

Fuego at the Computer Olympiad in Pamplona 2009: a Tournament Report*

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May 28, 2009

Abstract

The 14th Computer Olympiad took place in Pamplona, Spain from May 11-18, 2009. The Fuego program won the 9×9 Go competition, and took second place in 19×19 Go. This report provides some analysis of the games played by Fuego in the competition.

1 Introduction

This was the second Olympiad for Fuego. In its first participation, 2008 in Beijing, Fuego ended up in fourth place in both 9×9 and 19×19 . This year's competition took place in the beautiful historic Palacio del Contestable in the center of Pamplona. Komi was 7.5 and Chinese rules were used in both tournaments.

The Fuego team, software and hardware were as follows: Markus Enzenberger is the creator of Fuego and its lead programmer. Martin Müller is team leader, programmer and opening book author. Broderick Arneson is a programmer. Gerry Tesauro and Richard Segal of IBM Watson Research contributed the distributed memory implementation.

The software used was the current svn version of Fuego, with two experimental additions: First, the distributed memory implementation allowed the program to run on a cluster of eight 8-core machines provided by IBM and operated by Rich Segal. Second, for the 19×19 competition, an experimental version called *FuegoEx* was used. This version of Fuego employs knowledge of the classical Go program Explorer for move pruning in core parts of the UCT tree.

2 9×9 Tournament

The 9×9 competition was played on May 11 - 13. 9 programs took part and played a double round robin. The time limit was 30 minutes per program. Complete tournament results and many game records are given on <http://www.grappa.univ-lille3.fr/icga/tournament.php?id=194>.

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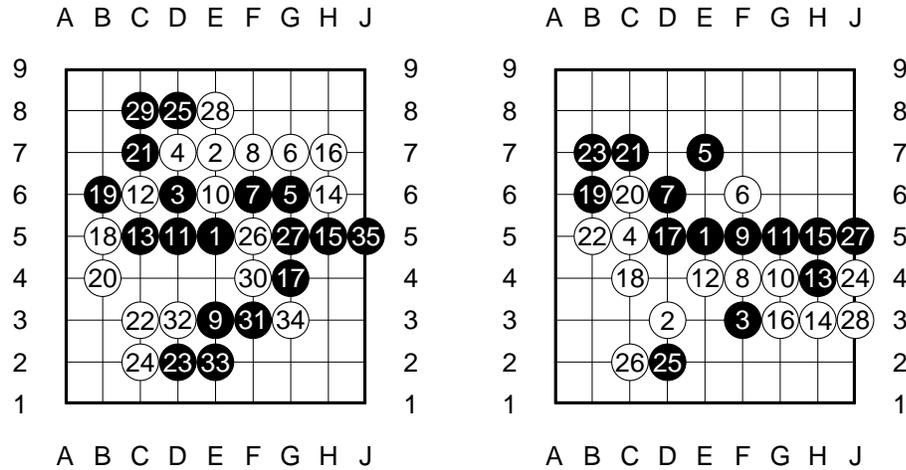


Figure 1: Round 1, Fuego - Yogo.

Round 1: Fuego - Yogo 2:0

Figure 1 shows the games of round 1 against Yogo. Yogo is a strong opponent which took third place in this competition. Last year in Beijing, Fuego and Yogo had split their mini-match with one win each. On the left in Figure 1, Yogo (White) - Fuego (Black). Up to White 4 is a common opening. Previously Black 5 at C7 was in Fuego's book, but it led to a poor winning percentage. Move 5 at G6 was a new move prepared for this competition, and it worked perfectly in this game. White replied passively and Black got an overwhelmingly strong position. 18 is a desperation move. The white group 18-24 can be killed, but Fuego plays safe with 25 and wins on territory. 35 moves. Black wins by resignation.

On the right in Figure 1, Fuego (White) - Yogo (Black). Up to 6 is in Fuego's opening book. 7 is unexpected, usually Black would connect. White 8 leads to a long tactical sequence. White 12 is a solid move that leads to a very close game. White has a safe half point lead in the end. 28 moves. White wins by resignation.

Round 2: Fuego - Bit 2:0

Figure 2 shows the games against the Chinese program Bit. On the left, Bit (White) - Fuego (Black). 37 moves. Black wins by resignation. On the right, Fuego (White) - Bit (Black). 38 moves. White wins by resignation.

Round 3: Fuego - Fudo Go 2:0

Figure 3 shows the games against Fudo Go. Fudo Go is Hideki Kato's program. It used to run on a set of Sony playstations, but for this tournament it used more standard

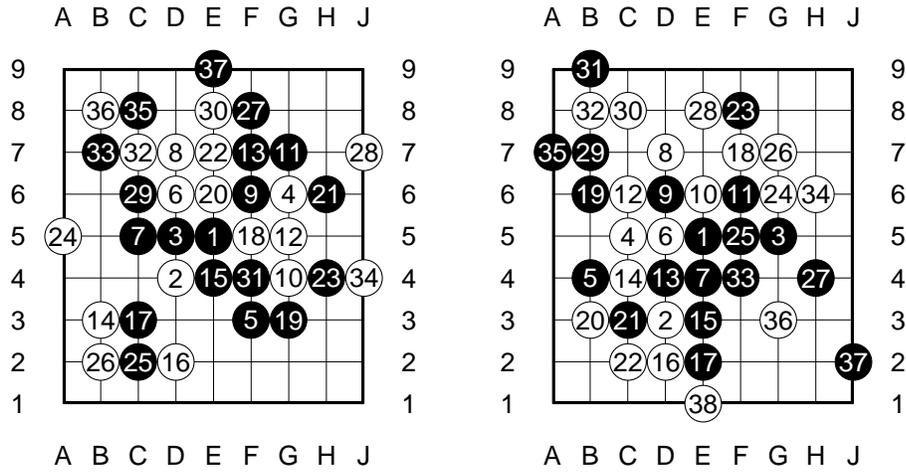


Figure 2: Round 2, Fuego - Bit.

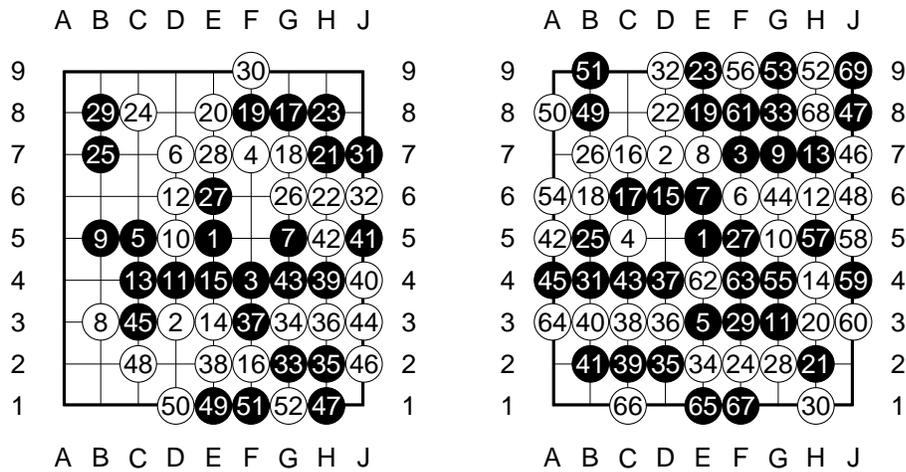


Figure 3: Round 3, Fuego - Fudo Go.

hardware - a cluster of 6 PC.

On the left, Fuego (White) - Fudo Go (Black). Up to move 7, the opening seems more promising for White. If White can establish two stable groups, it is often difficult for Black to get enough points to overcome the large 7.5 komi. For move 8, sliding into the black corner at F2 would be more natural. The wedge at move 10 is very surprising but the result up to 16 is good for White. Move 16 at F2 is a nice, restrained move. 17 is a desperation measure. With 24, White offers the top right in exchange for sure life in the top left. White 36 is an all-out move. Connecting at F3 would be easier to understand but 36 is strongest. 52 moves. White wins by resignation.

On the right, Fudo Go (White) - Fuego (Black). Fuego got a difficult game. For move 5, Fuego's recent book move was D3, but the results were not promising. So before the tournament I changed back to the older move at E3. This makes it a bit harder for White to invade. After White 6, the extension 7 is strongest resistance for Black. Capturing with G6 is safer, but may not be enough for Black. Up to 14 a complex fight starts. Black 15 is bad shape. But it is also a kind of testing move. With 16, Fudo Go decided to give way. Black 19 switches back to the corner. Black's play is a bit inconsistent here. If Black blocked at H3 instead, a semeai would result.

White 24 is a good move, utilizing the double threat of F4. Black 27 seemed weak. If White lives on both sides, it is hard for Black to win. Black 29 surprised me but it is a good try. White cannot ignore it because of H1. The combination of H2 and F3 makes it hard for White to reduce the bottom left. Black 31 closes off one side.

