

Large-Scale Search for The Witness Levels

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Level Design

- Significant work in games using AI for design
 - Browne, Isaksen, Jaffe, Nielson, A. Smith, G. Smith, Togelius, Zook (& many others)



Exhaustive Search

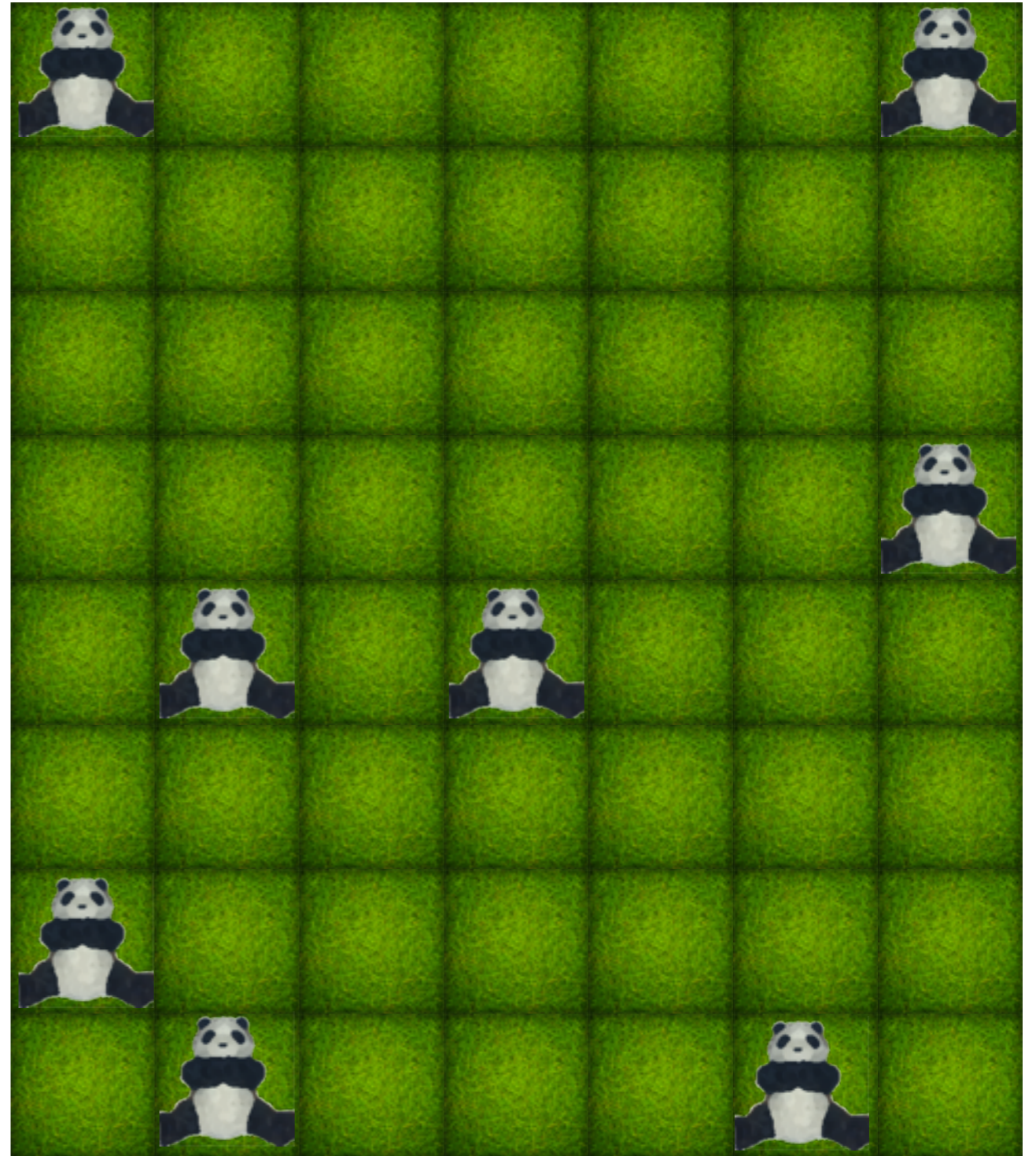
- Suppose we can generate all content:
 - No longer a question of *Content Generation*
 - A question of *Content Selection*
- How do we choose the best content?



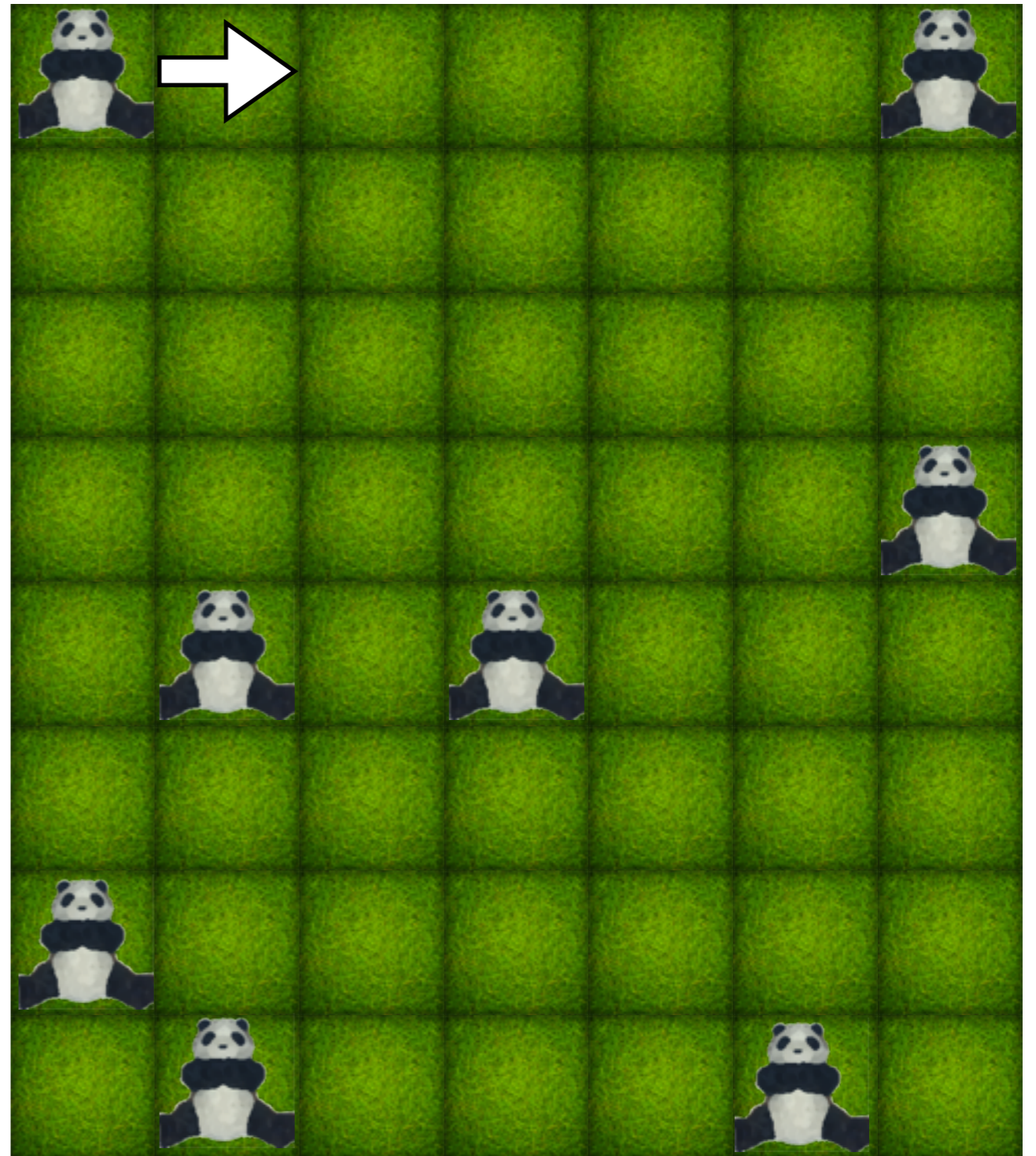
Previous Work: Fling!

