DRAFT (final version: ICGA Journal Vol 26 No 4 December 2003 pp 277-280)

Six wins Hex Tournament

Gábor Melis[1] and Ryan Hayward[2]

The contestants. 2003 saw a Hex tournament take place at the Computer Games Olympiad for the first time since 1999, when Vadim Anshelevich's HEXY (gold) defeated Jack van Rijswijck's QUEENBEE (silver) and Emanuel Brasa's KILLERBEE (bronze) [1].

This year's tournament had two new entrants: SIX by Gábor Melis, and MONGOOSE by Yngvi Bjornsson, Ryan Hayward, Mike Johanson, Morgan Kan, and Nathan Po. Both programs incorporate the key ideas behind Hexy [2], finding virtual connections via H-search (which uses AND and OR composition rules) and then computing an edge-to-edge resistance measure based on which pairs of cells are virtually connected.

SIX performs a 2-ply search with alpha-beta pruning, analysing the most promising 20 1-ply and 15 2-ply moves. With a game tree search this shallow, most of the work is done within the H-search. SIX's implementation of H-search keeps track of all computed virtual connections and virtual semi-connections between groups, but uses only a small number of them, namely those with the smallest carriers (the carrier of a virtual connection is the associated set of empty cells which guarantees the connection). The feature which most contributes to SIX's characteristic style of play is the computation of connections which go through the edge of the board, namely connections which can only be constructed by using one of the board edges as the pivot point in the AND rule. SIX does not have an opening book. During the opening four moves of the game, it dispenses with 2-ply altogether and considers only 30 1-ply moves, although with an H-search which is more thorough than usual. The SIX source code can be freely downloaded from http://hex.retes.hu/six.

MONGOOSE uses alpha-beta search with iterative deepening, searching as deeply as the allocated time for a given move permits. For opening play, it uses a book for the first two to four moves, depending on the position. A characteristic feature of MONGOOSE is its move pruning. As described in [3], it reduces the number of moves under consideration by in some cases deducing that a move is provably inferior to some other move, and in other cases determining that one or more stones can be added to the board without changing the theoretical outcome of the game.

Double-round 1. The first SIX/MONGOOSE double-round of four games (Figures 1 and 2) started in the Graz Casino on Sunday November 23 at 14:00. SIX (black) opened Game 1 with 1.A3 and won quickly after questionable early moves 6.H5 and 10.E5 by MONGOOSE. MONGOOSE opened Game 2 with 1.B3 and SIX swapped (taking black). Again, SIX won

[1] mega@hotpop.com, http://six.retes.hu/

[2] Department of Computing Science, University of Alberta, Edmonton Canada, hayward@cs.ualberta.ca, http://www.cs.ualberta.ca/~hayward. The support of NSERC and the UofA GAMES group is gratefully acknowledged.

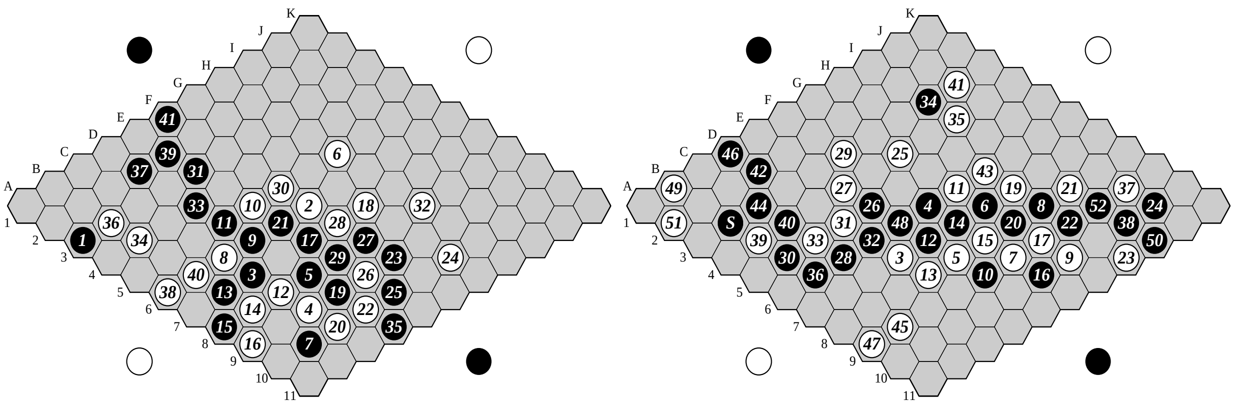

Figure 1: Games 1 and 2. In Game 1, Six (black) opens with 1.A3 and wins quickly. In Game 2, Mongoose opens with 1.B3, Six swaps (black), and Six wins again.

