

Artificial Intelligence

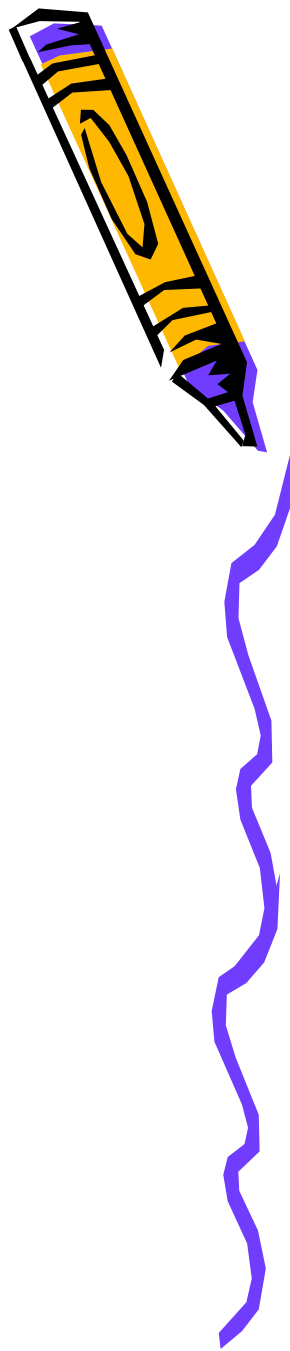
An Introduction

Russell and Norvig

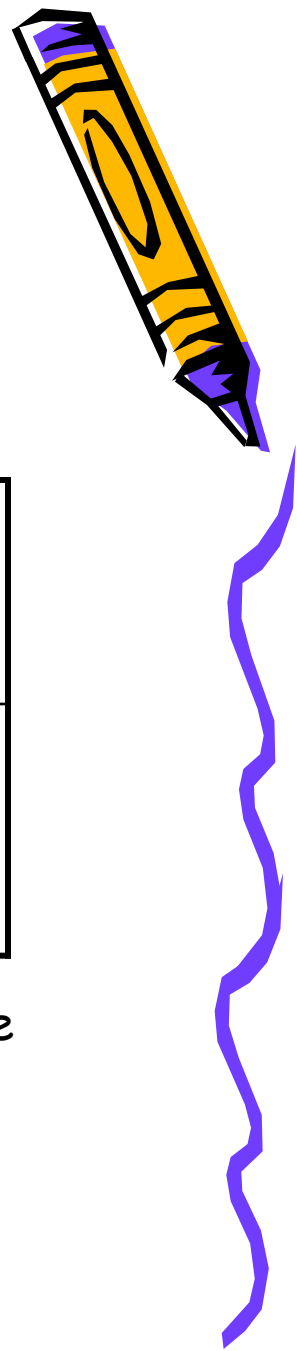


Outline

- Definition of AI
- AI history



What is AI



Thought
process and
reasoning

Systems that
think like humans

Systems that
think rationally

Behavior

Systems that act
like humans

Systems that act
rationally

Human performance

Ideal concept of intelligence



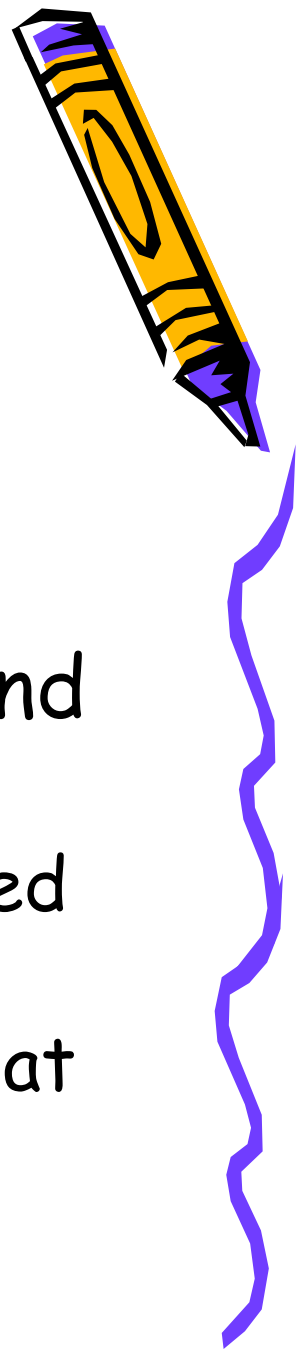
Thinking humanly: Cognitive Modeling



- Cognitive Modeling is a interdisciplinary field bringing together computer models from AI and experimental technologies from psychology.
- 1960s "cognitive revolution": requires scientific theories of internal activities of the brain
 - What level of abstraction?
 - How to validate?
 - Top-down: predicting and testing behavior of human subject.
