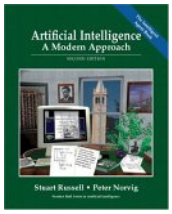
ذكاء اصطناعي
Artificial Intelligence (AI)
Comp 408

Book:



Artificial Intelligence :

A Modern Approach

Second Edition by Stuart J. Russell & Peter Norvig

(2003, Prentice Hall)

- Lectures, Hws, …etc will be available on
- http://scholar.cu.edu.eg/?q=areegsaid/node/25645

Comp 408 ARTIFICIAL INTELLIGENCE (2 cr. + 1 cr. Lab.)

- Prerequisite: comp 305. Offered in spring.
- Heuristic and algorithmic techniques in problem solving. Knowledge representation, Selected topics
- from natural language processing, automatic theorem proving, game playing, pattern recognition,
- and other current topics in artificial intelligence. Introduction to PROLOG (or LISP).

AI

- G. F. Luger & W. F. Stubblefield (1993), G. F. Luger (2005)

- AI is the branch of computer science concerned with the automation of intelligent behavior.

The sources of studying AI

- Philosophy: Logic, methods of reasoning
- Mathematics: Formal representation and proof algorithms, (un)decidability, probability
- Economics: Decision theory
- Neuoroscience: physical state for mental activity
- Psychology: perception, experimental techniques
- Linguistics, psycholinguistics
- Control System: design systems that maximize an objective function

Tentative syllabus for an AI course

Introduction and Agents (chapters 1,2)

Search (chapters 3,4,5,6)

Logic (chapters 7,8,9)

Natural Language Processing (chapter 22,23)

Remark: Comp 408 may not necessarily finish all the above

Grades

60 % Final

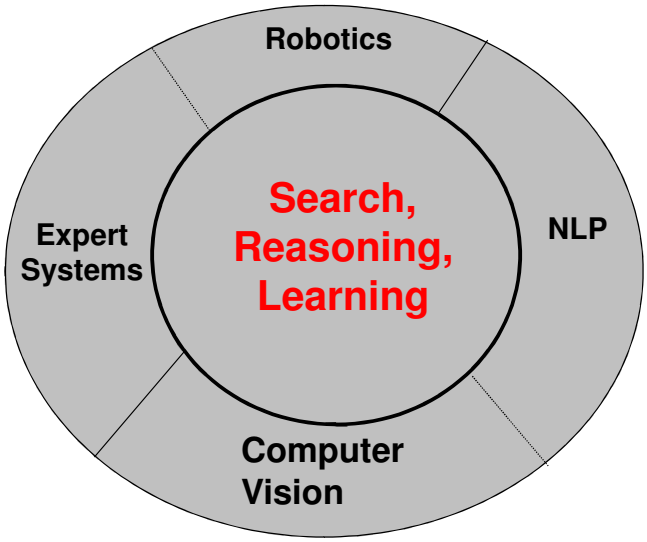
10 % Midterm

10 % Quiz

20 % Lab Assignments/ Quiz/ project

Hw will be assigned frequently to help you study. But no grades on it

Disciplines which form the core of AI inside
Fields which draw from these discipline ouside.



Human vs Machine Intelligence

- Intelligence is not a unique and unshared capability of human. It is more an open collection of attributes than it is a single well-defined entity
- Humans embody many aspects of intelligence while animals typically embody a smaller number of intelligent characteristics, and usually at a much lower level
- The advent of digital computers made possible credible attempts to fulfill the AI dreams
- Computer based intelligence must be specialized to very *restricted* domains to be comparable to human performance

Human vs Machine Intelligence

- The two hemispheres of the human brain deal with problems in two distinct paradigms:
  - sequential (or logical) approach that considers only a small portion of the available data at a time
  - parallel processing looks at data on a global basis

Many tasks which we might reasonably think require **intelligence** are performed by computers **without even thinking** → Complex Arithmetic

Other tasks that people do without thinking are extremely difficult to automate → Recognizing a Face

What is AI

For Defining AI, Books go in four directions:

- Think Like a human
- Act Like a human
- Think rationally
- Act rationally

The textbook adopts "acting rationally"

Thinking humanly

- 1960s "cognitive revolution"
- How the computer performs tasks does matter
- The reasoning steps are important
- Requires scientific theories of the activities of the brain
- Need ability to manipulate symbols
- How to validate? Requires

  1) Predicting and testing behavior of human subjects (top-down)--- Cognitive Science or

  2) Direct identification from neurological data (bottom-up) cognitive neuroscience

Both approaches are now distinct from AI Approaches

Thinking rationally

Aristotle: what are correct arguments processes?

