State Representation and Polyomino Placement for the Game Patchwork

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[Game] State Representation

Polyomino Placement

the Game

Patchwork

What is Patchwork?

- Released 2014 by Uwe Rosenberg
- Popular (place 64 on Board Game Geek)
- 2-player
- Full information
- Experimentally: average 23 plies and branching factor 83

Patchwork rules

- Central time board
- Buying patches and placing on boards
- Earn buttons and cover the board
- Packing the board well core challenge
  - To buy a patch it must fit on the board


Game state?

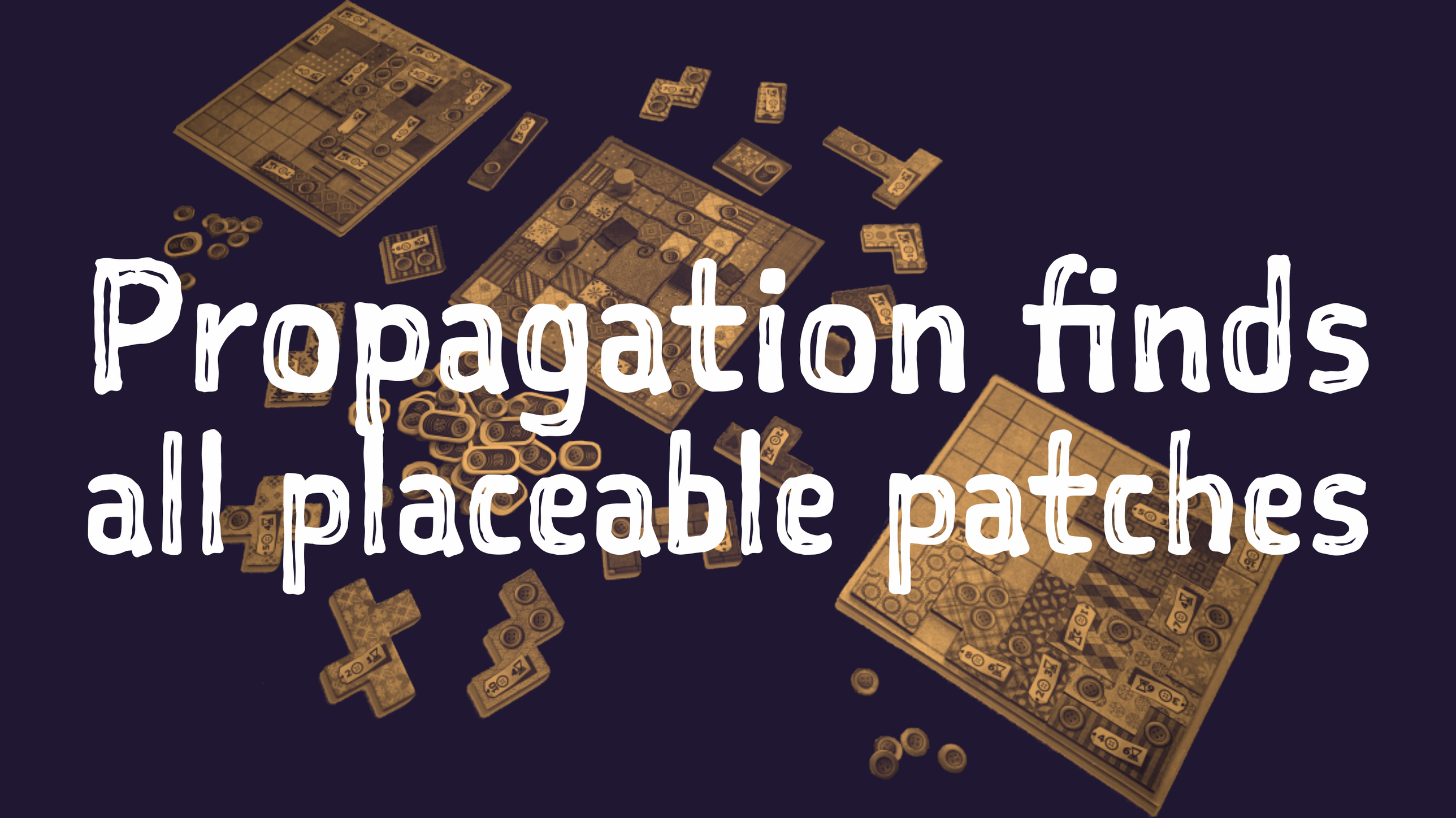
Game state

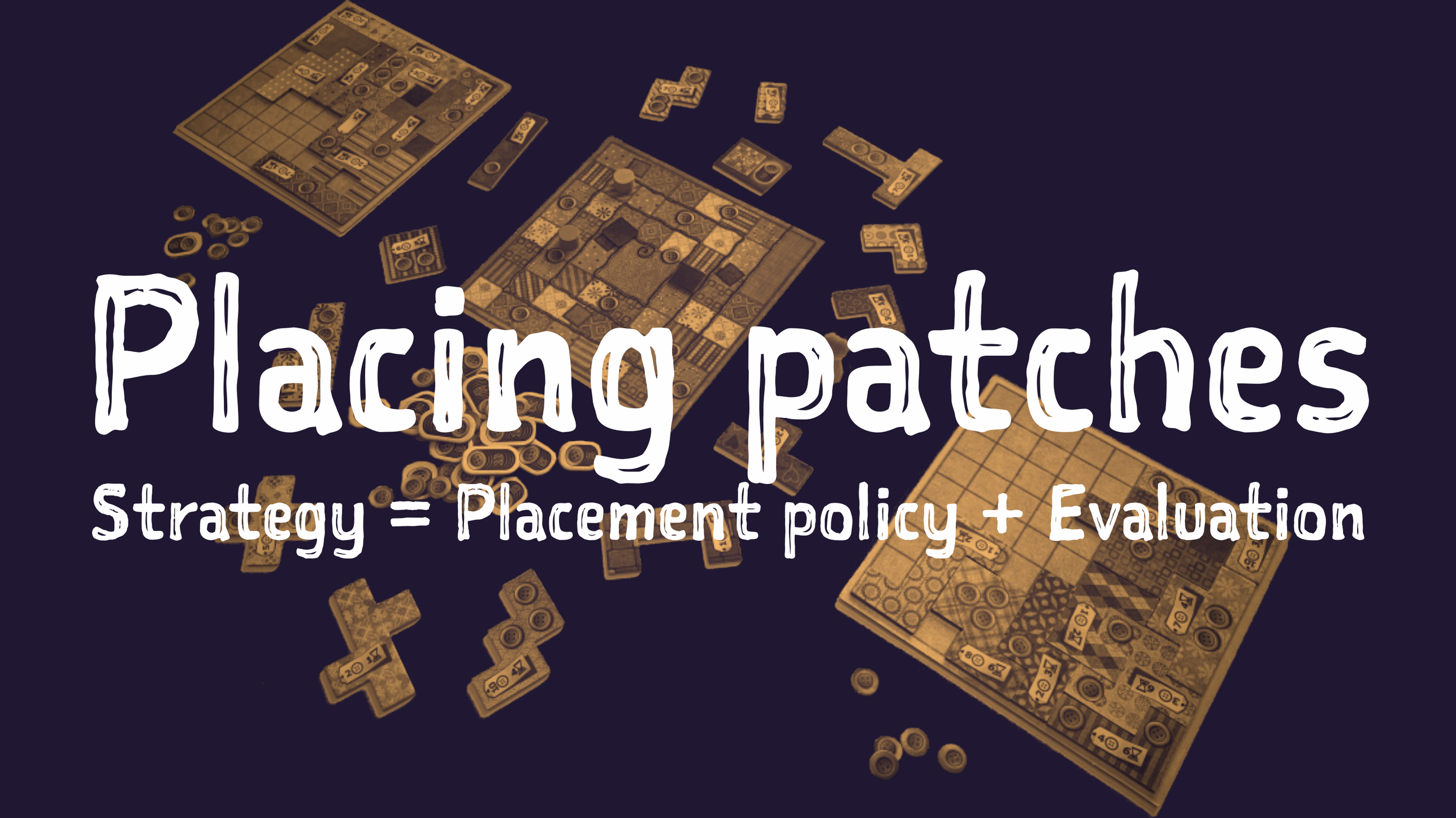
- Representing the current state of a game
- Must support needs of surrounding code
  - Possible moves, evaluation, making moves, ...
- Classical board game engines have hyper-optimized small states
- Modern board games are more complex


Constraint programming to the rescue!
Use constraint programming for the placement part
Re-use smart code in solvers

Placement using regular expressions

- Based on paper with Gilles Pesant from 2008
- Extended with
  - Explicit rotations
  - Reified placement
  - Usage constraints


Propagation finds
all placeable patches


Placing patches
Strategy = Placement policy + Evaluation

Placement policies

- Classic packing heuristics such as Bottom-Left
