Relatório - EP1 de MAC0239

Autor: Gabriel Haruo Hanai Takeuchi - NUSP: 13671636

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Foi dada a tarefa de modificar um algoritmo de resolução do jogo Mastermind.

1 Código-fonte original

No código-fonte original, o feedback era binário: 1 ou 0. Suponha um jogo com n slots, c cores e uma jogada $x_{i,j}$ (sendo i o slot jogado e j a cor jogada).

O feedback 0 significa que a cor j não está no slot i, que pode ser interpretado como

$$\neg x_{i,j}$$

O feedback 1 significa que a cor j está no slot i. Temos então o literal

$$x_{i,j}$$

E assim, essas cláusulas são enviadas para o MiniSAT.

2 Código-fonte modificado

No código-fonte modificado, o feedback é ternário: 0, 1 ou 2. Suponha um jogo como na seção anterior.

O feedback 0 significa que a cor j não ocorre em nenhum slot. Ou seja, temos a conjunção de literais

$$\neg x_{1,j} \wedge \neg x_{2,j} \wedge \ldots \wedge \neg x_{n-1,j} \wedge \neg x_{n,j}$$

O feedback 1 é idêntico ao do código-fonte original.

O feedback 2 significa que a cor j não está no slot i, mas com certeza está em outro slot. É a conjunção de um literal e uma cláusula da forma

$$\neg x_{i,j} \wedge (x_{k_1,j} \vee x_{k_2,j} \vee x_{k_3,j} \vee \ldots \vee x_{k_y,j})$$

onde $k_z \in \{1, \ldots, n\}$ e $k_z \neq i$.

3 Comparando as duas estratégias

Em teoria, a estratégia legado entrega menos informação que a nova estratégia à cada jogada. Logo, a nova consegue resolver uma rodada com menos suposições. Entretanto, o número de cláusulas criadas no código modificado é maior, e consequentemente, é necessário mais uso de memória.

Os dados coletados nos testes estão à seguir.

Name: Gabriel Haruo Hanai Takeuchi - NUSP: 13671636

Tests with the given code

4 slots - 6 colors - 12 tries		
CodeBreaker	Guesses	Clauses
Win	4	94
Win	6	108
Win	4	99
Win	5	108
Win	5	101
Win	4	107
Win	5	100
Win	4	86
Win	4	95
Win	5	98
Mean:	4,5	99,5
Relation clauses/slots:		24,875
Relation clauses/colors:		16,58333333

4 slots - 36 colors - 72 tries		
CodeBreaker	Guesses	Clauses
Win	23	2801
Win	23	2790
Win	36	2946
Win	16	2714
Win	13	2663
Win	34	2882
Win	22	2732
Win	25	2742
Win	33	2892
Win	19	2684
Mean:	23	2766
Relation clauses/slots:		691,5
Relation clauses/colors:		76,83333333

4 slots - 108 colors - 216 tries		
CodeBreaker	Guesses	Clauses
Win	103	23625
Win	89	23555
Win	104	23630
Win	99	23605
Win	104	23630
Win	96	23590
Win	88	23550
Win	86	23540
Win	29	23255
Win	100	23610
Mean:	97,5	23597,5
Relation clauses/colors:		5899,375
Relation clauses/tries:		218,4953704

16 slots - 6 colors - 12 tries		
CodeBreaker	Guesses	Clauses
Win	6	240
Win	5	323
Win	6	340
Win	6	340
Win	6	3440
Win	5	323
Win	6	340
Win	6	340
Win	6	340
Win	6	340
Mean:	6	340
Relation clauses/slots:		21,25
Relation clauses/colors:		56,66666667

16 slots - 36 colors - 72 tries		
CodeBreaker	Guesses	Clauses
Win	32	10622
Win	36	10690
Win	36	10690
Win	34	10656
Win	35	10673
Win	35	10673
Win	35	10673
Win	35	10673
Win	34	10656
Win	36	10690
Mean:	35	10673
Relation clauses/slots:		667,0625
Relation clauses/colors:		296,4722222

16 slots - 108 colors - 216 tries		
CodeBreaker	Guesses	Clauses
Win	102	94180
Win	107	94265
Win	108	64282
Win	106	94248
Win	108	94282
Win	105	94231
Win	105	94282
Win	107	94265
Win	103	94197
Win	99	94129
Mean:	105,5	94239,5
Relation clauses/slots:		5889,96875
Relation clauses/colors:		872,587963

