

HUMAN-COMPUTER GO REVOLUTION 2008

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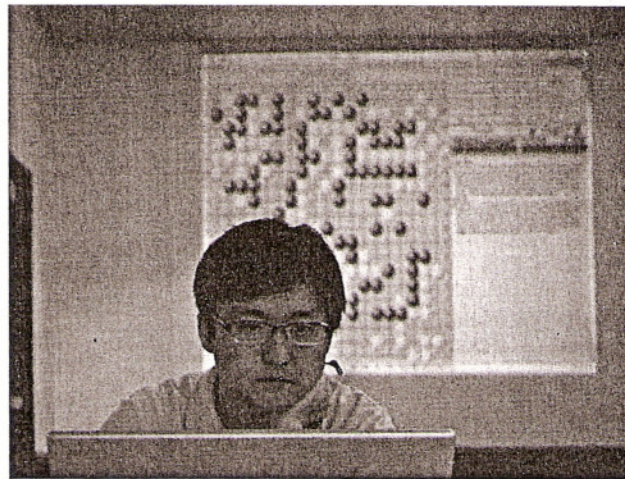
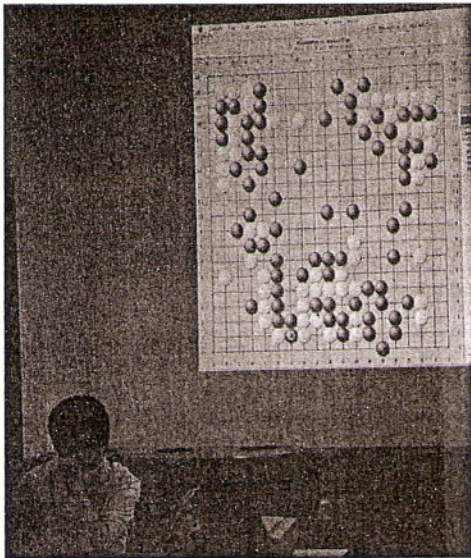
The Netherlands France Taiwan

Abstract

During the last three years, the level of Go programs has improved tremendously due to a new technique: Monte-Carlo Tree Search. In 2008, several Human-Computer Go events have been organized to assess the level of the new programs. MOGO (in some contests called MOGO TITAN) and CRAZYSTONE, the two pioneer Monte-Carlo Go Tree Search programs, managed to defeat professional players for the first time in history. MOGO won on the 9x9 board, and MOGO TITAN on the 19x19 board with a 9-stones handicap. A short time later, CRAZYSTONE set a new record by winning a game on a 19x19 board with an 8-stones handicap. In this report, we present the results of the most important human-computer matches that took place in 2008, in the USA, Japan, and Taiwan.

1. MOGO TITAN vs. Kim Myungwan, 8 dan professional, in Portland, Oregon, USA

The official 9-stones handicap game was played between MOGO TITAN and Kim Myungwan, an 8 dan professional. The game was played live on the 7th of August at the U.S. Go Congress, with over 500 persons watching online on the internet Go server KGS. During the congress, Kim Myungwan also played the US Open, which he won. The match against MOGO TITAN was played with one hour of thinking time per player; there was a 9-stones handicap for the human player. MOGO TITAN was using 800 cores of the supercomputer Huygens, provided by the Dutch research organization NCF in cooperation with SARA.



"MOGO TITAN played really well," said Kim, who estimated MOGO TITAN's current strength at "two or maybe three dan," though he noted that the program – which had a processing power of more than 1000 times higher than the chess program DEEP BLUE – "made some 5-dan moves." "I think there is no chance for me when the computer has a nine-stones advantage, it would even be difficult with eight stones. MOGO TITAN played really well; after getting a lead, every time I played aggressively, it just played safely, even when it meant sacrificing some stones. It did not try to maximize the win and just played the most sure way to win. It is like a machine."

