique that involves searching across levels of a tree prior to searching down specific paths

- ▶ Breadth-first tends to yield the best results



# Search Trees

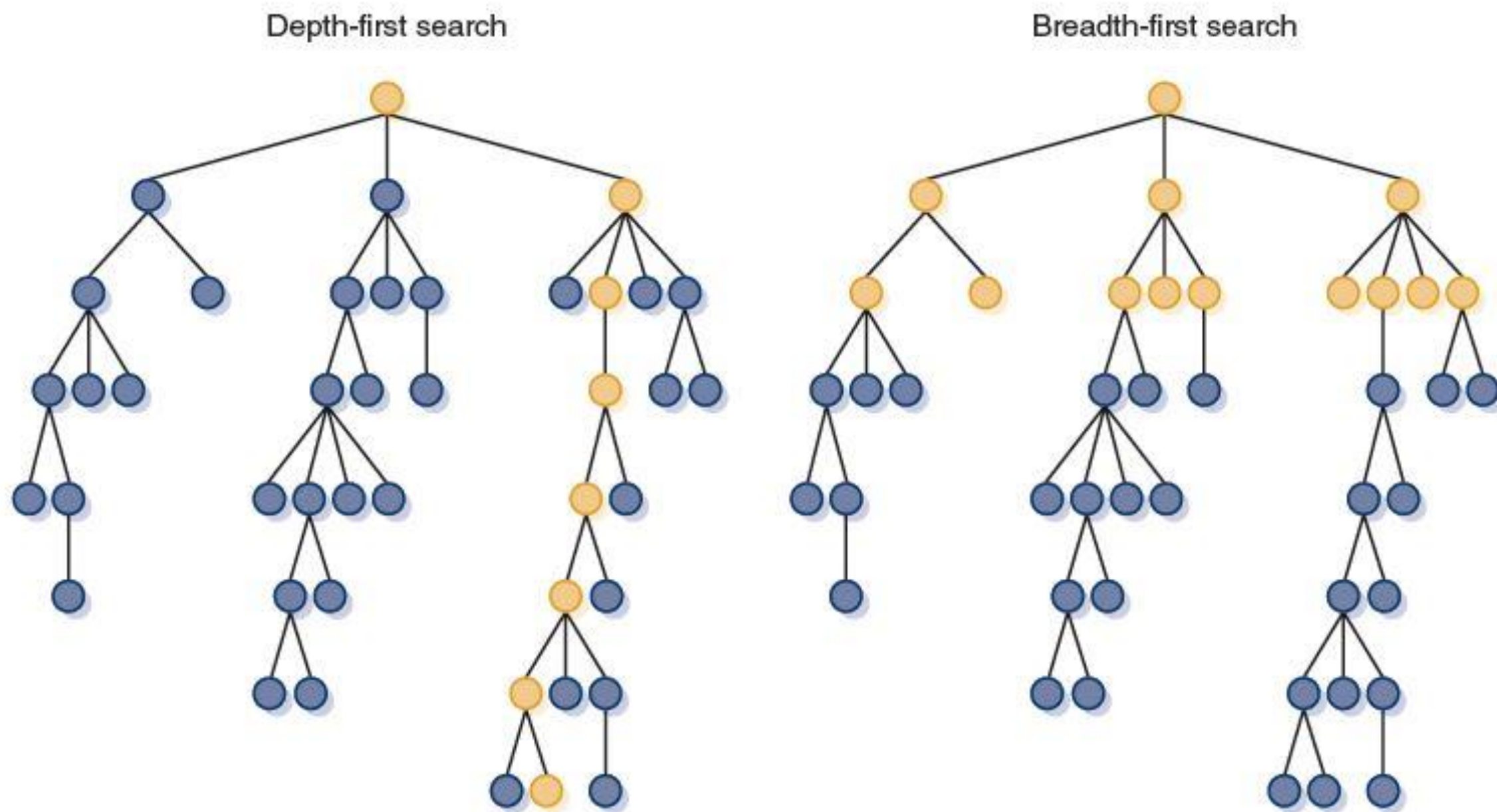


FIGURE 13.5 Depth-first and breadth-first searches

# Expert Systems 전문가 시스템

- Knowledge-based system
- Software that uses a specific set of information, from which it extracts and processes particular pieces
- Expert system [특정 지식구조를 추출하고 처리하여 결론을 얻는]
- A software system based on the knowledge of human experts; it is a

