

Invitation to Computer Science

5th Edition

Chapter 15

Artificial Intelligence

Objectives

In this chapter, you will learn about:

- A division of labor
- Recognition tasks
- Reasoning tasks
- Robotics

Introduction

- Artificial intelligence (AI)
 - Explores techniques for incorporating aspects of intelligence into computer systems
- Turing test
 - Allows a human to interrogate two entities, both hidden from the interrogator

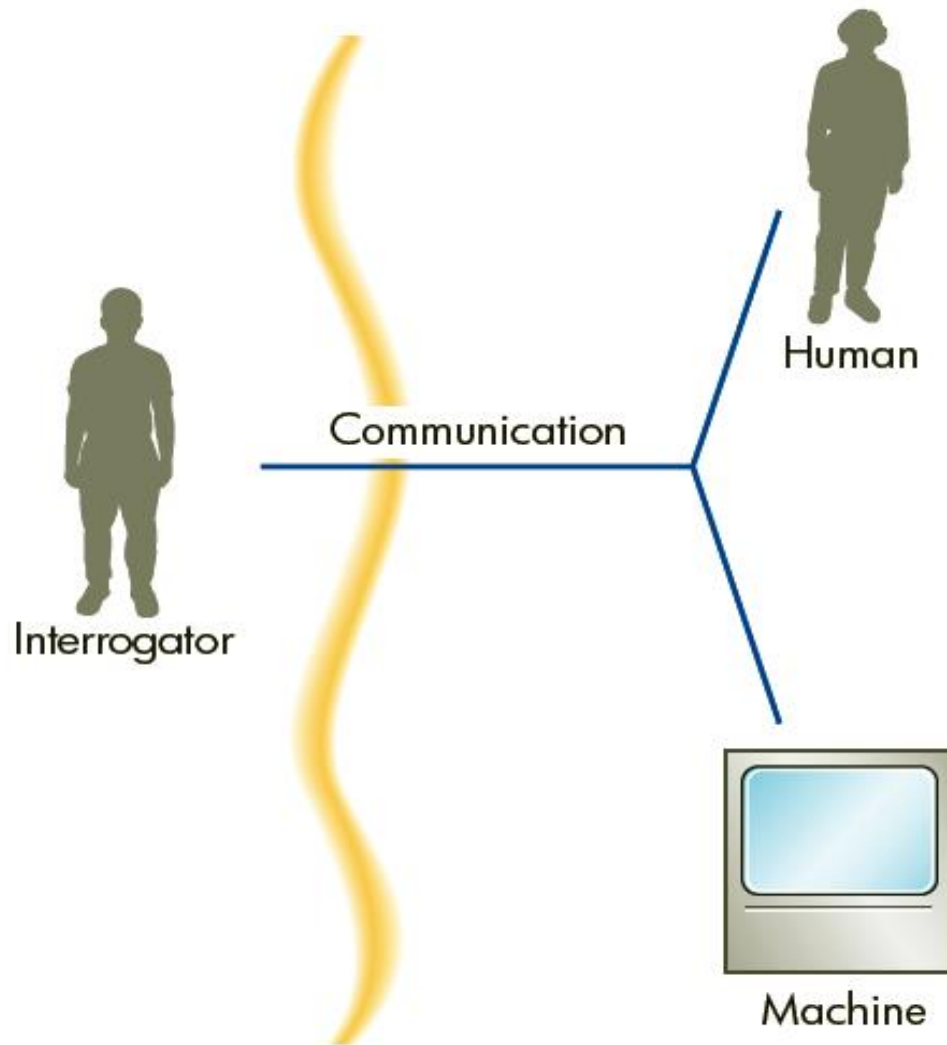


Figure 15.1 The Turing Test

A Division of Labor

- Computational tasks
 - Adding a column of numbers
 - Sorting a list of numbers into numerical order
 - Searching for a given name in a list of names
 - Managing a payroll
 - Calculating trajectory adjustments for the space shuttle

A Division of Labor (continued)

- Recognition tasks
 - Recognizing your best friend
 - Understanding the spoken word
 - Finding the tennis ball in the grass in your backyard

A Division of Labor (continued)

- Reasoning tasks
 - Planning what to wear today
 - Deciding on the strategic direction a company should follow for the next five years
 - Running the triage center in a hospital emergency room after an earthquake