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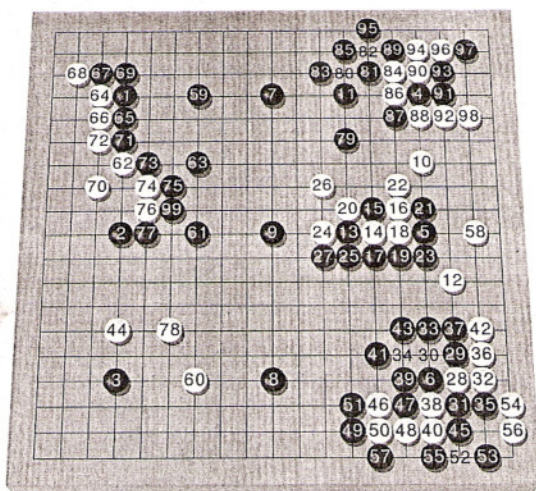


Figure 1: The moves 1 to 99 in the game MOGO TITAN vs. Kim Myungwan.

2. CRAZYSTONE vs. Kaori Aoba, 4 dan professional, in Tokyo, Japan

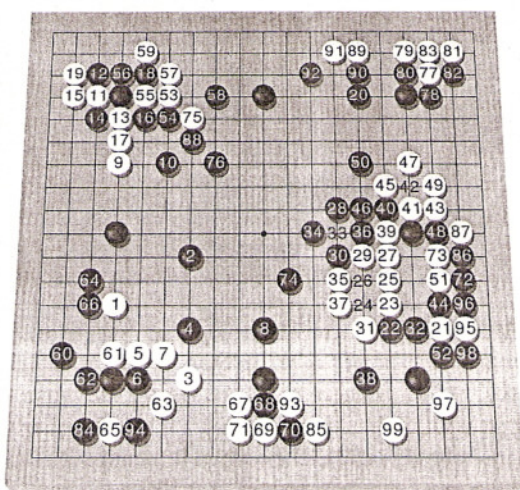
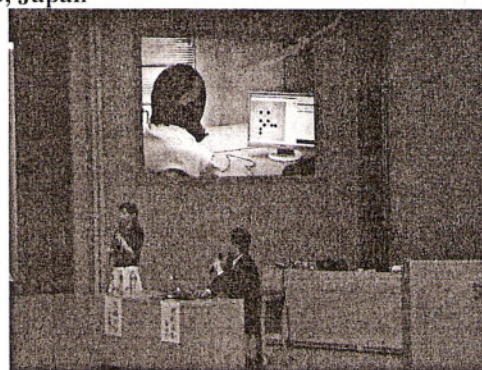
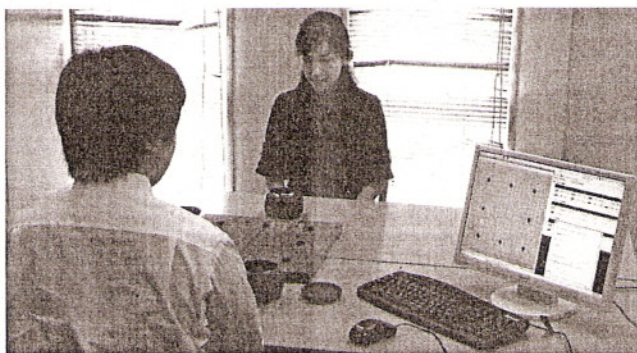


Figure 2: The moves 1 to 99 in the game CRAZYSTONE vs. Kaori Aoba

3. MOGO TITAN vs. Kim Myungwan, 8 dan professional, in Los Angeles, California, USA

A re-match between MOGO TITAN and Kim Myungwan was organized on the 21st of September in Los Angeles, during the Cotsen Go Tournament, in order to test whether MOGO TITAN could defeat Kim Myungwan even with a 7-stones handicap. The 7-stones handicap is quite different from 8-stones handicap, since it creates two

Before this match, three blitz matches were played, with 9-, 11-, and 12-stones handicap, and between 10 and 15 minutes per player. Kim Myungwan won the 9-stones and 11-stones handicap games, which suggests that Monte-Carlo Tree Search performs significantly better against a human being with a long thinking time. The first 99 moves of the game are reported in Figure 1.