- Look for constraints that players learn
 - Select solutions that reward the players' knowledge

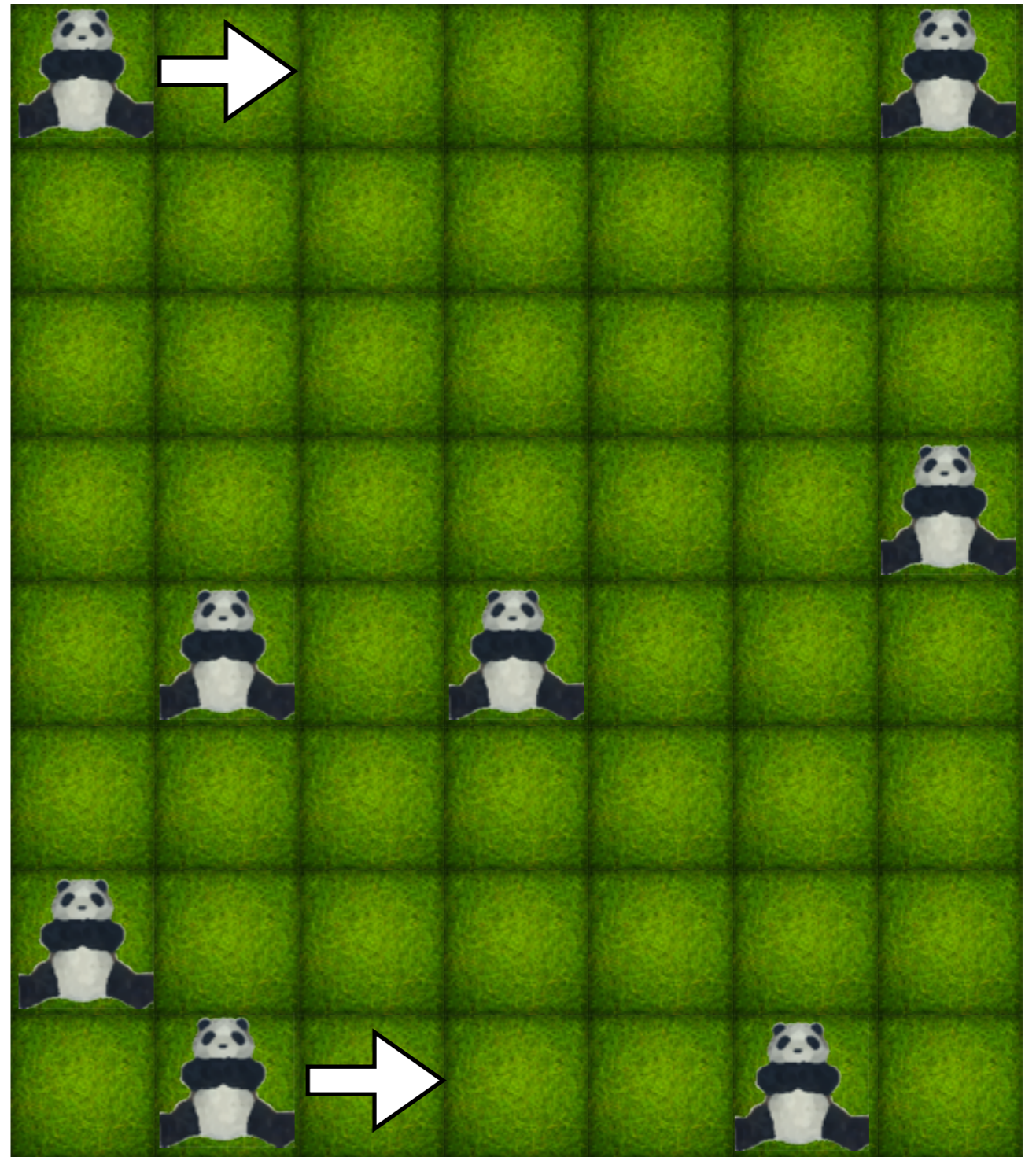
Constraint:
Each level has
1 solution



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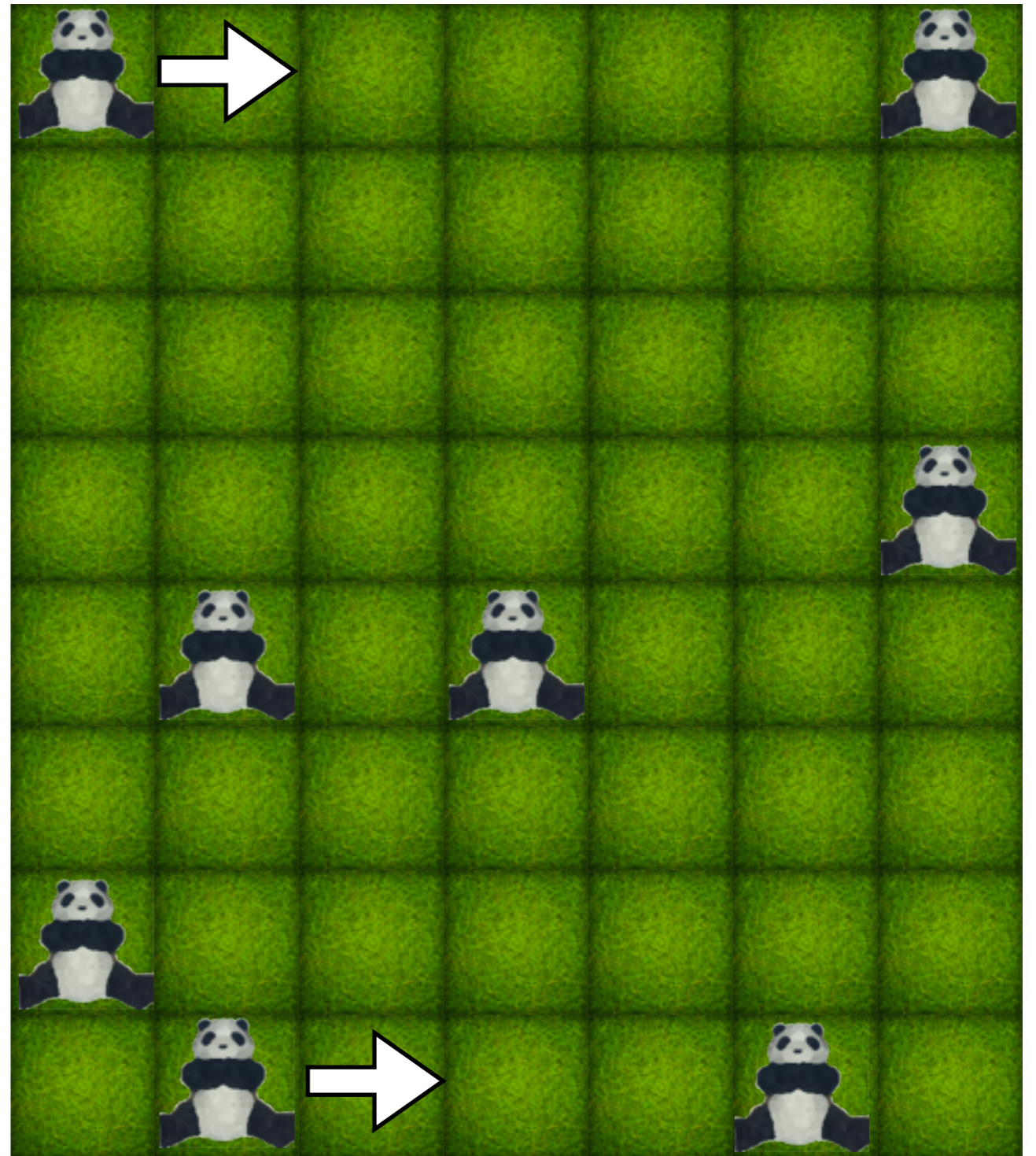


Constraint:

Each level has
1 solution

Result:

Cannot take
parallel moves





New Project: The Witness

- 2016 game by Jonathan Blow / Thekla, Inc
- Solve puzzles on deserted island

Can we create new,
compelling levels
for the game?