quickly after some suspect early Mongoose moves, namely 5.E8, 7.F9, and 9.G10. Six (black) also won Game 3 quickly. Game 4 was the longest and most interesting game of the double-round, but the outcome was the same, with Six (white) winning to take a 4-0 lead.

The interlude. After Double-round 1, the players retired to a restaurant to sample some local cuisine and analyse the games thus far. Queenbee had also registered for the tournament, so Six and Mongoose were not scheduled to play any further games against each other. For this reason, the after-dinner discussion was open and enlightening. In particular, it emerged that Mongoose's weak early play was likely a result of the odd/even-ply search effect: in Hex as in many other board games, position evaluations after a player's move are usually more optimistic than after an opponent's move.

This analysis came into play the next day, when Queenbee withdrew from the tournament due to illness. To complete the tournament, Six and Mongoose were required to play a second double-round.

Double-round 2. The second and final Six/Mongoose double-round of four games (Figures 3 and 4) took place in the Graz casino on Monday November 24. In Game 5, in order to avoid any weak 3-ply moves, Mongoose changed settings and restricted the search depth to 2-ply for the first 10 moves. The result was Mongoose's first win, and the sudden injection of some drama into the competition, which to this point had been decidedly one-sided. In Game 6, Mongoose seemed on the road to a second consecutive victory, with a strong ladder under construction in the middle game. But then the odd/even-ply gremlin struck Mongoose again, when a 3-ply search selected 29.J8 over the 2-ply selection 29.F2. This blunder allowed Six (black) to break the ladder with 30.F2 and win the game soon after. For the remaining two games, Mongoose played with search depth restricted to 2-ply, but the damage was done: Six had a 5-1 lead and the gold medal.

In Game 7, having already won the championship, Six decided to play an opening which would almost never be played in a tournament: 1.C5 is so strong that the opponent will probably swap and win easily. This was indeed what happened. Mongoose swapped (taking black) and went on to win, but not before Six put up a good fight. Six's 3.E7 was

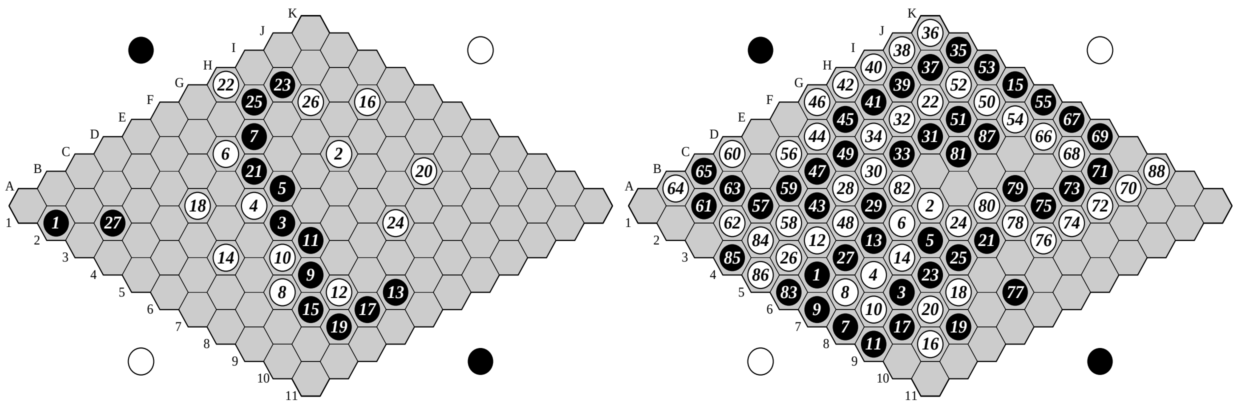

Figure 2: Games 3 and 4. Six (black) wins Game 3, with the Mongoose operator resigning after 27.B3. In Game 4 Mongoose puts up a better fight, but Six (white) wins again.

