1997


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`2000 "應氏杯" 世界電腦圍棋錦標賽
`2000 ING CUP WORLD COMPUTER GOE CHAMPIONSHIP
主辦：應昌期圍棋教育基金會
承辦：貴陽市棋類協會
貴陽應氏圍棋活動中心
(1985-2000)
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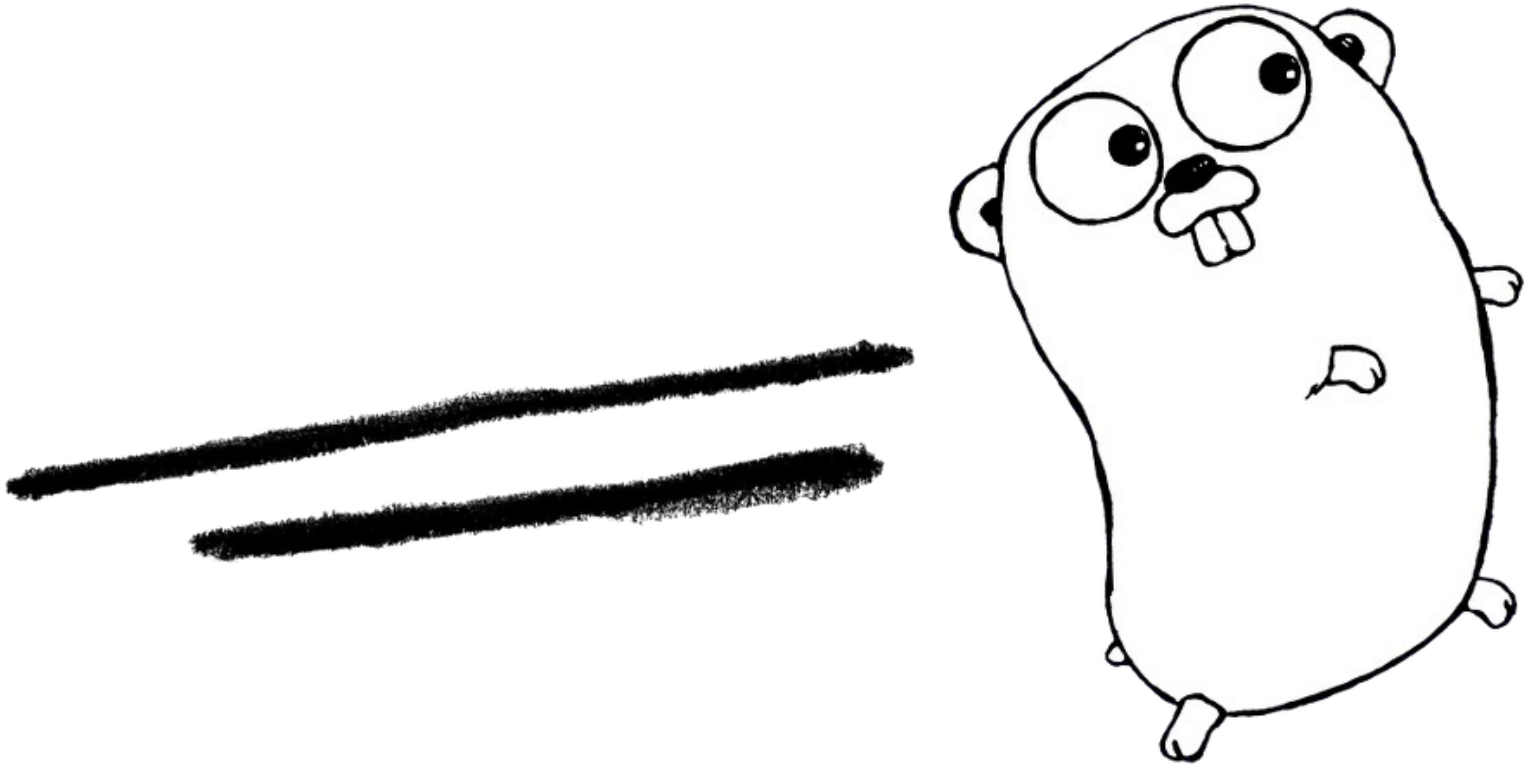
2009

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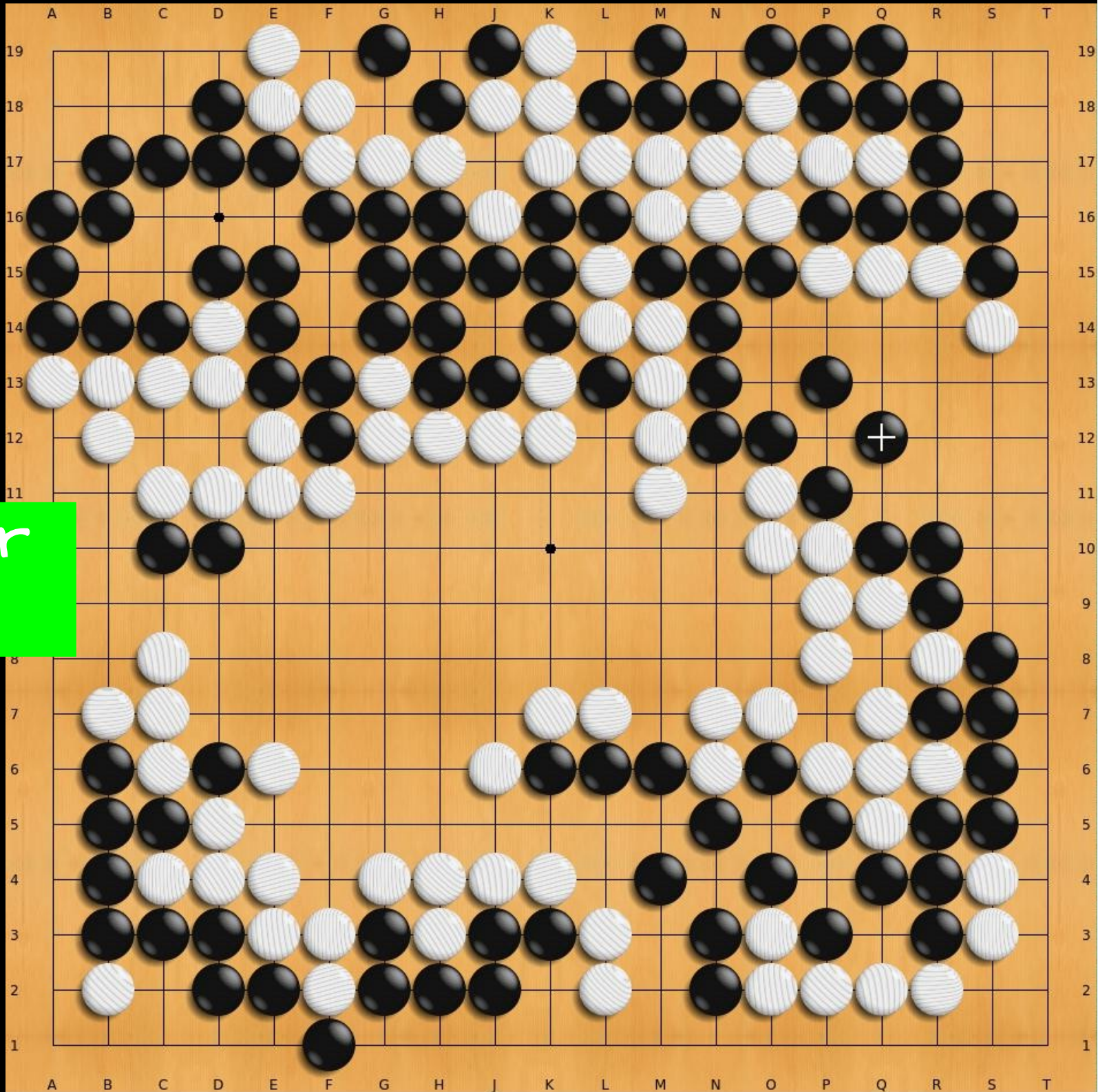
31st October 2015



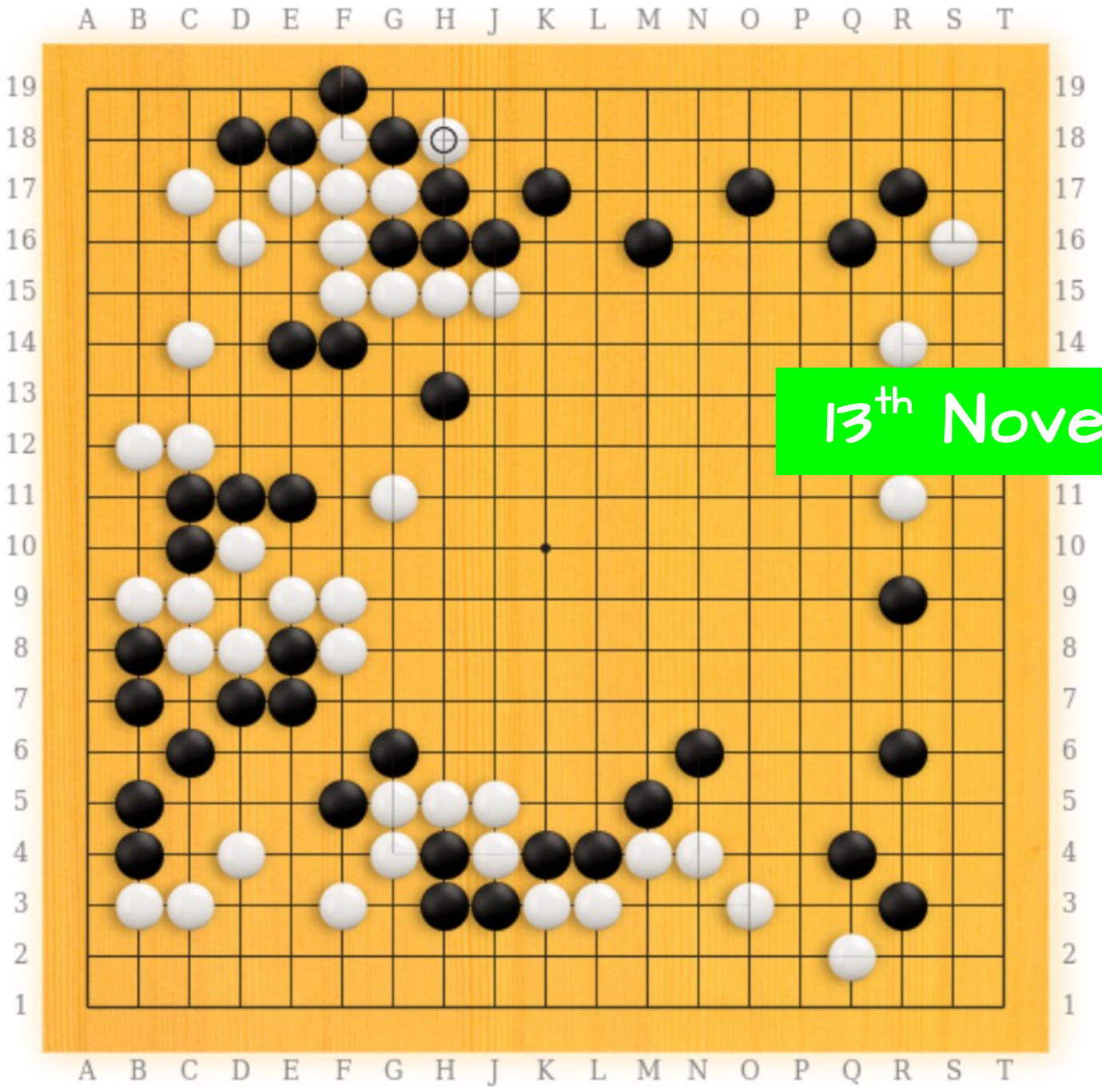
Another area of longer-term research is teaching our systems to plan. One of the things we've built to help do this is an AI player for the board game Go. Using games to train machines is a pretty common approach in AI research. In the last couple of decades, AI systems have become stronger than humans at games like checkers, chess, and even Jeopardy. But despite close to five decades of work on AI Go players, the best humans are still better than the best AI players. This is due in part to the number of different variations in Go. After the first two moves in a chess game, for example, there are 400 possible next moves. In Go, there are close to 130,000.

3rd November 2015

We've been working on our Go player for only a few months, but it's already on par with the other AI-powered systems that have been published, and it's already as good as a very strong human player. We've achieved this by combining the traditional search-based approach — modeling out each possible move as the game progresses — with a pattern-matching system built by our computer vision team. The best human Go players often take advantage of their ability to recognize patterns on the board as the game evolves, and with this approach our AI player is able to mimic that ability — with very strong early results.

So what happens when you start to put all this together? Facebook is currently running a small test of a new AI assistant called M. Unlike other machine-driven services, M takes things further: It can actually complete tasks on your behalf. It can purchase items; arrange for gifts to be delivered to your loved ones; and book restaurant reservations, travel arrangements, appointments, and more. This is a huge technology challenge — it's so hard that, starting out, M is a human-trained system: Human operators evaluate the AI's suggested responses, and then they produce responses while the AI observes and learns from them.

