Solving NoGo on Small Rectangular Boards

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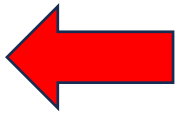
Contributions

- Sorted Bucket Hash (SBH)
- Solutions of NoGo on boards with up to 27 points
- Statistics and human-understandable strategies of NoGo

Plan

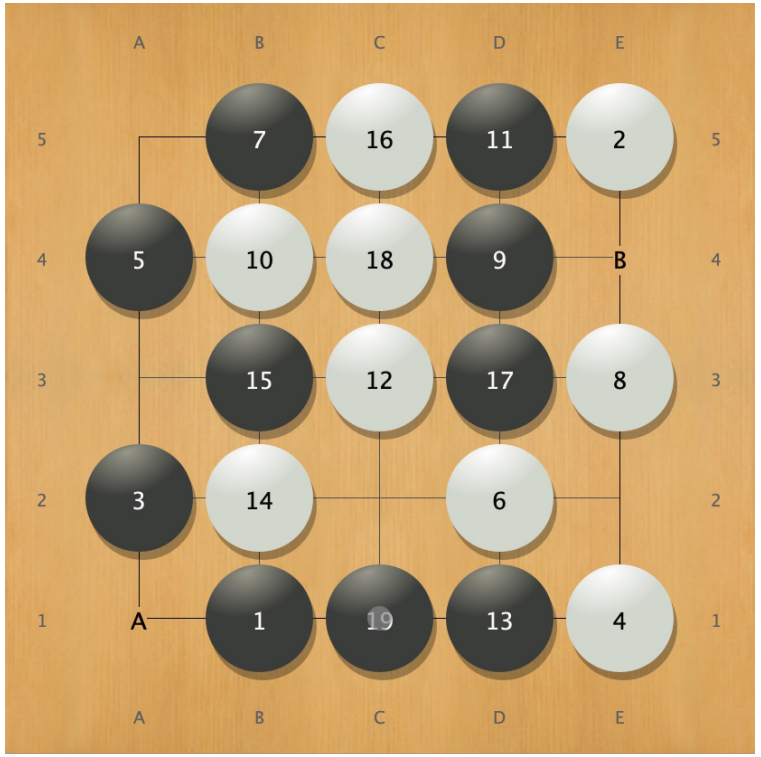
- Background of NoGo
- Sorted Bucket Hash
- Strategies for playing 4x4 & 5x5 NoGo

Plan

- Background of NoGo 
- Sorted Bucket Hash
- Strategies for playing 4x4 & 5x5 NoGo

Rules

- Two players, Black going first
- Block - connected stones
- Liberties



- All blocks must always have at least one liberty

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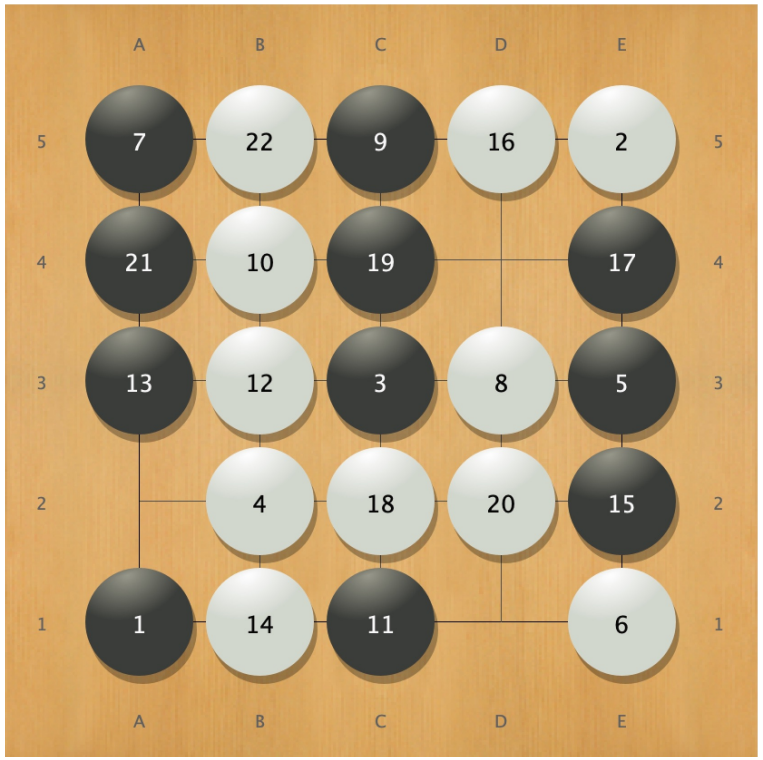
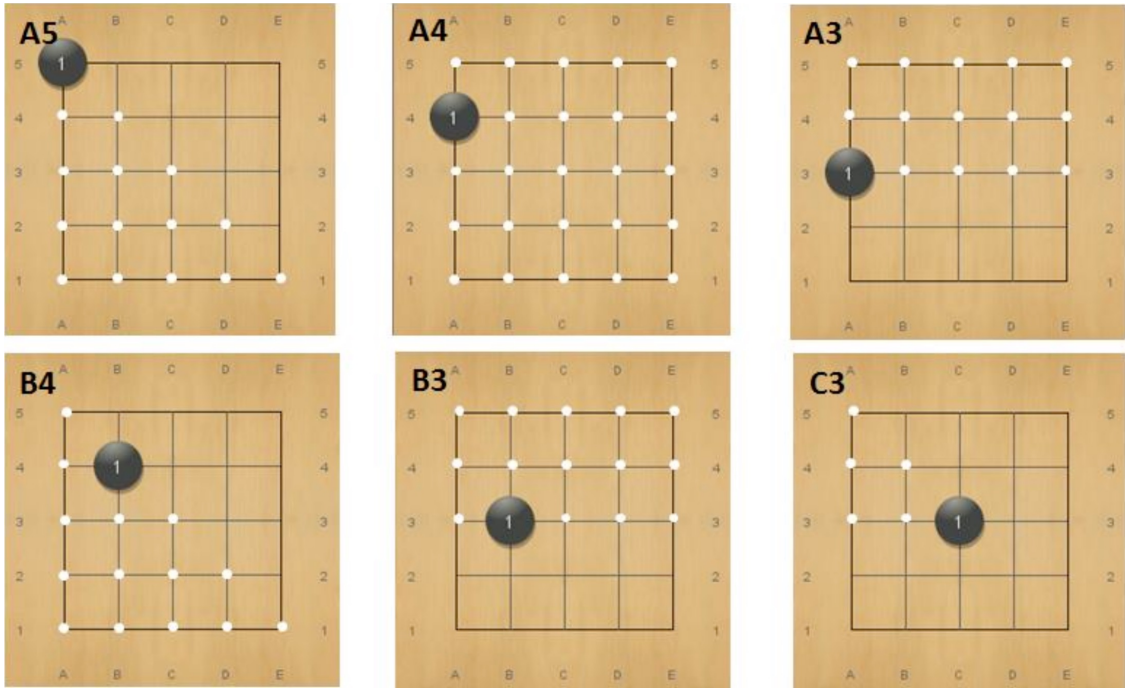


- All blocks must always have at least one liberty
- The game ends when a player has no legal move to play
- This player is deemed the loser

Previous work

- Pohsuan She, 2013
- 5x5 NoGo
- All 6 openings are wins for Black



She, P.: The Design and Study of NoGo Program. Master's thesis, National Chiao Tung University (2013)

Previous work

- Tristan Cazenave, 2020
- Up to 25 points

	1	2	3	4	5	6	7	8	9	10
1	2	1	1	2	1	1	1	1	1	1
2	1	1	2	2	1	1	1	1	2	2
3	1	2	1	2	1	1	1	1		
4	2	2	2	2	1	1				
5	1	1	1	1	1					
6	1	1	1	1						
7	1	1	1							
8	1	1	1							
9	1	2								
10	1	2								

Table 3: Winner for Nogo boards of various sizes

Cazenave, T.: Monte carlo game solver.
In: *Monte Carlo Search, MCS 2020*. (2021)

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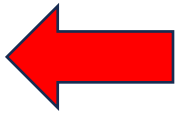
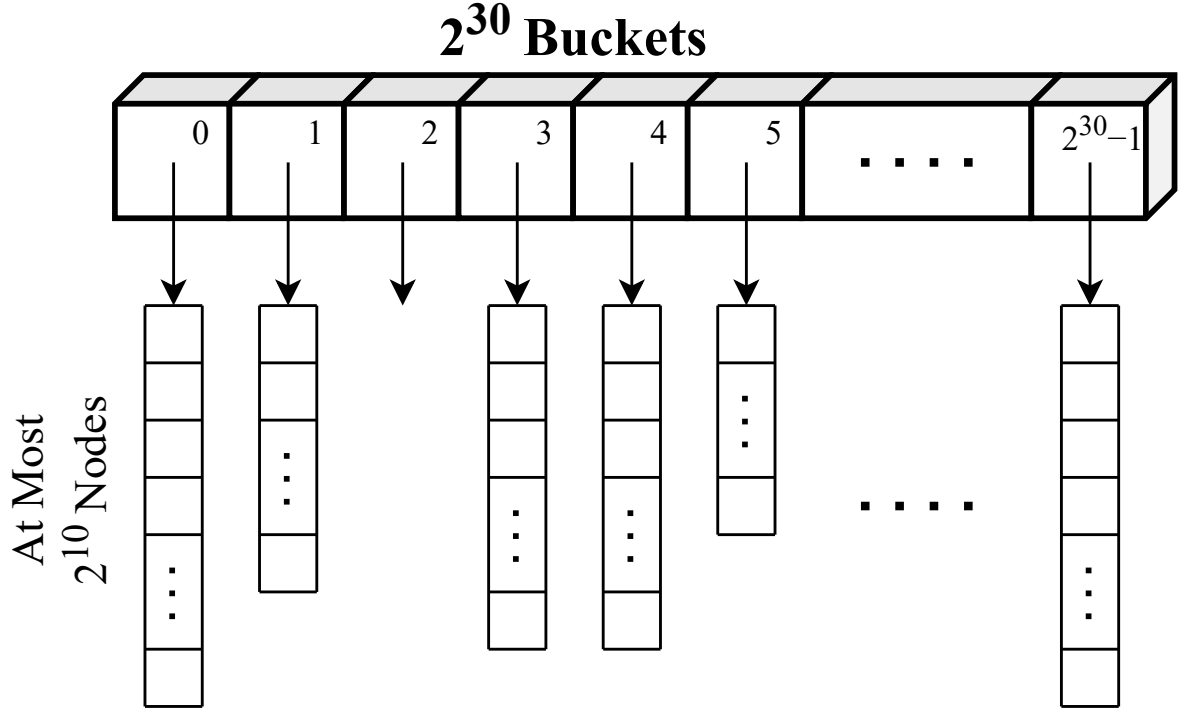
- Background of NoGo
- Sorted Bucket Hash 
- Strategies for playing 4x4 & 5x5 NoGo