After 33, the top left corner is unsettled. White can live with 6 points of territory, while Black can create a seki in sente, or a mannen ko in gote. The main question is how big the black corner in the bottom left will become. I believe that White 34 is the losing move, and if White jumped in at D2 it would win. D2 looks thin but it seems to work. By blocking with 35 Black gets enough points to win. After 54, Black wisely does not try to start the approach move ko. Making seki here is enough. 69 moves. Black wins by resignation.

Round 5: Fuego - FlexGo 2:0

Fuego had a bye in Round 4. Its round 5 opponent was FlexGo. Figure 4 shows the games. On the left of Figure 4, Fuego (White) - FlexGo (Black). The opening is unclear. Move 12 seems doubtful. Defending the other group with F8 or H3 seems preferable. For 13, jumping in at G8 seems more troublesome for White. 14 is an interesting defense. If White lives here the game is won. 32 is a blunder and must be on J6. J4 leaves an approach move ko. The question now becomes whether Black can create enough ko threats. 38, 40 and 42 are very solid. Black resigned without trying the ko. 42 moves. White wins by resignation.

On the right of Figure 4, FlexGo (White) - Fuego (Black). Up to 5, the same opening as against Yogo. White 6 is aggressive. White 14 at G4 leads to a difficult fight. Fuego's evaluation was pessimistic at 47%. White 16 and 18 are a strong combination. Black 27 is a surprising cut. Black's aim is to take sente and play F3 first. I believe that White 30 should be on E3. With 31, Black gets enough territory. 51 moves. Black wins by resignation.

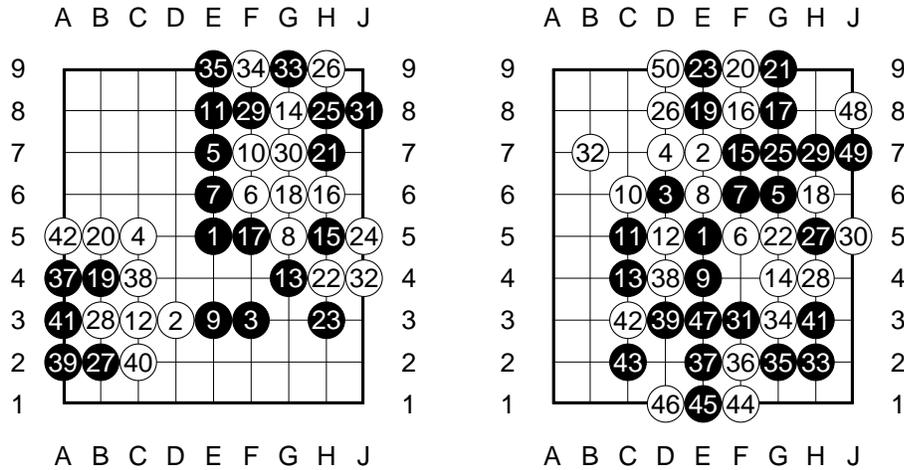


Figure 4: Round 5, Fuego - FlexGo. Left: (36) at (33). Right: (24) at (16), (40) at (3), (51) at (20).

Round 6: Fuego - MoGo 1:1

Figure 5 shows the games against MoGo. Both programs were undefeated after 5 rounds, so this promised to be an exciting match. However, both games were mostly decided by problems with the opening books.

On the left of Figure 5, MoGo (White) - Fuego (Black). Black 5 is dubious, after White's wedge at move 6 Black is in trouble. I looked at various lines after the game, but could not find anything promising for Black. Therefore I changed move 5 to F4, as we will see in the final playoff game. Move 7: the other atari on F7 does not work well, either. Move 9: this move looks crazy, since it allows White to capture the center stone on E5. However, the "solid" move E4 seems to give White an easy win.

Up to 27, Black plays for territory. But there are too many weaknesses in Black's position. 30, 36 and 40 are strong moves.

Black desperately tries to complicate the game with throw-ins such as 63. At this point MoGo is running quite short on time. White 68 seems to be a time-trouble move. However, all lines still seem to win for White by at least 0.5 points. Fuego resigns after move 70.

On the right of Figure 5, Fuego (White) - MoGo (Black). White 8 is Fuego's last move in book. White 12 is a tesuji. It makes miai of building a position in the top and bottom left corners. Apparently MoGo was in book up to move 13! The MoGo book is a huge automatically built one. I think it has over 2.3 million entries. However, MoGo's evaluation on leaving the book was only 47-48%. Arpad Rimmel of the MoGo team was very unhappy with this.

When Black kept sacrificing stones in the top right, everyone expected a vicious

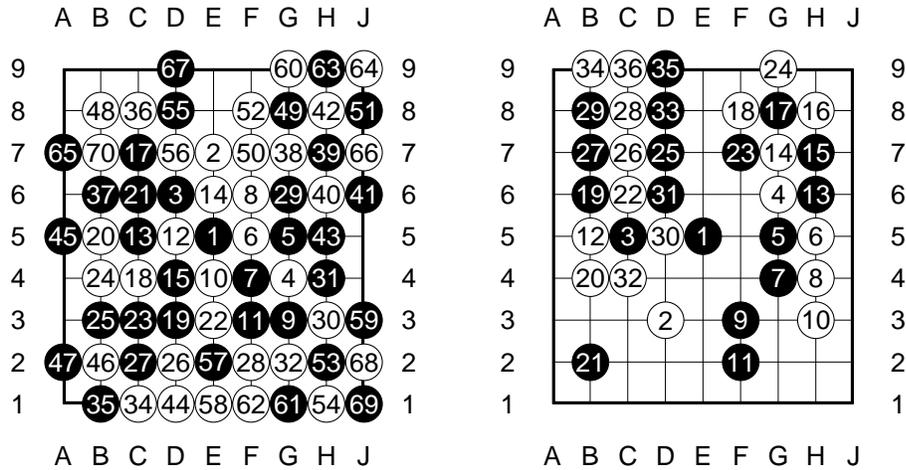


Figure 5: Round 6, Fuego - MoGo. Left: 16 at 1 33 at 4.

assault on the right side White group. Sure enough, Black attacked with 21 on B2. However, the cut with 22 is hard to deal with. After 26 White was completely safe. 36 moves. White wins by resignation.

Round 7: Fuego - Go Intellect 2:0

Figure 6 shows the games against Go Intellect. On the left of Figure 6, Fuego (White) - Go Intellect (Black). Up to 10, the two white groups look OK. White 16 is strange. G5 would work and capture a big corner. White 18 is a blunder. Black 21 tries to attack, but simply capturing on F5 would give a reasonable game. When White lives easily with both groups, Black's territory is too small. 44 moves. White wins by resignation.

On the right of Figure 6, Go Intellect (White) - Fuego (Black). Fuego is already out of book after move 4. Black 9 is a very interesting attachment. Black gets a strong position. With 16, white should probably live in the bottom right. 19 is a cool, solid answer to the hane. 63 moves. Black wins by resignation.

Round 8: Fuego - Jimmy 2:0

I am unclear about the opponent's name. The program was registered as Jimmy, which has been a long time participant in computer Go competitions. However, on KGS and in the GTP interface this program appears under the name "coldmilk". The GTP engine message reads: "coldmilk version 0.13, This program is designed by the student of Jimmy." Figure 7 shows the games against this program.

On the left of Figure 7, Fuego (White) - Jimmy (Black). White 8 looks conservative, but it seems hard for Black to surround enough area. This game looks like a solid win

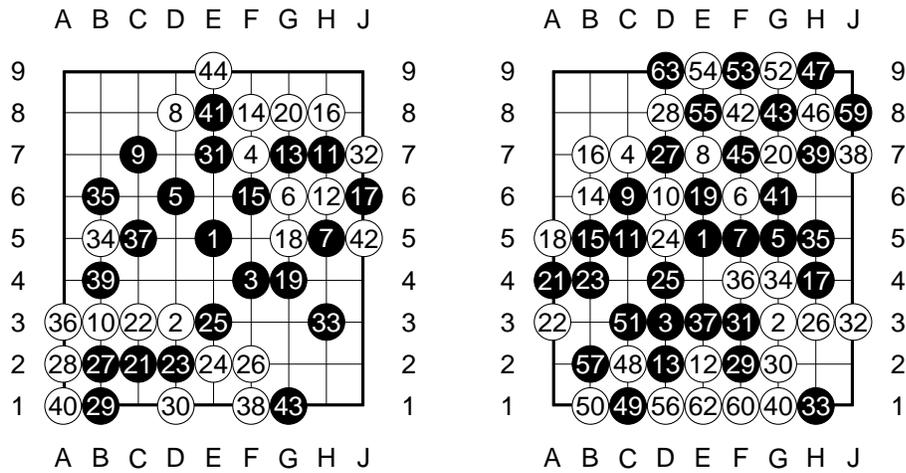


Figure 6: Round 7, Fuego - Go Intellect. Right: (44) at (10), (58) at (42), (61) at (55).