strong: on the short diagonal and only one cell from the center, it thwarts the threat from C5. Black then moved to reduce White's options, with 4.C8 forcing 5.C7. After 10.A9 11.B9 12.B8, White found itself in a bad position, with the upper part of the board cut off and a ladder forming on row eight. Black played a satisfactory ladder escape with 16.I7, and from that point all White could do was to delay the inevitable: the black stone at I7 was virtually connected to the lower edge, and once the possibility of a direct connection to the upper edge was lost, it simply steered back towards the black pieces at C5 and D7, eventually breaking through to the upper edge with 58.D4.

In Game 8, Mongoose returned the favour offered by Six in the previous game and opened with 1.C5. As expected, Six swapped (taking black) and won. Six's victory was quicker than in the previous game. After the swap, Mongoose played the rather weak 3.C9, which after 4.F7 left Black with a huge advantage. While 5.F6 seemed to be a reasonable attempt to cut off F7 from the upper edge, it was unlikely to succeed, as C5 was well placed to assist F7. 5.F8 might have been stronger. With a forcing escape at B10 available, Black had every opportunity to end the game quickly; instead, Black played quietly, securing the victory with a succession of positional moves.

Epilogue. While conceptually similar, Six and Mongoose exhibited different strengths and weaknesses. Once the odd/even-ply effect was muted, Mongoose played a convincing game that at times seemed stronger than what Six could offer. However, Six's forte, namely its opening and positional play, balanced the scales. For board-size 11, both programs played at a level that is on par with intermediate human players and clearly below that of human experts. It will be interesting to see how much progress can be made before the upcoming July 2004 Olympiad.

Game 1. Six vs Mongoose (2003/11/23, first round of day 1)
1.A3 2.F6 3.C7 4.C9 5.D8 6.H5 7.B10 8.C6 9.D6 10.E5 11.D5 12.C8 13.B7 14.B8 15.A8 16.A9 17.E7 18.G7 19.D9 20.C10 21.E6 22.D10 23.F9 24.G10 25.E10 26.E9 27.F8 28.F7 29.E8 30.F5 31.E3 32.H8 33.D4 34.B4 35.D11 36.B3 37.D2 38.A6 39.E2 40.B6 41.F1 Black (Six) wins.

Game 2. Mongoose vs Six (2003/11/23, first round of day 1)

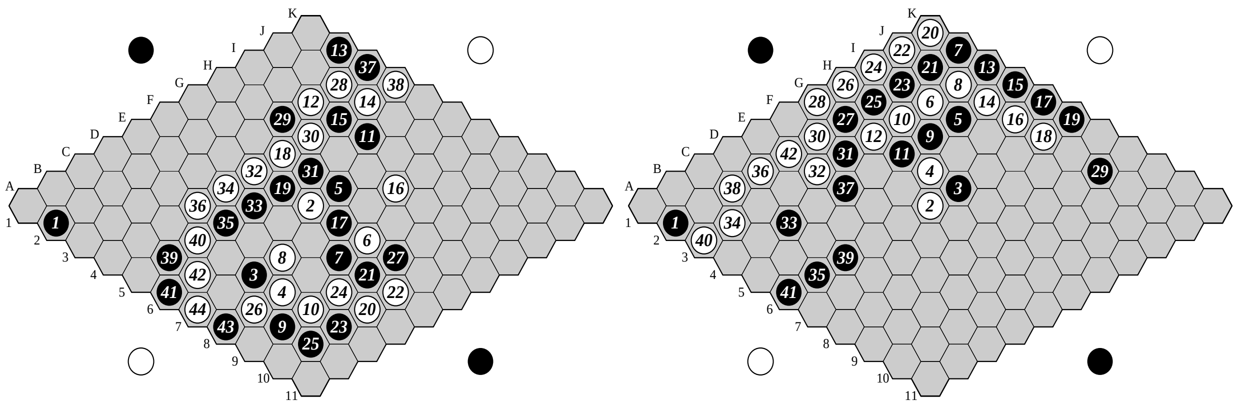

Figure 3: Games 5 and 6. In Game 5, Mongoose (white) wins for the first time. In Game 6, Mongoose blunders with 29.J8 and Six (black) wins.

