Artificial Intelligence
Chapter 1
Introduction

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1.1 What Is AI? (1)

- Artificial Intelligence (AI)
  - Intelligent behavior in artifacts
  - “Designing computer programs to make computers smarter”
  - “Study of how to make computers do things at which, at the meoment, people are better”
- Intelligent behavior
  - Perception, reasoning, learning, communicating, acting in complex environments
- Long term goals of AI
  - Develop machines that do things as well as humans can or possibly even better
  - Understand behaviors

1.1 What Is AI? (2)

- Can machines think?
  - Depend on the definitions of "machine", "think", "can"
- "Can"
  - Can machines think now or someday?
  - Might machines be able to think theoretically or actually?
- "Machine"
  - E6 Bacteriophage: Machine made of proteins
  - Searle's belief
    - What we are made of is fundamental to our intelligence
    - Thinking can occur only in very special machines – living ones made of proteins

1.1 What Is AI? (3)

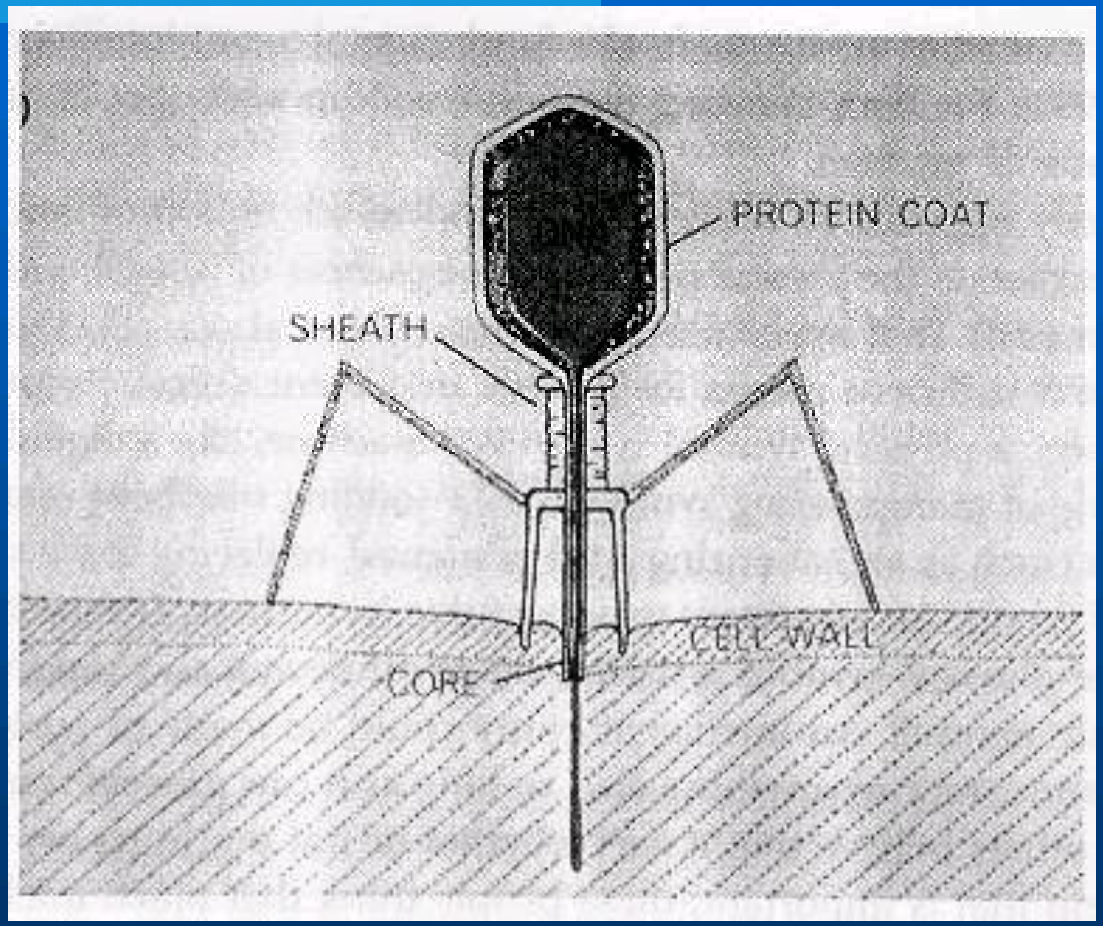
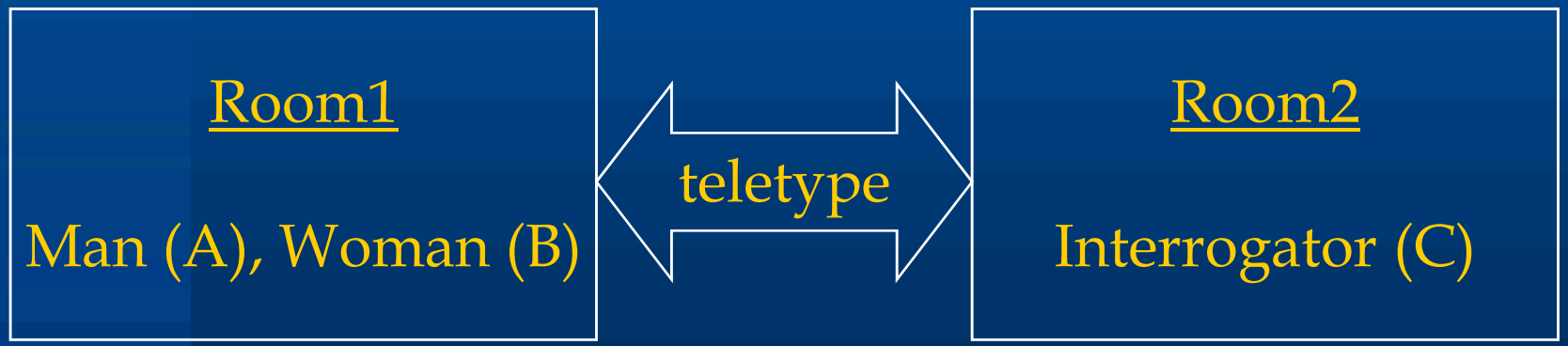


