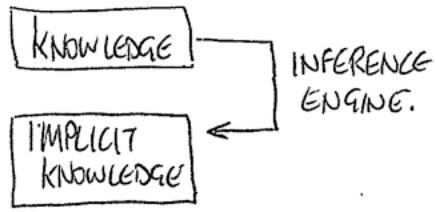
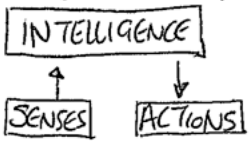


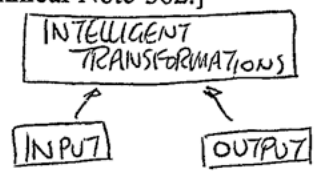
ARTIFICIAL INTELLIGENCE

THE SITUATED AUTOMATON DEFINITION

In the current view, the machine is regarded as knowing a fact if its state either explicitly encodes the fact as a sentence of an interpreted formal language or if such a sentence can be derived from other encoded sentences according to the rules of an appropriate logical system. We contrast this conception, the interpreted-symbolic-struucture approach, with another, the situated-automata approach, which seeks to analyze knowledge in terms of relations between the state of a machine and the state of its environment over time using logic as a metalanguage in which the analysis is carried out.

[Rosenschein, *Formal Theories of Knowledge in AI and Robotics*, SRI International, Technical Note 362.]





ROBOTICS

AN ARTIFICIAL INTELLIGENCE DEFINITION

Robotics is that field concerned with the connection of perception to action. Artificial Intelligence must have a central role in Robotics if the connection is to be intelligent. Artificial Intelligence addresses the crucial questions of:

* what knowledge is required in any aspect of thinking;
* how that knowledge should be represented;
* and how that knowledge should be used.

Robotics challenges AI by forcing it to deal with real objects in the real world. Techniques and representations developed for purely cognitive problems, often in toy domains, do not necessarily extend to meet that challenge.

[M. Brady, *Artificial Intellgence and Robotics*, in *Robotics and Artificial Intelligence*, NATO ASI Series, Vol F11, eds Brady, Gerhardt, and Davidson, Springer-Verlag, 1984.]

"ROBOT" INPUT: A/D CONVERTORS, CAMERAS

OUTPUT: AMPLIFIERS, ELETRIC MOTORS

ROBOTICS

AN ARTIFICIAL INTELLIGENCE DEFINITION

The fundamental technical problem in robotics is goal-seeking, i.e., the generation and control of behaviour that is successful in accomplishing a task or goal. In contrast to artificial intelligence, robotics is not primarily concerned with recognizing, classifying, naming, or understanding -- except in so far as these are required to to achieve behavioural goals. The purpose of a robot control system is to accomplish commanded tasks. The purpose of sensors and sensory processing is to detect the state of the environment ... This implies among other things that the processing of sensory data must be done in the context of the control problem.

[J.S Albus, *Robotics*, in *Robotics and Artificial Intelligence*, eds Brady, Gerhardt, and Davidson, NATO ASI Series, Vol F11, Springer-Verlag, 1984.]

see over

ARTIFICIAL INTELLIGENCE

IS SOMETHING MISSING?

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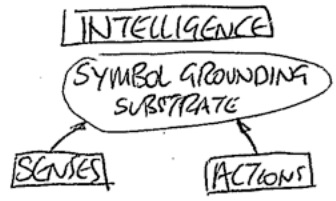
... it seems to me that something fundamental is missing in the orthodox AI "information processing" model of cognition, and that is some sort of substrate from which intelligence emerges as an epiphenomenon.

[D.R. Hofstadter, *Waking Up from the Boolean Dream,* Metamagical Themas, 1985, p643 in Penguin 1986 edition.]



ARTIFICIAL INTELLIGENCE

IS SOMETHING MISSING?

Although you can get a lot of clever performance by building in purely symbolic "knowledge," and although it had seemed so promising that symbol-strings could be interpreted as thoughts, beliefs, and mental propositions, I have argued that a mere extension of this modular "top-down" approach, hooking up eventually with peripheral modules, simply won't succeed in the long run ... because of the [symbol] grounding problem ...

We were persuaded by the power of computation -- Turing equivalence and all that -- to suppose that computation (symbol-crunching) just might *be* cognition. If every (discrete) thing anyone or anything (including the mind) does is computationally simulable, then maybe the computational functions capture the mental functions? But the fact that something is computationally simulable does not entail that it is implemented computationally (any more than behavior that is *describable* as ruleful is necessarily following an explicit rule). And some functions (such as transduction and causality) cannot be implemented computationally at all.