The match between CRAZYSTONE and Kaori Aoba was organized in Tokyo on September 4th during the FIT2008 conference. It had been planned to be played with a 9-stones handicap. However, after the victory of MOGO TITAN against Kim Myungwan with 9 stones, it was decided to use only a 8-stones handicap in order to try to establish a new record. The time control was set to 30 seconds per move, which is more than the time of MOGO TITAN against Kim Myungwan. However, CRAZYSTONE was using only 8 cores on a dual quad-core processor. The match can be considered as quite peaceful, as no complex fights occurred. CRAZYSTONE played solid moves the whole game, which maintained a sufficient advantage to the end of the game. Kaori Aoba resigned at the move 186. The first 99 moves of the game are reported in Figure 2.

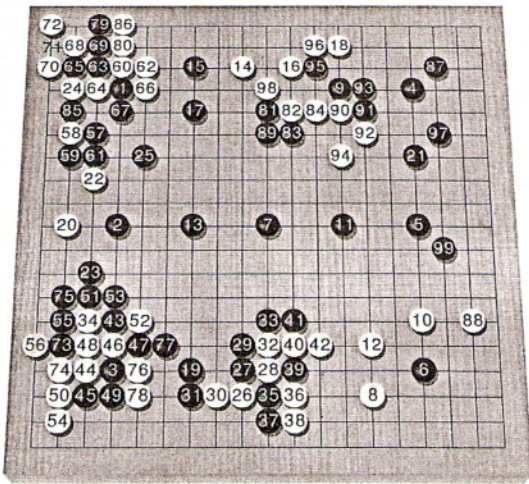


Figure 3: The moves 1 to 99 in the game MOGO TITAN vs. Kim Myungwan.

4. MOGO vs. Human Players, Taiwan

From August 26 to October 4 (<http://go.nutn.edu.tw/>) there was a human-computer contest at the National University of Tainan (NUTN) in Taiwan. We constructed a platform for the Go games. The profiles of all the Go players competing with MOGO in Taiwan are listed in Table 1. The Chinese rule was adopted and the related parameters of the games are listed in Table 2.

Title	Name	Age	Sex	Dan grade
Mr.	Jun-Xun Zhou	28	Male	9P Professional
Mr.	Biing-Shiun Luoh	45	Male	6D Amateur
Prof.	Shang-Rong Tsai	55	Male	6D Amateur
Mr.	Cheng-Shu Chang	50	Male	6D Amateur
Prof.	Cheng-Wen Dong	70	Male	5D Amateur
Child	Yu-Shu Huang	12	Female	4D Amateur
Child	Yu-Xin Wang	11	Male	3D Amateur
Mr.	Wen-Tong Yu	50	Male	3D Amateur
Child	Sheng-Yu Tang	10	Male	2D Amateur

Table 1: Profiles of all the Go players competing with MOGO.

Game Board	Komi	Time per side (min)
9×9	7.5 unless otherwise stated (some games with Komi 6.5)	30
19×19	7.5	45

Table 2: Parameters of the game.

During the tournament, MOGO ran (1) on the DELL PowerEdge R900 machine with 16 cores and (2) on the Supercomputer “Huygens” provided by the Dutch research organizations NCF and SARA. MOGO was allowed to use at most 25 out of the 104 nodes of the Supercomputer, i.e., 800 cores at 4.7GHz, with a floating point processing power of 15 Teraflop (more than 1000 times DEEP BLUE). The games were played through the KGS Go server platform when MOGO ran on the Huygens with different numbers of cores. Table III lists the related information and the results of the games that MOGO played against nine Taiwanese Go players in the tournament. The first column shows the game number and the second column denotes the performance of MOGO. The performance is represented by $XD+$ or $XD-$ with $X = L - H$, where L is the rank of a player and H is the handicap level. If MOGO won, then its performance is $XD+$, otherwise its performance is $XD-$. The level X kyu corresponds to $-(X-1)$ Dan; the higher the Dan number, the stronger the player. The 9P Mr. Zhou is assumed to be equivalent to 10P. Besides, we invited Mr. Biing-Shiun Luoh, who is a Go teacher with 6D amateur, and Prof. Shang-Rong Tsai to comment on some game results. Their comments on 9×9 and 19×19 games are stated in the next two subsections, respectively.

empty sides on the board. The time setting was set to 90 minutes per side, and MOGO TITAN was using the same hardware than for the 9-stones match: 800 cores of the supercomputer Huygens. In this match, MOGO TITAN initiated fights during the fuseki (first part of the game), from which it could build a strong central territory in the chuban (middle of the game). At the start of the jose (endgame), MOGO TITAN had a clear territorial advantage. However, it did not secure its territory well enough in the endgame, and lost its center. Such a behaviour is rare for a computer Monte-Carlo Tree Search program, which is usually strong at the endgame. MOGO TITAN resigned at move 262. The first 99 moves of the game are reported in Figure 3.

