Chapter 11

Artificial Intelligence

J. Glenn Brookshear

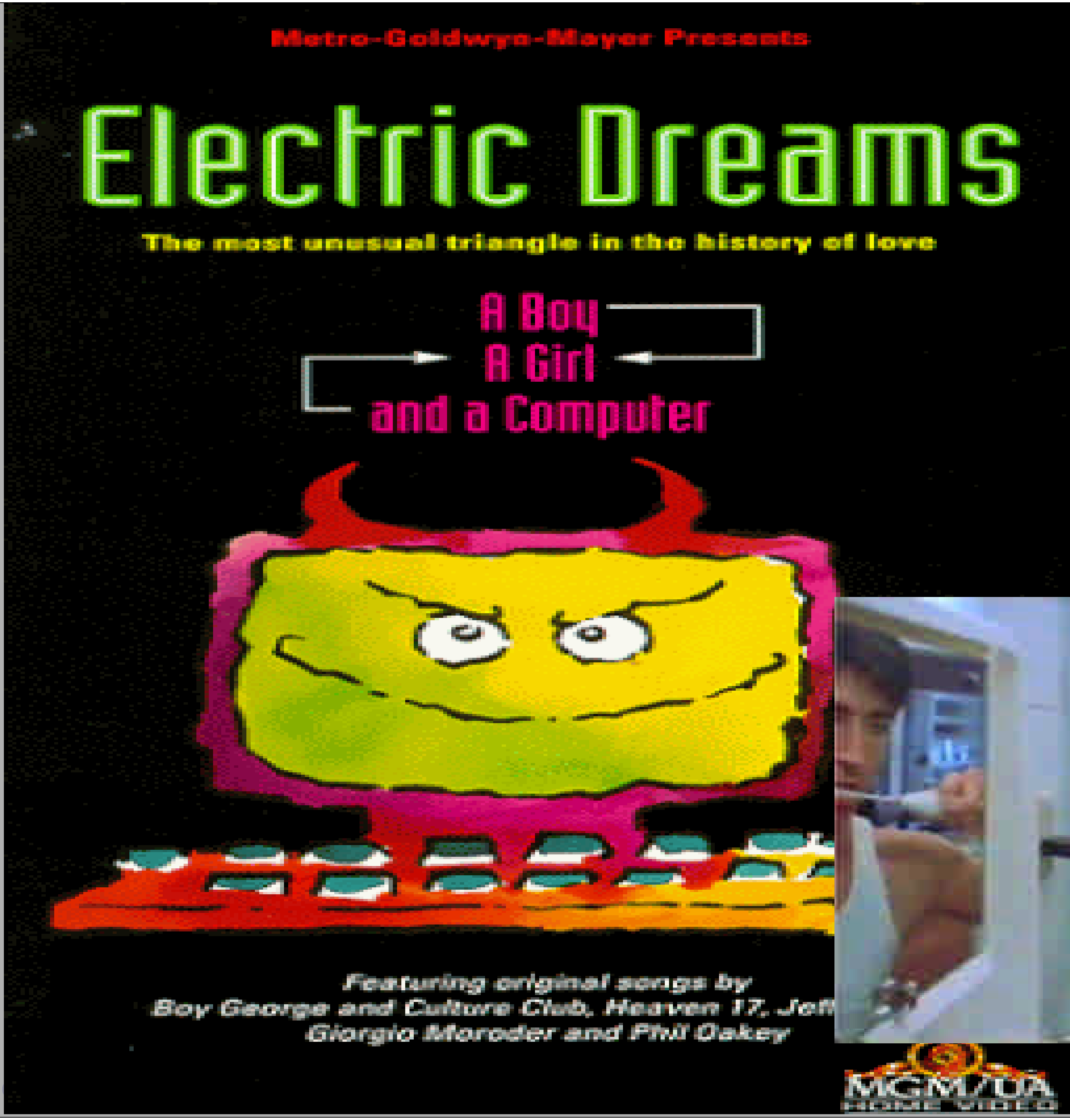
蔡文能

1

Chapter 11: Artificial Intelligence


TWO-DISC SPECIAL EDITION
HALEY JOEL OSMENT
JUDE LAW
A.I.
ARTIFICIAL INTELLIGENCE
"Steven Spielberg's A.I.
Is Extraordinary."
DVD
WIDESCREEN

C

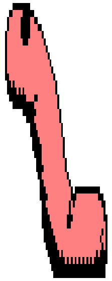

Metro-Goldwyn-Mayer Presents
Electric Dreams
The most unusual triangle in the history of love
A Boy
A Girl
and a Computer
Featuring original songs by
Boy George and Culture Club, Heaven 17,
Giorgio Moroder and Phil Oakey
MGM/UA
HOME VIDEO


HOMEWRECKER
片名-電腦情人夢


INTERACTIVITE
STORYBOARDS
LES COSTUMES DE T3
LES FIGURINES DE T3
MAKING OF DU JEU VIDEO

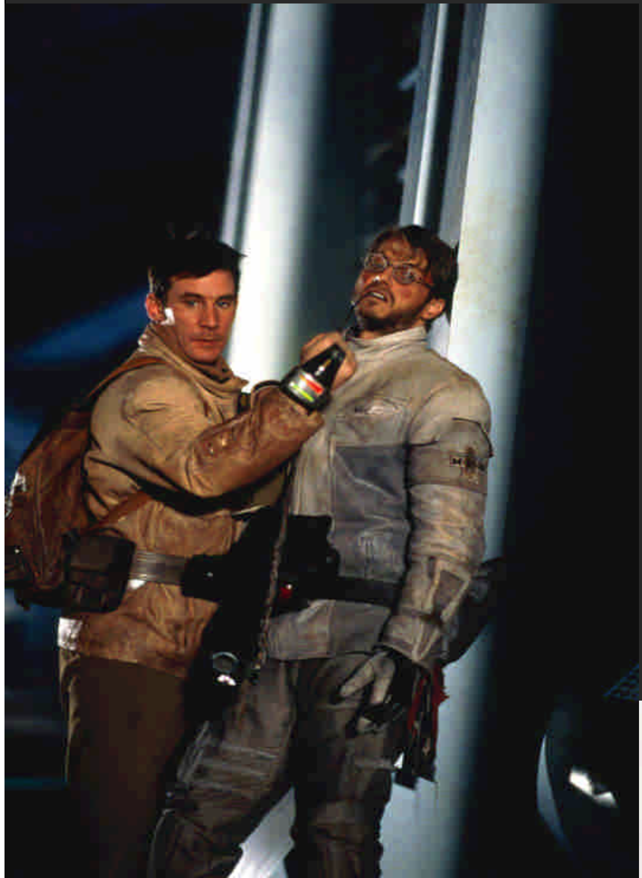
The Matrix

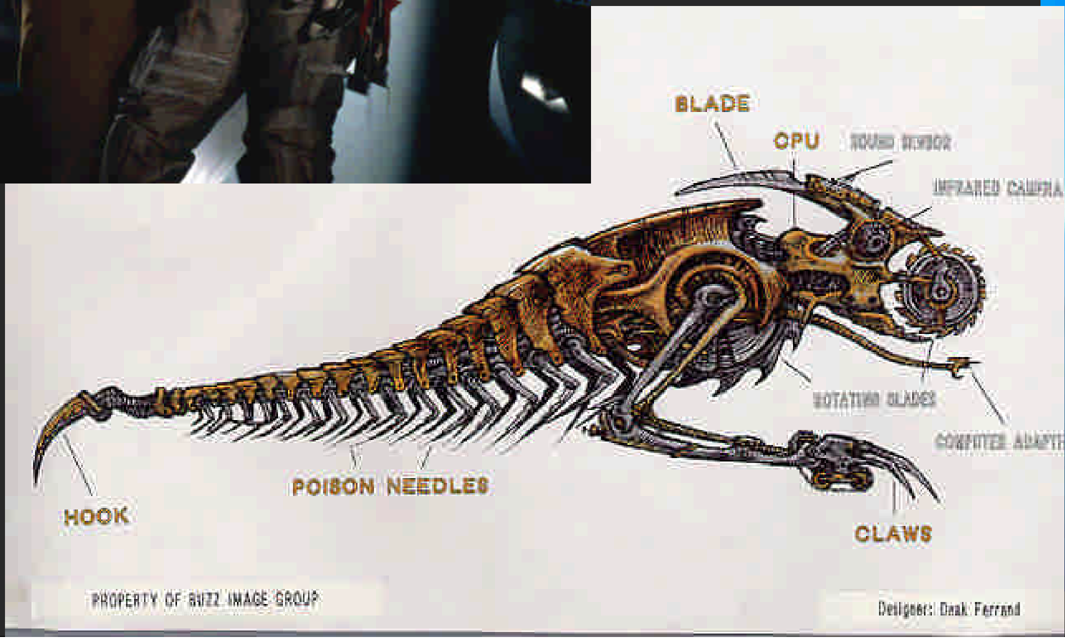
Computer Virus?



- 「駭客任務2」（**Matrix Reloaded**）描述電腦母體遭到電腦病毒攻擊，爲了拯救被困在電腦母體的人類，駭客們只好跟電腦人攜手合作打擊電腦病毒!

Screamers

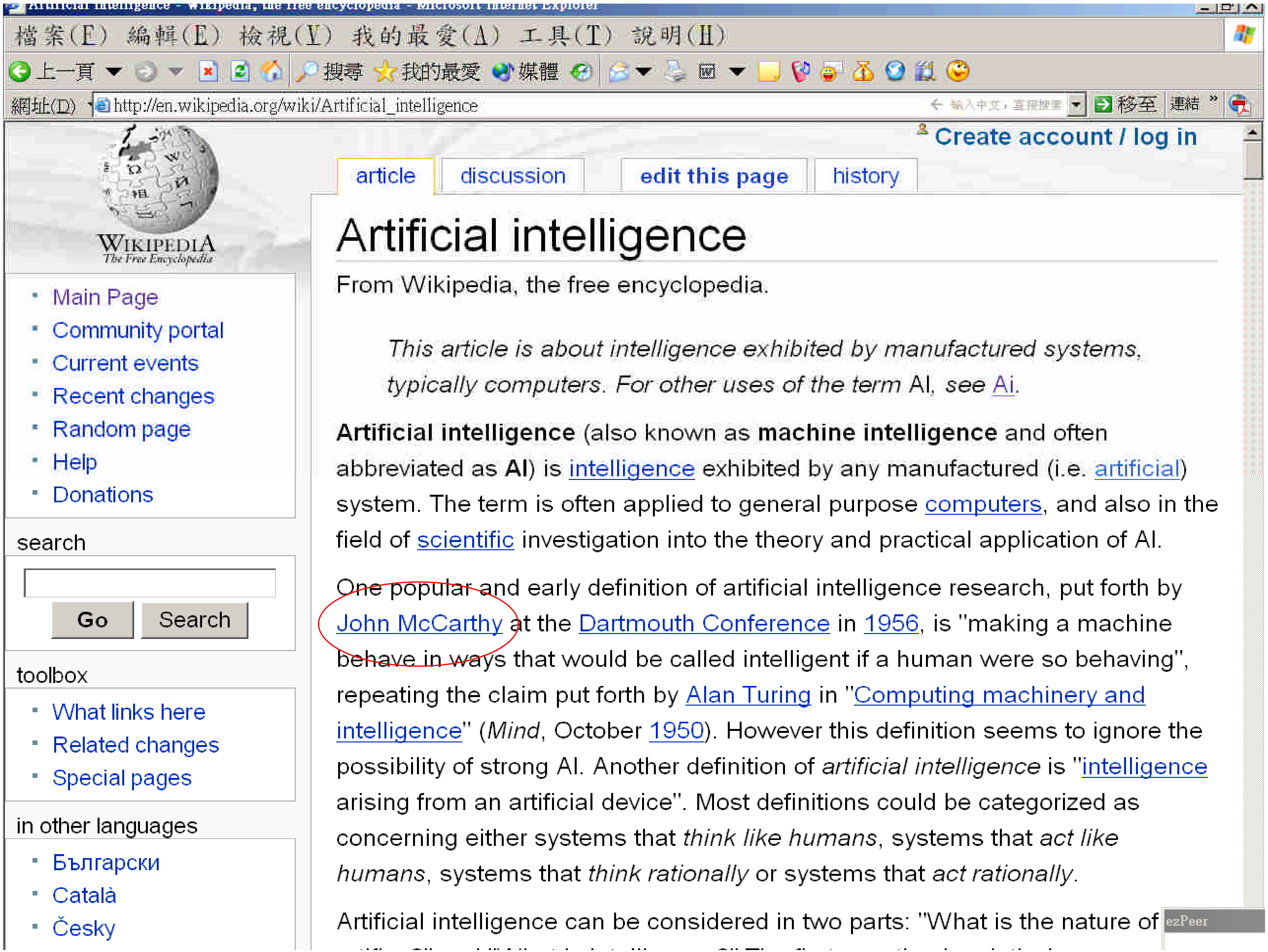



BLADE
CPU
HOOK
POISON NEEDLES
CLAWS
PROPERTY OF BUZZ IMAGE GROUP
Designer: Deak Ferrand

何謂人工智慧?
(Artificial Intelligence)

- **人工智慧**(Artificial Intelligence或簡稱AI)有時也稱作**機器智慧**，是指由人工製造出來的系統所表現出來的智慧。
  - 這裡，「人」也可以廣義理解爲任何生命體，比如說外星人，如果它們真的存在的話。
  - 通常人工智慧是指通過普通電腦實現的智慧。
  - 該詞同時也指研究這樣的智慧系統是否能夠實現，以及如何實現的科學領域。

資料來源: http://wikipedia.org


Artificial intelligence - Wikipedia, the free encyclopedia - Microsoft Internet Explorer
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Artificial intelligence
From Wikipedia, the free encyclopedia.
This article is about intelligence exhibited by manufactured systems, typically computers. For other uses of the term AI, see Ai.
Artificial intelligence (also known as machine intelligence and often abbreviated as AI) is intelligence exhibited by any manufactured (i.e. artificial) system. The term is often applied to general purpose computers, and also in the field of scientific investigation into the theory and practical application of AI.
One popular and early definition of artificial intelligence research, put forth by John McCarthy at the Dartmouth Conference in 1956, is "making a machine behave in ways that would be called intelligent if a human were so behaving", repeating the claim put forth by Alan Turing in "Computing machinery and intelligence" (Mind, October 1950). However this definition seems to ignore the possibility of strong AI. Another definition of artificial intelligence is "intelligence arising from an artificial device". Most definitions could be categorized as concerning either systems that think like humans, systems that act like humans, systems that think rationally or systems that act rationally.
Artificial intelligence can be considered in two parts: "What is the nature of
ezPeer

人工智慧的定義

- 人工智慧的定義可以分爲兩部分:「**人工**」和「**智慧**」。
- **John McCarthy** 1956:人工智慧就是要讓機器的行爲看起來就像是人表現出智慧的行爲一樣。
- **強人工智慧 vs. 弱人工智慧**
  - 強人工智慧觀點認爲有可能製造出*真正*能推理（**Reasoning**）和解決問題（**Problem solving**）的智慧機器，並且，這樣的機器將被認爲是有知覺的，有自我意識的。
  - 弱人工智慧觀點認爲不可能製造出能*真正*地推理和解決問題的智慧機器，這些機器只不過*看起來*像是智慧的，但是並不真正擁有智慧，也不會有自主意識。

人工智慧的應用

- 人工智慧目前在電腦領域內，得到了愈加廣泛的重視。在機器人(**Robotics**) 、電腦視覺(**Computer vision**) 、經濟政治決策、控制系統、 模擬系統中得到應用。
- **AI in Business**
  - **Expert Systems** 專家系統
  - **Neural Networks** 神經網路
  - **Genetic Algorithms** 基因演算法
  - **Intelligence Agent** 智慧代理人