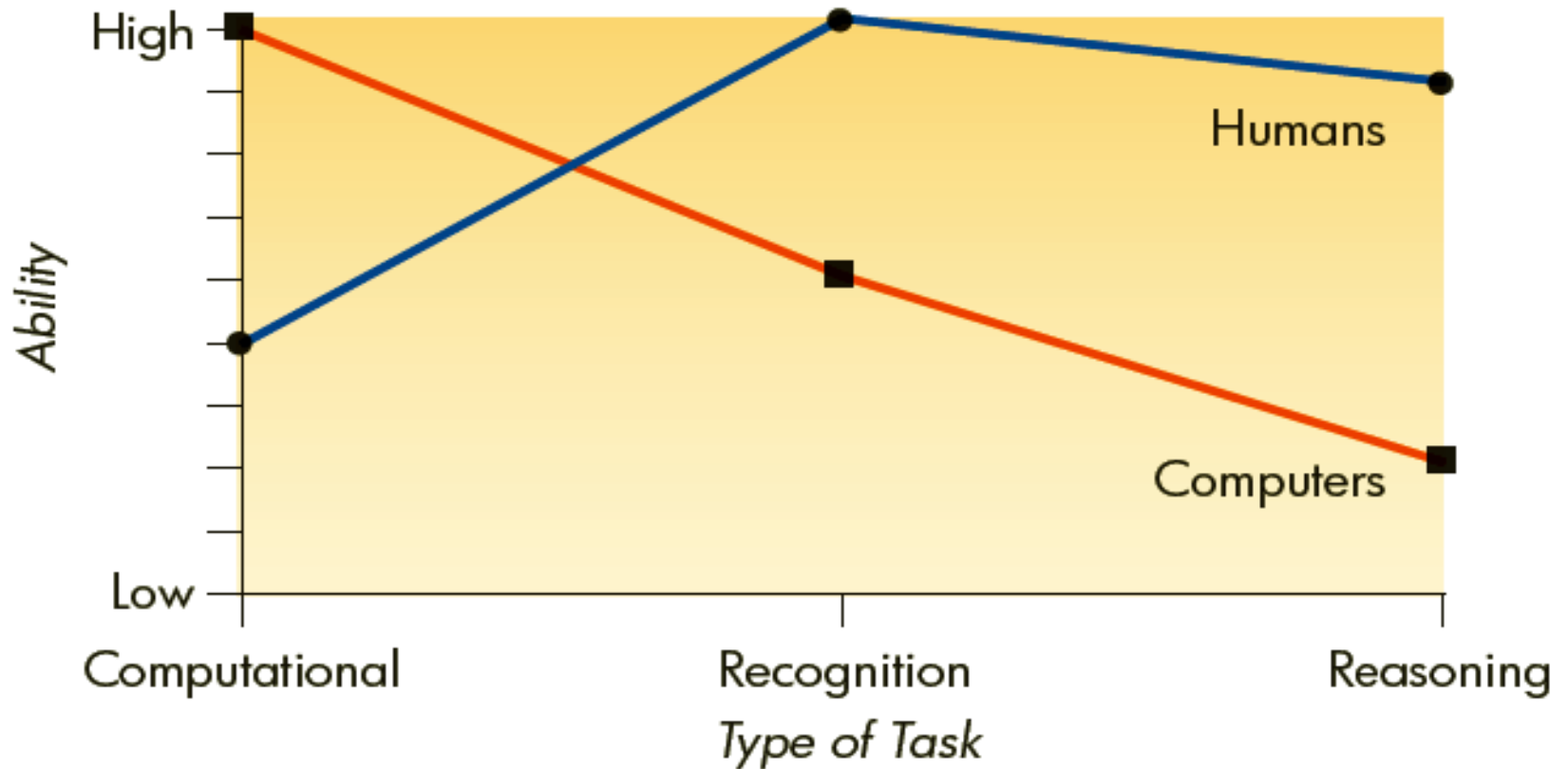


Figure 15.2 Human and Computer Capabilities

Recognition Tasks

- Neuron
 - Cell capable of receiving stimuli, in the form of electrochemical signals, from other neurons through its many **dendrites**
 - Can send stimuli to other neurons through its single **axon**
- Artificial neural networks
 - Can be created by simulating individual neurons in hardware and connecting them in a massively parallel network of simple devices

