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Research Division
Thomas J. Watson Research Center
P.O. Box 218
Yorktown Heights, New York 10598
(914) 945-3982

Contact: Marcy Holle, IBM
(914) 945-3970
mholle@vnet.ibm.com

Kelly Fitzgerald, TSI for IBM
(212) 696-2000 ext. 224
kfitz@tsipr.com

IBM PREVIEWS DEEP BLUE CHESS COMPUTER; SYSTEM "IN-TRAINING" FOR KASPAROV CHALLENGE

Optimized System Addresses Problems Beyond Chess

San Diego, Calif., Dec. 5, 1995 . . . IBM unveiled an early version of its Deep Blue* parallel computing system this week at Supercomputing '95, playing "blitz" games with opponents and showing off its lightning-fast computational speed -- all in a tune-up for a February showdown with World Chess Champion Garry Kasparov.

The Deep Blue research project from IBM was begun in 1989 to address the classical problem of designing computers strong enough to compete against the top human chess players.

The goal of the project, to join special purpose hardware and software with general purpose parallel computing systems, has generated significant advances that tackle the complex problem of chess. Through the lessons provided by Deep Blue's development, this same approach may be translated to other intricate disciplines such as molecular dynamic simulations in the pharmaceutical industry, data mining applications, and other complex scheduling problems such as airport trafficking.

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"We have designed this system to win at chess, but what we have learned from it will go far beyond chess matches," said C. J. Tan, Manager of Deep Blue, IBM Research. "Deep Blue is another example of the technological prowess that IBM brings to solving complex commercial computer problems for customers."

The system playing chess at Supercomputing'95 uses an IBM PowerParallel SP2 high–performance computer, based in Yorktown Heights, New York, which is sending its moves over the Internet to a RISC System/6000 stationed on the tradeshow floor.

The complete 32-node Deep Blue system will be put to the ultimate test in a six-game, full-length regulation match against the world chess champion, Garry Kasparov. The ACM Chess Challenge will take place February 10-17, 1996, in Philadelphia, as a featured event of the ACM (Association for Computing) 50th anniversary celebration.

Computational Power Reaches New Plateaus of Possibility

The Deep Blue computer is capable of searching 50 to 100 billion positions within three minutes, which is the time allotted to each player's move in classical chess. This computational power is thought to be great enough to give Deep Blue a chess strength comparable to that of Kasparov's.

Past computer designs that attempted to approximate human thinking often ended in poor results. Deep Blue was not designed to mimic human players, who employ an extremely complex evaluation function that includes intuition, experience and pattern recognition. Deep Blue relies more on computational power and a simpler search and evaluation function to find the best possible position by analyzing hundreds of millions of moves per second.

Providing a computer with the ability to play chess at the level of the world's human chess champion has been a grand challenge of computer science for more than 40 years. IBM's Deep Blue, now 1000 times faster than its predecessor, Deep Thought, is designed to meet that challenge and offer answers to other challenges in this century and into the next.

IBM Research Division

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IBM's Deep Blue
Backgrounder

Claude Shannon, the founder of information theory, stated in 1950 that "the investigation of the chess-playing problem is intended to develop techniques that can be used for more practical applications." Shannon further argued that chess represents the ideal hurdle for computer analysis: "The problem is sharply defined, both in the allowed operations (the moves of chess) and in the ultimate goal (checkmate). It is neither so simple as to be trivial nor too difficult for satisfactory solution." Since 1950 the goal of hundreds of engineers, programmers, and mathematicians has been to design computers and software strong enough to overcome the ingenuity and imagination of the world's Grandmaster chess players.

IBM Research's Deep Blue* project began in 1989 as a way to explore how to use parallel processing to solve complex problems. The Deep Blue team at IBM, Feng-Hsiung Hsu, Murray Campbell, A. Joseph Hoane Jr., Gershon Brody, and Chung-Jen Tan, saw this complex problem as a classical research dilemma: how to develop a chess-playing computer to test the best chess players in the world.