Figure 11.1 The eight-puzzle in its solved configuration

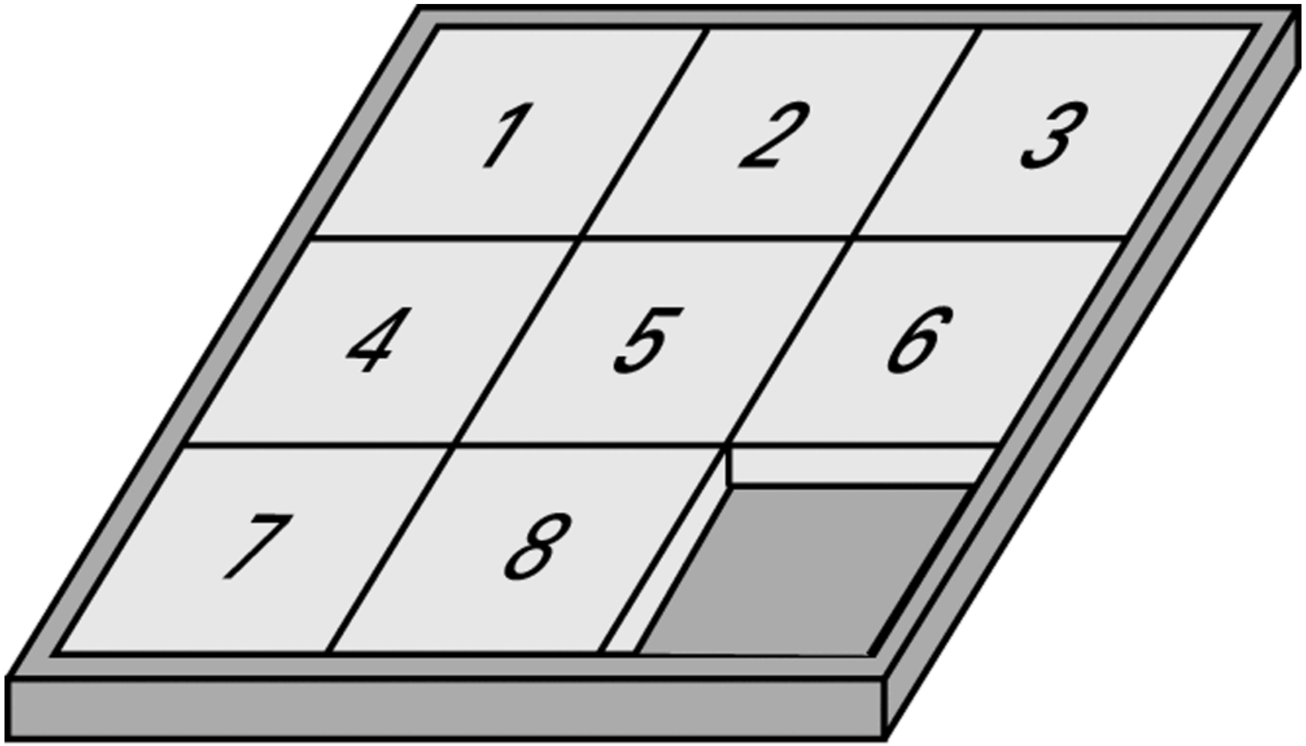
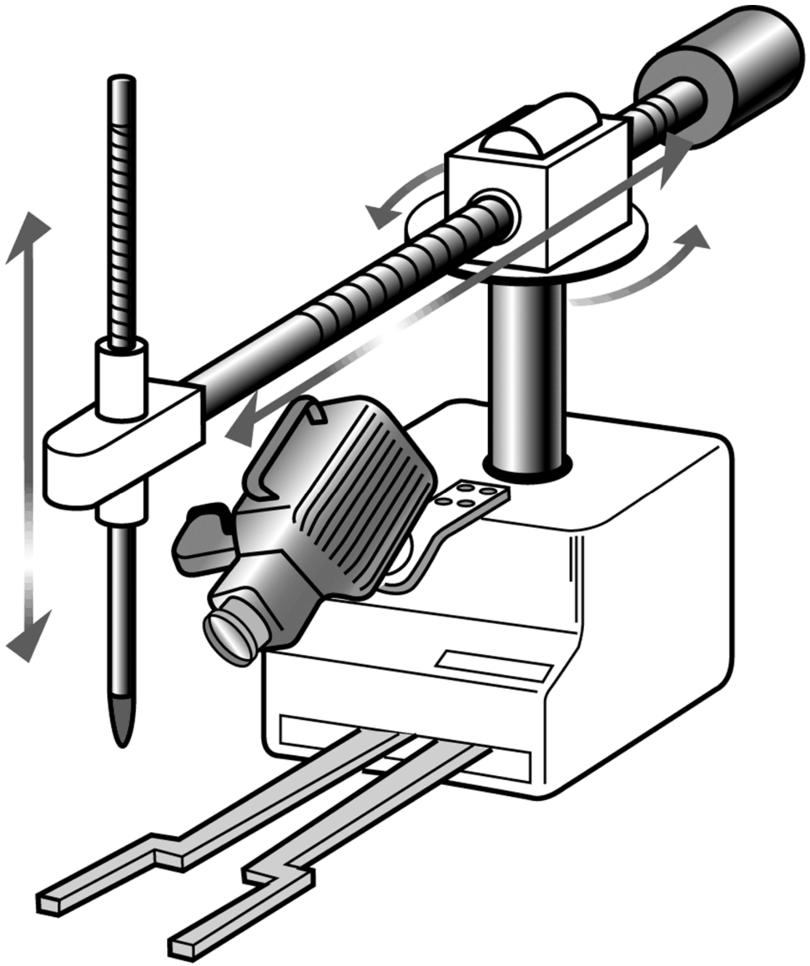
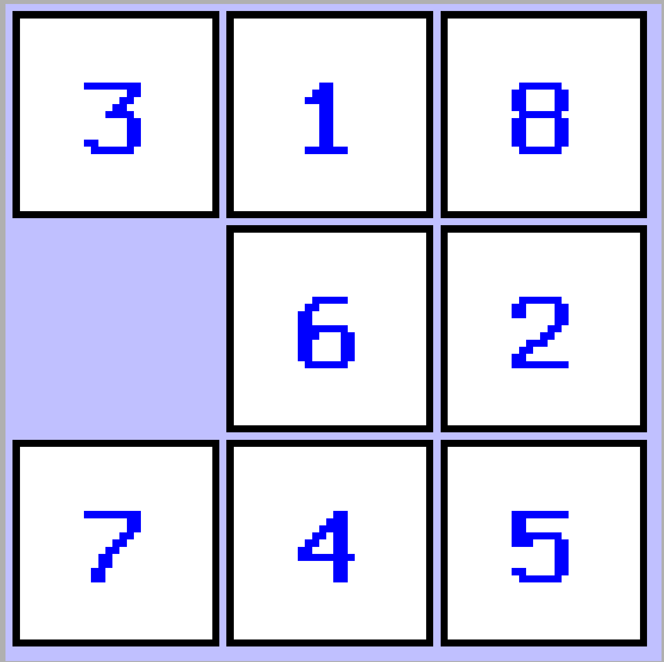


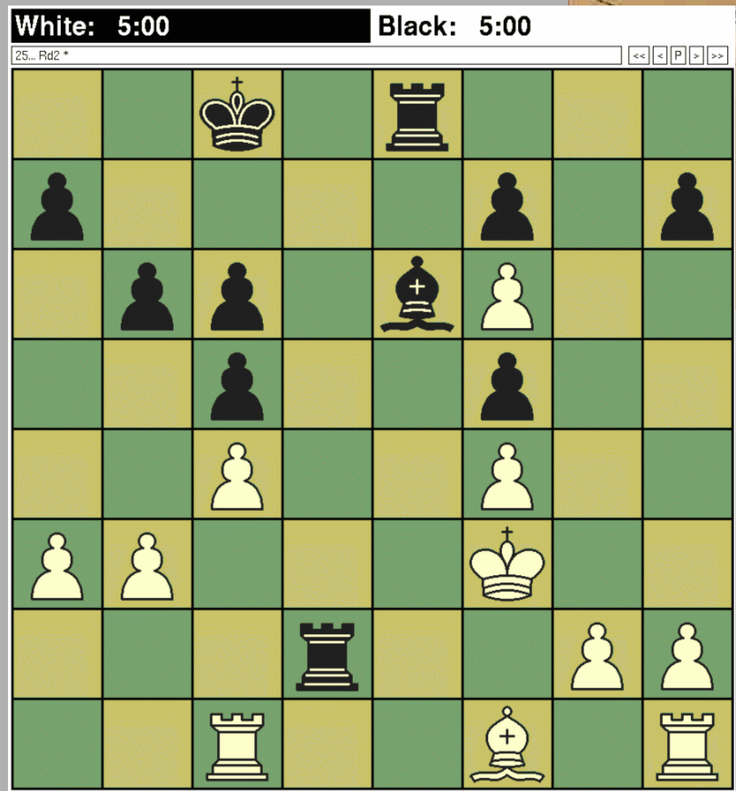
Figure 11.2 Our puzzle-solving machine

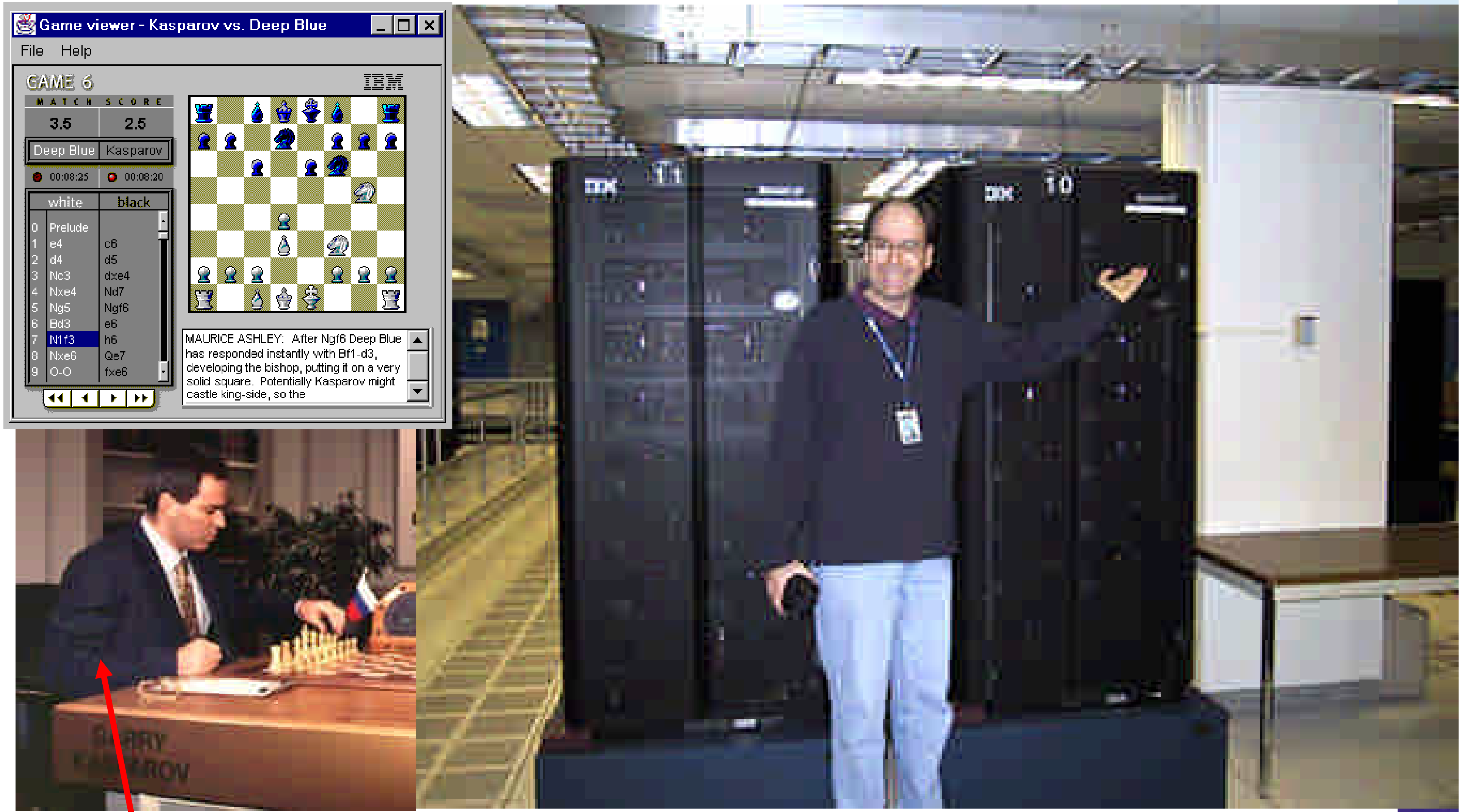


8- puzzle



Chess





- **Deep Blue**, the IBM RS/6000 parallel supercomputer that defeated Chess Grandmaster Garry Kasparov in **May 1997**.

人工智慧的研究 (1/3)

- 自然語言處理 (Natural language processing)
- 智慧搜索 (AI search)
- 圖形識別 (Pattern Recognition ; 樣式識別)
- 機器學習 (Machine Learning)
- 知識庫系統(Knowledge-based systems)
- 推理 (Reasoning) ，邏輯程式設計 (Logic programming)
- 專家系統 (Expert system)
- 類神經網路 (Neural network)
- 基因演算法(Genetic algorithm)
- 模糊理論 (Fuzzy theory) , …

人工智慧的研究 (2/3)

- Artificial intelligence began as an experimental field in the 1950s with such pioneers as Allen Newell and Herbert Simon, who founded the first artificial intelligence laboratory at Carnegie-Mellon University, and John McCarthy and Marvin Minsky, who founded the **MIT AI Lab** in 1959. (目前稱 **MIT CSAIL**)

人工智慧的研究 (3/3)

- Seminal papers advancing the concept of machine intelligence include ***A Logical Calculus of the Ideas Immanent in Nervous Activity*** (1943), by Warren McCulloch and Walter Pitts, and ***On Computing Machinery and Intelligence*** (1950), by **Alan Turing**, and ***Man-Computer Symbiosis*** by J.C.R. Licklider. See cybernetics and **Turing test** for further discussion in wikipedia.