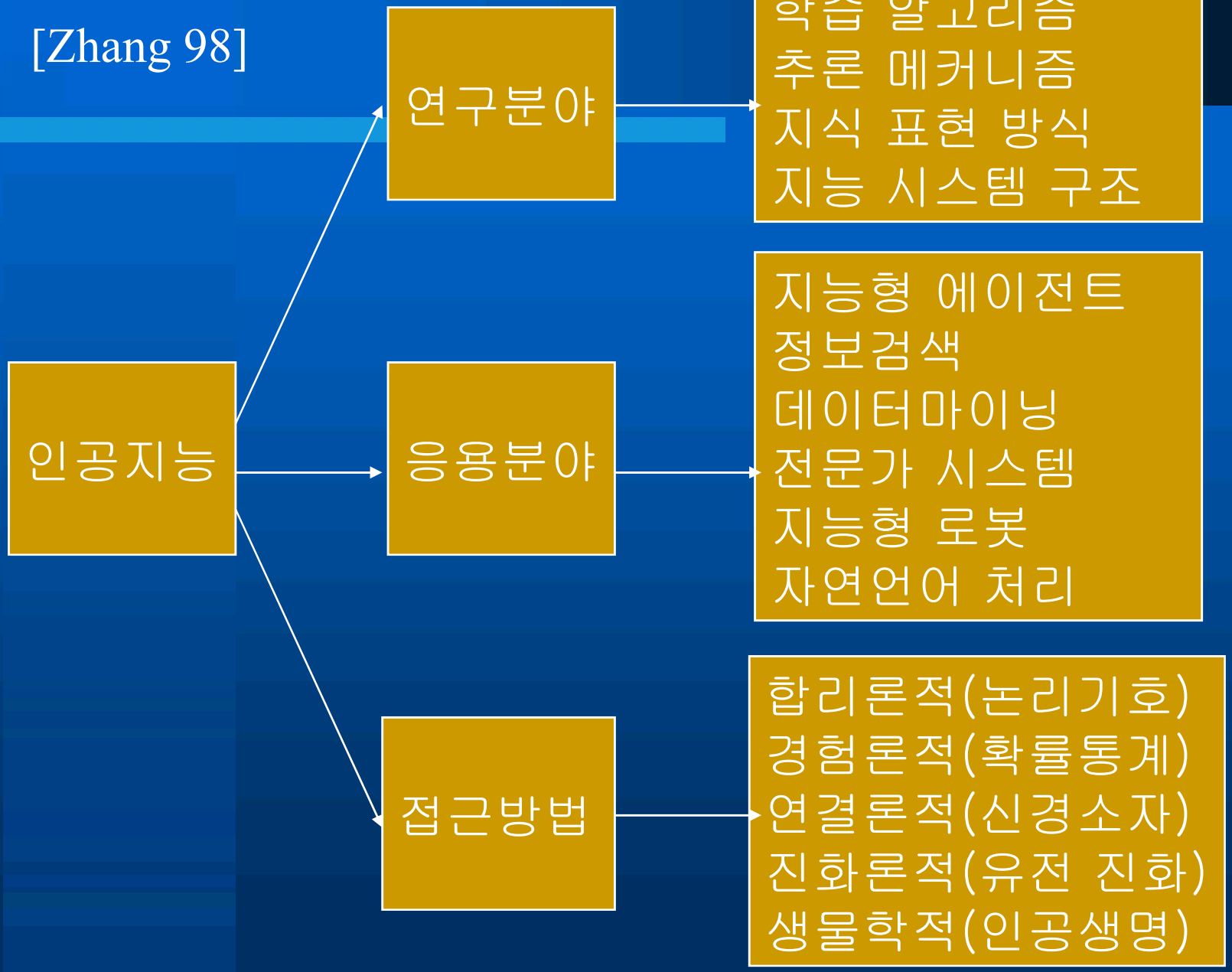
Figure 1.1 Schematic Illustration of E6 Bacteriophage