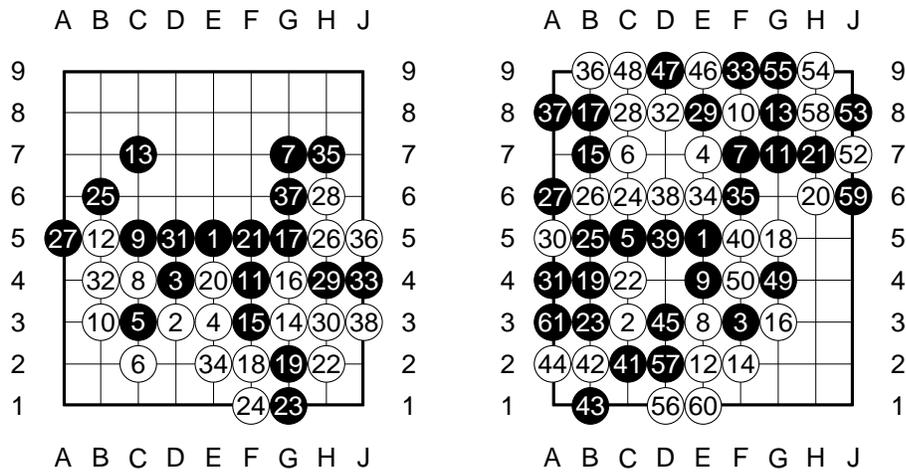


Figure 7: Round 8, Fuego - Jimmy. Right: (51) at (46).

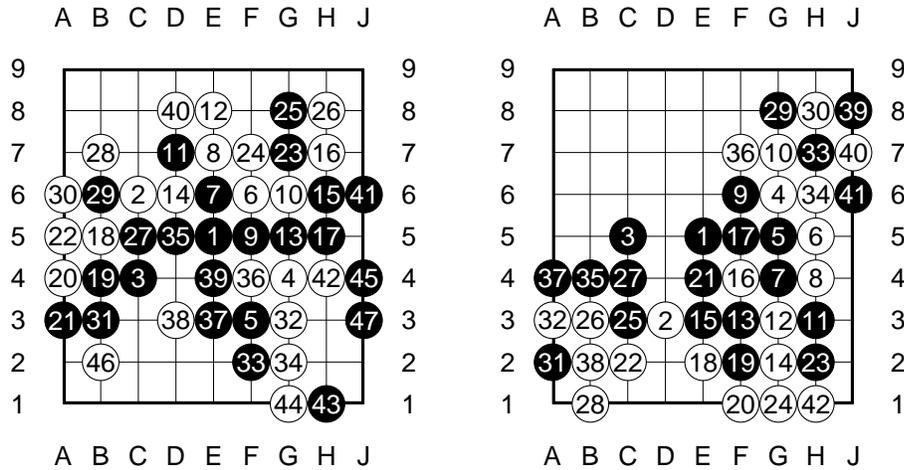


Figure 8: Round 9, Fuego - Erica. Right: 43 at 33.

for White throughout. Maybe Black needs to try another opening at move 5 or 7. 38 moves. White wins by resignation.

On the right of Figure 7, Jimmy (White) - Fuego (Black). Again, Fuego is out of book after White 4. Black 15 is surprising. White ignores it and Black captures the group with 17, but much aji remains. The game becomes very complex, and Black has several worrisome weaknesses. After 25, it looks like the Black position will hold together. Maybe White can try to wedge at D5 instead of 24. 46 is a blunder. White can get a ko with C9, A5, E9. Even so, if Black eventually connects at F8 the ko seems too indirect for White. 49 is silly but fortunately White answers it. 61 moves. Black wins by resignation.

Round 9: Fuego - Erica 2:0

Figure 8 shows the games against Erica. On the left of Figure 8, Black 7 is the last book move. The result to 17 feels good for Black. 23 and 25 are good endgame. With 31 Black has a sure 1.5 point win. 47 moves. Black wins by resignation.

On the right of Figure 8, Fuego (White) - Erica (Black). The opening is difficult. For 11, extending at G3 is an alternative. Black 15 seems soft, since with 18 - 22 White makes a big enough reduction of this corner. Black 15 at F2, White H2, Black F7 would be unclear. 42 moves. White wins by resignation.

Playoff: Fuego - MoGo 2:0

Figure 9 shows the playoff games against MoGo. After 16 games, MoGo and Fuego were tied with 15 wins 1 loss. The playoff rules were as follows: 2 games at first. If

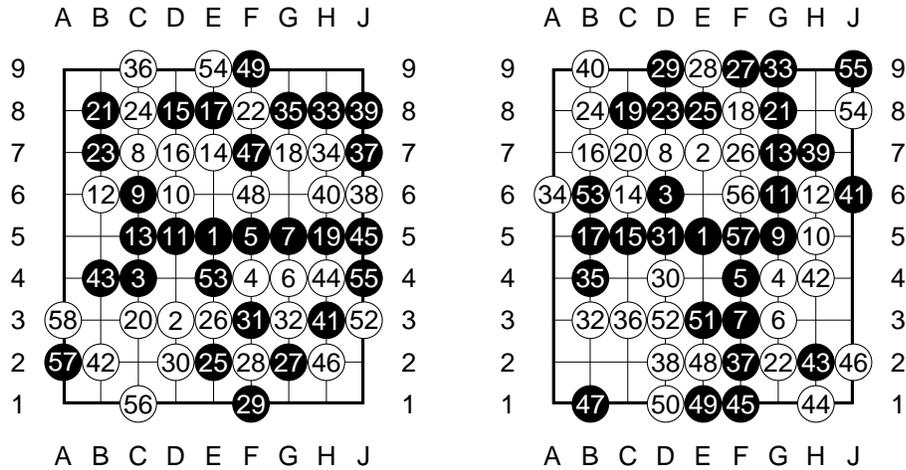


Figure 9: Playoff, Fuego - MoGo. Left: 50 at 47, 51 at 28.

the score is tied, 2 more games. If the score is still tied, colors are drawn for a deciding fifth game.

Both sides made changes to their opening book. MoGo switched to a different machine-built one. I changed the losing line with Black from the first match in Fuego.

On the left of Figure 9, Playoff Game 1: Fuego (White) - MoGo (Black). The first game follows a familiar script. White has two groups, and Black must attack. The moves up to 8 follow the book. Actually, Fuego is pessimistic in this opening, but in my judgment White is hard to kill. At move 10 Arpad already said that MoGo would lose. After White 14, both white groups look safe. For 30, connecting at F3 would simplify the game. White can live. Similarly, 52 should be on E4 and 54 on J4. Still, White lives and wins the game. At the end, Black could start a two step ko with B3, A1, D1 but cannot hope to win it. 58 moves. White wins by resignation.

On the right of Figure 9, Playoff Game 2, MoGo (White) - Fuego (Black). Move 5 is a new try after the loss in round 6 with G5. After 17, the corner looks big visually but it may not be enough to overcome the komi. I believe that with move 18, White is winning. However, 24 is a simple blunder that throws away the group, the game and the tournament. E8 instead would be a sure win. White goes for complications after this but eventually resigns. 57 moves. Black wins by resignation.

3 19 × 19 Tournament

6 programs played a double round robin. Five rounds were played on May 14, and 5 more rounds with colors reversed on May 16. The time limit was 1 hour per program for the first 250 moves, and unspecified with a possible referee's decision afterwards. These rules will be clarified for next year. Complete tournament results and all game records are given on <http://www.grappa.univ-lille3.fr/icga/tournament.php?id=193>.

Round 1: Fuego (White) - Fudo Go (Black) 1:0

The game is shown in Figure 10. Fuego often plays the one point jump of 12. 16 is an important junction point. 40 would be safer at N2. 43 is good and takes away White's eye space. White fights very aggressively in Black's sphere of influence. 51 is a surprising tenuki and seems to give White the upper hand in the fighting. 69 is a tactical mistake, since 70 captures the key stones. White has a clear advantage from this point.

Round 2: Fuego (White) - Zen (Black) 0:1

The game is shown in Figure 11. In the early opening, White goes for territory, but the exchange after move 24 reverses the position, with White getting influence and Black taking profit. 32 lacks substance. Up to 45 again White builds influence but gives Black lots of profit. 60 and 68 are slow. 72 loses points. 88 - 92 is a bad combination. White can connect at S17. 95 is big. 102 is terrible. After the sequence to 113 the game is hopeless for White. In this game, Zen was clearly the stronger program.

Round 3: Fuego (Black) - Go Intellect (White) 1:0

The game is shown in Figure 12. White gets into trouble in the bottom left corner. Up to 77, many white stones die. White cuts with 78 to find a chance, but Black captures the key stones with 89 and has a big lead.

Round 4: Fuego (Black) - GoKnot (White) 1:0

GoKnot is Jacques Basaldua's program. It plays a beautiful opening, but is still incomplete, so it has trouble in the later parts of the game. The game is shown in Figure 13.