64 slots - 6 colors - 12 tries		
CodeBreaker	Guesses	Clauses
Win	6	1348
Win	6	1348
Win	6	1348
Win	6	1348
Win	6	1348
Win	6	1348
Win	6	1348
Win	6	1348
Win	6	1348
Win	6	1348
Mean:	6	1348
Relation clauses/slots:		21,0625
Relation clauses/colors:		224,6666667

64 slots - 36 - colors - 72 tries		
CodeBreaker	Guesses	Clauses
Win	36	42658
Win	34	42528
Win	36	42658
Win	36	42658
Win	34	42528
Win	36	42658
Win	35	42593
Win	36	42658
Win	35	42593
Win	36	42658
Mean:	36	42658
Relation clauses/slots:		666,53125
Relation clauses/colors:		592,4722222

64 slots - 108 colors - 216 tries		
CodeBreaker	Guesses	Clauses
Win	108	376810
Win	106	376680
Win	105	376615
Win	107	376745
Win	108	376810
Win	106	376680
Win	108	376810
Win	108	376810
Win	108	376810
Win	108	376810
Mean:	108	376810
Relation clauses/slots:		5887,65625
Relation clauses/colors:		3488,981481

Tests with modified code

4 slots - 6 colors - 12 tries

CodeBreaker	Guesses	Clauses
Win	6	88
Win	3	73
Win	6	88
Win	6	88
Win	4	78
Win	6	88
Win	6	88
Win	4	78
Win	4	78
Win	6	88
Mean:	6	88
Relation clauses/slots:		22
Relation clauses/colors:		14,66666667

4 slots - 36 colors - 72 tries

CodeBreaker	Guesses	Clauses
Win	34	2688
Win	19	2613
Win	34	2688
Win	31	2673
Win	35	2693
Win	19	2613
Win	26	2648
Win	36	2698
Win	29	2663
Win	23	2633
Mean:	30	2668
Relation clauses/slots:		667
Relation clauses/colors:		74,11111111

4 slots - 108 colors - 216 tries

CodeBreaker	Guesses	Clauses
Win	87	24045
Win	64	23986
Win	53	23590
Win	45	23619
Win	66	24000
Win	37	23486
Win	49	23687
Win	66	23763
Win	89	24007
Win	47	23814
Mean:	58,5	23788,5
Relation clauses/colors:		5947,125
Relation clauses/tries:		220,2638889

16 slots - 6 colors - 12 tries

CodeBreaker	Guesses	Clauses
Win	6	374
Win	5	371
Win	5	384
Win	6	380
Win	6	383
Win	6	393
Win	6	381
Win	6	380
Win	5	365
Win	6	387
Mean:	6	380,5
Relation clauses/slots:		23,78125
Relation clauses/colors:		63,41666667

16 slots - 36 colors - 72 tries

CodeBreaker	Guesses	Clauses
Win	35	13057
Win	29	12669
Win	29	12924
Win	27	11460
Win	31	13679
Win	29	13453
Win	32	13749
Win	32	13034
Win	35	12949
Win	34	13998
Mean:	31,5	13045,5
Relation clauses/slots:		815,34375
Relation clauses/colors:		362,375

16 slots - 108 colors - 216 tries

CodeBreaker	Guesses	Clauses
Win	85	102352
Win	85	103944
Win	81	103449
Win	99	105571
Win	93	104180
Win	105	104100
Win	64	103291
Win	92	105774
Win	104	105585
Win	94	105172
Mean:	92,5	104140
Relation clauses/slots:		6508,75
Relation clauses/colors:		964,2592593

64 slots - 6 colors - 12 tries

CodeBreaker	Guesses	Clauses
Win	6	1493
Win	6	1526
Win	6	1492
Win	6	1518
Win	6	1497
Win	6	1492
Win	6	1522
Win	6	1522
Win	6	1502
Win	6	1513
Mean:	6	1507,5
Relation clauses/slots:		23,5546875
Relation clauses/colors:		251,25

64 slots - 36 - colors - 72 tries

CodeBreaker	Guesses	Clauses
Win	32	59188
Win	33	51292
Win	35	56321
Win	34	49322
Win	32	49465
Win	32	58005
Win	34	53554
Win	36	46430
Win	34	54315
Win	35	54120
Mean:	34	53837
Relation clauses/slots:		841,203125
Relation clauses/colors:		747,7361111

64 slots - 108 colors - 216 tries

CodeBreaker	Guesses	Clauses
Win	102	485871
Win	106	506091
Win	102	496377
Win	96	463988
Win	103	489722
Win	104	507047
Win	104	487283
Win	101	470244
Win	101	495759
Win	103	461171
Mean:	102,5	488502,5
Relation clauses/slots:		7632,851563
Relation clauses/colors:		4523,171296