

## Othello: Game of the Century

By Murakami Takeshi

Millions on this globe devote much of their lives to playing chess, shogi or *go*, fascinated by the seemingly small but actually infinite universe of these age-old games. But how many of these people know Othello? It is relatively new, yet it has the power and glamour to grip people in the same way its predecessors do.

I was captivated by the game of Othello as a high school student in 1981, and often enjoyed a quick game of Othello between classes with my friends. All those around me regarded Othello as a children's game, very simple and nothing at all like shogi or *go*, the popular Japanese games that attract hundreds of thousands of players for their profound complexity. But Othello had a peculiar charm unlike that of any other board game.

The concept was so easy that even young children could easily learn to play. Yet no one, not even grownups, could be quite sure of the correct strategy. The objective is to see who can get the most discs, but since so many discs are flipped with each move, you never know which side is really winning until the very end.

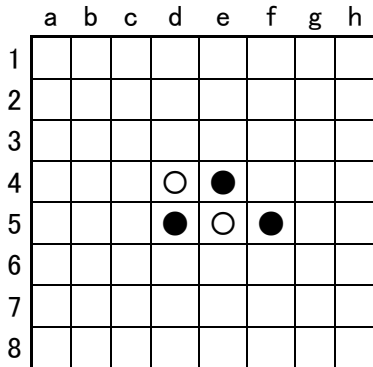
Playing it casually with my classmates, I felt as if I were standing before a cave, which, disguised by the simplicity of its rules, held a hidden inner dimension beyond the ken of human intelligence. I was pushed into the labyrinth by my first, devastating encounter with a dan-holder. Dans are ranks based on skill, as in martial arts, shogi and other Japanese sports and games. The ninth dan is the highest, and holding even the first dan suggests a considerable degree of skill. Having played many games with my friends, I had gained some skill at Othello—at least enough to beat everyone around me.





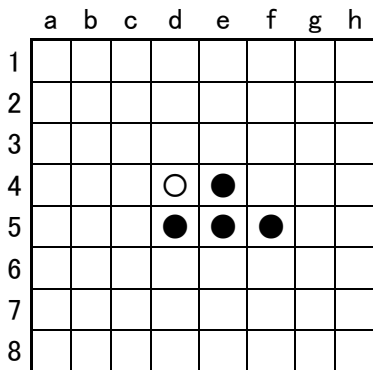
Starting position of Othello. Black to play.

Black plays to a square that puts at least one white disc between the black disc just placed and any other black disc already on the board.



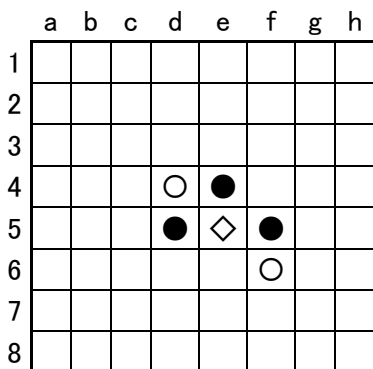
Black chose f5.

Here, black player has placed a black disc on the square f5. Black then flips over the white disc, which has been trapped between the black discs, to make it also a black disc.



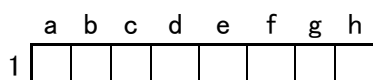
Black flips e6 and makes it his color.

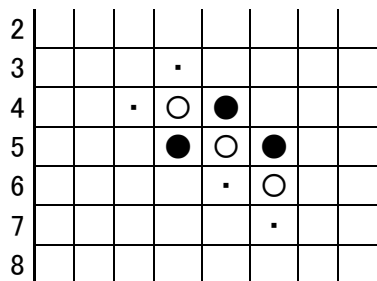
Then it is white's turn. White player plays to a square according to the same rule. As shown below, a disc can be trapped diagonally. In this play, white plays to the square f6, and flips over the trapped black disc on e5.



White has played to f6.

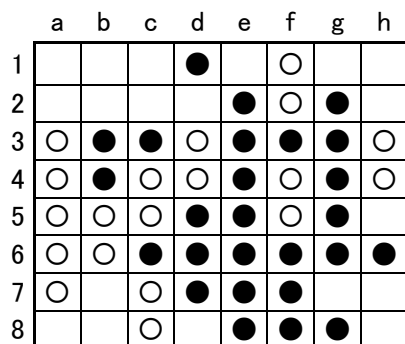
A player must play to a square that traps and flips at least one of the opponent's discs. As shown dotted below, black can now play to c4, d3, e6 or f7.