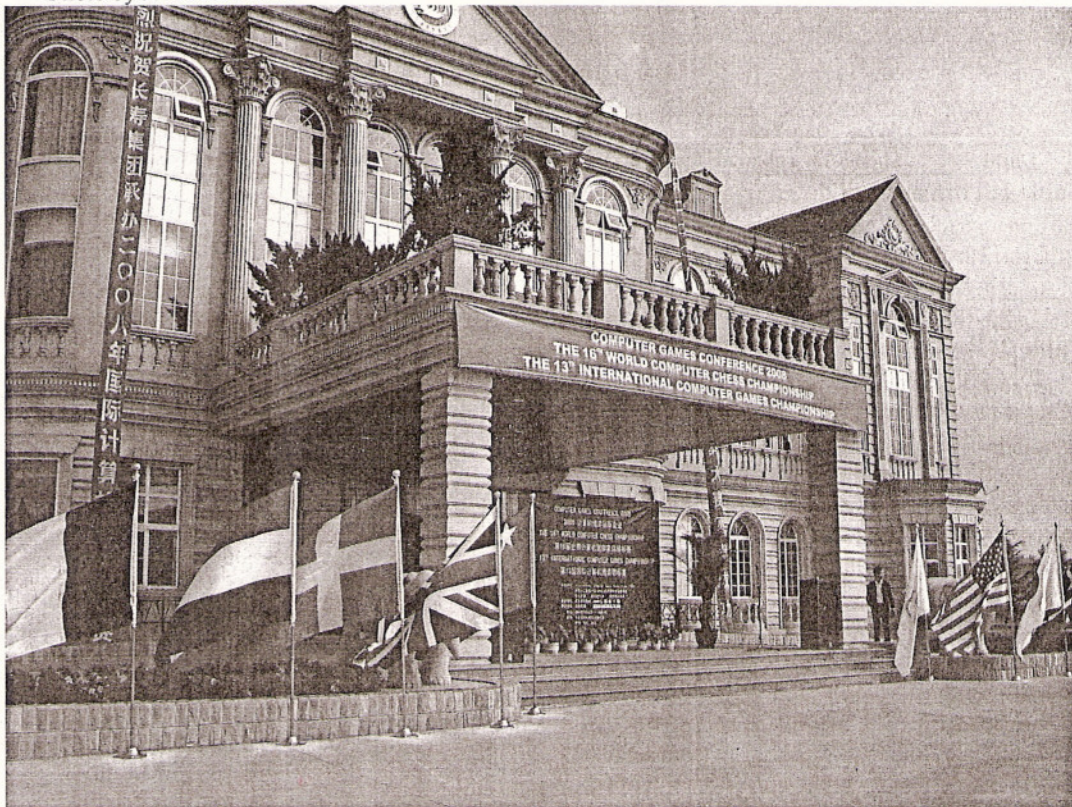
No	Performance	Date	Setup	Environment	White	Black	Result
1	9×9 5D+	08/26/2008	9×9	Huygens with 150CPUs	MoGo	Prof. Dong	W+0.5
2	1kyu+	08/26/2008	19×19 H5	Huygens with 150CPUs	Prof. Dong	MoGo	B+0.5
3	9×9 6D+	08/26/2008	9×9	Huygens with 150CPUs	Prof. Tsai	MoGo	B+Resign
4	9×9 6D-	08/26/2008	9×9	Huygens with 150CPUs	MoGo	Mr. Luoh	B+Resign
5	2 kyu+	09/24/2008	19×19 H6	R900 machine	Prof. Dong	MoGo	B+Resign
6	1D+	09/24/2008	19×19 H4	R900 machine	Prof. Dong	MoGo	B+Resign
7	1D+	09/25/2008	19×19 H4	R900 machine	Prof. Dong	MoGo	B+Resign
8	1D+	09/25/2008	19×19 H4	R900 machine	Prof. Dong	MoGo	B+Resign
9	1D+	09/25/2008	19×19 H4	R900 machine	Prof. Dong	MoGo	B+0.5
10	9×9 6D-	09/25/2008	9×9	Huygens with 320CPUs	Mr. Luoh	MoGo	W+Resign
11	9×9 6D-	09/25/2008	9×9	Huygens with 320CPUs	MoGo	Mr. Luoh	B+Resign
12	2D-	09/25/2008	19×19 H4	Huygens with 320CPUs	Mr. Luoh	MoGo	W+Resign
13	1D+	09/27/2008	19×19 H5	Huygens with 480CPUs	Prof. Tsai	MoGo	B+1.5
14	1D+	09/27/2008	19×19 H5	Huygens with 480CPUs	Mr. Chang	MoGo	B+1.5
15	9×9 10D-	09/27/2008	9×9	Huygens with 800CPUs	Mr. Zhou	MoGo	W+Resign
16	9×9 10D-	09/27/2008	9×9	Huygens with 800CPUs	MoGo	Mr. Zhou	B+Resign
17	3D-	09/27/2008	19×19 H7	Huygens with 800CPUs	Mr. Zhou	MoGo	W+Resign
18	3D+	10/02/2008	19×19	R900 machine	MoGo	Mr. Yu	W+11.5
19	2D+	10/02/2008	19×19 H4	R900 machine	Mr. Luoh	MoGo	B+7.5
20	1D-	10/03/2008	19×19 H5	R900 machine	Prof. Tsai	MoGo	W+Resign
21	1D-	10/03/2008	19×19 H5	R900 machine	Prof. Tsai	MoGo	W+Resign
22	4D+	10/04/2008	19×19	R900 machine	Child Huang	MoGo	B+0.5
23	3D+	10/04/2008	19×19	R900 machine	Child Wang	MoGo	B+2.5
24	9×9 2D+	10/04/2008	9×9	R900 machine	Child Tang	MoGo	B+0.5