Round 4: Zen (White) - MoGo (Black) 0:1

This round 4 game against MoGo, shown in Figure 14, is Zen's only loss in the tournament. The game looks favorable for White, but things start to go wrong in the top left corner and in the center fight. Still, White's early resignation is surprising.

Round 5: Fuego (Black) - MoGo (White) 1:0

The game is shown in Figure 15. The exchange in the top left seems OK for both. As against Zen, Fuego gives up territory in the next fight and builds influence. MoGo invades the bottom with 48 but goes wrong in the continuation. For 50, just extending at K3 would be fine. The resulting fight is good for Black. Both have low number of liberties but Black 67 works well. After 81, another complex fight starts. Just extending at G6 would be simpler. 91 is the first of three failures by Fuego to simply capture at E1. 91 makes the cut of 92 possible. 97 is the second miss. With 103, Black should save the three center stones. White's capture with 106 is big. 117 ignores E1 yet again. Black gives up a large territory in exchange for an unclear attack. Up to 128, Black isolates some white stones at the bottom but White becomes extremely strong in the top center. At this stage the game seems favorable for White. 135 is bizarre. 137 tries to cut. Up to 150, the stage is set for the decisive fight. White's chances are better but MoGo is starting to run short on time, while Fuego still has over 30 minutes left. 156 is the first bad move by Mogo in this fight. Attacking from the right or e.g. pushing on H16 seem better. 162 starts a huge ko fight. White wins it but the bottom changes hands with Black's ko threat on J1. Furthermore, Black retains the option of living in the top right corner. The game is very complex but probably better for black from this point. more complex fighting breaks out in the bottom right center. Black manages to live in sente and switch to the huge attacking move C6. The remaining fights do not change the result of this exciting game. With this win by Fuego, the top three programs Zen, MoGo and Fuego were tied for the lead after the first day, with four wins one loss each.

Round 6: Fuego (Black) - Fudo Go (White) 1:0

The game is shown in Figure 16. The sequence in the bottom left is worrying for Black. White gets a strong position. The cut at 19 seems to be an overplay. For 25, E9 seems to be the only move. But White should not play out the loose ladder. Up to 47, the result is unbelievably good for Black. 61 and 63 should just maintain the ladder on K5. 64 is better on D6. 87 is trying too hard. White 100 is a blunder. White loses either G15 or J16 in a ladder.

Round 7: Fuego (Black) - Zen (White) 0:1

The game is shown in Figure 17. For 37, M2 may be better. For 39, N2 is safe. 47 is bizarre. R5 would be normal. 51 does not work. Black's loss in this corner is huge. 57 is a move Fuego loves, but its position is too cramped here. 65 should probably cut at F14. 67 is an overplay and should connect on H15. For 81, K18 is very large. White answer to the cut on G6 is odd. Up to 117, Black gets a large territory here. For 123, L12 is natural. 127 should either continue in the lower right, or come back to L12. 135 is very bad. 145 is risky, S15 is a safe move here. 149, 151 and 175 are bizarre. For 153, R11 is safer. The sequence up to 182 is very big and gives White the lead. 193 is a blunder, White could now kill with H19. 194 is also a blunder. Still, getting a seki is

enough for White to win. 207 loses more points. The remaining Black moves have no meaning. A tough game but in the end a clear win for Zen.

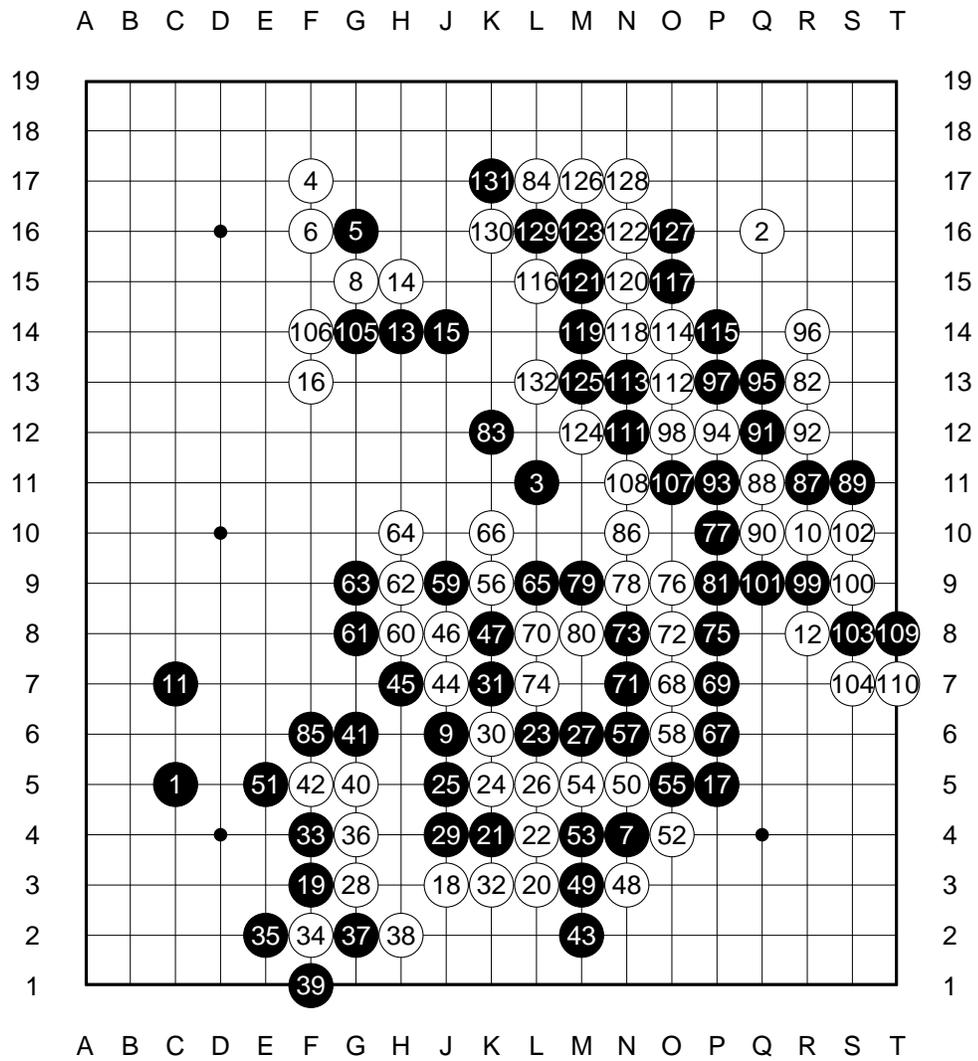


Figure 10: Round 1, Fuego (White) - Fudo Go (Black)

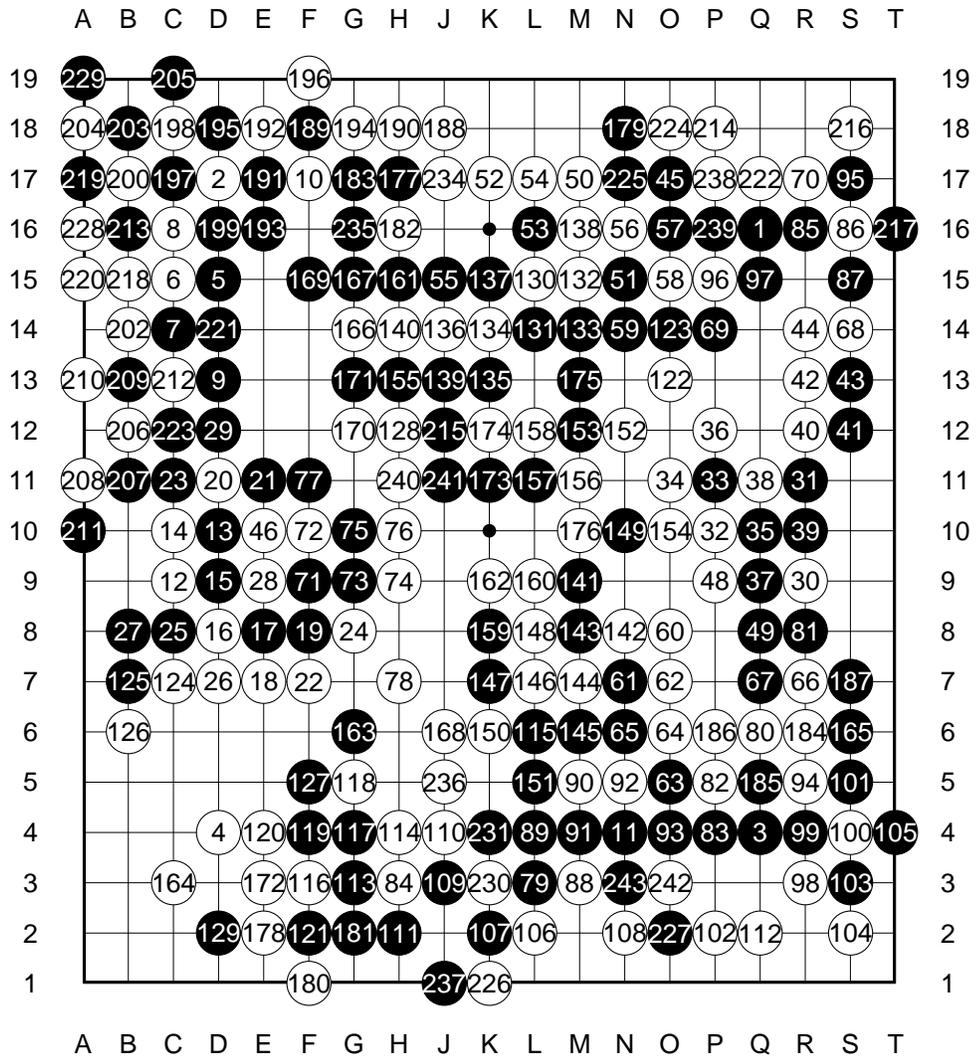


Figure 11: Round 2, Fuego (White) - Zen (Black). **47** at **(20)**, **201** at **(2)**, **232** at **(200)**, **233** at **(204)**.