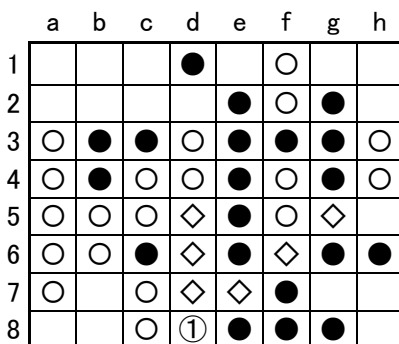


Black has four options.

He cannot play to other squares, because such moves would not trap and flip any white discs. A player can capture more than two discs in more than two directions. For example, if white plays to d8 in the diagram below, white flips six discs in two directions.

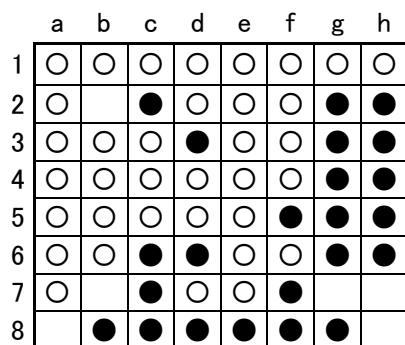


White to play.



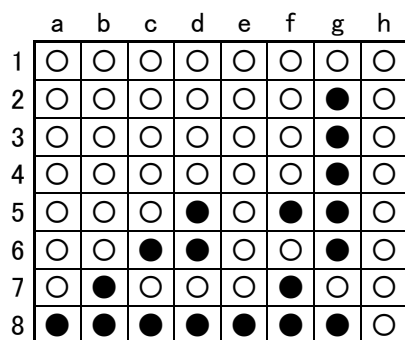
White has played to d8.

It is not allowed to leave any of the trapped discs unflipped: a player must flip all the discs that are trapped. And a player is not allowed to pass a turn while there are playable squares. A player must pass when there are no squares to which he can play. In the position below, black has no squares that would trap and flip any white discs. So black must pass until given some squares where he can play.



Black to play.

Black and white play in turns until all the squares are filled. The player with the most discs wins. The position below shows a game which has ended with 18 black discs and 46 white discs. White has won.



White has won 46-18.

“A minute to learn” is not an exaggeration if you have someone who shows you how to play with a board and discs in front of you. Even the elderly, to whom the rules of chess, shogi and go are a bit too complicated, can learn how to play Othello quite easily. “A lifetime to master” is an understatement; it would certainly take many lifetimes to master Othello.

In Othello, a player has on the average 10 options at each move. Since a game ends in 60 moves, there are roughly  $10^{60}$  possible combinations. Although this is a very small number when compared to the  $10^{120}$  for chess,  $10^{220}$  for shogi and  $10^{360}$  for go, it is still well beyond the range of human experience. One characteristic of Othello makes it exceptionally difficult for humans to play well, but I will come to that later.

This seemingly impossible coexistence of simplicity and complexity, only rarely leading to a draw, with little deviation of wins for either color—black and white have almost the same probability of winning—the fixed number (60) of moves and the beautiful design of the set with its thick black and white discs on a green board, have all made Othello uniquely qualified not only as a friendly home game, but as a game for highly competitive tournament play.

Which recalls the events of November 10, 1996. I was consumed by fever. My body was numb; my vision was clear but my mind was not functioning properly. I had to struggle mightily to think. As I faced the green board, about half of the 64 squares were already occupied by black and white discs.

	a	b	c	d	e	f	g	h
1		●	●	●	●			
2	○		●	●	●			
3	○	○	●	●	○	○	○	
4	○	●	○	●	●	○		
5	○	●	●	○	○	○	○	
6	○	○	●	○	○	○		
7	○		●	●	●	○		
8			●	●			○	

Black (Murakami) to move.