Table 3: Related information and results of the games that MoGo played against humans in the tournament.

Comments on the 9×9 games

The games No. 15 and No. 16 are 9×9 and very interesting. In these two games, MoGo played with the 9P Go player, Mr. Zhou. The boards for these two 9×9 games are shown in the Figures 4 and 5, respectively.

Photo by Joke Hellemons



The venue of the CG2008 Conference and the 13th International Computer-Games Championship.

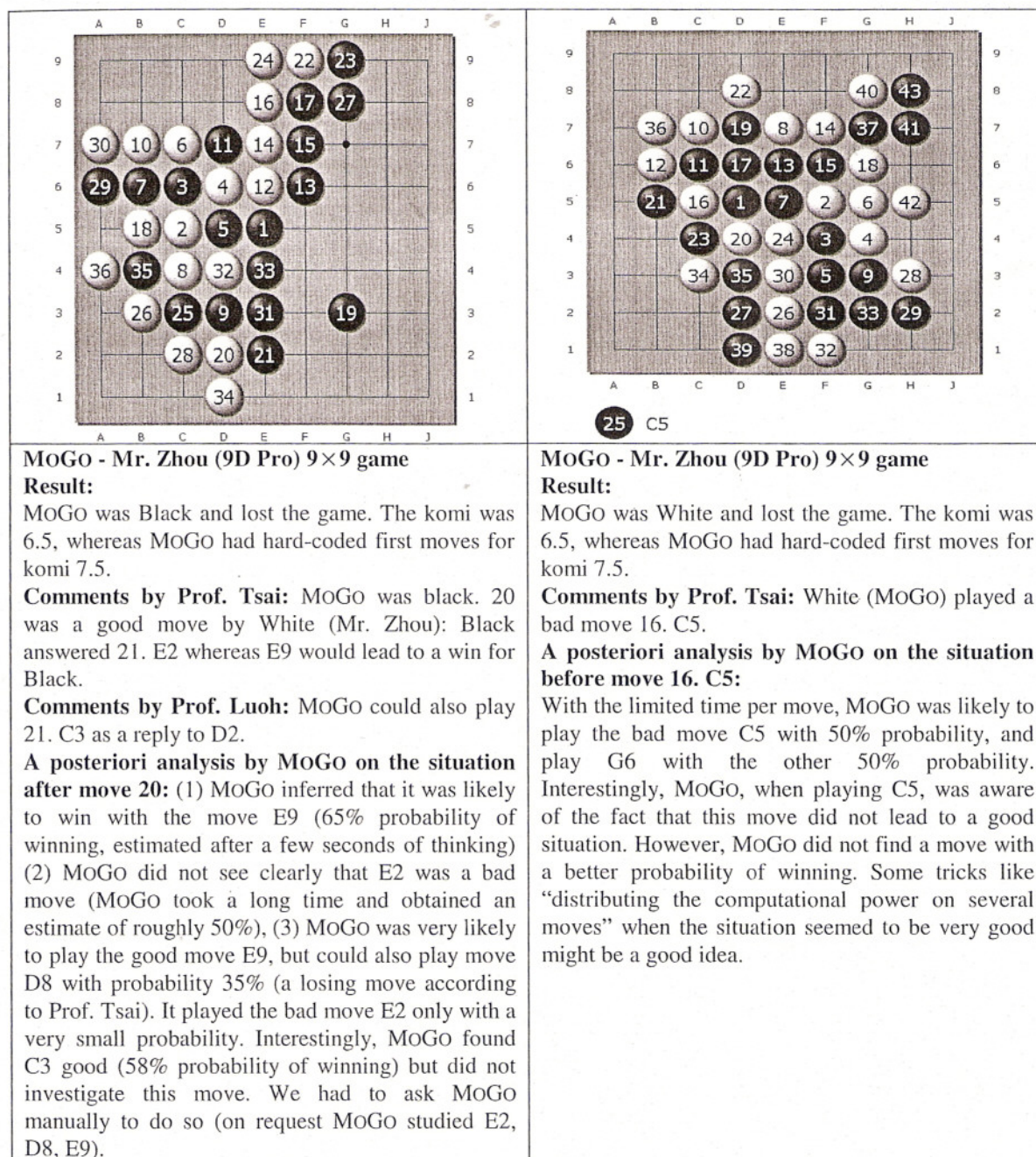
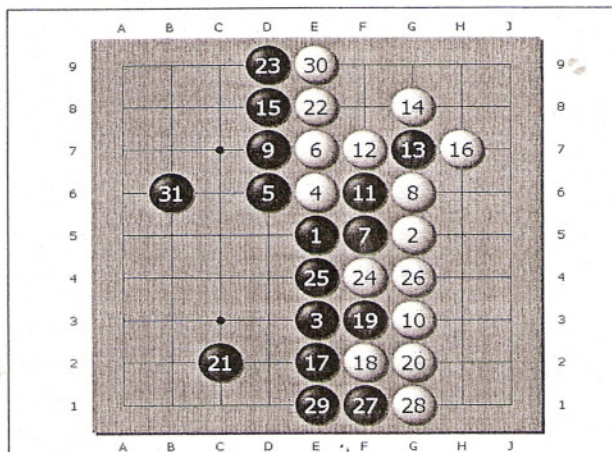


Figure 4: Game No. 15.

Figure 5: Game No. 16.

According to Prof. Tsai's and Mr. Zhou's comments, the game No. 15 was worth studying because MOGO might have a chance to win. But MOGO was tricked by Mr. Zhou by White 20 and lost the game. Mr. Zhou analyzed that if the time per side could be lengthened, then MOGO would take much more advantage. 9×9 Go is the first field invaded by the MCTS methods. However, the playing results in Taiwan were not good against top-level human players, as MOGO lost most of his 9×9 games: two games against Mr. Zhou, three games against Mr. Luoh. However, the komi has been modified in some games so that MOGO did not play the komi for which its openings were optimized. Besides, the first game against Mr. Zhou was difficult. The professional player estimated during the game that MOGO was likely to win the game, before its big mistake (see Figure 4). Nonetheless, MOGO won one out of the two games against 6D Prof. Tsai. Figure 6 and Figure 7 show the results of the game No. 3 and game No. 4, respectively. Figure 8 shows the result of the game No. 10.