人工智慧相關技術 (1/4)

- 知識表示法 (Knowledge Representation)
  - 研究如何將複雜的相關訊息表示於電腦系統。
  - 範例：M. L. Minsky發表的框架（Frame）理論。
- 經驗法則搜尋 (Heuristic search)
  - 從眾多的邏輯規則中，快速的找尋一條合乎限制的規則。
  - 所謂的經驗法則，就是並不是永遠成立，但是依經驗看在大部分情況都成立。

人工智慧相關技術 (2/4)

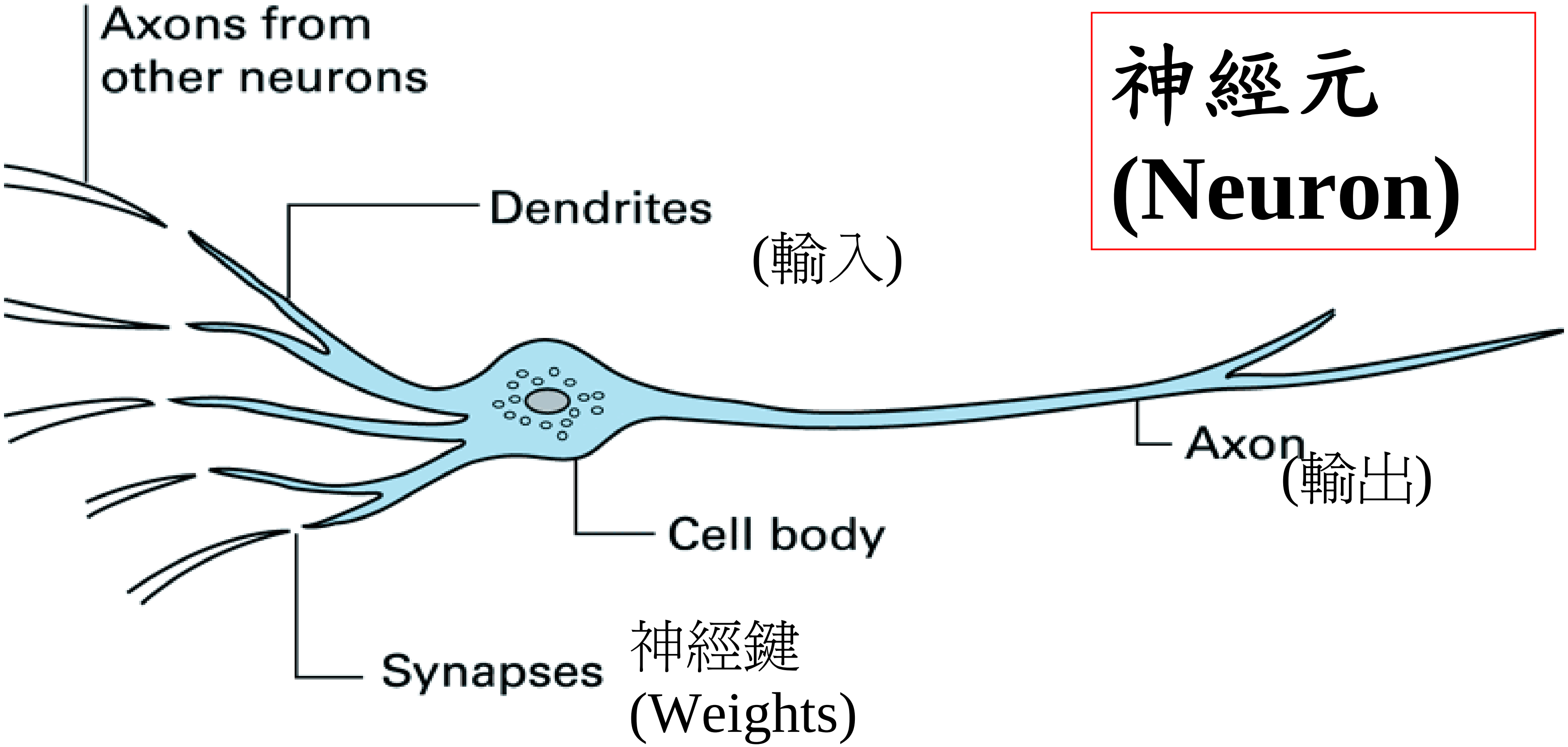
- 資料探勘 (Data Mining)
  - 很多企業資料已經建立在資料庫系統中。
  - 希望能夠從大量的未處理資料（Raw Data）中，挖掘出有建設性的資訊（Information）。
  - 在美國有名的實例
    - 利用資料探勘的技術後，發現啤酒和尿片常常一起被購買，而將這兩項貨品擺在附近，使得連鎖便利商店生意興隆。

人工智慧相關技術 (3/4)

- 邏輯推理
  - 邏輯(Logic)常被用來表示因果關係，像是「若下雨，則撐傘」；或是一些更複雜的規則。
  - 將人類進行事實的歸納及推理等活動，描述成一條條的規則建立在電腦系統裡，有時也稱爲生產系統（Production System）。
- 符號處理
  - 便於表示知識和邏輯推理。
  - 適於符號處理的程式語言，例如Lisp和Prolog語言。

人工智慧相關技術 (4/4)

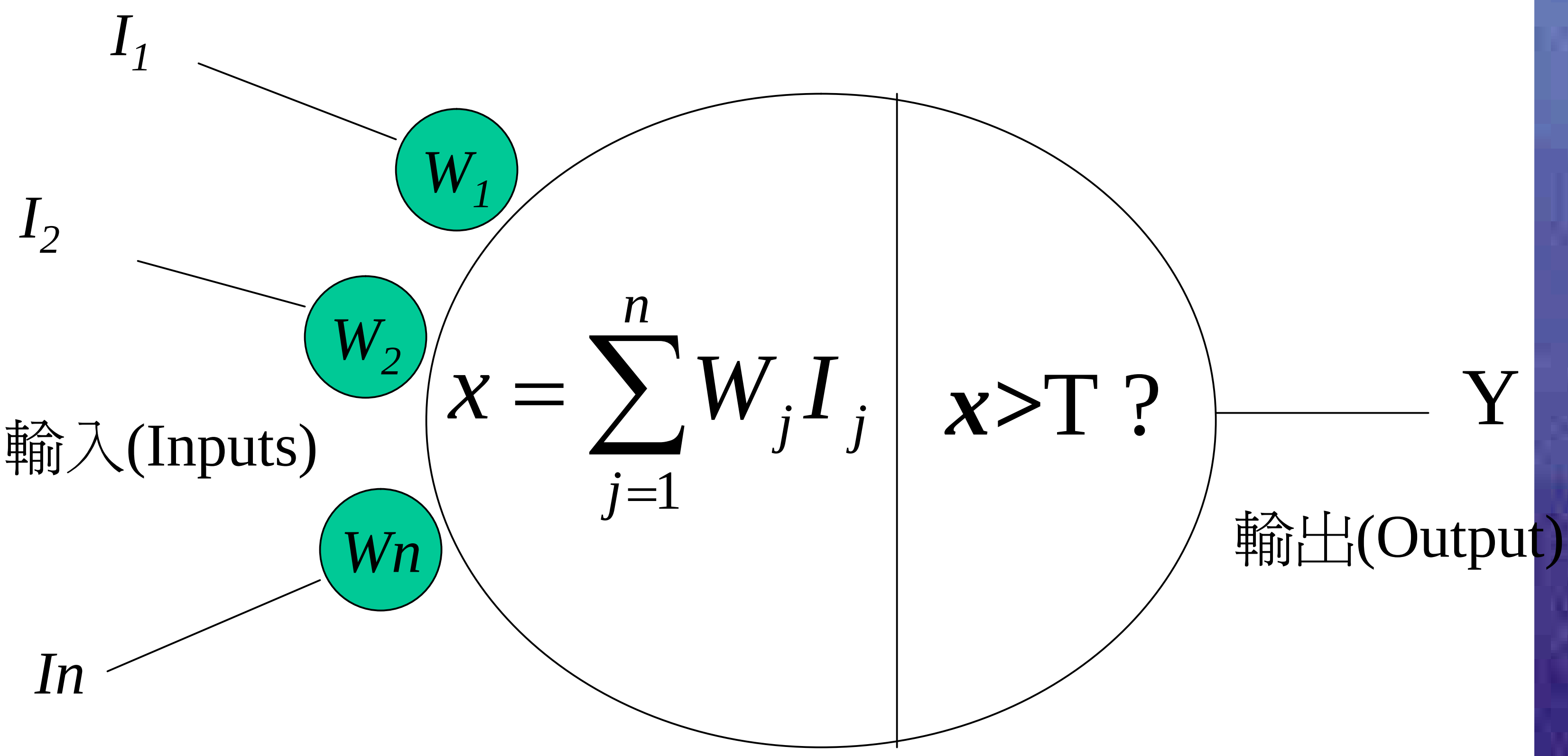
- **類神經網路：是指利用電腦來模仿生物神經網路的處理系統。**



神經元 (Neuron)

Source: J. Glenn Brookshear

類神經元 (Artificial Neuron)



T : Threshold 門檻值

第五代電腦(FGCS)

- Fifth Generation Computer System
- Next Generation Computer System (NGCS)

1982年由日本通產省主動提出十年的「第五代電腦計畫」，想要超越IBM，開創日本獨有的電腦技術，參與的企業包括NEC、富士通、松下、聲寶、日立、三菱、東芝、 NTT、及沖電氣共9家企業。目標要開發具人工智慧、能夠接受人類自然語言的新電腦。

第一代到第四代電腦

generation	年代	電子元件	電子元件size	運作速度
第一代	1946~1958	真空管 vacuum tube	燈泡	10^{-3} 秒 毫秒 *ms*
第二代	1959~1964	電晶體 transistor	小指頭	10^{-6} 秒 微秒 *us*
第三代	1964~1971	積體電路 Integrated Circuit(IC)	鉛筆心	10^{-8} 秒 毫微秒
第四代	1972~	VLSI / ULSI	比頭髮細	10^{-9} 秒 奈秒 *ns*

Intelligent Agents

- **Agent:** A “device” that responds to stimuli from its environment
  - Sensors
  - Actuators
- Much of the research in artificial intelligence can be viewed in the context of building agents that behave intelligently

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
  - Learning

Approaches to Research in Artificial Intelligence

- Engineering track
  - Performance oriented
- Theoretical track
  - Simulation oriented

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?

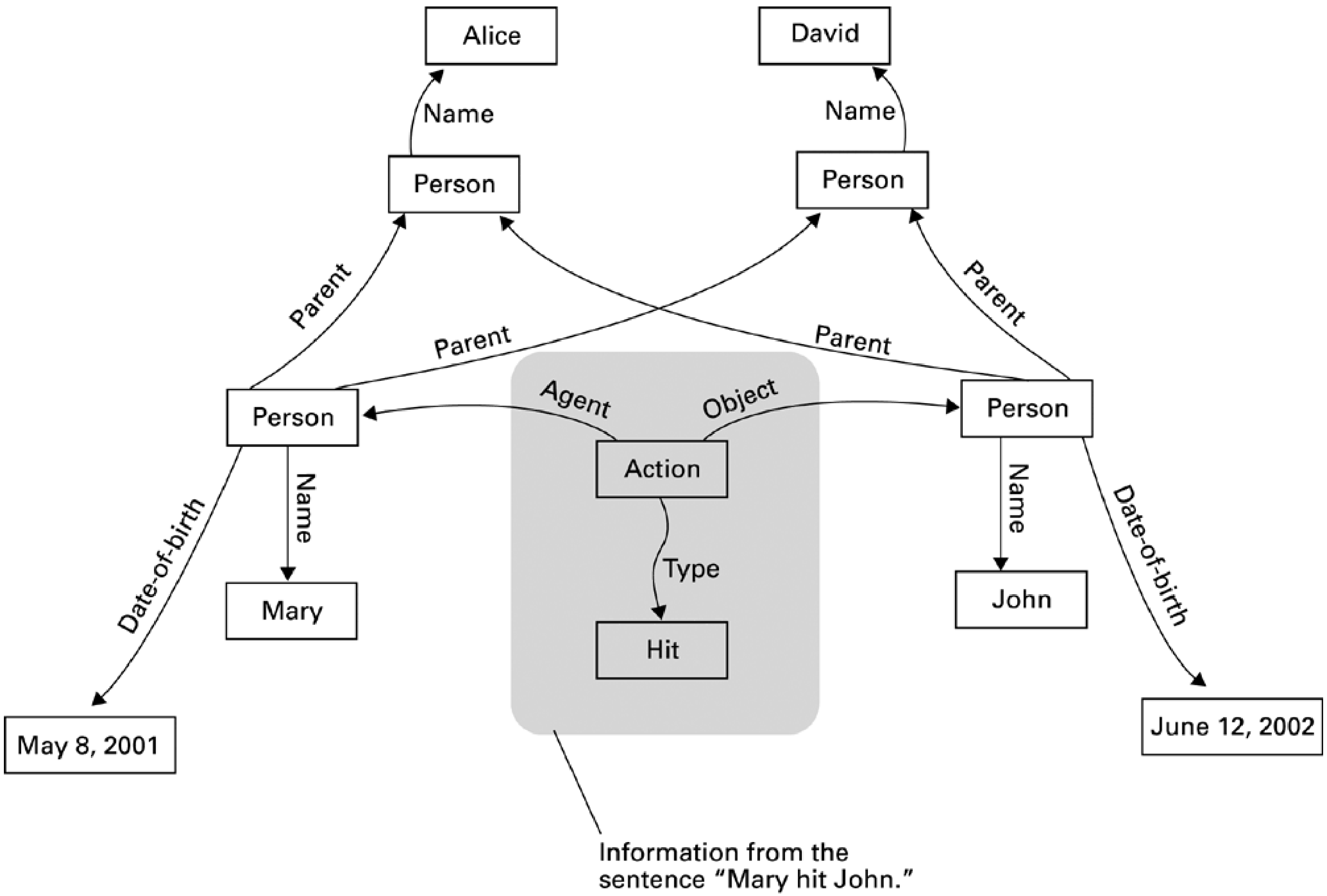
Techniques for Understanding Images

- Template matching
- Image processing
  - edge enhancement
  - region finding
  - smoothing
- Image analysis

Language Processing

- Syntactic Analysis (語法)
- Semantic Analysis (語意)
- Contextual Analysis

Figure 11.3 A semantic net



Components of a Production Systems

1. Collection of states
   - Start (or initial) state
   - Goal state (or states)
2. Collection of productions: rules or moves
   - 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