I knew what to do in the above position: play to b7, allowing white to take the a8 corner, and then play to b8. This would give white the whole west edge and most of the south edge and give in the end the game to black. But why should I have to give white any edges at all?

	a	b	c	d	e	f	g	h
1		●	●	●	●			
2	○		●	●	●			
3	○	○	●	●	○	○	○	
4	○	●	○	●	●	○		
5	○	●	●	○	○	○	○	
6	○	○	●	○	○	○		
7	○	①	●	●	●	○		
8	②	③	●	●			○	

Black's correct way of playing.

	a	b	c	d	e	f	g	h
1		●	●	●	●			
2	○		●	●	●			
3	○	○	●	●	○	○	○	
4	○	●	○	●	●	○		
5	○	●	●	○	○	○	○	
6	○	●	○	○	○	○		
7	○	●	●	●	●	○		
8	○	●	●	●			○	

White to move. White has no good moves left and black will win the game.

Greed killed me: Instead of finishing white off with b7, I broke through the white's wall at g6.

a b c d e f g h

1		●	●	●	●			
2	○		●	●	●			
3	○	○	●	●	○	○	○	
4	○	●	○	●	●	○		
5	○	●	●	○	○	◆	○	
6	○	○	●	◆	◆	◆	1	
7	○		●	●	●	○		
8			●	●			○	

A fatal mistake.

The sharp, fox-like countenance of Garry Edmead, a rising Othello genius from England, seemed to twitch a little, obviously sensing the wind shift as I failed to play the best move. He played to f8, rendering my b7 no longer effective.

My advantage vanished, and after many minutes of exhaustive and vain search for a win, I lost the game to Edmead, 31 to 33.

	a	b	c	d	e	f	g	h
1	○	○	○	○	○	○	○	○
2	○	○	○	○	○	○	●	○
3	○	●	○	●	●	●	●	●
4	○	●	○	●	●	○	●	●
5	○	●	●	○	○	●	○	●
6	○	●	●	○	●	○	○	●
7	○	●	○	●	○	○	○	●
8	●	●	●	●	●	●	●	●

	A	B	C	D	E	F	G	H
1	52	35	22	24	27	56	55	58
2	26	47	9	11	17	54	60	59
3	21	8	3	4	10	19	34	57
4	25	13	5	●	●	6	46	42
5	16	14	7	●	●	1	36	41
6	15	29	12	2	18	28	39	48
7	20	53	30	32	31	23	45	50
8	51	44	37	33	43	40	38	49

Semifinal Game 1

B: Takeshi Murkami (Japan) 31

W: Garry Edmead (UK) 33

I crumpled into a makeshift bed, made of eight chairs, in a room of the Palace Hotel, Tokyo, which overlooks the magnificent grounds of the Imperial Palace, and which was the venue for the 20<sup>th</sup> World Othello Championship. It was my second World Championship. In WOC Paris 1988, I had lost to Graham Brightwell of England in the semifinal.

It had taken me a long eight years to win the All Japan Championship and to again qualify for the world

competition. I then spent a long two days, fighting the cold I had caught before the tournament while challenging the top 22 players from around the globe in the 13 rounds of preliminary games.

I won 11 games and advanced to the last day of the tournament, where I fell to Edmead, losing the first game of semifinals just as I had done in Paris eight years before. As close to the top of Mount Olympus as I had ever been, I was failing again. To reach the pinnacle and reside as World Champion, I had to win the next two games straight to Edmead, and then win another two games out of three against whoever would advance to the final. The way ahead seemed impossibly long.

When the next game began, however, the fever had ceased to torture me. Perhaps the medicine I took before the first semifinal was finally beginning to work. So was my brain. I was able to see many moves ahead accurately, and was able to outplay Edmead to even the score. I was in a favorable position at the start of the third and decisive game. The game would have ended right in the middle game had it not been for Edmead's renowned tenacity. Edmead played his most brilliant defenses and never allowed me to strike a fatal blow.

The position evolved into a complex endgame in which the winning side was no longer clear, and by the time there were seven squares to fill, both Edmead and I had less than two minutes left on the clock. I was paralyzed by the extreme pressure. My mind could neither formulate nor calculate any lines of attack.

	a	b	c	d	e	f	g	h
1	●		○	●	●	○		
2		●	○	○	○	●		○
3	●	●	●	●	●	●	●	○
4	●	●	●	○	○	○	○	○
5	●	○	●	●	○	○	○	○
6	○	○	●	○	●	○	○	○
7	○	○	○	○	○	●		○
8	●	●	●	●	●	●	●	

White (Murakami) to move.

