6C-1

Reverse Tracking on Primitive Go Continuity Matrix

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1. Abstract

I develop a new method to know the PG winner for suffering from huge computation. [2] Binary reverse tracking on 4RO matrix reveals that Black wins at KOMI=0, White does at KOMI=16, which implies the presence of cyclic procedure like 3RO board.

2. The theory of reverse tracking on PG continuity matrix

The continuity matrix represents the continuity of each state or node. When we estimate the status of game tree nodes, the following three principles are well known.

1) The parent node becomes desired status if a child node is desired one.

2) The parent node becomes undesired status if all children nodes are undesired ones.

3) To represent multiple nodes' status by single number, they must be all the same.

It is somewhat hard to satisfy the restriction 3), because PG has two-pass end rule and cyclic end rule. On game tree tracking, the status (win, draw, lose, unknown) of two states having same state number are quite different, on the other hand the reverse tracking treat them to be equal. So we must think about the problem more closely. Now I pay attentions to the following terms. Mark current status = f (stones, KOMI).

A) The player cannot select to pass if current status is undesired, for two-pass end.

B) But there are some states to force the player to pass. (force-pass states)

C) The opponent player will win if the status of B) state is opponent desired one.

3. Reverse tracking on 2RO [1] matrix

On the board, the force-pass ternary expression states B) are only following four, (13, black), (26, white), (24, black), (12, white). The former two states have ICHI-GAN (one eye) figures and the latter NI-GAN (two eyes) ones. On selecting the starting states, KOMI and players' desire are considered. The sets of the states are only following four, (39, 53), (39), (24), (13, 24). The number 39 (=12+27) means (12, white) state. (Fig. 1)

starting states		KOMI								
		-4	-3	-2	-1	0	1	2	3	4
black player's	must win	39,53	39	39	39	39	39	none	none	none
desire	win or draw	39,53	39,53	39	39	39	39	39	none	none
white player's	must win	none	none	none	24	24	24	24	24	13,24
desire	win or draw	none	none	24	24	24	24	24	13,24	13,24

The current status A) are also directed by KOMI and players' desire as described above, so I prepare the estimation list of them before tracking. In case A), we may use the matrix more easily, if the first column of the matrix is fixed to the pass hand state. To track on the matrix, I also count in the game beginning state 0 (no parent), the first

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black hand (pass is forbidden) and not appeared state 27. Fig. 2 summarizes the result.

case	willing player	starting states	newly appeared states / iterations (hands)							
			1	2	3	4	5	6	7	8
1	black	39,**53**	1,5,12,**26**	35,**44**,51	8,**17**,24	29,32,**42**,43	2,**15**,16	**28**,31,40	**0**,4,13	none
2	black	39	1,5,12	none	none	none	none	none	none	none
3	white	24	29,32,51	none	none	none	none	none	none	none
4	white	**13**,24	29,32,**40**,51	4,**12**,16	31,**39**,43	**1**,5,15,17	**28**,42,44	**0**,2,8,26	35,53	none

The result depends strongly on starting states. Bold numbers indicate surefire ways, but there is no way in case 2 or 3 (~no winner). I am happy the result coincides the preceding game tree tracking result that game ends in a draw at KOMI=-3~+3. [1]

4. Reverse tracking on 3RO [2] matrix

The number of all force-pass quaternary states B) is 186. They include one eye states 6, multi-eyes states 150, KOU states 30, whose figure always has a put-forbidden point. Fig. 3 summarizes the result. The additional b means to involve the beginning state (0, black), t does TENGEN (256, white), s SUMI (1, white), h HEN (4, white) respectively. There is no surefire way to the beginning state at KOMI=7 or 8 (must win) apparently.

KOMI	willing player	no. of st. st.	the number of newly appeared states / iterations (hands)																													total
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
5	black	12	89	33	175	88	289	112	228	99	181	51	66	**30t**	**29b**	9	8	7	8	5	5	1	0										1525
6	black	6	41	21	112	71	244	118	309	120	242	58	79	**31t**	**30b**	9	8	7	8	5	5	1	0										1525
7	black	0	0																														0
5	white	90	411	119	325	95	204	107	124	68	**73s**	35	44	25	18	15	16	21	20	26	32	33	27	21	15	13	2	1	0				1980
6,7	white	90	411	119	325	95	204	107	124	68	**73s**	37	48	29	25	28	25	30	33	31	26	21	15	13	2	1	0						1980
8	white	90	411	119	325	95	204	107	124	68	**73s**	37	48	32	27	37	30	53	56	84	76	111	80	98	42	25	13	8	8	6	4	1	0	2492
9	white	93	414	131	337	141	243	238	224	347	**249s**	421	238	346	126	128	**36ht**	**27b**	4	0														3743

5. Reverse tracking on 4RO matrix

The preceding research [3] teaches us game ends in a draw at KOMI=0, but that does not apply to PG because of different game rules, counting not JI but stones. [1]

The number of all 4RO states is 6360880, which include 265314 KOU states. Also adopting 36558 states (one: 6, multi: 28952, KOU: 7600) as starting states, the game ends in a draw at KOMI=1~15 is discovered. CHUGEN means (1024, white). (Fig. 4)

KOMI	willing player	no. of st. st.	the number of italations (hands)					the number of appeared states
			appear SUMI	appear HEN	appear CHUGEN	**appear state 0**	max. hands	
0	black	15876	none	none	22	23	55	3124873
1	black	14413	none	none	none	none	38	3038668
2	black	12975	none	none	none	none	38	3014943
14	white	18276	21	21	none	none	36	3381870
15	white	18276	21	21	none	none	44	3383442
16	white	18279	21	21	29	30	31	6360879

The result argues that there are some cyclic procedures like 3RO board at KOMI=8.

6. References

[1] Junichi Hoshi: Invitation to Primitive Go

[2] Junichi Hoshi: 3 RO board analysis by Primitive Go

[3] Sei Shinichi et al.: A Solution of Go on 4x4 Board by Game Tree Search Program

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