EWIN wins EinStein Würfelt Nicht! tournament

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The 21st Computer Olympiad was held in New Taipei City, Taiwan, from July 7 to 13, 2018. One team from China could not attend due to visa problems. In total, nine teams from four countries participated in the EinStein Würfelt Nicht! (EWN) tournament, as listed in Table 1. EWN is a two-player zero-sum stochastic game designed by Althöfer in 2004 (Althöfer, 2011). The game is played on a 5×5 board with a dice. Two players, Red and Blue, respectively own six pieces numbered one to six. At the beginning of a game, red and blue pieces are placed in the top-left and bottom-right corners of the board respectively. The order of the pieces for the two colors should be rotationally symmetric for fairness. The players roll dice in each move to determine which pieces can be moved. The goal of the game is to move one piece to the opponent's corner or capture all opponent pieces. The detailed game rules can be found in the paper by Chu et al. (2017).

Table 1
The participants of the EWN tournament in the 21st Computer Olympiad

Program name	Author(s)	Operator	Country
κ=8ΠG	Kotaro Ataka	Kei Takada	Japan
EWNGAME	Ann Lao, Minqin Lee and Sijin Chen	Song Wang	China
EWIN	Yuan-Hao Chen, Yeong-Jia Roger Chu, Chu-Hsuan Hsueh and I-Chen Wu	Chu-Hsuan Hsueh	Taiwan
KAITEN	Pin-Ju Lin and Shun-Shii Lin	Pin-Ju Lin	Taiwan
EMIL	Wen-Yen Chou and Shun-Shii Lin	Shun-Shii Lin	Taiwan
SHUKA	Hao-Lun Luo	Hao-Lun Luo	Taiwan
DEEP NIKITA	Andrew Lin	Andrew Lin	USA
EMC2	Yasumasa Tamura	Yasumasa Tamura	Japan
VSWTN	Yunpeng Zhang, Wei Li and Yuxuan Zhang	Yunpeng Zhang	China

A round-robin system was applied for the tournament. Each program played eight games against all other programs. The initial positions were determined by rolling dice. For each initial position, two games were played with the two programs alternating as the first player. The final ranks were determined by the total numbers of games won by the programs. The detailed scores and the final ranks are listed in Table 2. EWIN won 47 games and was ranked first. The second and the third place winners were DEEP NIKITA and κ=8ΠG, which won 37 and 36 games respectively.

EWIN is based on Monte-Carlo tree search (MCTS) combined with n-tuple networks trained by Monte-Carlo learning (Chu et al., 2017). DEEP NIKITA applied expectiminimax and used a large endgame tablebase, while κ=8ΠG combined MCTS with deep convolutional neural networks (The 21st Computer Olympiad, 2018). As for other programs, EWNGAME, KAITEN, SHUKA, and VSWTN were based on expectiminimax, EMC2 was based on MCTS, and EMIL used convolutional neural networks (The 21st Computer Olympiad, 2018).

1. SELECTED GAMES

This report comments on two games, one between EWIN (the gold) and DEEP NIKITA (the silver), and the other between EWIN and κ=8ΠG (the bronze). A game record starts with the initial position, specifying the squares of red pieces numbered one to six and then blue pieces numbered one to six respectively. The record then contains all

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moves played in the game. Each move is denoted by the color to play (R for Red and B for Blue), the rolled dice number, the source square of the moved piece, and the destination square of the moved piece.

Table 2
The detailed scores and the final ranks

No.	Program name	Opponent No.									Score	Rank
		1	2	3	4	5	6	7	8	9		
1	K=8ΠG	-	4	3	6	6	3	3	5	6	36	3
2	EWNGAME	4	-	2	1	5	2	2	4	2	22	9
3	EWIN	5	6	-	6	5	6	6	5	8	47	1
4	KAITEN	2	7	2	-	2	2	3	5	2	25	8
5	EMIL	2	3	3	6	-	6	4	2	6	32	5
6	SHUKA	5	6	2	6	2	-	2	3	2	28	6
7	DEEP NIKITA	5	6	2	5	4	6	-	7	2	37	2
8	EMC2	3	4	3	3	6	5	1	-	2	27	7
9	VSWTN	2	6	0	6	2	6	6	6	-	34	4

Game 1: DEEP NIKITA (Blue) vs. EWIN (Red) 0-1

a3 b5 a4 a5 b4 c5 c1 e2 d1 e1 d2 e3, 1. B 2 e2 d2 2. R 5 b4 c3 3. B 6 e3 d3 4. R 2 b5 c4 5. B 6 d3 c4 6. R 2 a4 b3 7. B 6 c4 b5 8. R 1 a3 b3 9. B 2 d2 c2 10. R 2 a5 b5 11. B 5 e1 d1 12. R 6 c5 c4 13. B 4 d1 c2 14. R 3 b3 c2 15. B 4 c1 c2 16. R 5 c3 c2