Figure 11.4 A small portion of the eight-puzzle's state graph

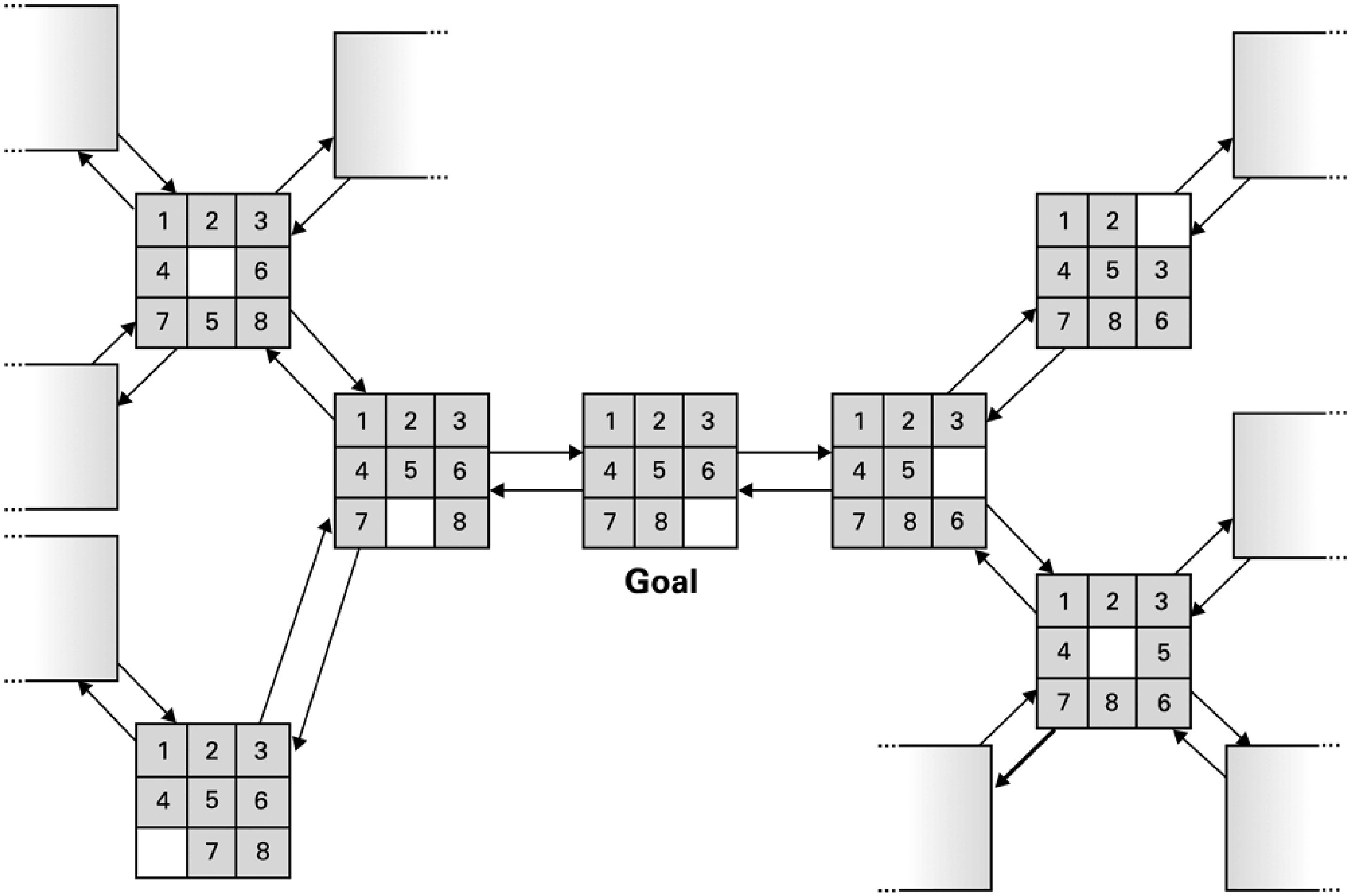


Figure 11.5 Deductive reasoning in the context of a production system

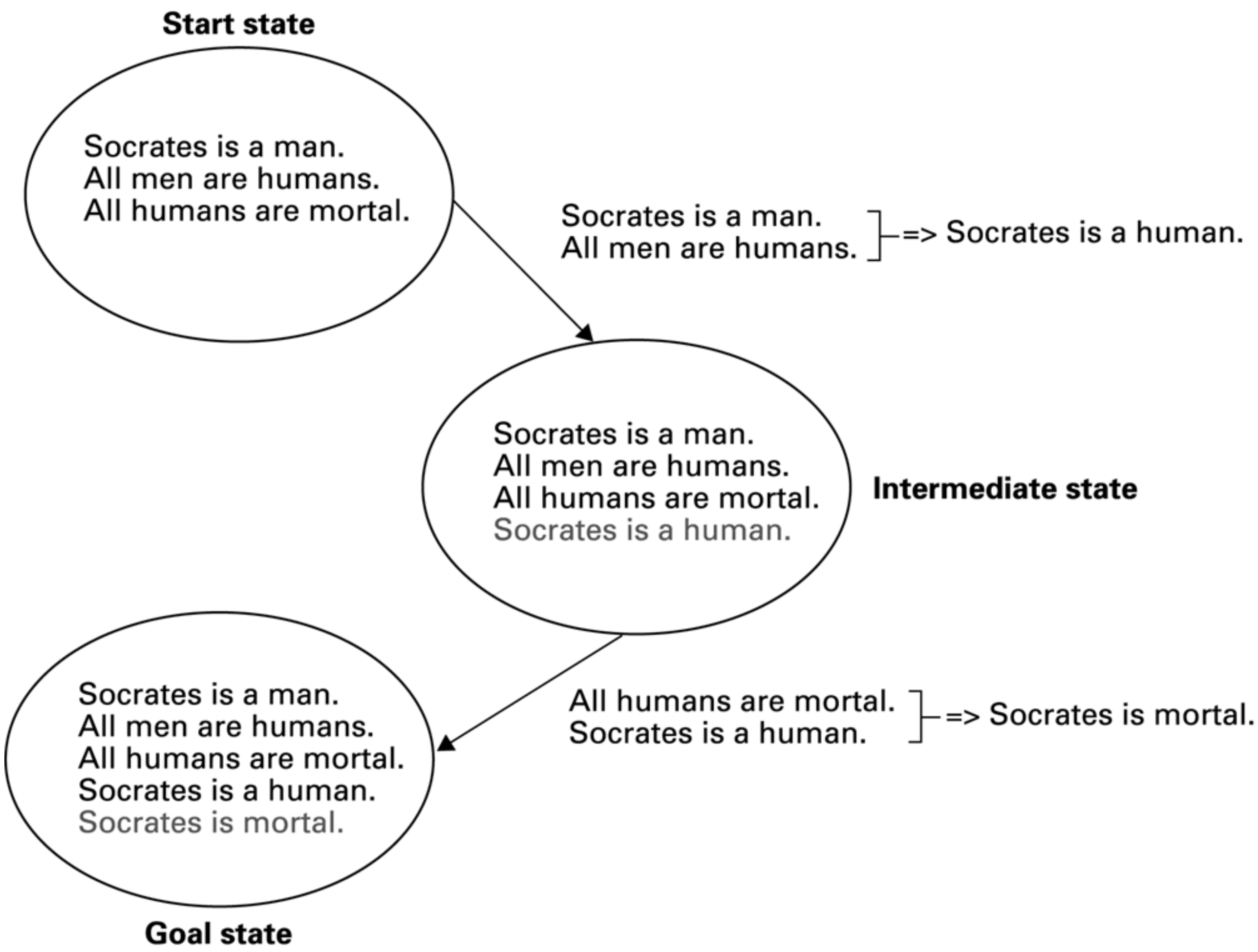


Figure 11.6 An unsolved eight-puzzle

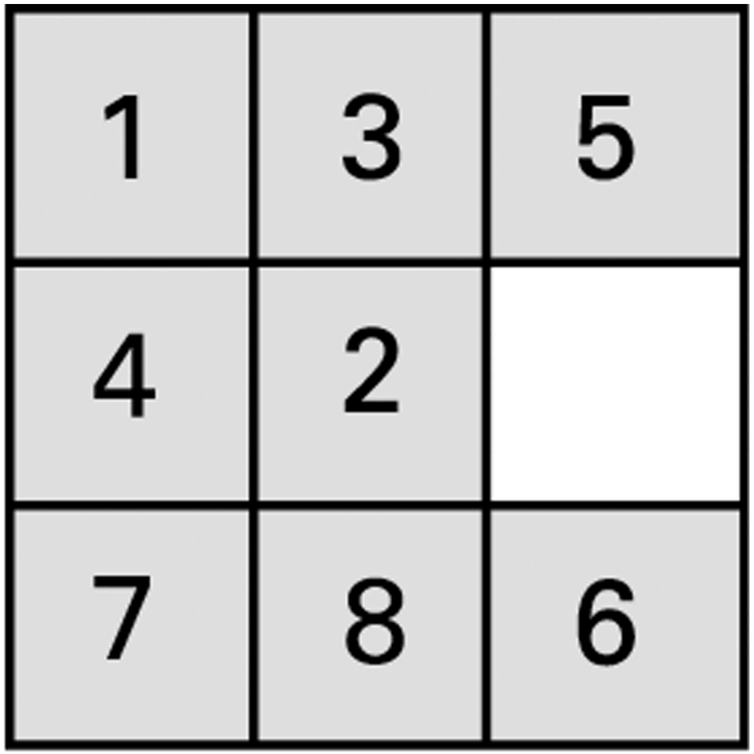


Figure 11.7 A sample **search tree**

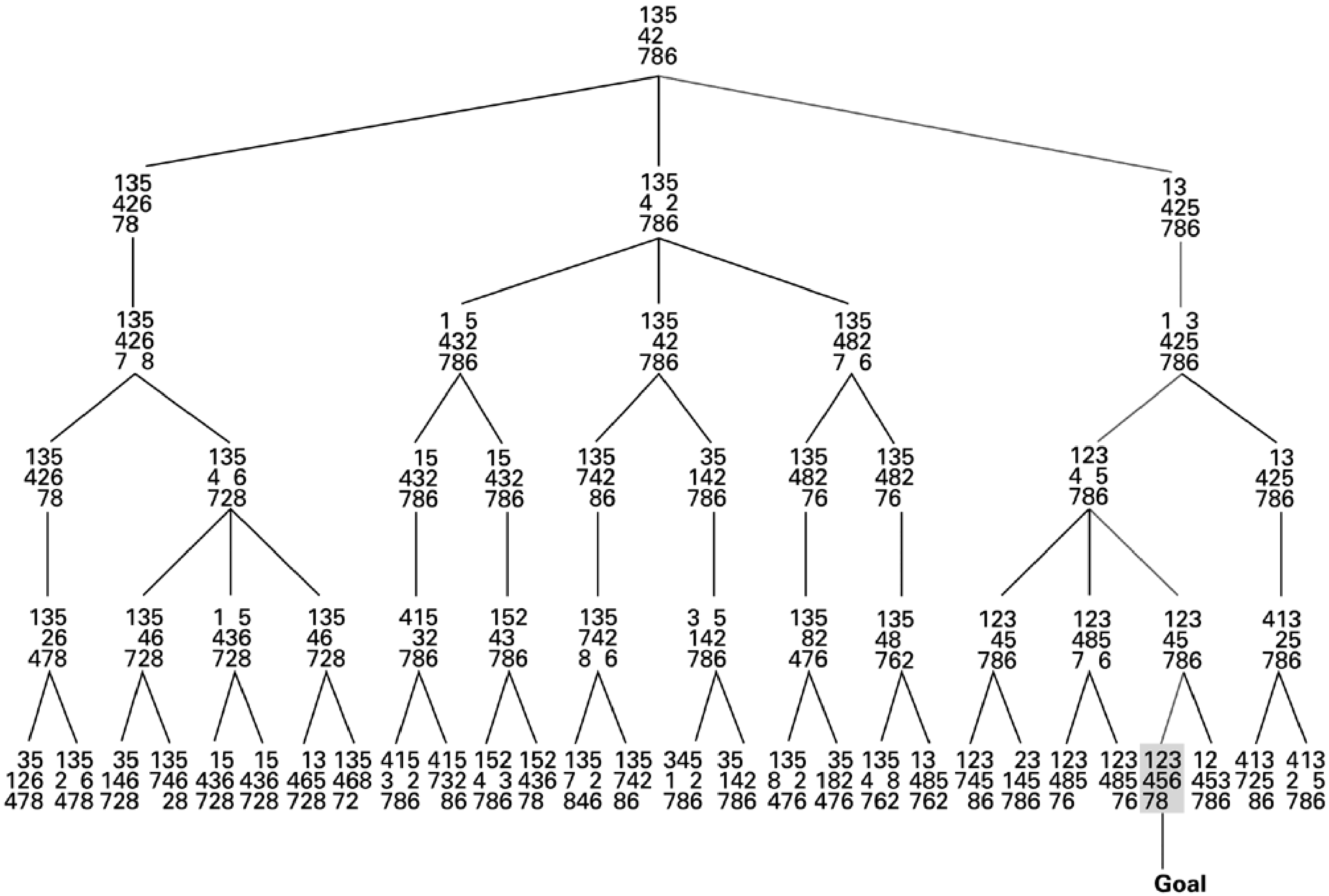
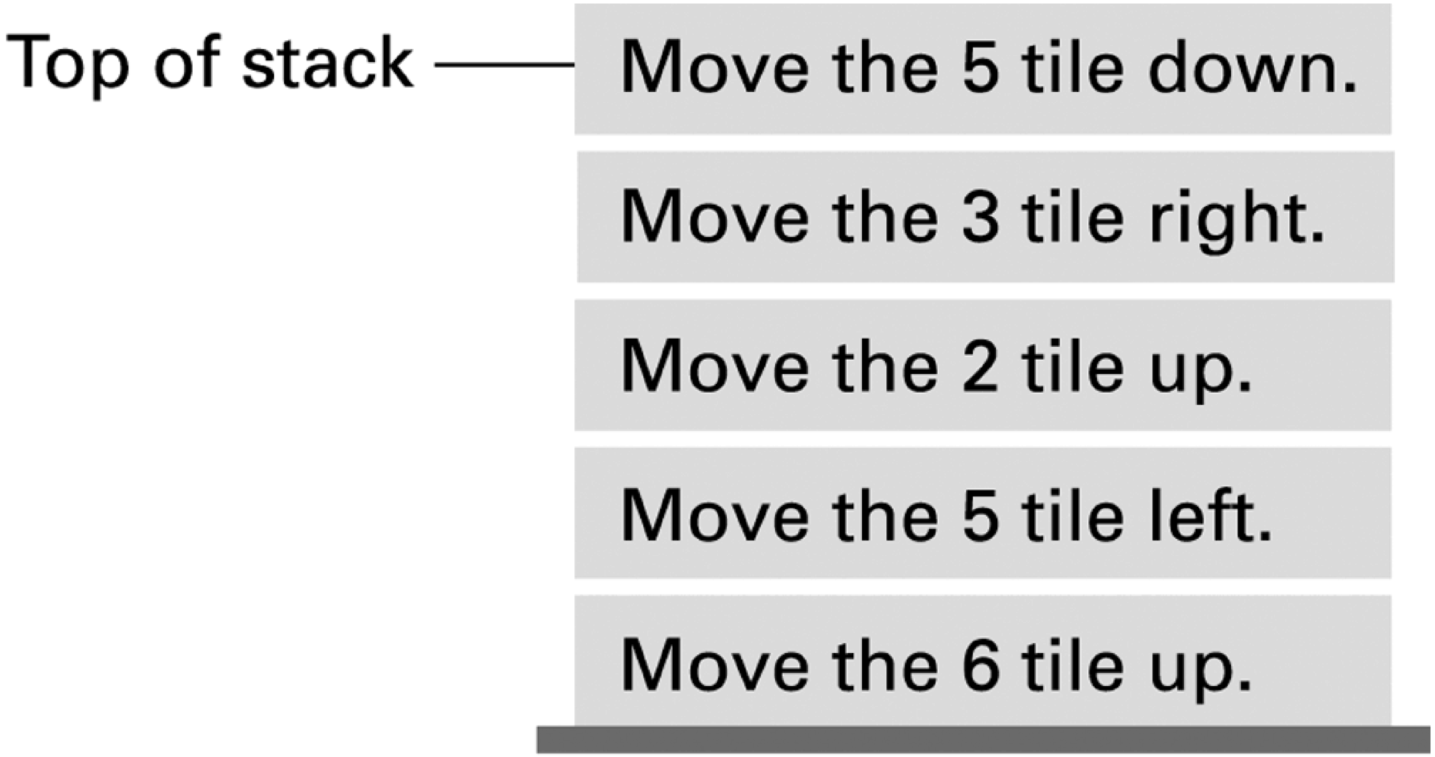


Figure 11.8 Productions stacked for later execution



Heuristic Strategies

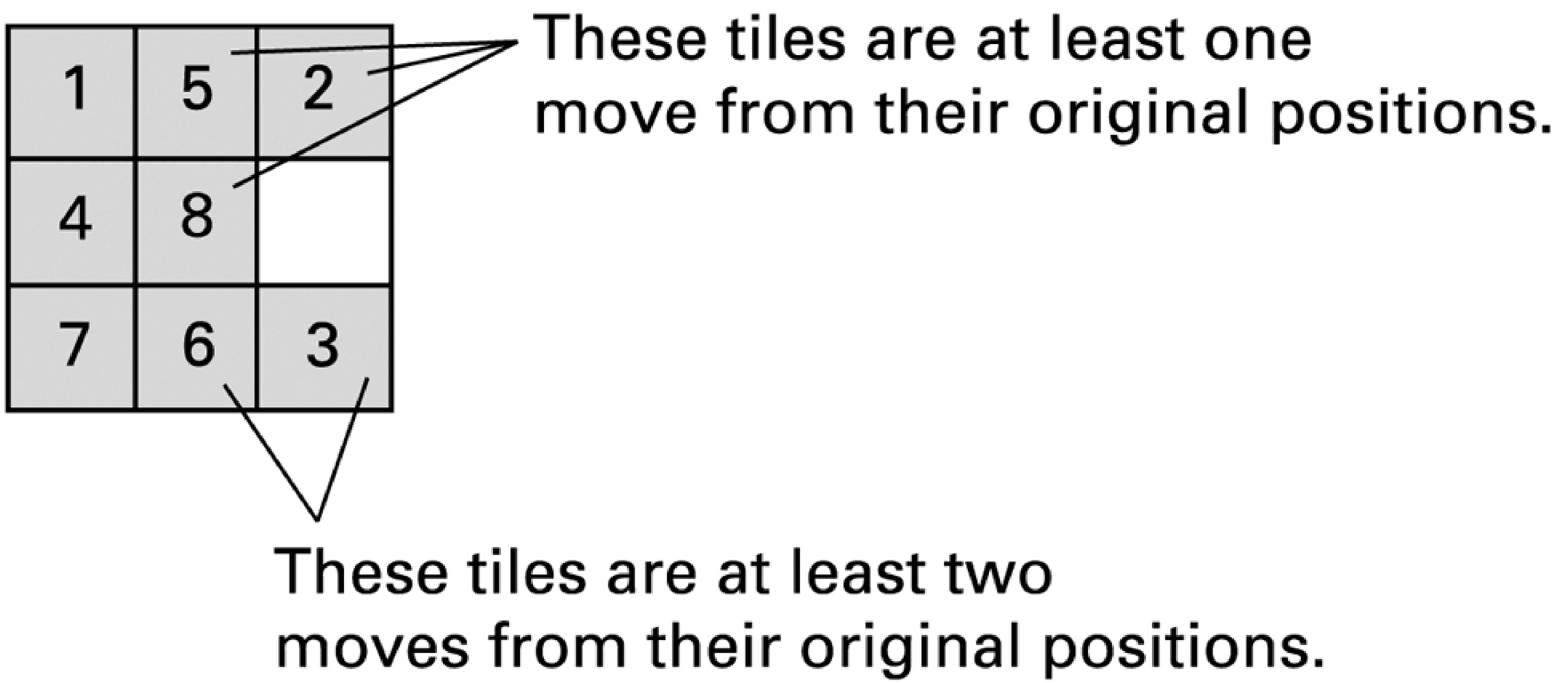
- **Heuristic:** A “rule of thumb” for making decisions
- Requirements for good heuristics
  - Must be easier to compute than a complete solution
  - Must provide a reasonable estimate of proximity to a goal