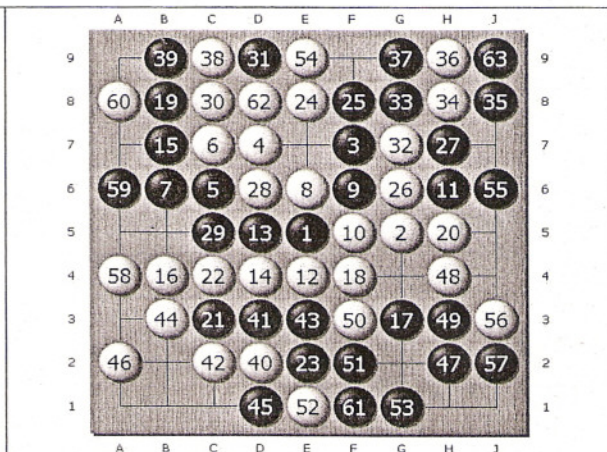
MOGO - Prof. Tsai (6D)

Result:

MOGO was Black and won the 9x9 game.

Comments by Prof. Tsai: With Black, MOGO played good moves 11, 13, and 15. MOGO showed a good yose technique. Therefore, Black obtained yose at 17.

Figure 6: Game No. 3.



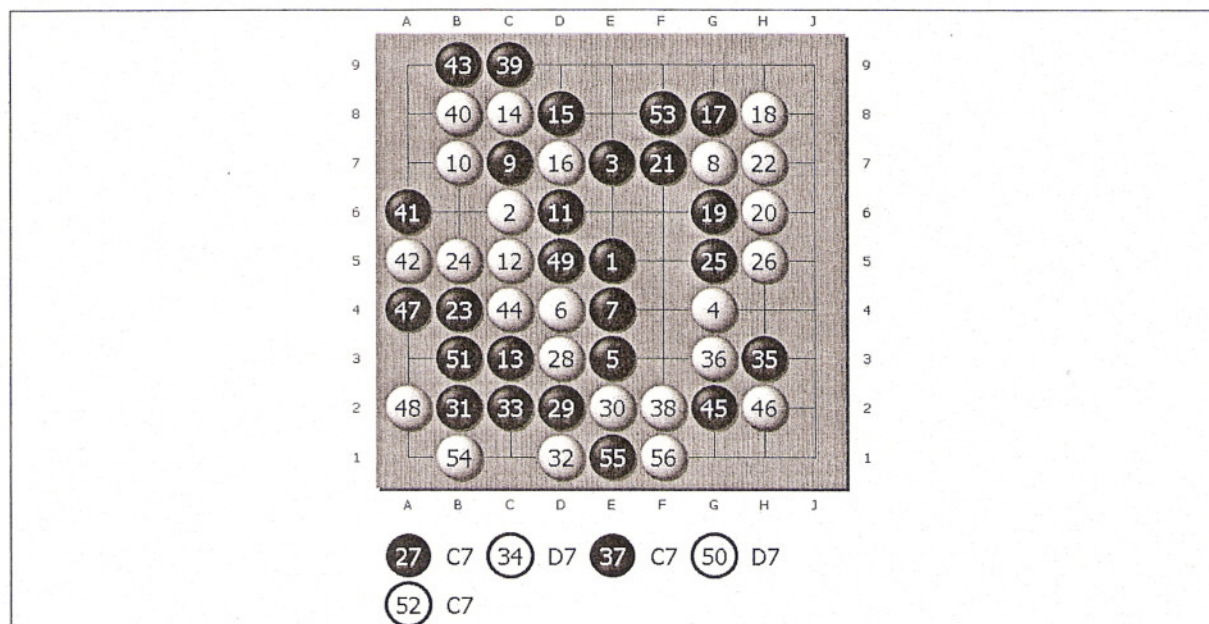
Mr. Luoh (6D) - MOGO

Result:

MOGO was White and lost the game.

