Impartial Clobber Solver

Xinyue, Jiayi

Algorithms

- Nimbers Are Inevitable
- On pruning search trees of impartial games (algorithm 5)

Nimbers Are Inevitable

Computing the nimber or outcome of a position P.

n is initially 0

- Algorithm 1: Compute the outcome of the couple (P, n)
  - P is splittable —> Algorithm 2(subgames, n)
  - P is not splittable —> Algorithm 1(moves, n), Algorithm 1(P, ni)
    - Return outcome
- Algorithm 2: Compute the outcome of a couple (P1 + · · · + Pk, n)
  - Calculate nimbers of subgames P1,P2,...Pk-1 with Algorithm 3
  - Algorithm 1(Pk, nimsum)
- Algorithm 3: Compute the nimber of a position P
  - Starting with nim = 0
  - If Algorithm 1 (P, nim) return Losing, the nimber of P is nim

    Else, increase nim by 1.

On pruning search trees of impartial games (algorithm 5)

Potential nimber of a position will be in set {0,1,2,…, len(moves)}
The check the children of the position.

- If the nimbers of the children in set{0,1,2,… len(moves)-1}
  - The nimber of the position won't be the nimbers of the children.
- If the nimbers of the children not in set{0,1,2,… len(moves)-1}
  - The nimber of the position won't be the max nimber in the set.

For some children, the exact value is not needed to determine the nimber of the position.

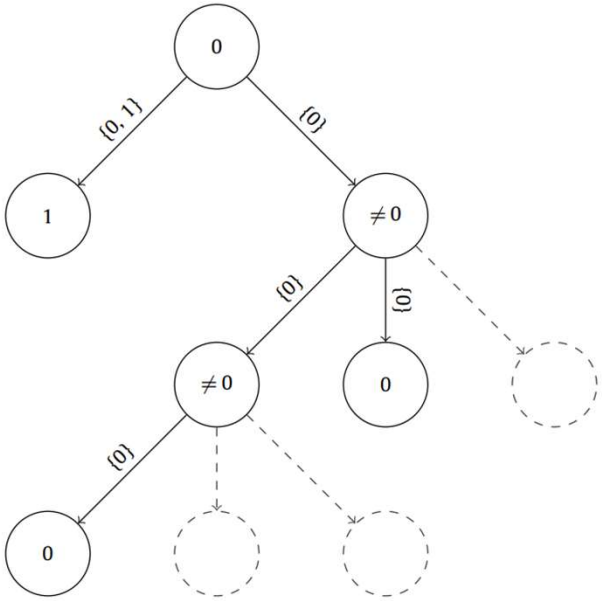

Figure from the paper

Experimental Results on 1-d Boards

- Nimbers Are Inevitable
  - Middle moves first vs. not

Board size	20	30	40
Middle moves first	0.014	0.215	0.030
Not	0.022	0.339	0.047

Tested with the same randomly generated 20 positions

Experimental Results on 1-d Boards

- Nimbers Are Inevitable vs.
  On pruning search trees of impartial games (algorithm 5)

(BW)^n, n =	1	2	3	4	5	6	7	8	9
On pruning	0.003	0.004	0.004	0.007	0.029	0.157	0.878	5.268	30.358
Nimbers	0.004	0.006	0.004	0.012	0.013	0.029	0.038	0.122	0.131

Results for (BW)^n

n	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
nimber	1	3	0	2	0	2	0	3
time cost	0.009	0.008	0.005	0.013	0.014	0.031	0.036	0.131
n	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
nimber	1	4	6	1	0	1	3	7
time cost	0.108	11.917	51.125	5.500	1.971	1.287	1.623	24.390

Computed using the algorithms from Nimbers Are Inevitable
(seconds)

Demo

More to Implement

- Parallelization in Nimbers Are Inevitable algorithm
  - Subgames' nimbers are independent
- Implementing the rest algorithms in On pruning search trees of impartial games
  - Enhanced Transposition Cutoff
  - resuming
- Based on how the moves change in Clobber, further pruning might be possible

References

- *Julien Lemoine and Simon Viennot. 2012. Nimbers are inevitable. Theor. Comput. Sci. 462 (November, 2012), 70–79. DOI:https://doi.org/10.1016/j.tcs.2012.09.002*
- *Beling, Piotr & Rogalski, Marek (2020). On pruning search trees of impartial games. _Artificial Intelligence_ 283:103262.*