Design Philosophy

- Select puzzles



Design Philosophy

- Select puzzles
- Understand puzzles



Design Philosophy

- Select puzzles
- Understand puzzles
- Subvert puzzles



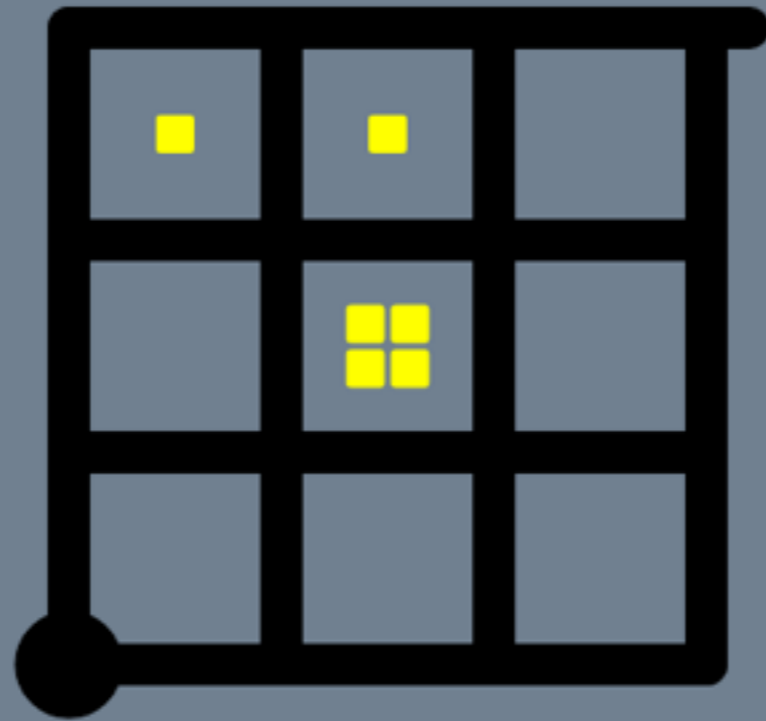
Design Philosophy

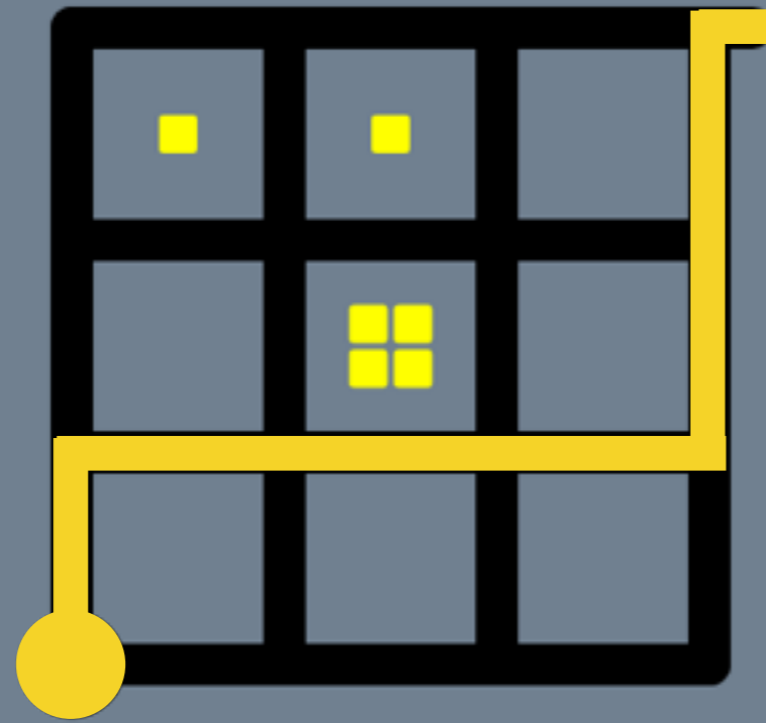
- Select puzzles
- Understand puzzles
- Subvert puzzles
- Repeat

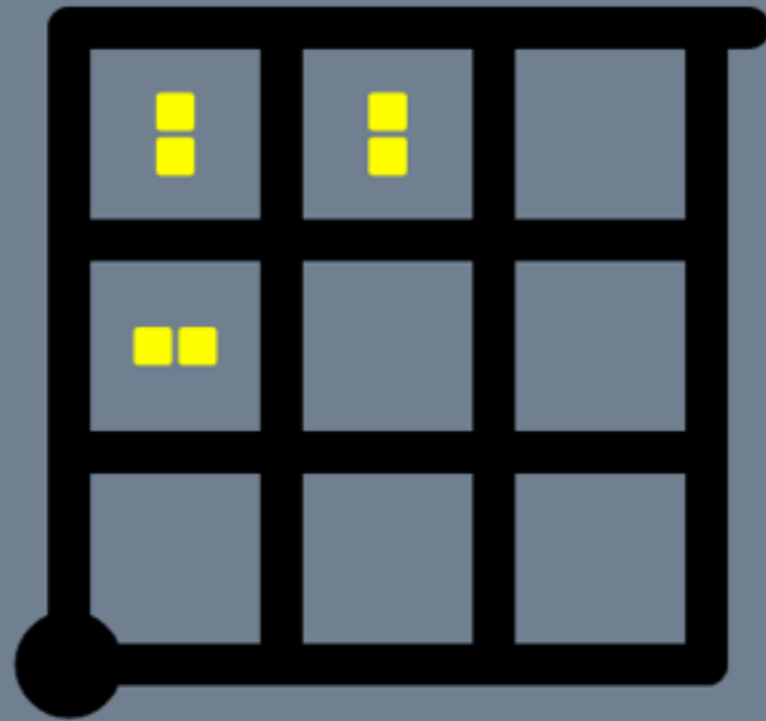


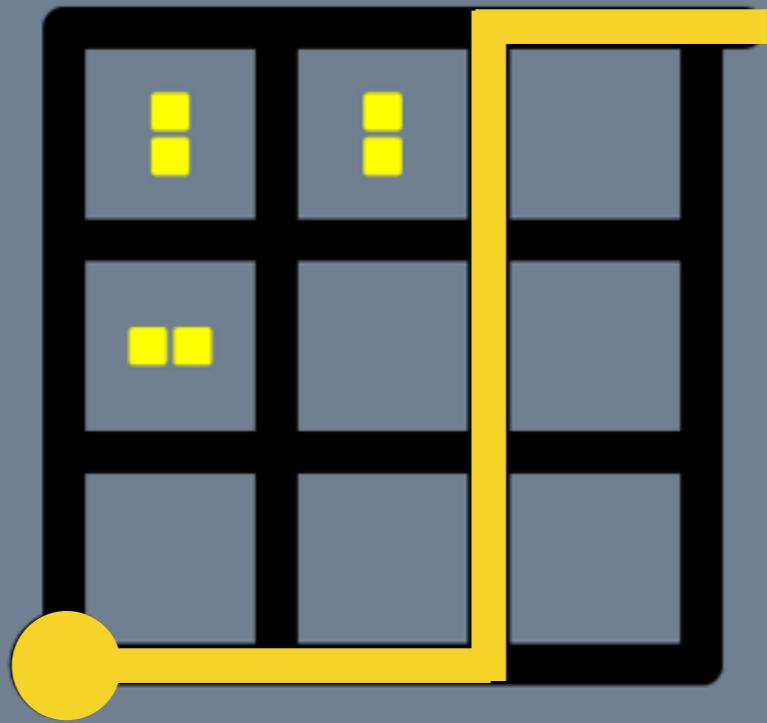
Design Philosophy

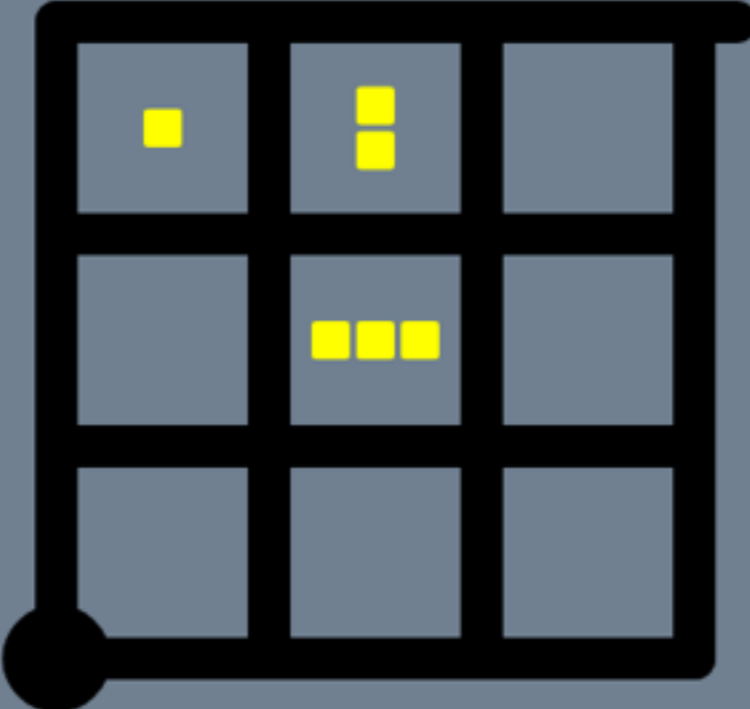
- Select puzzles
 - Understand puzzles
 - Subvert puzzles
 - Repeat
- } Designer in the loop