1.B3 2.Swap 3.D7 4.F6 5.E8 6.G7 7.F9 8.H8 9.G10 10.E9 11.G6 12.E7 13.D8 14.F7 15.F8 16.F10 17.G9 18.I9 19.H7 20.G8 21.I8 22.H9 23.H11 24.J10 25.G4 26.E5 27.E4 28.C6 29.F3 30.B5 31.D5 32.D6 33.C5 34.I3 35.I4 36.B6 37.J9 38.I10 39.B4 40.C4 41.J3 42.D2 43.H6 44.C3 45.B9 46.D1 47.A9 48.E6 49.B1 50.I11 Black (after swapping) (Six) wins.

Game 3. Six vs Mongoose (2003/11/23, second round of day 1)
1.A2 2.H5 3.E6 4.E5 5.F5 6.F3 7.G3 8.C8 9.D8 10.D7 11.E7 12.D9 13.E10 14.C6 15.C9 16.J4 17.D10 18.D4 19.C10 20.I7 21.F4 22.H1 23.I2 24.G8 25.H2 26.I3 27.B3 Black (Six) wins.

Game 4. Mongoose vs Six (2003/11/23, second round of day 1)
1.B6 2.F6 3.C8 4.C7 5.E7 6.E6 7.A8 8.B7 9.A7 10.B8 11.A9 12.C5 13.D6 14.D7 15.K4 16.B10 17.B9 18.D9 19.C10 20.C9 21.F8 22.I3 23.D8 24.F7 25.E8 26.B5 27.C6 28.E4 29.E5 30.F4 31.H4 32.H3 33.G4 34.G3 35.K2 36.K1 37.J2 38.J1 39.I2 40.I1 41.H2 42.H1 43.D4 44.F2 45.G2 46.G1 47.E3 48.D5 49.F3 50.J4 51.I4 52.J3 53.K3 54.J5 55.K5 56.E2 57.C3 58.C4 59.D3 60.D1 61.B2 62.B3 63.C2 64.B1 65.C1 66.J6 67.K6 68.J7 69.K7 70.J9 71.J8 72.I9 73.I8 74.H9 75.H8 76.G9 77.E10 78.G8 79.H7 80.G7 81.H5 82.F5 83.A6 84.B4 85.A4 86.A5 87.I5 88.K9 White (Six) Wins.

Game 5. Six vs Mongoose (2003/11/24, first round of day 2)
1.A2 2.F6 3.C7 4.C8 5.G6 6.F8 7.E8 8.D7 9.B9 10.C9 11.I5 12.I3 13.K2 14.J4 15.I4 16.H7 17.F7 18.G4 19.F5 20.D10 21.E9 22.E10 23.C10 24.D9 25.B10 26.B8 27.F9 28.J3 29.H3 30.H4 31.G5 32.F4 33.E5 34.E4 35.D5 36.D4 37.K3 38.K4 39.B5 40.C5 41.A6 42.B6 43.A8 44.A7 White (Mongoose) wins.

Game 6. Mongoose vs Six (2003/11/24, first round of day 2)
1.A2 2.F6 3.G6 4.G5 5.I4 6.I3 7.K2 8.J3 9.H4 10.H3 11.G4 12.G3 13.K3 14.J4 15.K4 16.J5 17.K5 18.J6 19.K6 20.K1 21.J2 22.J1 23.I2 24.I1 25.H2 26.H1 27.G2 28.G1 29.J8 30.F2 31.F3 32.E3 33.C4 34.B3 35.B6 36.D2 37.E4 38.C2 39.C6 40.A3 41.A6 42.E2 White (Six) wins.