Play Go Against a Deep Neural Network



Auto Move

Show Analysis

Make Move

Black captures: **0**
White captures: **1**

13th November 2015

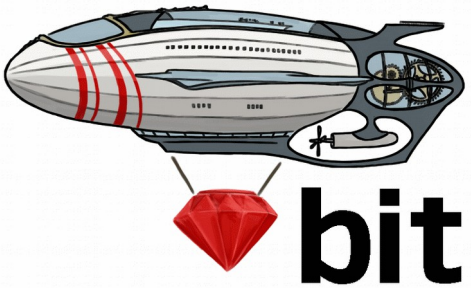
84 / 84

Beating Go thanks to the power of randomness

Tobias Pfeiffer

@PragTob

pragtob.info



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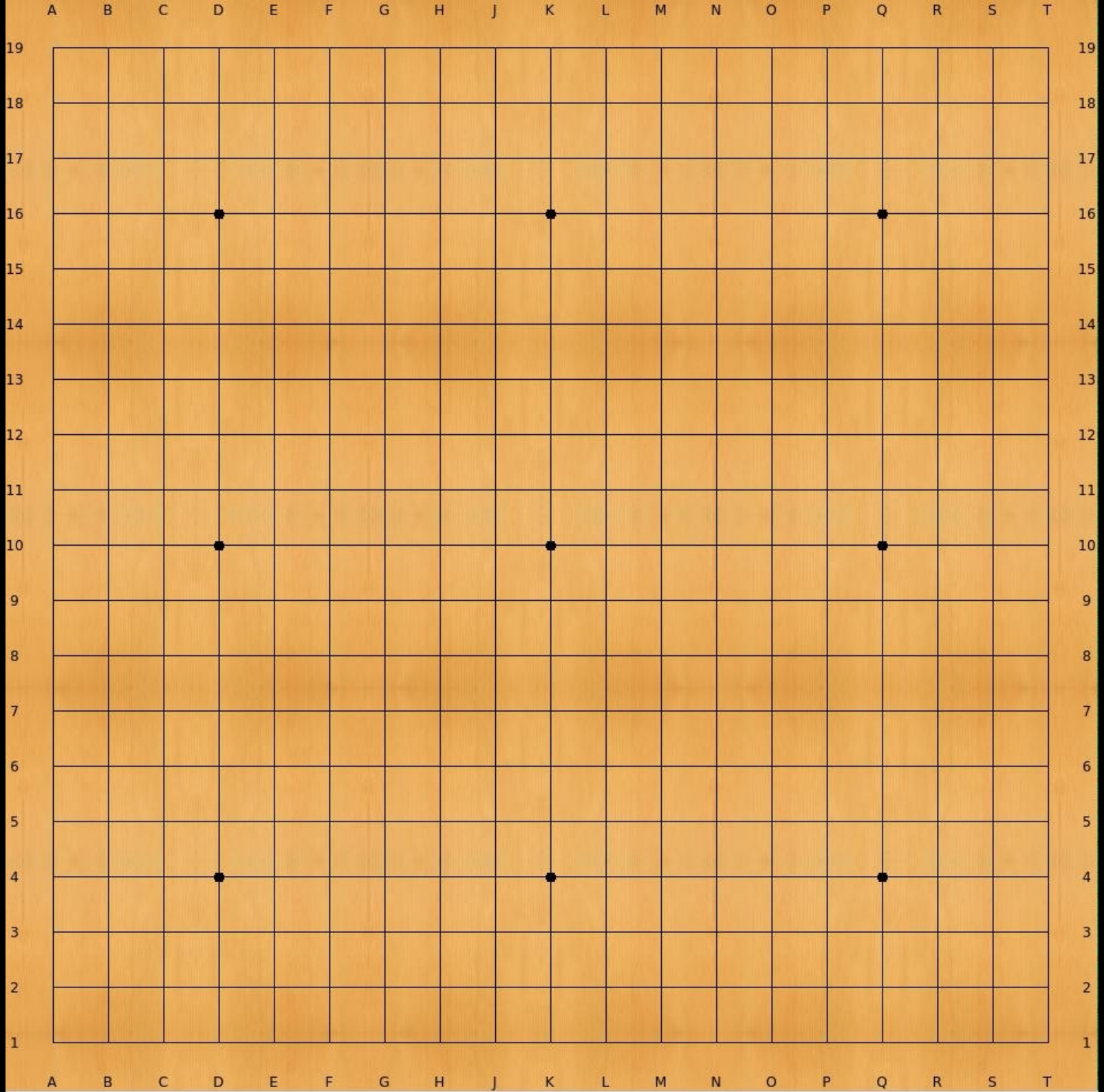
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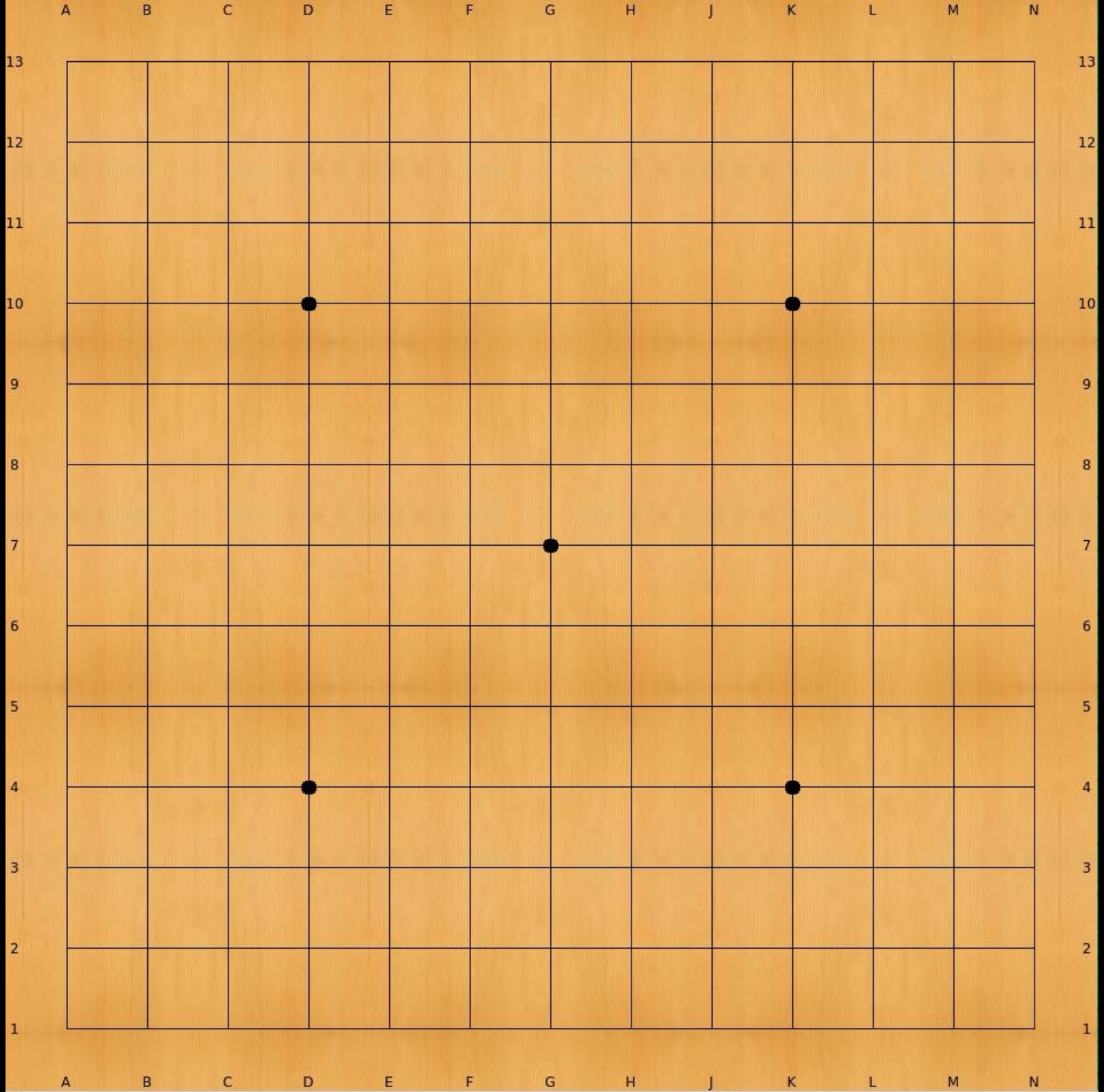
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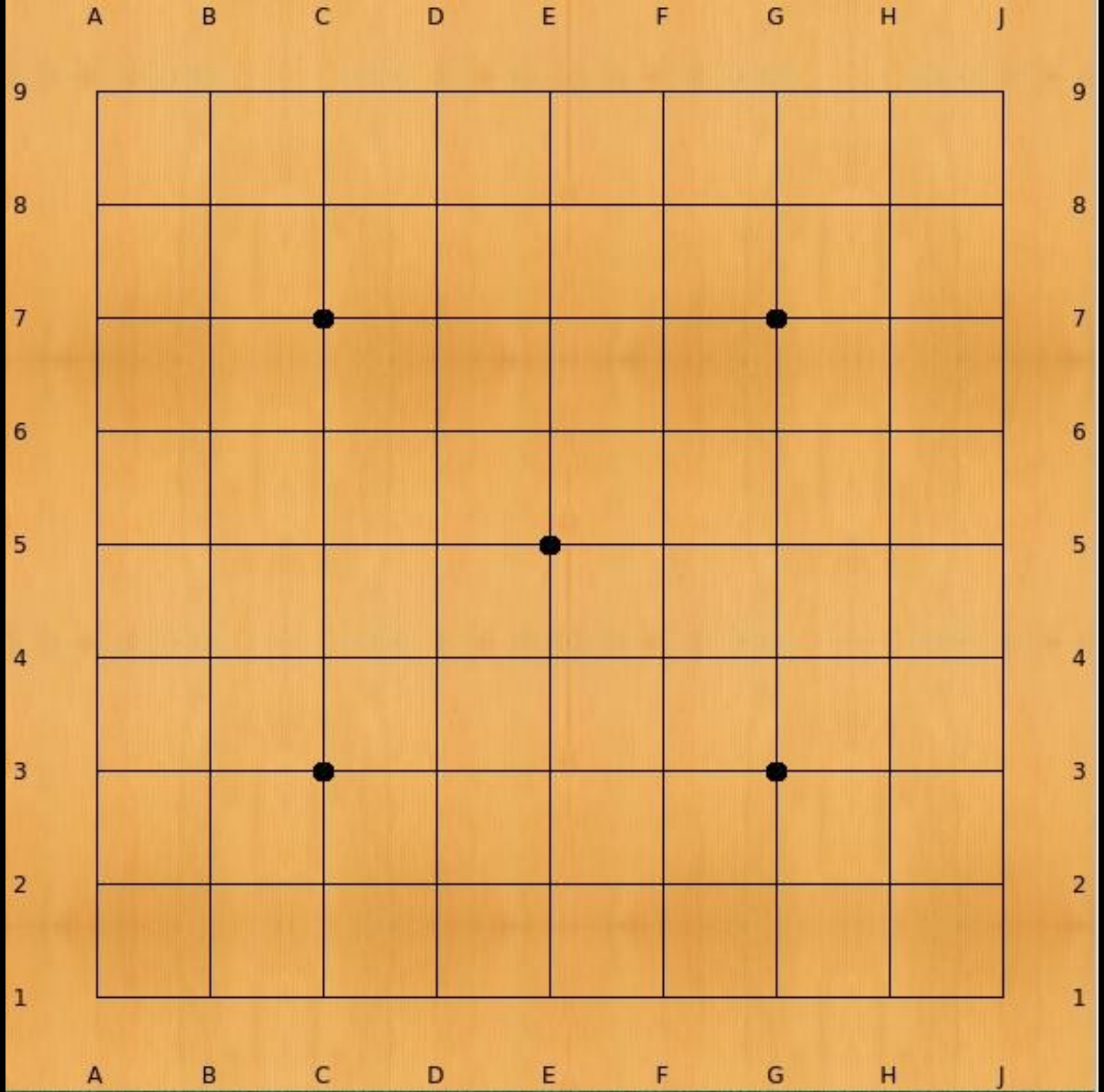
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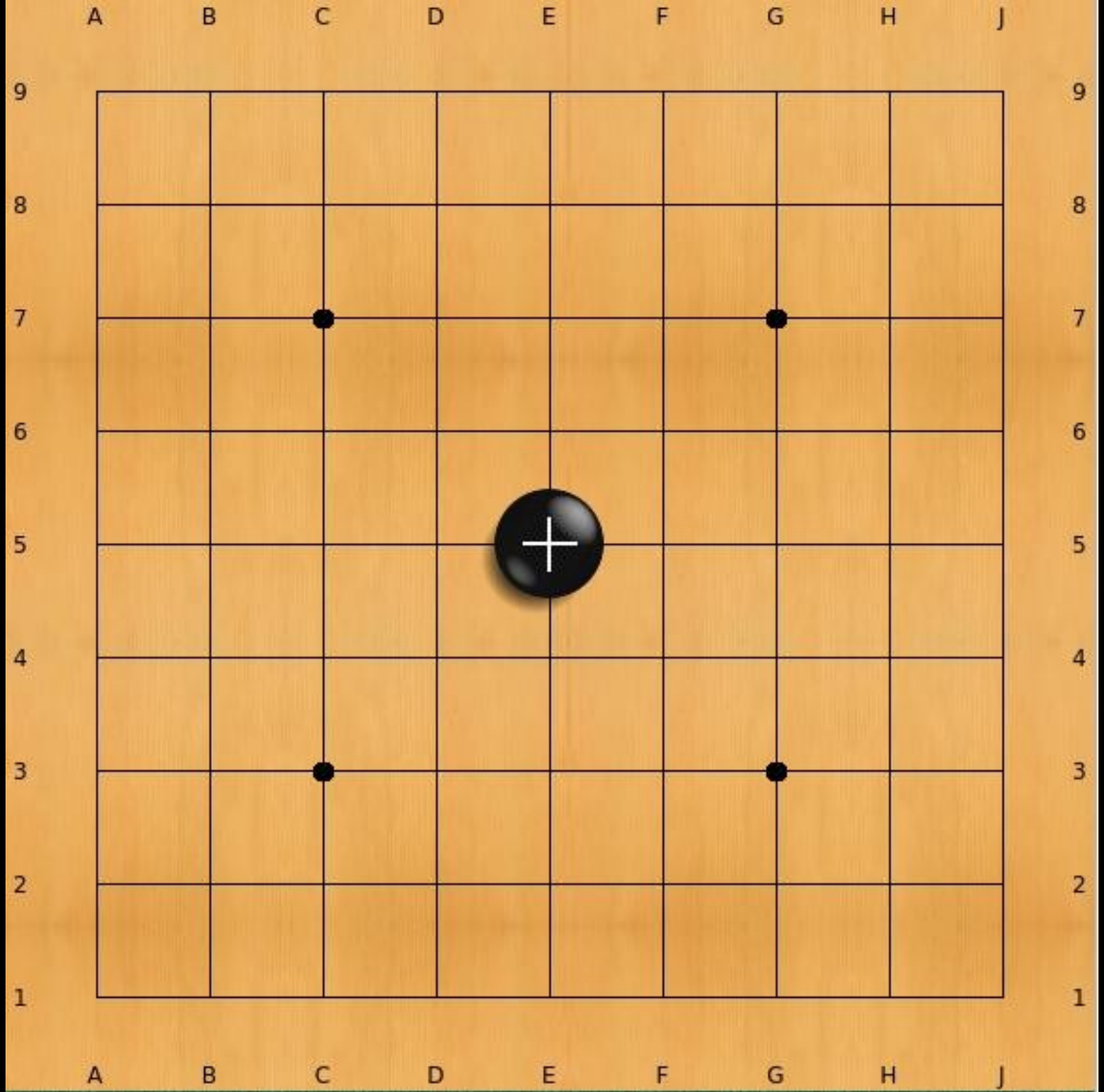
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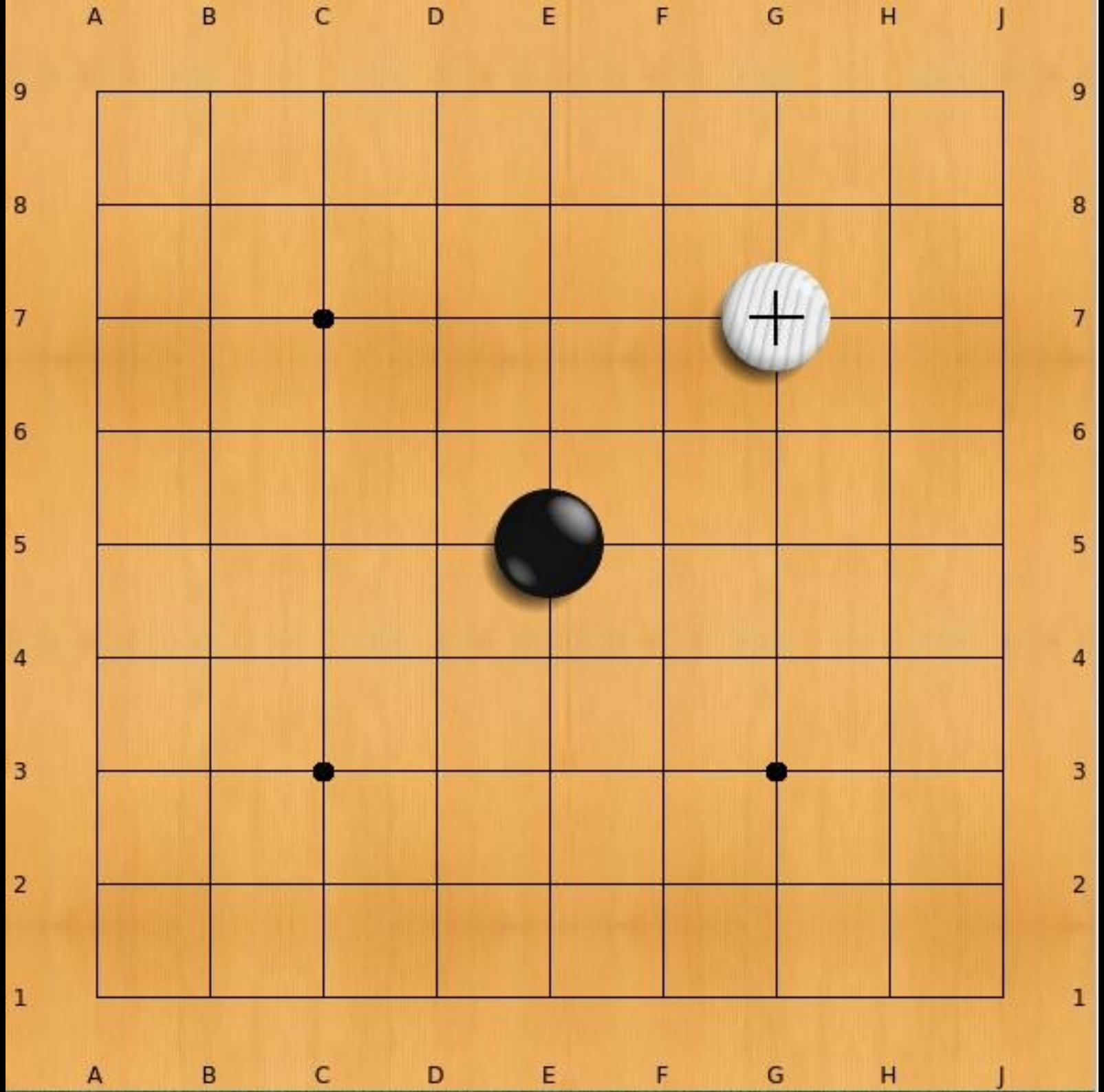
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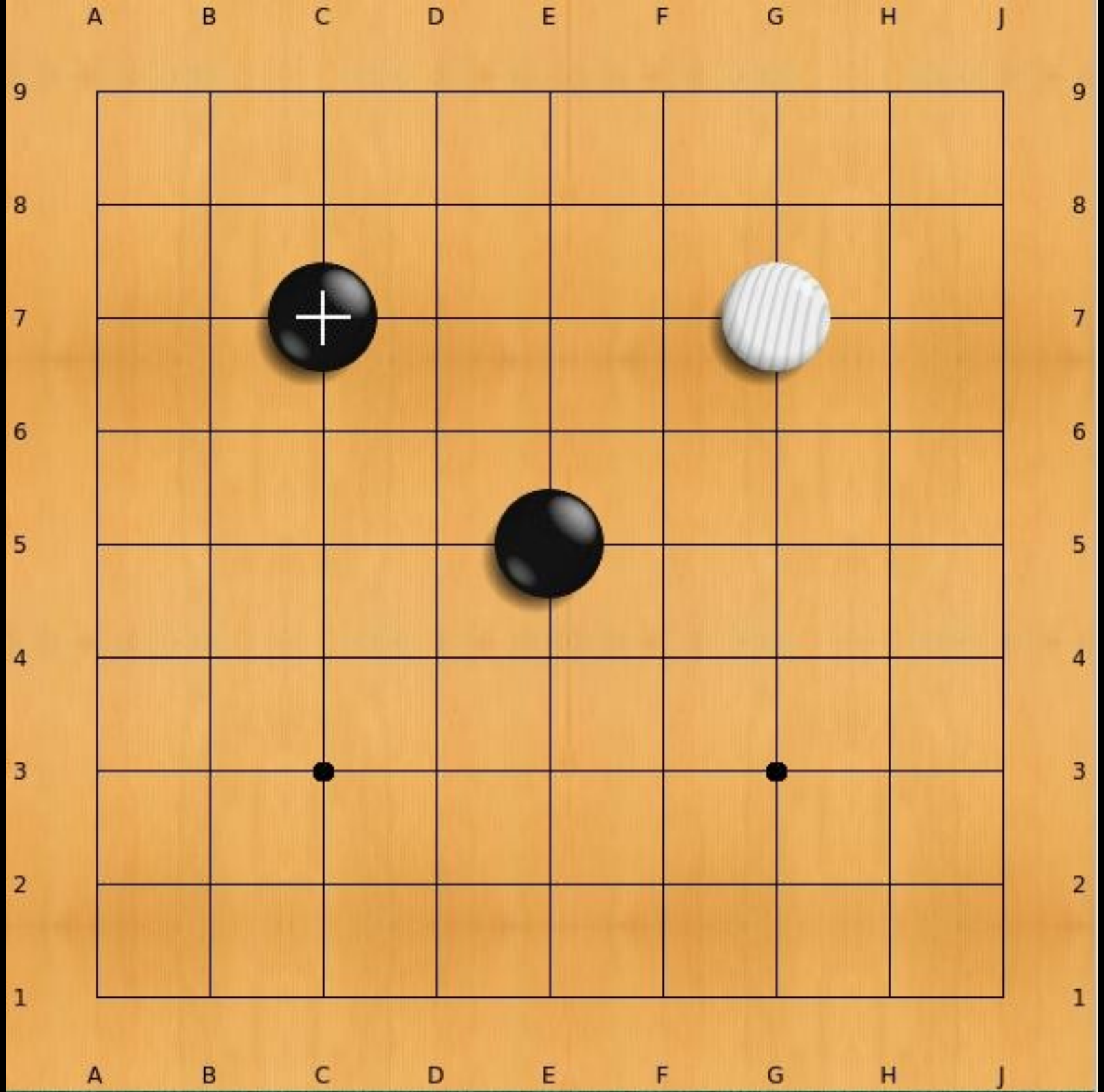
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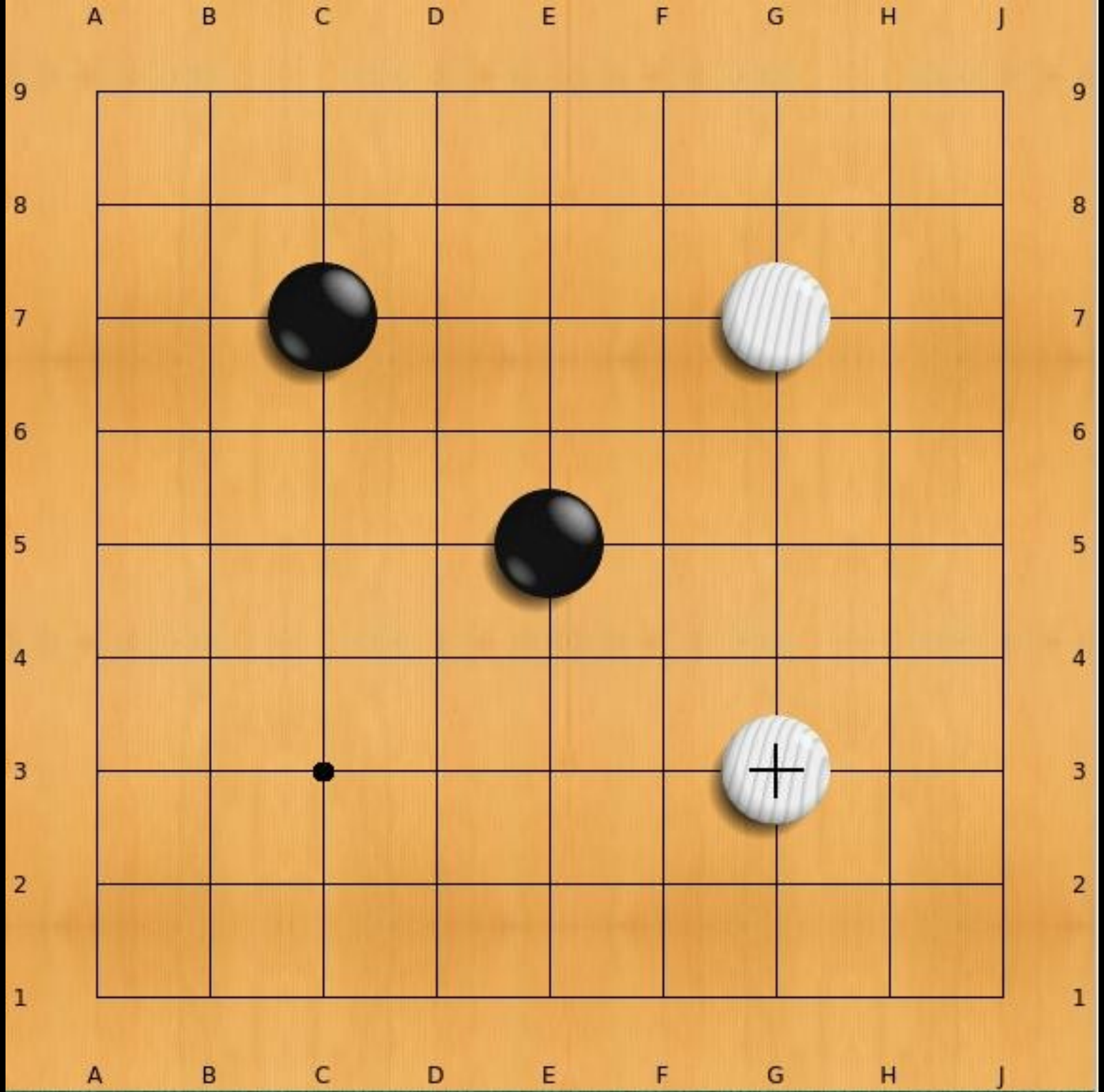