Othello 黑白棋

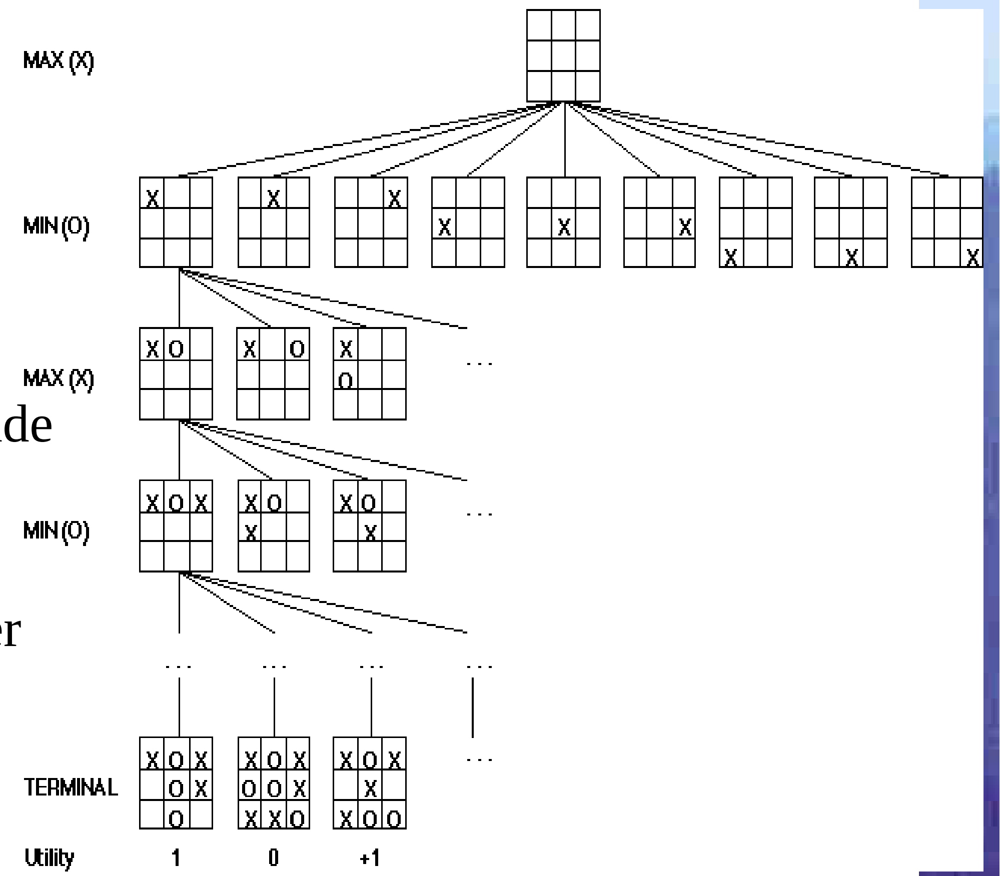
Heuristic search

金角銀邊

Figure 11.9 An unsolved eight-puzzle



Game Trees



- Problem spaces for typical games are represented as trees
- Root node represents the current board configuration; player must decide the best single move to make next
- **Static evaluator function** rates a board position. f(board) = real number with f>0 “white” (me), f<0 for black (you)
- Arcs represent the possible legal moves for a player
- If it is **my turn** to move, then the root is labeled a "**MAX**" node; otherwise it is labeled a "**MIN**" node, indicating **my opponent's turn**.
- Each level of the tree has nodes that are all MAX or all MIN; nodes at level i are of the opposite kind from those at level i+1

Minimax Procedure

- Create start node as a MAX node with current board configuration
- Expand nodes down to some **depth** (a.k.a. **ply**) of lookahead in the game
- Apply the evaluation function at each of the leaf nodes
- "Back up" values for each of the non-leaf nodes until a value is computed for the root node
  - At MIN nodes, the backed-up value is the **minimum** of the values associated with its children.
  - At MAX nodes, the backed-up value is the **maximum** of the values associated with its children.
- Pick the operator associated with the child node whose backed-up value determined the value at the root

Minimax Algorithm

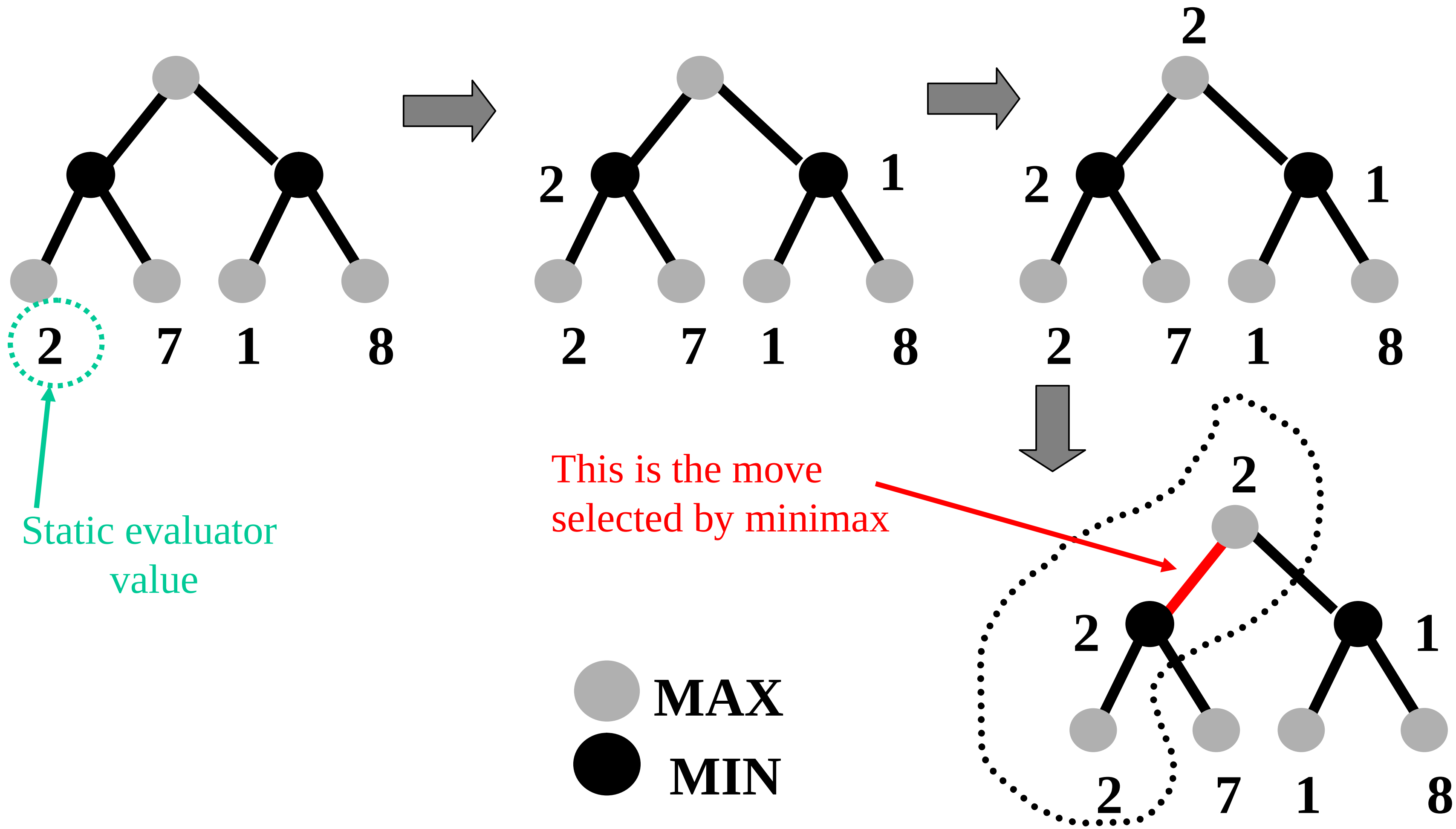


Figure 11.10 An algorithm for a control system using heuristics

```
Establish the start node of the state graph as the root of the
    search tree and record its heuristic value.
while (the goal node has not been reached) do
    [Select the leftmost leaf node with the smallest heuristic
        value of all leaf nodes.
     To this selected node attach as children those nodes that
        can be reached by a single production.
     Record the heuristic of each of these new nodes next
        to the node in the search tree
    ]
Traverse the search tree from the goal node up to the root,
     pushing the production associated with each arc traversed
    onto a stack.
Solve the original problem by executing the productions as they
    are popped off the stack.
```

