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Imagine a room filled with several hundred spectators watching two humans huddled over a chess board. The tension mounts as the clock ticks off minute after minute. The spectators yell out suggestions, hiss and boo, cheer and stomp their feet. Is this a competitive chess player's nightmare? No, it's a computer chess championship, and computers are the competitors, while the humans are here for the show.

Photo: Pieces positioned at the 55th move of the 1981 Mississippi State Closed Chess Championship between a human chess Master and the CRAY BLITZ computer chess program. (Handmade brass and aluminum chess set designed by Richard Weinberg, Cray Research, Inc.)
Improvements in computer hardware and software design over the years have enabled computer chess programs to become more competitive with top human chess players. CRAY BLITZ’s recent tournament victory in Mississippi is evidence of this fact—never before has a computer chess program won a state chess championship. And while no one can predict when a computer will become world chess champion, very few people will deny that one day the computer will be unbeatable.

Testing a program under competition

Developers of computer chess programs have two choices for testing a program under competition. They can enter open chess tournaments, where most, if not all, of the opponents are human. Alternatively, they can participate in computer chess championships, where only programs are allowed to enter. These two types of tournaments provide very different tests for computer chess programs of today.

The most notable difference between strong computer chess programs and strong human players is that human players sometimes make tactical mistakes but programs usually don’t. However, the tactical fallibility of human players is generally offset by the deeper positional understanding humans exhibit, so if human players can avoid tactical errors, they will usually win.

In tournaments pitting human players against computers, the test conditions are ideal: the strengths of one competitor are matched by the weaknesses of the other. In entering both BLITZ and CRAY BLITZ in tournaments against human players, I have demonstrated that the computer is indeed a formidable opponent. The tactical expertise of the computer chess program, along with its “Mr. Spock”-like lack of emotion, are advantages the program holds over the human opponent. A program simply doesn’t become unnerved when it is losing or when it is being attacked, and it never gets careless when it is ahead (a particular weakness of human players). Playing the best moves it can find, the program plays evenly, waiting for the human opponent to make a tactical mistake. This mistake is almost always forthcoming, and it often results in another victory for the computer. Fortunately, the human player can salve a damaged ego by thinking about the moves that would have beaten the computer, had they been played.

A chess game between two computers seems to be a non-optimal test condition, because the strong and weak points of the two programs may be quite similar. It is for this reason that luck generally plays an important role in deciding the victor of a contest between two programs. In an extended (multi-game) match, the better program will triumph, because play over a number of games should eliminate the factor of luck (or at least reduce it). Unfortunately, tournament play precludes two opponents meeting more than once.

Computer chess competitions

Each year, the Association for Computing Machinery (ACM) organizes and sponsors a tournament to measure progress in computer chess. An impressive array of computers participates: last year’s tournament included two CRAY-I computers, several AMDAHL 470/V7s and 470/V8s, and a Control Data Corporation CYBER 176. Rarely is that much computing power concentrated in one small room, especially to play chess! In addition to the yearly ACM tournament, a world computer chess tournament is held every three years to determine the best computer chess program in the world.

Computer chess tournaments are great crowd pleasers. Because computers don’t mind noise, the spectators can actively participate by booing, hissing, applauding, and suggesting moves. As interest in the outcome reaches a peak, attendance can exceed 500 for the final two rounds of a tournament.

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Each side in a computer chess game has a fixed amount of time to make a predetermined number of moves. The requirement is usually that 40 moves must be made in two hours, for an average of three minutes per move. Time is measured precisely by two clocks at the tournament site, one for each program. When it is one program’s turn to move, that program’s clock is started and the opponent’s clock is stopped. Because time is so important in a match, the computers used in the tournament are normally dedicated during play. Dedicated time allows for the maximum amount of computer time per move.

In addition to playing regular tournament chess at three minutes per move, the better chess programs are extremely good at playing speed chess, where the entire game lasts only five minutes. The tactical accuracy of these programs seems to offset their lack of knowledge to the extent that even the strongest human players in the world have a difficult time winning. No human has ever beaten CRAY
BLITZ in over-the-board speed chess, including several chess Masters. Even David Levy, who established himself as the arch-nemesis of computer chess programs and programmers, fell to BLITZ in speed chess. Five years ago, this record would have been labeled science fiction; today it is a demonstrable fact.

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ACM has sponsored the computer chess tournament annually as a controlled experiment. Since the first tournament in 1970, the time allowed per move has remained the same. Thus, increases in playing strength can be directly attributed to improvements in hardware and software.

