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COVER PHOTOGRAPH BY WEBB CHAPPELL
Deep Blue's victory over Gary Kasparov may have been entertaining, but contrary to popular belief, it tells us nothing about the future of artificial intelligence. What's needed is a more creative test of mind versus machine.

Chess Is Too Easy

BY SELMER BRINGSJORD

Computer science is of two minds about artificial intelligence (AI). Some computer scientists believe in so-called "Strong" AI, which holds that all human thought is completely algorithmic, that is, it can be broken down into a series of mathematical operations. What logically follows, they contend, is that AI engineers will eventually replicate the human mind and create a genuinely self-conscious robot replete with feelings and emotions. Others embrace "Weak" AI, the notion that human thought can only be simulated in a computational
BRUTUS. 1's SYSTEM ARCHITECTURE

Inside the Mind of a Storytelling Machine

STORY GENERATION

device. If they are right, future robots may exhibit much of the behavior of persons, but none of these robots will ever be a person; their inner life will be as empty as a rock's.

Past predictions by advocates of Strong and Weak Al have done little to move the debate forward. For example, Herbert Simon, professor of psychology at Carnegie Mellon University, perhaps the first and most vigorous adherent of Strong Al, predicted four decades ago that machines with minds were imminent. "It is not my aim to surprise or shock you," he said. "But the simplest way I can summarize is to say that there are now in the world machines that think, that learn and 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."

On the other side of the equation, Hubert Dreyfus, a philosophy professor at Berkeley, bet the farm two decades ago that symbol-crunching computers would never even approach the problem-solving abilities of human beings, let

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The victory last spring by IBM's Deep Blue computer over the world's greatest human chess player, Gary Kasparov, obliterated Dreyfus's prediction. But does it also argue for Strong rather than Weak AI? Kasparov himself seems to think so.

To the delight of Strong AI supporters, Kasparov declared in *Time* last March that he “sensed a new kind of intelligence” fighting against him.

Moreover, the well-known philosopher Daniel Dennett of Tufts University would not find such a reaction hyperbolic in light of Deep Blue's triumph. Ever the arch-defender of Strong AI, Dennett believes that consciousness is at its core algorithmic, and that AI is rapidly reducing consciousness to computation.

But in their exultation, Kasparov, Dennett, and others who believe that Deep Blue lends credence to Strong AI are overlooking one important fact: from a purely logical perspective chess is remarkably easy. Indeed, as has long been known, invincible chess can theoretically be played by a mindless system, as long as it follows an algorithm that traces out the consequences of each possible move until either a mate or draw position is found.

Of course, while this algorithm is painfully simple (undergraduates in computer science routinely learn it), it is computationally complex. In fact, if we assume an average of about 32 options per play, this yields a thousand options for each full move (a move is a play by one side followed by a play in response). Hence, looking ahead five moves yields a quadrillion (10^15) possibilities. Looking ahead 40 moves, the length of a typical game, would involve 10^120 possibilities. Deep Blue, which examines more than 100 million positions per second, would take nearly 10^112 seconds, or about 10^104 years to examine every move. By comparison, there have been fewer than 10^18 seconds since the beginning of the universe, and the consensus among computer-chess cognoscenti is that our sun will expire before even tomorrow's supercomputers can carry out such an exhaustive search.

But what if a computer can look very far ahead (powered, say, by the algorithm known as alpha-beta minimax search, Deep Blue's main strategy), as opposed to all the way? And what if it could combine this processing horsepower with a pinch of knowledge of some basic principles of chess—for example, those involving king safety, which, incidentally, were installed in Deep Blue just before its match with Kasparov? The answer, as Deep Blue resoundingly showed, is that a machine so armed can best even the very best human chess player.

**CREATIVITY EX MACHINA?**

But the kind of thinking that goes into chess, stacked against the full power and range of the human mind, is far from the whole story. Nineteenth century mathematician Ada Byron, known as Lady Lovelace, was perhaps the first to suggest that creativity is the essential difference between mind and machine—the defining essence that goes beyond what even the most sophisticated algorithm can accomplish.

Lovelace argued that computing machines, such as that contrived by her contemporary, Charles Babbage, can't create anything, for creation requires, minimally, originating something. Computers can originate nothing; they can merely do that which we order them, via programs, to do.

A century later Alan Turing, the grandfather of both AI and computer science, responded to Lady Lovelace's objection by inventing the now-famous Turing Test, which a computer passes if it can fool a human into thinking that it is a human. Unfortunately, while chess is too easy, the Turing Test is still far too difficult for today's computers. For example, deception—which a potent computer player in the Turing Test should
Betrayal

Dave Striver loved the university. He loved its ivy-covered clock towers, its ancient and sturdy brick, and its sun-splashed verdant greens and eager youth. He also loved the fact that the university is free of the stark unforgiving trials of the business world—only this isn’t a fact: academia has its own tests, and some are as merciless as any in the marketplace. A prime example is the dissertation defense: to earn the PhD, to become a doctor, one must pass an oral examination on one’s dissertation. This was a test Professor Edward Hart enjoyed giving.

Dave wanted desperately to be a doctor. But he needed the signatures of three people on the first page of his dissertation, the priceless inscriptions which, together, would certify that he had passed his defense. One of the signatures had to come from Professor Hart, and Hart had often said—to others and to himself—that he was honored to help Dave secure his well-earned dream.

