

Nondeterministic MCTS for a Partially Observable Problem: Chinese Dark Chess(CDC)

Shi-Jim Yen
National Dong Hwa University
顏士淨
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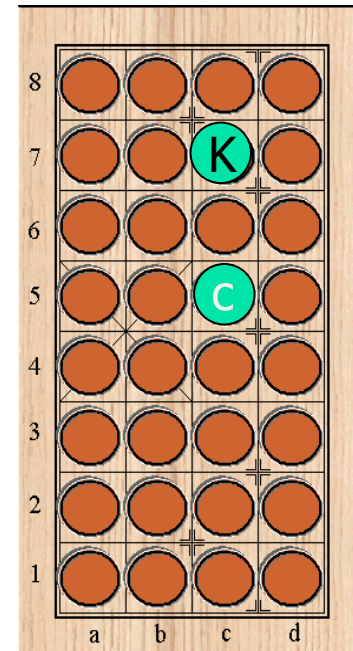
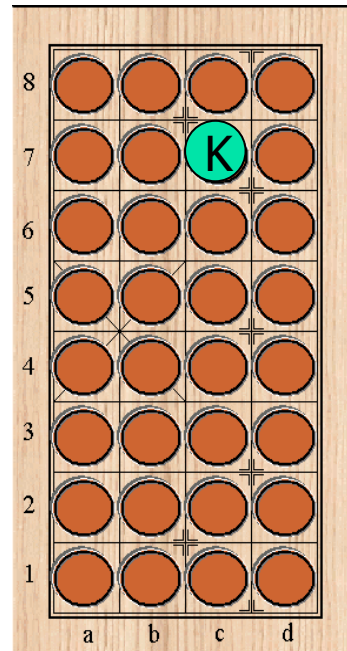
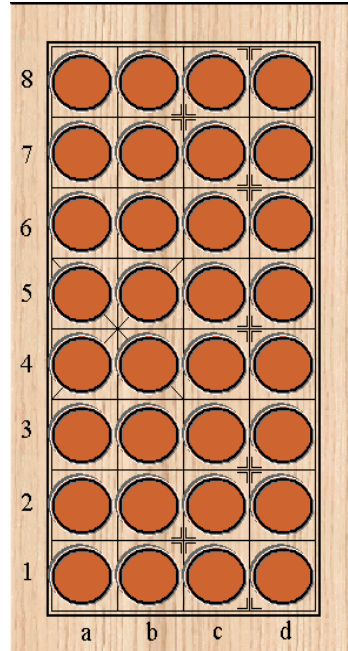
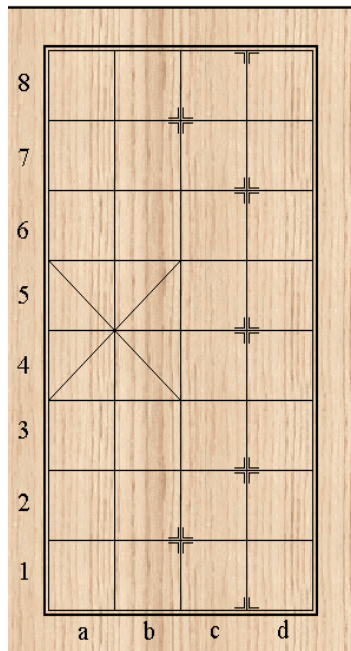


Partially Observable Problems





























	Observable information is shared	probability distribution of hidden information	Example Game
1	O	O	CDC
2	X	O	Poker, MJ
3	X	X	Phantom Go

Chinese Dark Chess(CDC)

- The board and the initial board



The pieces of CDC

Type of Pieces	King	Guard	Minister	Rook	Knight	Cannon	Pawn
Number	1	2	2	2	2	2	5
Red	K	G	M	R	N	C	P
Icon	 	 	 	 	 	 	 
Black	k	g	m	r	n	c	p
Icon	 	 	 	 	 	 	 
Rank	1(Highest)	2	3	4	5	6	7(Lowest)