1.1 What Is AI? (4)

- "Think"
  - Turing test: Decide whether a machine is intelligent or not
    - Interrogator (C): determine man/woman
    - A: try and cause C to make the wrong identification
    - B: help the interrogator
  - Examples: ELIZA [Weizenbaum], JULIA [Mauldin]



[Zhang 98]



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1.2 Approaches to AI (1)

- Two main approaches: symbolic vs. subsymbolic

1. Symbolic
   - Classical AI ("Good-Old-Fashioned AI" or GOFAI)
   - Physical symbol system hypothesis
   - Logical, top-down, designed behavior, knowledge-intensive
2. Subsymbolic
   - Modern AI, neural networks, evolutionary machines
   - Intelligent behavior is the result of subsymbolic processing
   - Biological, bottom-up, emergent behavior, learning-based

- Brain vs. Computer
  - Brain: parallel processing, fuzzy logic
  - Computer: serial processing, binary logic

1.2 Approaches to AI (1)

- Symbolic processing approaches
  - Physical symbol system hypothesis [Newell & Simon]
    - "A physical symbol system has the necessary and sufficient means for general intelligence action"
    - Physical symbol system: A machine (digital computer) that can manipulate symbolic data, rearrange lists of symbols, replace some symbols, and so on.
  - Logical operations: McCarthy's "advice-taker"
    - Represent "knowledge" about a problem domain by declarative sentences based on sentences in first-order logic
    - Logical reasoning to deduce consequences of knowledge
    - applied to declarative knowledge bases

1.2 Approaches to AI (2)

- Top-down design method
  - Knowledge level
    - Top level
    - The knowledge needed by the machine is specified
  - Symbol level
    - Represent knowledge in symbolic structures (lists)
    - Specify operations on the structures
  - Implementation level
    - Actually implement symbol-processing operations

1.2 Approaches to AI (3)

- Subsymbolic processing approaches
  - Bottom-up style
    - The concept of *signal* is appropriate at the lowest level
  - Animat approach
    - Human intelligence evolved only after a billion or more years of life on earth
    - Many of the same evolutionary steps need to make intelligence machines
  - Symbol grounding
    - Agent's behaviors interact with the environment to produce complex behavior
  - Emergent behavior
    - Functionality of an agent: emergent property of the intensive interaction of the system with its dynamic environment