Sorted Bucket Hash (SBH)

- Motivations:

- Weakly solving games
- Perfect hashing
- Memory footprint (32GB)



SBH – intuition

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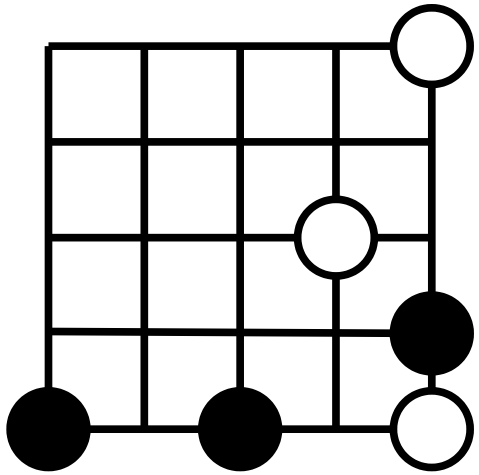

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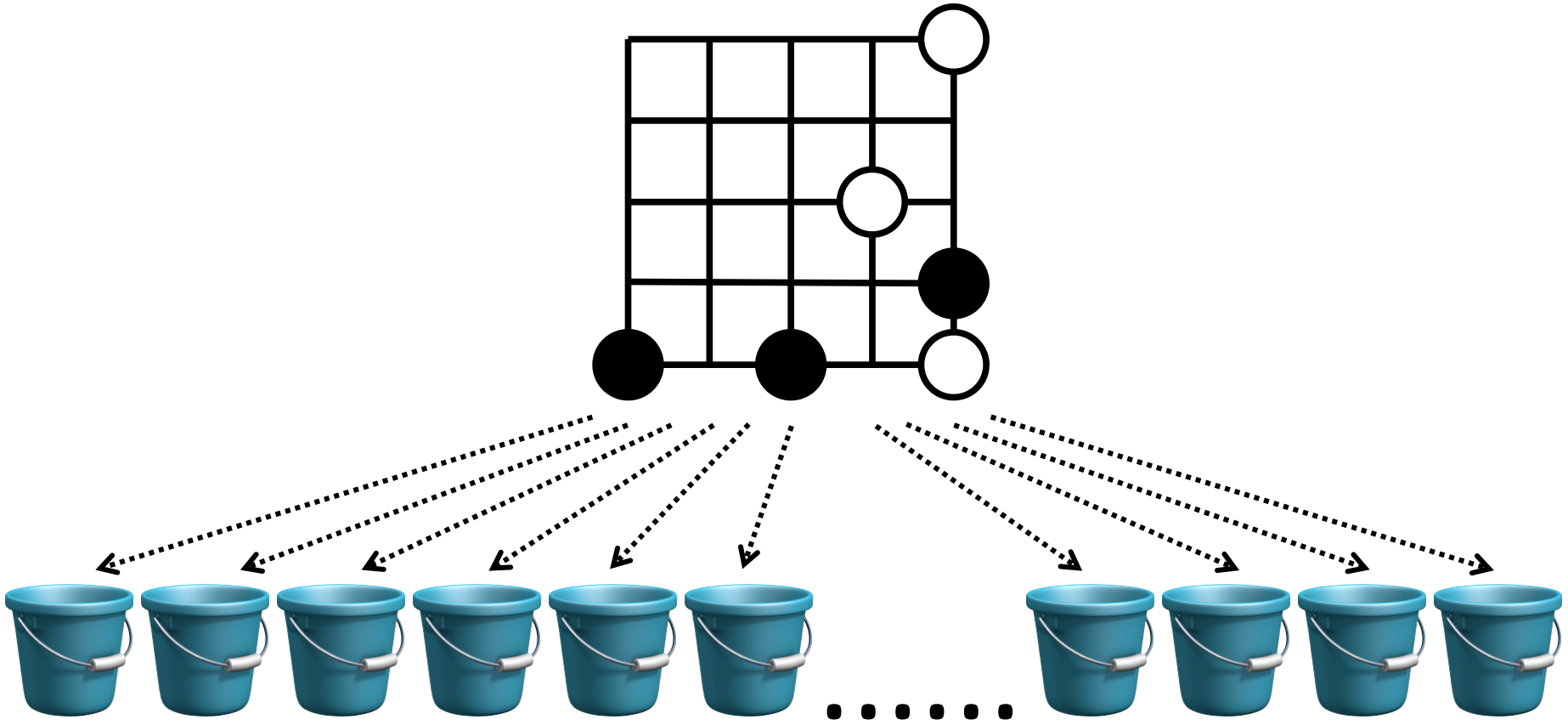

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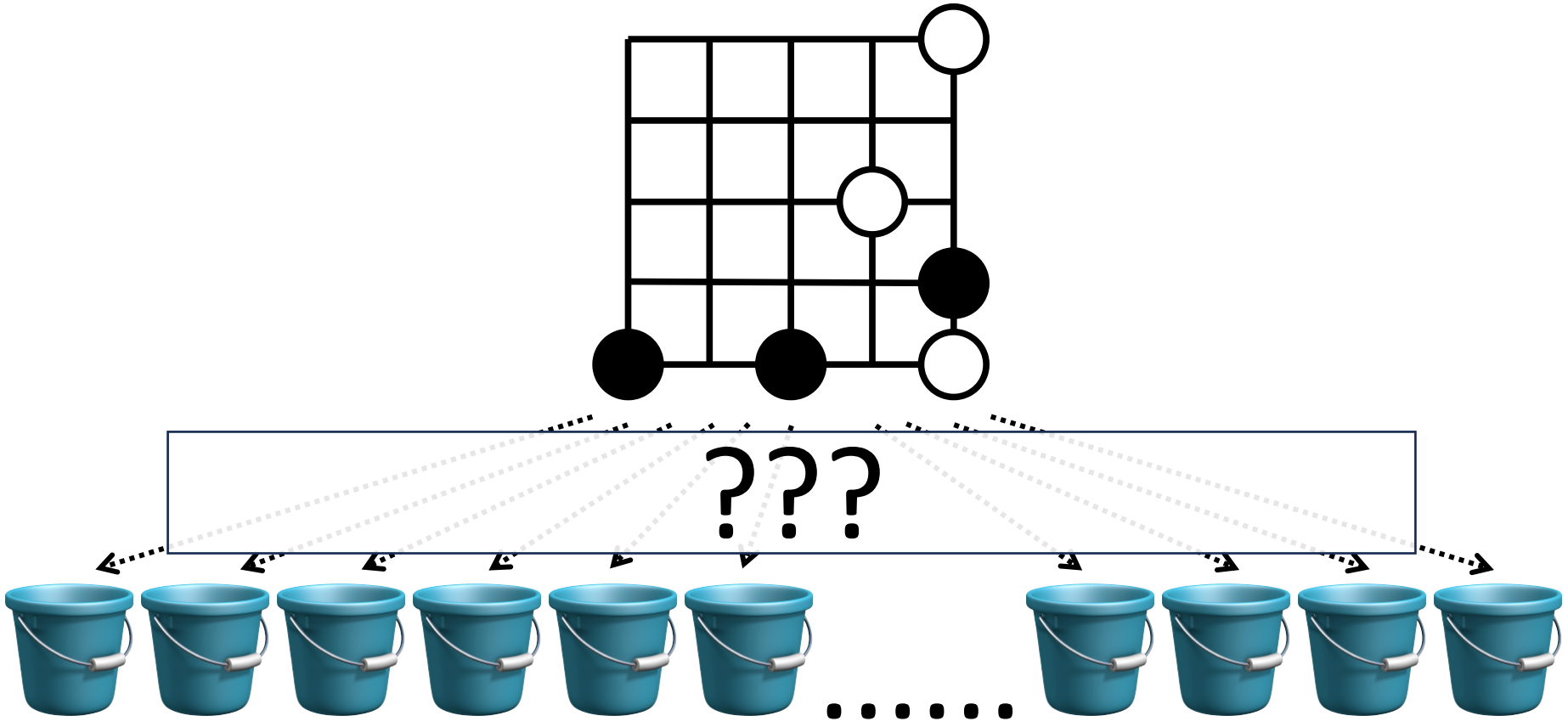
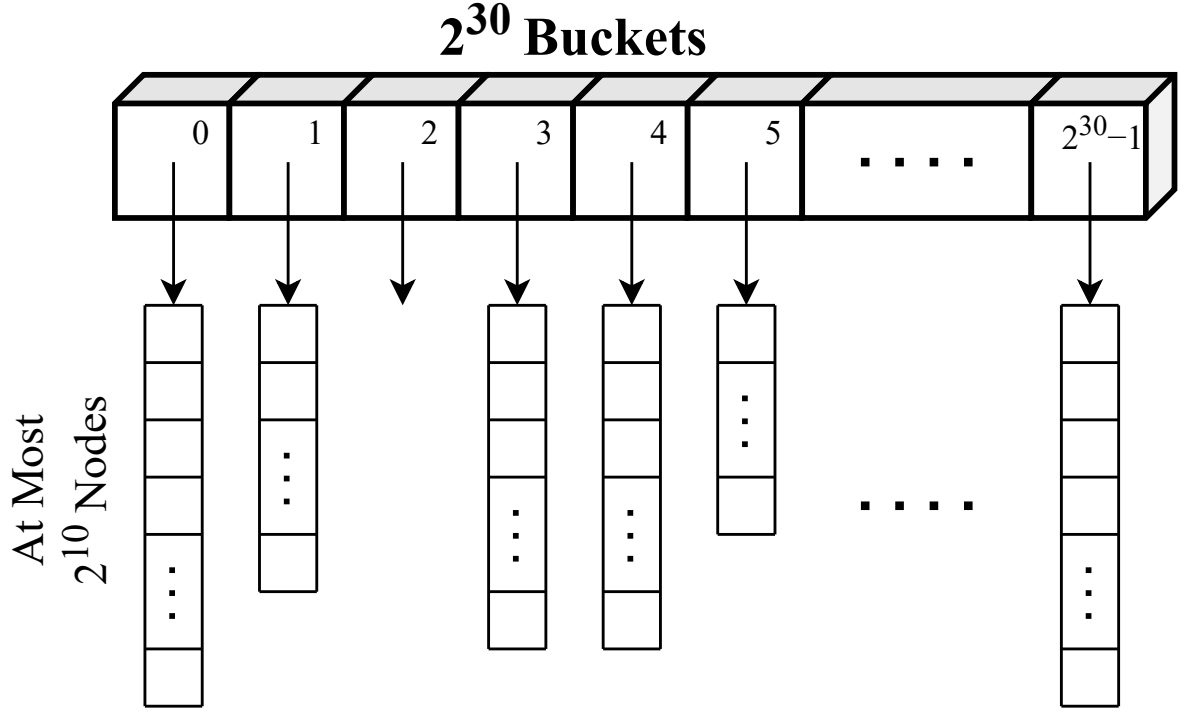