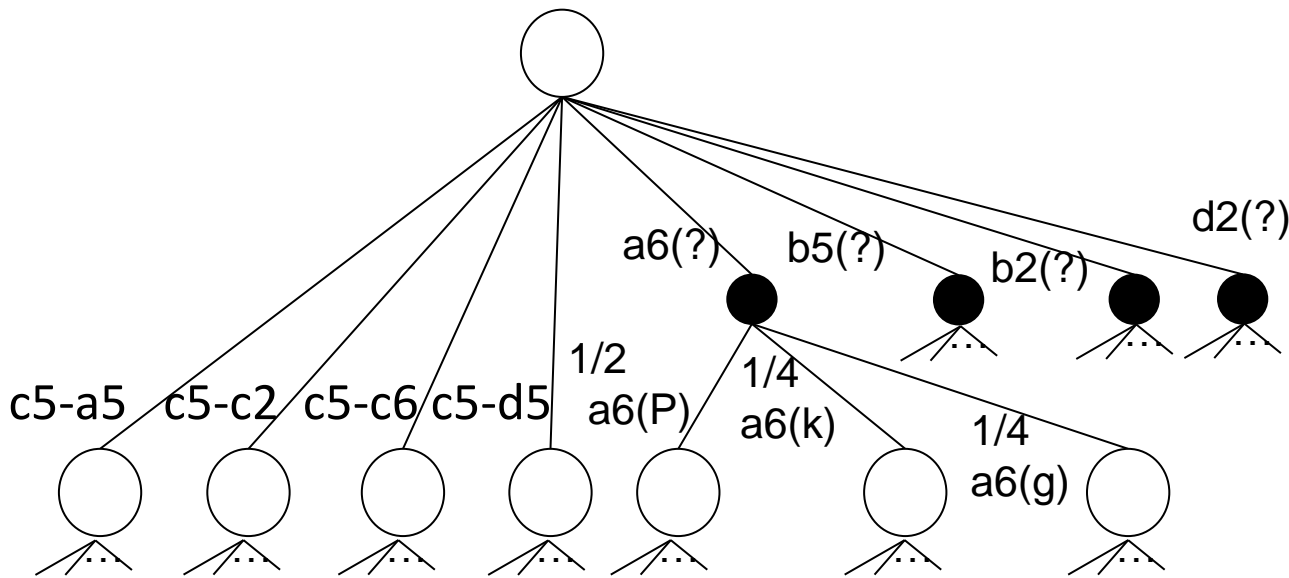
Actions in CDC

- Deterministic action: move a face-up piece
 - c5-d5, c5-c6, ...
- Nondeterministic action: flip a face-down piece
 - a6(?), b5(?), ...

