Lecture 24

Artificial Intelligence (S&G, §§13.1–13.3)

Definition of Artificial Intelligence

• “Artificial Intelligence (AI) is the part of computer science concerned with designing intelligent computer systems,
• that is, systems that exhibit the characteristic we associate with intelligence in human behavior —
• understanding language, learning, reasoning, solving problems, and so on.” — *Handbook of Artif. Intell.*, vol. I, p. 3

“Thinking Machines”

• Could a machine think?
• What do we mean by “thinking”?
• How could we tell if a machine were thinking?
• One operational approach to these issues is the Turing Test

The Turing Test

• Two humans and a computer play the “imitation game”
• Interrogator communicates with other two through an interface that hides superficial differences
• Computer tries to fool interrogator into thinking it is the human subject
• The human tries to help the interrogator to conclude that the other subject is the computer

Controversy

• The Turing Test is widely accepted
• But controversial
• Is it too hard?
• Is it too easy?
• If a machine could pass the Turing Test, would we be justified in concluding it had a mind?
• What do you think?

Turing’s Optimism

• In 1950 Turing wrote, “I believe that in about fifty years’ time it will be possible to programme computers, with a storage capacity of about $10^9$, to make them play the imitation game so well that an average interrogator will not have more than 70 percent chance of making the right identification after five minutes of questioning.”
• Hasn’t happened …
Turing’s Optimism (2)

- “I believe that at the end of the century the use of words and general educated opinion will have altered so much that one will be able to speak of machines thinking without expecting to be contradicted.”
- Also hasn’t happened
- Nevertheless, computers have been programmed to do many “intelligent” things and AI techniques are used in many applications

Major Kinds of Tasks

- Computational
  - calculation (in the broad sense)
  - computers do better than people
- Reasoning
  - planning
  - making decisions
  - computers follow rules mechanically, people follow them intuitively
- Recognition & action
  - humans (& other animals) do very well
  - contemporary computers do poorly

Foundations of Intelligence

- General inferential procedures
  - allow the interrelation of any facts or hypotheses
  - “if all M are P and S is an M, then S is P”
  - “inference engine”
- Knowledge
  - general: “all birds have wings”
  - specific: “Shakespeare wrote Hamlet”
  - “knowledge base”

Knowledge Representation

- Natural language
  - statements
- Formal logic
  - formulas
- Graphical
  - networks
- Pictorial
  - images

Knowledge Representation

- Formal Language
  - Symbolic Logic

- Spot is a brown dog, and, like any dog, has four legs and a tail. Also, like any dog, Spot is a mammal, which means Spot is warm-blooded.
- More formally:
  - Spot is a dog.
  - Spot is brown.
  - Every dog has four legs.
  - Every dog has a tail.
  - etc.
  \[
  \begin{align*}
  &\text{Specific propositions} \\
  &\text{General propositions}
  \end{align*}
  \]

- Formal Language
  - Symbolic Logic

- Spot is a dog
- Spot is brown
- Every dog has four legs
- Every dog has a tail
- Every dog is a mammal
- Every mammal is warm-blooded
- dog(Spot)
- brown(Spot)
- (\(\forall x\))(dog(x) \(\rightarrow\) four-legged(x))
- (\(\forall x\))(dog(x) \(\rightarrow\) tail(x))
- (\(\forall x\))(dog(x) \(\rightarrow\) mammal(x))
- (\(\forall x\))(mammal(x) \(\rightarrow\) warm-blooded(x))
Graphical Representation (Semantic Net)

Example

Inference

mammal

warm-blooded

dog

four-legs

tail

brown

Spot

Pictorial Representation (Image-based)

- Much information is implicit in an image
- But can be extracted when needed
- Humans have prototype images for each basic category
- Brains use a kind of analog computing for image manipulation

Desirable Characteristics of a Knowledge Representation System

- **Adequacy**
  - Can it capture all the relevant knowledge?
- **Efficiency**
  - How large is the representation, and how easily can implicit knowledge be extracted?
- **Extendability**
  - Can we add new concepts, properties, individuals, rules of inference?
- **Appropriateness**
  - Is it well suited to the intended knowledge domain?