SBH – data structure



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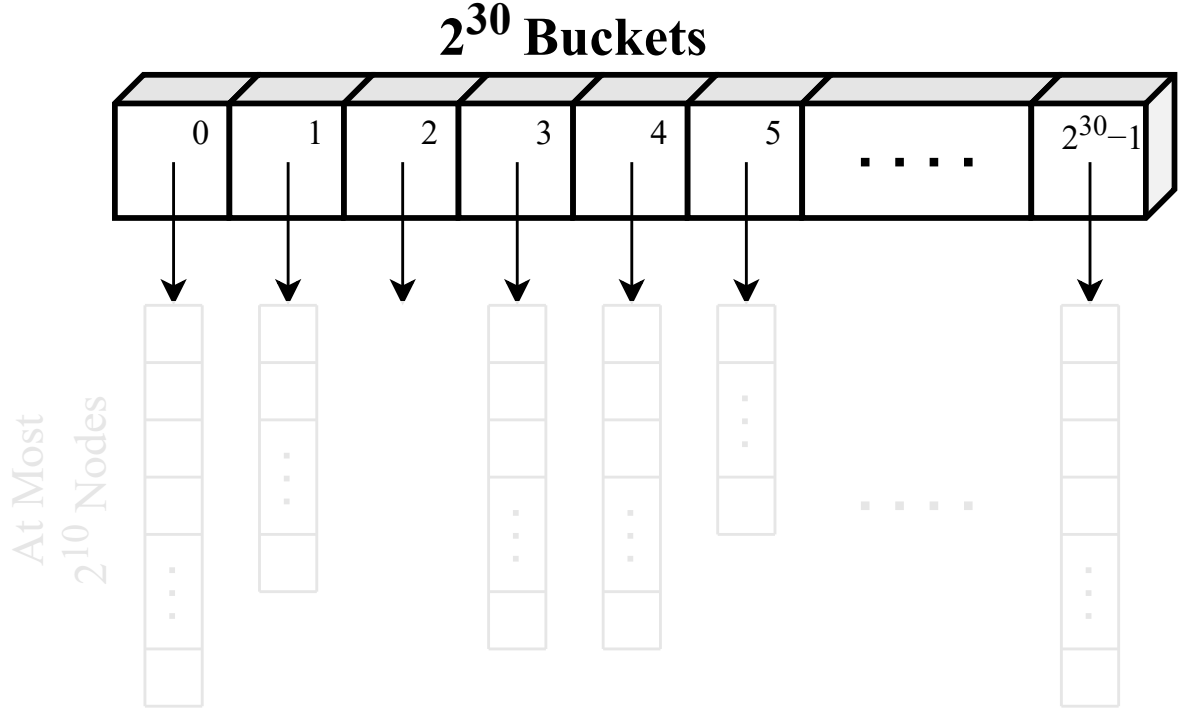

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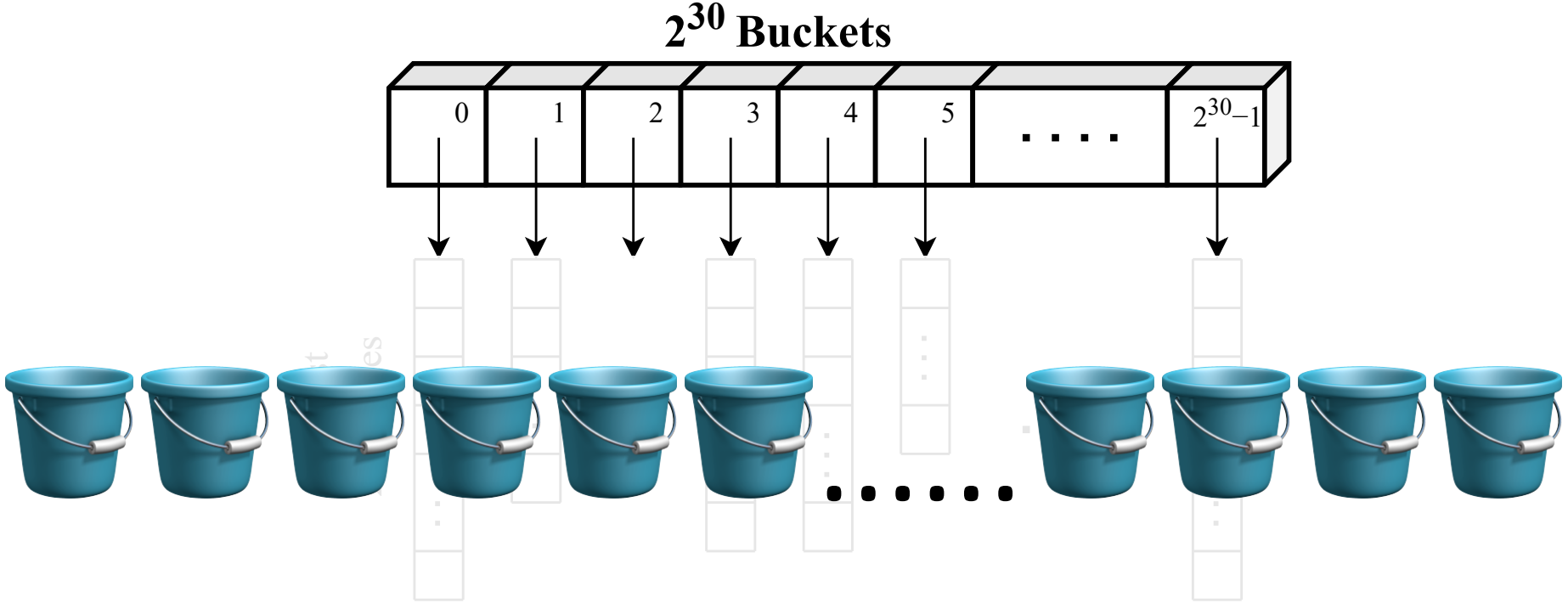
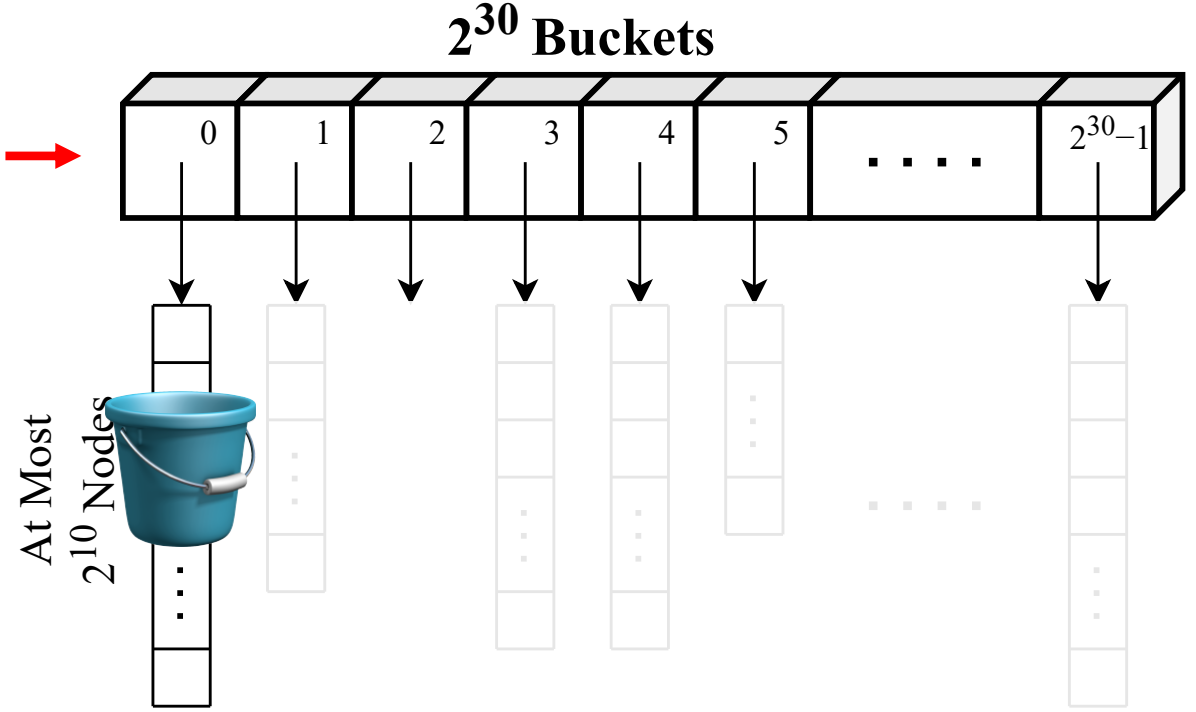