Figure 11.11 The beginnings of our heuristic search

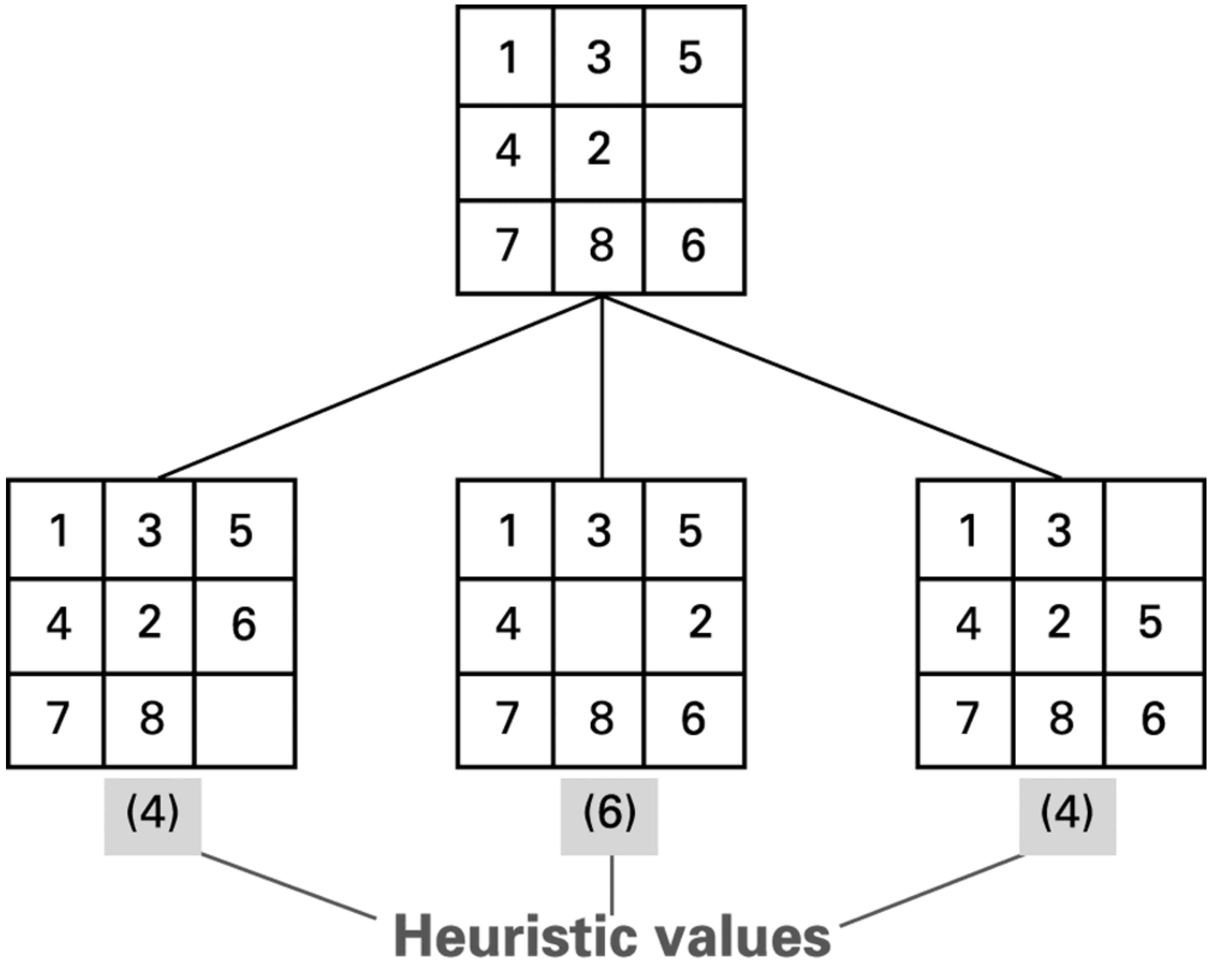


Figure 11.12 The search tree after two passes

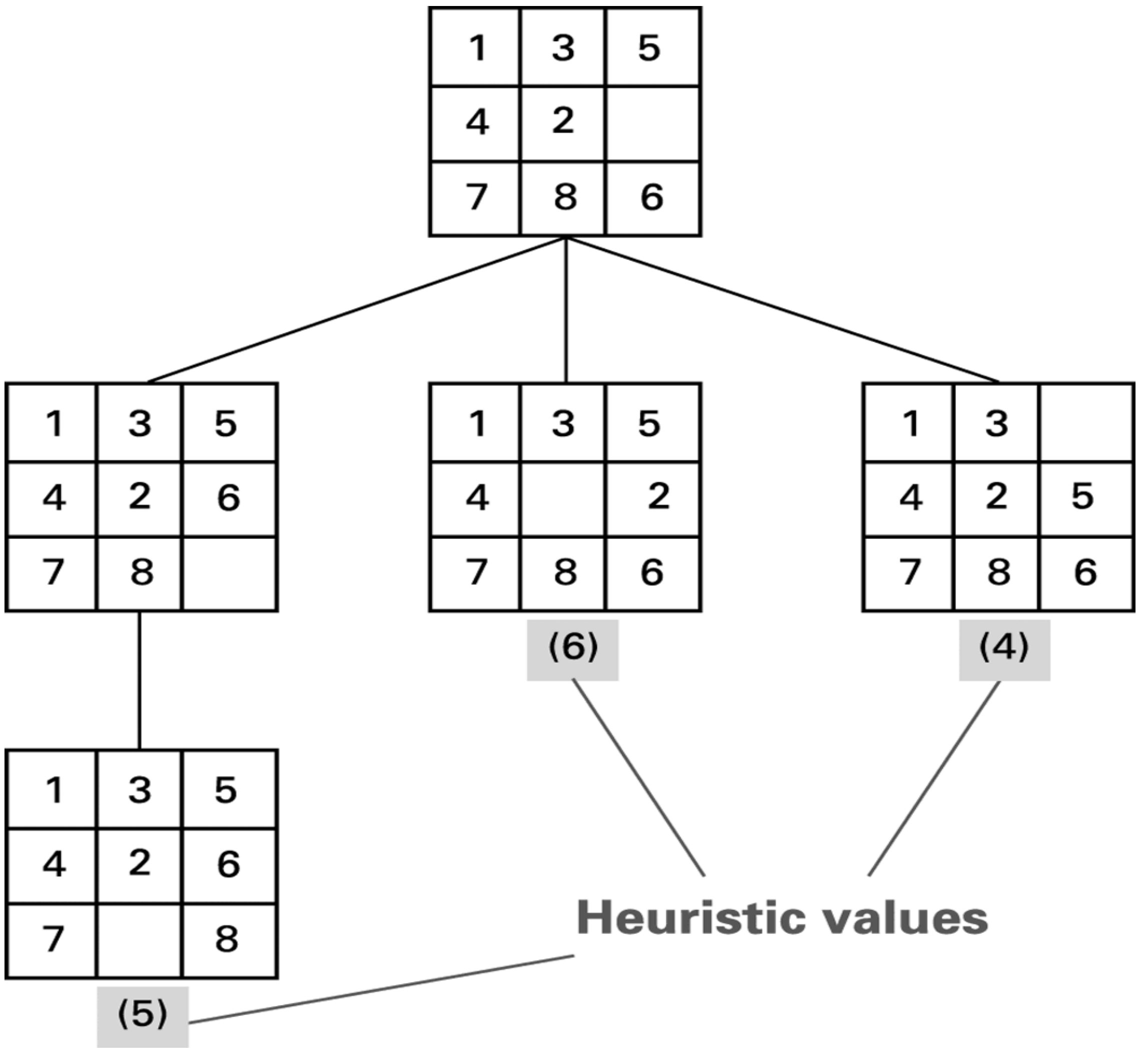
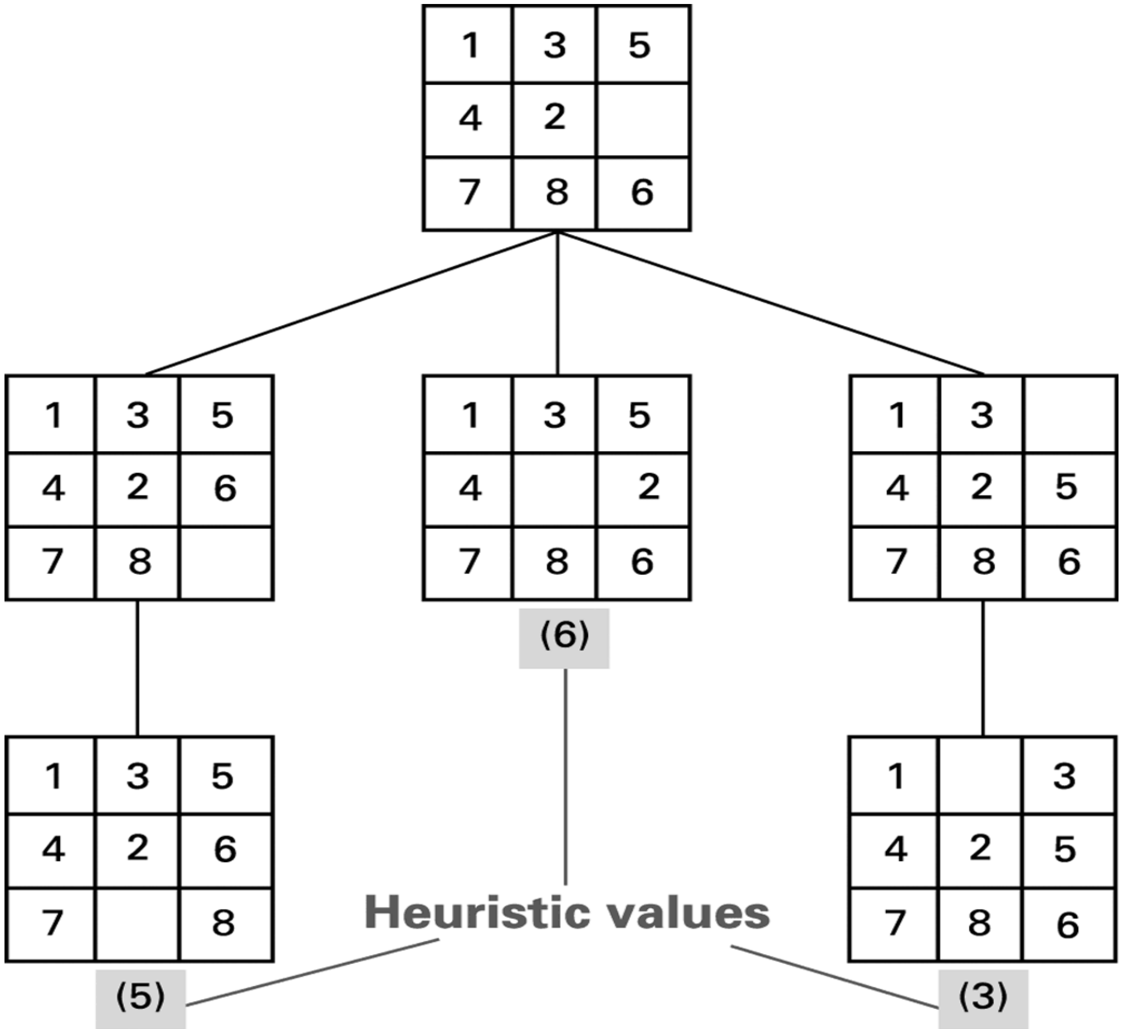


Figure 11.13 The search tree after three passes



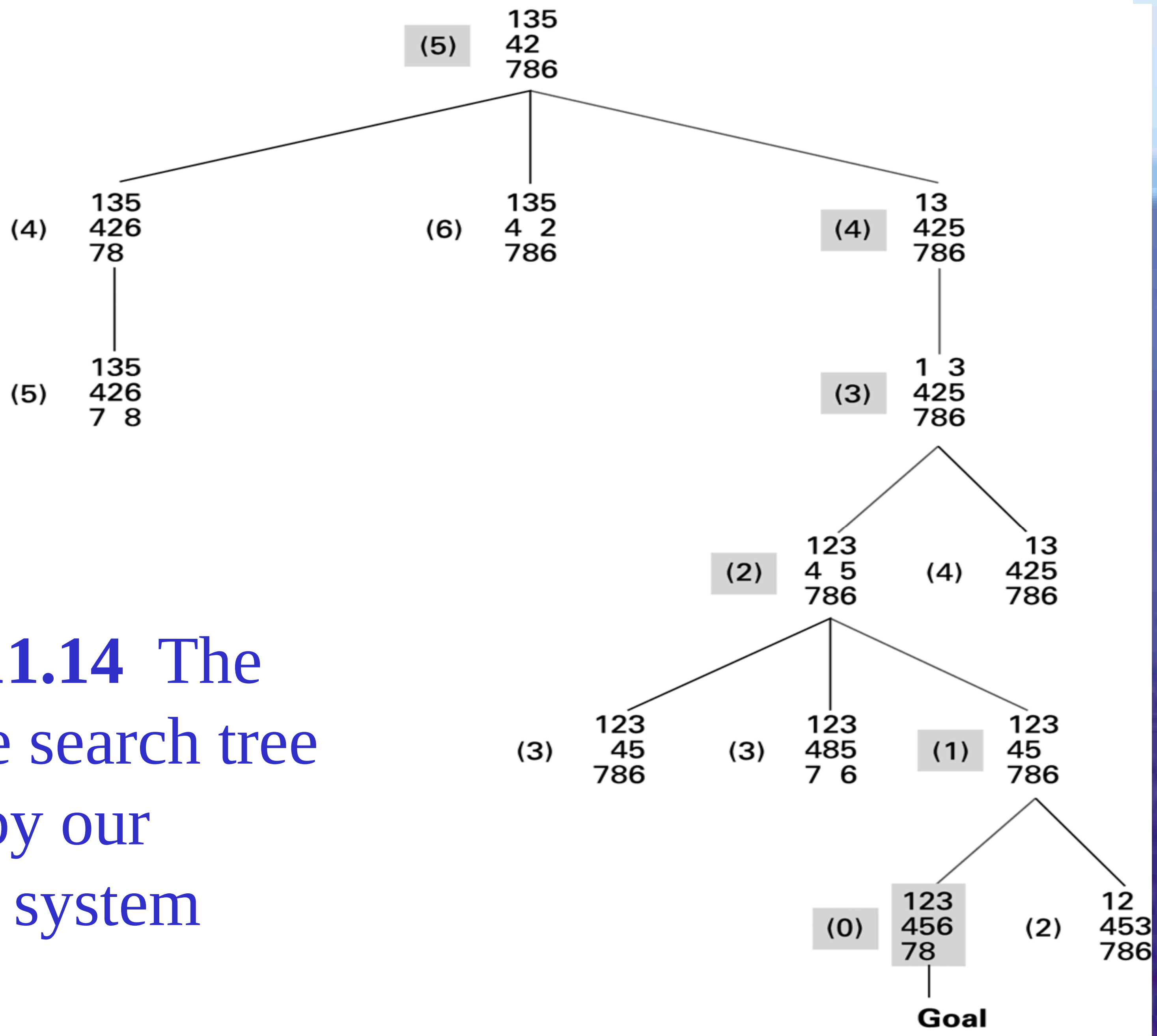
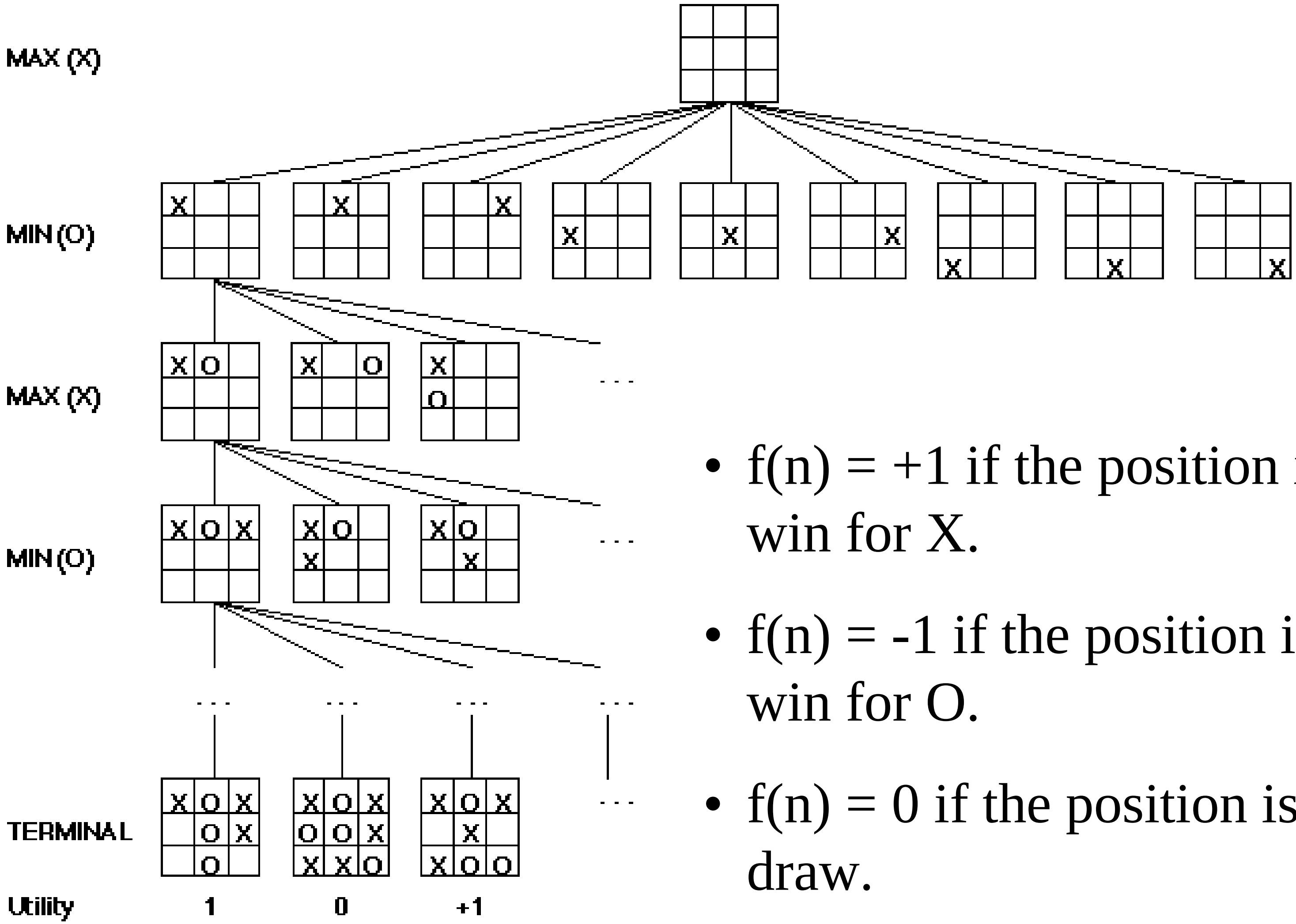


Figure 11.14 The complete search tree formed by our heuristic system

Partial Game Tree for Tic-Tac-Toe



- f(n) = +1 if the position is a win for X.
- f(n) = -1 if the position is a win for O.
- f(n) = 0 if the position is a draw.

Handling Real-World Knowledge

- Representation and storage
- Accessing relevant information
  - Meta-Reasoning
  - Closed-World Assumption
- Frame problem

Learning

- Imitation
- Supervised Training
- Reinforcement
- Evolutionary Techniques

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.