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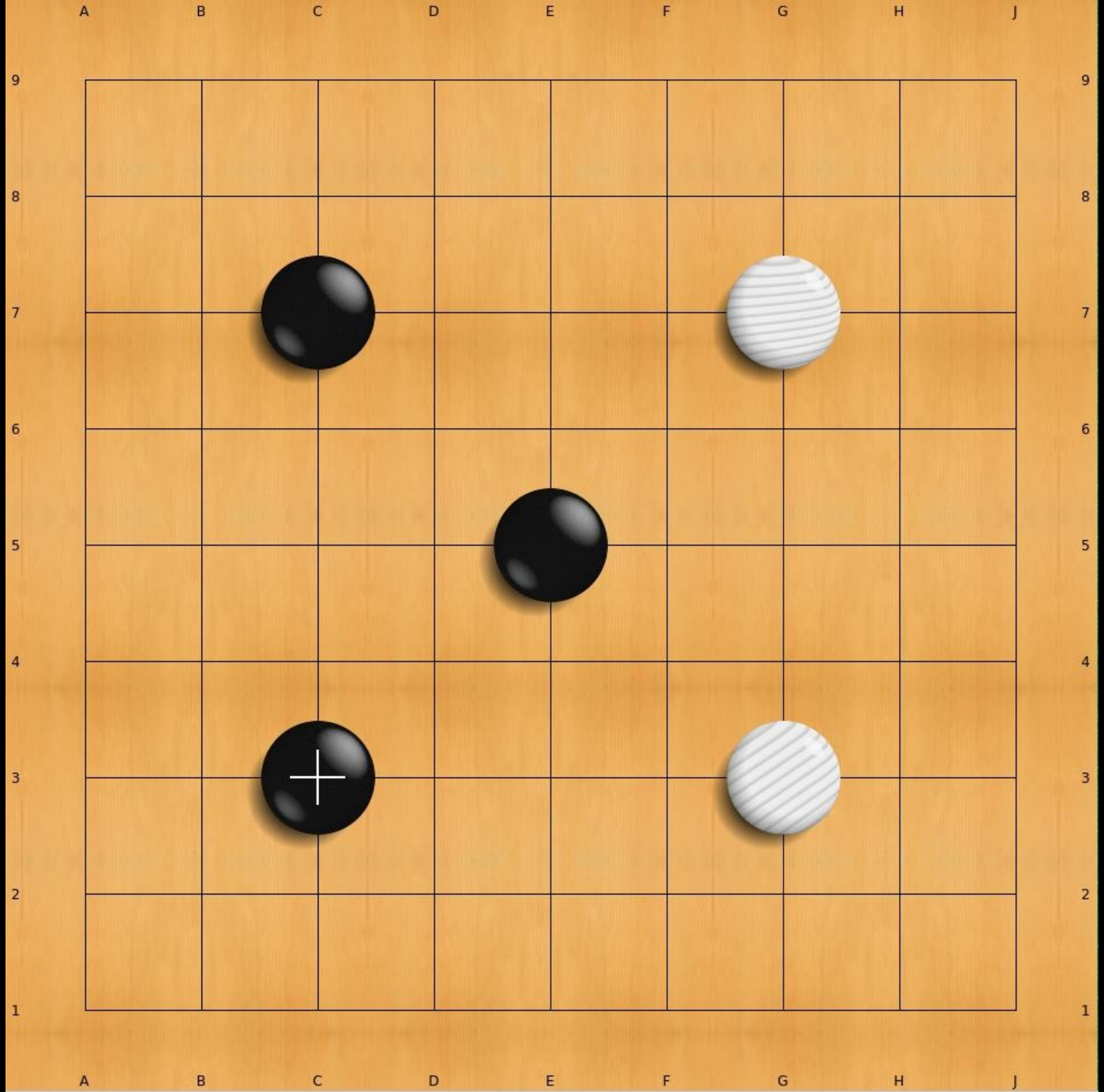
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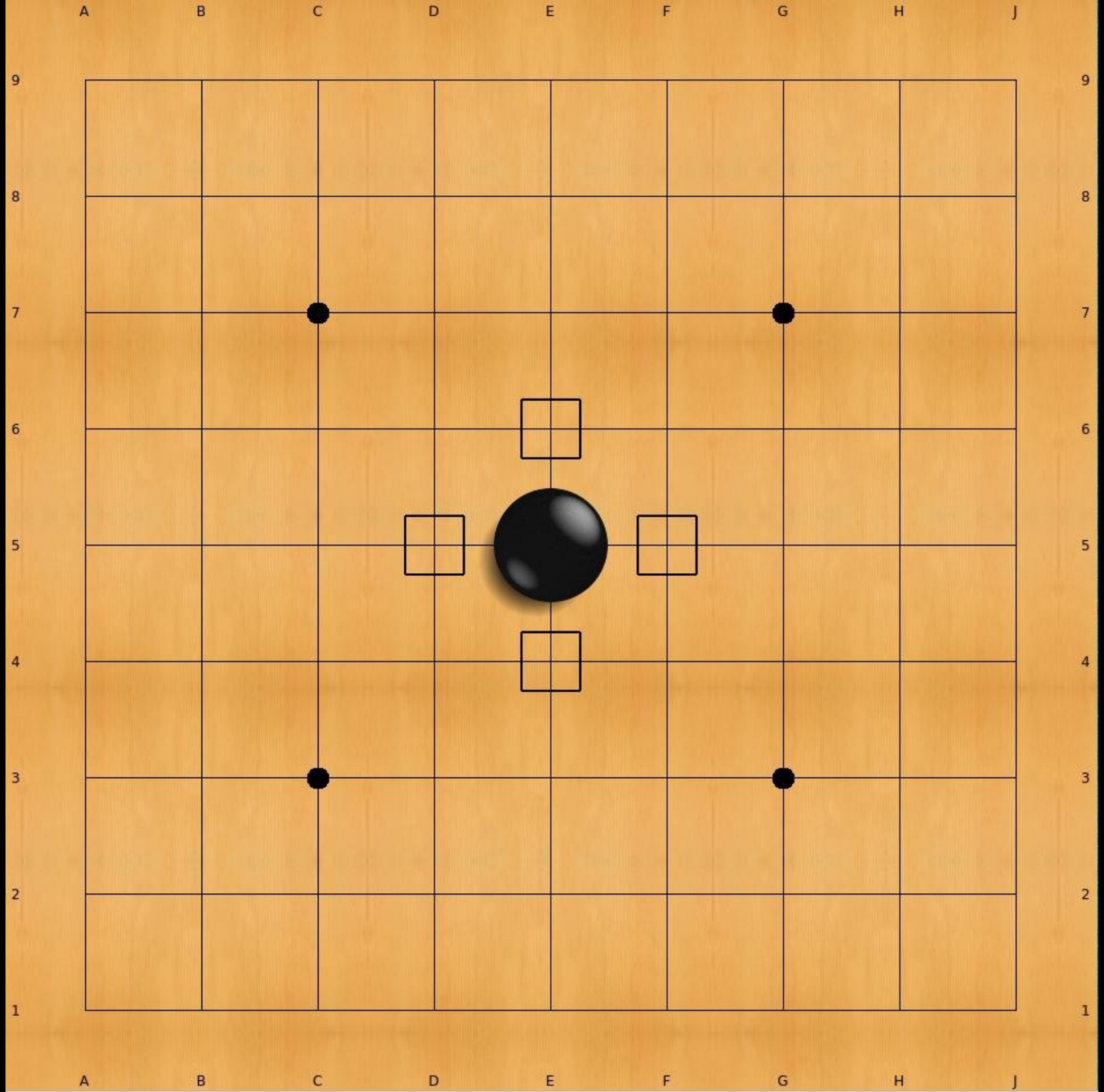
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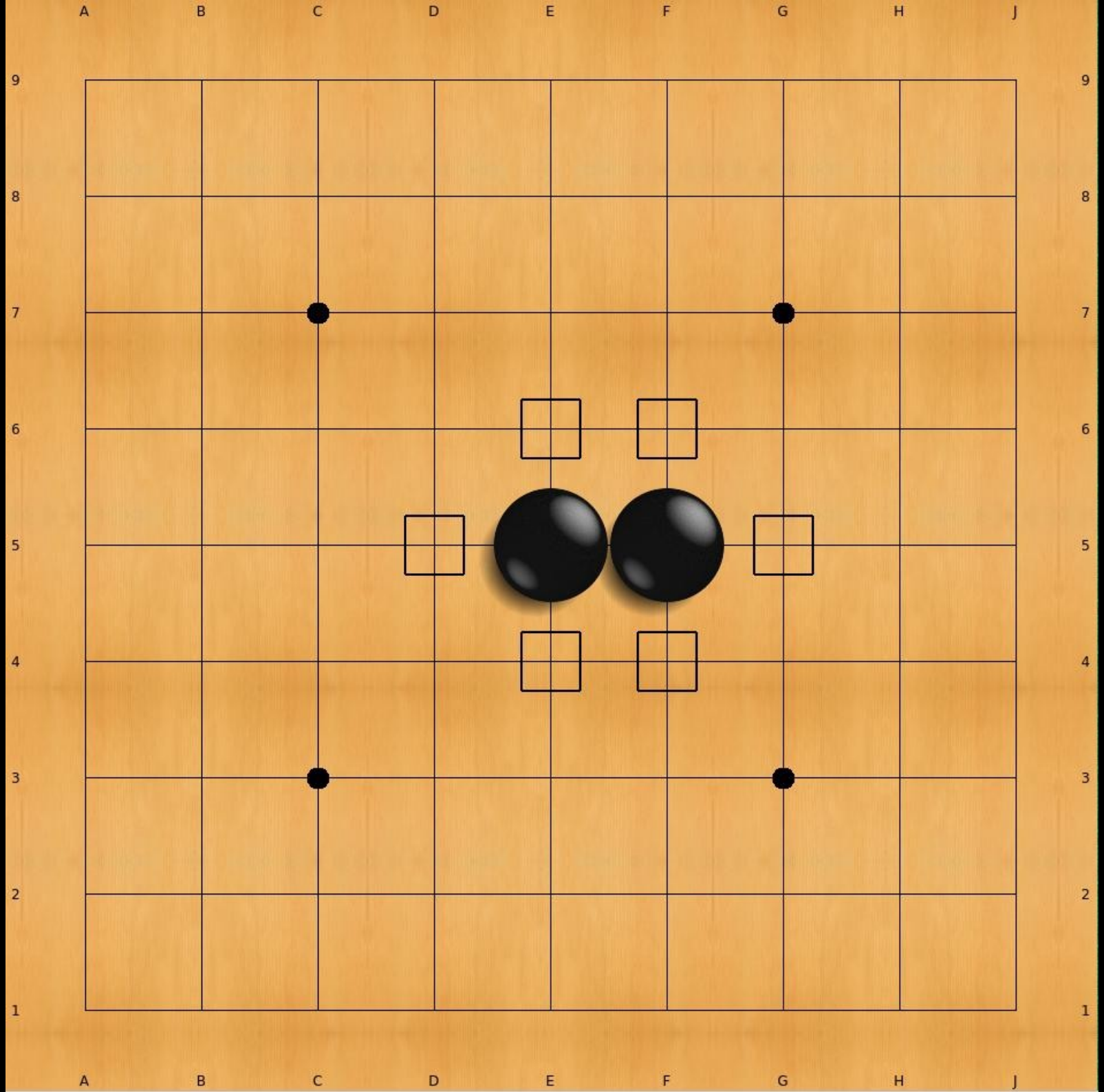
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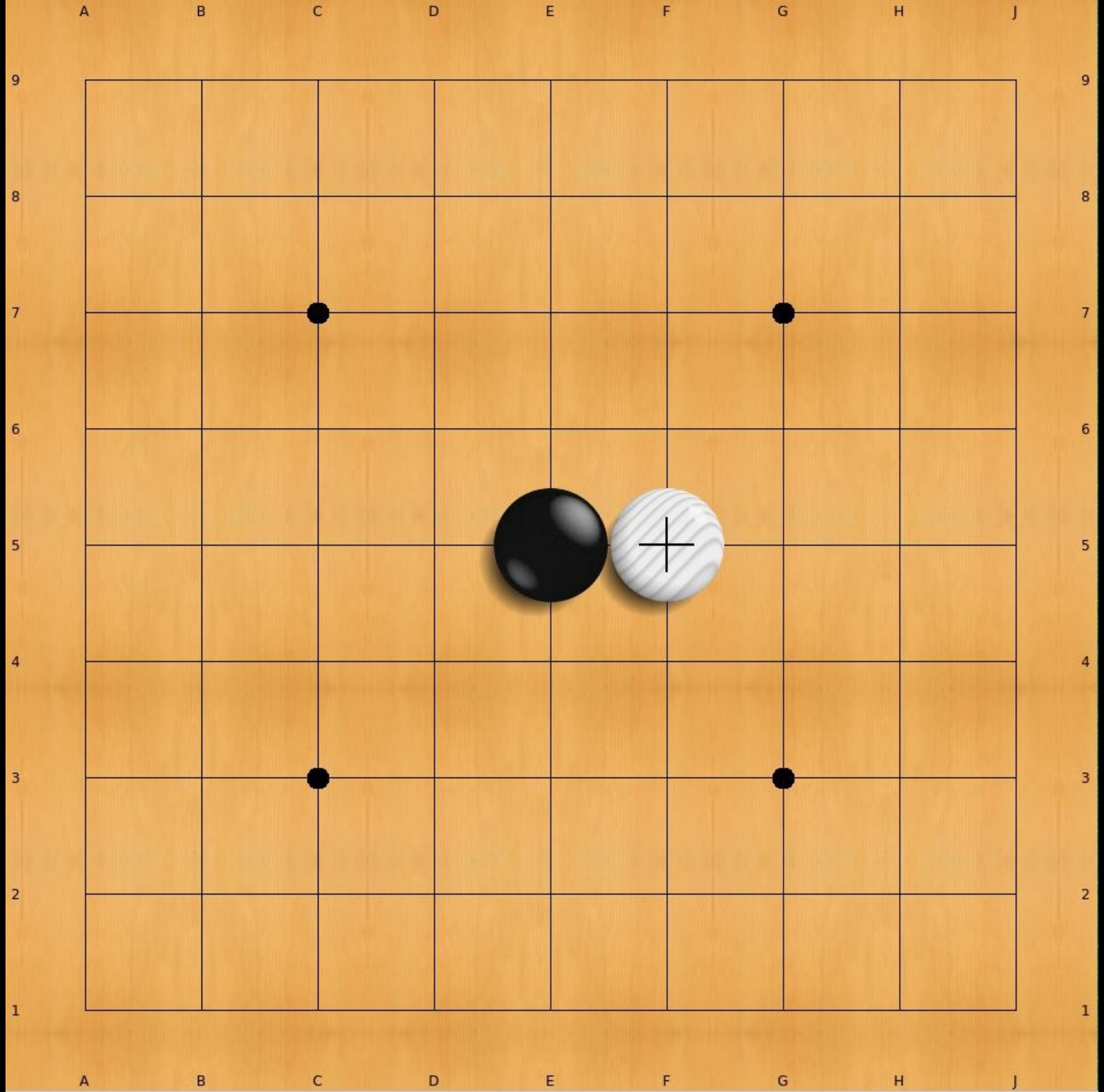
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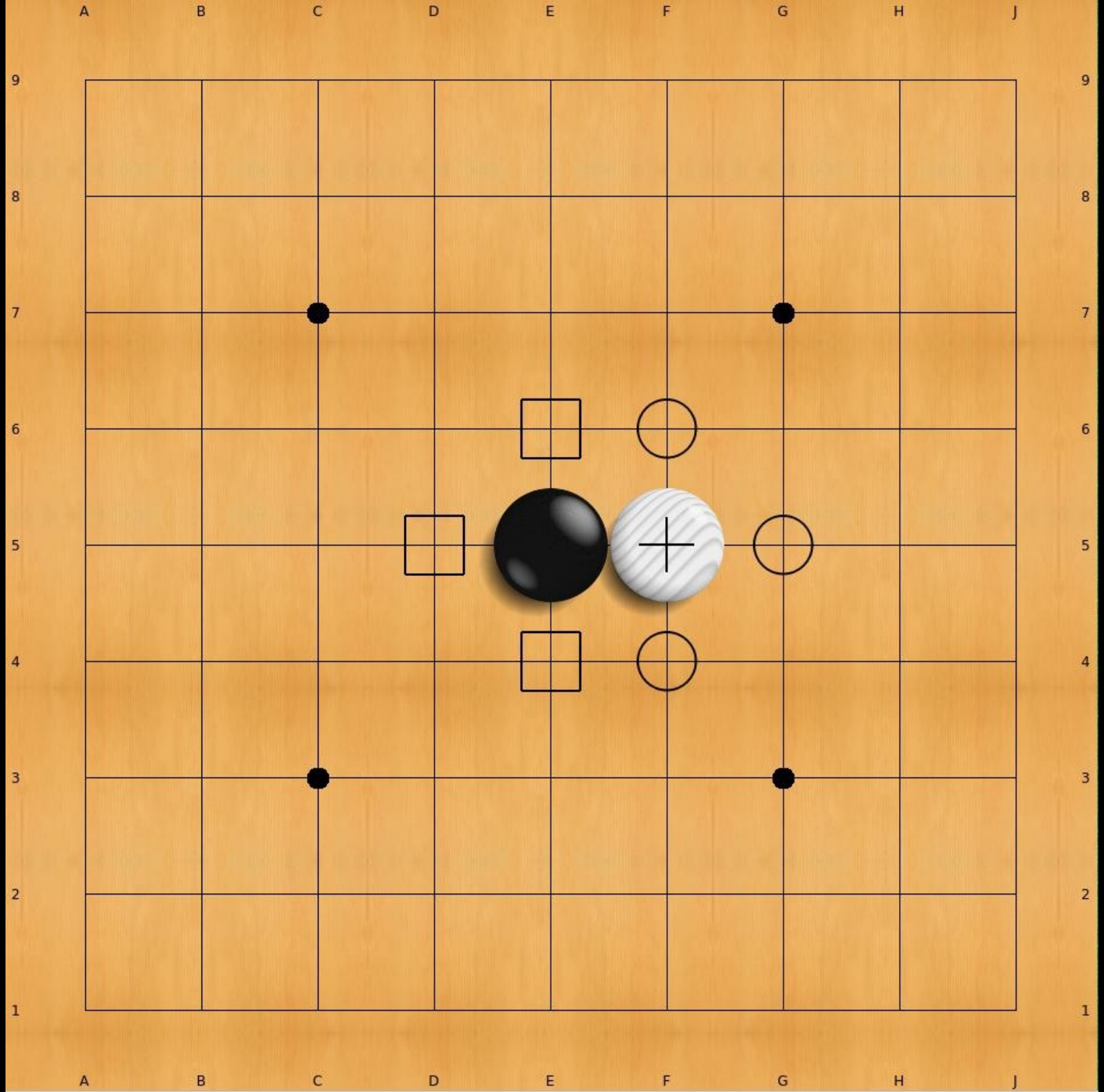
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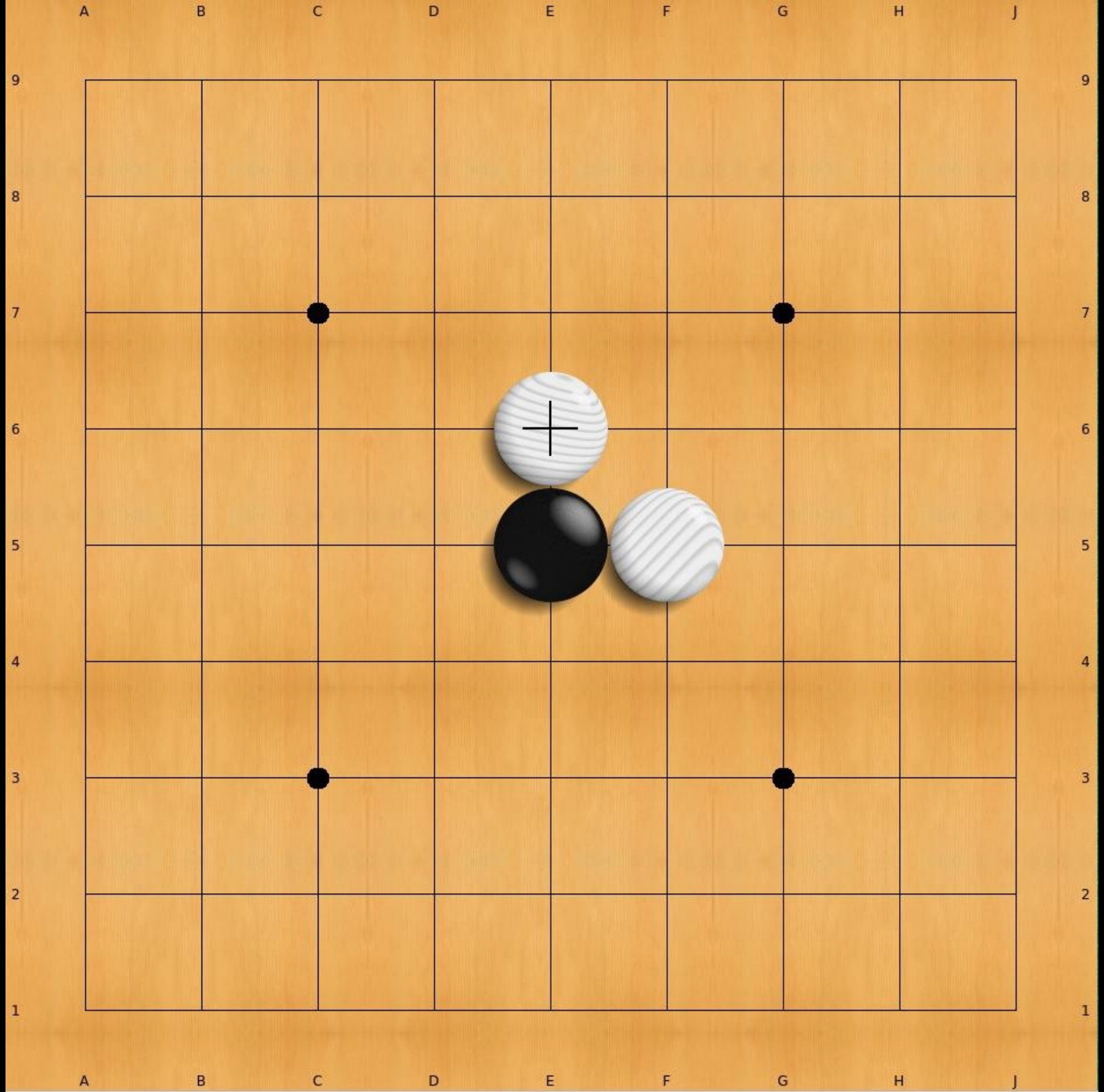
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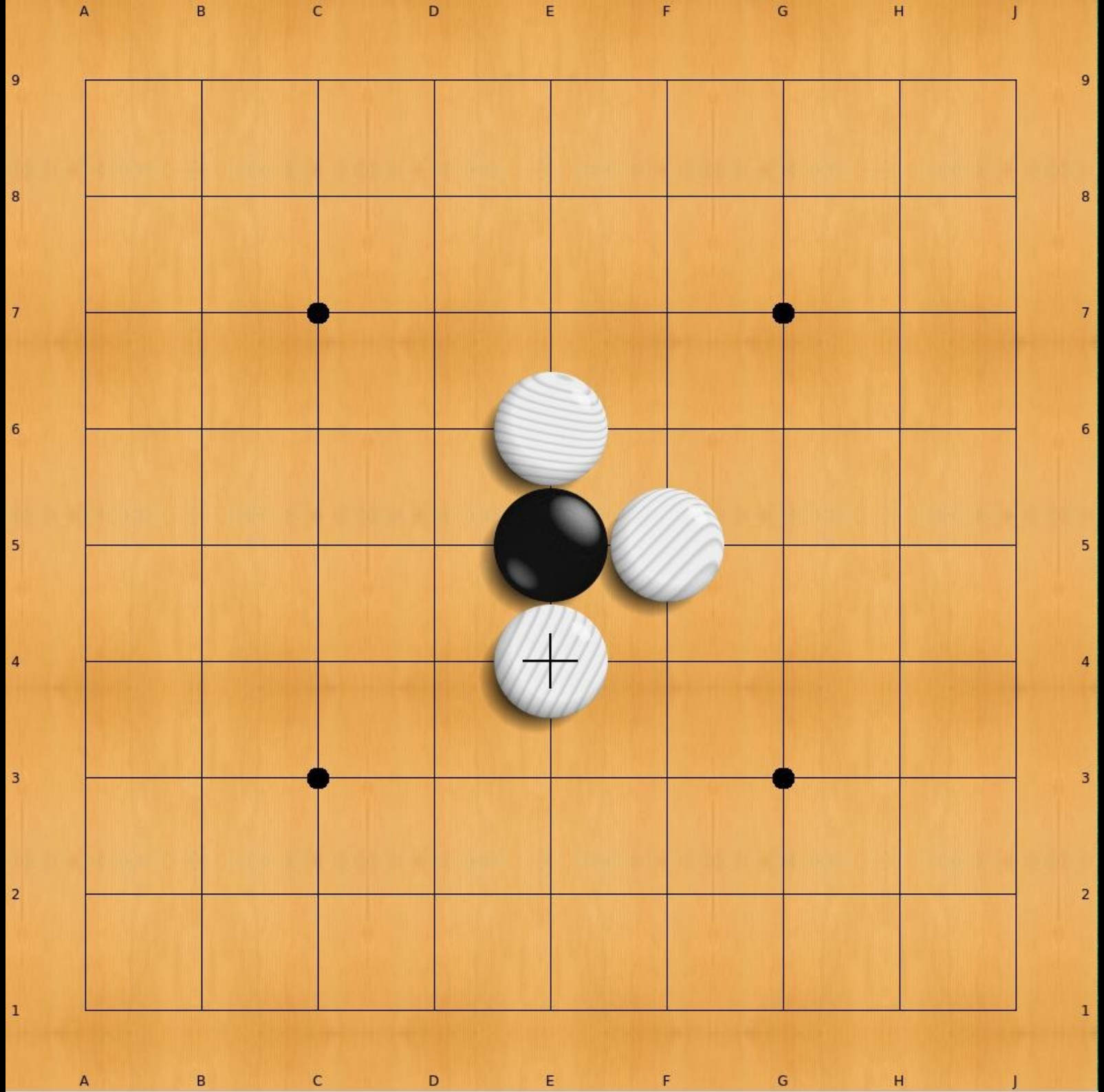
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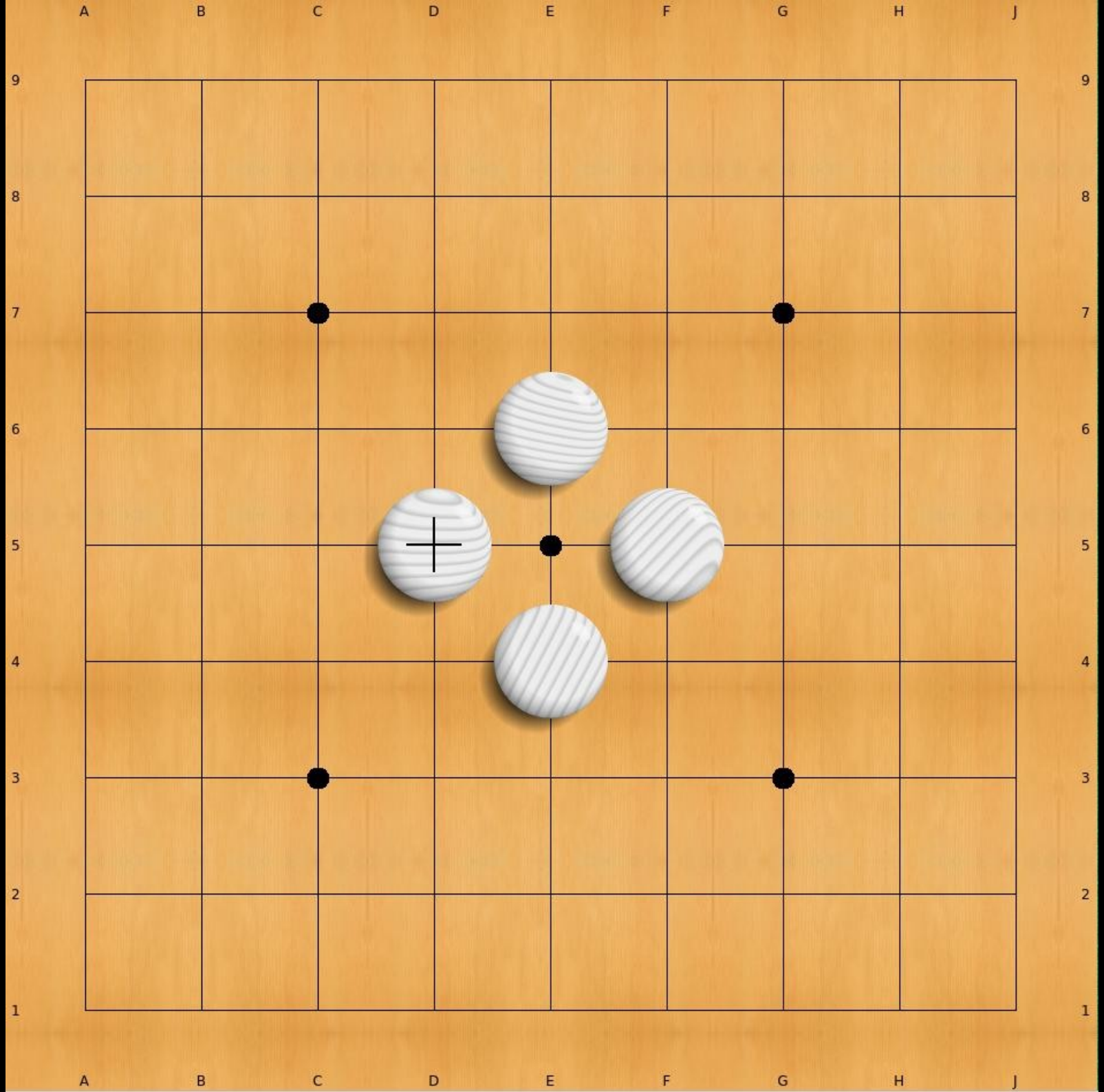
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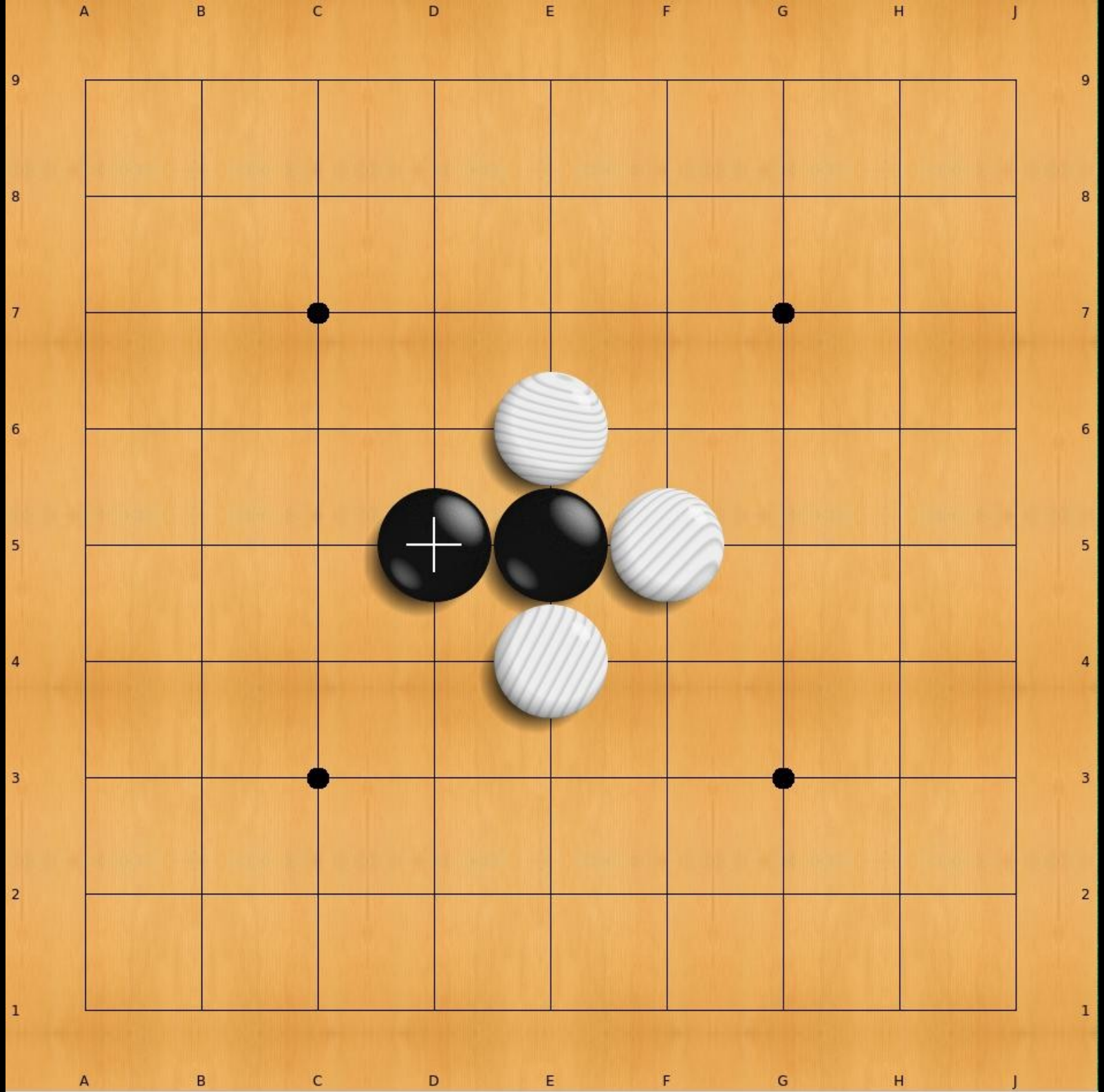