 - Bottom-up: direct identifying from neurological data.
- Share with AI
 - The available theories do not explain anything resembling human-level general intelligence.



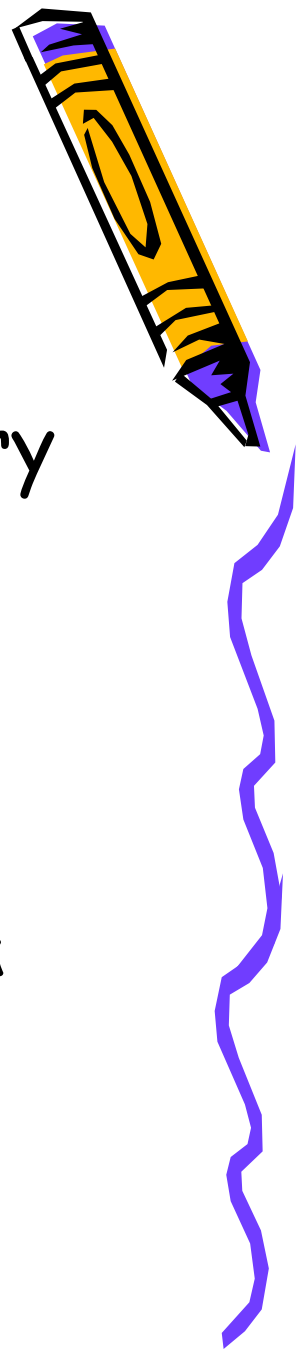
Thinking rationally: Laws of Thought (right thinking)



- Aristotle: what are correct arguments/thought processes?
- Direct line through mathematics and philosophy to AI
 - Not all intelligent behavior is mediated by logical deliberation.
 - What is the purpose of thinking? What thoughts should I have?



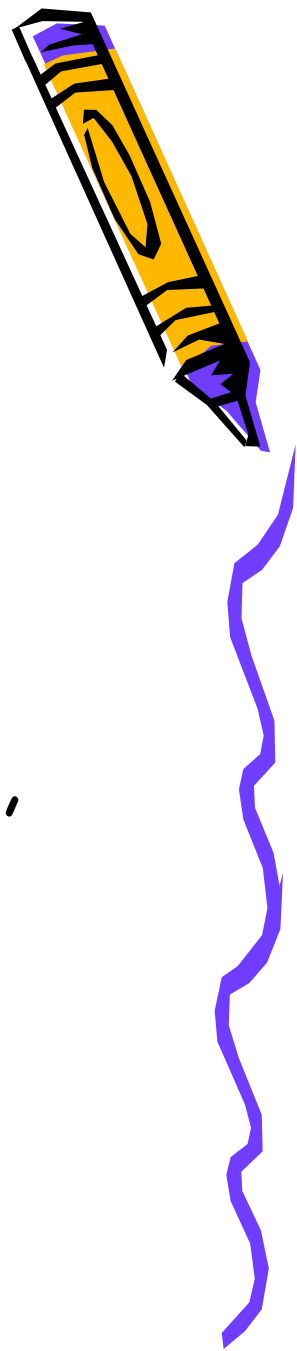
Acting humanly: The Turing Test Approach



- Turing (1950) "computing machinery and intelligence" (ch 26)
 - Operational test for intelligent behavior.
 - Predicted that by 2000, a machine might have a 30% chance of fooling a person for 5 minutes.