● = {P, P, k, g}

8				
7				
6	●			
5	Ⓜ	●	Ⓢ	
4			Ⓟ	
3				
2		●	Ⓜ	●
1			Ⓚ	
	a	b	c	d

Game Tree Search solution

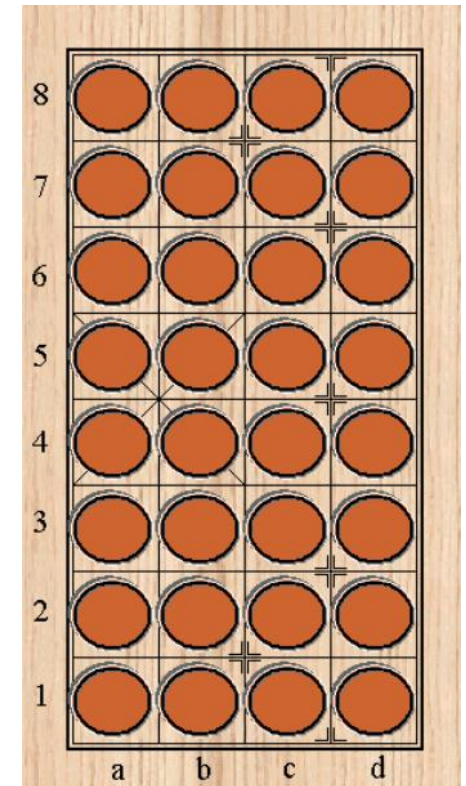


● = {P, P, k, g}

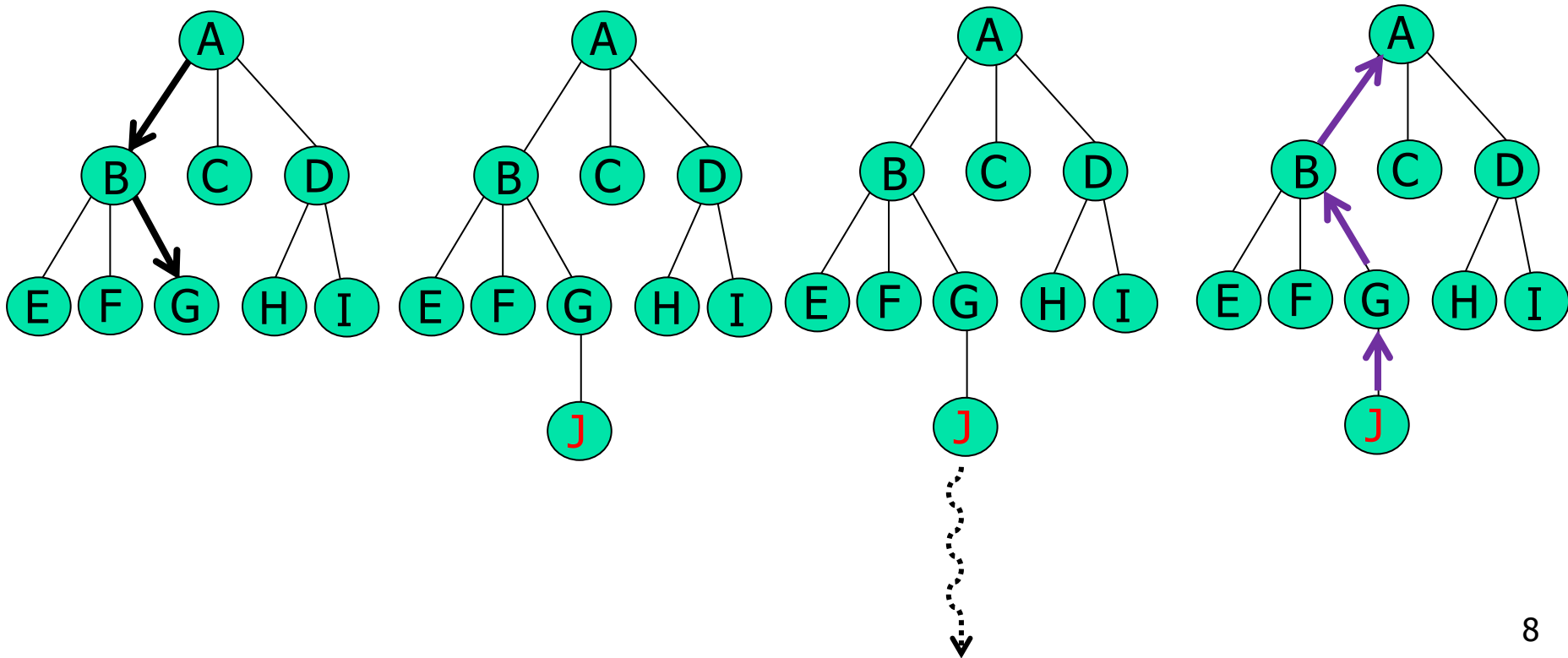
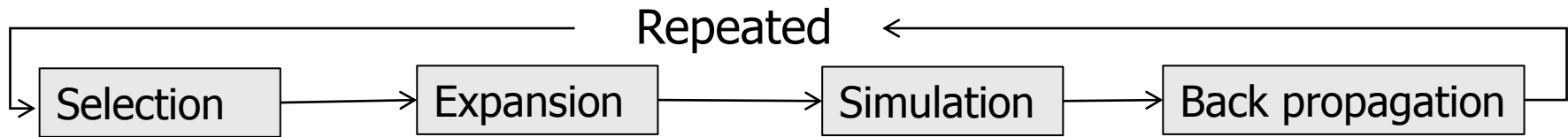
8				
7				
6	●			
5	R	●	c	
4			P	
3				
2		●	M	●
1			K	
	a	b	c	d