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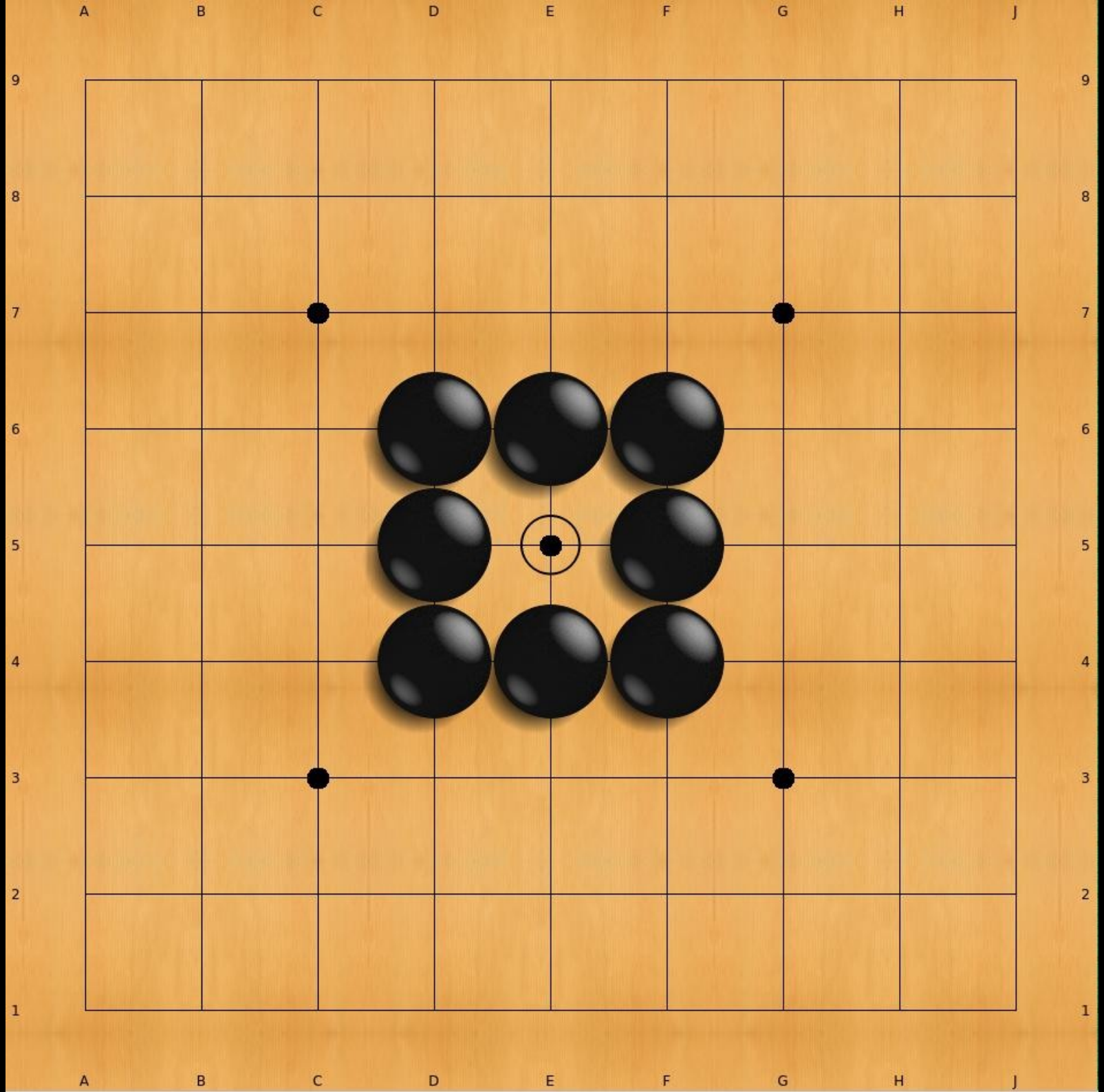
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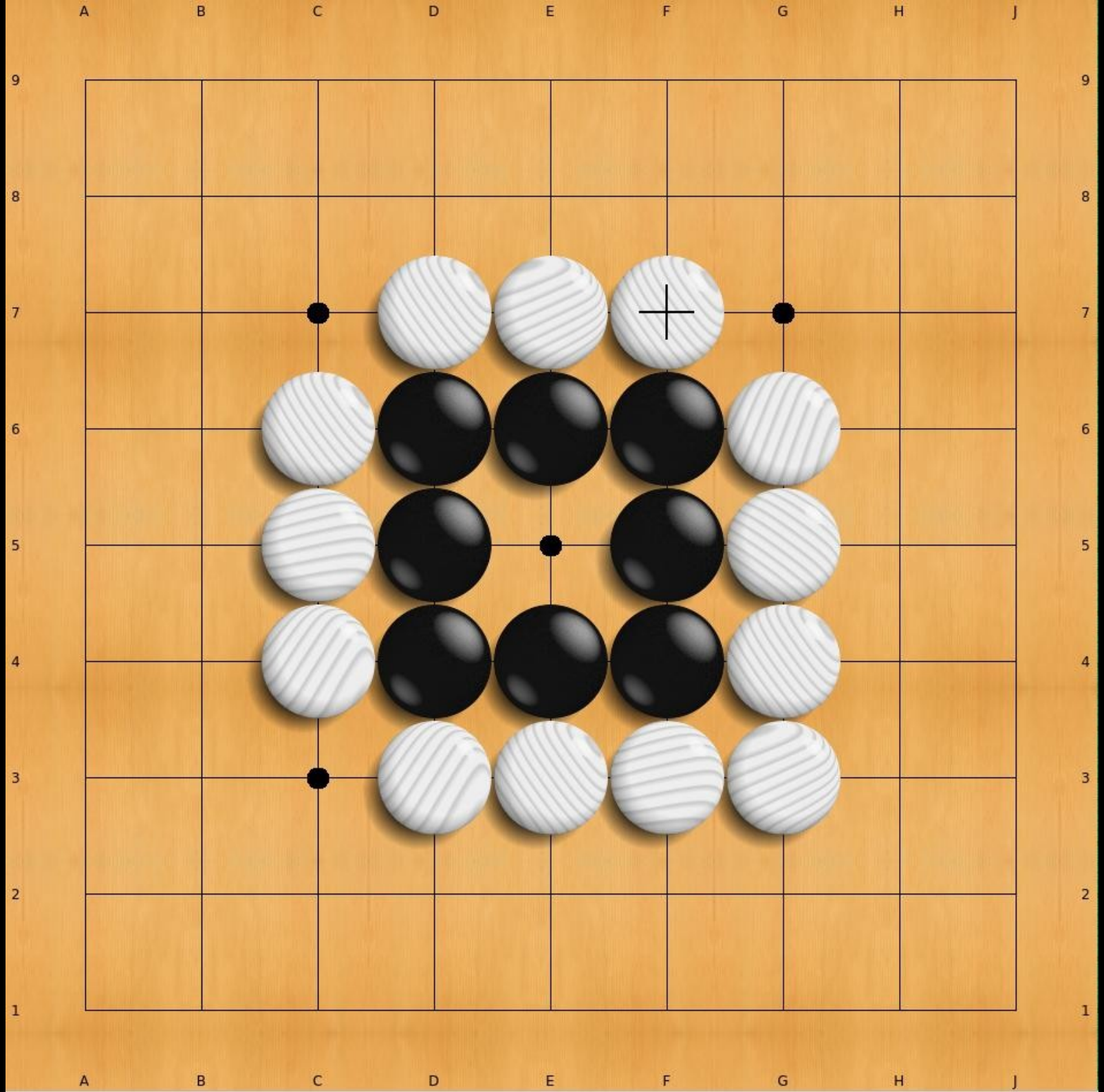
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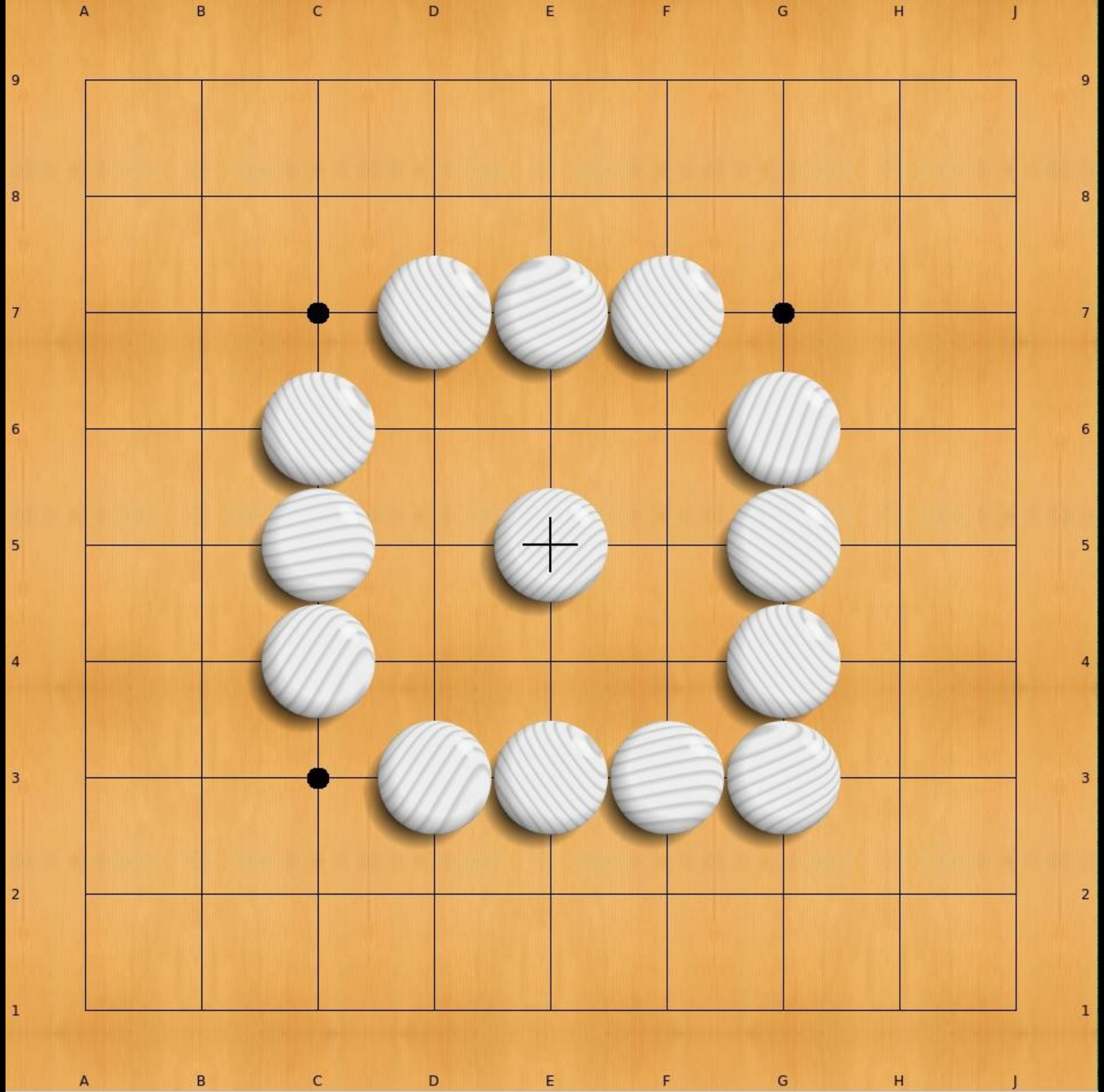
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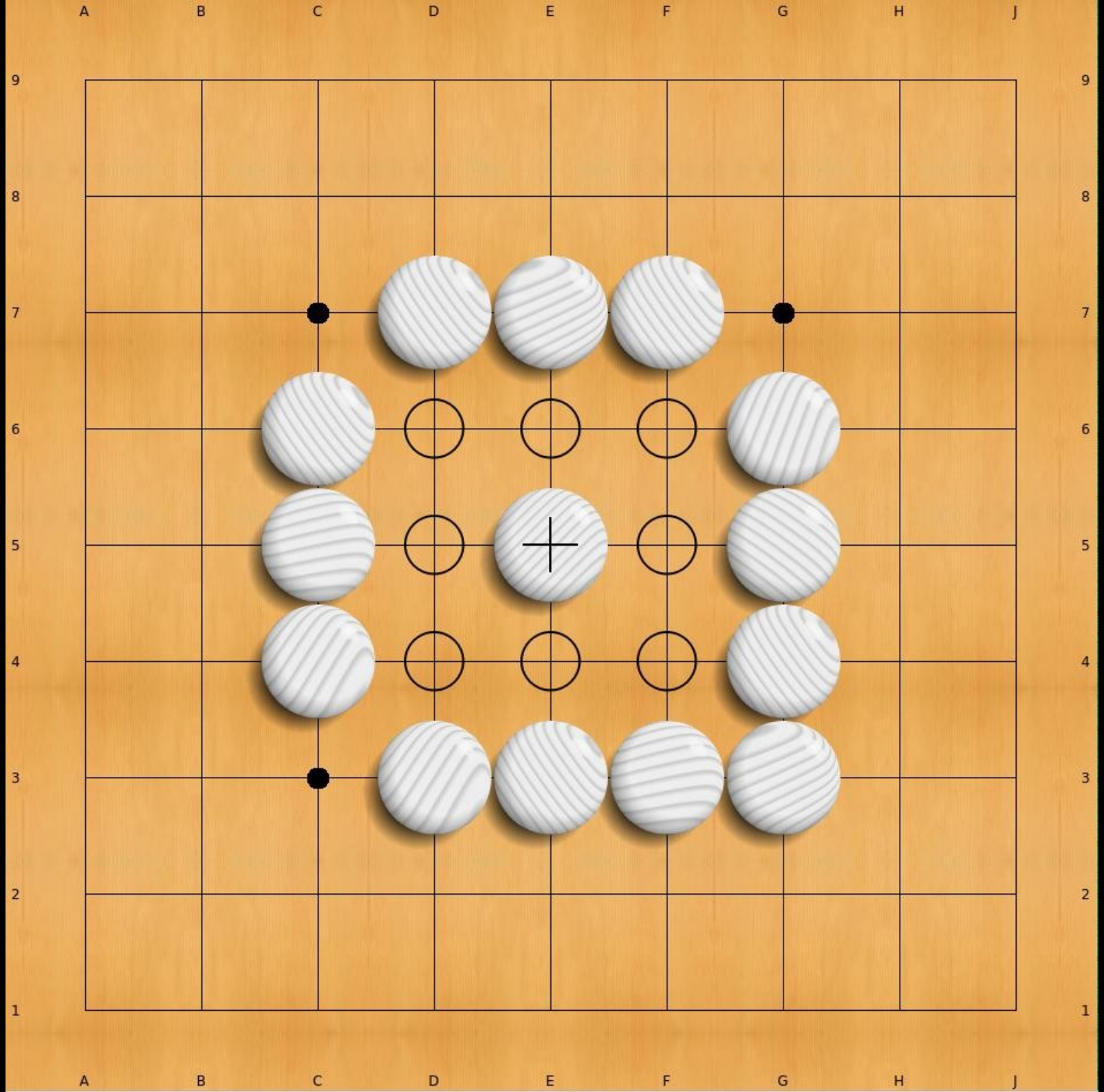
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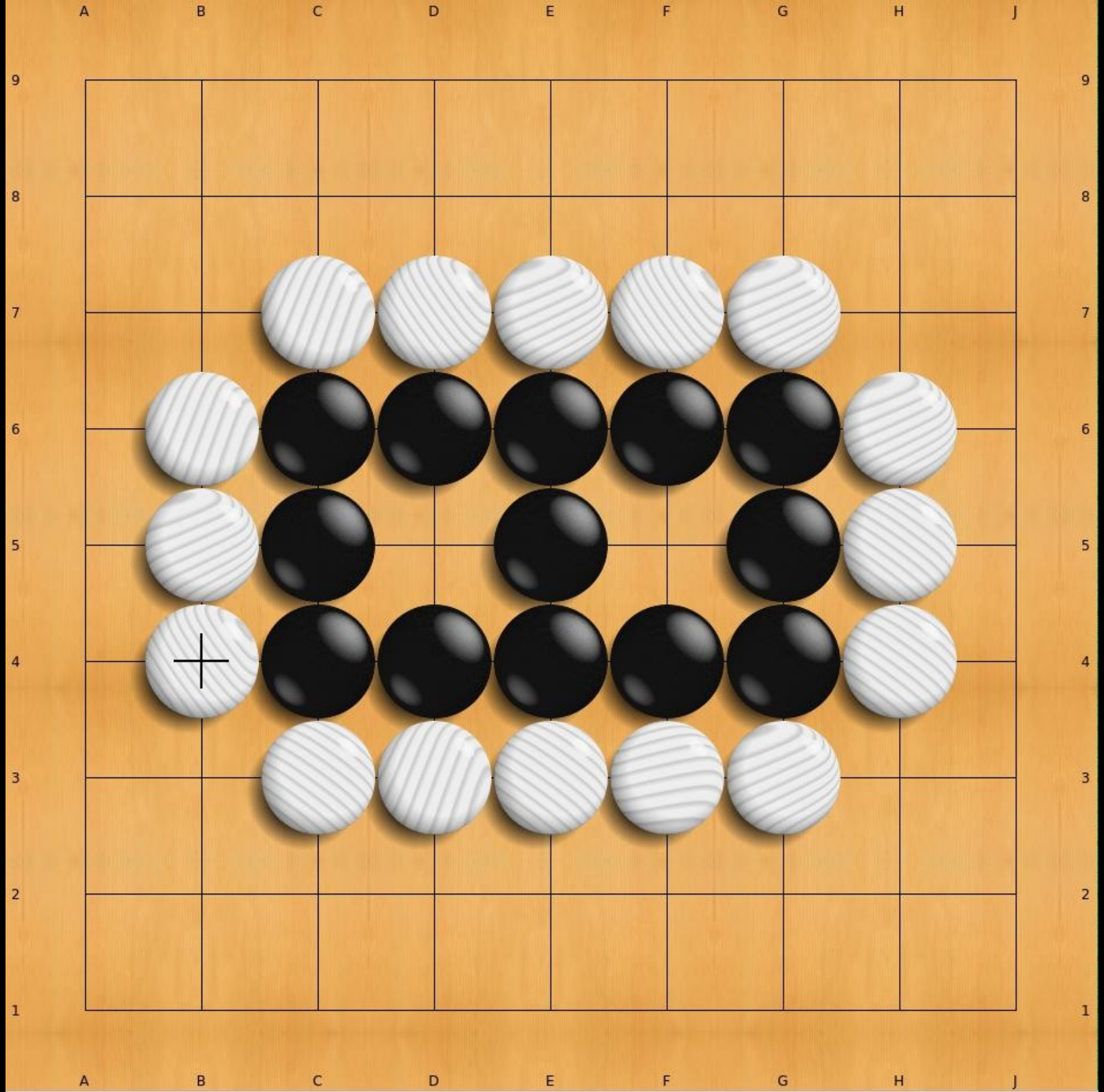
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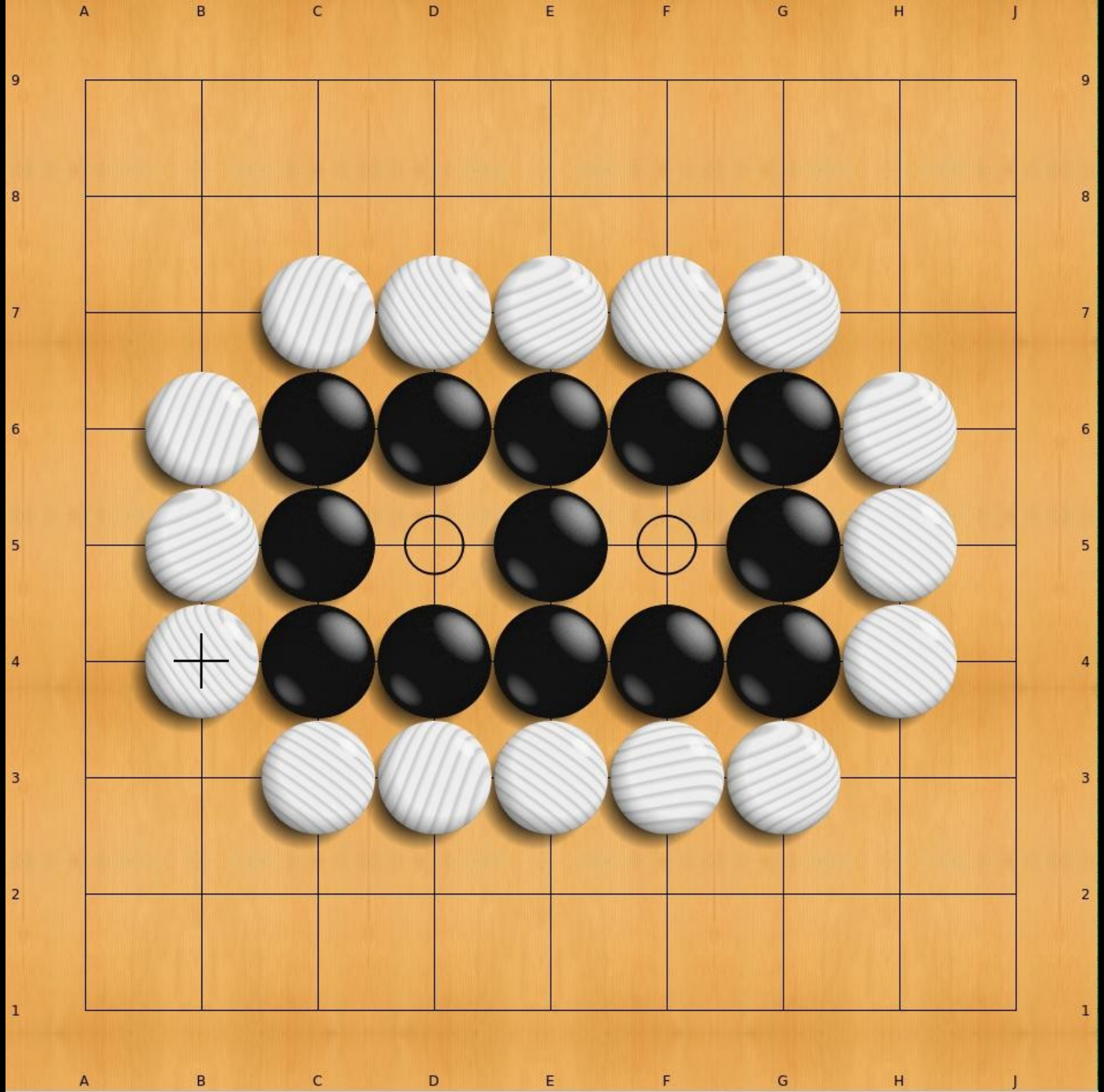
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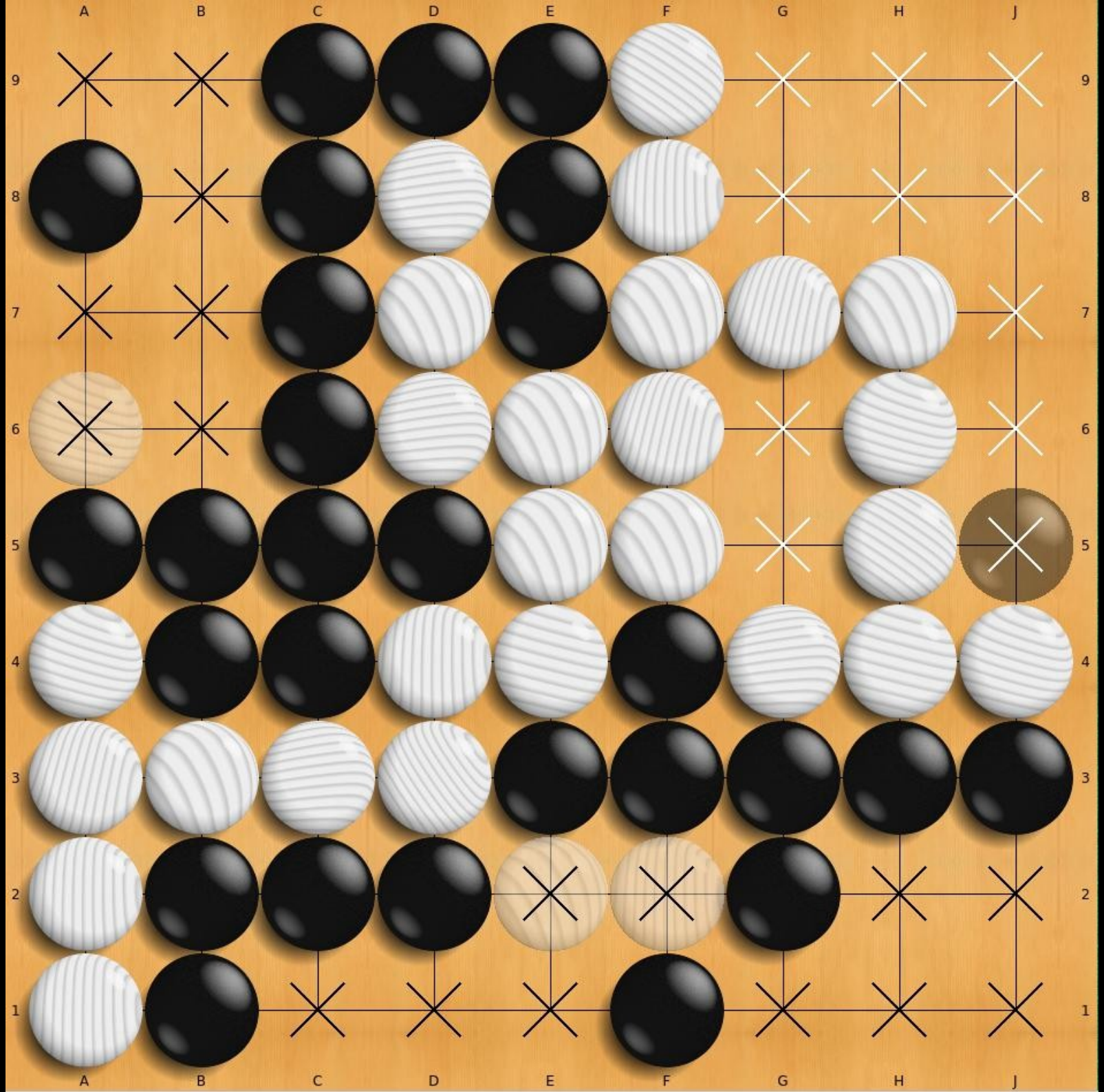
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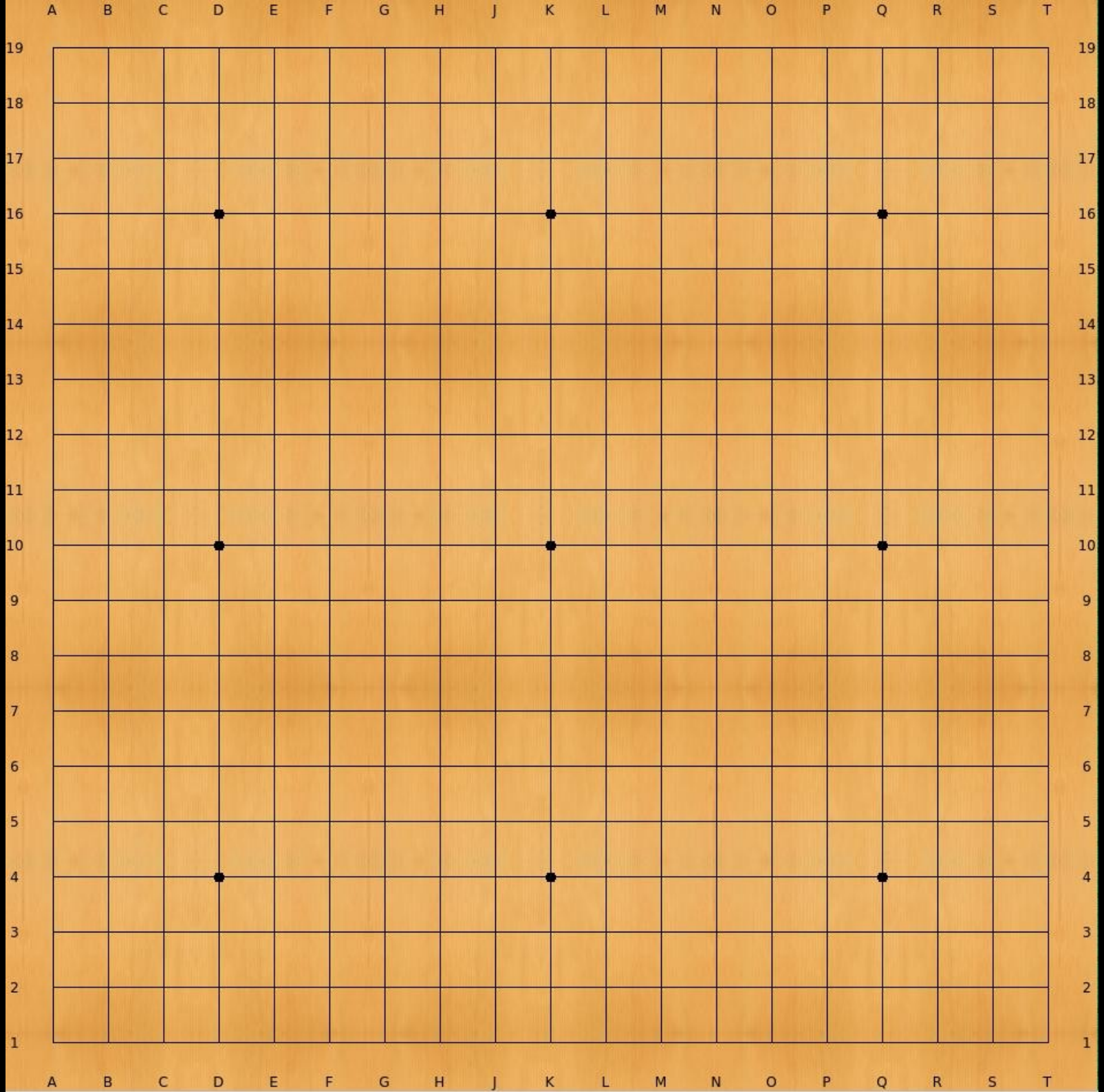
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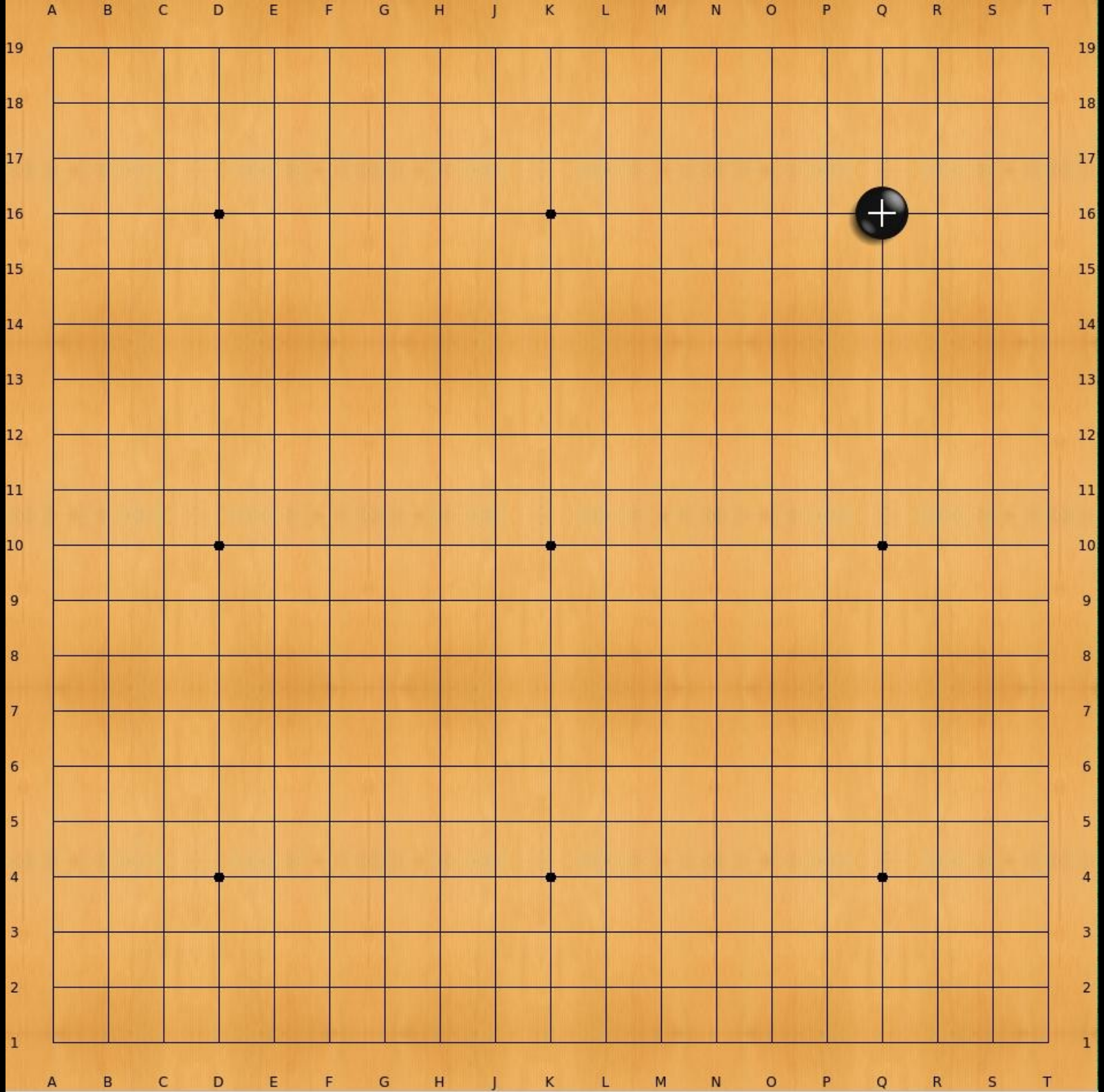
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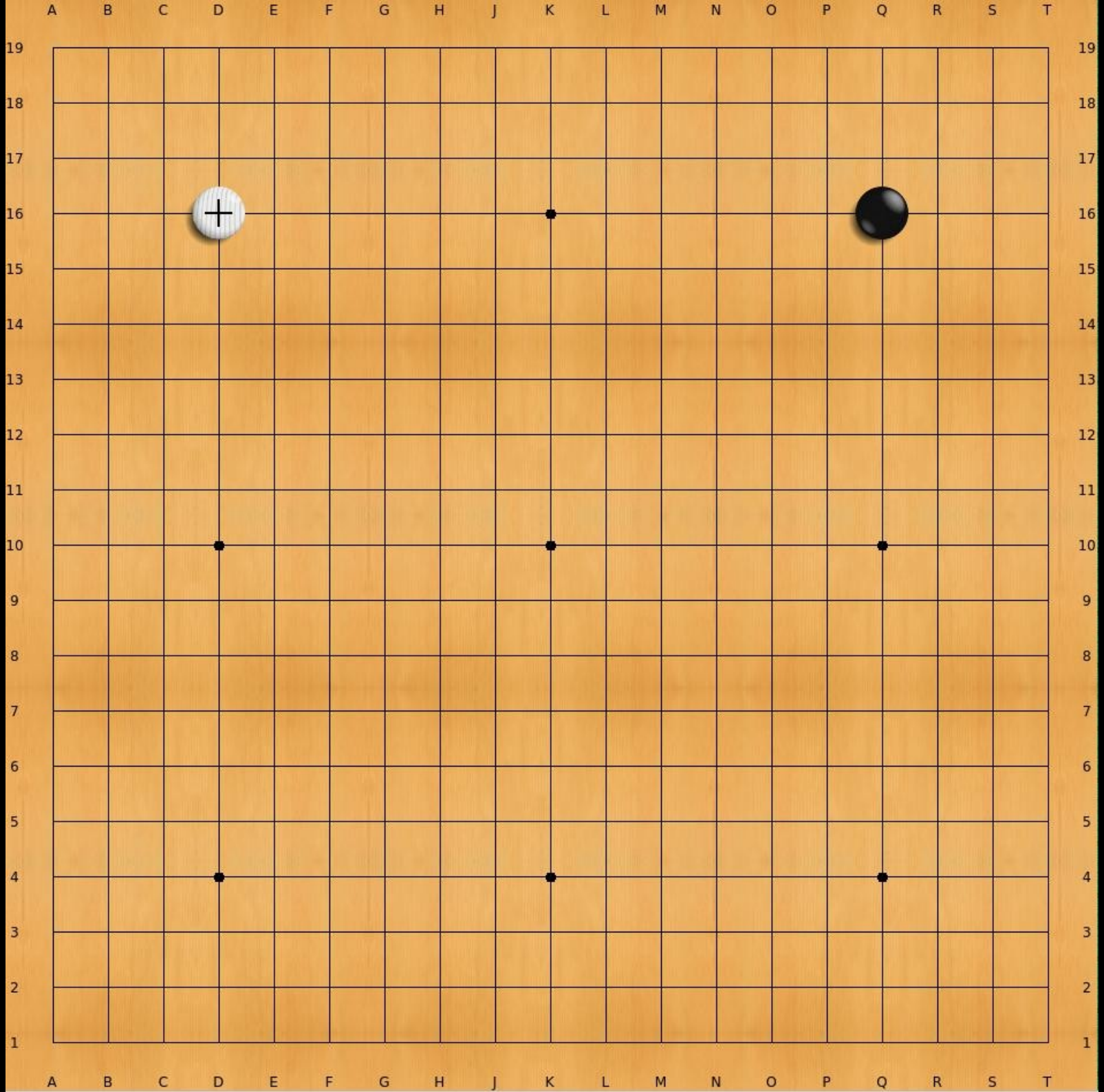