SBH – data structure

array of pointers →



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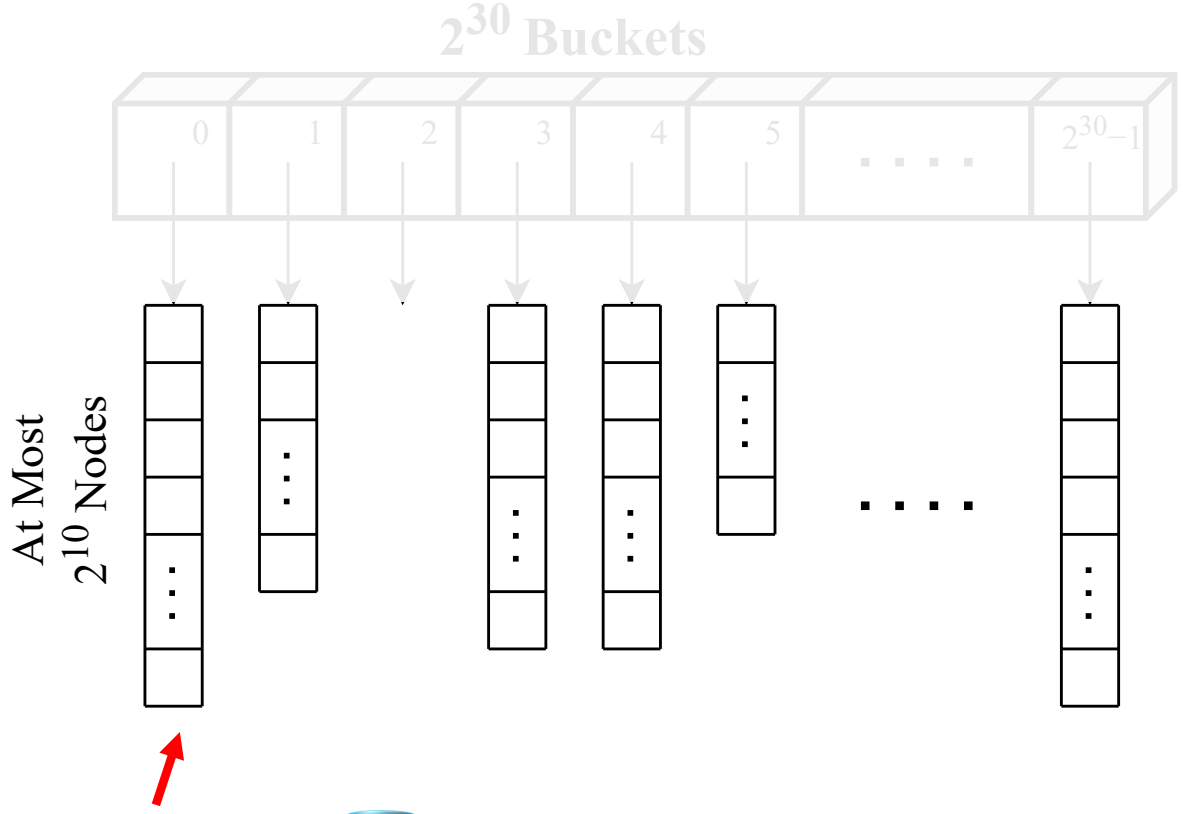

dynamically allocated array

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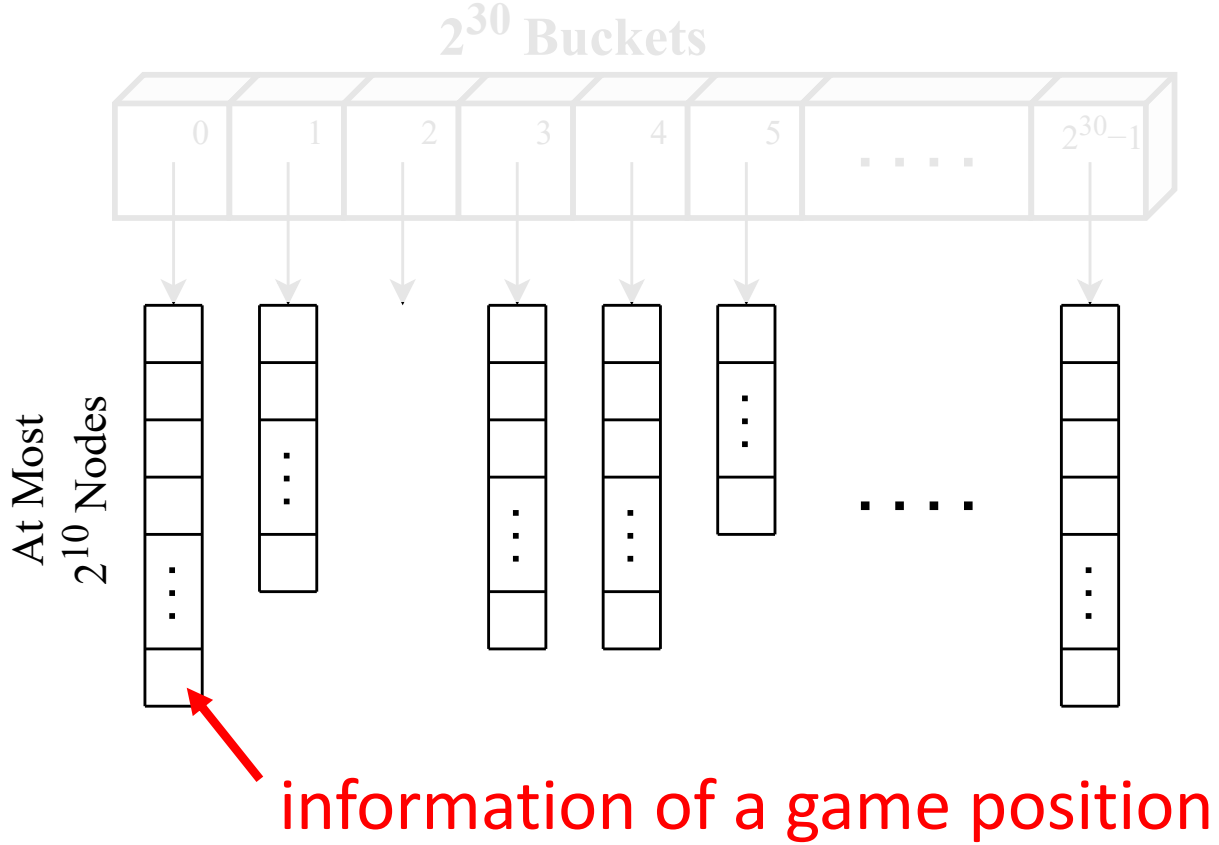

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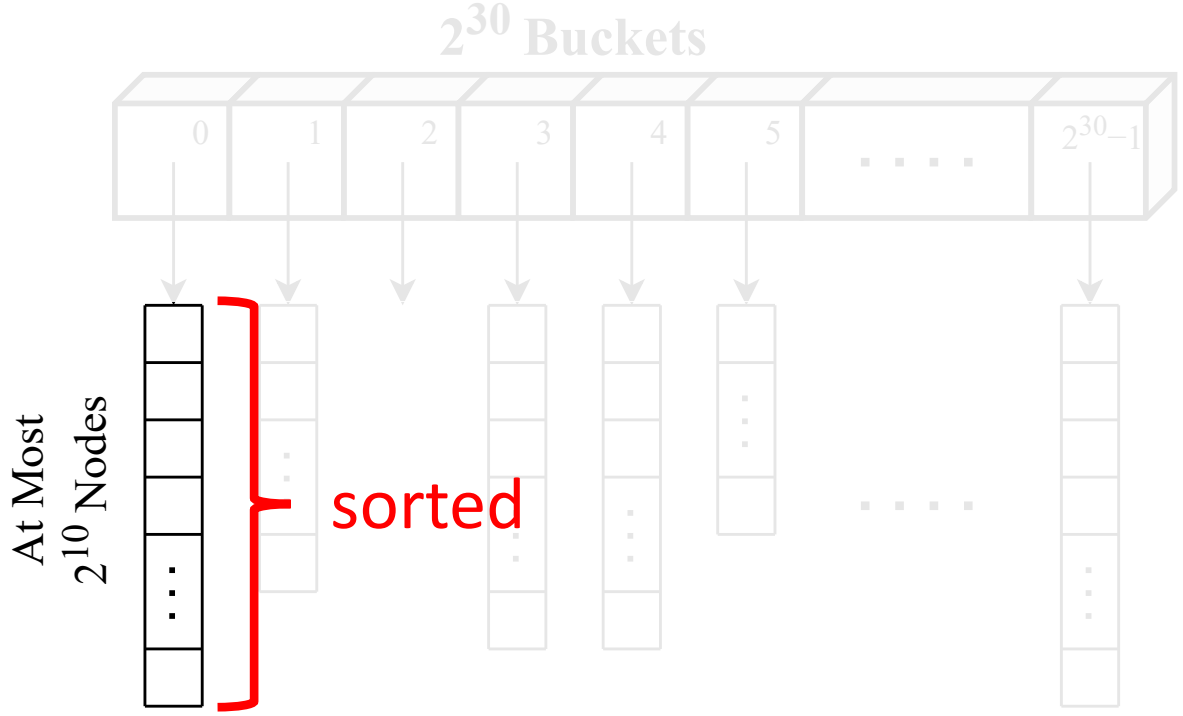