Then it came. As clearly as if it had been an oracle from the God of Othello: g7!

	a	b	c	d	e	f	g	h
1	●		○	●	●	○		
2		●	○	○	○	●		○
3	●	●	●	●	●	●	●	○
4	●	●	●	○	○	○	○	○
5	●	○	●	●	○	○	○	○
6	○	○	●	○	●	○	○	○
7	○	○	○	○	○	◇	①	○
8	●	●	●	●	●	●	●	

At first sight g7 is a terrible move. It lets black take the h8 corner, followed by h1, which gives black the entire east edge. Having already given black the south and the north edges, giving black still another edge seems suicidal.

As it turned out, however, this was in fact the only winning move I had in the position above. The rest of the empty squares filled rapidly. The hands of both players scurried across the board, deftly flipping the discs, sharply punching the timer buttons with each play. When I filled the last empty square, I had taken six more discs

than Edmead as shown below. "Well played," he said graciously, as we shook hands firmly.

	a	b	c	d	e	f	g	h
1		④					③	⑥
2	⑤						⑦	
3								
4								
5								
6								
7								
8								②

	a	b	c	d	e	f	g	h
1	●	●	●	●	●	●	●	●
2	○	○	○	○	○	○	○	●
3	○	○	●	●	○	○	○	●
4	○	●	○	○	○	○	○	●
5	○	○	○	○	●	○	○	●
6	○	○	●	○	○	●	○	●
7	○	○	○	○	○	○	●	●
8	●	●	●	●	●	●	●	●

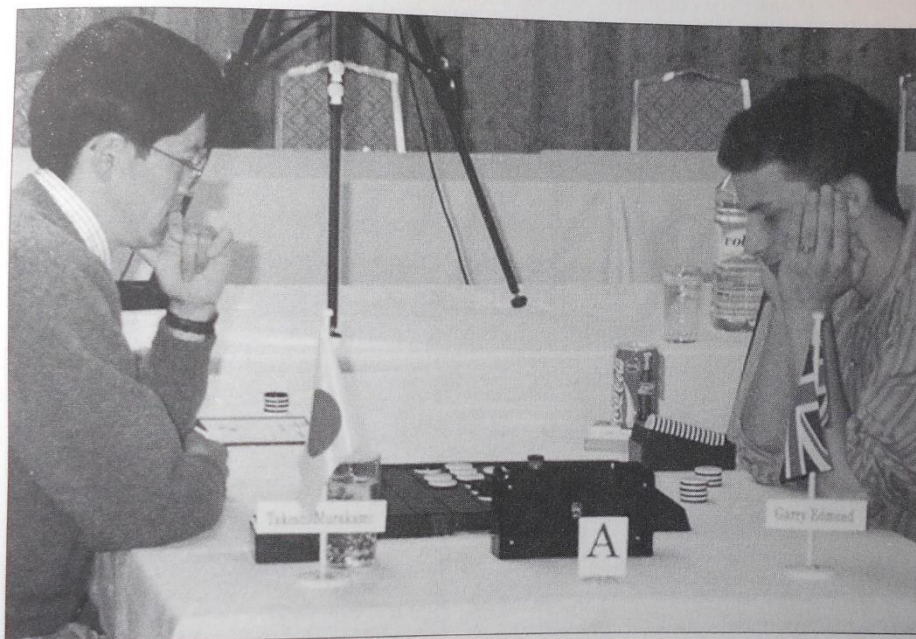
White gave up all four corners but gained enough interior discs to win.

	A	B	C	D	E	F	G	H
1	53	57	34	35	31	32	56	59
2	58	48	23	28	30	33	60	26
3	49	39	38	22	17	9	27	25
4	37	43	36	○	●	4	7	14
5	47	24	6	●	○	1	12	13
6	40	29	19	15	3	2	5	10
7	52	46	18	20	8	11	54	44
8	51	50	21	41	42	16	45	55

Semifinal Game 3

B: Garry Edmead (UK) 29

W: Takeshi Murkami (Japan) 35



Murakami Takeshi, left, and Garry Edmead contemplate their respective situations in the 1996 World Othello Championship competition in Tokyo.

Shimonosono Kōzō

The finals turned out to be less challenging than the semifinals. Stephane Nicolet of France, whose Othello

tournament career was much shorter than mine and was exhausted after the long flight from Paris and the long three days of the tournament, seemed somewhat resigned to defeat, and I was able to win two straight games.