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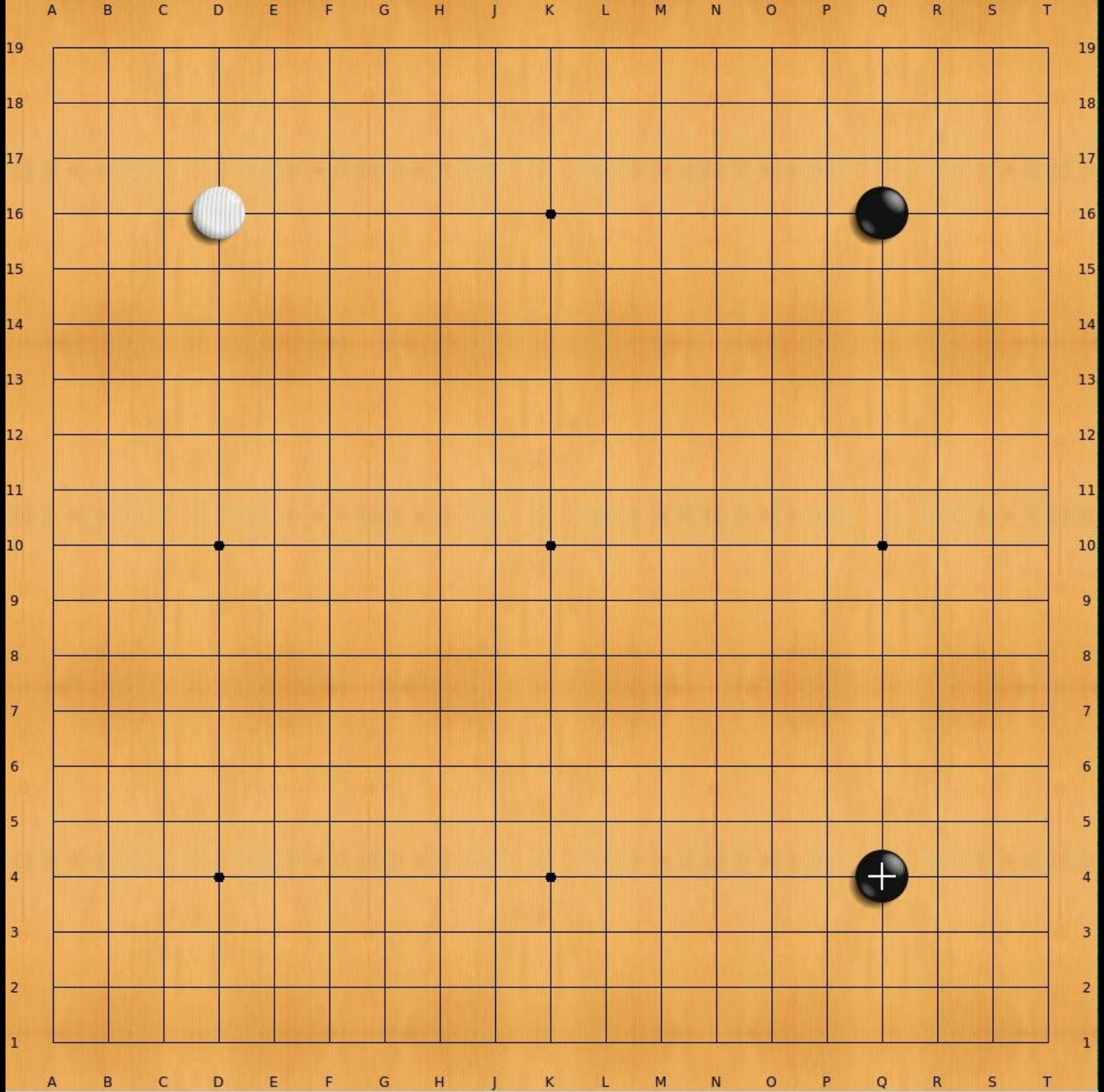
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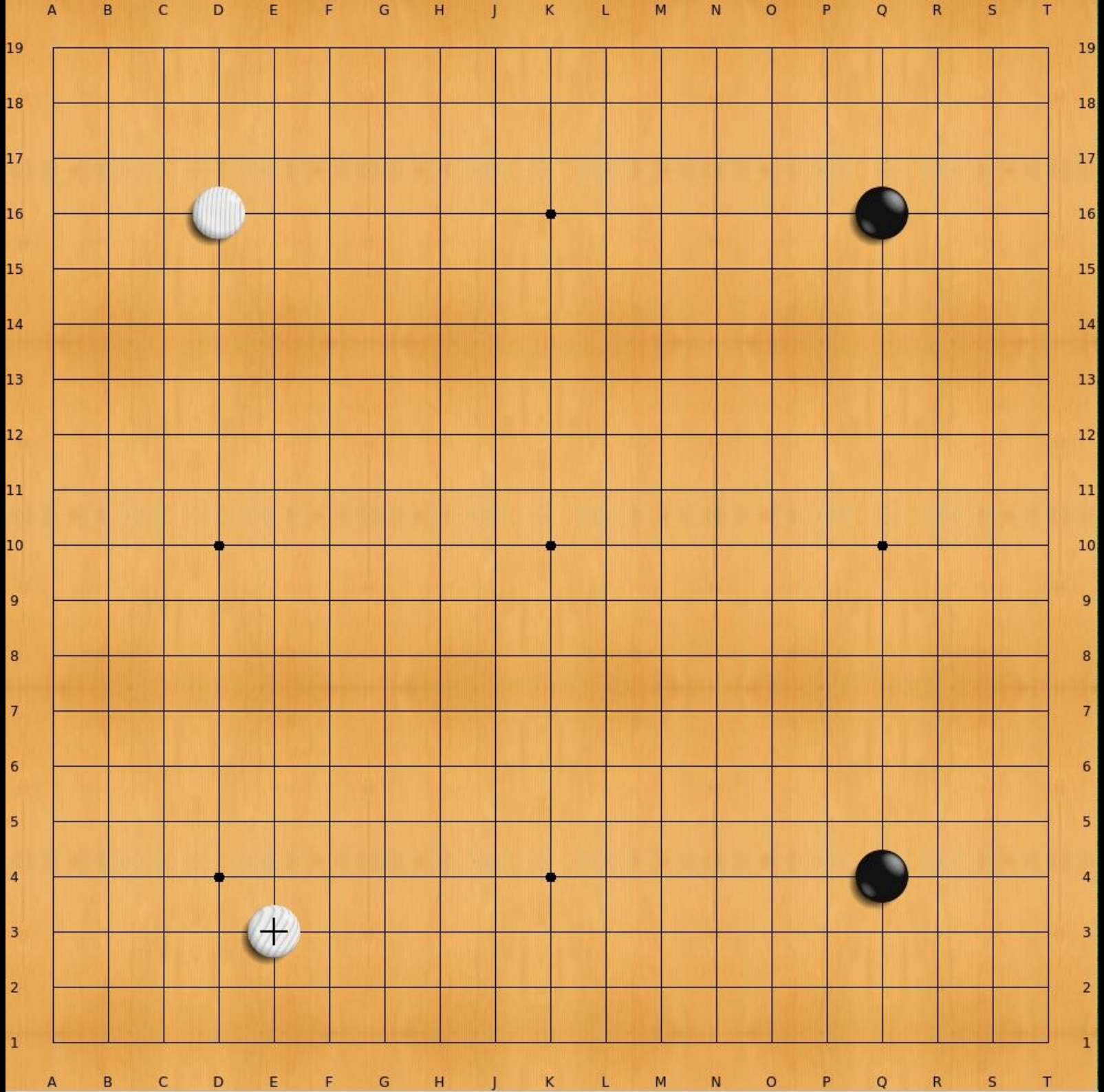
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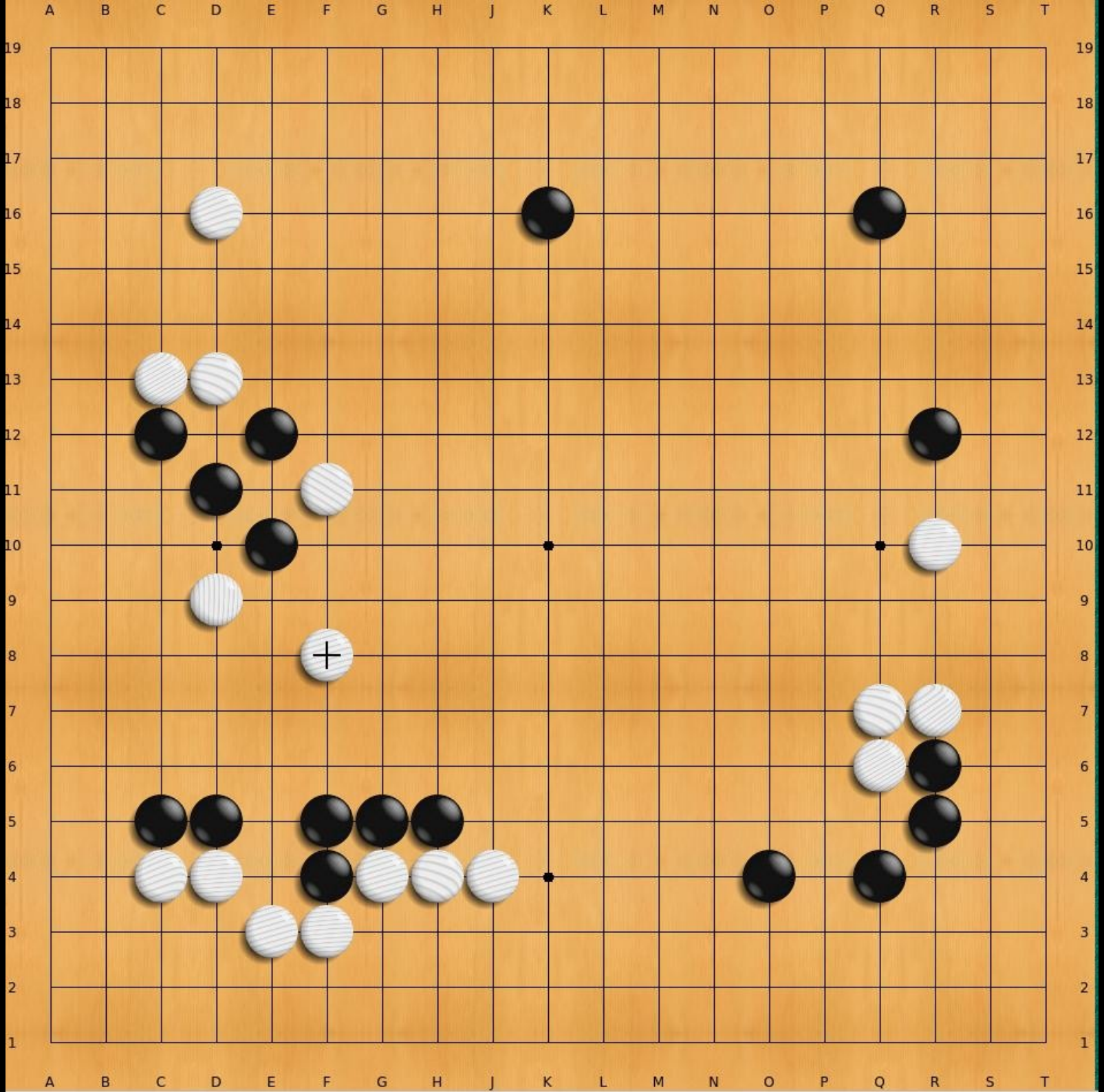
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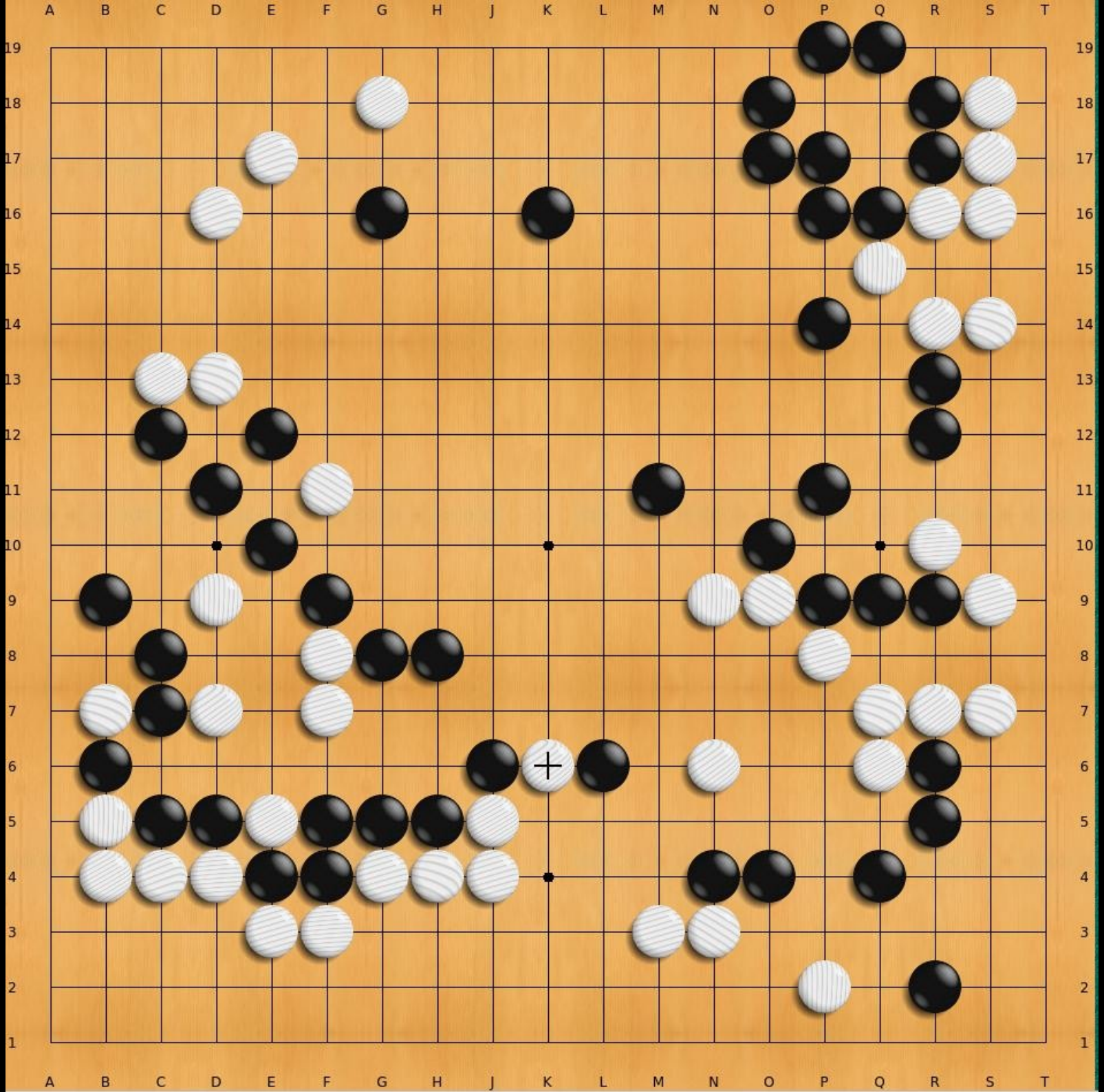
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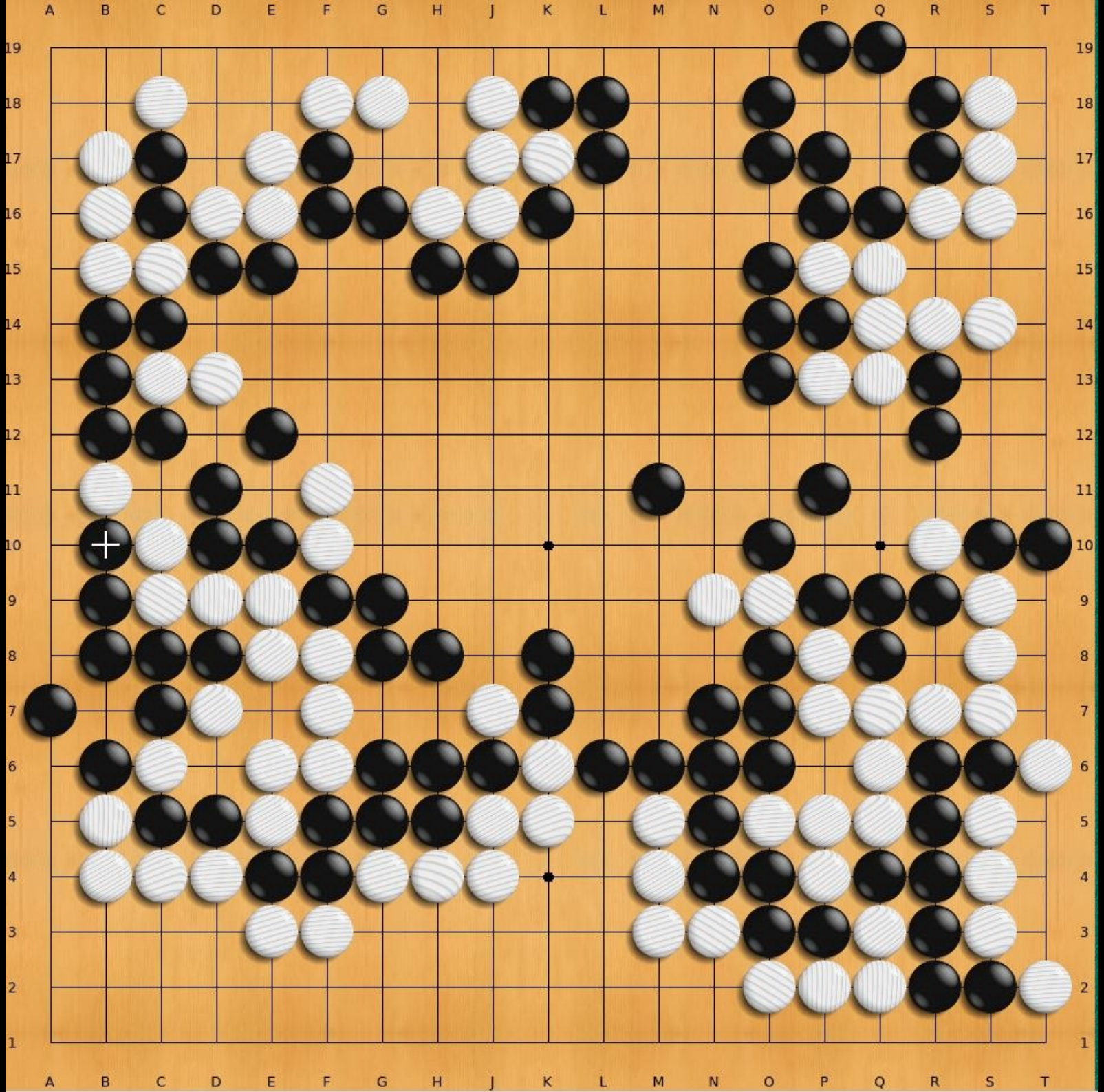
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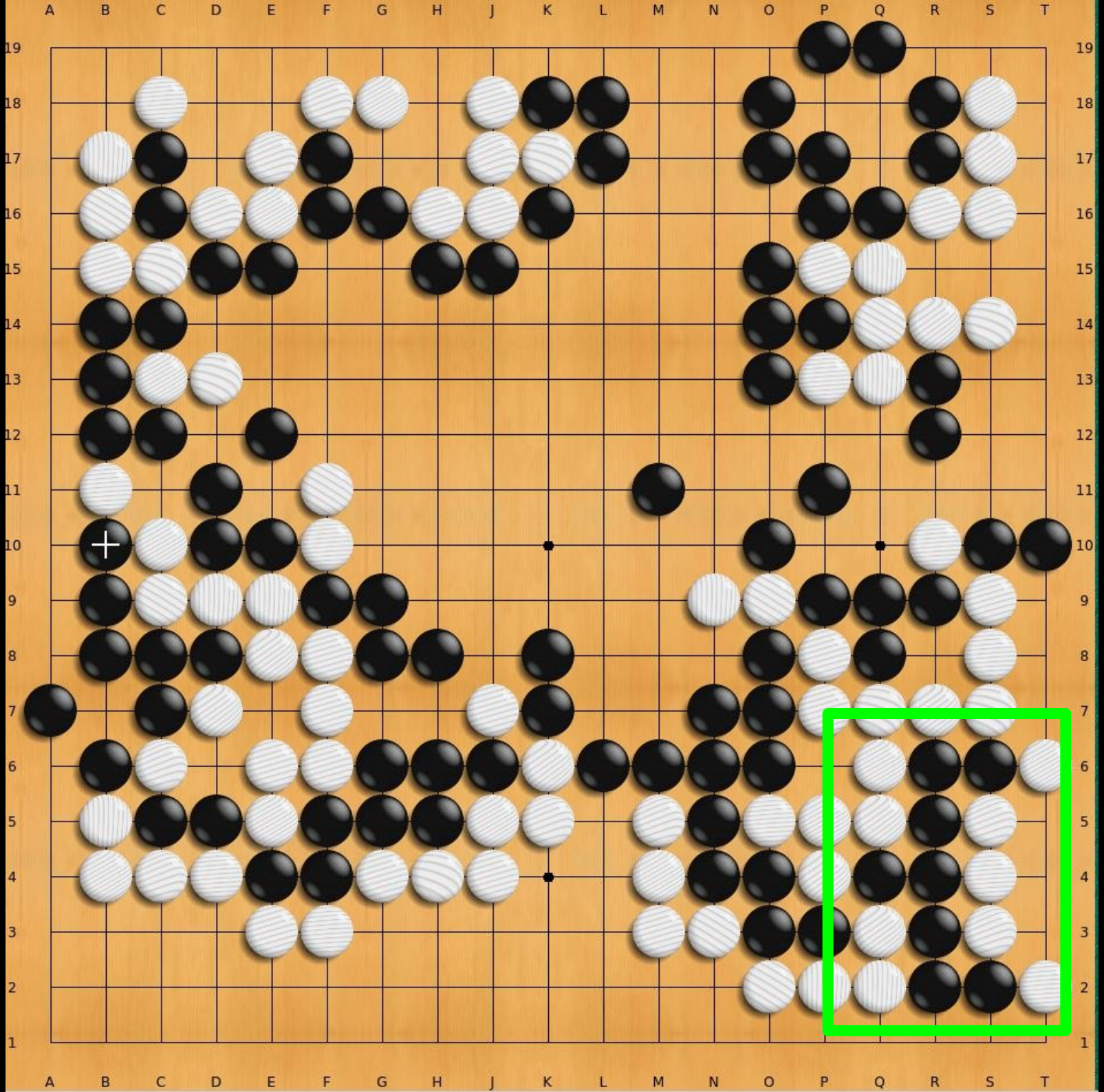
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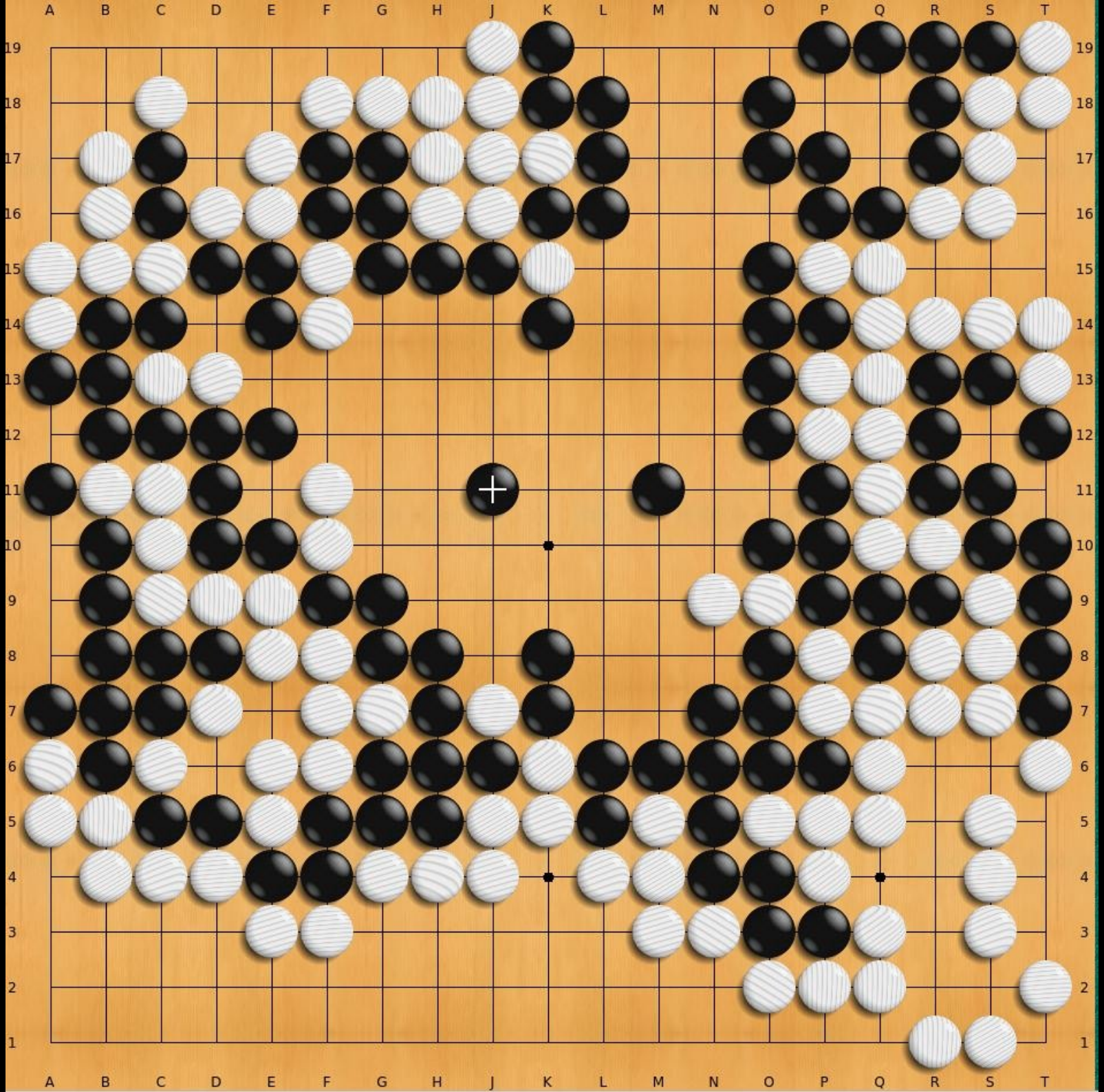
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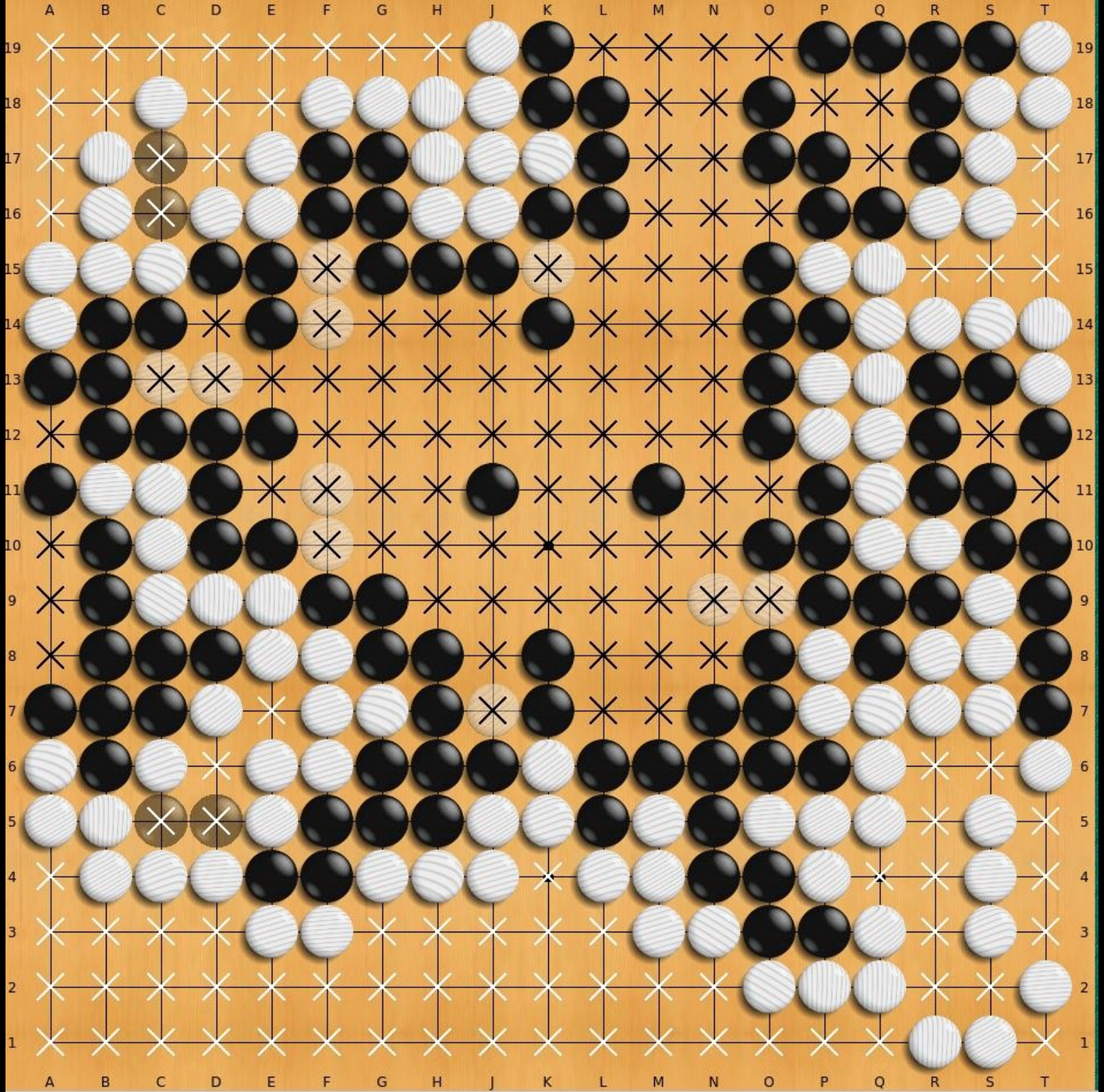
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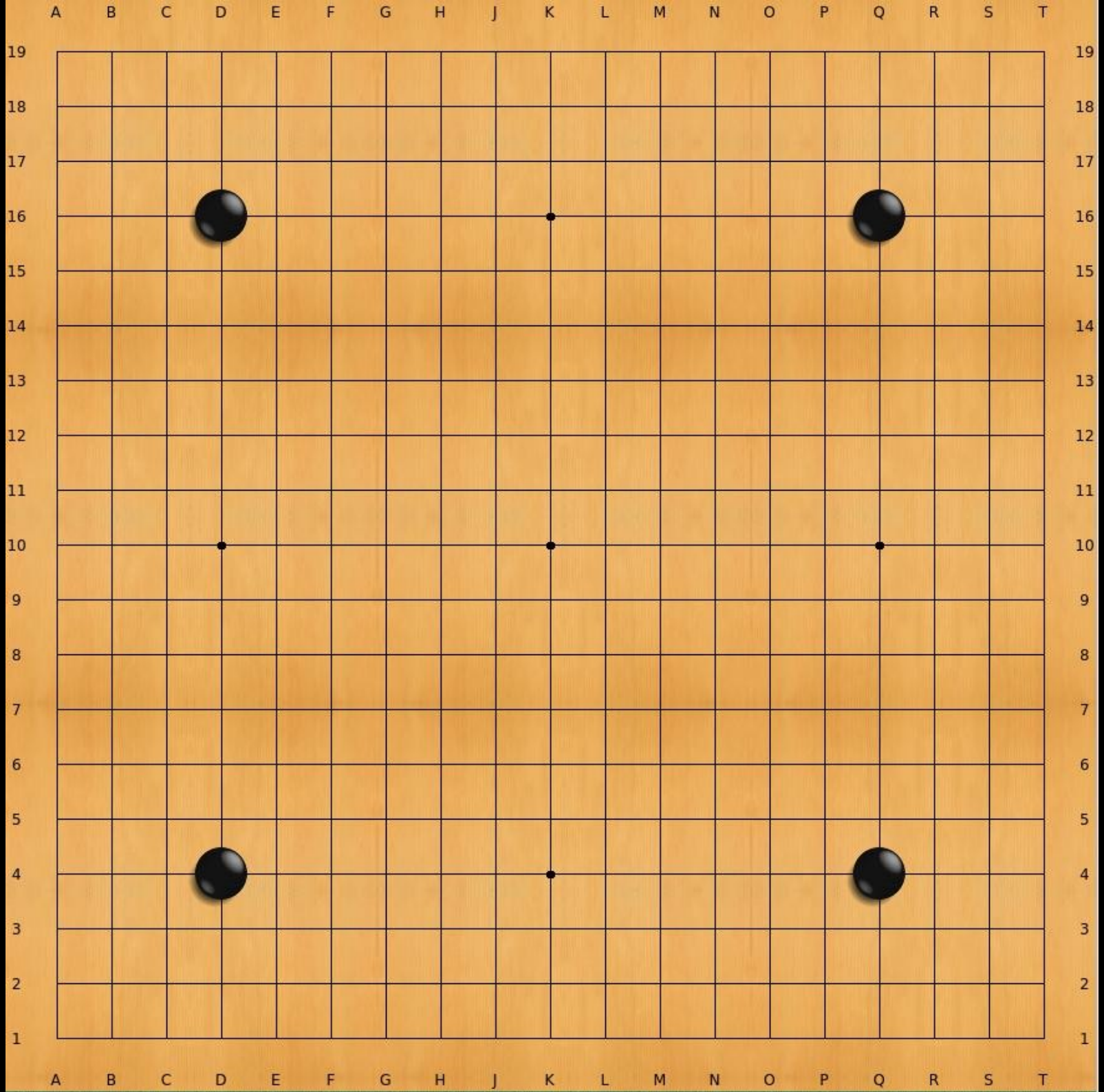
Go vs. Chess