- ▶ Rule-based system - A software system based on a set of if-then rules 규칙 기반 시스템 : 어떤 조건을 충족하고 그것이 기인해 결론을
- ▶ Inference engine - The software that processes rules to draw conclusions

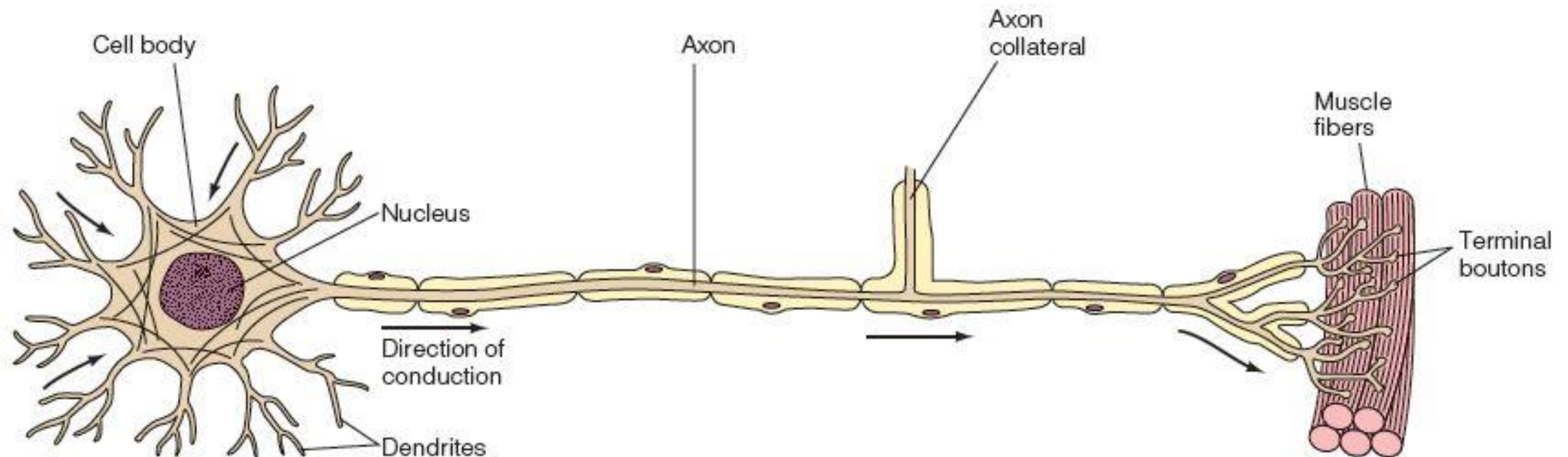
추론기 : 사용자가 입력하는 사실, 가설을 바탕으로 새로운 사실, 가설 도출  
 해결과를 도출



# Artificial Neural Network

- Artificial neural networks
- A computer representation of knowledge that attempts to mimic the neural networks of the human body
- Yes, but what is a human neural network?

# Neural Network



**FIGURE 13.6** A biological neuron

# Neural Network

- Neuron

- ▶ A single cell that conducts a chemically-based electronic signal
- ▶ At any point in time a neuron is in either an excited state or an inhibited state

- Excited state

- ▶ Neuron conducts a strong signal

활발한 상태

- Inhibited state

- ▶ Neuron conducts a weak signal

억제된 상태

# Artificial Neural Networks

- Each processing element in an artificial neural net is analogous to a biological neuron
  - ▶ An element accepts a certain number of input values (dendrites) and produces a single output value (axon) of either 0 or 1
  - ▶ Associated with each input value is a numeric weight (synapse)

# Artificial Neural Networks

- The effective weight of the element is the sum of the weights multiplied by their respective input values

▶  $v_1 * w_1 + v_2 * w_2 + v_3 * w_3$

$$\frac{\quad}{0} \text{ threshold}$$

- Each element has a numeric threshold value
- If the effective weight exceeds the threshold, the unit produces an output value of 1
- If it does not exceed the threshold, it produces an output value of 0

# Artificial Neural Networks

- Training

- ▶ The process of adjusting the weights and threshold values in a neural net

- How does this all work?