The Matematization of Betrayal

To enable Brutus1 to write the short short story "Betrayal," David Ferrucci and I devised a mathematical definition of the concept of betrayal and programmed it into Brutus1 using Prolog and a logic-programming language called Flex. We also gave Brutus1 knowledge of "story grammars," essentially time-honored plot structures that all good authors know by heart, and "literary grammars," which attempts to capture the logical structure and sound of creative prose. While the exact specification of the betrayal as it is expressed in Brutus1 is too esoteric to reproduce here, we can give you a sense of what these specifications are, based on the logic statements illustrated below.

Agent B betrays agent A

IF AND ONLY IF there exists some state of affairs p such that

1. A wants p to occur;

2. B believes that A wants p to occur;

3. Either
   1. B agrees with A that p ought to occur and A wants some action a that B performs in the belief that p will thereby occur
   2. A wants no action a that B performs in the belief that p will thereby not occur;

4. There is some action a such that:

5. B believes that A believes that there is some action a that B will perform in the belief that p will thereby occur.

II. There exists no state of affairs q such that q is believed by B to be good for A and B performs a in the belief that q will not occur; AND Finally
Brutus I is capable of writing short short stories based on the notion of betrayal. But to adapt Brutus I to play well in a short story game, he would have to understand not only betrayal, but other great literary themes as well—unrequited love, jealousy, patricide, and so on. cannot tell which response is coming from the mechanical muse and which is from the human, we say that the machine has won the game.

How will future machines fare in such a game? I think the length of the story is a key variable. A story game pitting mind against machine in which the length and complexity of the narrative is open-ended would certainly seal the machine's defeat for centuries to come. Though advocates of Strong AI would hold that a machine could eventually prevail in a contest to see whether mind or machine could produce a better novel, even they would agree that trying to build such a machine today is unthinkable. The task would be so hard that no one would even know where to begin.

In short, though the Turing test is, as noted, too hard to provide the format for mind-machine competition at present, many people think they can imagine a near future when a machine will hold its own in this test. When it comes to the unrestricted story game, however, such a future simply can't be conceived. We can of course imagine a future in which a computer prints out a novel—but we can't imagine the algorithms that would be in operation behind the scenes.

So, just to give Strong AI supporters a fighting chance, I would restrict the competition to the shortest of short stories, say, less than 500 words in length. This version of the game should prove a tempting challenge to Strong AI engineers. And, like the full version, it demands creativity from those—mind or machine—who would play it.

How then might future machines stack up against human authors when each is given that one sentence as the jumping-off point toward a short short story?

I may not be positioned badly to make predictions. With help from the Luce Foundation, Apple Computer, IBM, Rensselaer Polytechnic Institute (RPI), and the National Science Foundation, I have spent the past seven years (and about three-quarters of a million dollars) working with a number of researchers—most prominently Marie Meteer, a scientist at Bolt, Beranek and Newman; David Porush, a professor at RPI; and David Ferrucci, a senior scientist at IBM's T.J. Watson Research Center—to build a formidable artificial author of short short stories.

Part of what drives me and other researchers in the quest to create such synthetic Prousts, Joycees, and Kafkases is a belief that genuinely intelligent stand-alone entertainment systems of the future will require, among other things, AI systems that know how to create and direct stories. In the
To tell
a truly compelling
story, a machine would
need to understand
the 'inner lives' of its
characters. And to do
that, it would need
not only to think
mechanically
in the sense of swift
calculation, but
experimentally in
the sense of having
awareness.

ski on the edge, or need
a good night's sleep. But
any such example, I
claim, will demand
capabilities no machine
will ever have.

Renowned human
storytellers understand
this concept. For ex-
ample, playwright Henrik
Ibsen said: "I have to
have the character in
mind through and
through, I must pene-
trate into the last wrin-
kle of his soul." Such a
modus operandi is for-
ever closed off to a
machine.

Supporters of Strong
AI, should they strive to
build a machine that is
able to prevail in the
short short story game,
must therefore strive to
build precisely what
distinguishes Strong
from Weak AI: a con-
scious machine. Yet in
striving for such a machine, Strong AI researchers are wait-
ing for a culmination that will forever be arriving, never
present.

Believers in Weak AI, like myself, will seek to engineer sys-
tems that, lacking Ibsen's capacity to look out through the
eyes of another, will create richly drawn characters. But
though I expect to make headway, I expect that, unlike chess
playing, first-rate storytelling, even at the humble length of
short short stories, will always be the sole province of
human masters.

Still, I'll continue with the last three years of my project,
largely because I expect to have a lot of fun, as well as to be
able to say with some authority that machines can't be cre-
ative and conscious (seeing as how I'm using state-of-the-art
techniques), and to produce working systems that will have
considerable scientific and economic value.

Kasparov no doubt will return soon for another round of
chess with Deep Blue or its descendants, and he may well
win. In fact, I suspect it will be another 10 years before
machine chess players defeat grand masters in tournament
after tournament. Soon enough, however, Kasparov and
those who take his throne will invariably lose.

But such is not the case when we consider the chances of
those who would seek to humble not only great chess play-
ers, but great authors. I don't believe that John Updike or his
successors will ever find themselves in the thick of a story-
telling game, sweating under lights as bright and hot as those
that shone down on Gary Kasparov.