Complex vs. Complicated

*„While the Baroque rules of **chess could only have been created by humans**, the rules of **go** are so elegant, organic, and rigorously logical that **if intelligent life forms exist** elsewhere in the universe, they almost **certainly play go**.“*

Edward Lasker (chess grandmaster)

Range	Stage
30k-20k	Beginner
19k-10k	Casual Player
9k-1k	Intermediate Amateur
1d-7d	Advanced Amateur
1p-9p	Professional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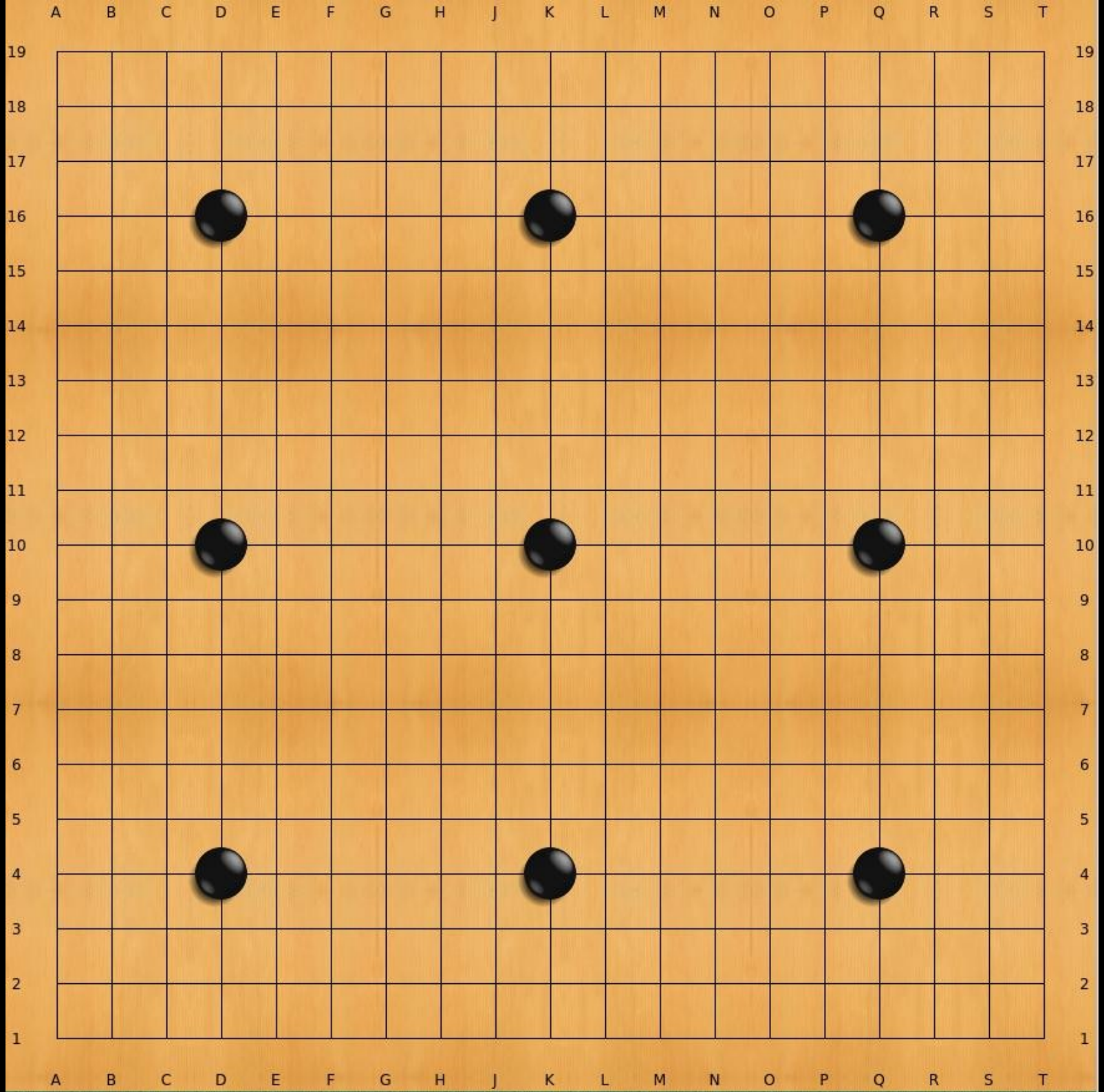
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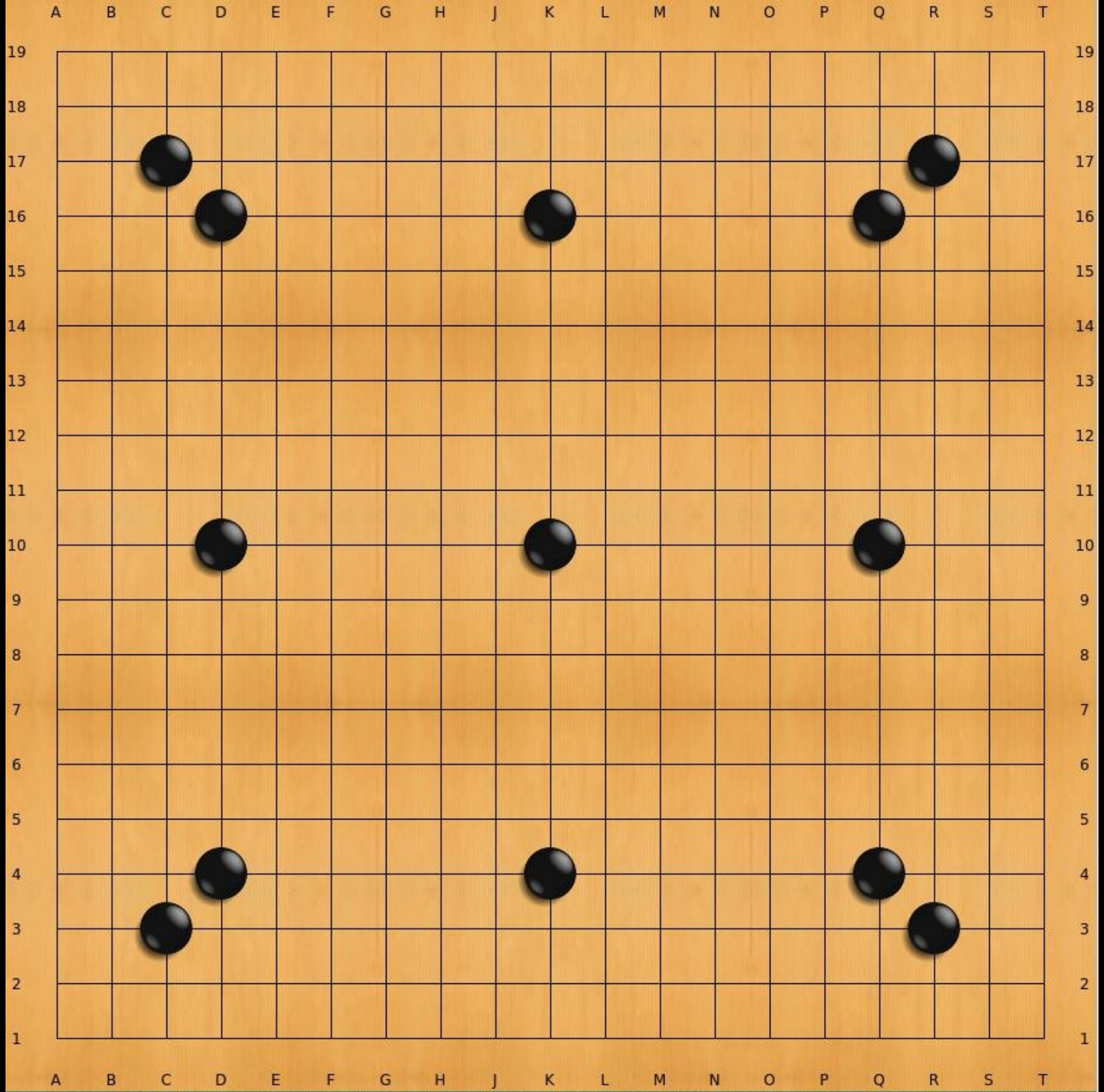
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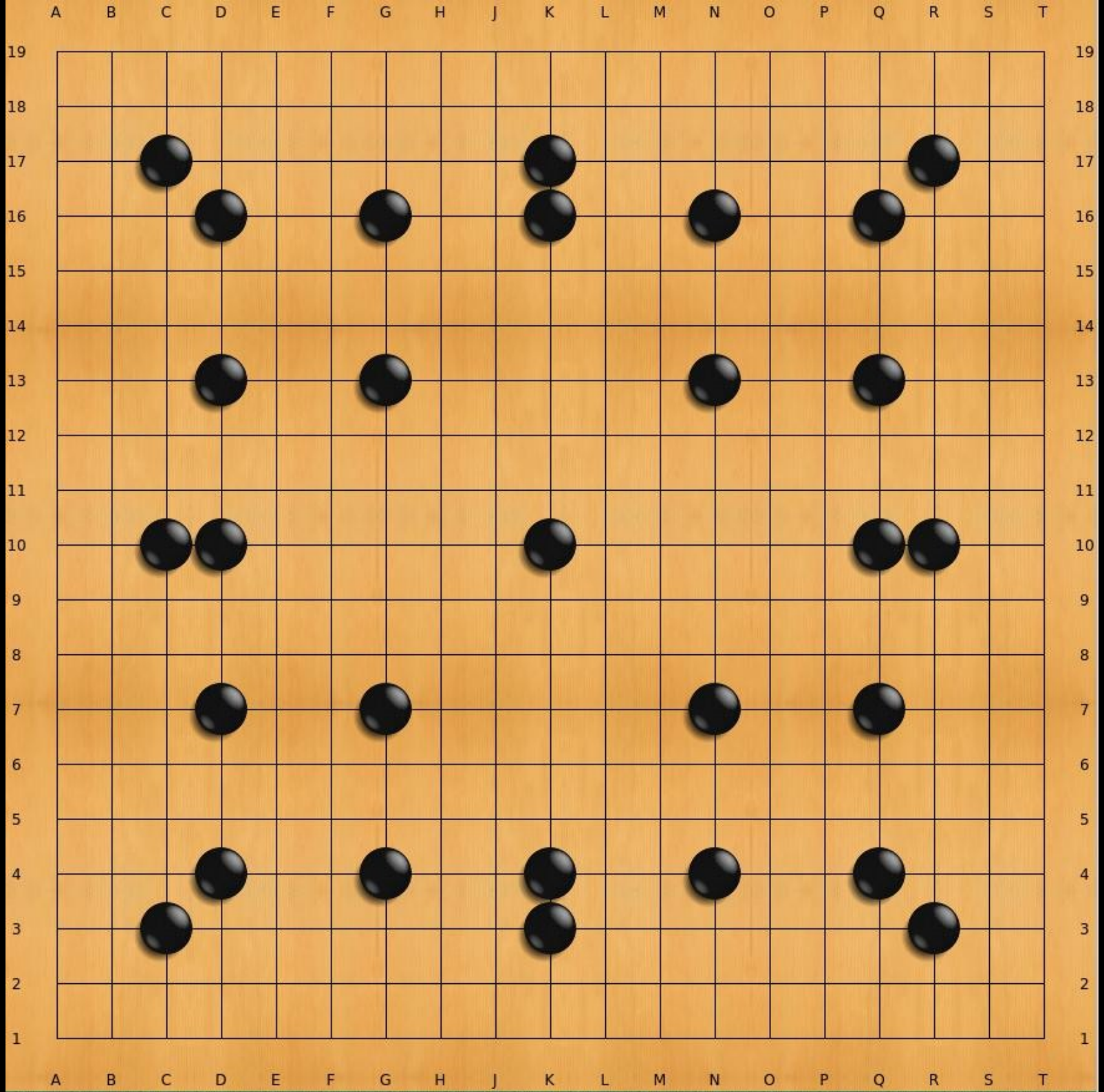
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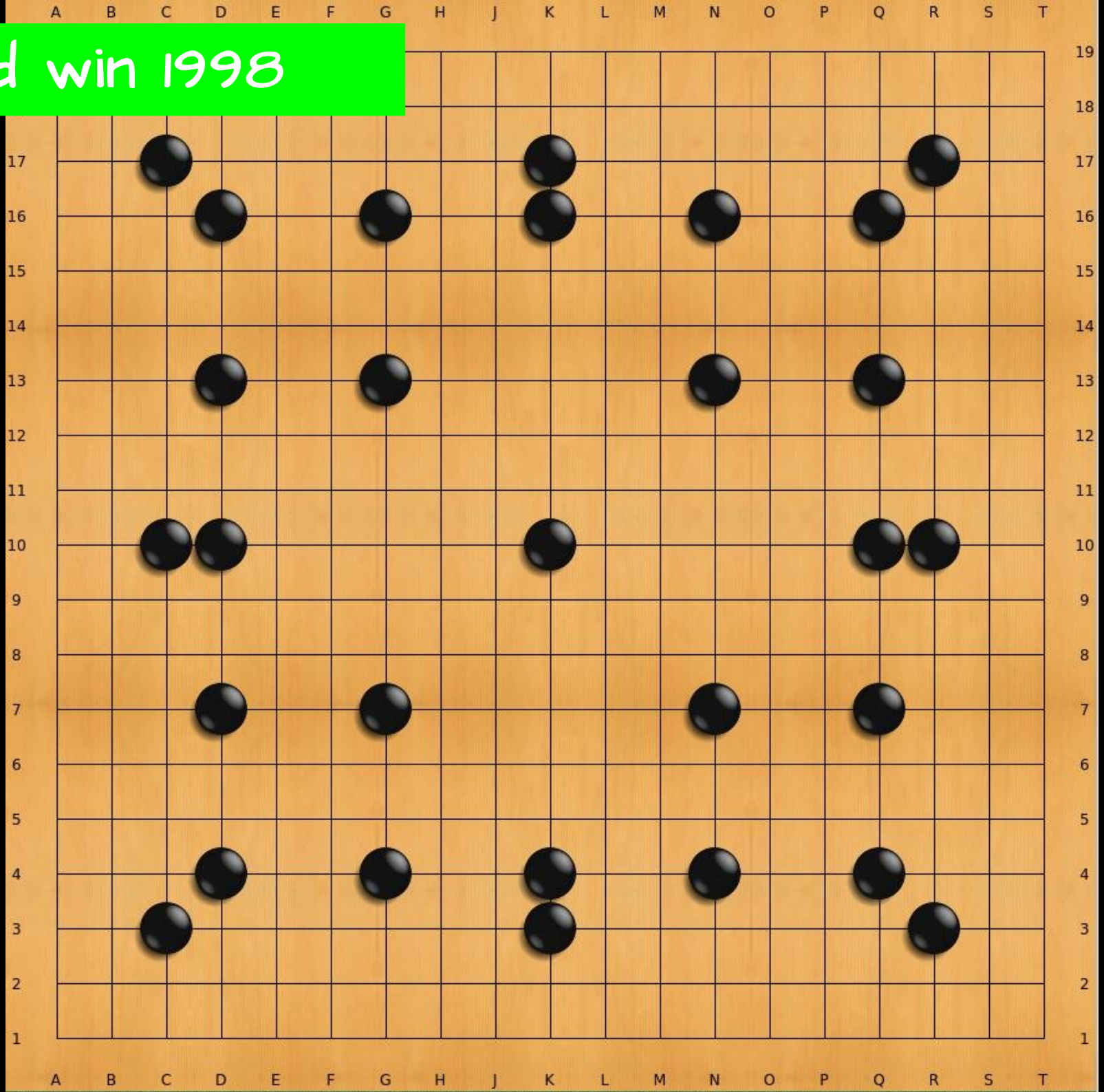
5d win 1998



Why is Go so hard?