Acting rationally: Rational Agent

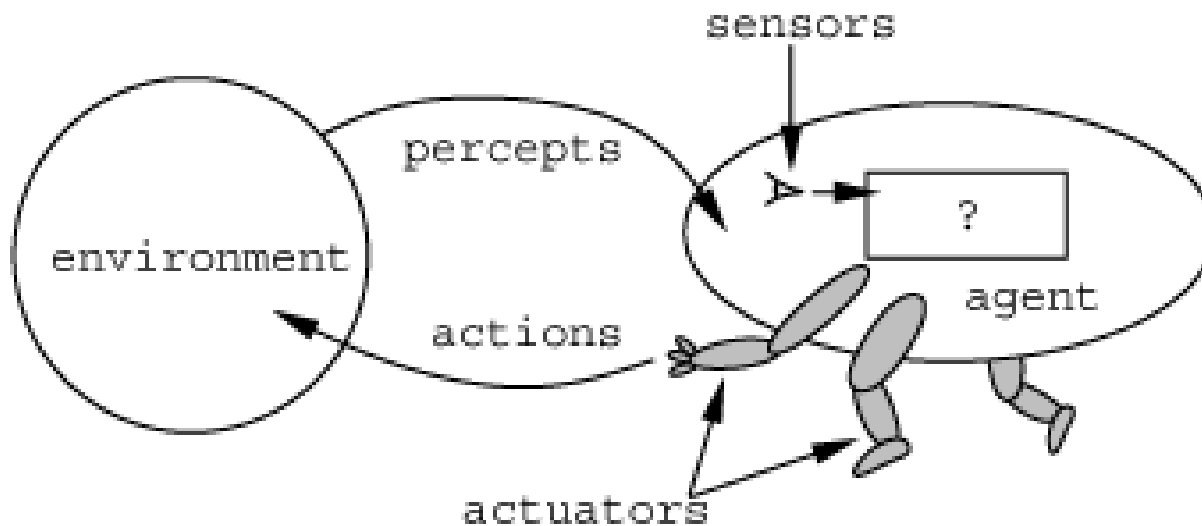


- Rational behavior: doing the **right** thing.
- The right thing: that which is expected to max goal achievement, given the available information.
- Watch example.



Rational Agents

- An agent is an entity that perceives and acts.



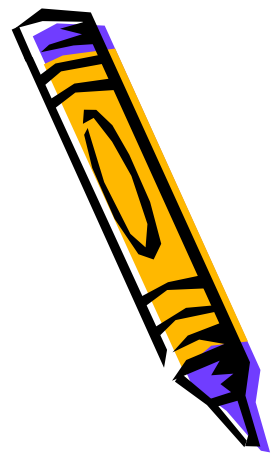
AI prehistory



- Philosophy: logic, methods of reasoning mind as physical system, foundations of learning, language, rationality
- Mathematics: formal representation and proof algorithms, computation, decidability, probability....
- Psychology: adaptation, phenomena of perception and motor control experimental techniques....
- Economics: formal theory of rational decisions.
- Linguistics: knowledge representation, grammar.
- Neuroscience: plastic physical substrate for mental activity
- Control theory: homeostatic systems, stability....



History of AI (I)