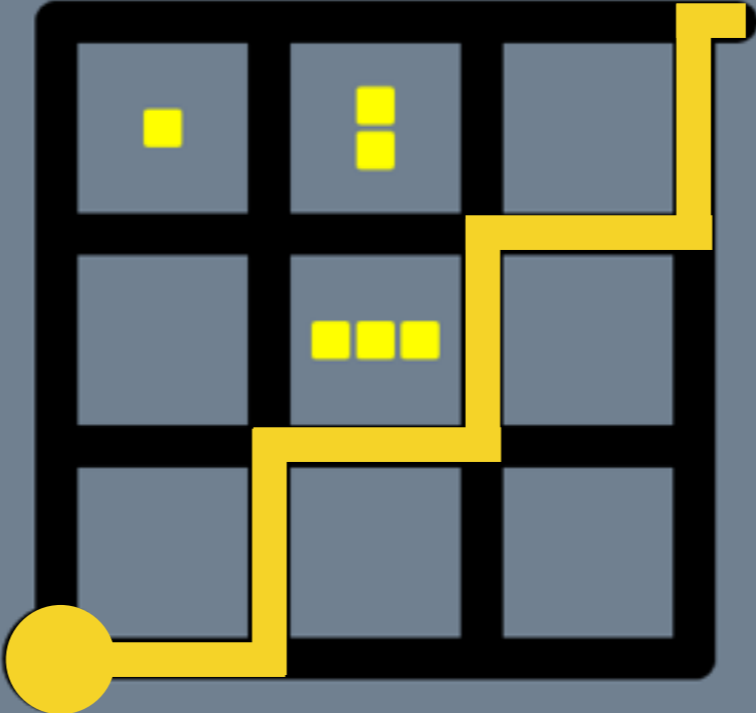


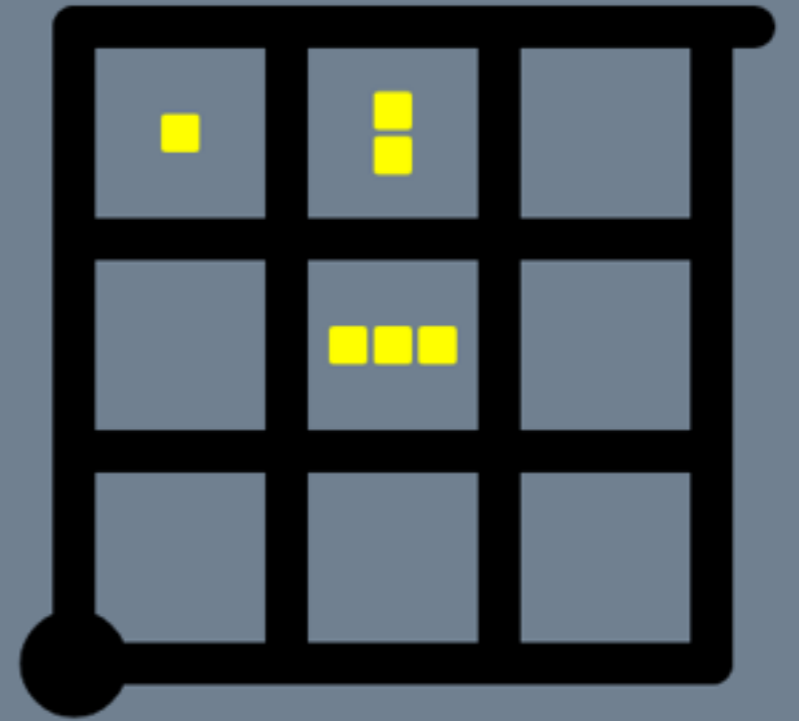
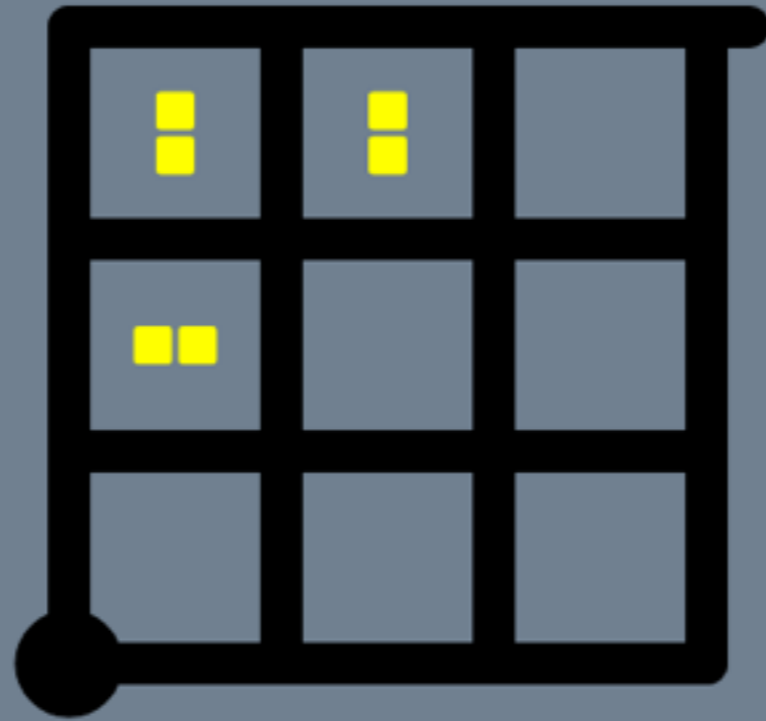
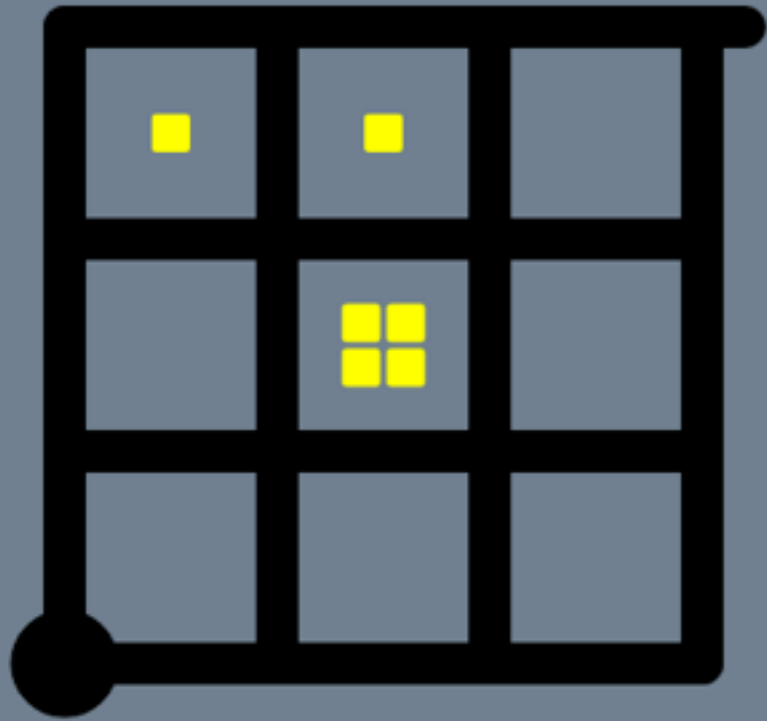