고양이 사진으로 교육



- ▶ Train a neural net to recognize a cat in a picture
- ▶ Given one output value per pixel, train network to produce an output value of 1 for every pixel that contributes to the cat and 0 for every one that doesn't

다른 고양이 사진도 학습 |

# Natural Language Processing

- Three basic types of processing occur during human/computer voice interaction
- Voice synthesis
- Using a computer to recreate the sound of human speech
- Voice recognition
- Using a computer to recognize the words spoken by a human
- Natural language comprehension
- Using a computer to apply a meaningful interpretation to human communication

# Voice Synthesis 음성합성.

## 신 테시스

- One Approach to Voice Synthesis
- Dynamic voice generation
- A computer examines the letters that make up a word and produces the sequence of sounds that correspond to those letters in an attempt to vocalize the word
  - ① 단어를 만드는 문자 단어를 인식
  - ② 그 단어를 소리내듯 말할 때 어떻게 나누어 말할지
- Phonemes
- The sound units into which human speech has been categorized

사람이 말하는 것을 조각조각 내어 (음절로) 카테고리화.



# Voice Recognition

- Problems with understanding speech
  - ▶ Each person's sounds are unique
  - ▶ Each person's shape of mouth, tongue, throat, and nasal cavities that affect the pitch and resonance of our spoken voice are unique
  - ▶ Speech impediments, mumbling, volume, regional accents, and the health of the speaker are further complications

# Voice Recognition

- Other problems
  - ▶ Humans speak in a continuous, flowing manner, stringing words together
  - ▶ Sound-alike phrases like “ice cream” and “I scream”
  - ▶ Homonyms such as “I” & “eye” or “see” & “sea”
- Humans clarify these situations by context, but that requires another level of comprehension
- Voice-recognition systems still have trouble with continuous speech

# Natural Language Comprehension

- Natural language is ambiguous! <애려무호>
- Lexical ambiguity 이/혹/24 이/24가 애려무호  
▶ The ambiguity created when words have multiple meanings
- Syntactic ambiguity 문/24/37가 애려무호  
▶ The ambiguity created when sentences can be constructed in various ways
- Referential ambiguity 동/은/0/이/이/이  
▶ The ambiguity created when pronouns could be applied to multiple objects

# Natural Language Comprehension

- What does this sentence mean?

시간이, 속다

- Time flies like an arrow.

문제

- ▶ Time goes by quickly
- ▶ Time flies (using a stop watch) as you would time an arrow
- ▶ Time flies (a kind of fly) are fond of an arrow

# Natural Language Comprehension

- Lexical ambiguity \* 뜻이 많아서 문제
  - ▶ Stand up for your country.
  - ▶ Take the street on the left.
- Syntactic ambiguity
  - ▶ I saw the bird watching from the corner.
  - ▶ I ate the sandwich sitting on the table.
- Referential ambiguity
  - ▶ The bicycle hit the curb, but it was not damaged.
  - ▶ John was mad at Bill, but he didn't care.

# Subsumption Architecture

- Rather than trying to model the entire world all the time, the robot is given a simple set of behaviors each associated with the part of the world necessary for that behavior

