Incorporating Domain Knowledge into Monte Carlo Tree Search in Dark Chess

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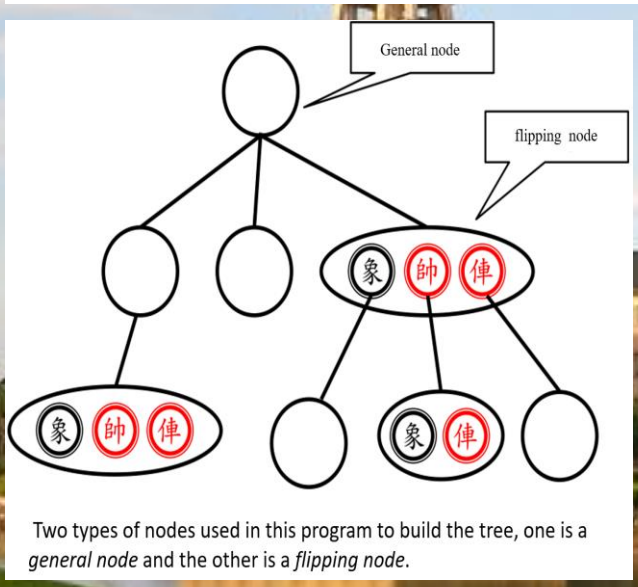
- A Dark Chess computer program based on Monte Carlo Tree Search (MCTS).
- We introduce a method that utilizes domain knowledge about piece values and positioning to score new nodes in the search tree.
- The move pre-scoring uses the three domain knowledge judgments, namely *suicide judgment*, *escape judgment* and *eating judgment*.
- This approach improves the strength of the Dark Chess computer program.

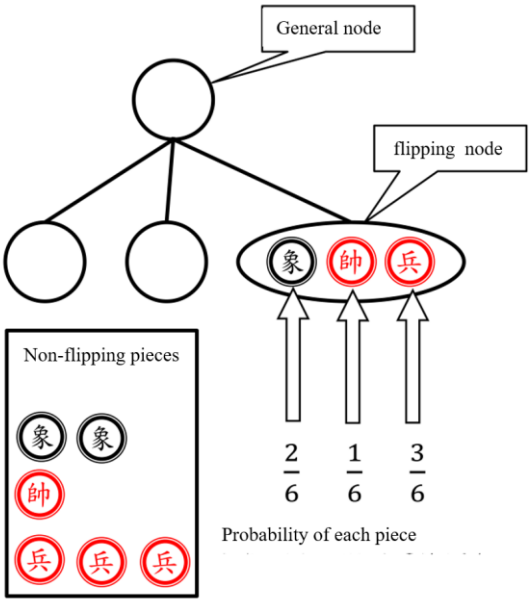


Two types of nodes used in this program to build the tree, one is a *general node* and the other is a *flipping node*.

	Turn	Win		Loss		Draw	
ORI	1st	210	42.0±4.4	203	40.6±4.4	87	17.4±3.4
	2nd	212	42.4±4.4	180	36.0±4.3	108	21.6±3.7
	Total	422	42.2±3.1	383	38.3±3.1	195	19.5±2.5
vD	1st	310	62.0±4.3	47	9.4±2.6	143	28.6±4.0
	2nd	309	61.8±4.3	59	11.8±2.9	132	26.4±4.0
	Total	619	61.9±3.1	106	10.6±1.9	275	27.5±2.8
vDP	1st	314	62.8±4.3	53	10.6±2.8	133	26.6±4.0
	2nd	330	66.0±4.2	39	7.8±2.4	131	26.2±3.9
	Total	644	64.4±3.0	92	9.2±1.8	264	26.4±2.8

CDC is a demonstration algorithm. The MCTS basic program developed by ORI, vD adds domain knowledge to pre-score the work, and vDP is based on vD and adds progressive search.

- **Addresses low accuracy with fewer simulations:** The proposed method uses domain knowledge (move scoring) and progressive search to improve accuracy when the number of simulations in the traditional MCTS is low.
- **Leveraging human move priorities:** The method incorporates a scoring system that prioritizes moves similar to human players' choices, focusing on capturing opportunities, escaping threats, and avoiding pointless moves.
- **Bounded trust interval with move score:** The winning rate is improved by considering the move score in the calculation of a "bounded trust interval" (exact detail not provided).



If a flipping node is encountered, the probability of each unit being revealed at this point in time will be calculated based on all the arms that have not yet been discovered and their individual quantities.