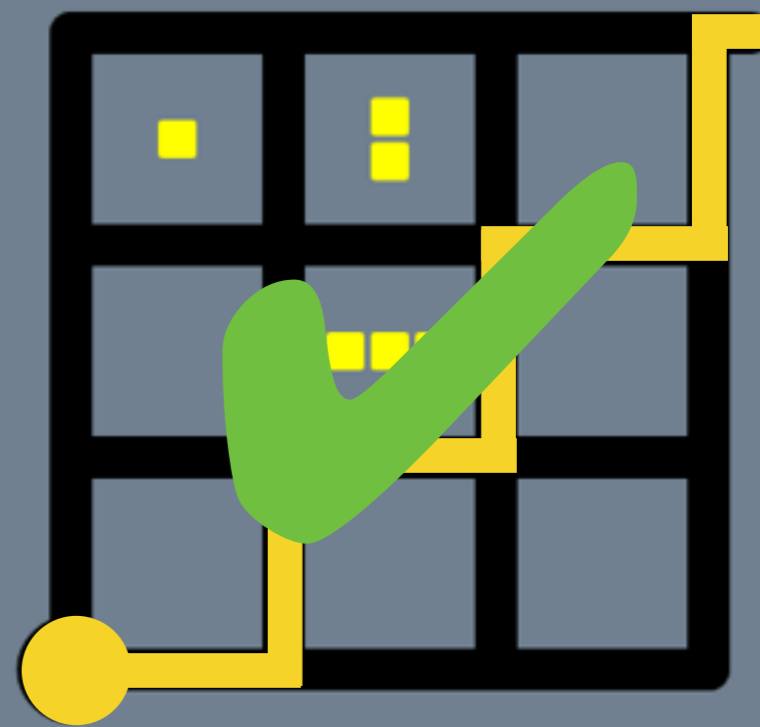
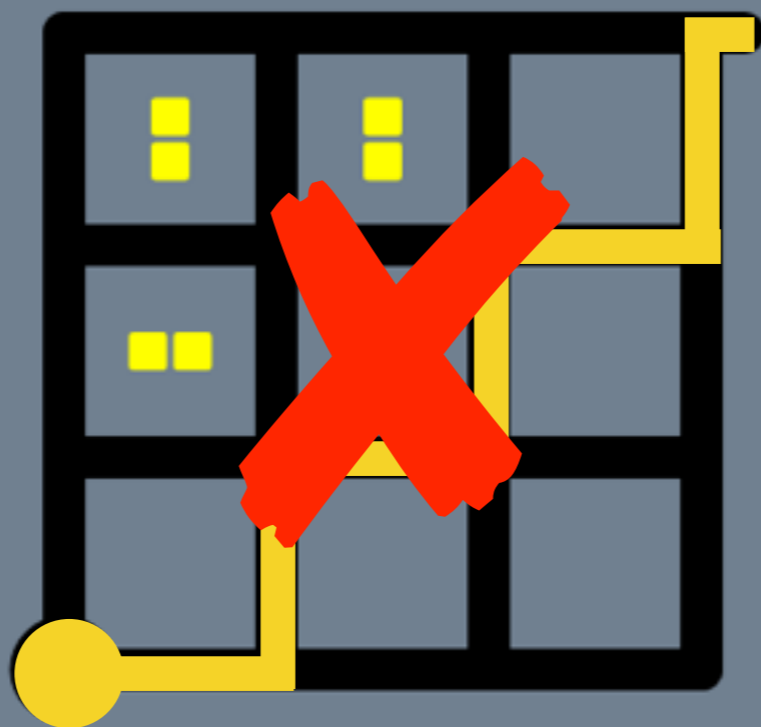
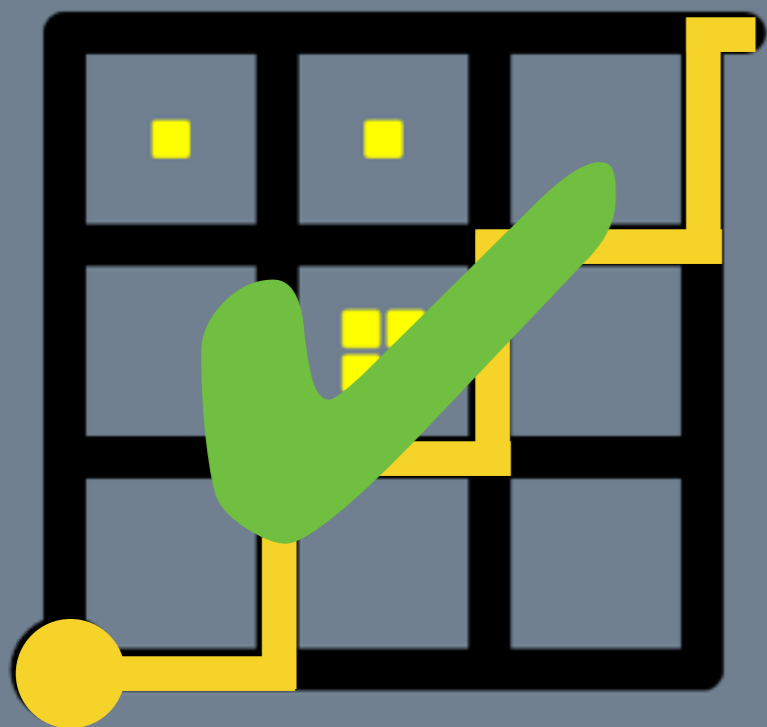














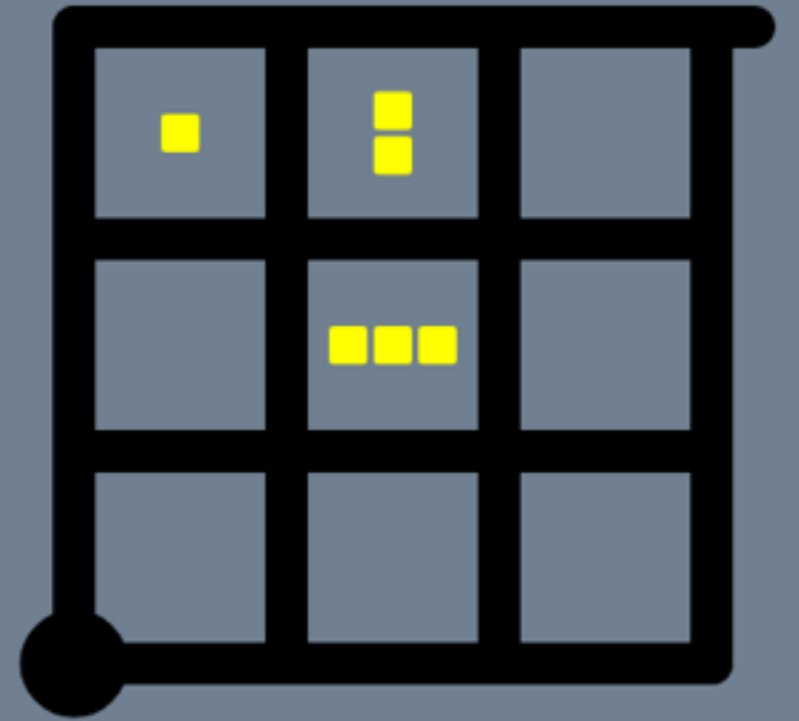
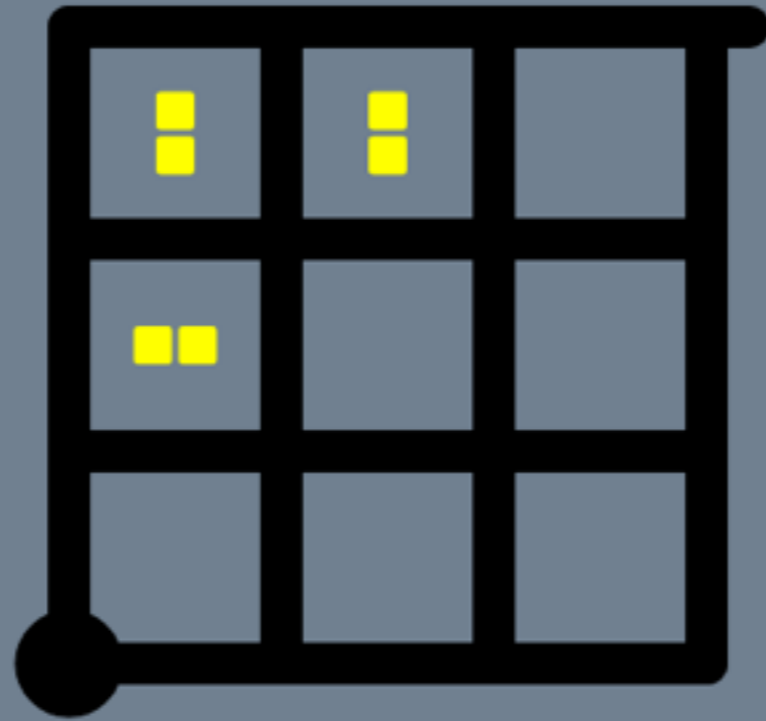
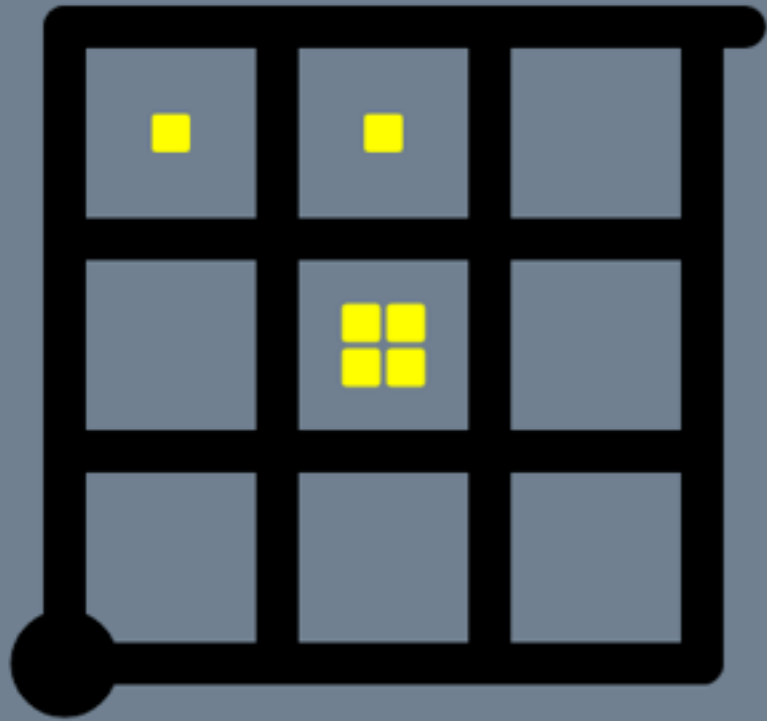
First iteration

