Chapter 24. Speed Bumps

The Quest for Artificial Intelligence, Nilsson, N. J., 2009.

Lecture Notes on Artificial Intelligence, Spring 2012

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Overview of Chapter 24

- Many researchers had a doubt about the AI
  - Computer cannot do what human brain do
    - Differences between brain and computer
  - Computer do not have Intentionality and Global processes
  - Problem about combinatorial search
- AI's shortcoming
- 1980 - AI winter

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24.1 Opinions from Various Onlookers

24.1.1 The Mind Is Not a Machine

- Human beings are merely very elaborate bits of clockwork, and that our having “minds” is simply a consequence of the fact that the clockwork is very elaborate
- Any machine is merely a product of human ingenuity (in principle nothing more than a shovel), and that though we have minds, we cannot impart that peculiar feature of ours to anything except our offpring: no machine can acquire this uniquely human characteristic.

- Alan Ross Anderso, Minds and Machines,

24.1.2 The Mind Is Not a Computer

- New Physics Is Needed
  - Sir Roger Penrose
    - Computers could never be conscious, nor could they have the full range of human intelligence
    - To escape from the limitation : a new kind of physics must be invoked, “correct quantum gravity”

24.1.2 The Mind Is Not a Computer

- Intentionality Is Needed
  - John Searle
    - Computational processes do not have something humans do have, “intentionality”
    - Intentionality: feature of certain mental states by which they are directed at or about objects and states of affairs in the world, e.g., beliefs, desires, intentions
    - Computational processes lack “aboutness”: they don’t know what their *symbols* are about. (The Chinese Room experiment)

24.1.2 The Mind Is Not a Computer

- Strong and Weak AI
  - Strong AI
    - An appropriately programmed computer could be a mind and could think at least as well as humans do.
    - Searle's article attempts to show that is impossible.
  - Weak (cautious) AI
    - AI use programs as a tool to study the mind by formulating and testing hypotheses about it.

24.1.2 The Mind Is Not a Computer

- "Global Processes" Are Needed
  - Hubert L. Dreyfus' RAND paper (1961)
    - Reasons for AI stagnation
      - "thinking involves global processes, which cannot be understood in terms of a sequence or even a parallel set of discrete steps."
    - Global processes
      - Fringe consciousness
      - Distinguishing the essential from the unessential
      - Global context
      - A combination of these permits "perspicuous grouping"
    - "Brain processed globally the way a resistor analogue solves the problem of the minimal path through a network."
    - The need for "embodiment"
      - Body plays a crucial role in making possible intelligent behavior

24.1.2 The Mind Is Not a Computer

- "Being There" Is Needed
  - Nilsson's opinion
    - Intelligence in humans derives from their "being in the world" and not because they are guided by rules.
    - "Being in the world"
      - Through having a body embedded in the world
      - "What we experience is significant for us"
      - Dynamic interactions between parts of its body and its environment
    - Not because rules
      - The use of rules in AI programs might allow competent behavior but not expert behavior

24.1.3 Differences between Brains and Computers

Criteria	Computers	Brains
Number of processing units	Hundreds	Trillions
Operations per second	Billions	Thousands
With fault	Crash	Fault tolerant
Kinds of signals	Binary	Analog
Task	Only programmed	Can creative
Information processing	Serial operations	Massively parallel
Constrain	Logical	Intuitive
Learning	Cannot learn (Just programmed)	Can learn

24.1.4 But Should We?

- Should not do
  - The inappropriateness of machines attempting to perform tasks that are inherently human-centric, such as teaching, counseling and rendering judicial opinions.
- Joseph Weizenbaum
  - The dangers of giving computers responsibilities that he thought ought best be left to humans
- “Notes of a Biology-Watcher” (Lewis Thomas)
  - “The most profoundly depressing of all ideas about the future of the human species is the concept of artificial intelligence”