1.2 Approaches to AI (4)

- Well-known examples of machines coming from the subsymbolic school
  - Neural networks
    - Inspired by biological models
    - Ability to learn
  - Evolution systems
    - Crossover, mutation, fitness
  - Situated automata
    - Intermediate between the top-down and bottom-up approaches

1.3 Brief History of AI (1)

[Zhang 98]

Symbolic AI	Biological AI
• 1943: Production rules	• 1943: McCulloch-Pitt's neurons
• 1956: "Artificial Intelligence"	• 1959: Perceptron
• 1958: LISP AI language	• 1965: Cybernetics
• 1965: Resolution theorem proving	• 1966: Simulated evolution
	• 1966: Self-reproducing automata
• 1970: PROLOG language	• 1975: Genetic algorithm
• 1971: STRIPS planner	
• 1973: MYCIN expert system	• 1982: Neural networks
• 1982-92: Fifth generation computer systems project	• 1986: Connectionism
	• 1987: Artificial life
• 1986: Society of mind	
	• 1992: Genetic programming
• 1994: Intelligent agents	• 1994: DNA computing

1.3 Brief History of AI (2)

- 1940~1950
  - Programs that perform elementary reasoning tasks
  - Alan Turing: First modern article dealing with the possibility of mechanizing human-style intelligence
  - McCulloch and Pitts: Show that it is possible to compute any computable function by networks of artificial neurons.
- 1956
  - Coined the name “Artificial Intelligence”
  - Frege: Predicate calculus = Begriffsschrift = “concept writing”
  - McCarthy: Predicate calculus: language for representing and using knowledge in a system called “advice taker”
  - Perceptron for learning and for pattern recognition [Rosenblatt]

1.3 Brief History of AI (3)

- 1960~1970
  - Problem representations, search techniques, and general heuristics
  - Simple puzzle solving, game playing, and information retrieval
  - Chess, Checkers, Theorem proving in plane geometry
  - GPS (General Problem Solver)

1.3 Brief History of AI (4)

- Late 1970 ~ early 1980
  - Development of more capable programs that contained the knowledge required to mimic expert human performance
  - Methods of representing problem-specific knowledge
  - DENDRAL
    - Input: chemical formula, mass spectrogram analyses
    - Output: predicting the structure of organic molecules
  - Expert Systems
    - Medical diagnoses

1.3 Brief History of AI (5)

- DEEP BLUE (1997/5/11)
  - Chess game playing program
- Human Intelligence
  - Ability to perceive/analyze a visual scene
    - Roberts
  - Ability to understand and generate language
    - Winograd: Natural Language understanding system
    - LUNAR system: answer spoken English questions about rock samples collected from the moon

1.3 Brief History of AI (6)

- Neural Networks
  - Late 1950s: Rosenblatt
  - 1980s: important class of nonlinear modeling tools
- AI research
  - Neural networks + animat approach: problems of connecting symbolic processes to the sensors and efforts of robots in physical environments
- Robots and Softbots (Agents)

1.4 Plan of the Book

- Agent in grid-space world
- Grid-space world
  - 3-dimensional space demarcated by a 2-dimensional grid of cells “floor”
- Reactive agents
  - Sense their worlds and act in them
  - Ability to remember properties and to store internal models of the world
  - Actions of reactive agents: *f*(current and past states of their worlds)