[Stevan Harnad, in a network discussion of his book, *Categorical Perception,* Cambridge University Press, 1987]

ARTIFICIAL INTELLIGENCE

IS SOMETHING MISSING?

I suspect much current AI work will in hindsight appear to have been chasing details of epicycles. Current models for AI are based on concepts of knowledge and belief and symbol processing systems. I claim that all such things are concepts invented by observers of intelligent systems to explain them. The intelligent systems themselves do not work like that. .... I believe AI will progress significantly only when the fundamental underlying model being used moves towards process and away from state.

[R.A. Brooks, *Achieving Artificial Intelligence through Building Robots,* MIT AI Memo 899, 1986.]

ARTIFICIAL INTELLIGENCE

ITS HISTORY AND FUTURE

(MORAVEC'S VIEW)

During the late 1950s and early 1960s programs were written that proved theorems in geometry and logic, solved problems in algebra, calculus, and wider domains, gave creditable performance in intellectual games, exhibited learning, and in general functioned near the epitome of human thought, doing things that only some humans could do well, and no other creatures could do at all. These pioneering programs were almost exclusively in carefully hand-optimized machine language and typically ran in 32K words at 10K instructions/sec, on machines like the IBM 605 and 704.

...

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In the late 1960s the new centers, running largely on the optimism and momentum from the first generation of intelligent programs and their own succesful system-building startups, attempted major integrations. Reasoning systems were applied to practical problems, and whole robot systems, preceded by great promises, were built up using the none-too-reliable methods of the previous work. The promises greatly exceeded the results. The high level reasoners continued to hover at amateur adult level in narrow areas, while the robot systems ... almost never worked at all. By the early 1970s there were hints of pessimism and cynicism. This negative spirit was made official in 1972 by the report of a British Government commission [as a consequence of which UK funding of AI research was severely reduced], and in 1974 when ARPA, almost the sole source of funding for this work in the USA, announced large cutbacks for the major centers.

...

The intelligent machine effort has produced computer programs that exhibit narrow reasoning abilities at the performance level of amateur adult humans and perceptual and motor skills on a par with a grasshopper. The level of research on the two areas is the same. Why do the low level skills seem so much harder than the high level ones?

The human evolutionary record provides the clue. While our sensory and muscle control systems have been in development for a billion years, and common sense reasoning has been honed for probably about a million, really high level, deep, thinking is little more than a parlor trick, culturally developed over a few thousand years, which a few humans, operating largely against their natures, can learn. As with Samuel Johnson's dancing dog, what is amazing is not how well it is done, but that it is done at all.

...

Computers do not challenge humans in perceptual and control areas because these billion year old functions are carried out by large fractions of the nervous system ... present day computers ... are too puny ... Evidence comes from the most extensive piece of reverse engineering yet done on the vertebrate brain, the functional decoding of some of the visual system by D.H. Hubel, T.N. Weisel, and colleagues ... The visual system in humans occupies 10% of the brain. ... The computer [of today] is thus 100,000 times too slow to mimic the human visual system.

...

I argue that the most fruitful direction for this track [the development of artificial intelligence] is along the oxtrail forged by natural evolution before stumbling on us. ... It is my view that developing a responsive mobile entity is the surest way to approach the problem of general intelligence in machines.

The argument hinges on the observation made earlier that instinctive skills are much better developed in humans than high level thinking, and are thus the difficult part of the human emulation problem. ... I guess that amateur quality high level thinking can be done by an efficiently organised system doing 10E8 ips while average quality perception and action requires 10E11. Master quality high level thinking by people may happen when parts of the task are mapped into the highly computationally efficient perceptual or motor parts of the brain (enabling solutions to be seen or felt?), and such expert performance should be intermediate in difficulty between the 10E11 of low level and the 10E8 ips of routine high level thought.

...

The smallest vertebrates, shrews and humming birds, derive interesting behavior from nervous systems 1/10,000th the size of a human's ... by my calculations and impressions present robot control systems are similar in power to the control systems of insects.

[Hans Moravec, *Locomotion, Vision, and Intelligence,* in *Robotics Research 1,* eds Brady and Paul, MIT Press, 1984.]