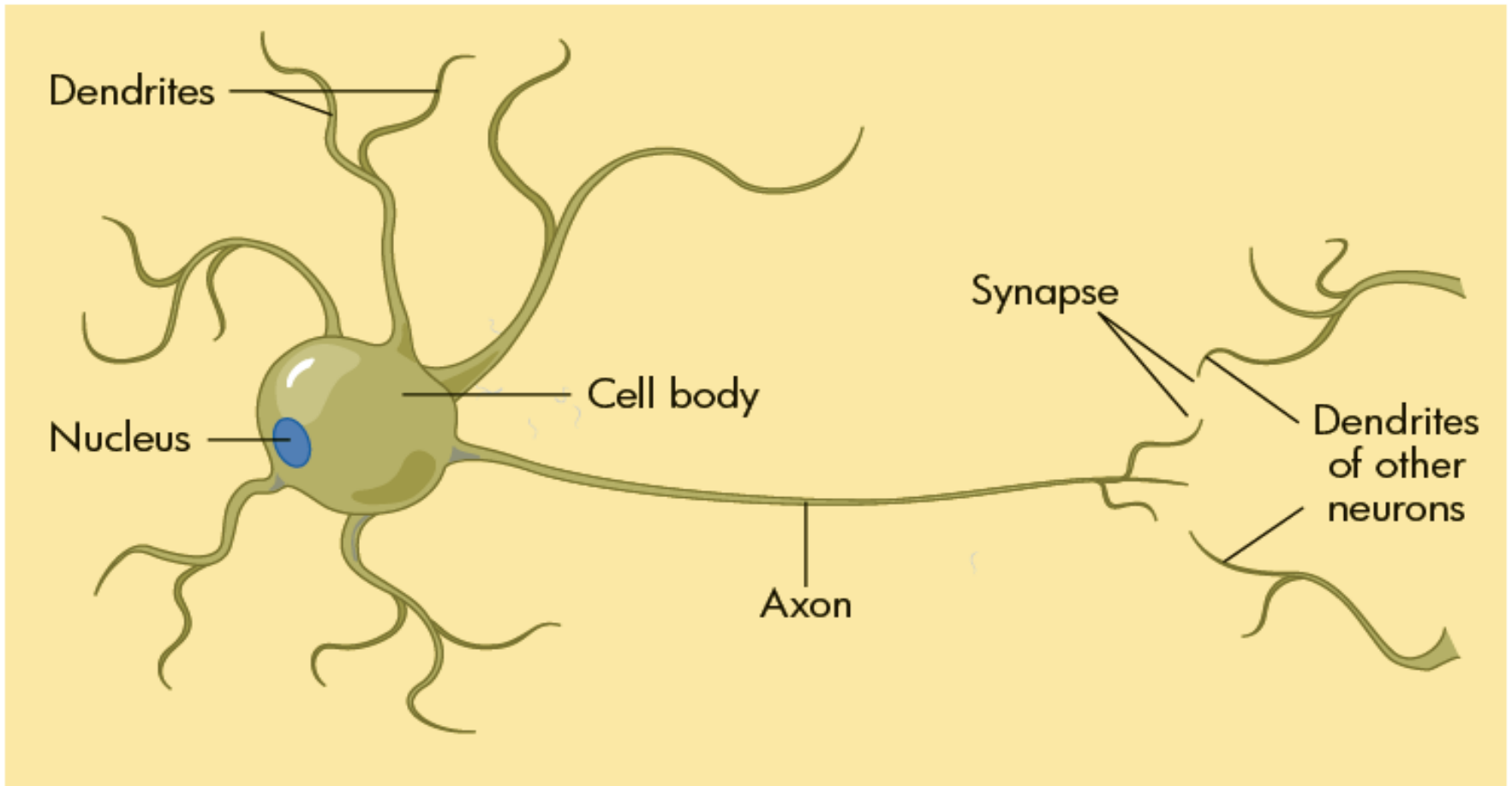


Figure 15.4 A Neuron

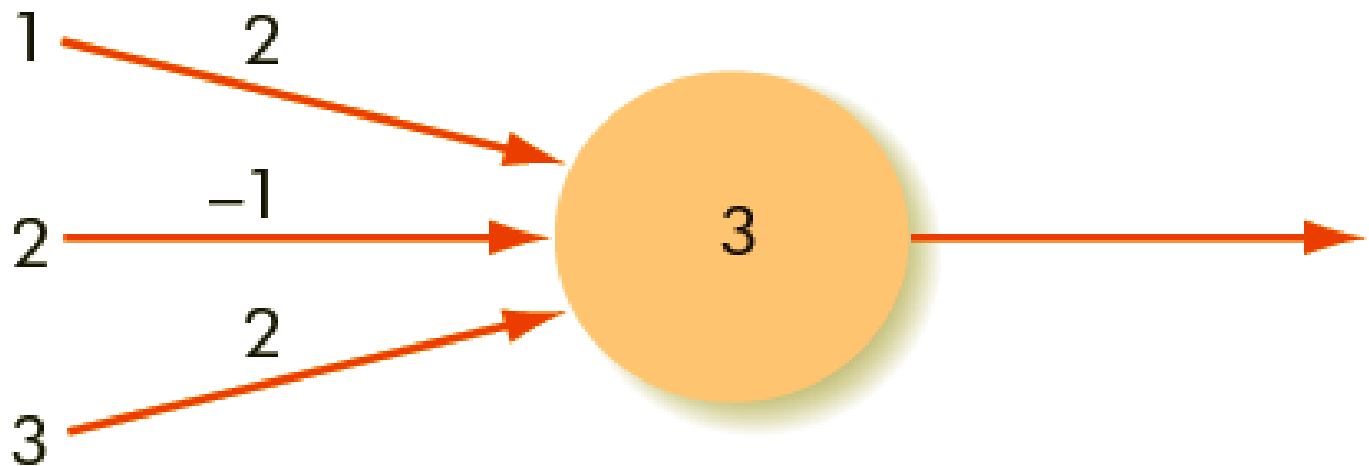


Figure 15.5 One Neuron with Three Inputs

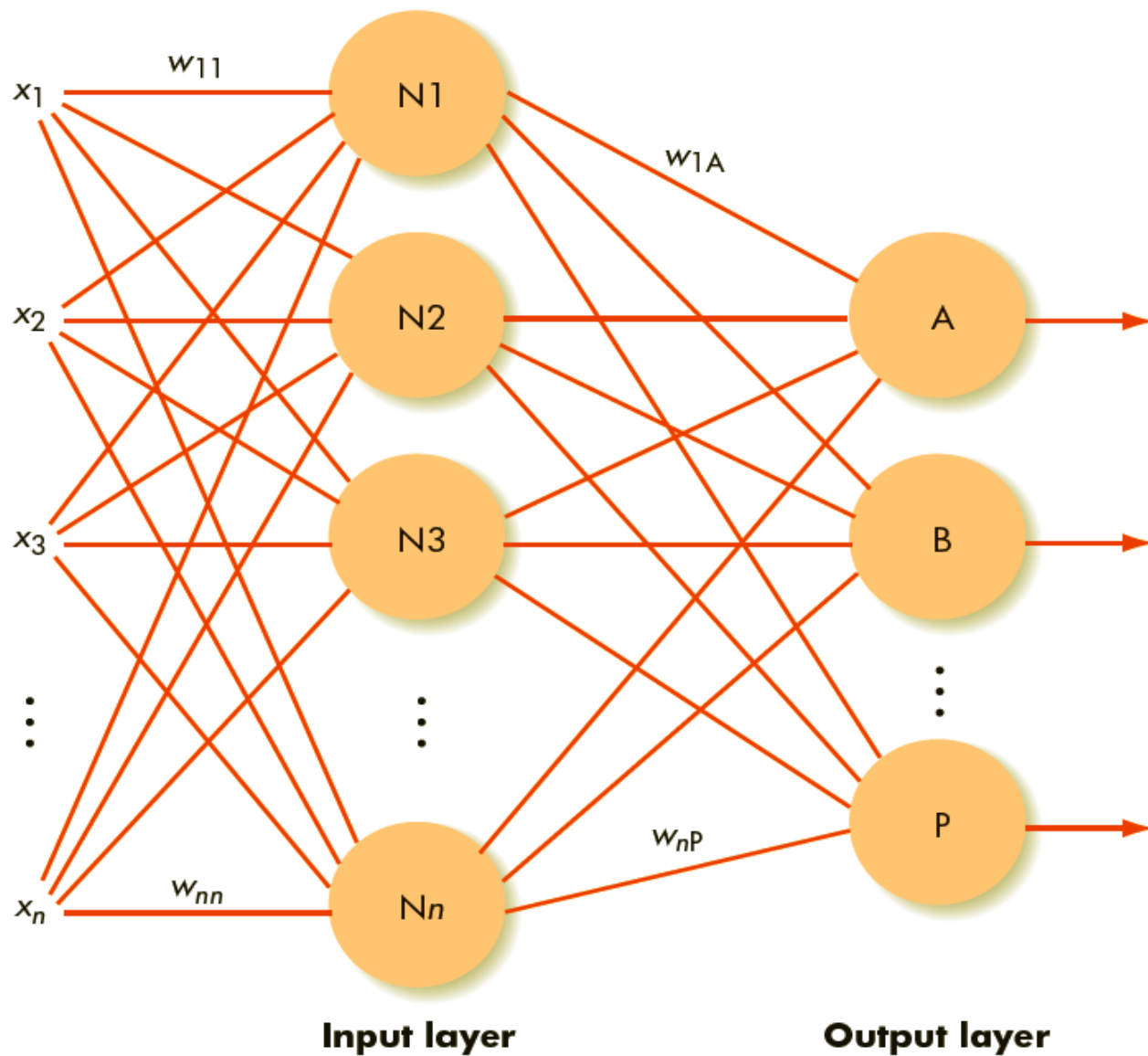


Figure 15.6 Neural Network Model

Recognition Tasks (continued)

- Neural network
 - Can learn from experience by modifying the weights on its connections
 - Can be given an initial set of weights and thresholds that is simply a first guess
 - Network is then presented with **training data**
- Back propagation algorithm
 - Eventually causes the network to settle into a stable state where it can correctly respond to all inputs in the training set

Reasoning Tasks

- Characteristic of human reasoning
 - Ability to draw on a large body of facts and past experience to come to a conclusion
- Artificial intelligence specialists try to get computers to emulate this characteristic

Intelligent Searching

- Decision tree for a search algorithm
 - Illustrates the possible next choices of items to search if the current item is not the target
- Decision tree for sequential search is linear
- Classical search problem benefits from two simplifications
 - Search domain is a linear list
 - We seek a perfect match