In 1970, the best program entered in the ACM tournament was barely a United States Chess Federation (USCF) class C player with a rating of approximately 1500. In 1981, the best programs are rapidly approaching the Master rating (USCF rating of 2200 or better). CRAY BLITZ is the first (and only) program to have achieved this status to date, with a rating of 2258. In speed class, the better programs are currently rated at over 2400, and steady improvements are being seen in longer timed events.

CRAY BLITZ's performance

CRAY BLITZ has been playing chess for almost two years. Before being implemented on the CRAY-1, BLITZ had been playing chess for about four years. Needless to say, the CRAY-1 greatly improved the strength of the program, due to the depth of search made possible by the tremendous speed of the machine.

At a rate of one move every three minutes, CRAY BLITZ generally performs an exhaustive search to a depth of seven plies in the middle game. In the end game, CRAY BLITZ has performed searches exceeding 35 plies. While a depth of seven half-moves might not sound very impressive at first, it is deep enough to find some extremely clever tactics. Research has shown that as depth increases, the accuracy of move selection in a human lesseres. In a program using exhaustive searching, however, inaccuracy is not a problem because every move is considered.

Tournament action

To appreciate what goes on at a tournament, join me in playing the following game. This game was played by CRAY BLITZ in the 1981 Mississippi State Closed Chess Championship. CRAY BLITZ won with a perfect score of 5 wins, 0 losses. The program's performance earned it the title of "Mississippi State Chess Champion" for 1981, making CRAY BLITZ the first computer program ever to win a state chess championship tournament. The opponent is a USCF chess Master and state champion for the previous two years. CRAY BLITZ played black. I am including the number of nodes the program examined, the position evaluation (where +1.2 means the program is 1.2 pawns ahead, for example), and the program's analysis (the moves it anticipates being played). I am also including the time elapsed per move for each side so that it is possible to determine how much time each side has left at any point. The time rules for the tournament require 50 moves every two hours. Also included are my remarks and (in quotes) those that came directly from CRAY BLITZ.

We are sitting across the board from our human opponent. A terminal connected to the CRAY-1 is facing us so that the opponent cannot see. Whenever our opponent makes a move, we enter the move via the terminal and wait for CRAY BLITZ's response. While BLITZ performs the search, it periodically displays on the terminal the current evaluation and expected sequence of moves. These values are updated whenever BLITZ's evaluation changes. Because the program is a much stronger evaluator than any human present, we rely on its analysis to let us know how the game is going.

Because computers don't mind noise, the spectators can actively participate by booing, hissing, applauding, and suggesting moves.

The only problem is time. We must sit patiently, waiting for a clue from CRAY BLITZ to let us know how the game is going. If the opponent takes 15 minutes for a move, we sweat it out until the move is made and the program starts displaying its analysis. As the evaluation climbs, we smile; as it drops sharply, we worry. It is very much like watching one's children play in a competitive event.

Remember that while the tournament is in progress, we can't turn the page to check the evaluation 10 moves from now! We have to wait (and worry).
24. Qxg7+ Kd8 (2:01) 358,566 nodes – 0.431
Kd8 Qxa8 + Ke7 g7 Ng7 Rx8 e6fx5 Bd7f5 At this point, the program sees trying a9 in advance. However, the Master has used a lot of time and can't afford to carefully analyze each move now, and he soon begins to falter.

25. Rxf5 (6:33) Nxf5 (2:29) 419,712 nodes – 0.413
Nxf5 Qxe8 + Qe8 f7 Ne4 c8+ Kc7 Qxex5 e5fx5 Now we are ahead again. Rx8f was not best, as can be seen from the program's prior analysis. Qxh8 + was better.

26. Qf6 + (0:32) d5f6 (2:07) 417,621 nodes – 0.455
Ne7 g7 Qxg8 e4 Kd7 c7fx5 e5fx5 Now the pawn is finally stopped. CRAY BLITZ is threatening Nf8, making it further.

27. g7 (2:27) Qe6 (0:15) 383,444 nodes + 0.266
Qe6 Qe4 Kd5 c7fx5 Nc6 Qe7 Qxg7 f7 + Kxe7 The pawn looks dangerous, but we have defended well. For the time being, everything is held together.