	A	B	C	D	E	F	G	H
1	37	14	36	29	39	52	53	
2	25	57	9	10	38	45	44	54
3	26	8	3	4	21	17	46	42
4	20	12	5			6	41	43
5	19	15	7			1	33	34
6	16	18	11	2	13	40	30	47
7	27	50	22	23	35	28	59	48
8	58	32	31	24	51	49	56	55

### Final Game 1

B: Takeshi Murakami (Japan) 50

W: Stephan Nicolet (France) 13

	A	B	C	D	E	F	G	H
1	59	56	33	36	28	32	47	57
2	60	55	37	26	13	29	48	58
3	46	25	24	27	5	10	8	16
4	54	45	11			4	9	17
5	35	31	6			1	7	14
6	53	34	30	12	3	2	19	15
7	51	49	21	44	22	20	41	18
8	50	52	38	40	39	23	43	42

### Final Game 2

B: Stephan Nicolet (France) 29

W: Takeshi Murakami (Japan) 35

Washed by the flash of cameras, I received the comfortable weight of the 20-year-old supreme silver cup in my arms. I was overcome by the joy that I finally did realize the dream of a lifetime: I was the World Champion of Othello!



A proud Murakami Takeshi holds the trophy, symbolizing the accomplishment of his dreams: winning the 1996 World Othello Championship in Tokyo.

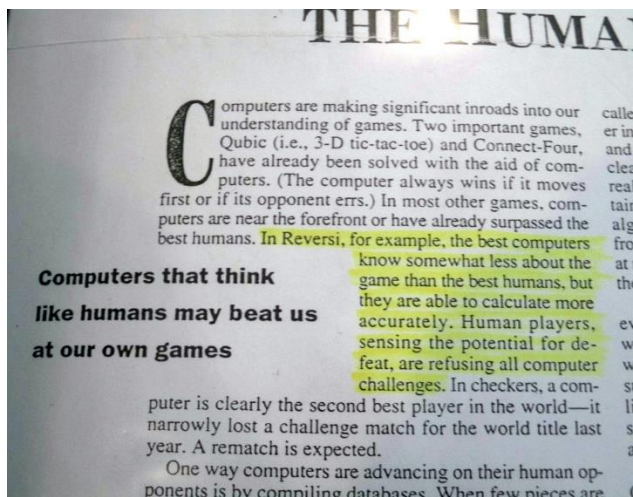
The first All Japan Championship for Othello was held in 1973, the year the game was invented, and has been held every year since then, drawing several thousand players annually. The All Japan Championship is played in five divisions: open, women's, boys' & girls' (15 and under), masters (40 and over), and blind.

The winners of open and women's divisions plus Meijin, the winner of another prestigious tournament, Meijin-sen (literally Master Tournament), go on to the World Championship.

The first World Championship was held in Tokyo in 1977, and the 23rd World Championship, held in Milan in October 1999, drew 34 top players from 15 countries (up to three players are allowed to enter the tournament from each country).

Since Japan has by far the largest number of serious tournament players, the qualities of play displayed by Japanese champions are accordingly high, and 18 World Championships out of 23 have been grabbed by the Japanese; the Americans have won three and the French won the other two.

As I was struggling to distinguish myself from the flock of top players around the world, a whole new challenge was taking shape in my path. "Human (Othello) players, sensing the potential for defeat, are refusing all computer challenges." These were the words of Dr. Hans Berliner, a leading specialist in artificial intelligence at Carnegie Mellon University, in an article titled "Losing the Human Edge" for the May 1993 issue of the computer magazine Byte.



After reading the article, sent by a French Othello player, I felt pure anger. True, computers had already become formidable adversaries for human Othello players. But as far as I knew, no Japanese top players had been invited by Dr. Berliner to play against his computer program, nor would we decline such a challenge out of fear of defeat.

As a player who believes in sportsmanship, I took Dr. Berliner's comments as an insult. I wrote to him, saying, I would accept any challenge from any player, living or otherwise. Dr. Berliner tried to organize a match between the program and I, but because of his wife's illness and a lack of sponsors, the match never materialized.