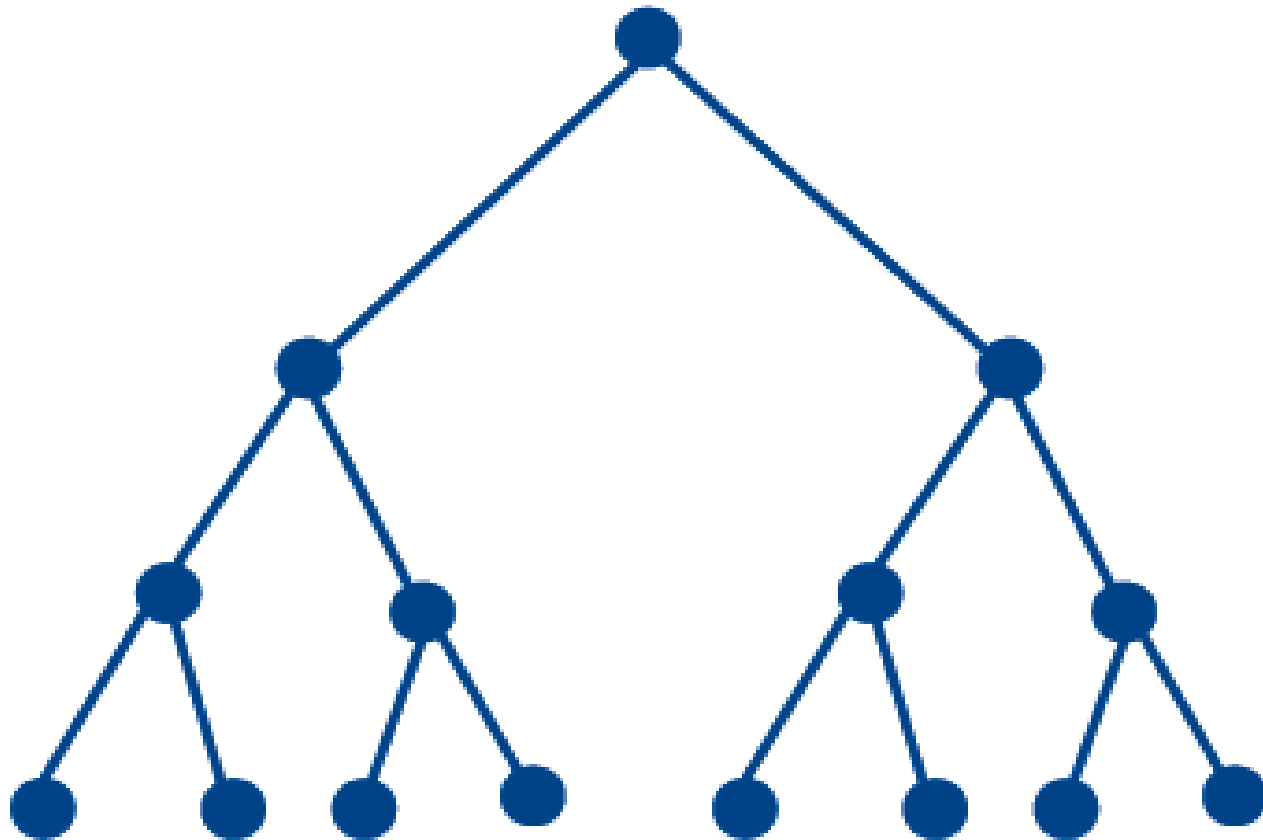


Figure 15.11 Decision Tree for Binary Search