Larger board

19x19 vs. 8x8

Almost every move is legal

Average branching factor:

250 vs 35

State Space Complexity:

10^{171} vs 10^{47}


10^{80}
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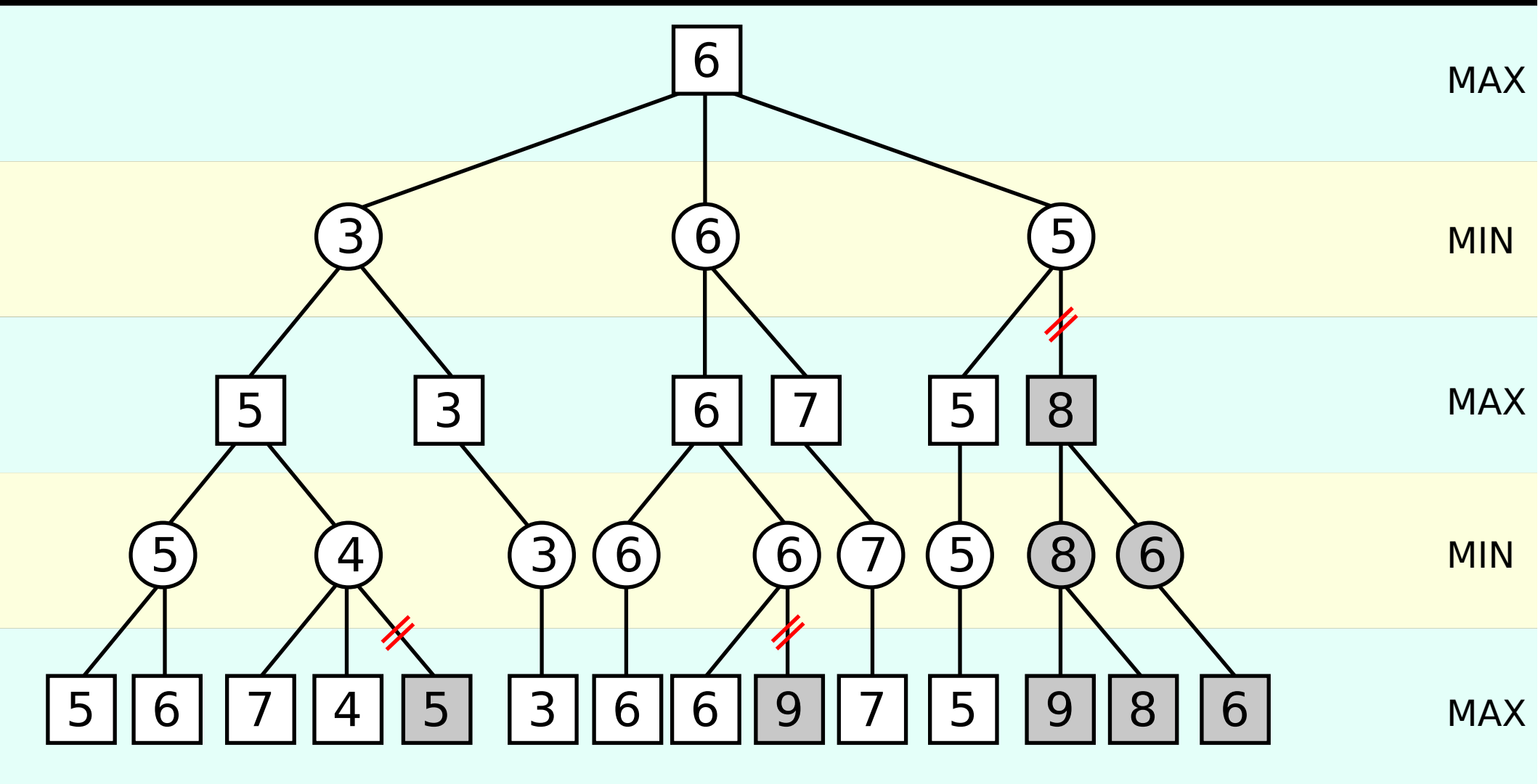
Global impact of moves


Artifical Intelligence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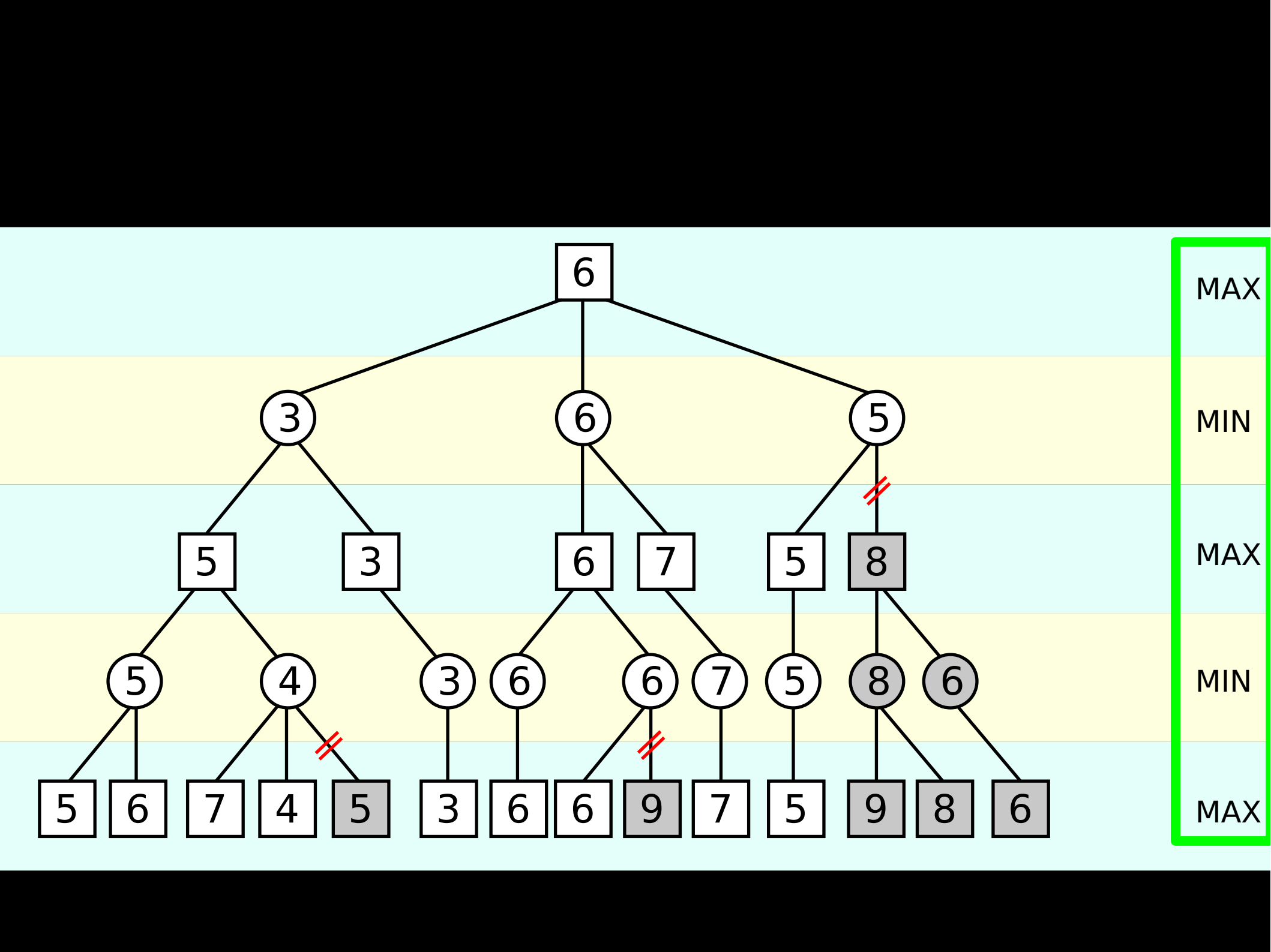
MAX
MIN
MAX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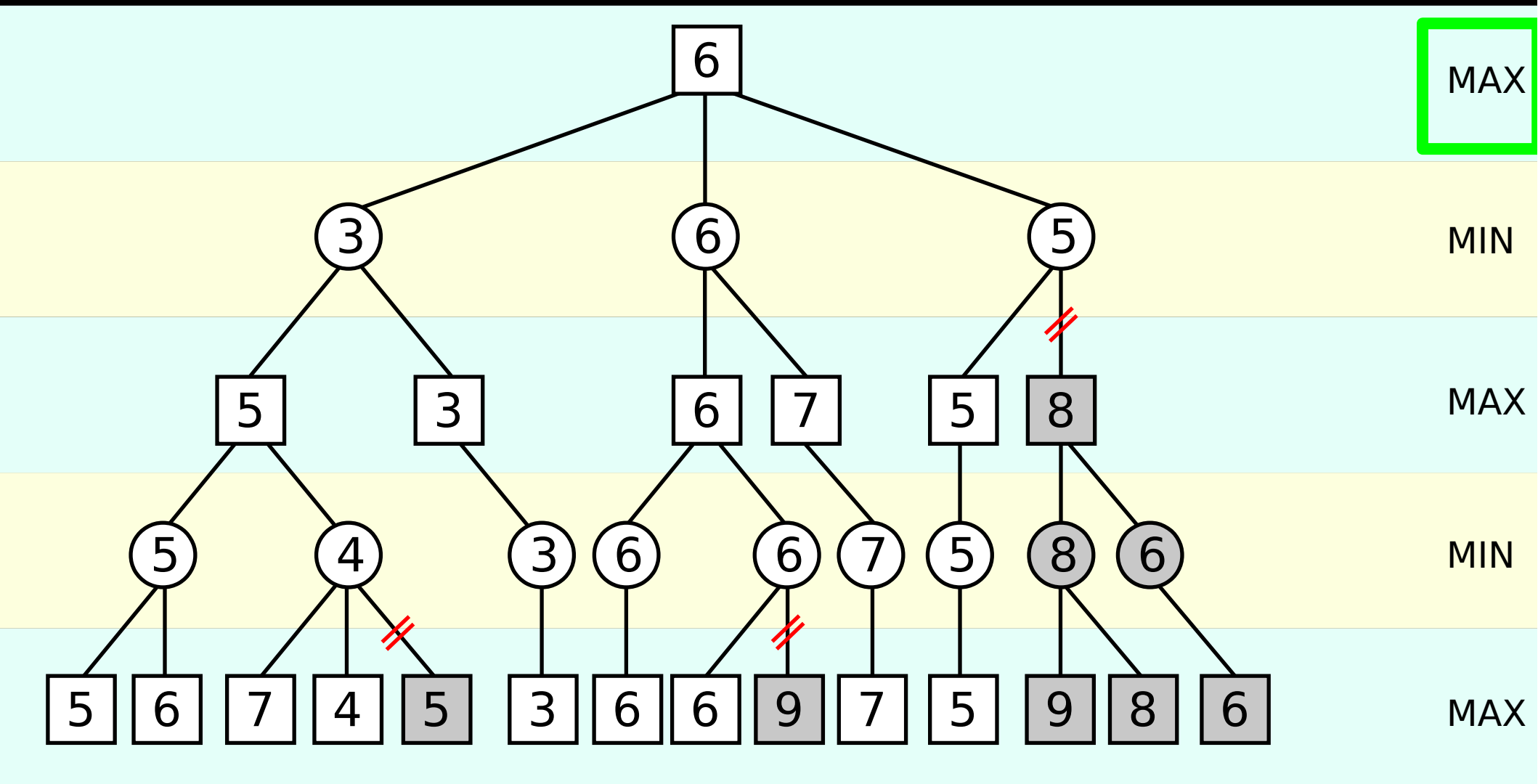
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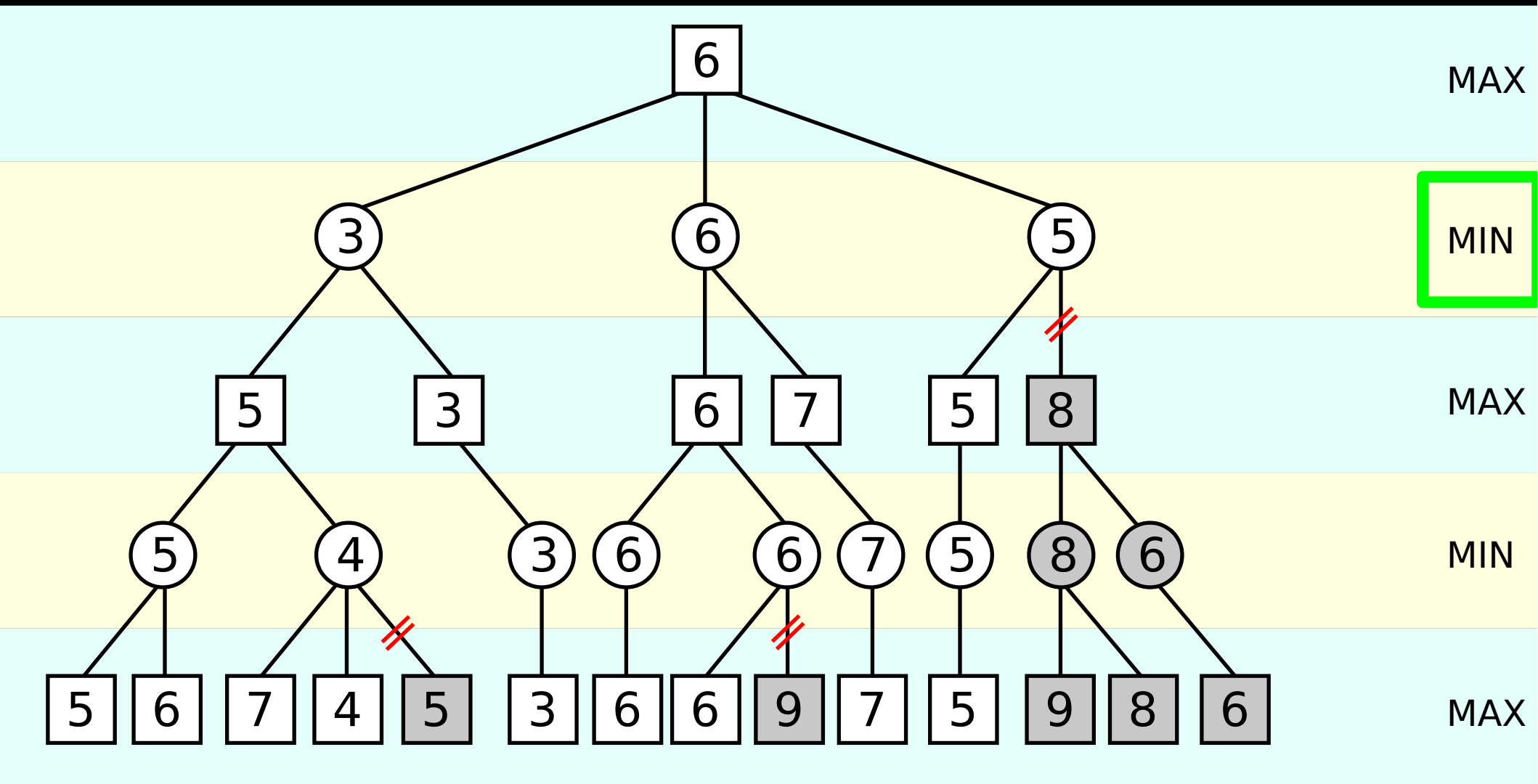
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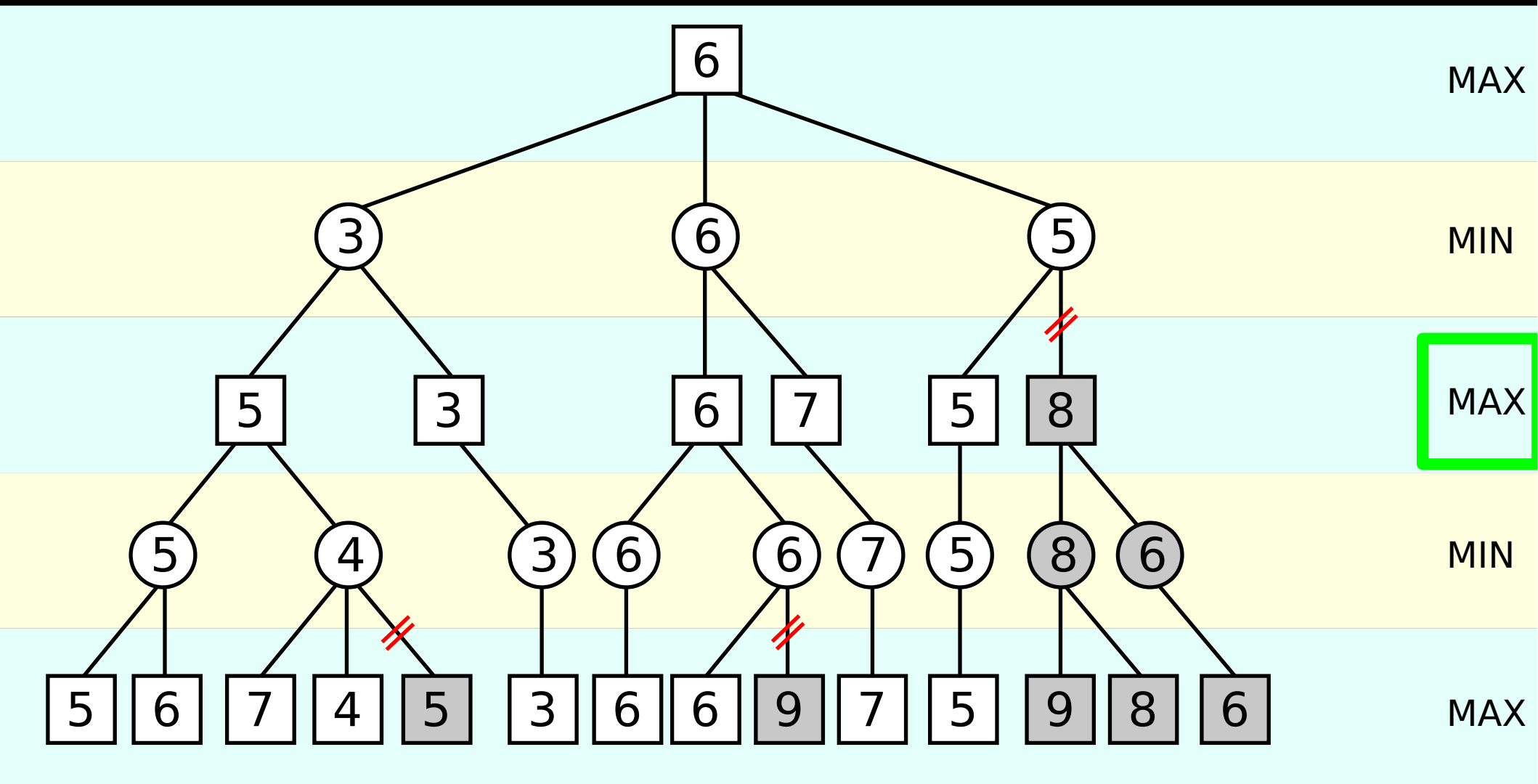
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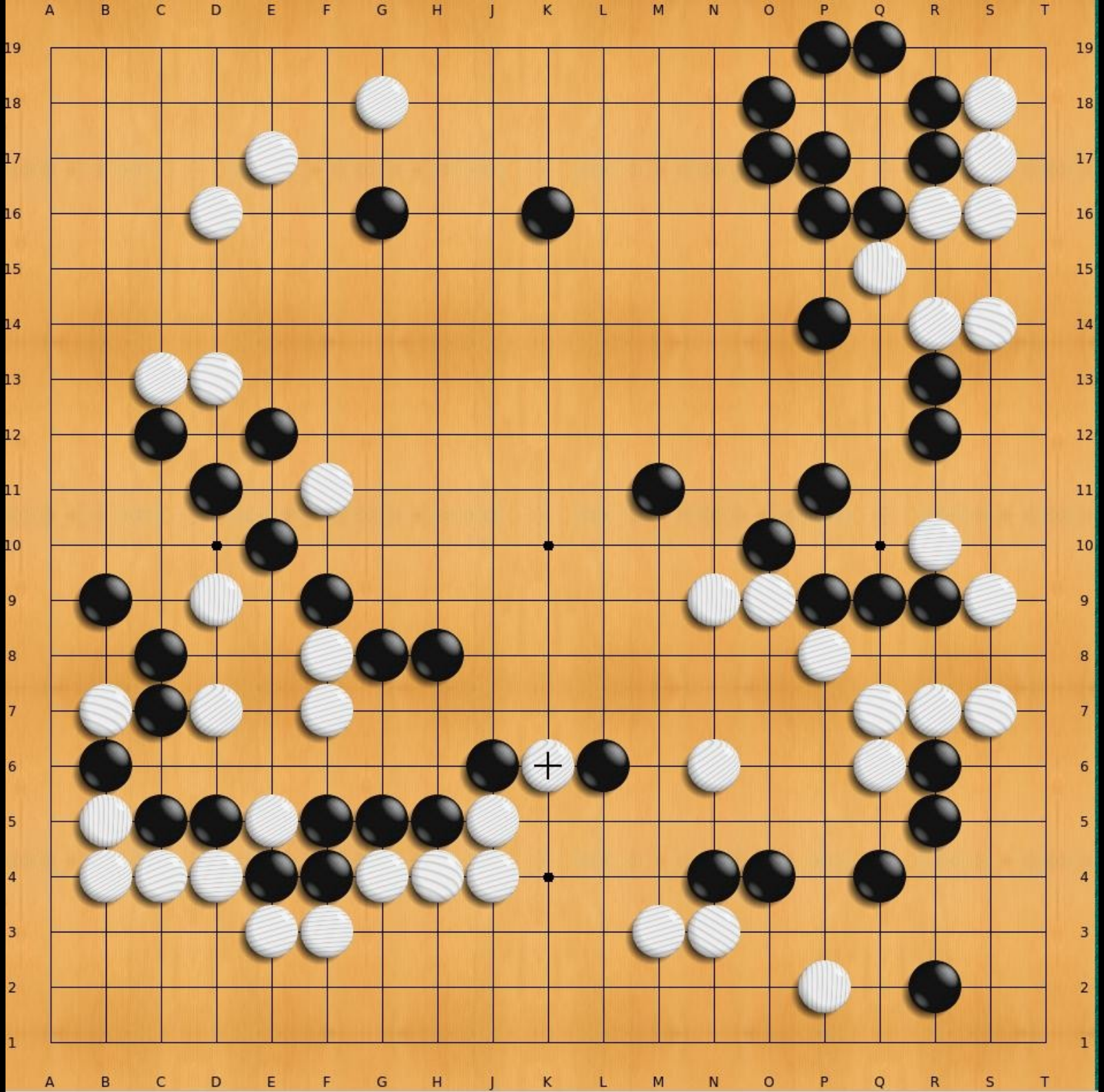
MIN
MAX
MIN
MAX

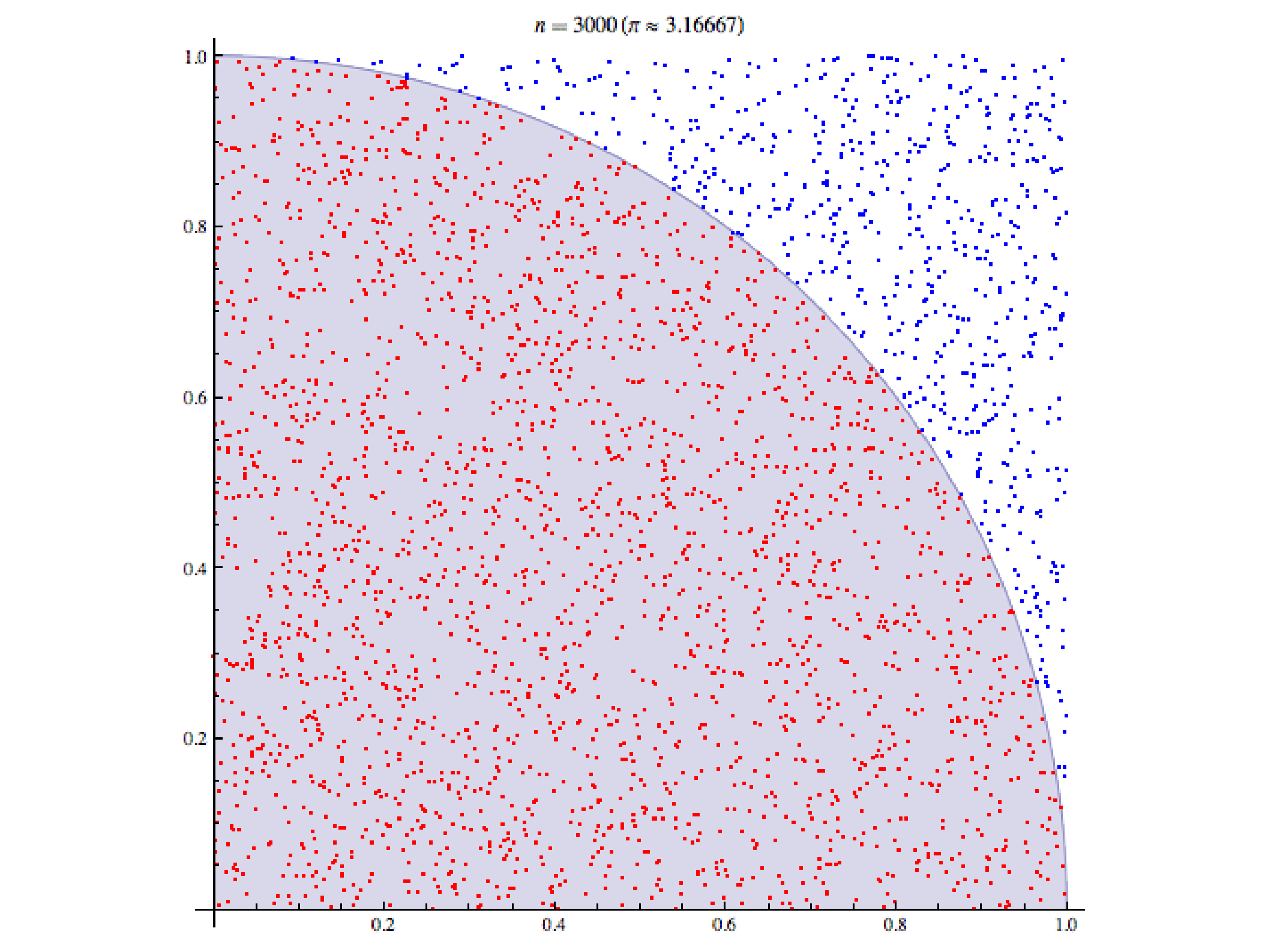
Evaluation function


A B C D E F G H J K L M N O P Q R S T
19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

