*technical*opinion

Thoughts on Deep Blue vs. Kasparov

The result of the much-publicized tournament between IBM's Deep Blue and Garry Kasparov, the World Chess Champion, was Deep Blue with 1 win, 3 loses, and 2 draws.

With a bit more power, perhaps the machine might win the title within a year or two. This year coincides with ACM's 50th anniversary, and it has been 40 years since the name artificial intelligence (AI) was coined at the Dartmouth conference.

Since the beginning of AI, chess has been a popular topic in the field, and people speculated for a long time that the computer might defeat the world chess champion within 10 years. Several decades have passed since then, and it has still not happened. But now that day seems to be right around the corner.

What is the significance of this close match between the human champion and the machine? On the surface, it is a competition between human and machine intelligence. One popular notion of AI is that it mimics human intelligence and has the potential to eventually surpass it. When the machine beats the human, people might say that AI finally surpassed the human, at least in chess playing. The implication is not that simple, however. Although we cannot simply extend an event in one particular topic to every domain of AI, one macroscopic perspective may be to look at this event in terms of the complexity level of computation and understand the current status of the machine.

Apparently, the complexity levels of machine and human are different. Simple tasks for the human are not necessarily simple for the machine and vice versa.

To streamline our discussion, we will over-simplify the complexity of the machine levels to I, II, and III. At the simplest level, I, we have arithmetic computations such as 2 + 2 = 4, followed by a simple spelling check by a word processor, straightforward database retrieval, and so forth. Symbolically integrating $sin^2x\ e^{-x}$ would be at the high end of this level. The computer has been superior to the human at this level. Many current "intelligent" applications in everyday use are essentially at similar states to sym-

bolic integration. That is, they are at the high end of the simplest level. Their computation processes may not necessarily be elegant, but they are well defined, and the machine performs the processes with incredibly fast speed. If we find newer application domains at this complexity level, the chances for successful real-world applications are high.

Chess playing would be at the second complexity level, II. The problem domain is well defined and relatively small, but it is complex enough that the machine has a much harder time beating the human than it does at the simplest level. It is noteworthy to observe the basic strategy of Deep Blue; the machine is not designed to imitate the human. The machine is still far behind the human's comprehensive abilities such as intuition, memory, pattern recognition, and more advanced levels of intelligent activities such as creativity. Since there is no single accurate phrase to represent these human comprehensive abilities, commonsense is often used. Deep Blue is designed to take advantage of its difference from a human opponent. It relies on computational power. For instance, it can search 50- to 100-billion positions within three minutes, the time allotted for a player's move. That is, the basic strategy of Deep Blue is essentially a large-scale application of the type of computation implemented at the simple level I.

For the relatively limited domain of chess playing, the powers of the human's complex ability and the machine's computational power are about comparable at present. This suggests other applications at similar complexity levels might succeed to a similar extent. In fact, such applications have already been reported, such as molecular dynamic simulations in the pharmaceutical industry, data mining, and complex scheduling problems as byproducts of Deep Blue (see *ACMemberNet*, Feb. 1996). This type of application will be one of the most promising practical AI areas in the near future: areas currently performed by human intelligence or commonsense, but can be compatible with humans by employing the machine's computational power.

Finally, we are surrounded by scores of more challenging problems at level III, the most complex level for the machine. No one knows exactly what the essential characteristics the problems have at this level. But probably most would agree on two distinguishable characteristics. One, the problems require human comprehensive abilities such as intuition, memory, pattern recognition, and so on. Two, the problem domains are much more complicated than the game of chess, which requires only a small number of pieces played on a two-dimensional, 8-by-8 grid board. The problems at level III may include humanlike perceptions of vision and speech, knowledge processing such as expert judgement and language translation, and learning.

When we realize our current machine level for the relatively simple chess playing problem, we must be cautious on investments in research for the level III problems. Take, for example, an autonomous humanoid machine with humanlike cognitive process based on modern technologies such as AI, neural networks, evolutionary computing, physiology, and psychology. Truly practical implementation of such a machine at the current level of technology is still a fantasy. However, as advanced computation, AI has offered massive commercial and industrial applications as presented in two *Communications* AI special issues (Mar. 1994 and Nov. 1995).

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