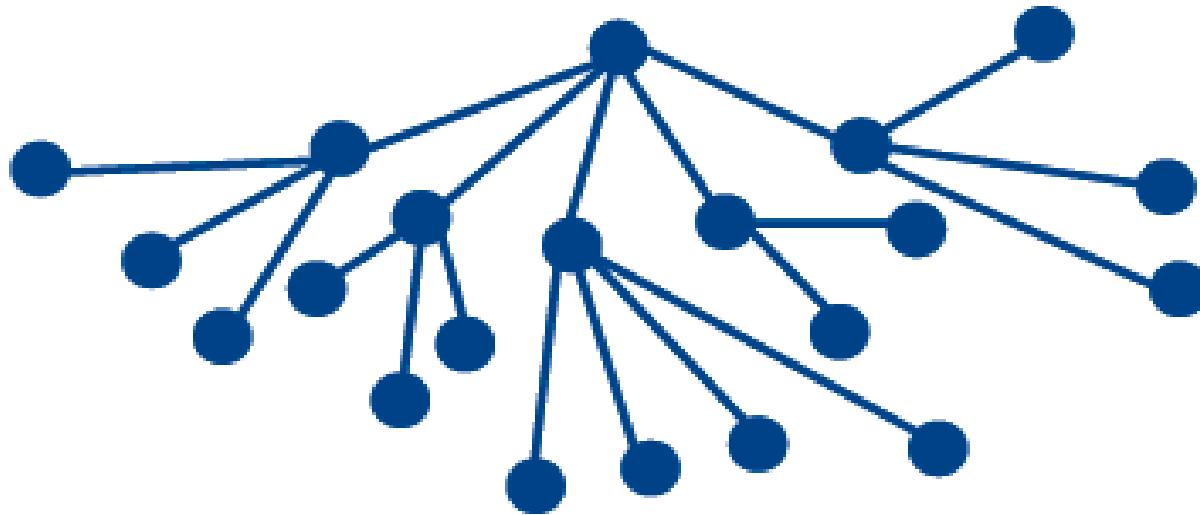
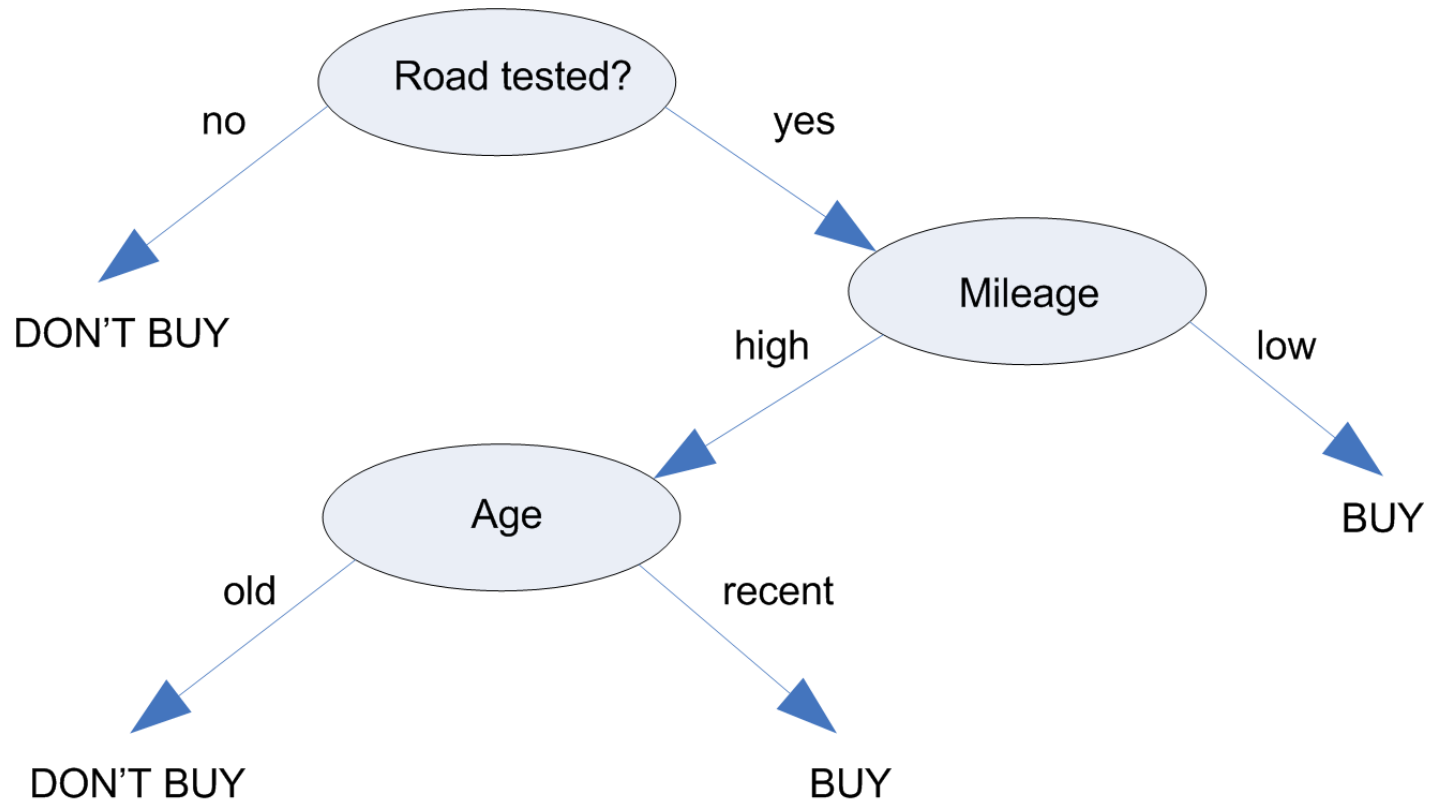
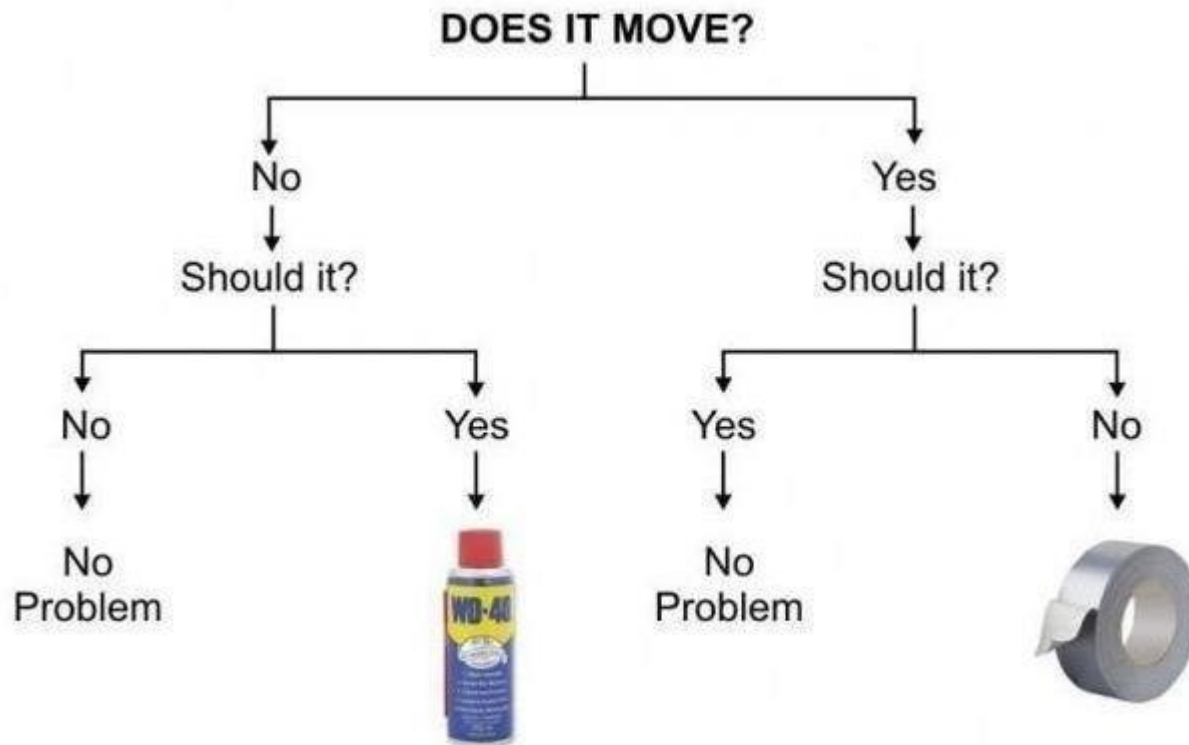