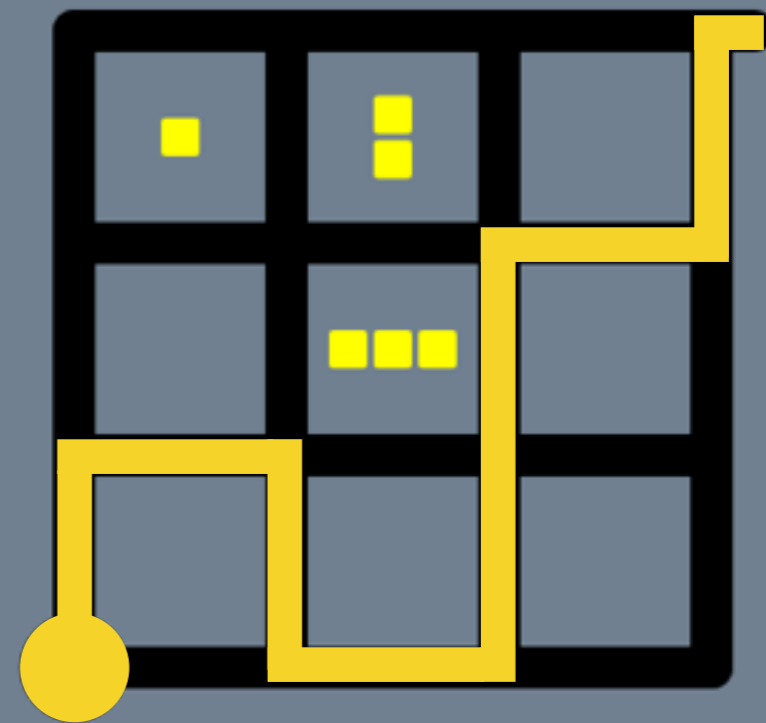
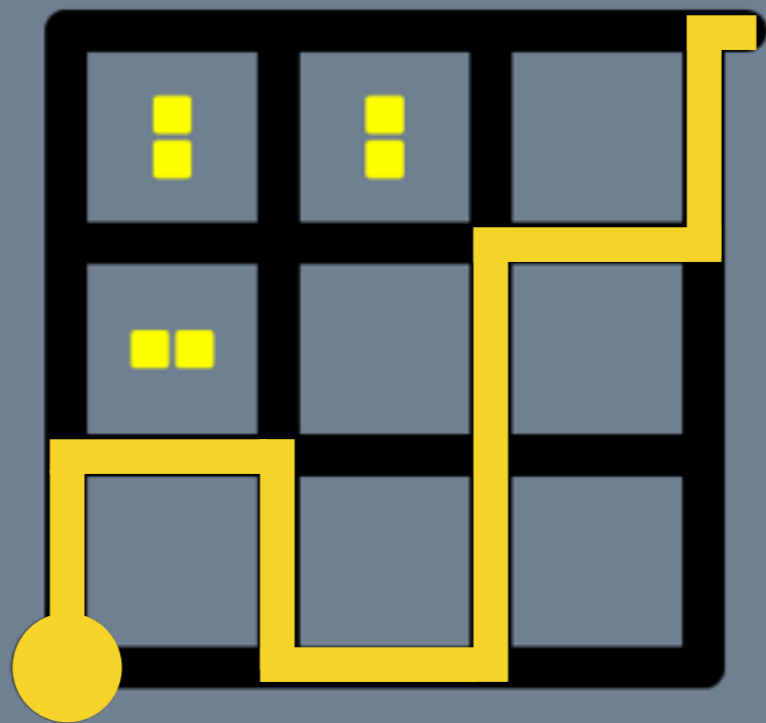
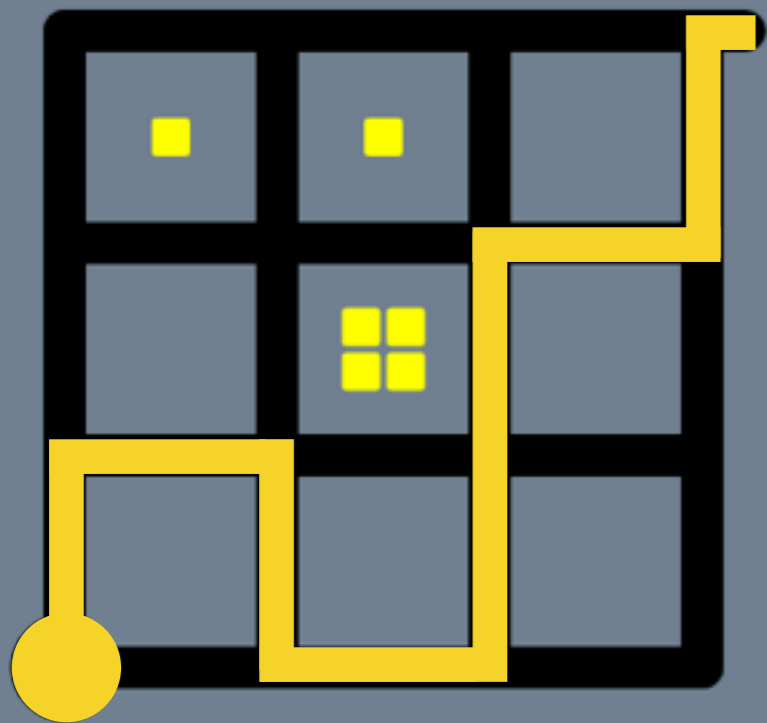
- Select puzzles
- Understand puzzles
 - Problems:
 - First solution solves all 3 puzzles
 - 2 puzzles taken alone have single solution



Subvert

- *Reminiscent of secret sharing algorithms*
 - Given any $n-1$ puzzles reveal as little information about the final solution
 - Single joint solution
- Find triples of puzzles where:
 - Every pair has many joint solutions
 - Taken together there is only one solution