- CP heuristics based
- Meta-policy for all rotations of patch
- All placements

Which placement?

- Evaluation chooses between alternatives
- Goal is to make best choice
  - First-fail is the wrong approach
  - In essence: only left-most branch of search tree
- Ideas: Left/bottom-most, least bounding box, first, random, ...

Propagation Guided Global Regret

- Choose the placement that makes as little propagation as possible
  - Morally inverse of impact based search
- Mathy expression

$$\mathrm{pggr}(B, B', p) = \sum_{i=0}^{8} \sum_{j=0}^{8} \begin{cases} 0 & \text{if } B'_{ij} = p \\ |B_{ij}| - |B'_{ij}| & \text{otherwise} \end{cases}$$

Which strategy is best?

- 1000 packings for all 119 combinations tested
- Most important thing is propagation guided global regret
- Smart CP heuristics are the wrong choice for policy
- Policy is a choice between speed and quality

Key takeaways

- Game state representation using CP
- Propagation gives us many important signals
- Play Patchwork!
- github.com/zayenz/cp-mod-ref-2019-patchwork

Teaser: Nmbr9 poster tomorrow

- Another fun game!
  - More complicated polyomino placement problem
- Key points
  - Too hard to solve with my current best model
  - Open challenge, do you have a smart idea?
- github.com/zayenz/cp-2019-nmbr9/

Thank you!

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Questions?