3C-2

3 RO board analysis by Primitive Go

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1. Abstract

Next, I pursue 3RO board. Analyzing each stone piece (a bulk or group of same color stones) is required by increasing board figures. On the board KOU newly happens, so I add 6) KOU rule to elder five rules [1]. The continuity of each state (figure and turn) forms an eight-branch tree, whose longest branches exceed hundreds hands, each nodes generated about fourfold by a hand. I also find figures and flows which appear on 19RO board very much. To make ME (eye) at corner is most important, because the game ends in a draw at KOMI = 7 or 8.

2. Against increasing board figures

The number of board figures without regard to KOU is 3^9=19683. Considering the board symmetry and 5) cyclic procedure rule, it decreases to 2862. Against such increasing figures, I code DAME (open points around a piece) count program. As the result it returns the number 1824 of allowed board figures.

A board figure may be split into black stone figure and white stone one, also each stone figure into several stone pieces. These are all represented by binary numbers. Only 511th figure (nine stones) is forbidden by 2) KATSURO rule, that brings the number 101 of allowed stone figures. (Fig. 1)

pieces	stone figure number
0	0
1	1 2 3 7 11 15 16 18 19 23 26 27 30 31 47 56 57 58 59 61 63 79 94 95 111 121 122 123 124 125 126 127 186 187 189 191 239 247 254 255 367 381 383 495
2	5 10 12 13 14 17 28 29 40 41 43 45 68 70 71 78 86 87 102 103 105 107 108 109 110 114 115 118 119 175 231 238 245 335 351 365
3	21 42 69 84 97 98 99 101 106 113 117 171 173 229 327 343
4	85 170 325
5	341
total	101 stone figures

The 255th has one ME at corner, so it seems to be most important figure. Less than five pieces are in a figure, the kind of pieces is only above 44. The 10th is DAME of 1st piece and the 21st is DAME of 2nd piece, they make unique KOU structure.

3. Presence of KOU

Once KOU battle happens, the unseen point condition generates where putting a stone is forbidden. This is just 6) KOU rule. To express the condition I adopt the quaternary number, represents 0 is open, 1 is black, 2 is white, 3 is the condition. Also running KOU

detect program on former 1824 figures which utilizes the above KOU structure and that UCHIAGE stone is only one, the possibilities of KOU battle are found on 90 figures. Even two KOU are present within them.

4. Continual states under KOU presence

Each of 96 KOU figures which have point value 3, appears only on one side turn. Then the kind of whole states becomes 1824*2 + 96 = 3744. (Fig. 2)

kind		class				total
		ordinary	KOU			
			one KOU	two KOU		
				2DAN_KOU	RYOKOU	
board figure		1824	80	12	4	1920
state	black turn	1824	40	6	2	1872
	white turn	1824	40	6	2	1872
	sum	3648	80	12	4	3744

Applying the rule 2), 5), 6) and 3) UCHIAGE rule to above 3744 states, the continuity matrix [1] is computed automatically. To examine the matrix, the nodes make an eight-branch tree is found out.

5. The features of no pass trees and PG trees

board	tree	max. hands	total nodes	hands of peak nodes	number of peak nodes	increase rate	kind of figures	kind of states
3RO	no pass	>=292	>>127199653517			～2.74	1804	3149
	PG	>=284	>>360650969962			～3.60	1920	3743
2RO	no pass	7	15	3	3	1	9	9
	PG	16	1095	11	186	1.48	13	25

Fig. 3 summarizes the features of 3RO and 2RO trees with no pass and PG. The max hands and total nodes show terrible numbers, so that may be a cause of establishing JI rules. Not appeared state of PG tree is only one and that's same as 2RO board.

On 3RO board, there are 1105th TAKEFU, 17476th PONNUKI, 22033rd GETA and 76193rd RYOU_UTTEGAESHI. The 26158th plays a rotating KOU novel and peculiar on the board [2]. It is fine NAKADE all appear, but SEKI conditions like 17992nd or 18066th depend on KOMI, which may induce SEMEAI or ISINOSHITA.

Though 17800th is a famous MEARI-MENASHI (ME vs. KAKEME), the figures having one or two ME are much more important because the game ends in a draw at KOMI = 7 or 8. However, it differs from the common view of KOMI = 8.

6. References

[1] Junichi Hoshi: Invitation to Primitive Go

[2] Erik C. D. van der Werf et al.: Solving Go on Small Boards