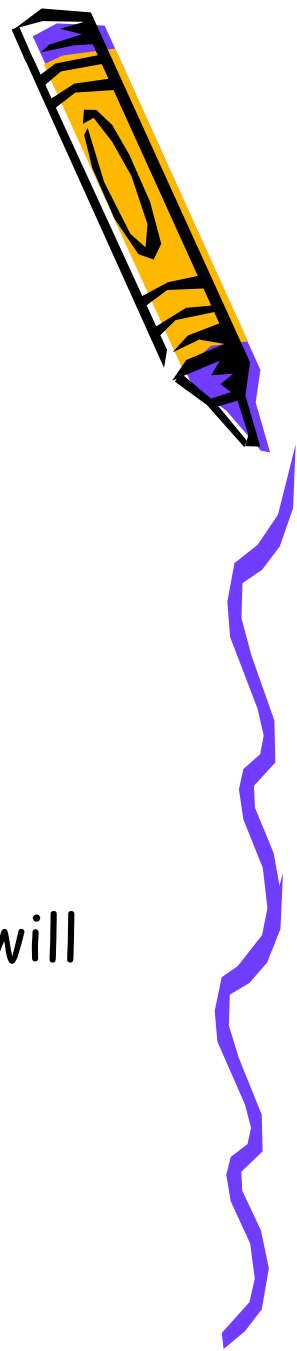


- Gestation (1943-1955)
 - McCulloch & Pitts (1943): boolean circuit model of brain.
 - Minsky & Edmonds (1950): first neural network computer.
 - Turing (1950): "Computing Machinery and Intelligence".

Any computable function could be computed by a neuron network connected by logic connectives.



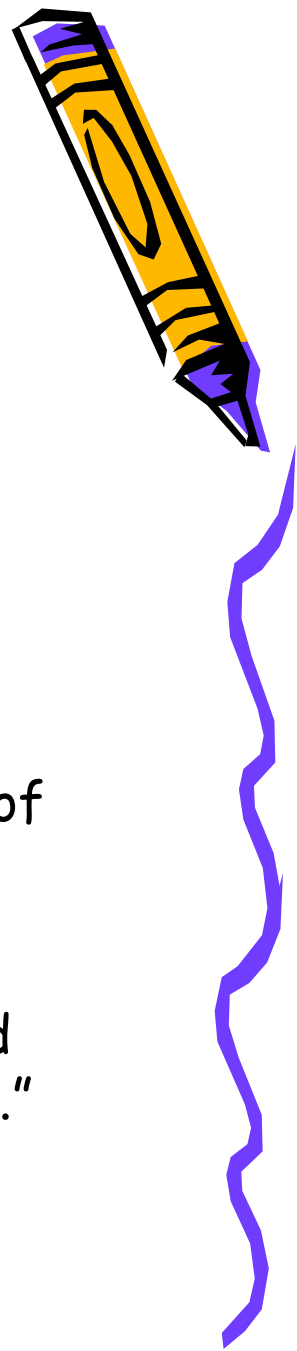
History of AI (II)



- Birth (1956)
 - Dartmouth workshop - John McCarthy
 - Minsky, Shannon, Rochester, More, Samuel, Solomonoff, Selfridge, Newell and Simon.
 - AI from the start embraced the idea of duplicating human faculties.
 - AI is the only field to build machines that will function autonomously in complex, changing environment.



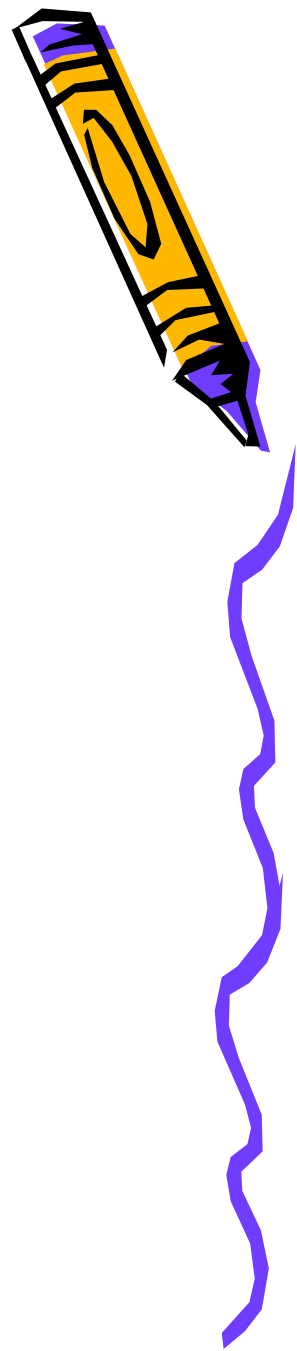
History of AI (III)



- Early enthusiasm, great expectations (1952-1969)
 - Samuel's checker program (1952).
 - Newell & Simon's Logic Theorist (1956).
 - "We have invented a computer program capable of thinking non-numerically."
 - Physical Symbol System (1976)
 - "A physical symbol system has the necessary and sufficient means for general intelligence actions."