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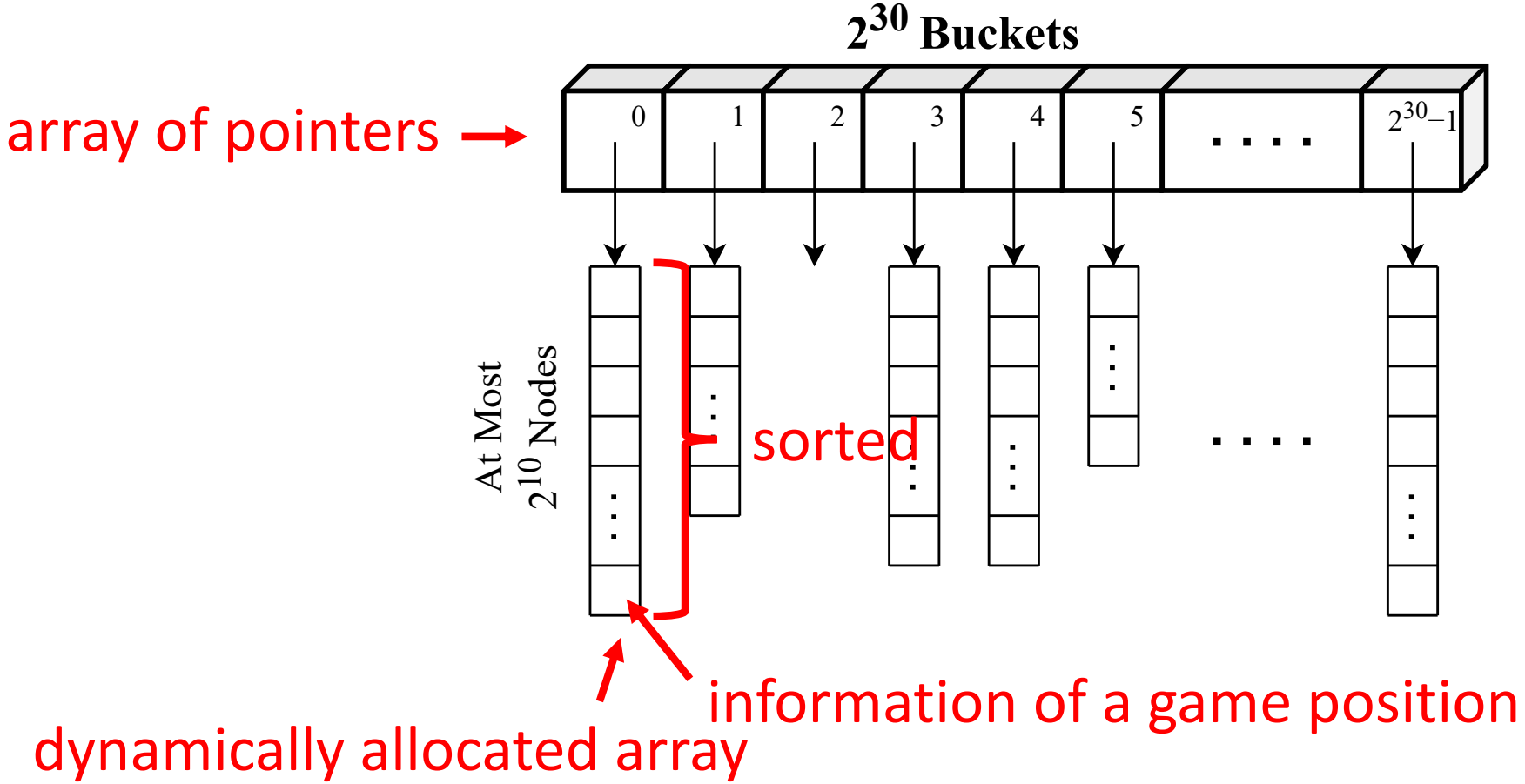

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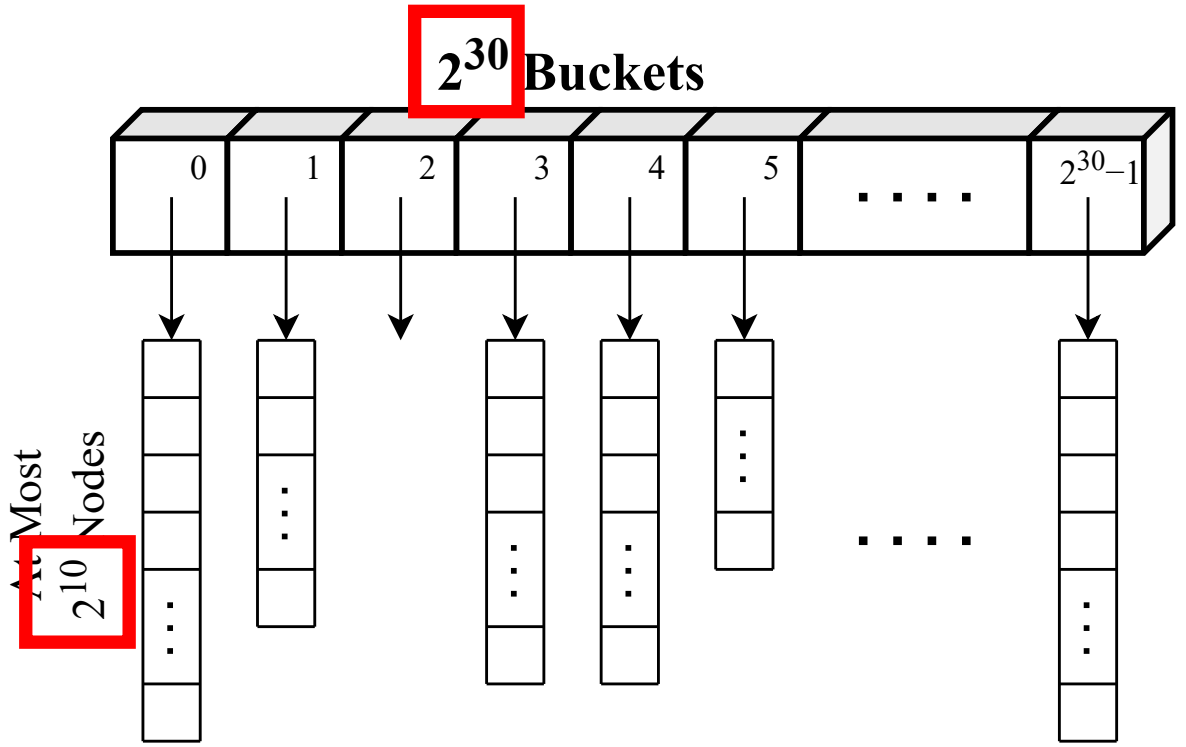

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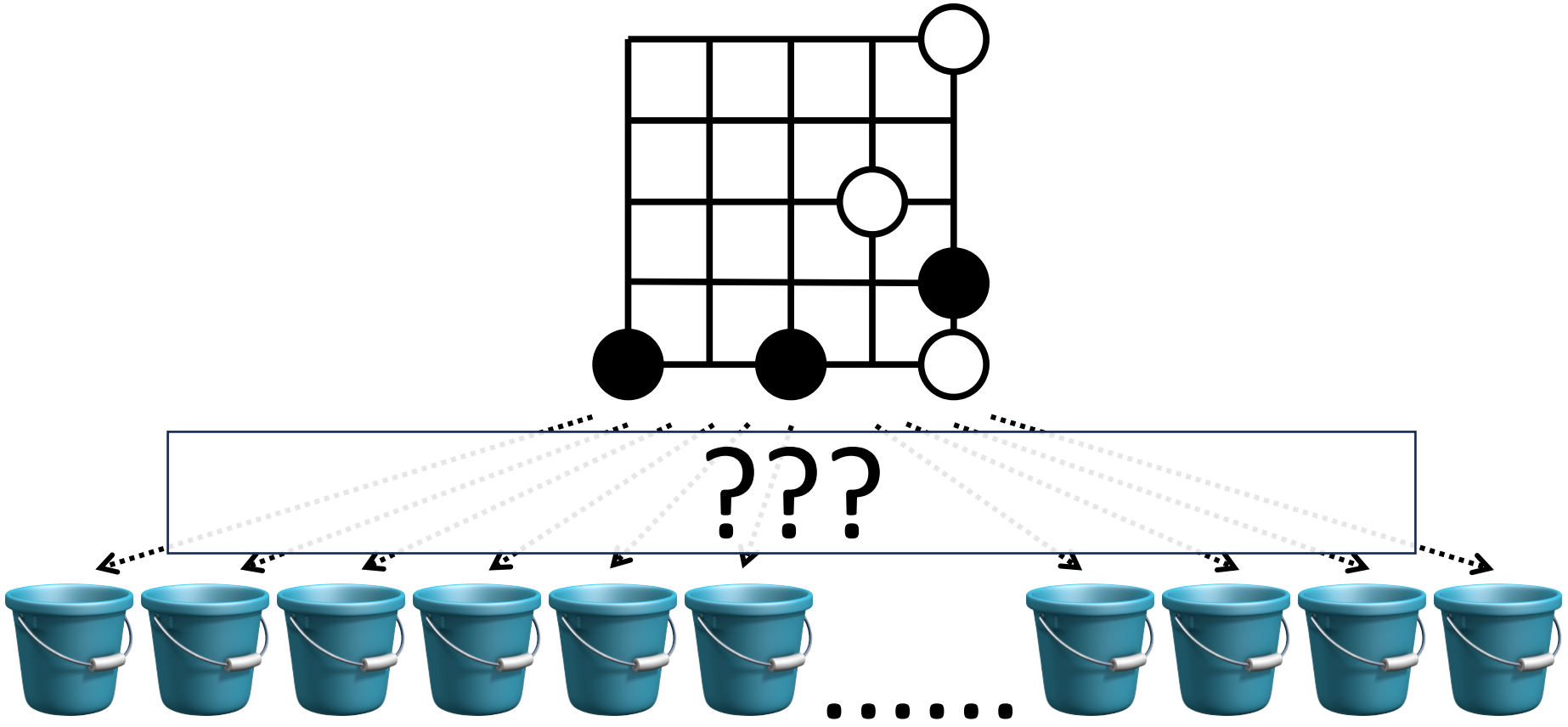
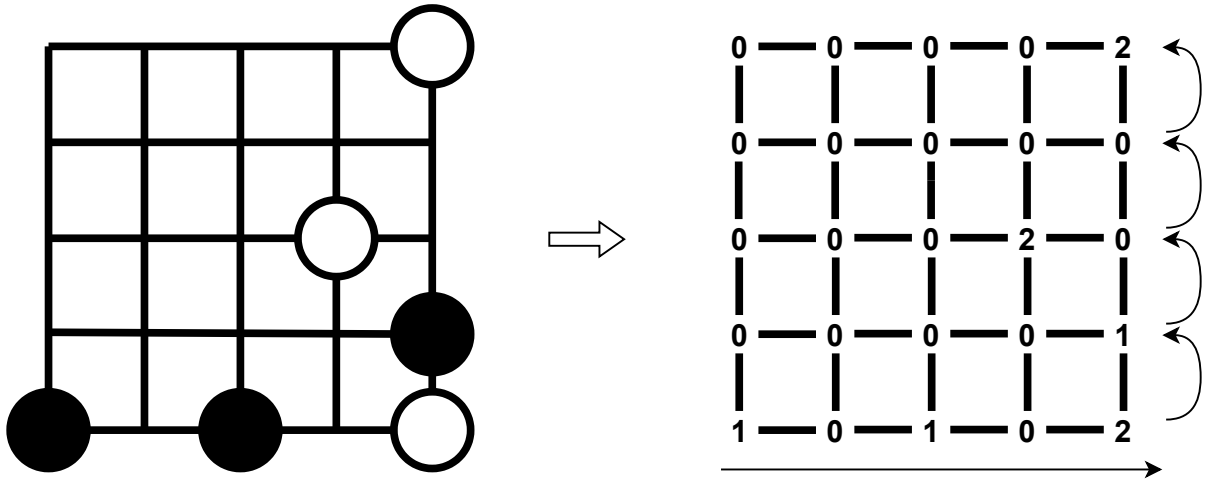