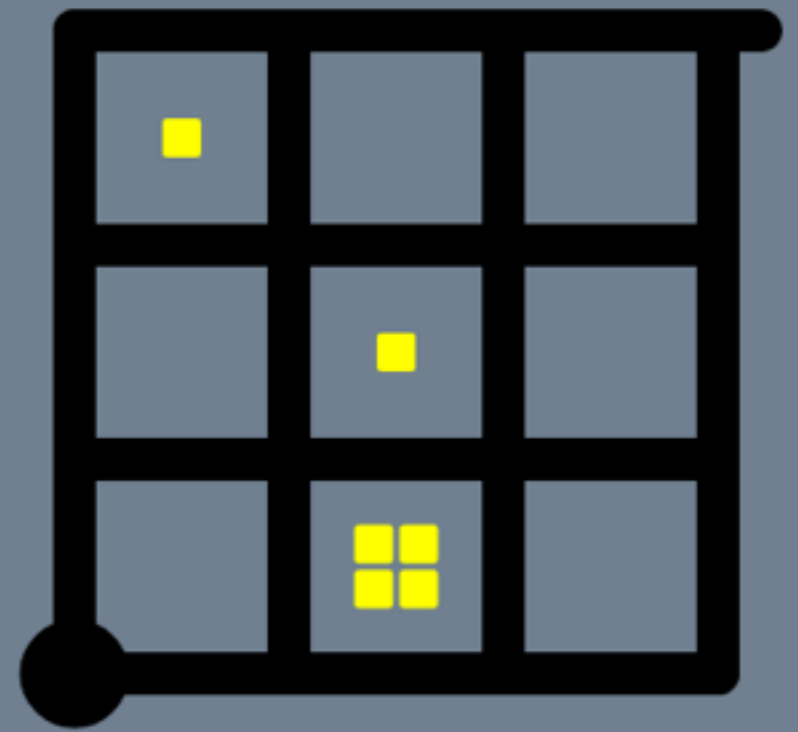
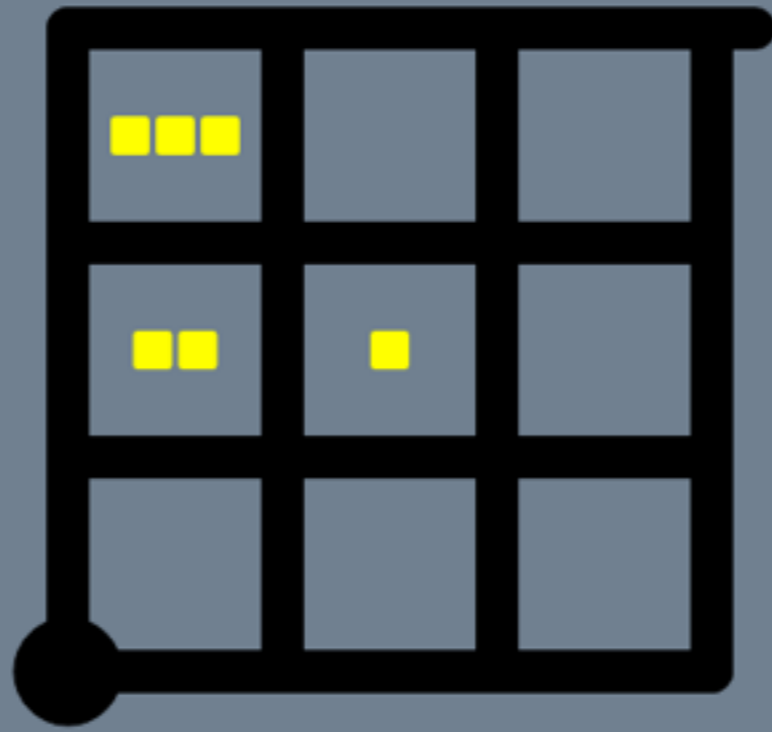
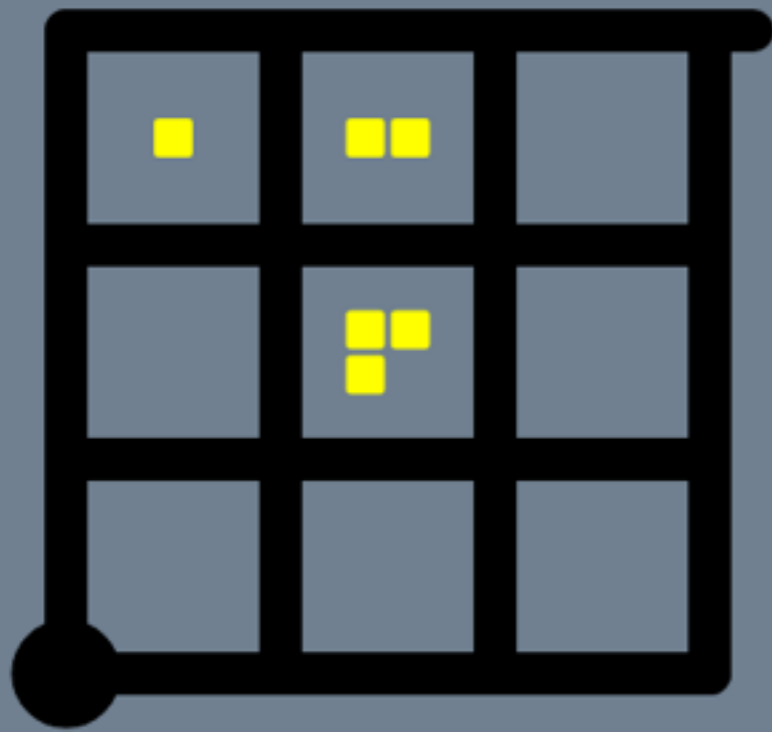


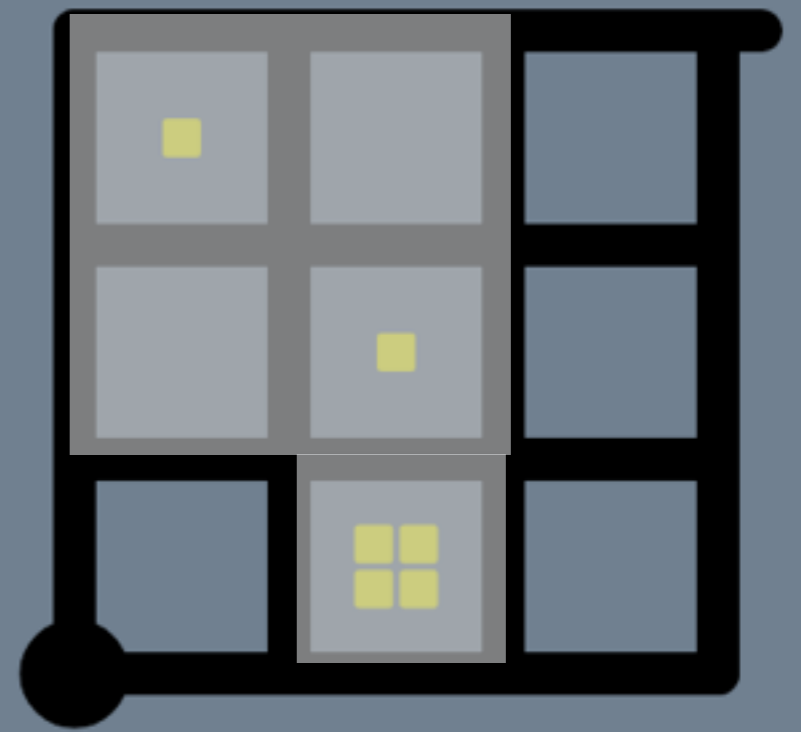
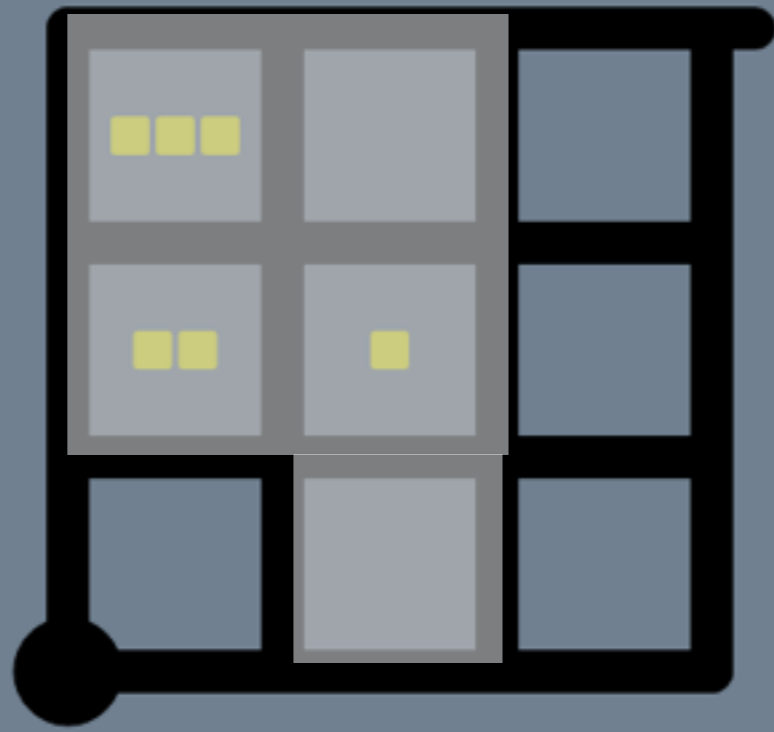
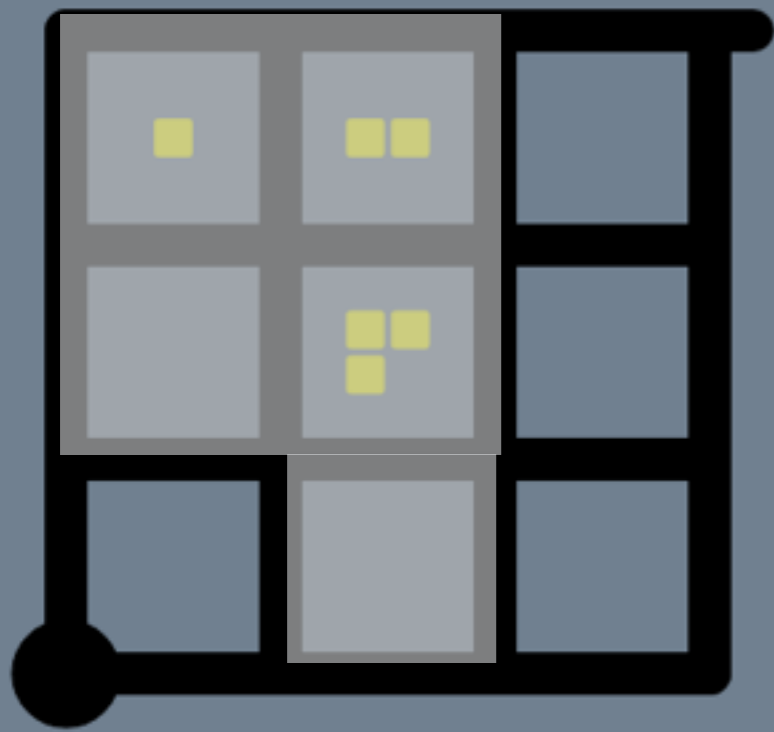