Figure 15.12 A State-Space Graph with Exponential Growth

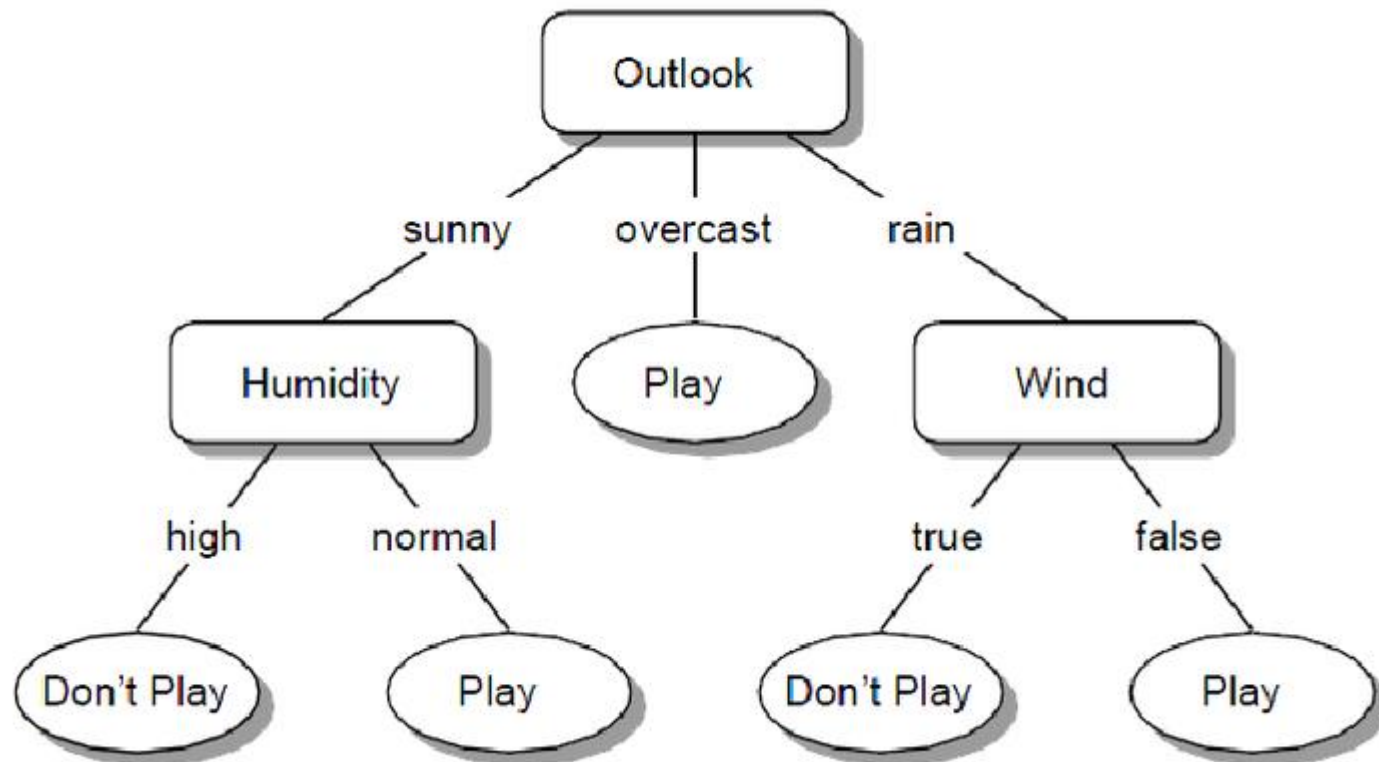
Decision Tree Example



Decision Tree Example



Decision Tree Example



Clustering Definition

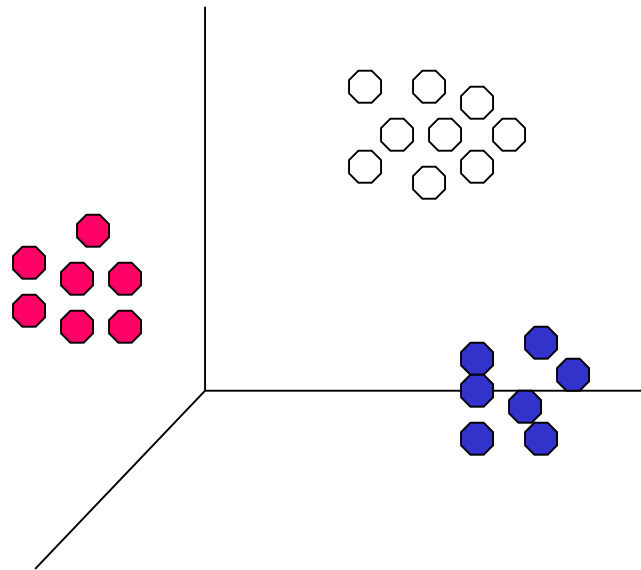
- Given a set of data points, each having a set of attributes, and a similarity measure among them, find clusters such that
 - Data points in one cluster are more similar to one another.
 - Data points in separate clusters are less similar to one another.
- Similarity Measures?
 - Euclidean Distance if attributes are continuous.
 - Other Problem-specific Measures.

Illustrating Clustering

Euclidean Distance Based Clustering in 3-D space.