28. Bf3 (3:01) Kg7 (2:35) 385,273 nodes + 0.451
Kg7 ed Bf8 Kh1 dxex6 Qf6 Kh4 Qxh4 So far, so good...

29. Rf1 Ng8 (2:35) 382,522 nodes – 0.306
Ng8 Qf6 Qf6 Kh1 Ke7 c4 Nf6 exd5 exd5 Trading quacks is not easy. Here the threat of the opposing pawn is threatening again via Rf6 Rf6 – Q = Q. Can we survive this last rush?

30. Qe6 (0:35) Kg6 (1:49) 351,300 nodes + 0.278
Kg6 Qe8 + Kh4 Qe8 Qd8 c7fx5

31. e4 (10:58) dxex4 (2:45) 385,266 nodes – 0.219
dxex4 Qe4 + e4 Bxe4 Bf4 Kd7 Qf7? Not the opponent has only 34 minutes for the final 20 moves, while the program has over one hour left.

32. c3 (3:05) Ba3 (3:40) 604,912 nodes + 0.000
Rc3 c3 Rf2 RxR c3 Rf6 Bc3 c3 Bc3

33. Ba4 (1:38) Bf4 (3:46) 391,722 nodes – 0.713
Bf4 Bg3 Bf4 RxR d5 Bf4 Kg5 Qd8

34. Qg3 (6:23) Qxa4 (2:46) 610,609 nodes – 1.459
Qxa4 + bxa4 Bb7 Rb8 Ra8 Bb8 Bh7 Ne7 g7 = Q Ng6 Bb8 Not so Black is over a pawn behind. BLITZ is analyzing deeper than the Master, however, and the Master doesn't find the best moves.

35. hxg3 (0:37) Ba7 (2:46) 670,710 nodes – 1.359
Ba7 Rb8 RxR Bb8 Bh7 Ne7 g7 – Q Nxg8 Bb8 Black is over a pawn behind. BLITZ is analyzing deeper than the Master, however, and the Master doesn't find the best moves.

36. Rf6 (7:31) Rc8 (0:00) 1,395,400 nodes – 1.311
Rc8 Bb8 Bb8 Bh7 Ne7 g7 = Q Nxg8 Bb8 Black is the Master's only chance. However, he is almost out of time.

37. Bh6 (1:56) Rc8 (4:00) 624,126 nodes + 0.000
RxR Bb8 RxR Rc8 Bb8

38. Rg8 (4:14) Rxg3+! (3:00) 610,779 nodes – 0.090
Rxg3 + cRc2 Bb4 b5 Rb8 Rg3 Rxg3 The move Rxg3 is too late!
That was a wild game that could have gone either way. I have some general comments on the game. First, the worst thing CRAY BLITZ saw was coming out a pawn down, but even being a pawn down was not critical because the opponent was so short on time. Second, the opponent was behind on time because the program came up with some surprising defensive moves and generally presented the opponent with a lot of tactical problems.

In winning the other four games in the tournament, the program never found itself with a negative evaluation; that is, it was ahead all the way. In winning the state championship title, the program achieved a rating of 2258, placing CRAY BLITZ in the Guinness Book of World Records as the first computer chess Master.

It should be noted that, to date, only three programs have beaten chess Masters in tournament play: BELLE of Bell Laboratories, Control Data Corporation’s CHESS 4.9, and CRAY BLITZ. Three years ago, no one thought a program would ever beat a human. Now it is becoming commonplace. Watch out, Bobby!

The future for CRAY BLITZ

Performance against other programs is the next testing phase for CRAY BLITZ. The annual “computer only” tournament sponsored by ACM takes place in November in Los Angeles, California. CRAY BLITZ will be there to defend its “World Computer Speed Chess Champion” title and to try to wrest the regular world title from BELLE.

The current version of CRAY BLITZ has only played one other computer program, BELLE. In a four-game match played in August, BELLE and CRAY BLITZ split at two games each, which gives an indication of how close they really are. Remember that tactical errors don’t really exist in games between top-class

programs, so Lady Luck has a chance to enter into the fray, sometimes at the most embarrassing times. CRAY BLITZ is anxiously awaiting the successor to the CRAY-1 for additional hardware advantages, while human opponents have resigned themselves to the fact that computer chess programs can only improve.

--- ABOUT the AUTHOR ---

Robert Hyatt is an Instructor and Chief of Systems at the University of Southern Mississippi in Hattiesburg. He received his B.S. in Computer Science from USM in 1970 and has remained there to teach and do research. Bob has been competing in computer chess tournaments with BLITZ since 1976. He has had CRAY-1 support from Cray Research since April of 1980.