Early enthusiasm, great expectations (cont.)



- McCarthy (1958)
 - Lisp
 - "Programs with Common Sense."
 - Advice Taker - first complete AI system.
 - Knowledge Representation and Reasoning.



Early enthusiasm, great expectations (cond.)



- Minsky (1958)
 - Microworlds - block world

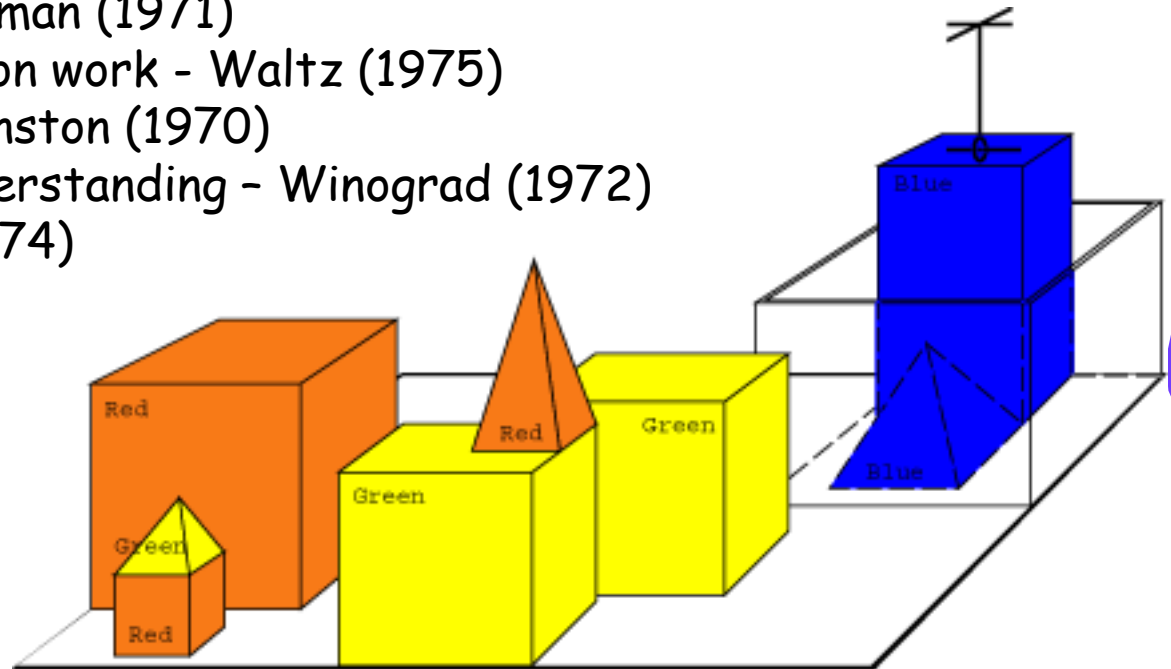
Vision project - Huffman (1971)

Constraint-propagation work - Waltz (1975)

Learning theory - Winston (1970)

Natural language understanding - Winograd (1972)

Planner - Fahlman (1974)