In 1995, Dr. Michael Buro of NEC Research Institute in Princeton, New Jersey, inquired whether I was still interested in a match against top software. His program, Logistello, had been developed in 1993, and, having won many computer tournaments, was now renowned as one of the very best Othello programs. We agreed on a match as soon as possible. In 1996, I won the World Championship. Buro called me a few days later. "Congratulations! How are you feeling?" "Great! It's a dream come true." He must have felt great, too, as the match was now catapulted to "must" status, pitting his beloved program against the current world champion. He promised to invite me and my wife to the United States at the institute's expense for a match in August 1997.

In May, 1997 World Chess Champion Garry Kasparov lost a highly publicized six-game match against IBM's Deep Blue. These two unexpected events—my victory in the 1996 World Championship and Kasparov's historic chess defeat—propelled the Othello match between Logistello and I from a minor event of interest largely within the Othello community to one seized upon by the media.

Since Othello is especially popular in Japan, all six principal Japanese TV stations sent crew, joining hordes of newspaper reporters at the NEC Research Institute, site of the match. Many Japanese followed the progress of the six-game match, wondering whether yet another human champion would fall prey to the silicon terror, or whether he would hang tough and demonstrate the superiority of human intellect.



Murakami and Dr. Michael Buro.

Before his matches, Kasparov had believed in his own superiority over Deep Blue. He still does and he is probably right. He would have won the match under better match conditions.

### Studying the Combinations in Advance

But what were my odds? Before the match, I got transcripts of the sequence of play in Logistello's games in various previous computer tournaments. Analysis of these games and information about how Logistello functions revealed its unerringly superhuman accuracy and strength, which led me to believe that I would have a very slim chance of prevailing. I had hoped to win at least one of the six games, but it was not to be.

The result of the match, held in Princeton from August 4 to 7, was a devastating 6-0 whitewash for Logistello. The best I managed was a 27 to 37 outcome.

	A	B	C	D	E	F	G	H
1	54	37	17	30	22	24	31	56
2	47	53	9	14	23	32	58	39
3	48	8	3	4	15	19	26	33
4	49	12	5			6	28	34
5	59	13	7			1	29	35
6	16	18	11	2	10	20	42	45
7	60	50	27	38	25	21	46	57
8	51	52	36	41	40	43	44	55

Game 6

B: Logistello 37

W: Murakami 27

In the fourth game, I had just nine discs left on the board. I had never lost so completely and defenselessly against

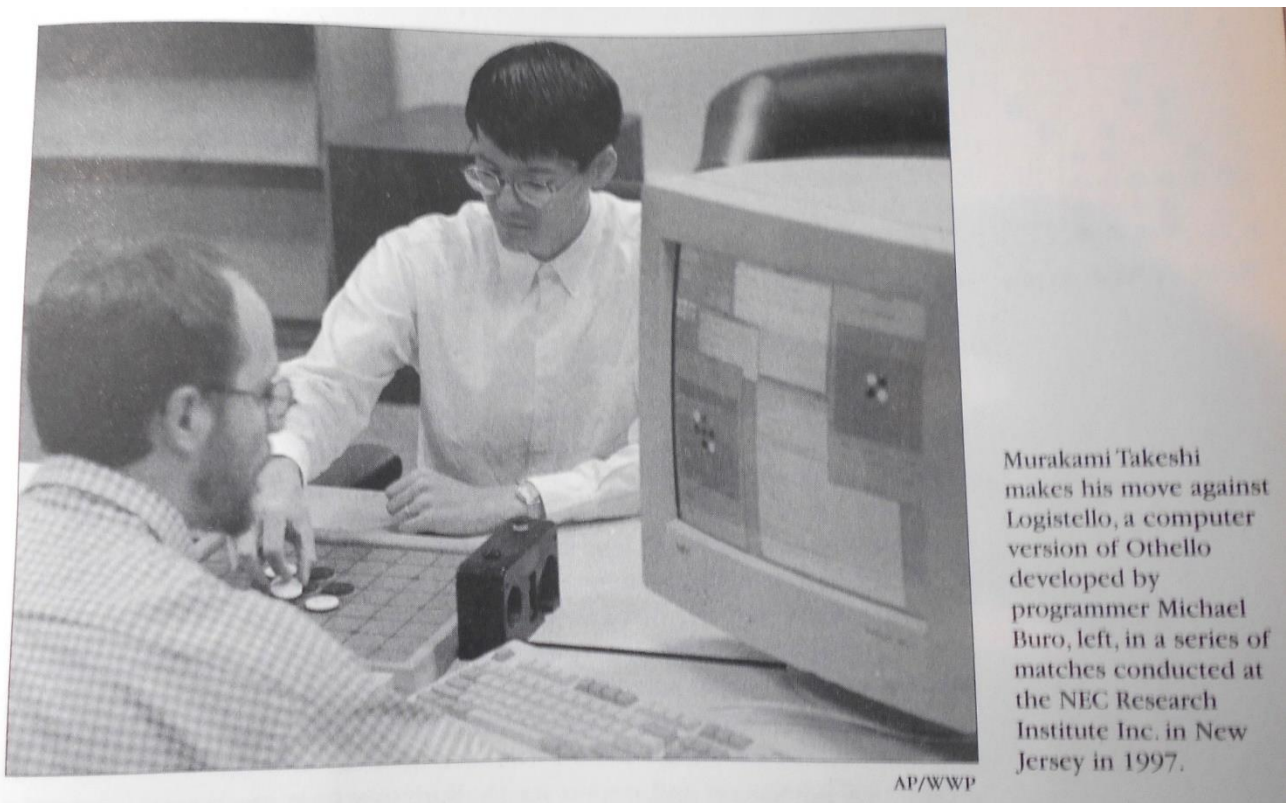
human players.