Intracuster distances
are minimized

Intercluster distances
are maximized



Clustering: Applications

- Marketing: Help marketers discover distinct groups in their customer bases, and then use this knowledge to develop targeted marketing programs
- Land use: Identification of areas of similar land use in an earth observation database
- Insurance: Identifying groups of motor insurance policy holders with a high average claim cost
- City-planning: Identifying groups of houses according to their house type, value, and geographical location
- Earth-quake studies: Observed earth quake epicenters should be clustered along continent faults

Classification: Definition

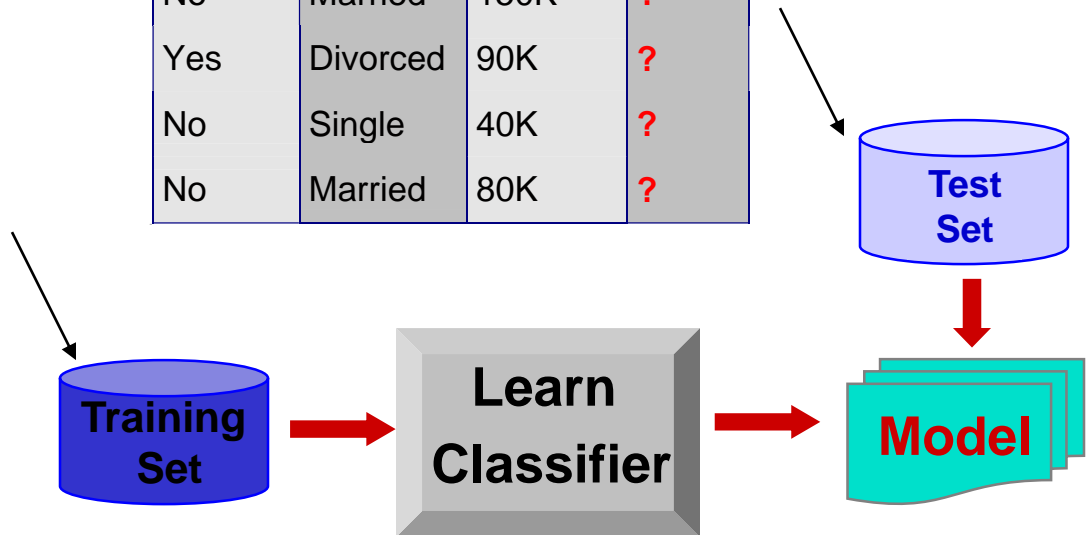
- Given a collection of records (*training set*)
 - Each record contains a set of *attributes*, one of the attributes is the *class*.
- Find a *model* for class attribute as a function of the values of other attributes.
- Goal: previously unseen records should be assigned a class as accurately as possible.
 - A *test set* is used to determine the accuracy of the model. Usually, the given data set is divided into training and test sets, with training set used to build the model and test set used to validate it.

Classification Example

categorical
categorical
continuous
class

<i>Tid</i>	Refund	Marital Status	Taxable Income	Cheat
1	Yes	Single	125K	No
2	No	Married	100K	No
3	No	Single	70K	No
4	Yes	Married	120K	No
5	No	Divorced	95K	Yes
6	No	Married	60K	No
7	Yes	Divorced	220K	No
8	No	Single	85K	Yes
9	No	Married	75K	No
10	No	Single	90K	Yes

Refund	Marital Status	Taxable Income	Cheat
No	Single	75K	?
Yes	Married	50K	?
No	Married	150K	?
Yes	Divorced	90K	?
No	Single	40K	?
No	Married	80K	?



Classification: Application 1

- Ad Click Prediction
 - Goal: Predict if a user that visits a web page will click on a displayed ad. Use it to target users with high click probability.
 - Approach:
 - Collect data for users over a period of time and record who clicks and who does not. The {click, no click} information forms the class attribute.
 - Use the history of the user (web pages browsed, queries issued) as the features.
 - Learn a classifier model and test on new users.

Classification: Application 2

- Fraud Detection
 - Goal: Predict fraudulent cases in credit card transactions.
 - Approach:
 - Use credit card transactions and the information on its account-holder as attributes.
 - When does a customer buy, what does he buy, how often he pays on time, etc
 - **Label** past transactions as fraud or fair transactions. This forms the class attribute.
 - Learn a model for the class of the transactions.
 - Use this model to detect fraud by observing credit card transactions on an account.

Expert Systems

- Rule-based system
 - Attempts to mimic the human ability to engage pertinent facts and string them together in a logical fashion to reach some conclusion
 - Must contain these two components
 - A knowledge base
 - An inference engine

Robotics

- Uses for robots in manufacturing, science, the military, and medicine
 - Assembling automobile parts
 - Packaging food and drugs
 - Placing and soldering wires in circuits
 - Bomb disposal
 - Welding
 - Radiation and chemical spill detection

Robotics (continued)

- Two strategies characterize robotics research
 - **Deliberative strategy**: says that the robot must have an internal representation of its environment
 - **Reactive strategy**: uses heuristic algorithms to allow the robot to respond directly to stimuli from its environment

Summary

- Artificial intelligence
 - Explores techniques that incorporate aspects of intelligence into computer systems
- Categories of tasks
 - Computational, recognition, and reasoning
- Neural networks
 - Simulate individual neurons in hardware and connect them in a massively parallel network

Summary (continued)

- Intelligent agent interacts with a user
- Rule-based systems
 - Attempt to mimic the human ability to engage pertinent facts and combine them in a logical way to reach some conclusion
- Robots can perform many useful tasks