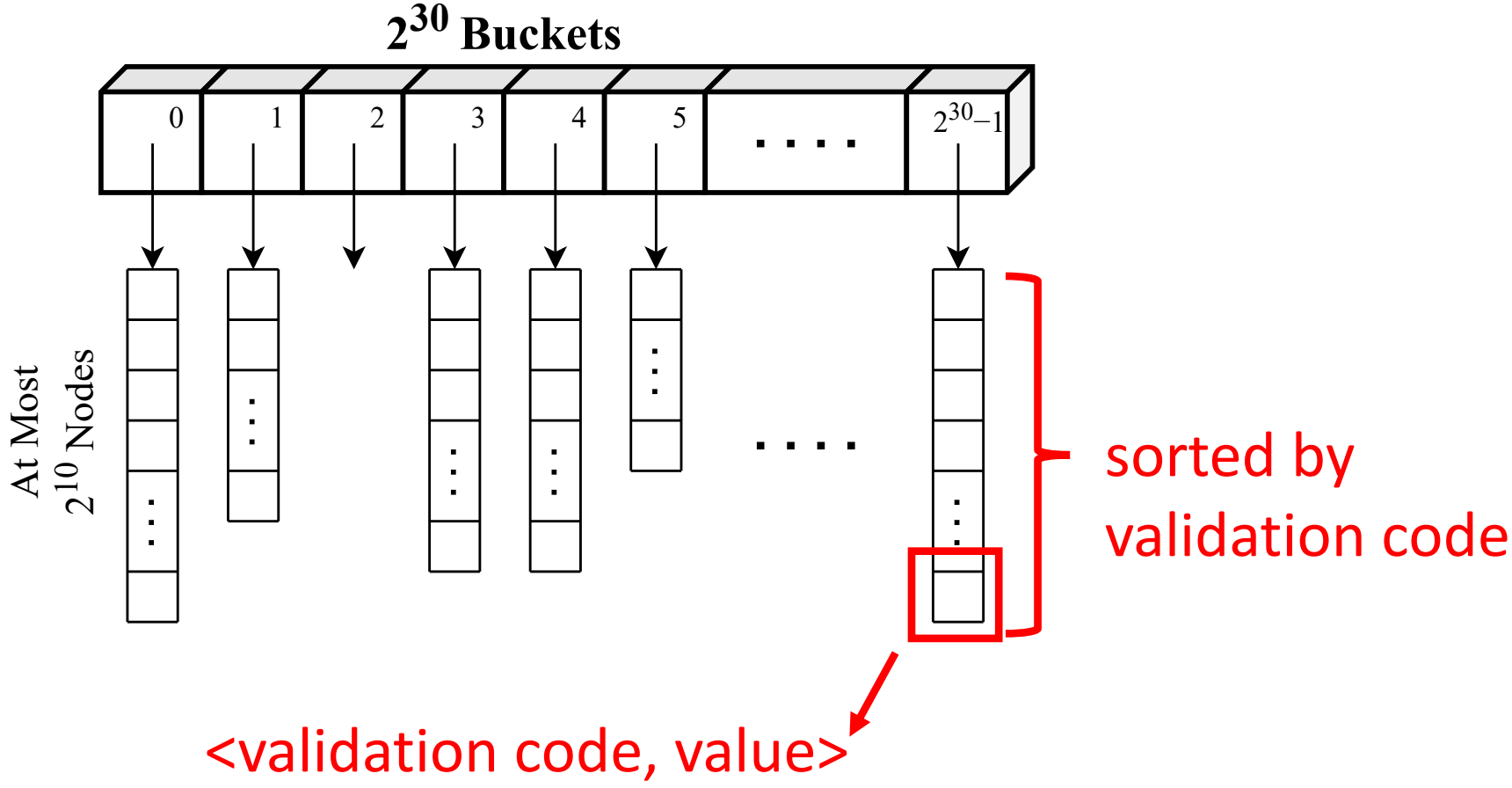
SBH – calculating hashcode



hashcode →

<validation code, value>

SBH – transposition table



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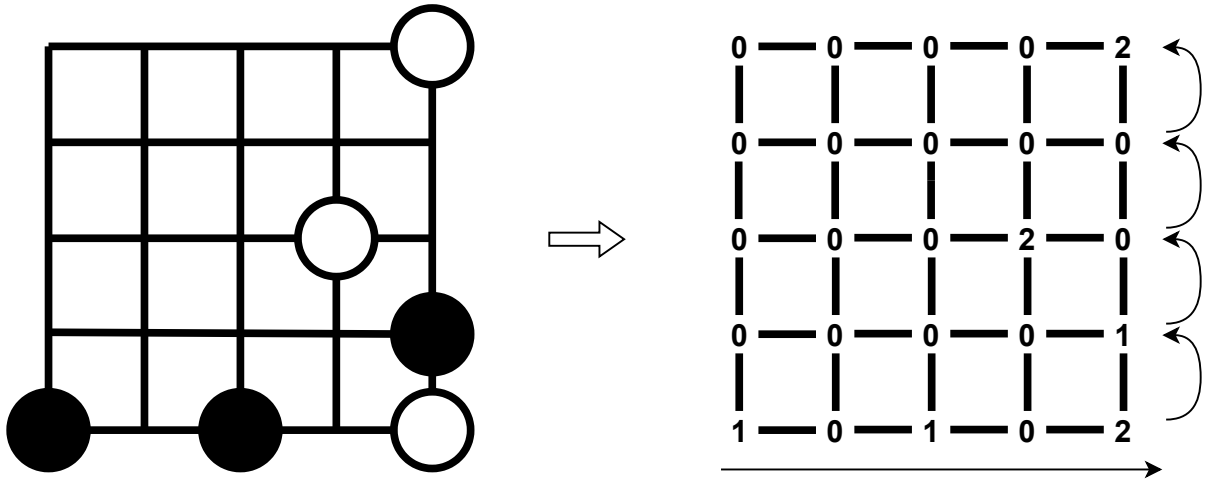