	A	B	C	D	E	F	G	H
1	60	59	48	47	46	54	49	53
2	56	58	38	43	45	44	50	42
3	37	33	29	7	6	9	17	41
4	30	27	26	●	●	14	18	20
5	40	10	5	●	●	1	8	15
6	39	31	11	4	3	2	19	21
7	32	34	25	12	13	23	36	22
8	35	28	51	52	24	16	57	55

Game 4

B: Logistello 55

W: Murakami 9



Othello offers more than 5 million possible combinations in the first 10 moves alone. Analyses of openings by top players run to the 20s, 30s and sometimes beyond, but human players check only a small fraction of the innumerable possible lines—only those that look promising.

Logistello, on the other hand, has played against itself ever since it was put into function in 1993, running 24 hours a day, 365 days a year, accumulating a huge database of game results.

The upshot is that Logistello has evolved countless new, effective openings that have either been overlooked or dismissed by human players as unpromising.

Humans have a very hard time reaching an even position, let alone a favorable one, in the opening against Logistello. In the middle game, Logistello's superiority becomes obvious. What makes Othello so difficult for humans is the fact that a move can flip up to 18 discs in up to eight directions.

	a	b	c	d	e	f	g	h
1	●							●
2	○						○	
3	○					○		
4	○				○			
5	○			○				
6	○		○					
7	○	○						
8		○	○	○	○	○	○	●

Black's move to a8 flips 18! discs.

	a	b	c	d	e	f	g	h
1	●							●
2	◆						◆	
3	◆					◆		
4	◆				◆			
5	◆			◆				
6	◆		◆					
7	◆	◆						
8	①	◆	◆	◆	◆	◆	◆	●

	a	b	c	d	e	f	g	h
1					●			
2	●				○			
3		○			○			●
4			○		○		○	
5				○	○	○		
6	●	○	○	○		○	○	●
7				○	○	○		
8			●		●		●	

Black's move to e6 flips in 8! directions.

	a	b	c	d	e	f	g	h
1					●			
2	●				◆			
3		◆			◆			●
4			◆		◆		◆	
5				◆	◆	◆		
6	●	◆	◆	◆	①	◆	◆	●
7				◆	◆	◆		
8			●		●		●	

This means that the configuration of black and white discs changes drastically with each move, making it extremely difficult for humans to visualize future positions. This is probably what makes Othello unique compared to chess, shogi, or *go*, where one move normally causes only one change over the whole configuration of pieces (although, of course, that one change can generate a huge strategic shift).

This characteristic of Othello, in which discs change from black to white and back again whenever a move is made, often leads even the seasoned players to make "Oh, I thought I would have an access here!" "What!? Wasn't this disc supposed to be black?" "Gosh, I didn't realize this move would also flip in that direction!" kinds of mistakes.

During the match, I was checking several lines 10 to 15 plies ahead. This is about the limit for human players. But Logistello was checking every existing line into a 14-ply depth, and 22 plies ahead if it deems a line promising. The software has no difficulty visualizing future positions as, unlike humans, it has memorized its own board. This is like a human player having another board and set of discs to check future positions during the game. Of course humans are forbidden from using this approach.