Figure 11.15 A neuron in a living biological system

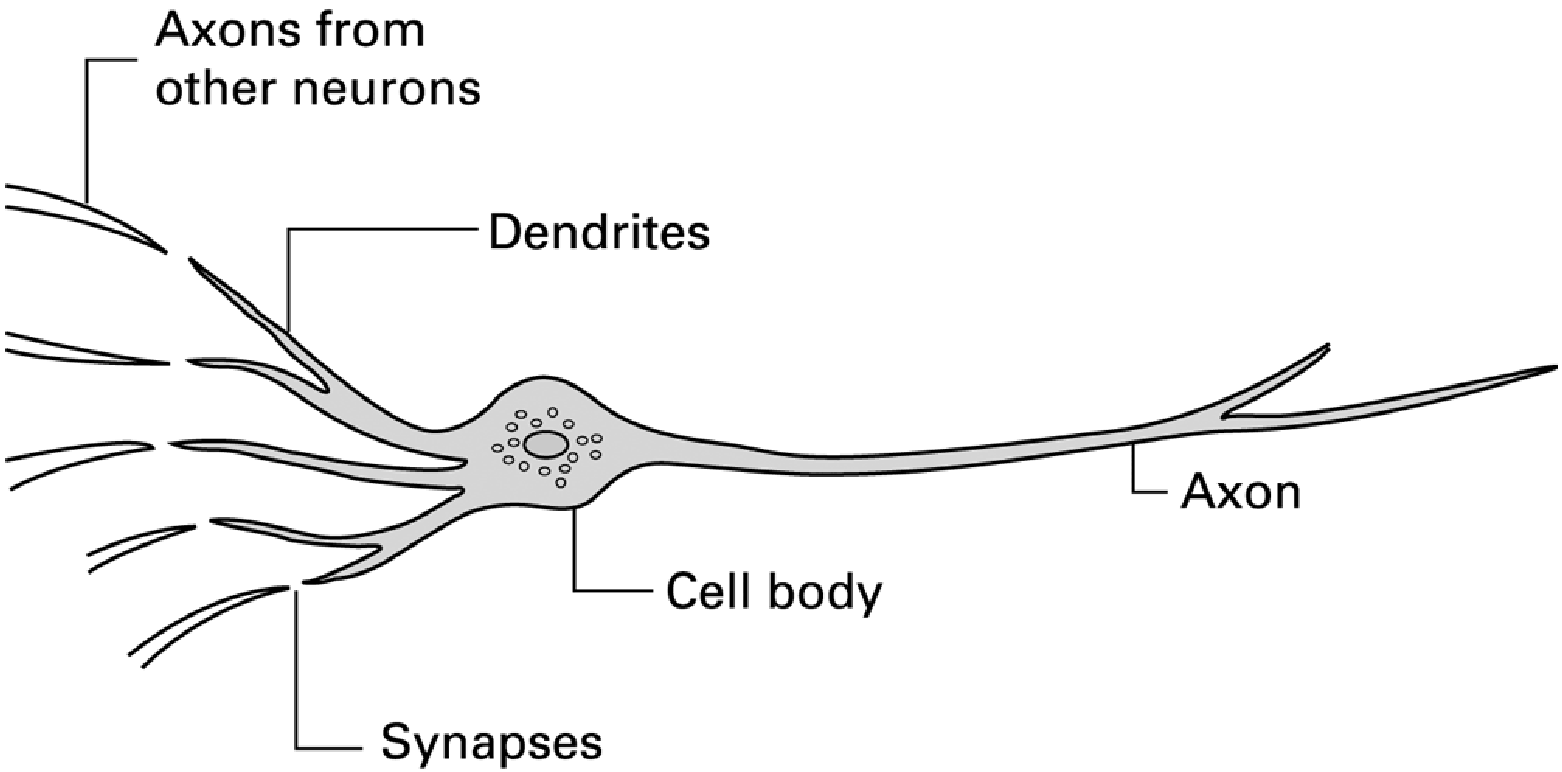


Figure 11.16 The activities within a processing unit

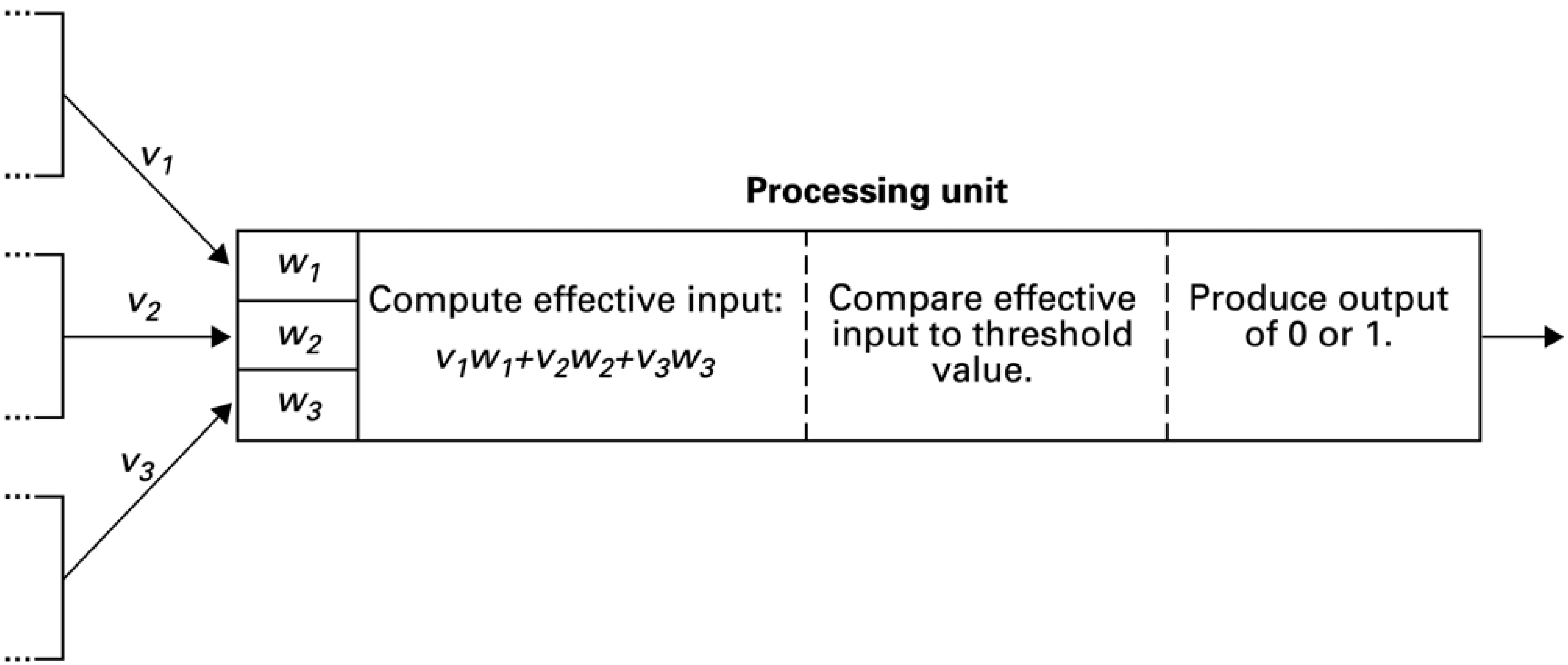


Figure 11.17 Representation of a processing unit

Figure 11.18 A neural network with two different programs

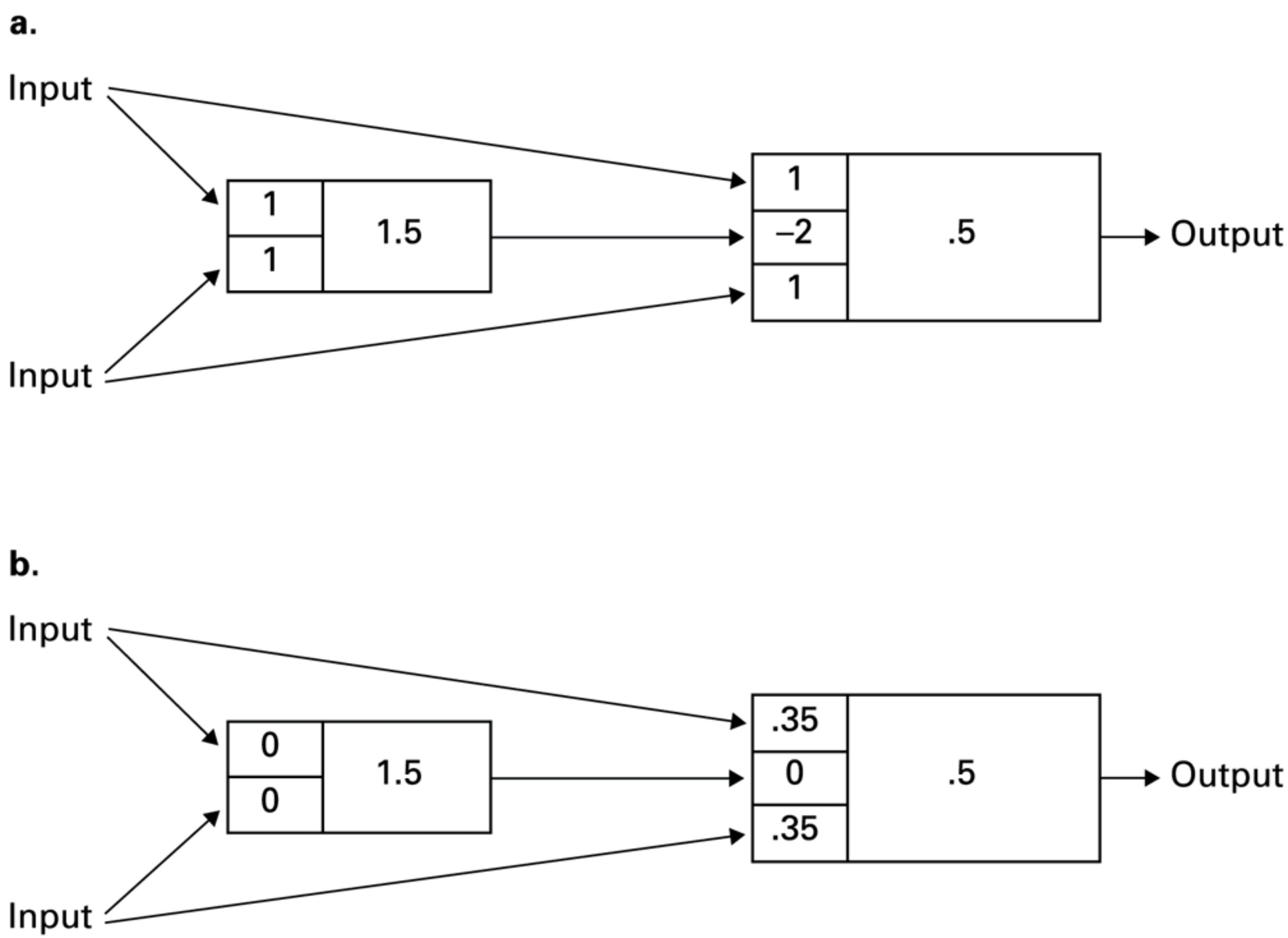


Figure 11.19 An artificial neural network

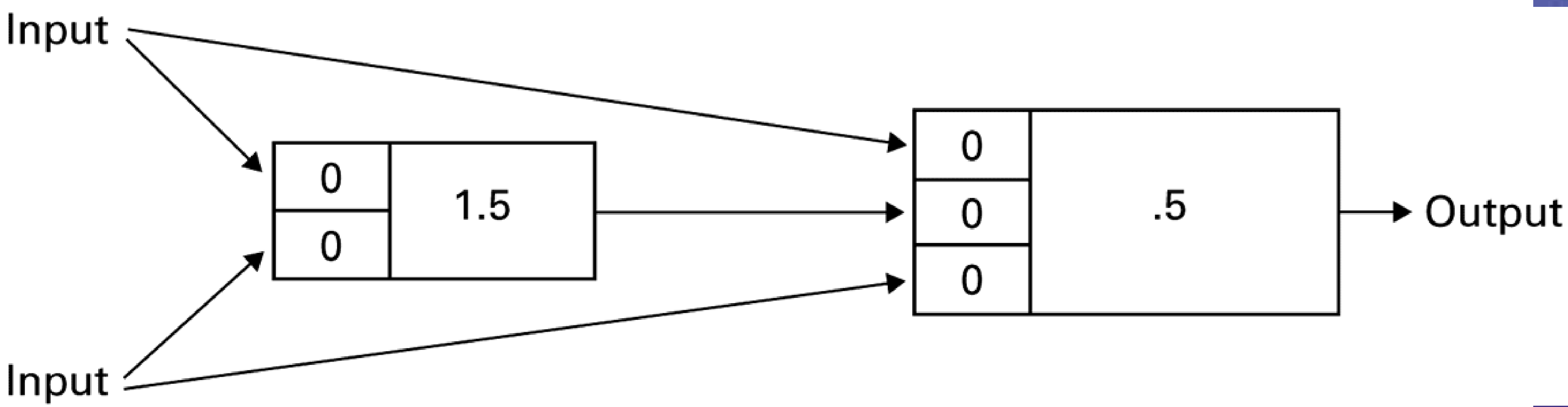
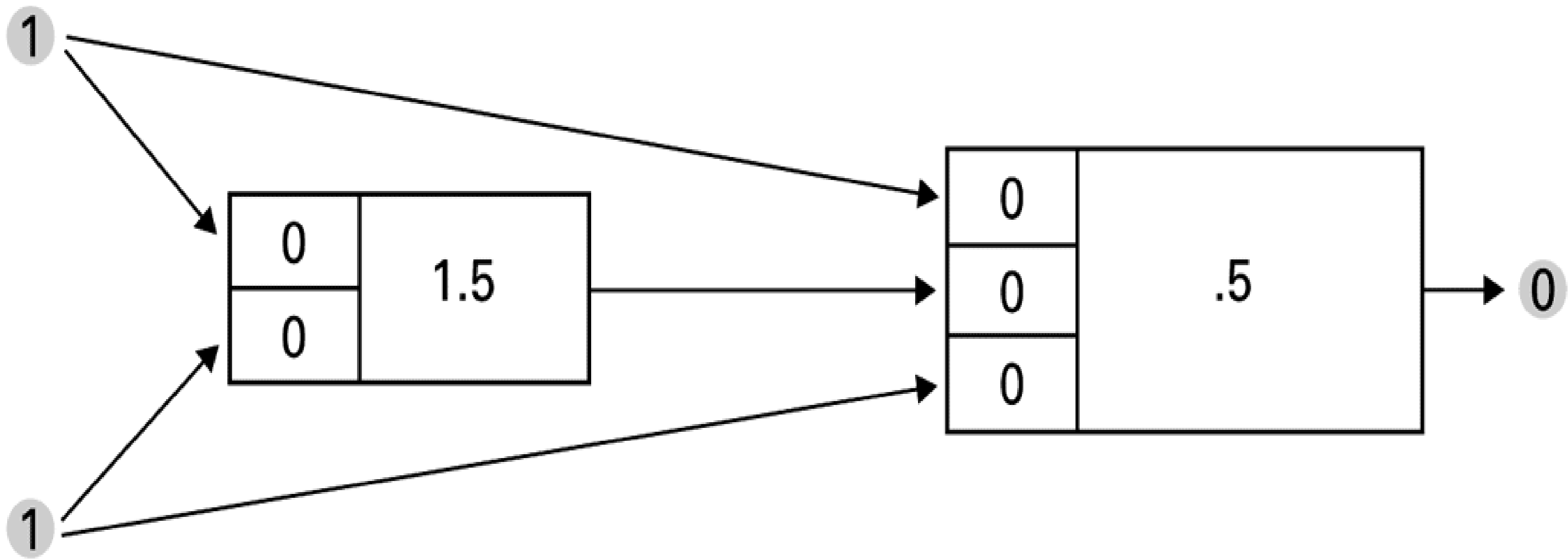
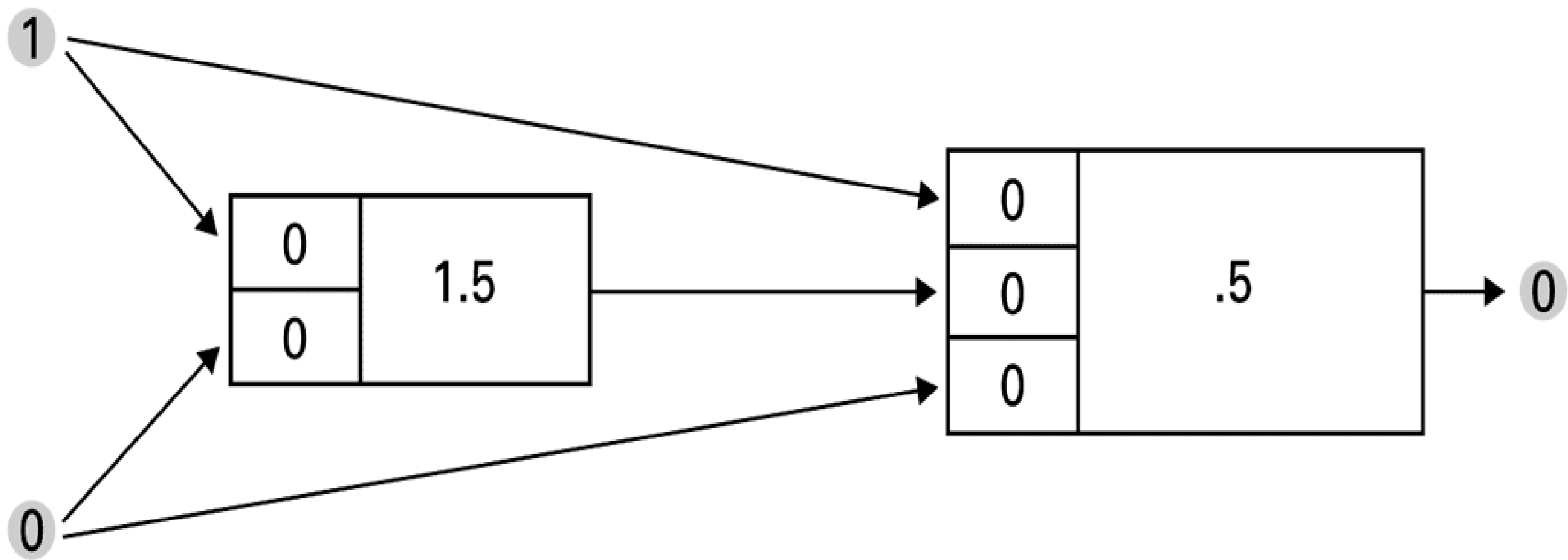


Figure 11.20 Training an artificial neural network



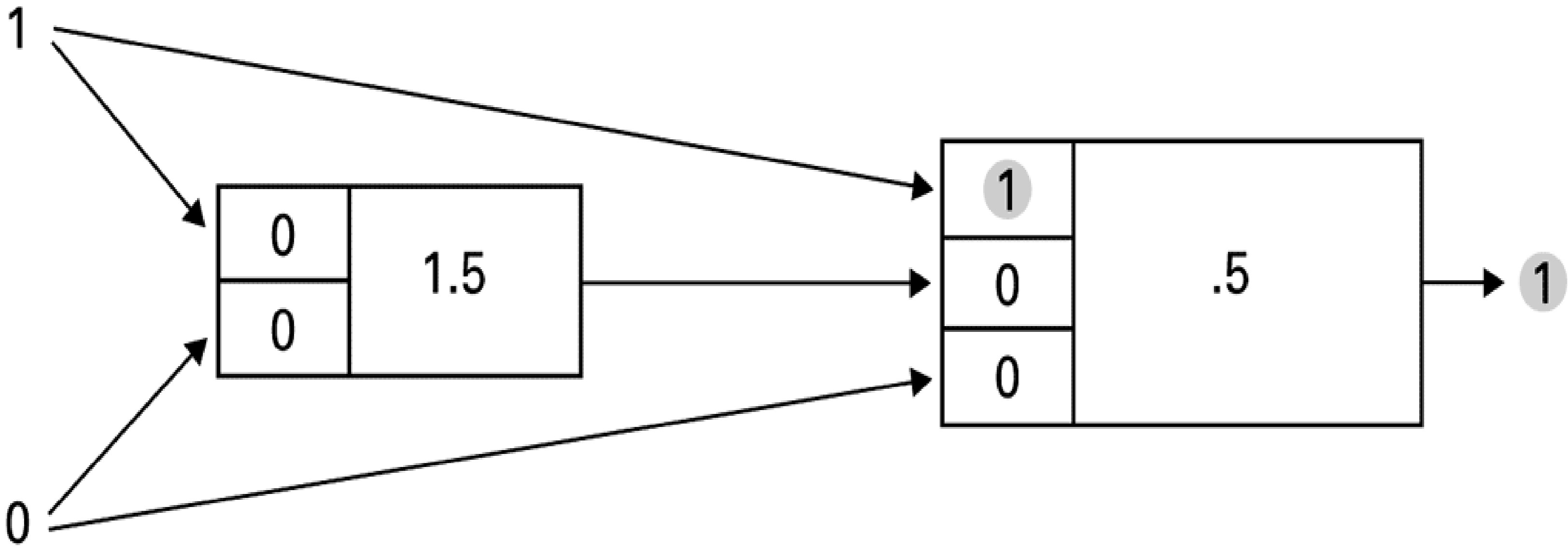
a. The network performs correctly for the input pattern 1, 1.