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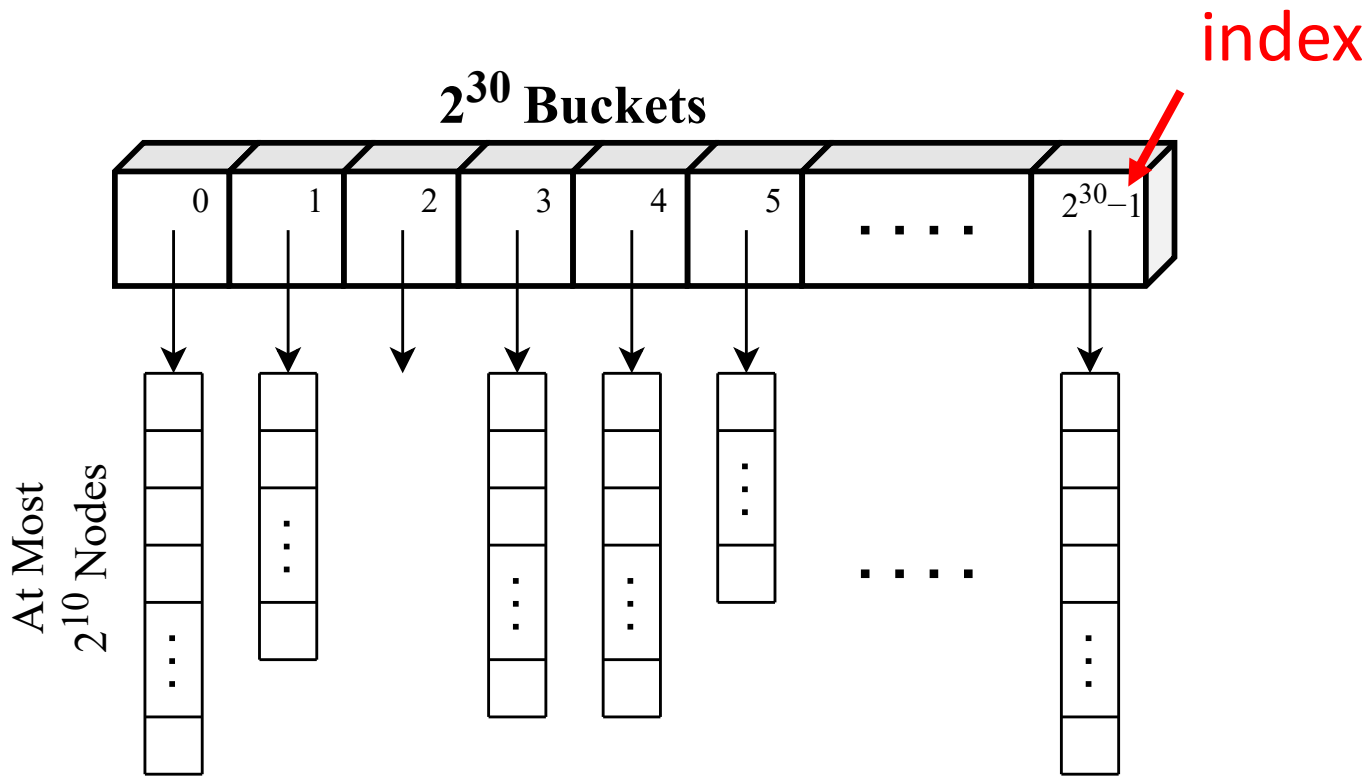
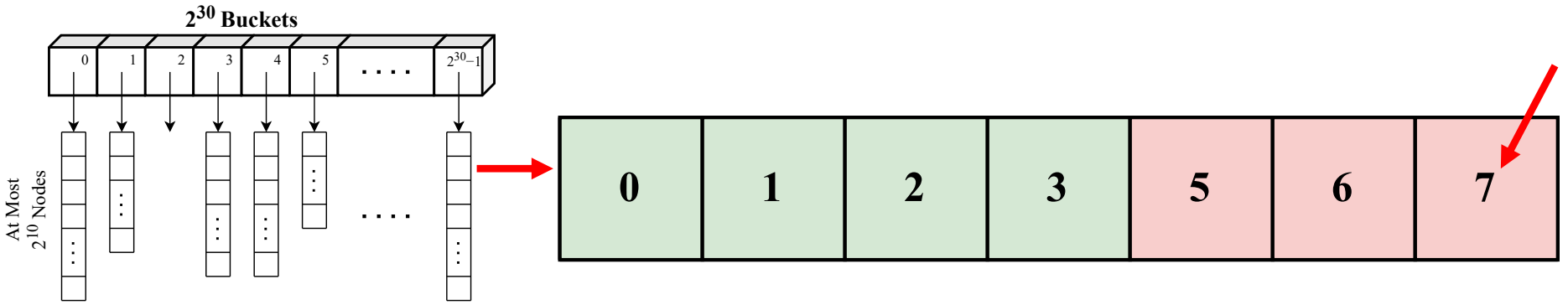
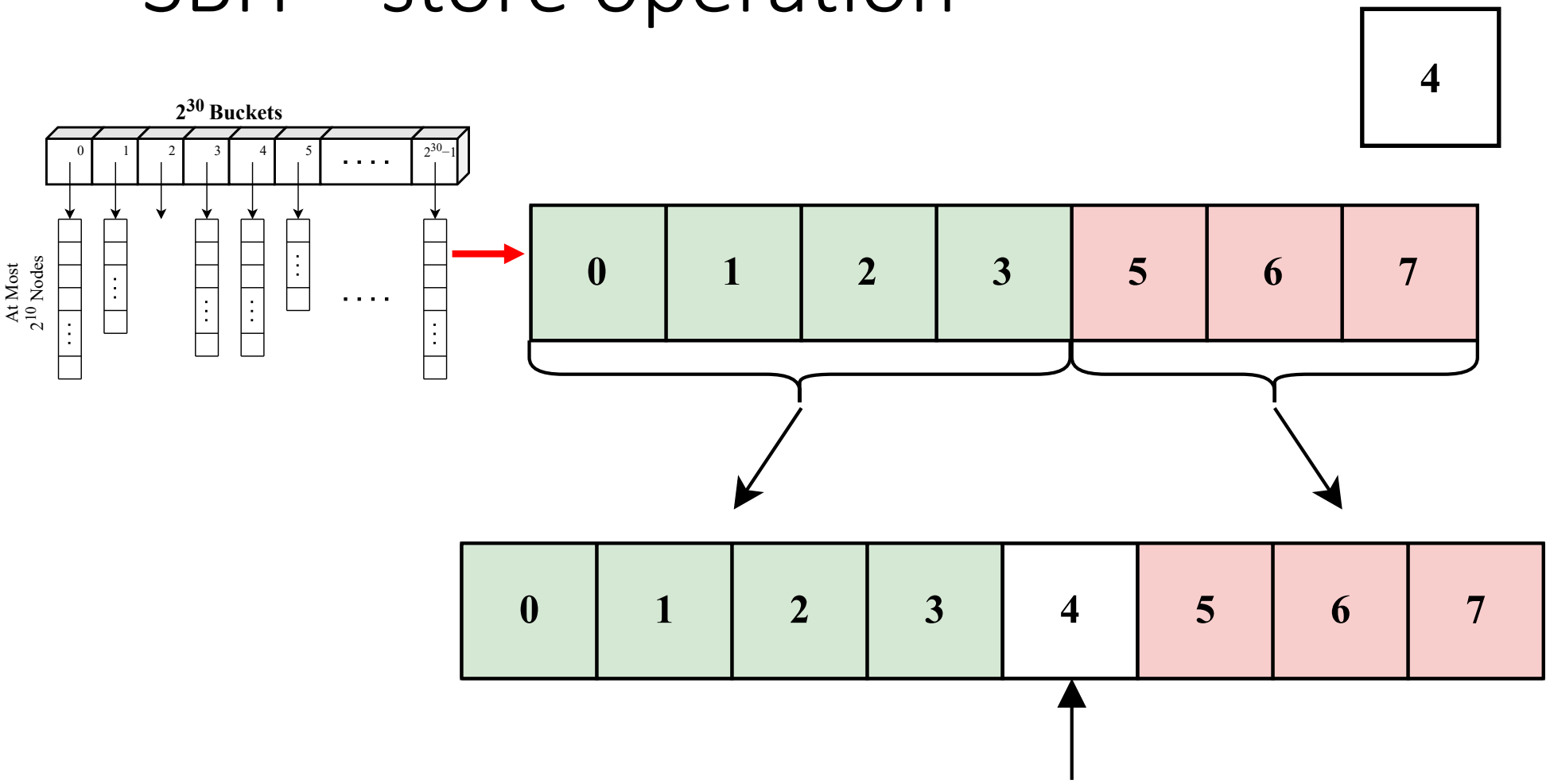


SBH – find operation



SBH – store operation



SBH – efficiency gains

- 5x5 NoGo

- She, 2013 520 x 10^9 points
- Cazenave, 2020 46 x 10^9 moves
- **SBHSolver** 3 x 10^9 game positions

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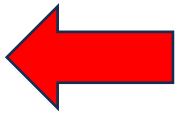
- Strategies for playing 4x4 & 5x5 NoGo 

4x4 NoGo

- White wins
- Strategy for White: playing symmetrically

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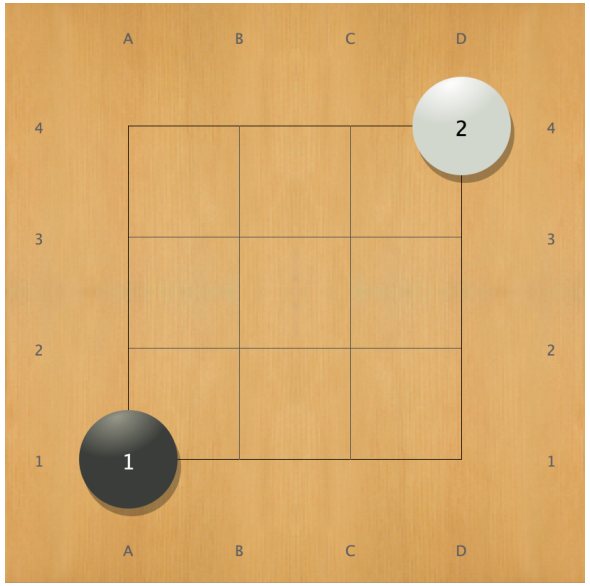
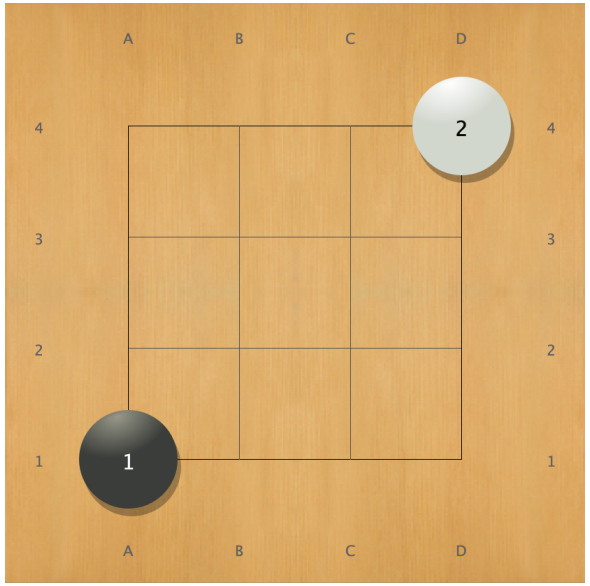


