Artificial Intelligence: Describe, Infer, Learn

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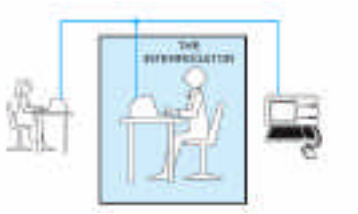
Turing Test



Research and Applications

- Game Playing
- Automated Reasoning and Theorem Proving
- Expert Systems
- Natural Language Understanding and Semantic Modelling
- Modelling Human Performance
- Planning and Robotics
- Languages and Environments for AI
- Machine Learning
- Alternative Representations: Neural Nets and Genetic Algorithms
- AI and Philosophy

Issues

1. The use of computers to do reasoning, pattern recognition, learning, or some other form of inference.
2. A focus on problems that do not respond to algorithmic solutions. This underlies the reliance on heuristic search as an AI problem-solving technique.
3. A concern with problem-solving using inexact, missing, or poorly defined information and the use of representational formalisms that enable the programmer to compensate for these problems.
4. Reasoning about the significant qualitative features of a situation.
5. An attempt to deal with issues of semantic meaning as well as syntactic form.

Issues

6. Answers that are neither exact nor optimal, but are in some sense "sufficient". This is a result of the essential reliance on heuristic problem-solving methods in situations where optimal or exact results are either too expensive or not possible.
7. The use of large amounts of domain-specific knowledge in solving problems. This is the basis of expert systems.
8. The use of meta-level knowledge to effect more sophisticated control of problem-solving strategies. Although this is a very difficult problem, addressed in relatively few current systems, it is emerging as an essential are of research.

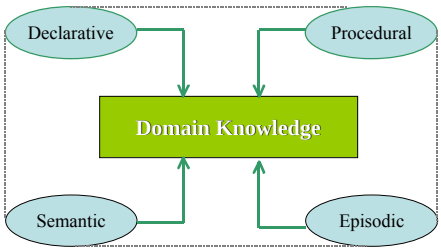
Two Kinds of AI

- **Strong AI:** Claim that computers can be made to actually think, just like human beings do. More precisely, the claim that there exists a class of computer programs, such that any implementation of such a program is really thinking.
- **Weak AI:** Claim that computers are important tools in the modeling and simulation of human activity.

Weak AI

- The “weak” notion reflects the degree to which the mechanisms in the software should mimic psychologically informed and plausible mechanisms.
- We will adopt the weak stance and focus on knowledge.
- The mechanisms will be psychologically informed but plausibility will not be a criterion.

Varieties of Knowledge



Declarative Knowledge

- Declarative knowledge is knowledge that is made explicit. It is *knowing that* something is the case. It is “context free.”
- Declarative knowledge claims often conform to the accepted style or rules for reporting in a particular domain.

Procedural Knowledge

- Procedural knowledge focuses on *knowing how* to do something. Procedural knowledge involves reacting to a situation on the basis of acquired skill or experience.
- Procedural knowledge makes action possible.
- However, having procedural knowledge does not entail that one can state what the knowledge.

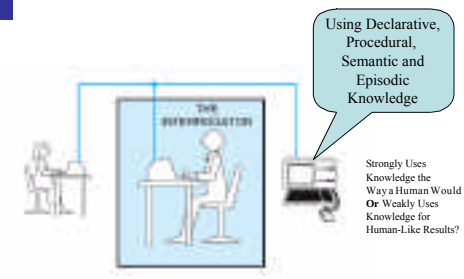
Semantic Knowledge

- Semantic knowledge is a form of long-term knowledge that reflects the meaning of representations.
- The elements of semantic knowledge include words and linguistic symbols, meanings and usage rules, referents and interrelations, and procedures, for manipulating the words, symbols, concepts, or relations.

Episodic Knowledge

- Episodic knowledge is the most biographical or experiential form of knowledge.
- The agent acquires episodic knowledge through experience and groups or ‘chunks’ it into episodes. This knowledge may be labeled with a particular time and place.

Amended Turing Test



Expertise

Topics

- Types of Knowledge
- Examples
- Gaining Expertise
- Experts and Novices
- Issues
- A Natural History of Knowledge

Types of Knowledge

- Factual or syntactic knowledge
- Semantic knowledge
- Schematic knowledge
- Strategic knowledge

Factual or Syntactic Knowledge

- Basic knowledge about the domain of interest
- Knowledge of language units and rules of combination
- Knowledge of symptoms
- Knowledge of tests

Semantic Knowledge

- Knowledge of concepts that underlie problems
- Mental models of locations, objects, actions, etc.
- Knowledge of connections between symptoms or test and underlying conditions or phenomena

Schematic Knowledge

- Knowledge of problem types
- Categories of routines, structures, or actions
- Knowledge of relations among sets of symptoms, test results, data, etc.
- Knowledge of explanation or prediction templates

Strategic Knowledge

- Knowledge of strategies for generating, monitoring, and modifying plans
- Knowledge of problem solving heuristics
- Knowledge of hypothesis generation techniques and testing plans

Example 1 - Physics

	Novices	Experts
Factual or syntactic knowledge	Posses small function units	Possess large functional units
Semantic knowledge	Build naïve, surface representations	Build physics law based representations
Schematic Knowledge	Categorize based on surface similarities	Categorize based on structural similarities
Strategic Knowledge	Work backward from unknowns to givens	Work forward from givens to unknown

Example 2 - Computer Programming

	Novices	Experts
Factual or syntactic knowledge	Slow and effortfully recognize incorrect syntax	Rapid and effortlessly recognize incorrect syntax
Semantic knowledge	Lack useful mental models	Possess many mental models
Schematic Knowledge	Categorize based on surface characteristics	Categorize based on type of routine required
Strategic Knowledge	Low level plans; few subparts; few alternatives	High level plans, fine subparts, many alternatives

Example 3 - Medicine

	Novices	Experts
Factual or syntactic knowledge	Slow and effortfully recognize abnormalities	Rapid and effortlessly recognize abnormalities
Semantic knowledge	Do not connect observations with internal conditions	Observations connected to various internal conditions
Schematic Knowledge	Lack connection of large clusters of observations to diagnosis	Large clusters of observations connected to possible diagnoses
Strategic Knowledge	Few alternatives, few tests, few hypotheses	More alternatives and more tests focused on hypotheses

Gaining Expertise - 1

- Declarative knowledge is explicit, reportable and conscious (knowledge that)
- Procedural knowledge is implicit and skill based (knowledge how)
- Proceduralization - The process by which people switch from explicit use of declarative knowledge to direct application of procedural knowledge

Gaining Expertise - 2

- Tactical learning is the acquisition of specific procedures for specific problems
- Strategic learning is the acquisition of way to organize problem solving skills that are well suited to problems in a particular domain.
- Chunk learning is the acquisition of patterns that repeat over time.

Experts and Novices

- Experts exhibit greater proceduralization, increased reliance on strategic knowledge, and more systematic chunks than novices.
- In the cognitive stage the person develops a declarative encoding
- In the associative stage errors are detected and connections are strengthened
- In the autonomous stage procedures are compiled and automated.

Issues

- Practice and deliberate practice
- Transfer of skill
- Dual encoding
- Education
- Automation

A Natural History of Knowledge

- In the early stages of knowledge production experts possess the knowledge in the context of their work.
- At a later stage the expert's knowledge can be transferred through apprenticeship.
- In the final stage, knowledge is "context independent," declarative and public.