Figure 11.20 Training an artificial neural network (continued)



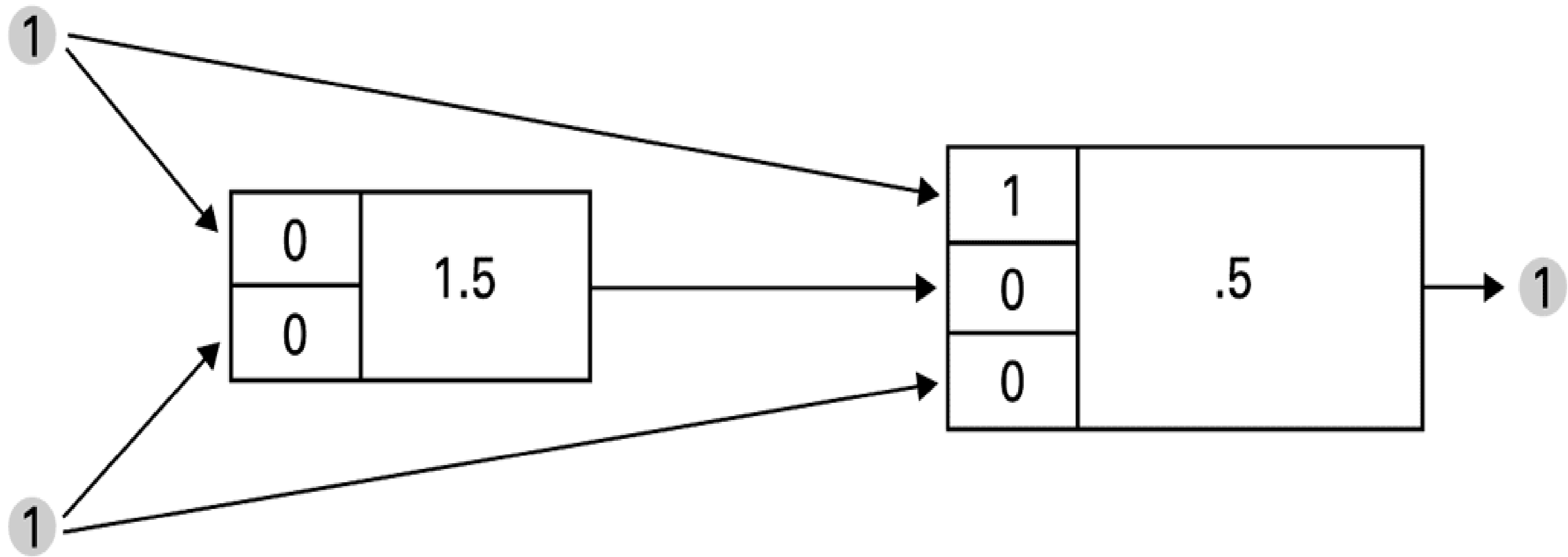
b. The network performs incorrectly for the input pattern 1, 0.

Figure 11.20 Training an artificial neural network (continued)



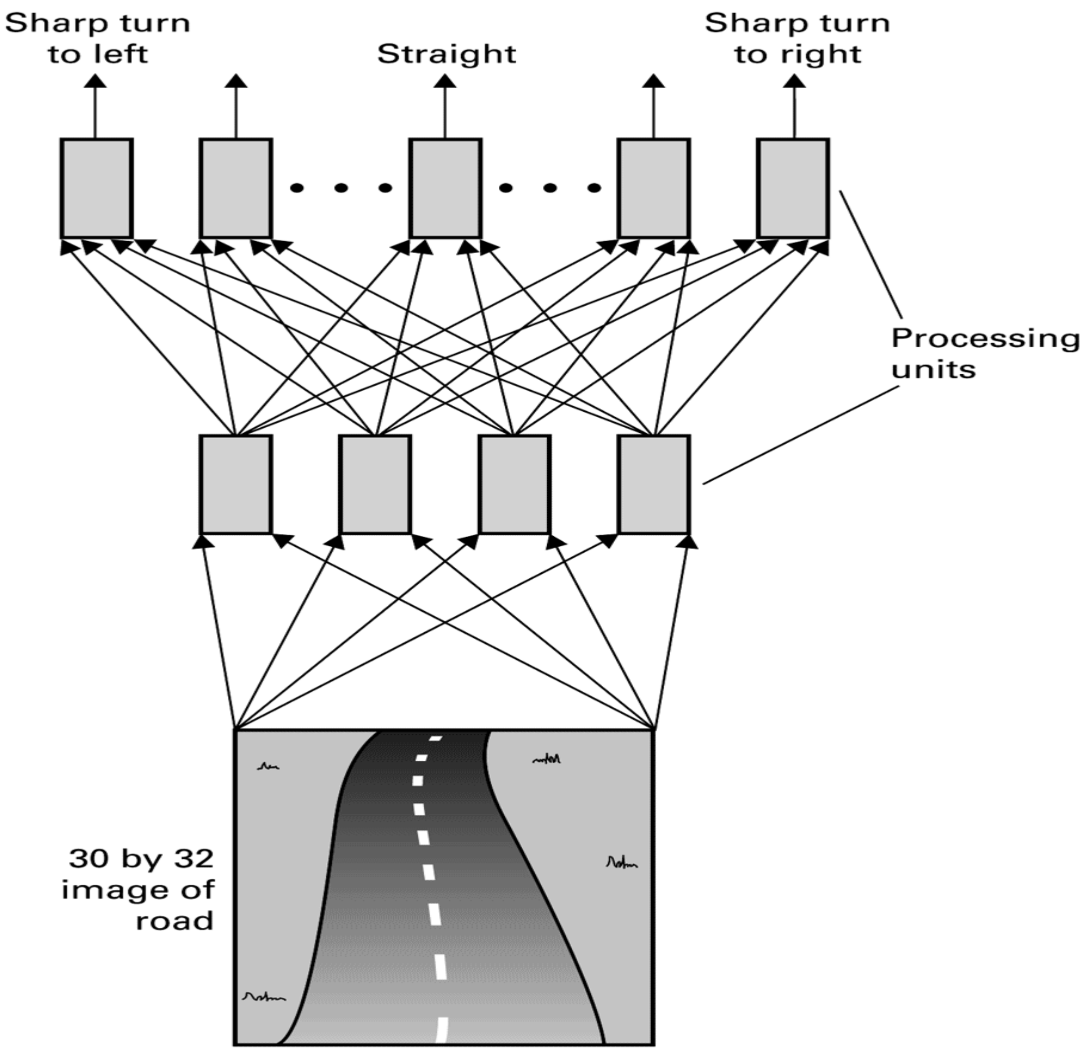
c. The upper weight in the second processing unit is adjusted.

Figure 11.20 Training an artificial neural network (continued)



d. However, the network no longer performs correctly for the input pattern 1, 1.

Figure 11.21 The structure of ALVINN



Associative Memory

- **Associative memory:** The retrieval of information relevant to the information at hand
- One direction of research seeks to build associative memory using neural networks that when given a partial pattern, transition themselves to a completed pattern.

Figure 11.22 An artificial neural network implementing an associative memory

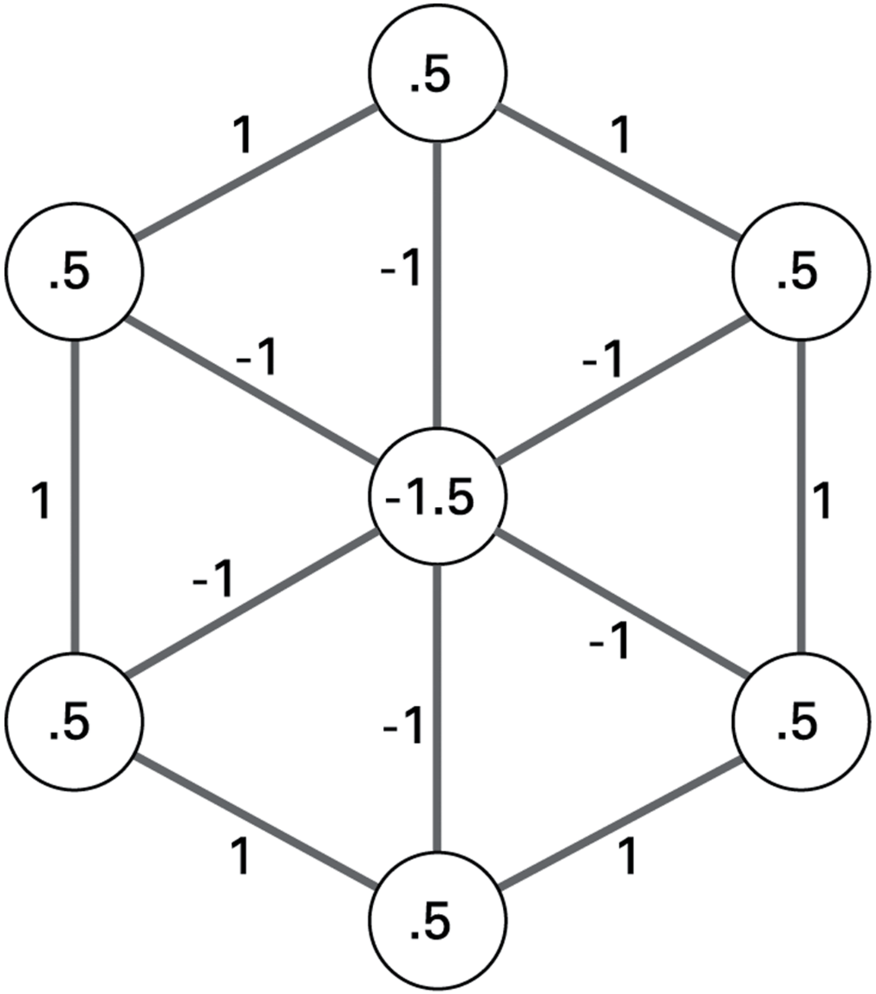
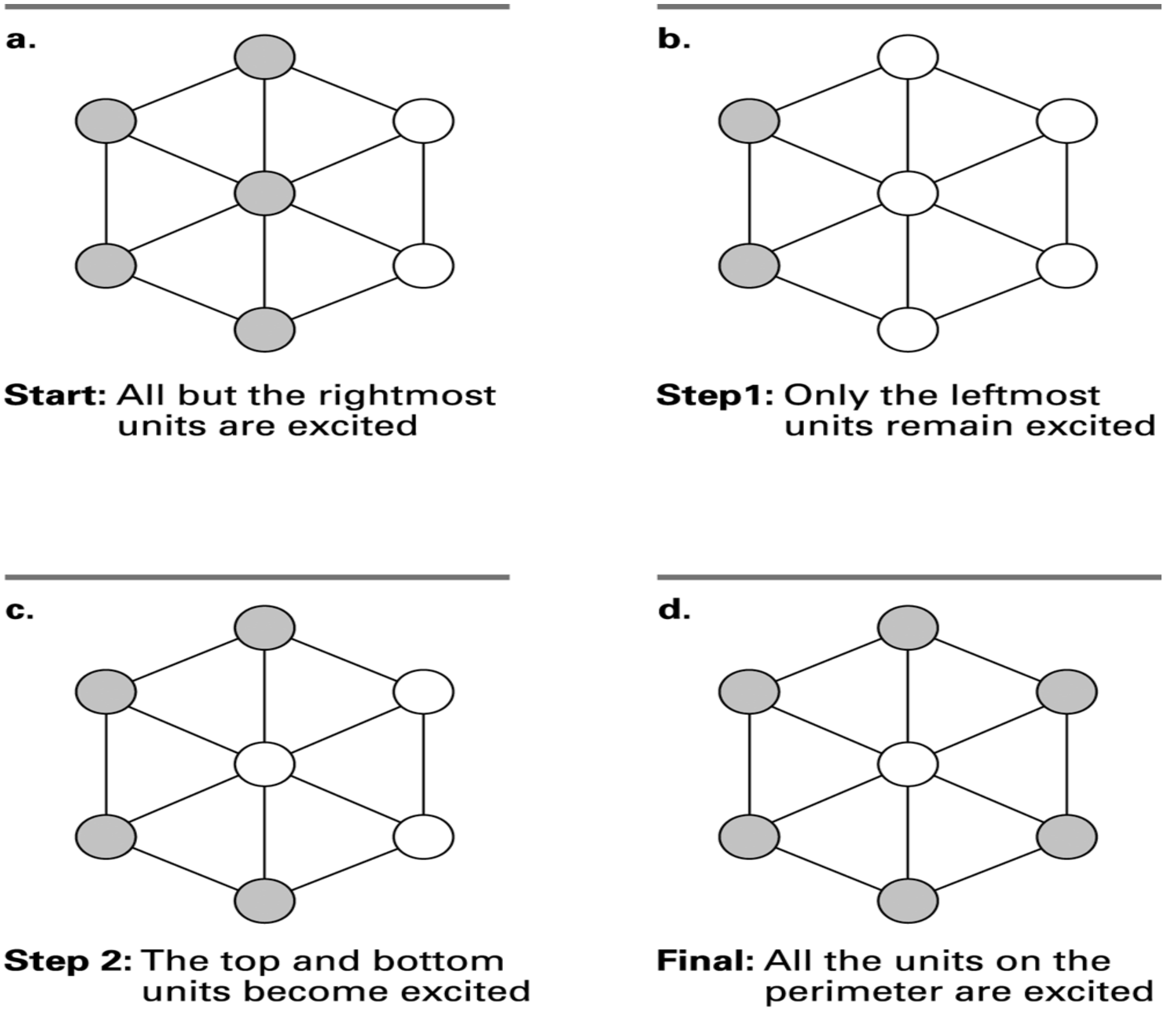


Figure 11.23 The steps leading to a stable configuration



Robotics

- Truly autonomous robots require progress in perception and reasoning.
- Major advances being made in mobility
- Plan development versus reactive responses
- Evolutionary robotics

Issues Raised by Artificial Intelligence

- 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?

Thank You!

Chapter 11

Artificial Intelligence

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