4x4 NoGo

- White wins
- Strategy for White: playing symmetrically
- It is the winning move for 85.3%



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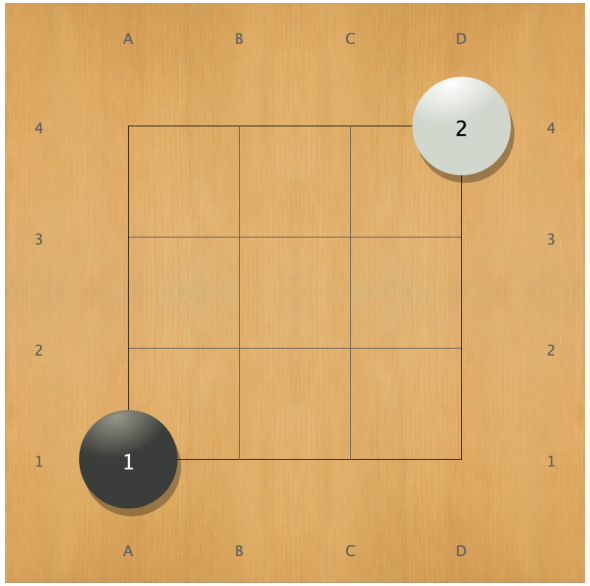

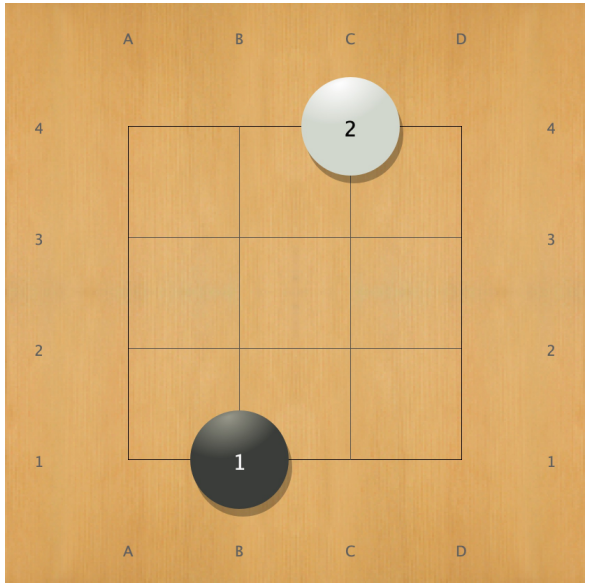

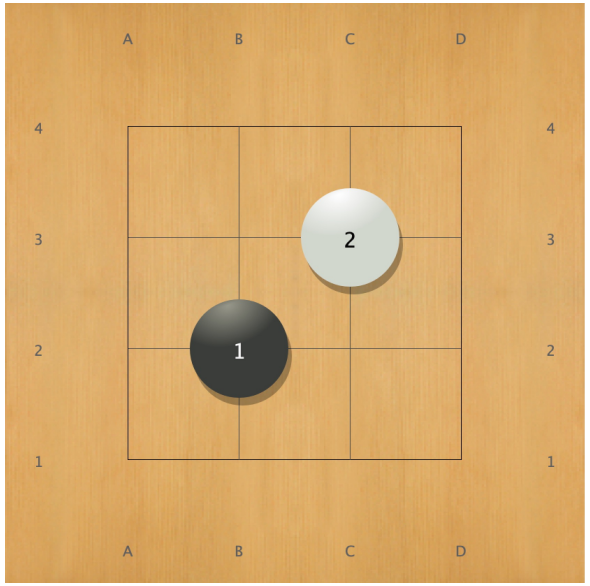

5x5 NoGo

- Black wins
- Strategy for Black: making eyes

5x5 NoGo

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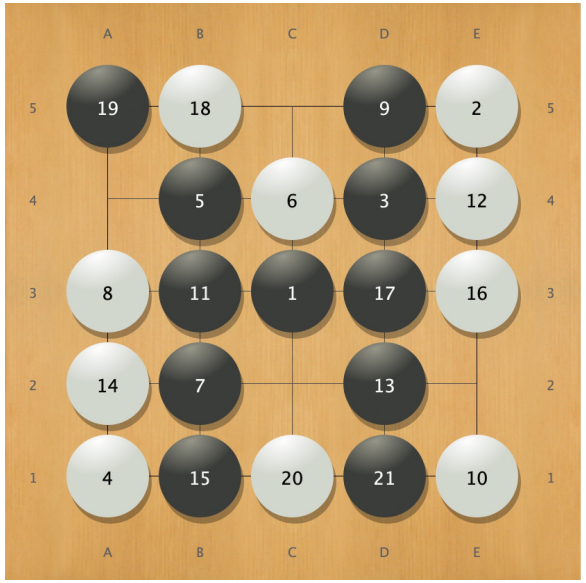
- Strategy for Black: making eyes

- In solution of A1 opening,
- 45.2% of the endgame positions contain any eyes

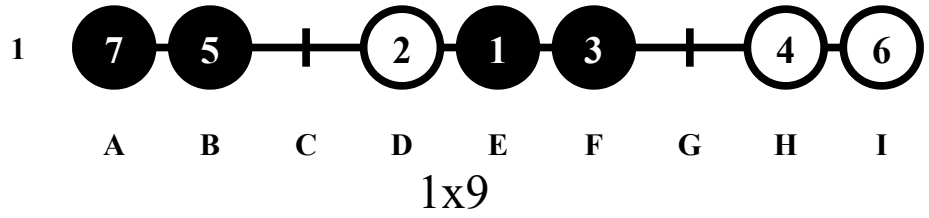
5x5 NoGo

- Black wins
- Another strategy:
- creating long blocks to separate the opponent's stones

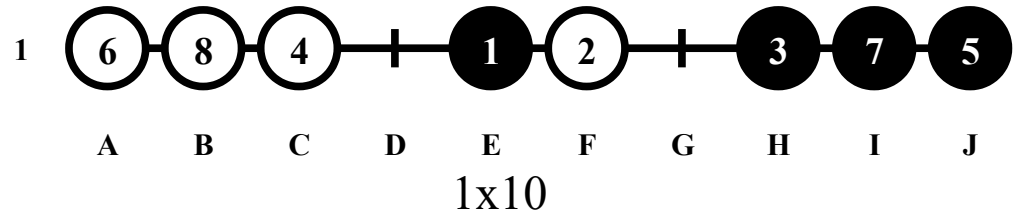


What's more

- Implement choices for SBH
- Performance of SBH
- More findings of 5x5 NoGo
- Solutions of 1x*n* NoGo, $n \leq 27$
- Two general results for 1x*n* NoGo



1x9

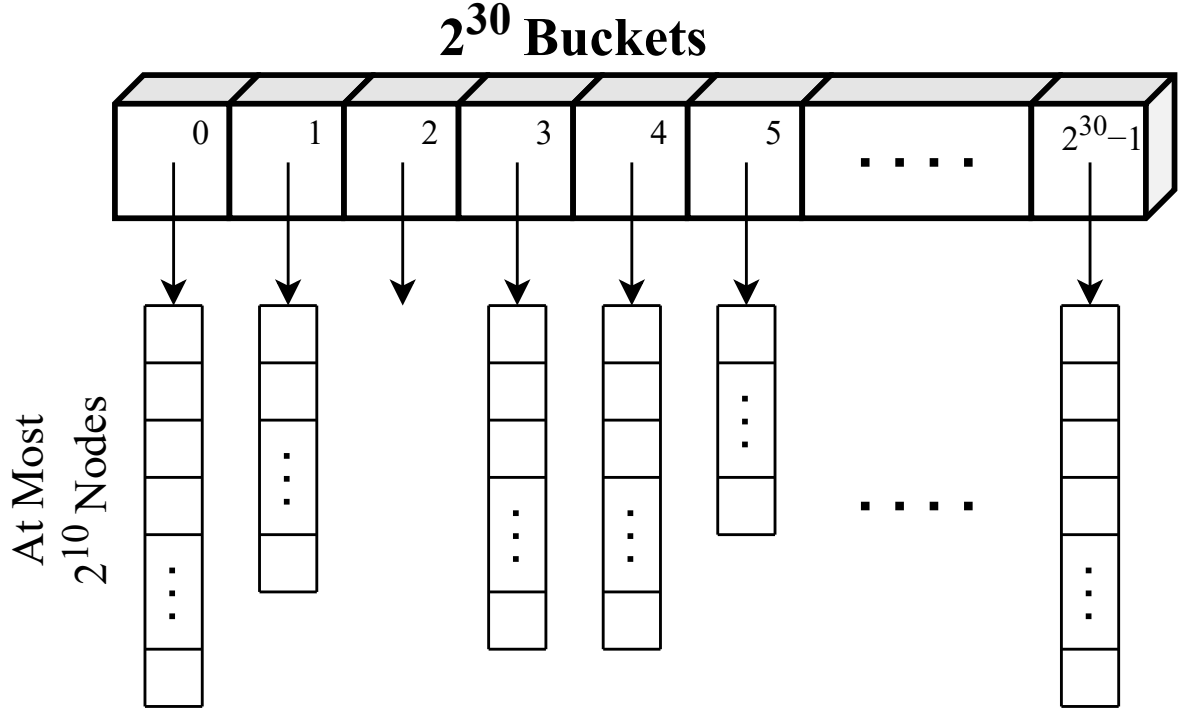


1x10

Future Work

- Solve larger boards
- Two-tier storage scheme (memory + disk)

- Improve the efficiency of find and store operations

Hashcode, Index, & Validation Code

- $2^{39} < 3^{25} < 2^{40}$
- k = 40 hashcode
- m = 30 index
- n = 10 validation code