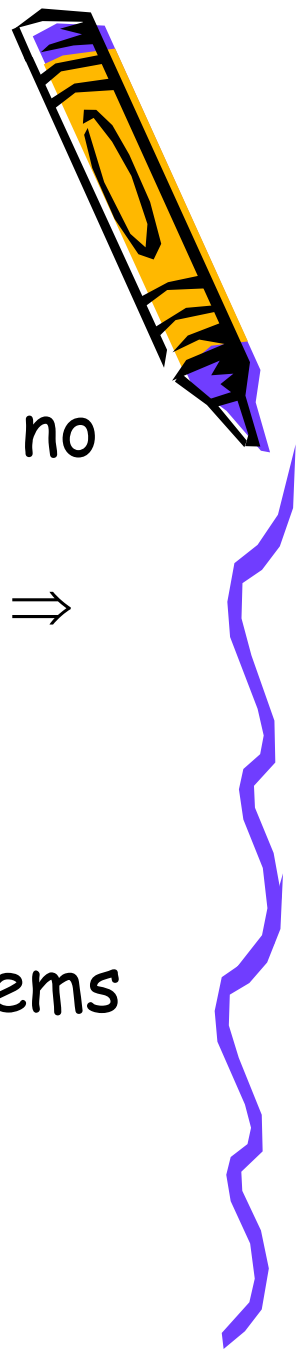
History of AI (IV)



- A dose of reality (1966-1973)
 - AI discovers computational complexity.
 - Neural network research almost disappears.
 - Simon (1957)
 - "It is not my aim to surprise or shock you - but the simplest way I can summarize is to say that there are now in the world machines that think, that learn and that create. Moreover, their ability to do these things is going to increase rapidly until - in a visible future - the range of problems they can handle will be coextensive with the range to which the human mind has been applied."



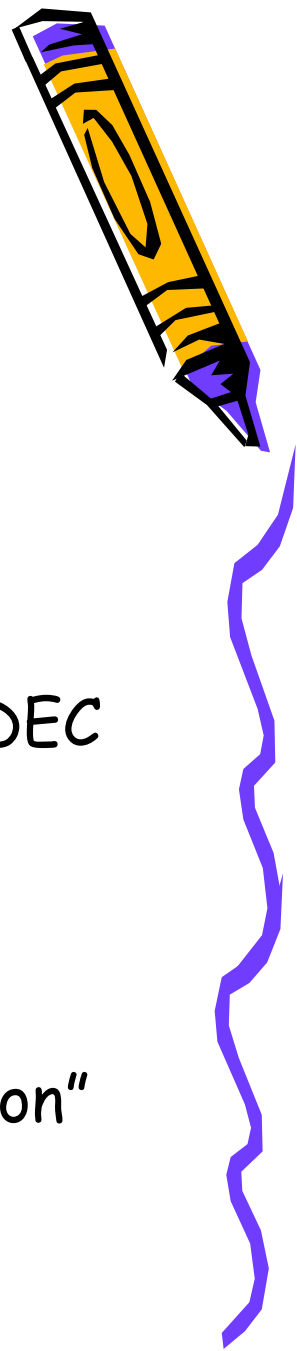
A dose of reality (cont.)



- Most early programs contained little or no knowledge of their subject matter.
 - "The spirit is willing but the flesh is weak." \Rightarrow "The vodka is good but the meat is rotten."
 - "There has been no machine translation of general scientific text, and none is in immediate prospect. (1966)"
- The intractability of many of the problems that AI was attempting to solve.



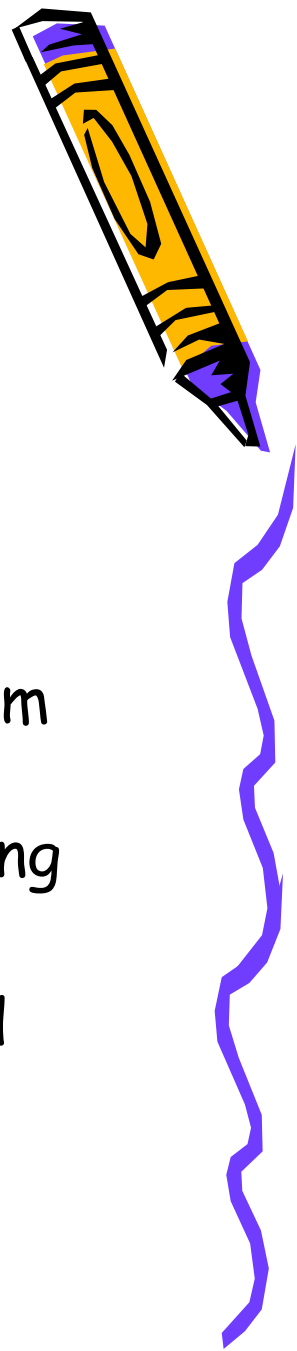
History of AI (V)