The predecessor of Deep Blue, called Deep Thought, was created in 1988 by a team of Carnegie-Mellon graduate students including Feng-Hsiung Hsu and Murray Campbell. The basic version of Deep Thought's chess engine contained 250 chips and two processors on a single circuit board and was capable of analyzing 750,000 positions per second or 10 half moves ahead, for an international performance rating of 2450, which placed it in the lower ranks of the world's Grandmasters. Computers' rating points are determined by a combination of both their speed and knowledge. That same year, Deep Thought stunned the chess world, becoming the first computer to defeat a Grandmaster in a tournament. However, in October 1989, an experimental six-processor version of Deep Thought, capable of searching more than two million positions per second, played a two-game exhibition match against Gary Kasparov, the reigning world champion, and was beaten. In August 1993, Deep Thought defeated Judit Polgar, the youngest grandmaster in history and the strongest female player in the world. In June 1994, the computer again won the title of International Computer Chess Champion.

The successor to Deep Thought, now entitled Deep Blue, was designed to address many of the system limitations of Deep Thought, specifically in the areas of calculation speed and processing power. The research team aimed to design a machine which would outcalculate Deep Thought by a factor of at least 1,000 and examine more than one billion moves per second.

Therefore, over a period of years, the team designed a chess-specific processor chip that is capable of searching two to three million positions per second. Secondly, the team joined this special purpose hardware with IBM's RISC System/6000 Scalable POWERparallel Systems (SP)* high-performance computer for a further several hundred-fold gain over the original Deep Thought.

The latest iteration of the Deep Blue computer is a 32–node IBM SP high-performance computer. Each node of the SP employs a single microchannel card containing 8 dedicated VLSI chess processors, for a total of 256 processors working in tandem. Deep Blue's programming code is developed in C and runs under the AIX* operating system. The net result is a scalable, highly parallel system capable of calculating 50 to 100 billion moves within three minutes, which is the time allotted to each player's move in classical chess.

In order to give Deep Blue even greater resources from which to draw, the Deep Blue team collected an opening game database which provides the system with grandmaster games played over the last 100 years. Alongside the opening database is an endgame database which is activated when only five chess pieces remain on the board. This database provides billions of endgame scenarios.

Deep Blue's Advantages

"Computers do not become tired or distracted," says Murray Campbell, Research Scientist, IBM Research. "There is no psychology at work. Deep Blue, for example, will never make an obvious tactical error or an error with short-term consequences. If it makes an error at all, it will only become clear later on in the game."

Kasparov's Advantages

Says Hsu, "Kasparov has a deep understanding of the game which is entirely different from Deep Blue's. Deep Blue does not mimic human thought – it reaches the same end by different means. Kasparov's advantages are his intuition, judgement and experience."

The attempt to develop chess computers which play in similar fashion to human players has often ended with poor results. Deep Blue has been explicitly designed to take advantage of its differences from human opponents. Although a human player is only capable of searching 1 or 2 possible positions per second, their focus is much more selective. In addition, humans use an extremely complex evaluation function which includes

intuition, experience, memory and pattern recognition. Conversely, Deep Blue searches several hundreds of millions positions per second using a simpler search and evaluation function.

Kasparov himself adamantly believes that the very best players in the world should be able to prepare themselves to exploit what he believes to be the special weaknesses presented by machines. Kasparov has long maintained that human creativity and imagination, especially his own, will always triumph over silicon: "Chess gives us a chance to compare brute force with our abilities. In serious, classical chess, computers do not have a chance in this century. I will personally take any challenge."

In February, 1996, Kasparov will face Deep Blue in a six-game, regulation match at the 50th anniversary celebration of the Association for Computing (ACM) in Philadelphia.

Real World Applications

The lessons learned from this research project may be used to further develop IBM's parallel processing knowledge in applying customized versions of the Deep Blue technology to everyday business problems. Among these are highly complex, difficult problems such as molecular dynamic simulations employed in the pharmaceutical industry, data mining, for example, in financial markets, and traffic and cargo scheduling at the world's largest international airports. By conquering the classical chess paradigm through parallel computing systems, IBM will use the knowledge and technology which they have gained to solve these and other intricate problems well into the next century.

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