Repeat

- Select new puzzles
- Understand
 - “Problems”
 - Simple heuristics lead to solutions

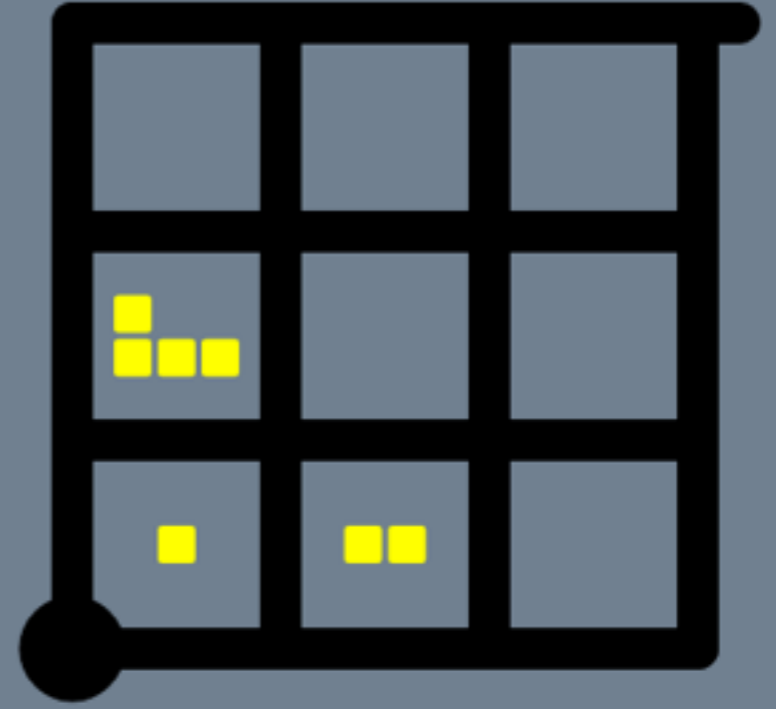
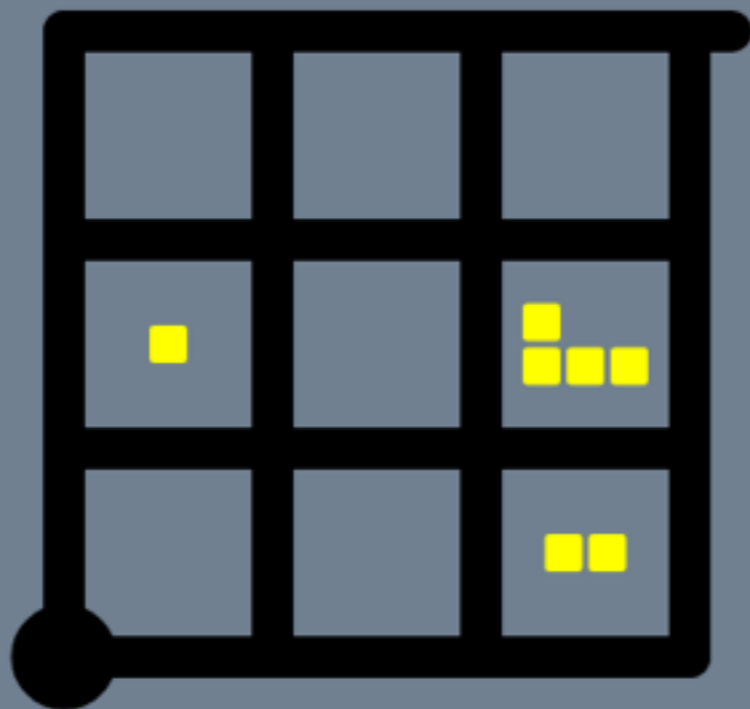
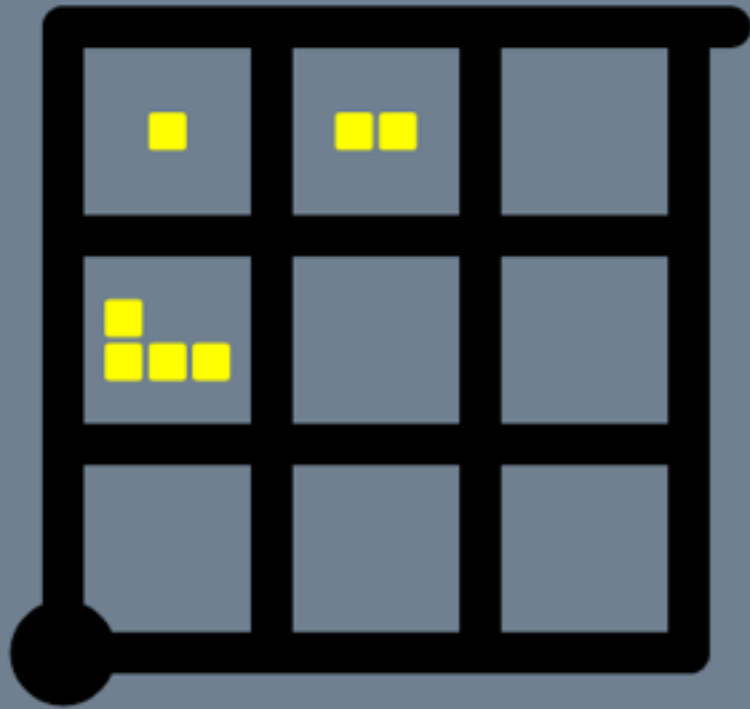




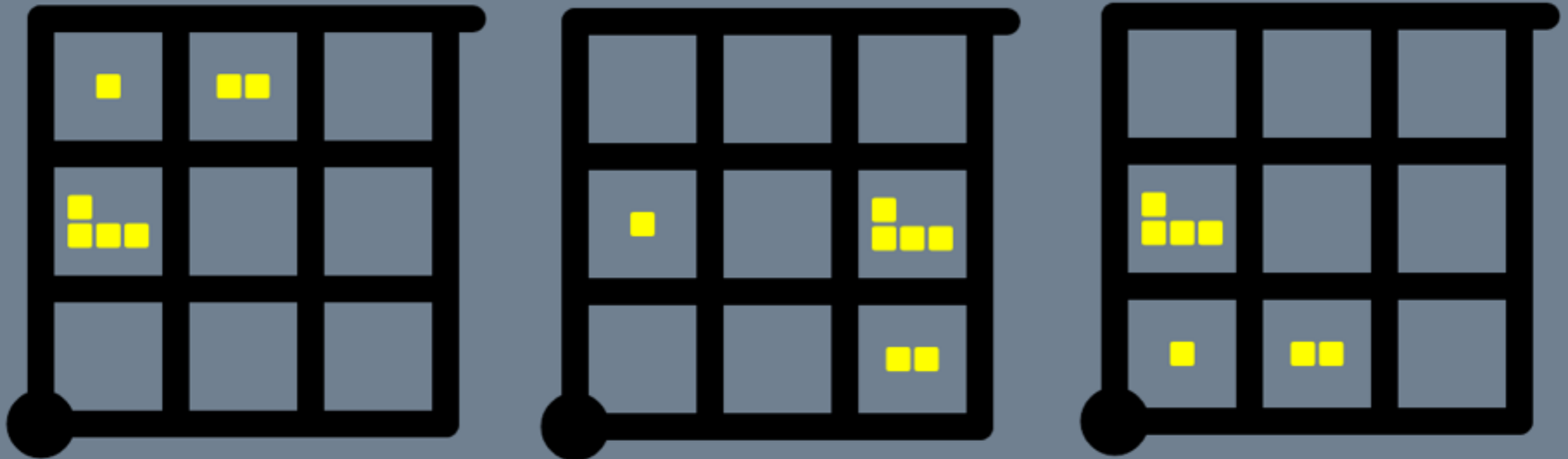


Subvert

- Add new constraints
- Break the heuristics that are learned



Thanks!



See full sequence:
<http://movingai.com/witness.html>