- AI becomes an industry (1980-present)
 - Expert system
 - R1 - first commercial expert system at DEC (1982). It was saving the company \$40M/year.
 - DuPont had 100 in use and 500 in development; saving \$10M/year.
 - Japanese announced the "Fifth Generation" project (1981).



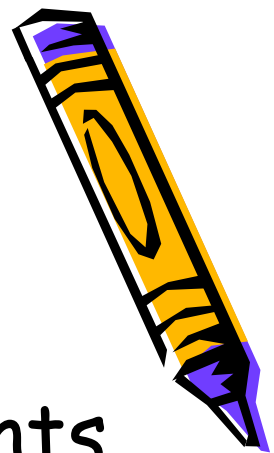
History of AI (VI)



- The return of neural networks (1986-present)
- AI becomes a science (1987-present)
 - Machine learning should not be isolated from information theory.
 - Uncertainty reasoning \Leftrightarrow stochastic modeling
 - Search \Leftrightarrow optimization theory
 - Automated reasoning \Leftrightarrow formal method and static analysis.



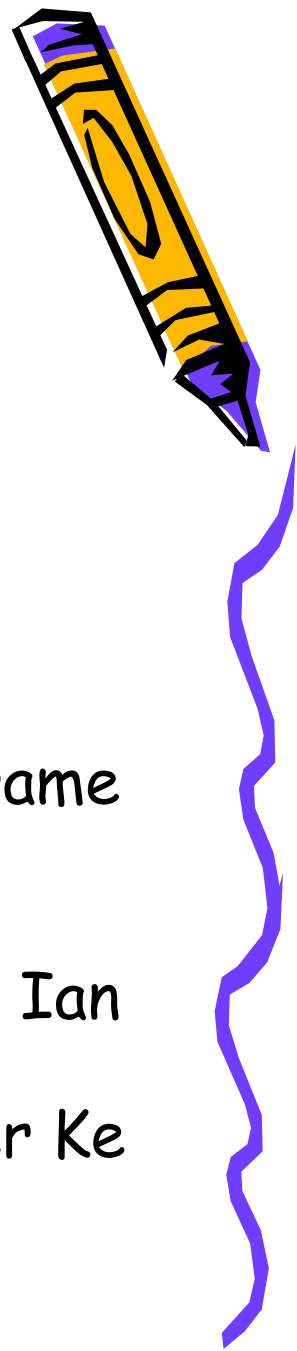
History of AI (VII)



- The emergence of Intelligent Agents (1995-present)
 - Realizing that the previously isolated subfields of AI might need to be reorganized when their results are to be tied together.
 - AI has been drawn into much closer contact with other fields, such as control theory and economics, that also deal with agents.



State of the Art



- 1997: Deep Blue defeated the reigning world chess champion Garry Kasparov.
- 2002: Roomba, an autonomous robot for room cleaning.
- 2006: Deep Learning, Geoffrey Hinton at the University of Toronto.
- 2009: Autopilot car, Tesla, Google.
- 2011: IBM Watson defeats champions of US game show Jeopardy.
- 2011-14: Siri (Apple).
- 2014: Generative Adversarial Network (GAN), Ian Goodfellow, Apple.
- 2017: Alpha Go beats world champion Go Player Ke Jie.
- 2022: OpenAI - ChatGPT
- 2025: DeepSeek - light GPT.



An unintentionally funny story



- One day Joe Bear was hungry. He asked his friend Irving Bird where some honey was. Irving told him there was a beehive in the oak tree. Joe threatened to hit Irving if he didn't tell him where some honey was. (The end.)