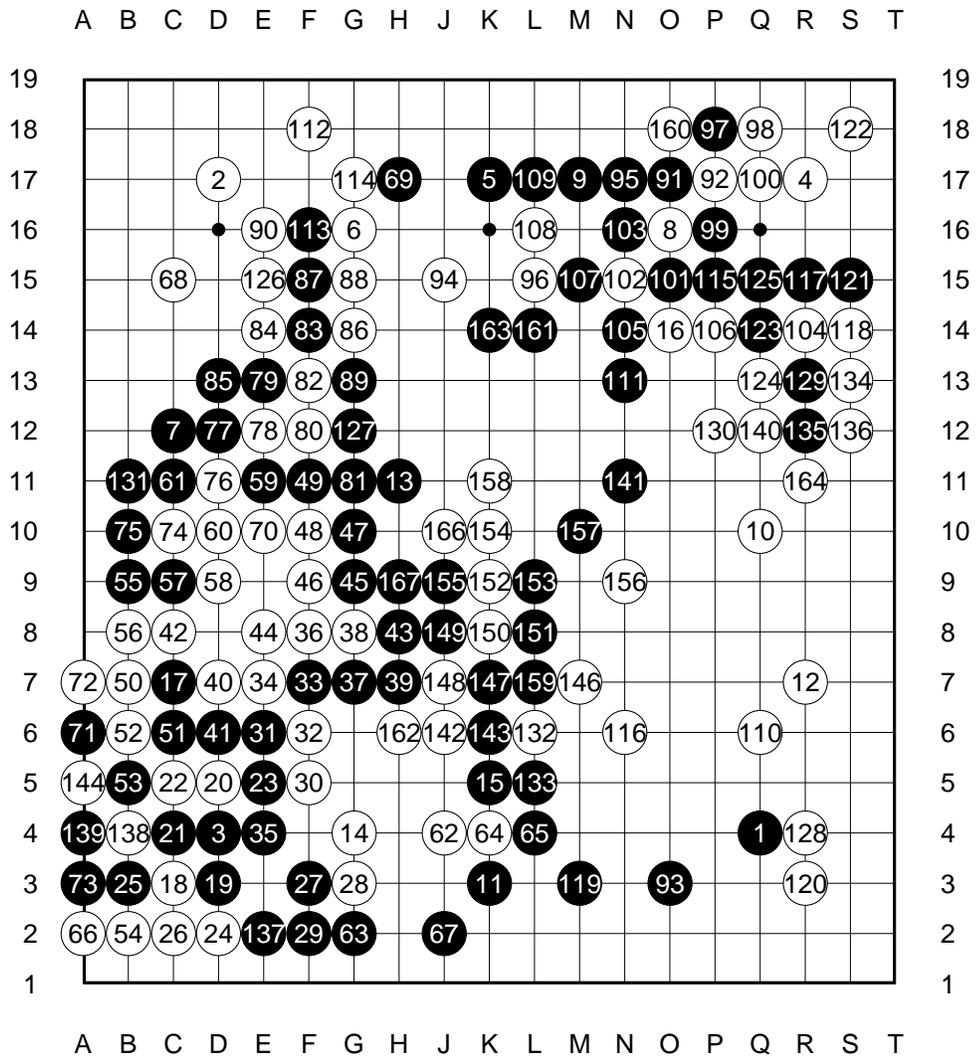


Figure 12: Round 3, Go Intellect (White) - Fuego (Black). 145 at 138, 165 at 71. 167 moves. Black wins by resignation.

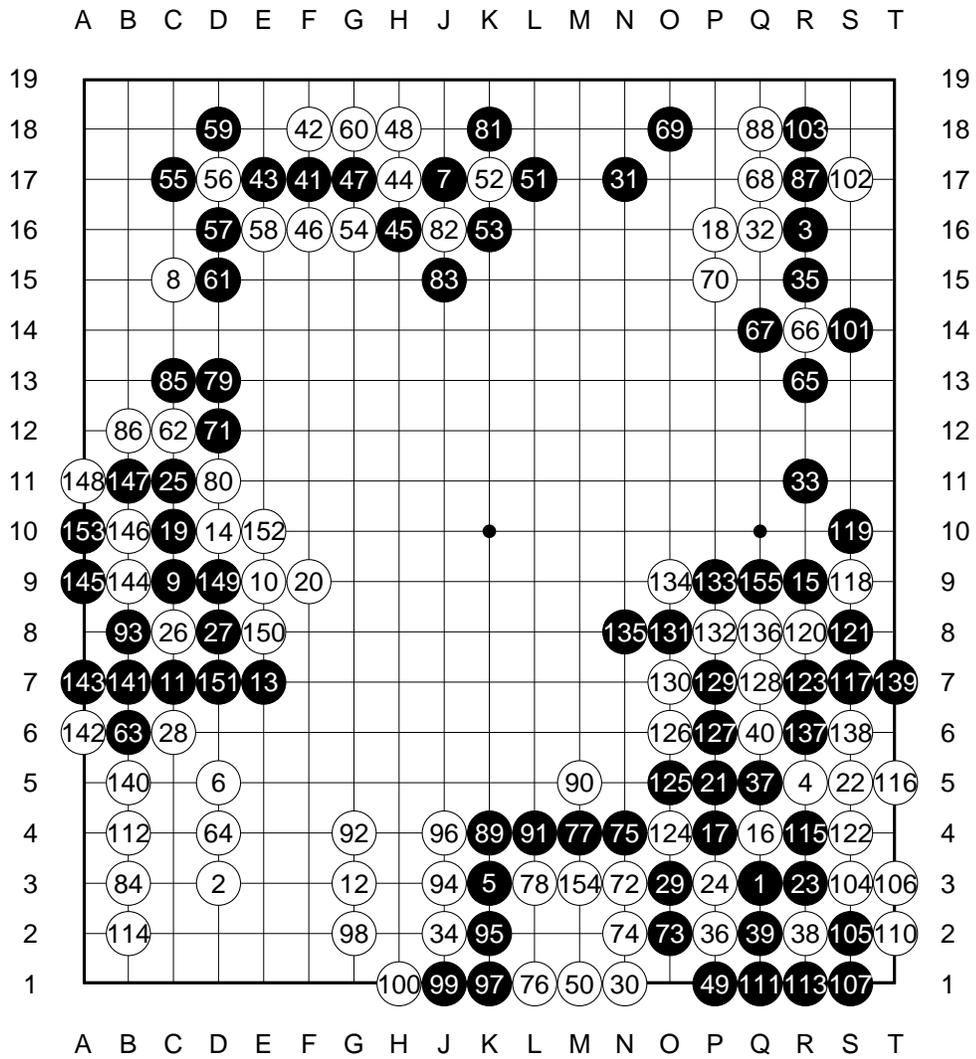


Figure 13: Round 4, GoKnot (White) - Fuego (Black). 108 at (24), 109 at (36). 155 moves. Black wins by resignation.