Game 7. Six vs Mongoose (2003/11/24, second round of day 2)
1.C5 2.Swap 3.E7 4.C8 5.C7 6.D7 7.C9 8.D8 9.D9 10.A9 11.B9 12.B8 13.A10 14.E8 15.E9 16.I7 17.G8 18.F8 19.F9 20.H9 21.I8 22.J7 23.H8 24.J8 25.I10 26.I9 27.G11 28.F10 29.E11 30.F11 31.H6 32.G7 33.H7 34.I5 35.I6 36.K5 37.K6 38.J6 39.G9 40.G10 41.J5 42.K4 43.J3 44.J4 45.H4 46.I3 47.I4 48.H5 49.G6 50.G5 51.G4 52.F6 53.E6 54.F5 55.F4 56.E5 57.E2 58.D4 59.C3 60.F3 61.H1 62.F2 63.F1 64.G1 65.B6 66.E4 Black (after swapping) (Mongoose) wins.

Game 8. Mongoose vs Six (2003/11/24, second round of day 2)
1.C5 2.Swap 3.C9 4.F7 5.F6 6.H5 7.H4 8.G5 9.G3 10.G4 11.I2 12.E5 13.F4 14.J2 15.I3 16.J3 17.I4 18.I5 19.J4

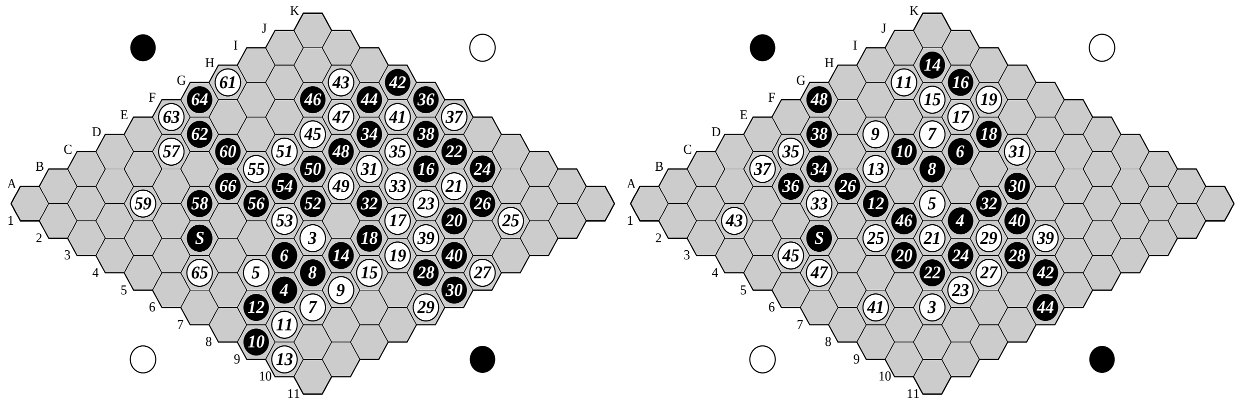

Figure 4: Games 7 and 8. Six opens Game 7 with 1.C5; Mongoose swaps (black) and wins. Mongoose opens Game 8 with 1.C5; Six swaps (black) and wins. Six defeats Mongoose 6-2.

20.D7 21.E7 22.D8 23.D9 24.E8 25.D6 26.E4 27.E9 28.F9 29.F8 30.H7 31.I6 32.G7 33.D4 34.E3 35.E2 36.D3 37.D2 38.F2 39.G9 40.G8 41.B8 42.F10 43.B3 44.E11 45.B5 46.E6 47.B6 48.G1 Black (after swapping) (Six) wins.

References

[1] Vadim Anshelevich. Hexy Wins Hex Tournament. *ICGA*, 23(3):181–184, 2000.

[2] Vadim Anshelevich. A Hierarchical Approach to Computer Hex. *Artificial Intelligence*, 134:101–120, 2002. (Also in: Schaeffer, J.; and Van den Herik, J. (Eds) 2002. Chips, Computers and Artificial Intelligence, Elsevier, 141-160).

[3] Ryan B. Hayward, Yngvi Björnsson, Michael Johanson, Morgan Kan, Nathan Po, and Jack van Rijswijck. Solving 7×7 Hex: Virtual Connections and Game-state Reduction. In H. Jaap van den Herik, Hiroyuki Iida, and Ernst A. Heinz, editors, *Advances in Computer Games*, volume 263 of *IFIP International Federation for Information Processing*, pages 261–278. Kluwer Academic Publishers, Boston, 2003.