Problem of chance node

- Branching factor is huge
- Ex. Branching factor of first move is $14 \times 32 = 448$, bigger than that of Go

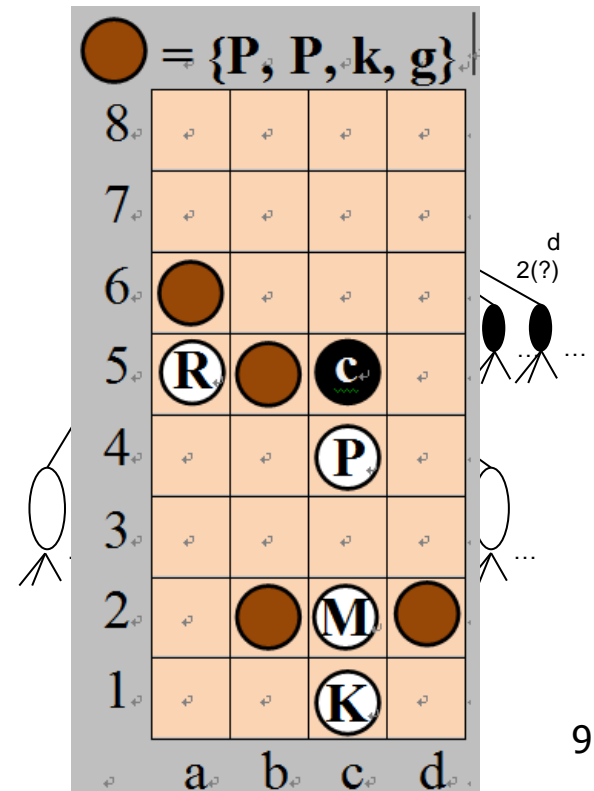
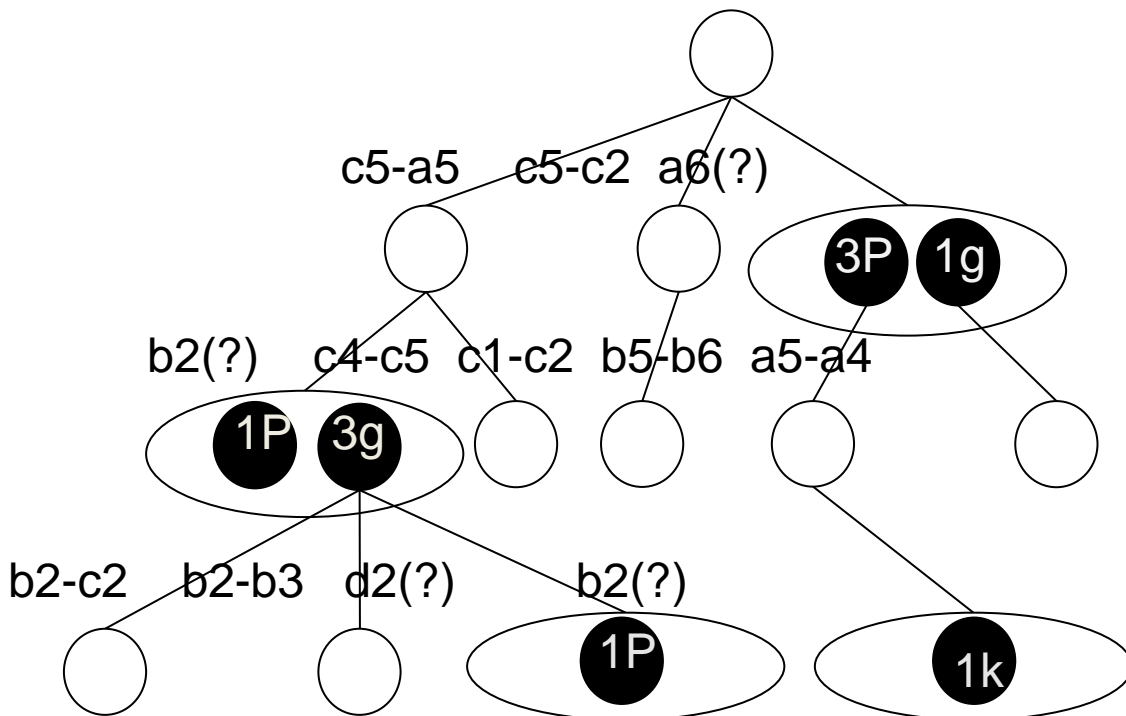