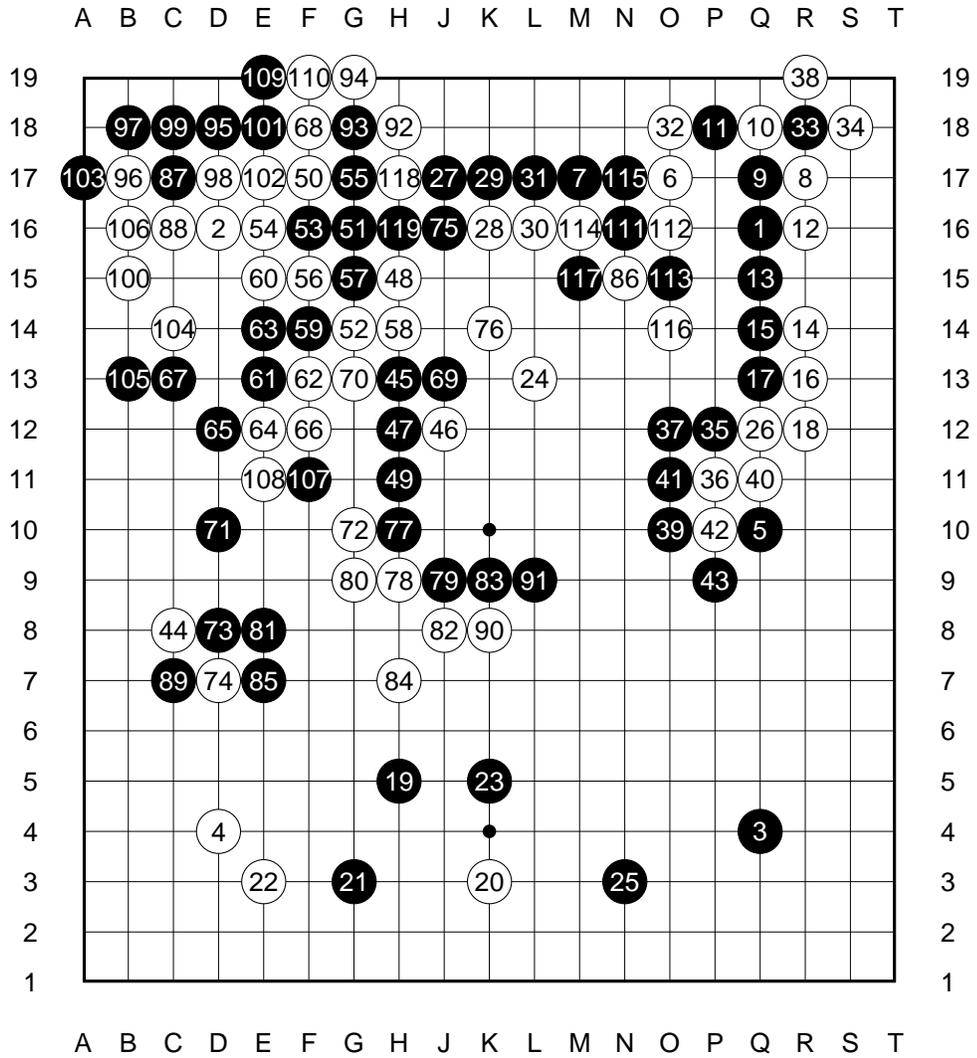


Figure 14: Round 4, Zen (White) - MoGo (Black). 119 moves. Black wins by resignation.

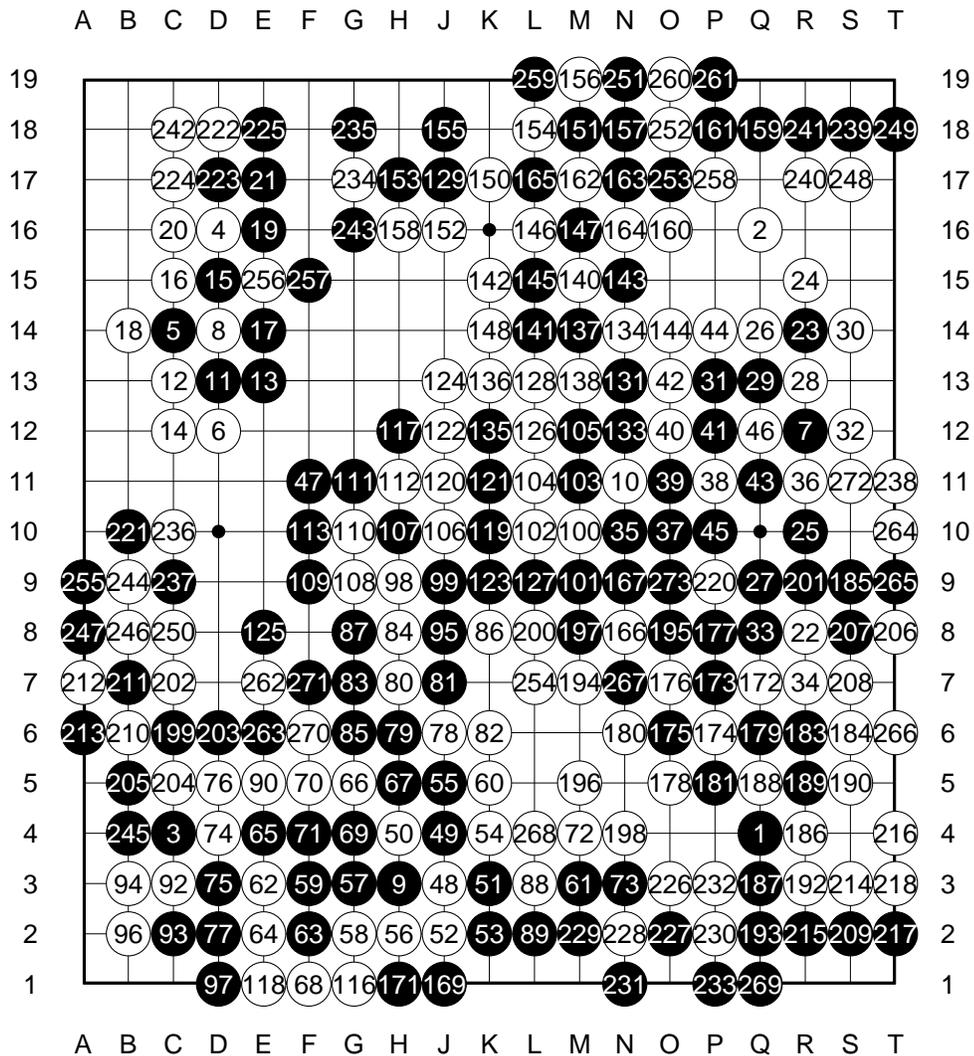


Figure 15: Round 5, MoGo (White) - Fuego (Black). 91 at 50, 114 at 107, 115 at 7, 130 at 46, 132 at 38, 139 at 10, 149 at 140, 168 at 162, 170 at 165, 182 at 175, 191 at 188, 219 at 41. 273 moves. Black wins by resignation.

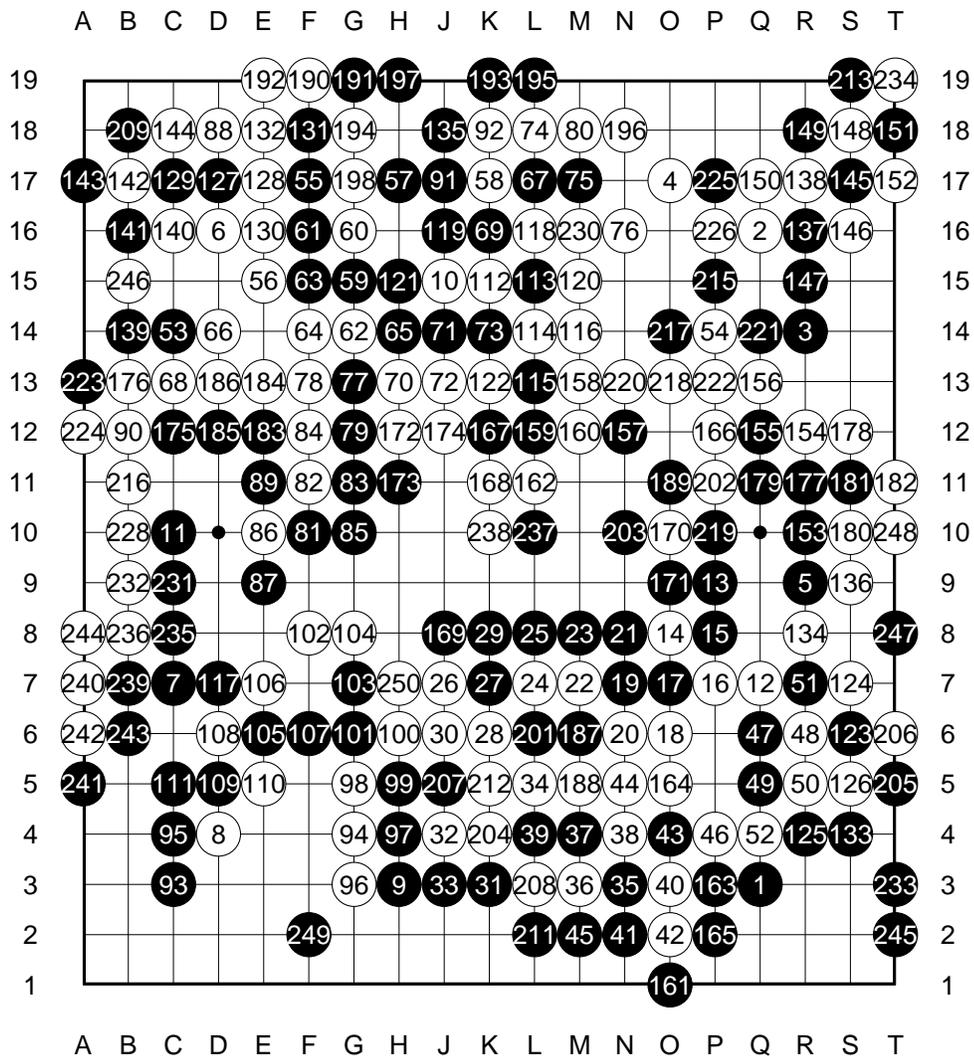


Figure 17: Round 7, Zen (White) - Fuego (Black). 199 at 113, 200 at 112, 210 at 129, 214 at 145, 227 at 10, 229 at 113, 251 at 43, 252 at 40. 252 moves. White wins by resignation.