\* 필요한 기능만  
남게

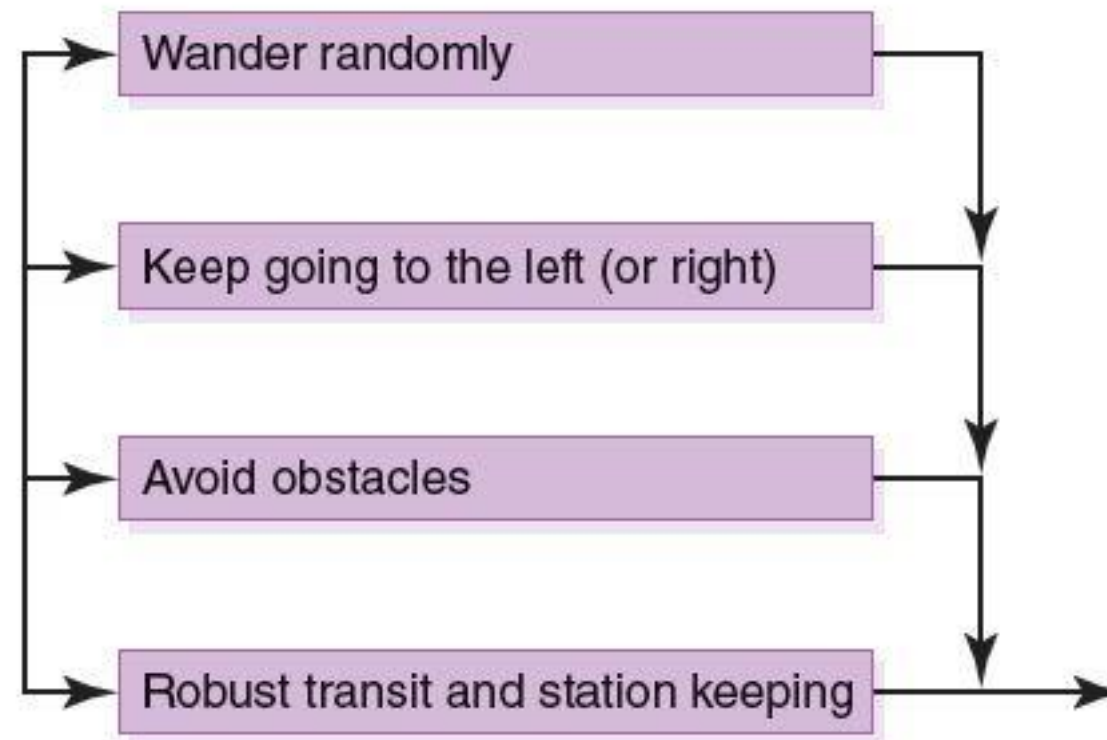
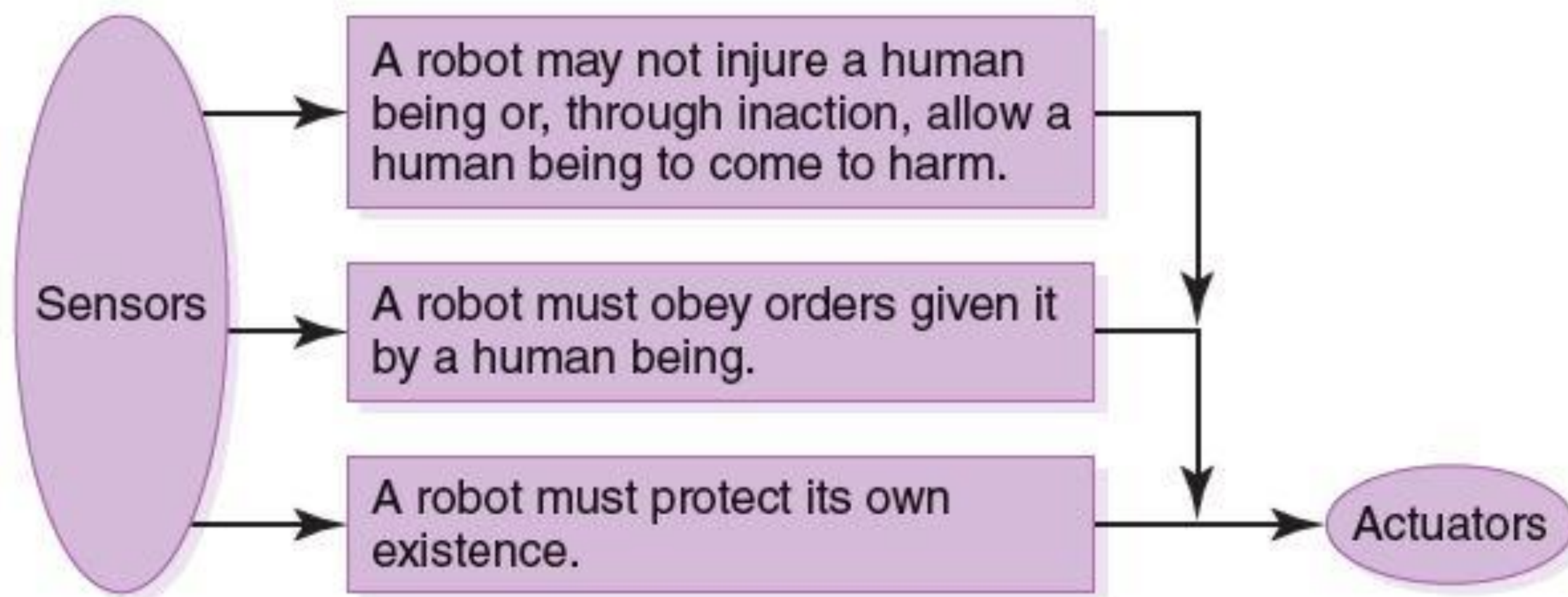


FIGURE 13.9 The new control paradigm

# Subsumption Architecture



**FIGURE 13.10** Asimov's laws of robotics are ordered