Monte-Carlo Tree Search(2007, Herik)



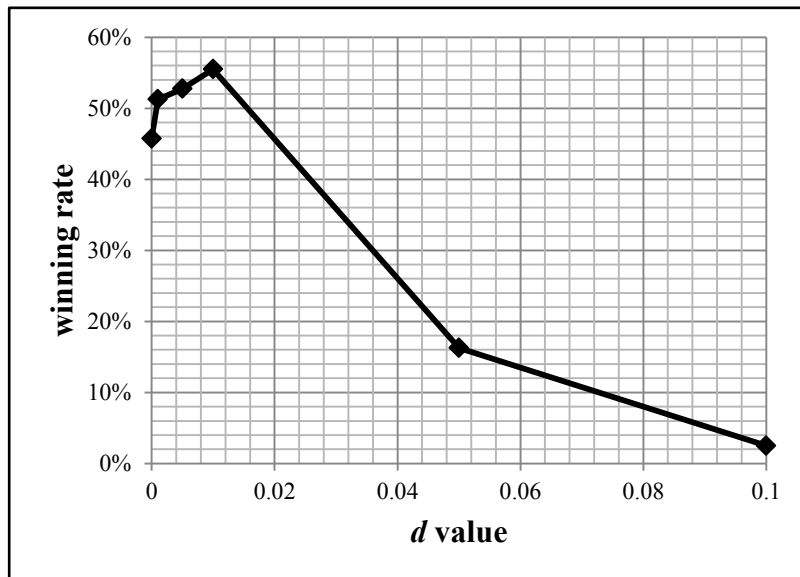
Nondeterministic MCTS

- Only expand a part of chance node's children (by roulette wheel selection), 3 vs. 12 at 1st level



Tree policy heuristic

- Shorter Simulation is better (SS)
 - $Wins_{i+1} = Wins_i + 1 + d \times (PGL - S)$
- Avoid draw





Three simulation Heuristics

- Capturing First (CF)
- Probability of Capturing piece Weight (PCW)
- Probability of Capturing and Escaping piece Weight (PCEW)

K	G	M	R	N	C	P
5500	5000	2500	1000	800	3000	800



NMCTS Result

- Subject: an game tree search CDC program

CF	SS	PCW	PCEW	W(%)	L(%)	D(%)
O	X	X	X	45.25	13.00	41.50
O	O	X	X	47.25	10.75	42.00
X	O	O	X	50.75	9.25	40.00
X	O	O	O	59.00	6.25	34.75



Tournament result(TCGA 2011)

	Dia	Lea	Dar	Fli	Pir	Bla	Mo	Scores	Rank
Diablo	-	1.5	1.5	1.5	1.5	1.5	2	9.5	1
Leave or Love	0.5	-	1	1	1.5	2	2	8	2
Dark Chesser	0.5	1	-	1	1	2	2	7.5	3
Flipper	0.5	1	1	-	1	0.5	2	6	4
Piranha	0.5	0.5	1	1	-	0.5	2	5.5	5
Black Cat	0.5	0	0	1.5	1.5	-	1	4.5	6
MoDark	0	0	0	0	0	1	-	1	7



Tournament result(TAAI 2011)

	Dia	Cra	Che	Bla	Scores	Play-off	Rank
Diablo	-	1.5	1.5	2	5		1
DarkCraft	0.5	-	1	1	2.5	2.5	2
Dark Chesser	0.5	1	-	1	2.5	1.5	3
Black Cat	0	1	1	-	2		4



Conclusion

- Nondeterministic MCTS is good for CDC
- Other Partially Observable Problems?