Round 8: Fuego (White) - Go Intellect (Black) 1:0

The game is shown in Figure 18. 34 should probably be at S15. Up to 41 White becomes extremely thick, but Black takes territory. For 52, atari on P19 is the obvious move. 61 is equivalent to a pass. With 64, defending the right side would be easier to understand. 67 is big, but White tries to go for a huge center. 72 is the wrong atari and must be on R4. 79 is painful for White. Black gets itself into trouble in the top left. Up to 98 White gets a huge profit here. Now White is better. But 154, P5, is too deep. White dies in gote here and lets black make eyes in the top left. This makes the game close again. But then Black ignores the threat of 170, so White wins. From move 205, the huge block of black stones in the middle remains unsettled until 263 accidentally saves them. 267 is suicidal and makes them unsettled again. After 278, Black ran out of time, but it had passed the 250 move mark. Since White has a safe lead of over 10 points even if Black's block lives, Black's operator resigned.

Round 9: Fuego (White) - GoKnot (Black) 1:0

The game is shown in Figure 19.

Round 9: MoGo (White) - Zen (Black) 0:1

The game that decided the championship, shown in Figure 20. It was actually played last, after the end of round 10. The game was favorable for MoGo in the middle game, but again MoGo ran short on time, and got outplayed in the fight after move 170.

Round 10: Fuego (White) - MoGo (Black) 1:0

The last game for Fuego is shown in Figure 21. For this game, MoGo switched to the Huygens supercomputer, <http://huygens.supercomputer.nl/>. MoGo used 20 nodes with 32 cores each, for 640 cores in total. White 10 is wrong, joseki is R4. Up to 27, Black's profit seems superior to White's influence. For 38, the only shape is ko at S13. 64 looks like a strong attack but 69 is very good. White gets no compensation for the loss of the bottom left. With 75 and 79 it is Black's turn to go wrong. 75 on S7 and 79 on S8 were better. Up to 86 the black stones are cut off. White should answer 105. The fight at the bottom ends with black capturing five stones and White solidifying its position. White 135 and 137 are extremely big. The game is good for White now. 162 moves. White wins by resignation.

Appendix: Fuego Technical Details

The program version was svn version 869 and 871. The only differences in 871 are some changes to the 9 × 9 opening book. The default settings were used, except for the following. Please see the Fuego documentation for explanations.

```
go_param debug_to_comment 1
go_param auto_save (filename)
```

```
go_sentinel_file (filename)
uct_param_search max_nodes 150000000
uct_param_player reuse_subtree 1
uct_param_player ponder 1
go_rules kgs
sg_param time_mode real
uct_param_search number_threads 8
uct_param_search lock_free 1
uct_param_search virtual_loss 1
uct_param_search number_playouts 2
```

The most interesting of those is probably `uct_param_search number_playouts 2`. It was used only on 9×9 . The benefit of doing two playouts per leaf is to reduce memory contention, since fewer tree updates are performed. In informal tests before the competition, this was slightly better than the default of one playout.

In addition to the standard Fuego settings above, there were more settings for controlling the experimental code in FuegoEx and the MPI parallelization.

Revision History

Version 1 Published May 25, 2009

Version 2 Published May 28, 2009. Fixed typos and Figure numbering. Added references to Figures for 19×19 games.

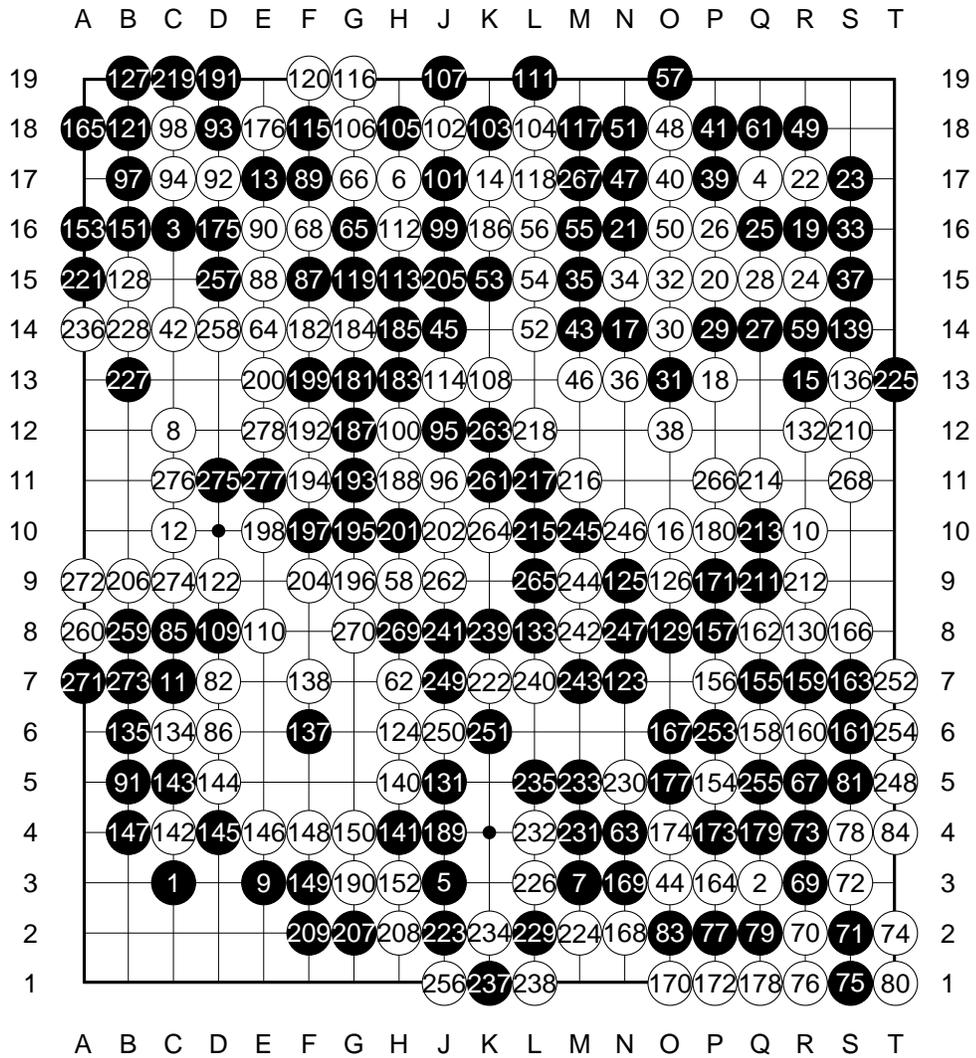


Figure 18: Round 8, Fuego (White) - Go Intellect (Black). (60) at (31), (203) at (102), (220) at (13). 278 moves. White wins by resignation.