- Logic and reasoning
- Requires reasoning structures
- Not easy to represent informal information
- Approaches: Machine Learning, NN, Reasoning
- Problems:

× Not all things can be formally represented in logic notation, particularly if there is any uncertainty

× It is usually the case that even small scale problems can exhaust the computational power of any computer unless heuristics are used

Acting humanly

- Turing (1950) "Computing machinery and intelligence"
- "Can machines think?" → "Can machines behave intelligently?"
- Take a task that people normally do : playing chess, diagnosis a disease, navigating a building … etc

  then build a computer system does is automatically

Acting humanly

To pass the Turing Test, the computer would need:

1. Natural Language Processing → Communication
2. Knowledge Representation →store info before and during interrogation
3. Automated Reasoning→ answer questions and draw new conclusions
4. Machine learning→ adapt to new circumstances

Acting Rationally: rational agent

- Rational behavior: doing the right / best thing
- The right thing: maximize goal achievement, given the available information
- Does not necessarily involve thinking
- Act rationally = reason logically to the conclusion and act on that conclusion

The Rational Agent Approach

- An agent is something that perceives and acts
- A rational agent is one that acts so as to achieve the best outcome

History of AI

- 1940-1950: Early days
  - 1943: Boolean circuit as a model of the brain
  - 1950: Turing's "Computing Machinery and Intelligence"
- 1950—70: Excitement
  - 1950s: Early AI programs, Samuel's checker
  - 1956: "Artificial Intelligence" adopted
  - 1965: Logical reasoning
- 1970—90: Knowledge-based approaches
  - 1969: Development of knowledge-based systems
  - 1980: Expert systems industry booms
  - 1988: Expert systems industry busts
- 1990—: Statistical approaches
  - Probabilitistic reasoning, focus on uncertainty
  - General increase in technical depth /engineering
  - Agents and learning systems… "AI best times"
- 2000—: Advanced A I

AI "old" Languages

- Programming languages best suited to AI tasks are Lisp (1960) and Prolog (1972).
  - PROgramming in LOGic
  - Emphasis on *what* rather than *how*
- There also have been specialized knowledge representation systems and languages, used to develop knowledge bases and knowledge-based systems. This includes expert systems, in which probability and beliefs play an important role.

Prolog's strong and weak points

- Assists thinking in terms of *objects* and *entities*
- *Straight forward translation of logic statements*

Not good for *number manipulation*

- *Aged !!!*
- Useful applications of Prolog in
  - *Expert Systems* (Knowledge Representation and Inferencing)
  - *Natural Language Processing*
  - *Relational Databases*

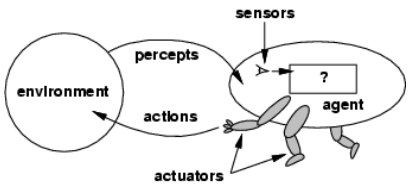
Back to AI

Agent

Agents

- An agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through actuator
- The complete set of inputs at a given time is called a **percept**
- The current percept, or a sequence of percepts can influence the actions of an agent.
- The agent can change the environment through actuators.
- An operation involving an actuator is called an action. Actions can be grouped into action sequences.
- The agent can have goals which it tries to achieve.

Agents and environments



- An agent can be looked upon as a system that implements a mapping from percept sequences to actions

$$[f: \mathcal{P}^* \rightarrow \mathcal{A}]$$

- The agent program runs on the physical architecture to produce *f*
- agent = architecture + program

Examples of Agents

Humans: senses, body parts move

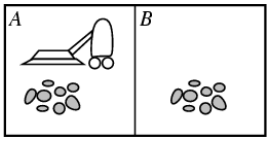
Programs: keyboard, mouse, speakers

Robots: cameras, motors

- An Intelligent Agent must **sense,** must **act,** must be **autonomous** (to some extent), must be **rational**
- A **rational agent** is one that does the right thing

1. What are the functionalities (goals)?
2. What are the components?
3. How do we build them?

Vacuum-cleaner world



- Percepts: location and contents, e.g., [A,Dirty]
- Actions: *Left*, *Right*, *Suck*, *NoOp*
- Agent function: mapping from percepts to actions.

Percept	Action
[A, clean]	Right
[A, dirty]	Suck
[B, clean]	Left
[B, dirty]	Suck

Rational agents

- An agent should strive to "do the right thing", based on what it can perceive and the actions it can perform. The right action is the one that will cause the agent to be most successful
- Performance measure: An objective criterion for success of an agent's behavior
- E.g., performance measure of a vacuum-cleaner agent could be amount of dirt cleaned up, amount of time taken, amount of electricity consumed, amount of noise generated, etc.

Rational agents

- Rational Agent: For each possible percept sequence, a rational agent should select an action that is expected to maximize its performance measure, given the evidence provided by the percept sequence and whatever built-in knowledge the agent has.
- **Rational Action** is the action that maximizes the expected value of the performance measure given the percept sequence .

Bounded Rationality

- Perfect Rationality assumes that the rational agent will take the action that maximizes its utility.
- Human beings do not satisfy this definition of rationality 
- Herbert Simon, 1972 "Because of the limitations of the human mind, humans must use approximate methods to handle many tasks."
- The agent has to select the best action to the best of its knowledge depending on its percept sequence, its background knowledge and its feasible actions.
- Therefore rationality must take into account the limitations of the agent.

Rational vs. Omniscient Agents

- An omniscient agent knows the *actual outcome of its actions and can act accordingly;*
- *omniscience is* impossible in reality
- Our definition of rationality does not require omniscience because the rational choice depends only on the percept sequence to date
- Rationality is distinct from omniscience (all-knowing with infinite knowledge)

learning and autonomy

- Agents can perform actions in order to modify future percepts so as to obtain useful information (information gathering, exploration)
- An agent is autonomous if its behavior is determined by its own experience (with ability to learn and adapt)

Summary of agents kinds

- A **rational** agent is one that does the right thing
- The **omniscience** of an agent knows the *actual outcome assuming infinite knowledge*
- The **autonomy** of an agent is the extent to which its behaviour is determined by its own experience