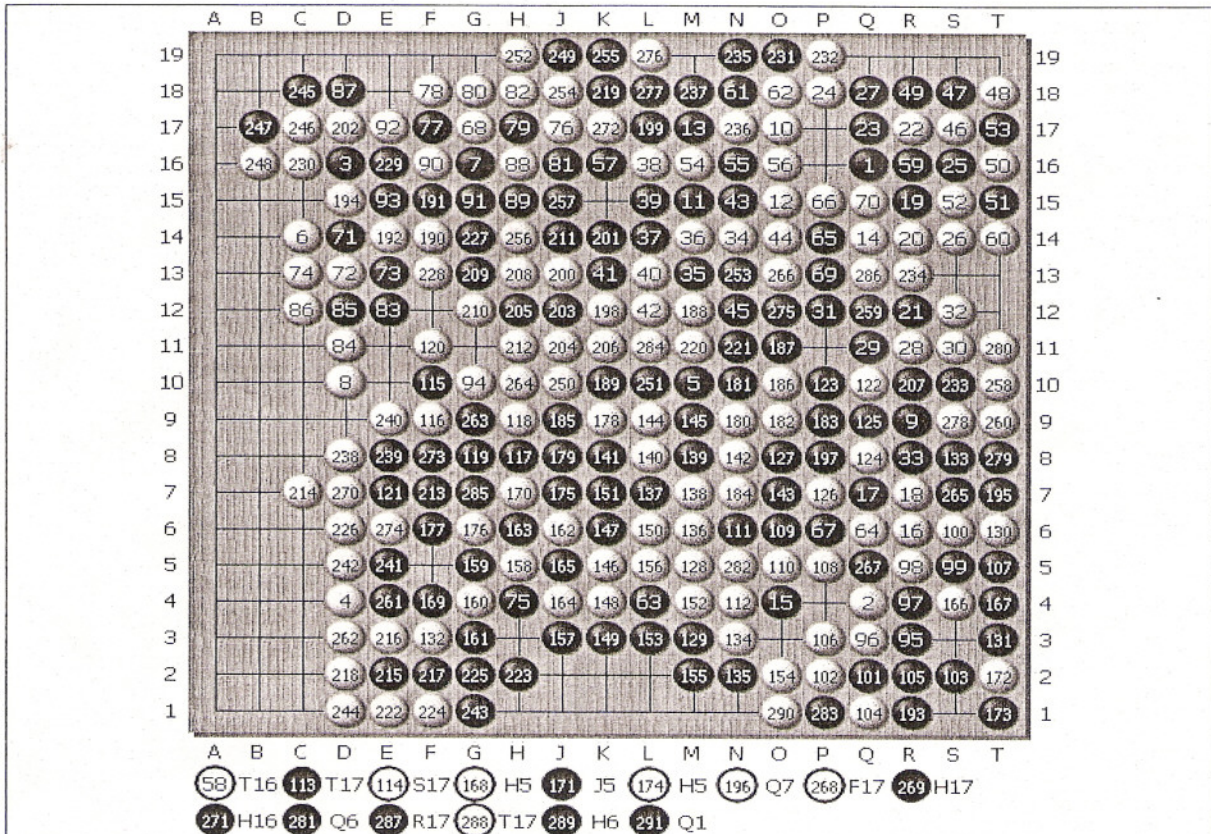
Comments by Prof. Tsai: This game focussed on complex fights. Therefore, there were so many variations in the game that it was difficult to analyse.

Figure 7: Game No. 4.



Comments on 19×19 games

It is very clear from the table of results, as well as from many Monte-Carlo Tree Search programs that MOGO does not like handicap games; its results are much better in games without a handicap. In particular, in the Taiwan games, MOGO did not lose a single game against players of the 4th Dan or below, independently of the handicap, whereas MOGO lost 5 handicap games against 5th Dan players. Below we provide an interesting 19x19 game played without handicap, and won by MOGO, against a 4th Dan player.



Game against Child Huang (4D), without handicap stones.

Result: MOGO was Black and won the game. The game was characterized by a big fight, which was favourable for MOGO.

Conclusion

Human-Computer Go matches are becoming increasingly popular as the level of programs increases quickly. From the results of the matches, it appears that the new programs are able to win against professionals on a 9x9 board, and on a 19x19 board with 9- and 8-stones handicap. Winning an even match on 19x19 still remains a long-term challenge, but computers might outperform the best player on the 9x9 board in the near future. Only such an event is already remarkable since nobody would have believed it to be possible three years ago.