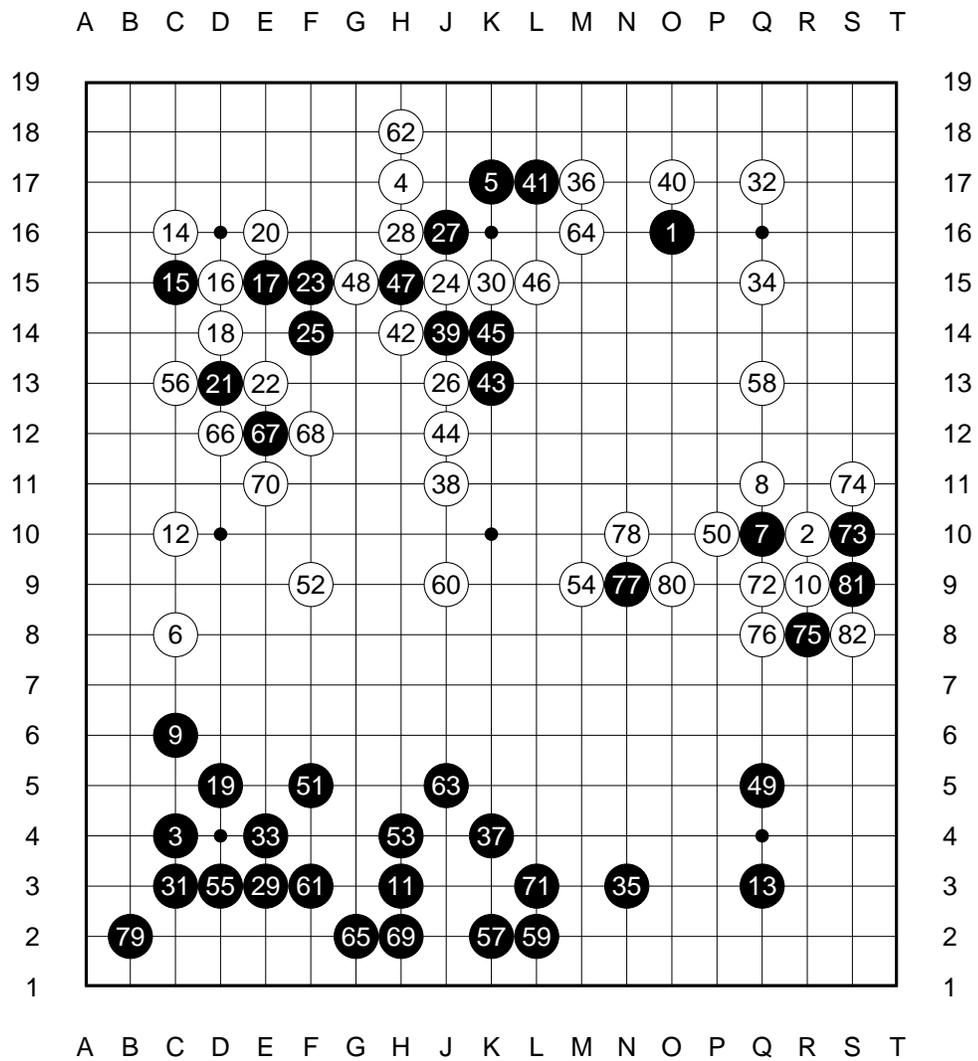


Figure 19: Round 9, Fuego (White) - GoKnot (Black). 82 moves. White wins by resignation.

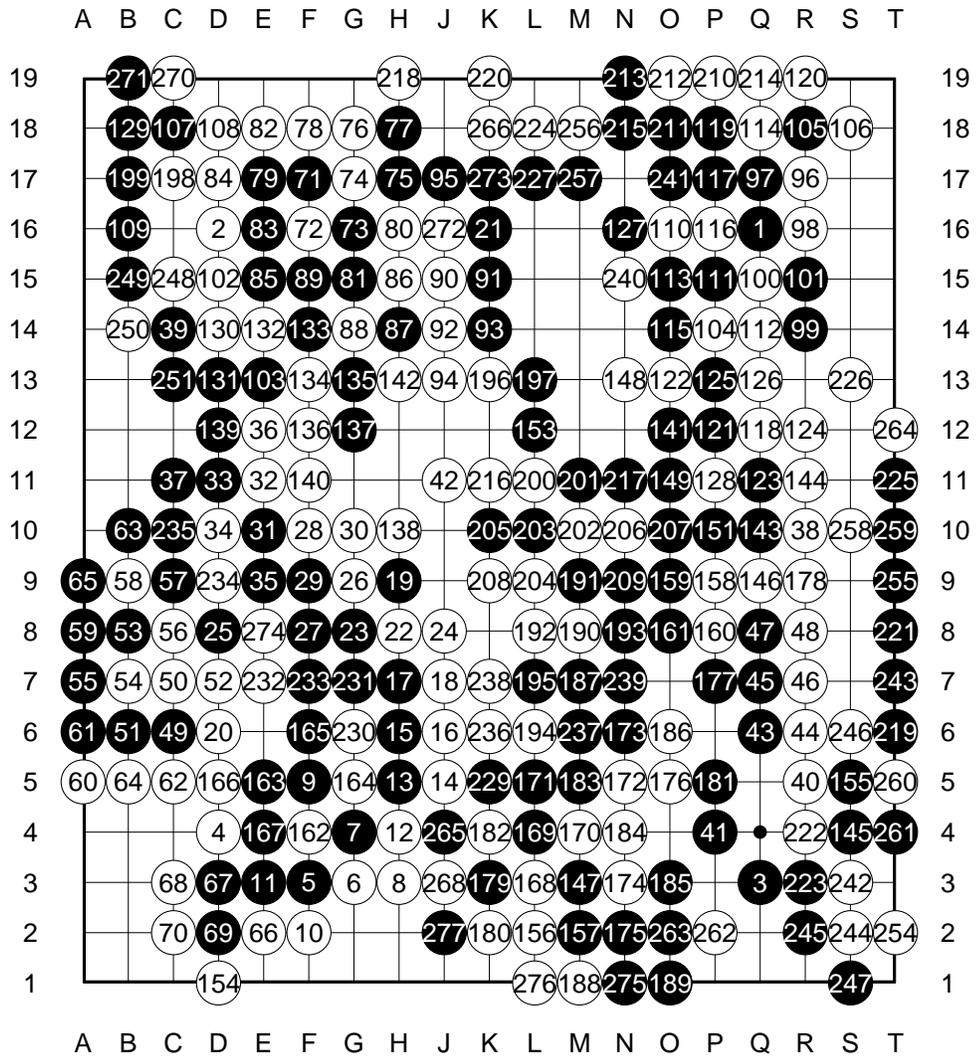


Figure 20: Round 9, MoGo (White) - Zen (Black). 150 at 88, 152 at 72, 228 at 7, 252 at 202, 253 at 206, 267 at 260, 269 at 182. 277 moves. Black wins by resignation.

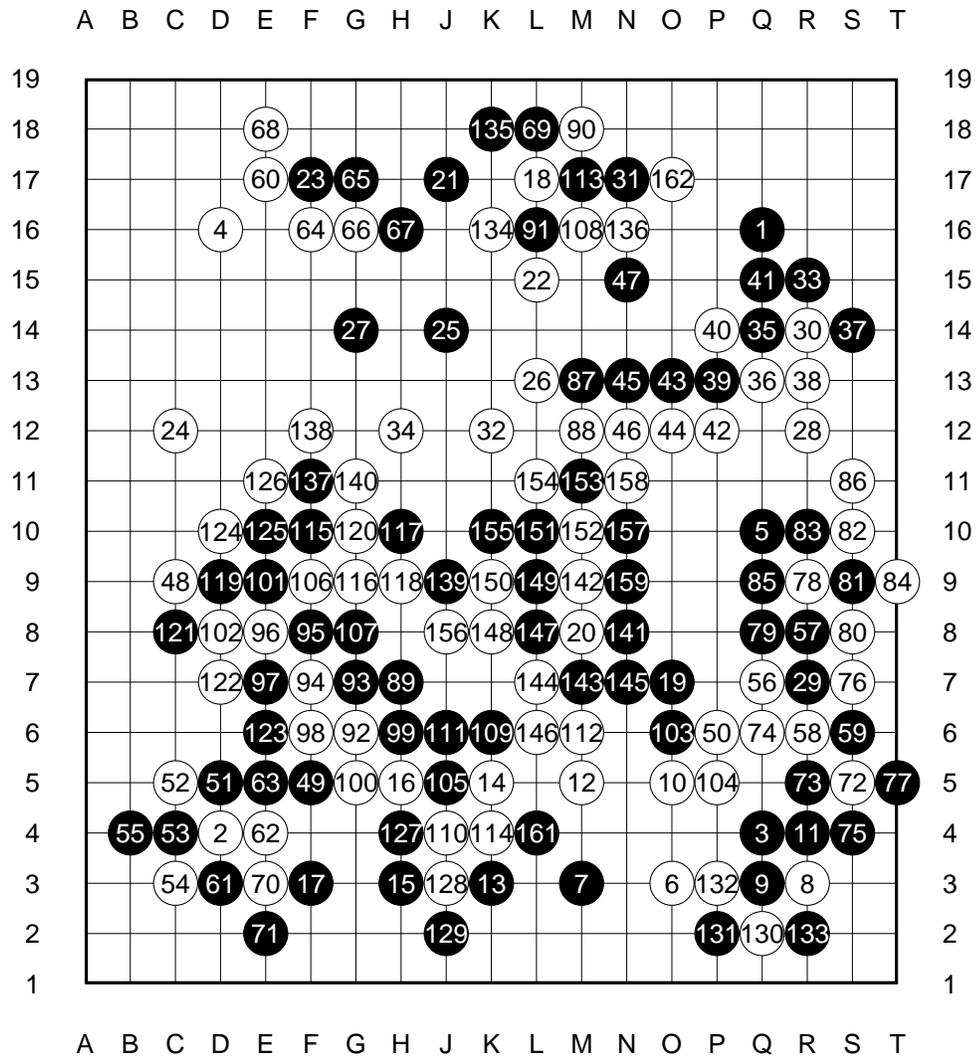


Figure 21: Round 10, Fuego (White) - MoGo (Black). 160 at 153. 162 moves. White wins by resignation.