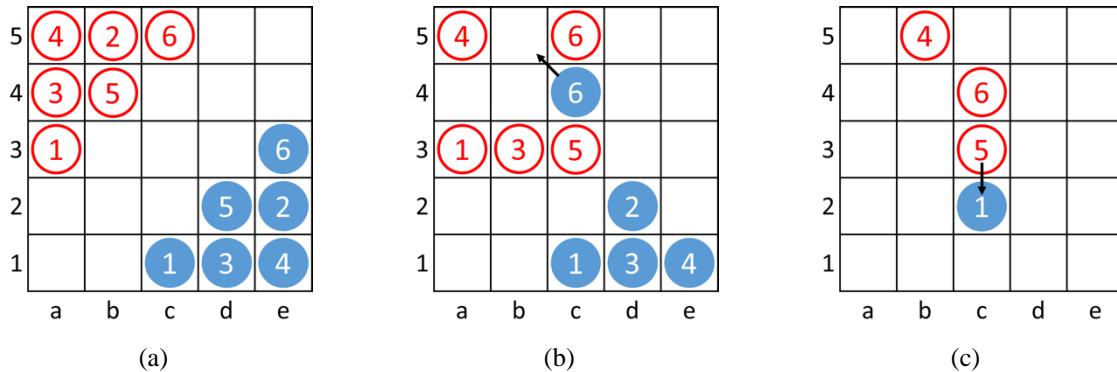(a)   (b)   (c)

Fig. 1. The commented game between DEEP NIKITA (Blue) and EWIN (Red): (a) the initial position, (b) the 7th move, and (c) the winning move

The initial position of the game is shown in Fig. 1(a). In this game, Blue was the first player. At the 7th move, Blue rolled the number of six and moved its ❻ from c4 to b5, as shown in Fig. 1(b). With a probability of 1/3 (rolling the number of five or six), Blue could win on its next turn by moving the ❻ to the target square a5. At the 8th move, Red rolled one and captured its own ③ to increase the probability of moving ④ (the only piece that could capture the opponent ❻). With the ③ captured, the probability of moving ④ increased from 1/6 to 1/2 (rolling two, three, or four allows Red to move ④). The strategy succeeded as Red rolled two and captured the opponent ❻ on the 10th move, which resolved the crisis of losing on the next opponent move. Finally, Red won the game by capturing all blue pieces on the 16th move, as shown in Fig. 1(c).

Game 2: EWIN (Red) vs. K=8ΠG (Blue) 1-0

b5 c5 b4 a5 a3 a4 e2 e3 d2 e1 c1 d1, 1. R 2 c5 d4 2. B 3 d2 c3 3. R 6 a4 a3 4. B 1 e2 e3 5. R 4 a5 b4 6. B 4 e1 d2 7. R 4 b4 c3 8. B 3 d2 c3 9. R 3 d4 d3 10. B 2 e3 d3 11. R 2 a3 b2 12. B 2 c3 b3 13. R 3 b2 c2 14. B 6 d1 c2 15. R 1 b5 c4 16. B 5 c1 b1 17. R 1 c4 d3 18. B 2 b3 a4 19. R 1 d3 e2 20. B 5 b1 a1 21. R 1 e2 e1
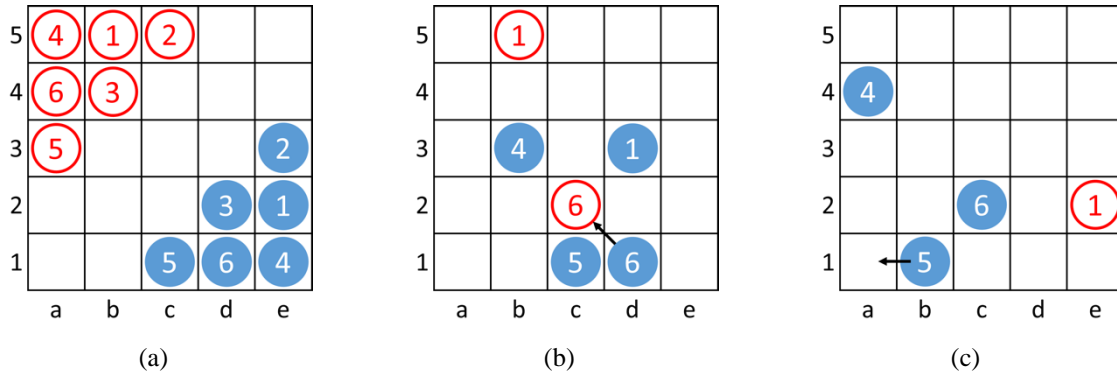
Fig. 2. The commented game between EWIN (Red) and κ=8πG (Blue): (a) the initial position, (b) the 14th move, and (c) the 20th move

The initial position of the game is shown in Fig. 2(a). In this game, Red was the first player. After Blue captured the opponent ⑥ on the 14th move, as shown in Fig. 2(b), Red had only one piece remaining, i.e. ①, and no longer needed to roll the dice for the rest of the game. On the next (15th) move, Red moved its ① to c4, which had a probability of 1/2 to lose on the 16th move if the opponent rolls one, two, or three to capture ① by ❶. However, Blue ended up rolling five. Red then captured the opponent ❶ on the 17th move to eliminate the threat, though the probability for the opponent to move ❹ (the piece closest to the target square a5) was increased from 1/2 to 2/3. On the 20th move, Blue had a probability of 2/3 to win if one, two, three, or four is rolled, in which case ❹ can be moved to the target square a5. However, Blue rolled five and missed the chance to win, as shown in Fig. 2(c). As a result, Red won on the 21st move by moving its ① to the target square e1.

Fig. 3. An EWN game set given to the winning team

Althöfer, the designer of EWN, provided an EWN game set with a wooden board and glass pieces as a reward to the winning team. The game set, as shown in Fig. 3, was awarded to the authors of EWIN.

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