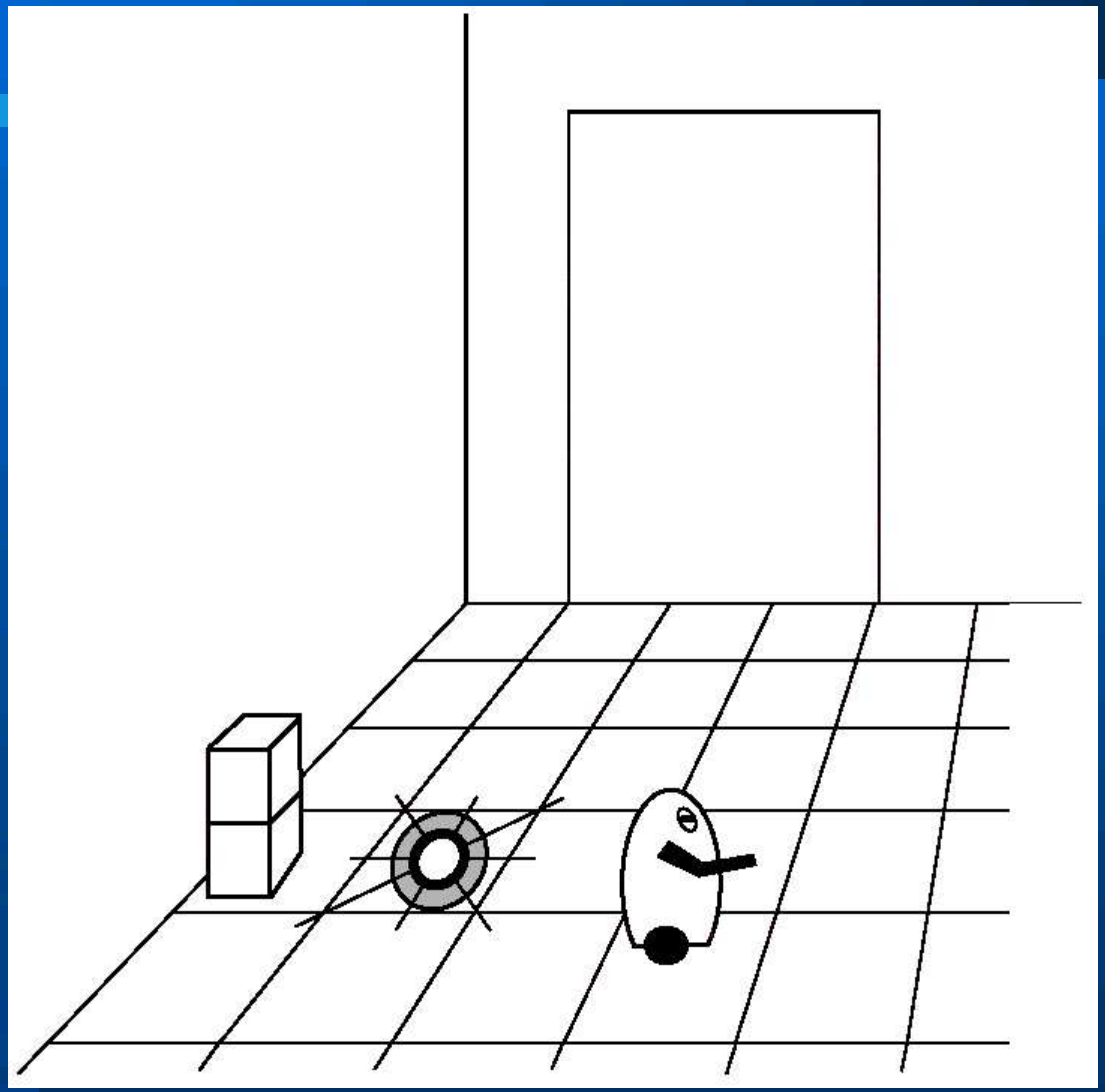

Figure 1.2 Grid-Space World

1.4 Plan of the Book

- Model
  - Symbolic structures and set of computations on the structures
  - Iconic model
    - Involve data structures, computations
    - Iconic chess model: complete
    - Feature based model
      - Use declarative descriptions of the environment
      - Incomplete

1.4 Plan of the Book

- Agents can make plans
  - Have the ability to anticipate the effects of their actions
  - Take actions that are expected to lead toward their goals
- Agents are able to reason
  - Can deduce properties of their worlds
- Agents co-exist with other agents
  - Communication is an important action

1.4 Plan of the Book

- Autonomy
  - Learning is an important part of autonomy
  - Extent of autonomy
    - Extent that system's behavior is determined by its immediate inputs and past experience, rather than by its designer's.
  - Truly autonomous system
    - Should be able to operate successfully in any environment, given sufficient time to adapt