Logistello's dominance over human opponents is definitely the most secure in the endgame. Since the number of possibilities diminishes considerably as the game nears its end—in computer terms, of course, since humans often have trouble finding the best move with a mere five empty squares, and finding the best move with 15 empty squares is nearly impossible—Logistello calculates every possible line in the range of 24 empty squares within six minutes. Imagine that. When 36 of the 60 squares are filled, Logistello ponders for five minutes and determines the winner and the score that would result if the rest of the squares are filled correctly. If the calculations favor Logistello, I have no chance, as it makes no mistakes. If the prediction favors me, I still have 12 moves to

make, of which at least some are going to miss the mark. I have rarely seen a game between two humans in which each player played his or her last 12 moves perfectly.

	a	b	c	d	e	f	g	h
1	●		●	●	●	●		
2	●	●	●	●	●	●		
3	●	○	●	●	●	●	●	●
4	●	○	●	●	●	○	○	○
5	●	●	○	●	○	●	○	○
6	●	●	●	○	○	●	●	○
7	●	●	●	○	●	○	●	●
8	●	○	○	○	○	○	○	○

White (Shaman) to move.

Look at the position above for example. It was in a preliminary game of the 1996 World Championship between Karsten Feldborg (Black) of Denmark and David Shaman (White) of the United States. White has four options: b1, g1, g2 and h2.

Any computer could instantly determine that one of the options would win, two would draw and one would lose.

What about humans?

Shaman, the World Champion in 1993 and the eventual winner of this tournament, concentrated for several minutes and still missed the best move. The optimal sequence is white g2 → black h2 → white h1 → black passes → white b1, leading to a 33-31 victory for white. The sequence actually played was white h2 → black h1 → white b1 → black g2 → white g1, for a draw at 32-32. Shaman did not blunder; most experienced players, myself included, would make the same mistake. The Othello endgames are often simply too difficult for human players. In what other board games would the last mere five moves be so tough that even world-class players are incapable of finding the correct move?

Below is the position I faced in the fifth game against Logistelo. I had just made the 35<sup>th</sup> move to h3, and waited for Logistelo's reply.

	a	b	c	d	e	f	g	h
1								
2				●	○			
3		○	●	●	○	○		●
4	○	○	●	○	●	○	●	
5	○	●	○	○	●	●	○	
6	●	●	●	●	●	●	○	○
7			●	●	●	●		
8			●	●	●	●		

White (Logistello) to move.

It started searching for a win—searching for a winning move takes a lot less time than the search for the optimal move—and, after about three minutes, played h5. It had calculated that with this move white would win the game, at least with 34-30. The only thing I knew at that point was that I seemed to be a little behind.

Kasparov must have felt much frustrated knowing that if he had been able to play his best, he would surely

have beaten Deep Blue. But I did not feel any frustration nor regret because I knew I had done my best, and that I would have lost even if I had been 10 times stronger. What I felt was a profound admiration and respect for Dr. Buro, who had implanted many new ingenious ideas into Logistello to make it a state-of-the-art program.

When I described my game situation, over the phone, to a reporter for The Washington Post, I told him, "I was like Carl Lewis competing with a motorcycle." In the story, though, I was quoted as having said, "I was like a car competing with a motorcycle."

Sigh.

Since then, I have often told my students about the misquote, to remind them that they should work on their English pronunciation.

When I accepted Dr. Buro's challenge, some Othello players in Japan tried to convince me that I should not play against Logistello. They feared that if I lost, people around the world would think Othello is in fact as simple as it looks, and not worth serious play. My promotion to the World Champion underscored their concern. I shared their apprehension but declined their advice. I believed that nothing was going to degrade the authority of the champion more than declining a challenge for fear of defeat. I also thought that this match would be a good opportunity to let Americans and other people know about Othello, which, despite its overwhelming popularity in its home country, is still very little known outside Japan compared to chess, shogi or *go*. I think I was right.

No matter how strong computers become, the joy and excitement of playing Othello among humans will remain. I know I have learned only a fraction of what can be learned about Othello, and that hundreds of lifetimes are needed to master it. But that's what makes Othello so interesting.

Using computers as a helpful teacher, I will enjoy the game and try to improve my play for the rest of my life.

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