24.1.5 Other Opinions

- Donald Knuth
  - “I'm intrigued that AI has by now succeeded in doing essentially everything that requires “thinking" but has failed to do most of what people and animals do “without thinking“- that, somehow, is much harder! I believe the knowledge gained while building AI programs is more important than the use of the programs.”
- John R. Pierce
  - “Artificial intelligence is real stupidity.“
- Edsger W. Dijkstra
  - To the artificial intelligentsia that argue “But we are only symbol manipulating machines, aren't we?" one can only answer “There is none so blind as them that won't see!" The analogy is so shallow that I can characterize an appeal to it only as typically medieval thinking

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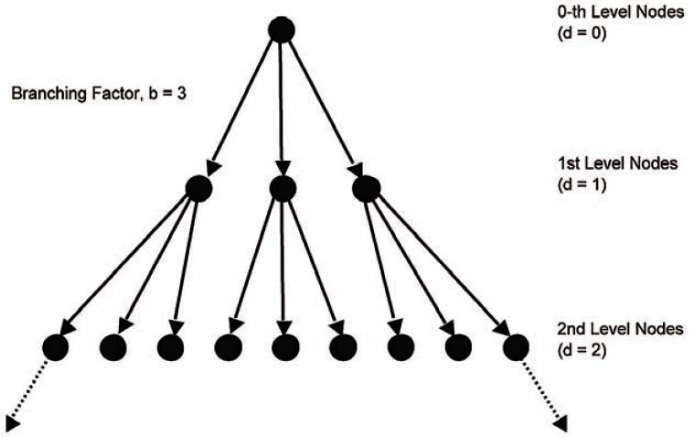
24.2 Problems of Scale

24.2.1 The Combinatorial Explosion

- Search plays such a prominent role in AI
- The total number of nodes
  - $\frac{b}{(b-1)}\left(b^d - 1\right), (b: branching\ factor, the\ d^{th}\ level)$
  - It's an "exponential" function or "combinatorial explosion"
- The difficulty of that search
  - Computing time
  - Storage space



24.2.2 Complexity Theory

- "Complexity theory"
  - How does the size of a problem affect the time and space required to solve it?
- Some examples
  - To find the largest number in a list: linear complexity
  - Sorting: polynomial complexity
  - The search procedures in AI: exponential complexity
- AI problems (a sliding tile puzzle) belong to the class NP

24.2.3 A Sober Assessment

- The results in complexity theory caused some people to have grave doubts about the AI
- “The Limits of Artificial Intelligence” (Schwartz)
  - The human brain used its prodigious computational and storage abilities “to organize information presented in relatively disordered form into internally organized structures on which sophisticated, coherent courses of symbolic and real-world action can be based”
  - Computer can deal with “fully structured material”
- AI researchers quickly recovered and found various ways around the combinatorial explosion problem
  - Richard Korf’s the sliding tile problem

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24.3 Acknowledged Shortcomings

AI's shortcomings

- In proving nontrivial math theorems
  - Humans are able to do it from intuition, experience, but computers cannot.
- In chess game playing
  - David Levy defeated the reigning Computer Chess Champion, CHESS 4.7,
  - Computer might look farther ahead than human but human follows the important branch in the prediction tree and more strategic.
- In Expert systems
  - The computers reason usefully
  - But they are brittle when confronted with problems outside their area or they have no provide examples.
  - They don't know what they don't know. ex) MYCIN accepted the male amniocentesis.
  - One reason that is the lack of common sense.
    - "Commonsense knowledge is knowledge about the structure of the external world that is acquired and applied without concentrated effort by any normal human that allows him or her to meet the everyday demands of the physical, spatial, temporal and social environment with a reasonable degree of success."

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24.4 The “AI Winter”

AI winter

- During the early 1980
  - AI sponsors were gone disappointed in there are no application and not well performing.
  - Many of companies closed and AAAI membership gradually fell down.
  - DARPA’s budget for AI fell from 47 to 31 million.