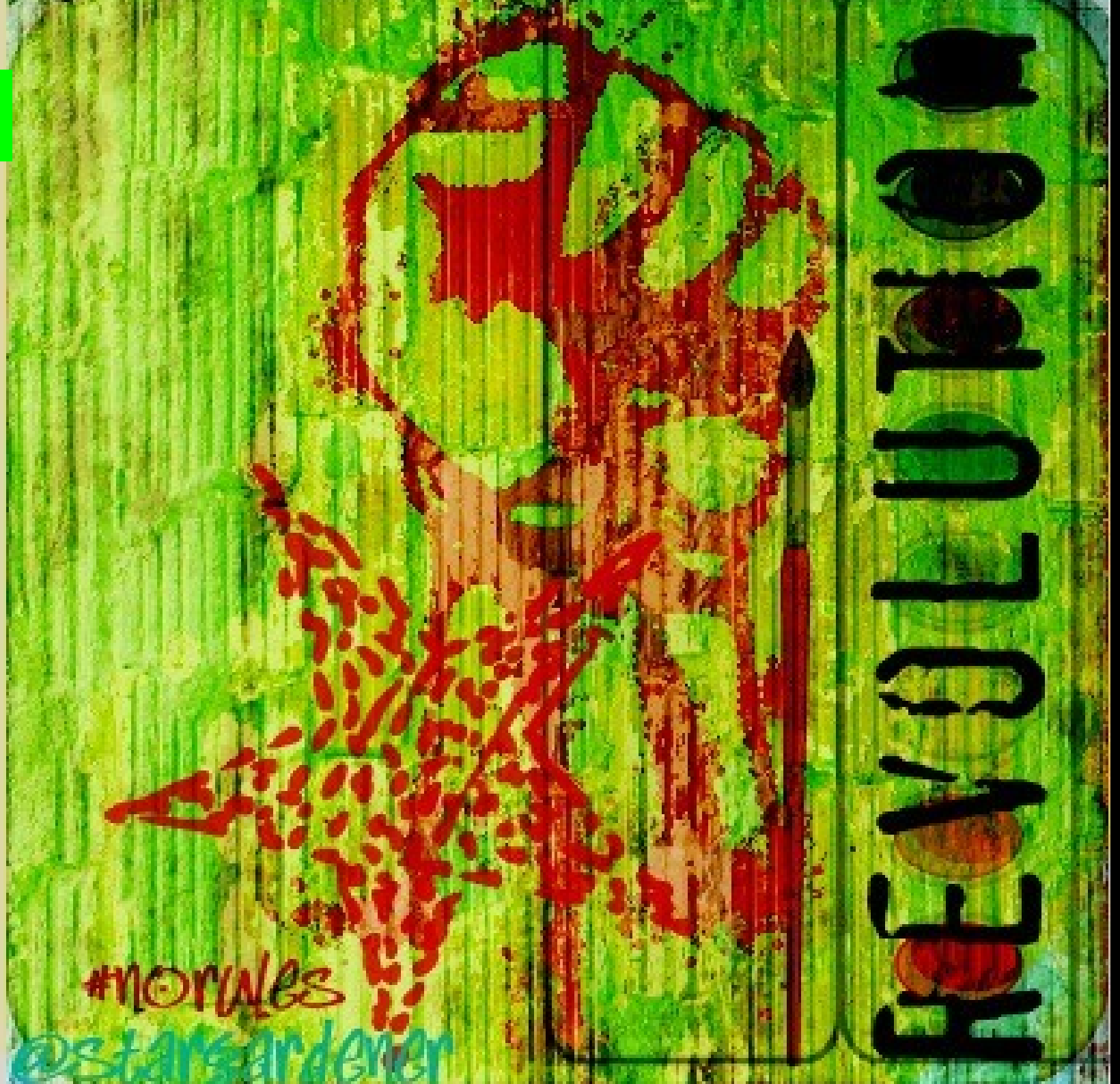

Monte Carlo Method

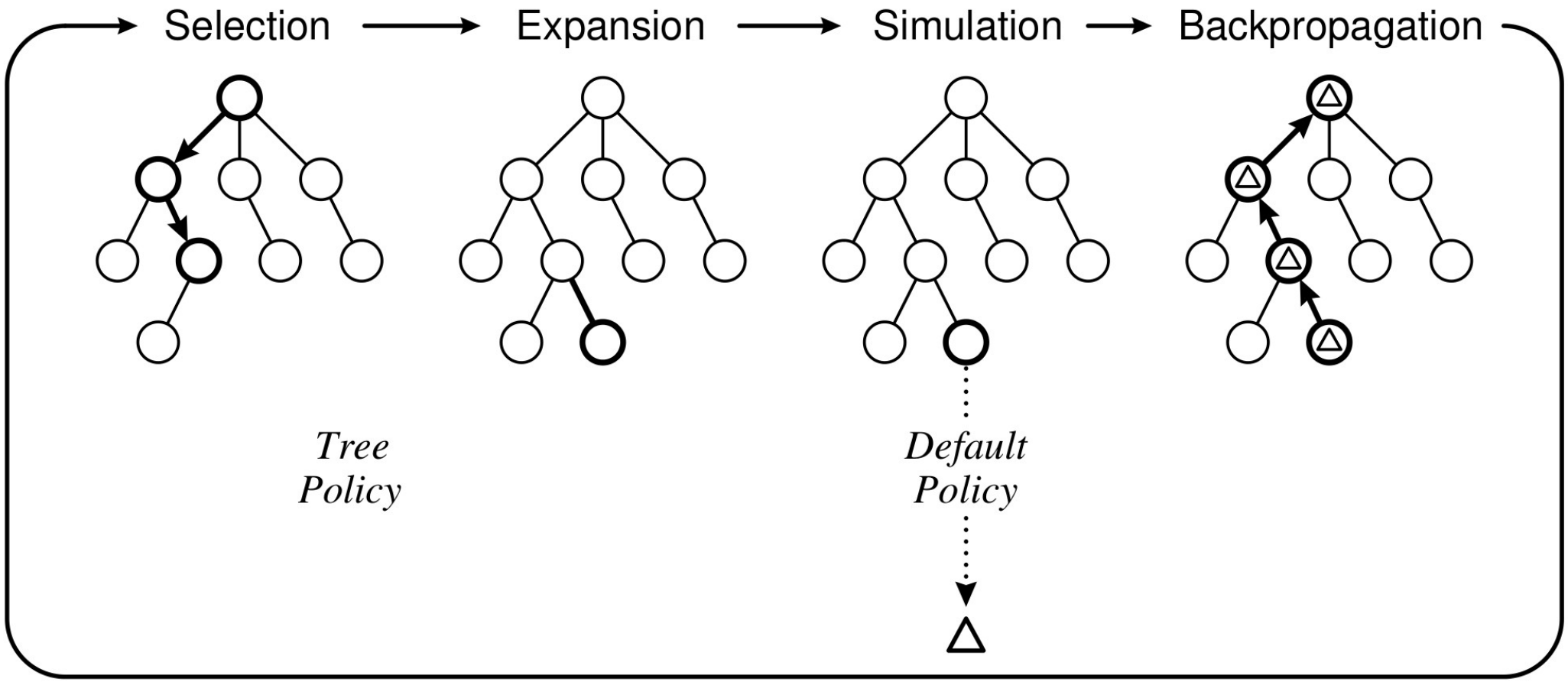
What is Pi?

How do you determine Pi?

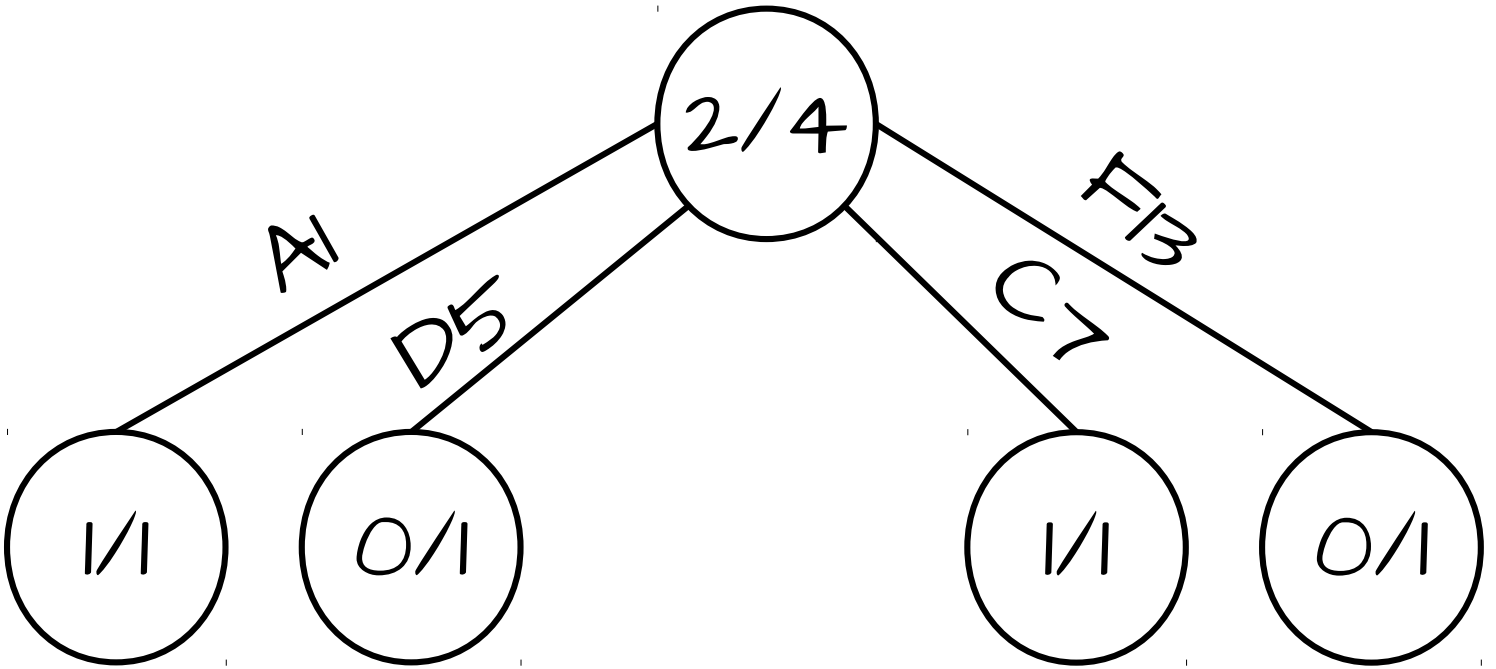

$n = 3000\ (\pi \approx 3.16667)$
1.0
0.8
0.6
0.4
0.2
0.2
0.4
0.6
0.8
1.0

2006

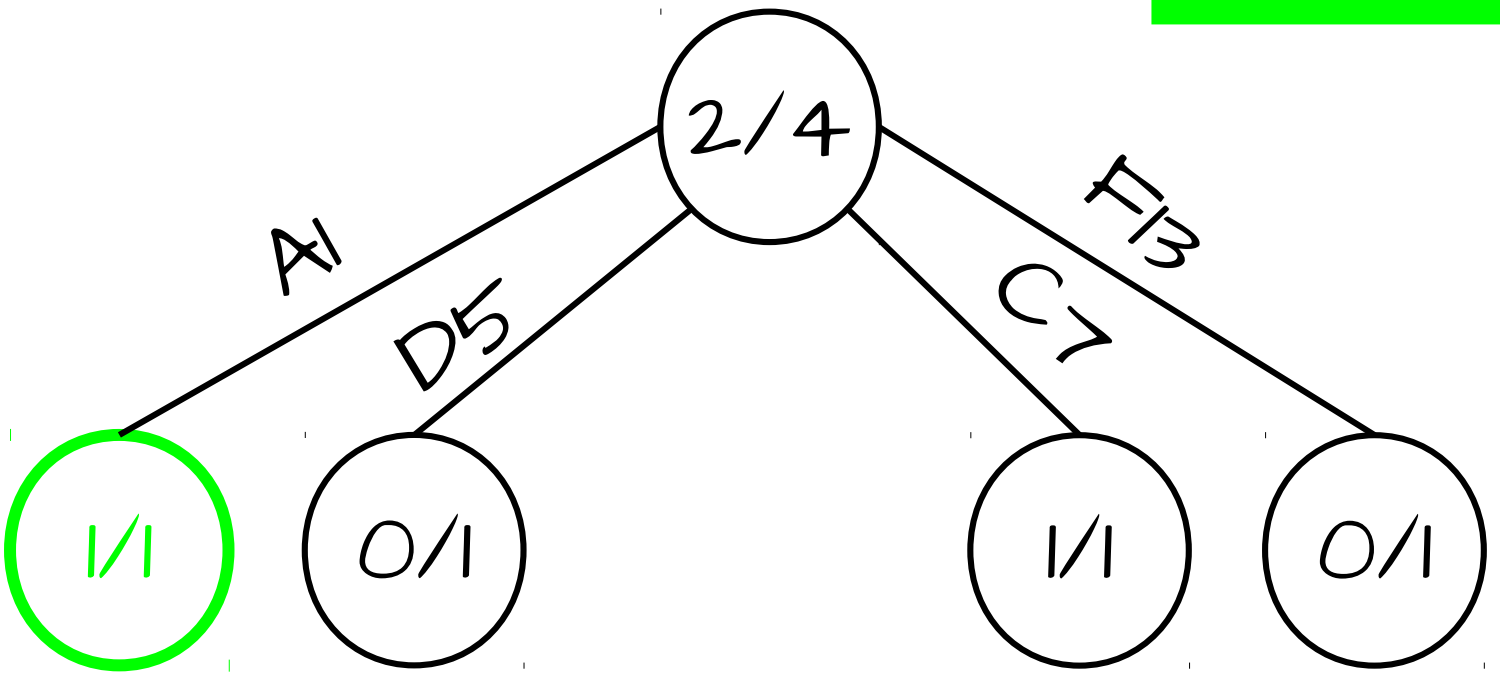




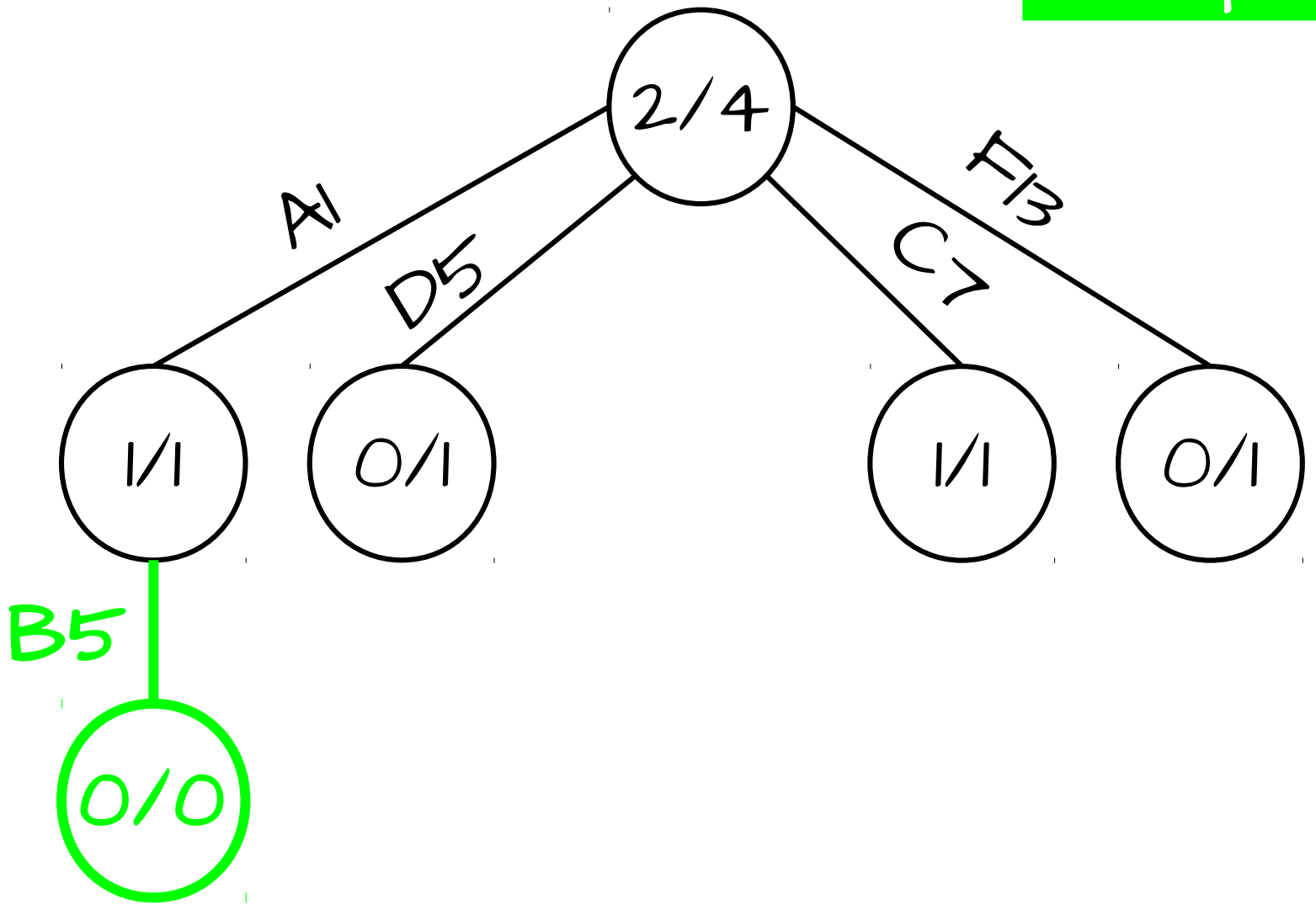
Browne, Cb, and Edward Powley. 2012. A survey of monte carlo tree search methods. Intelligence and AI 4, no. 1: 1-49


2/4
A1
D5
C7
F13
1/1
0/1
1/1
0/1

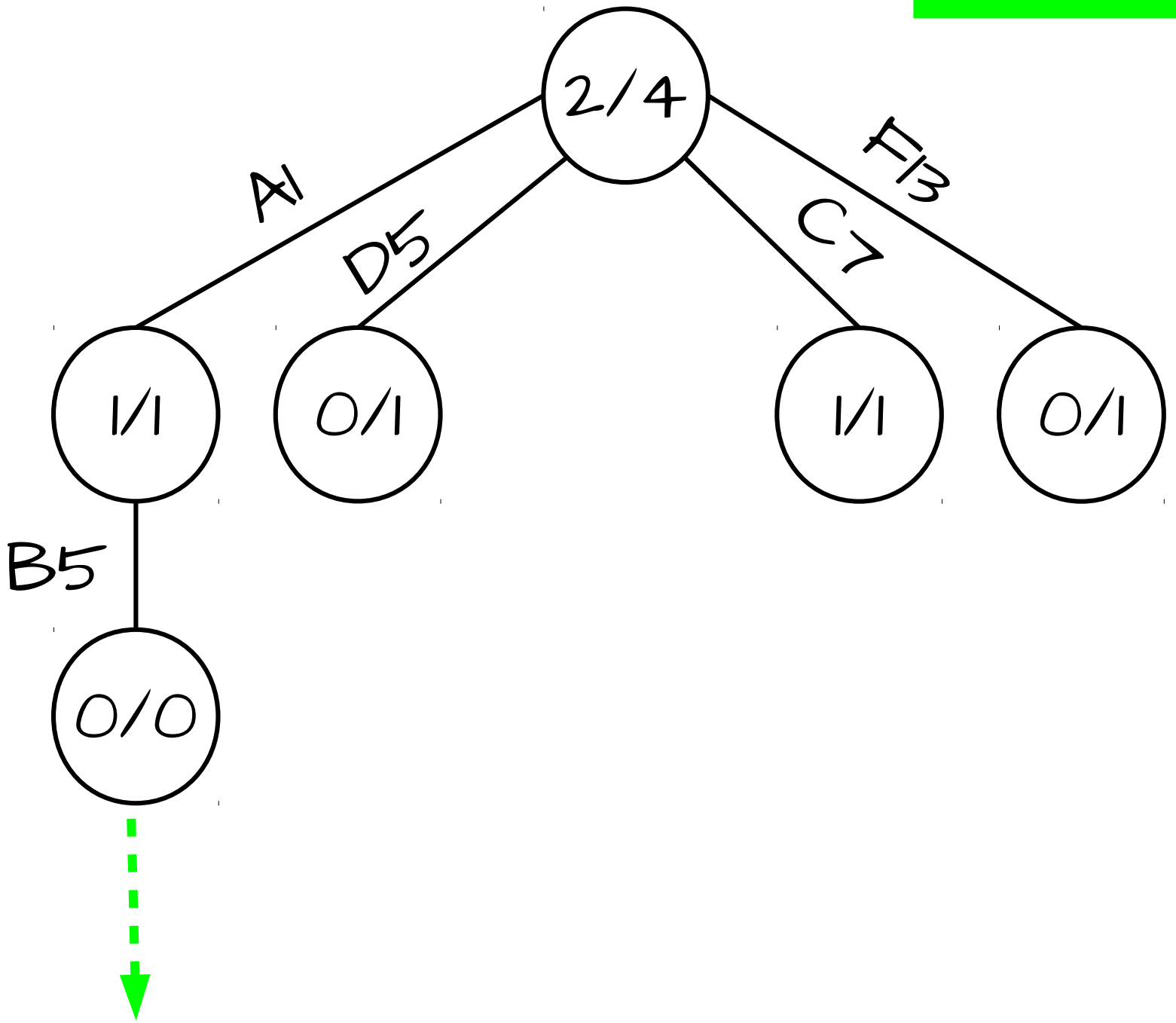
Selection



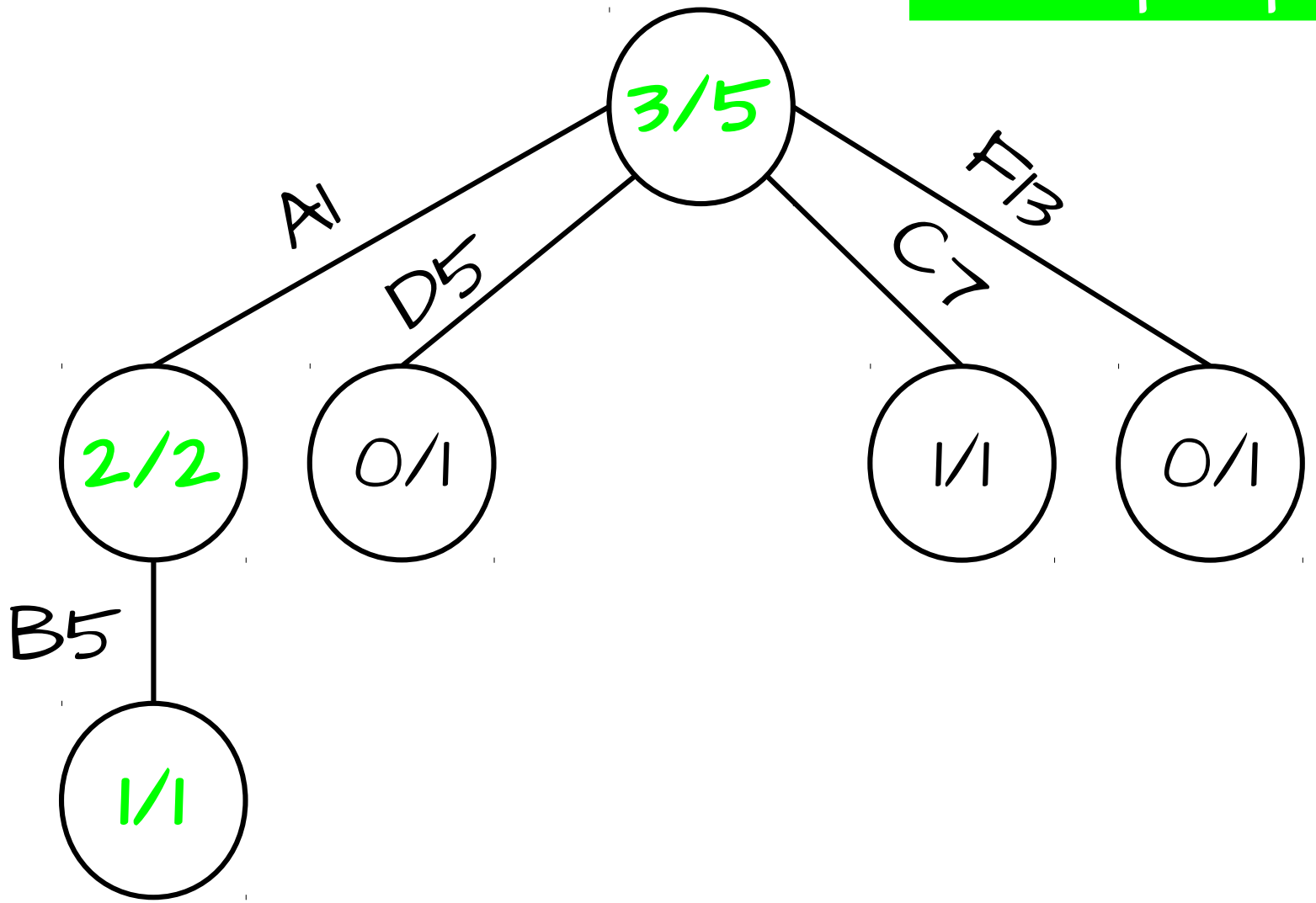
Expansion



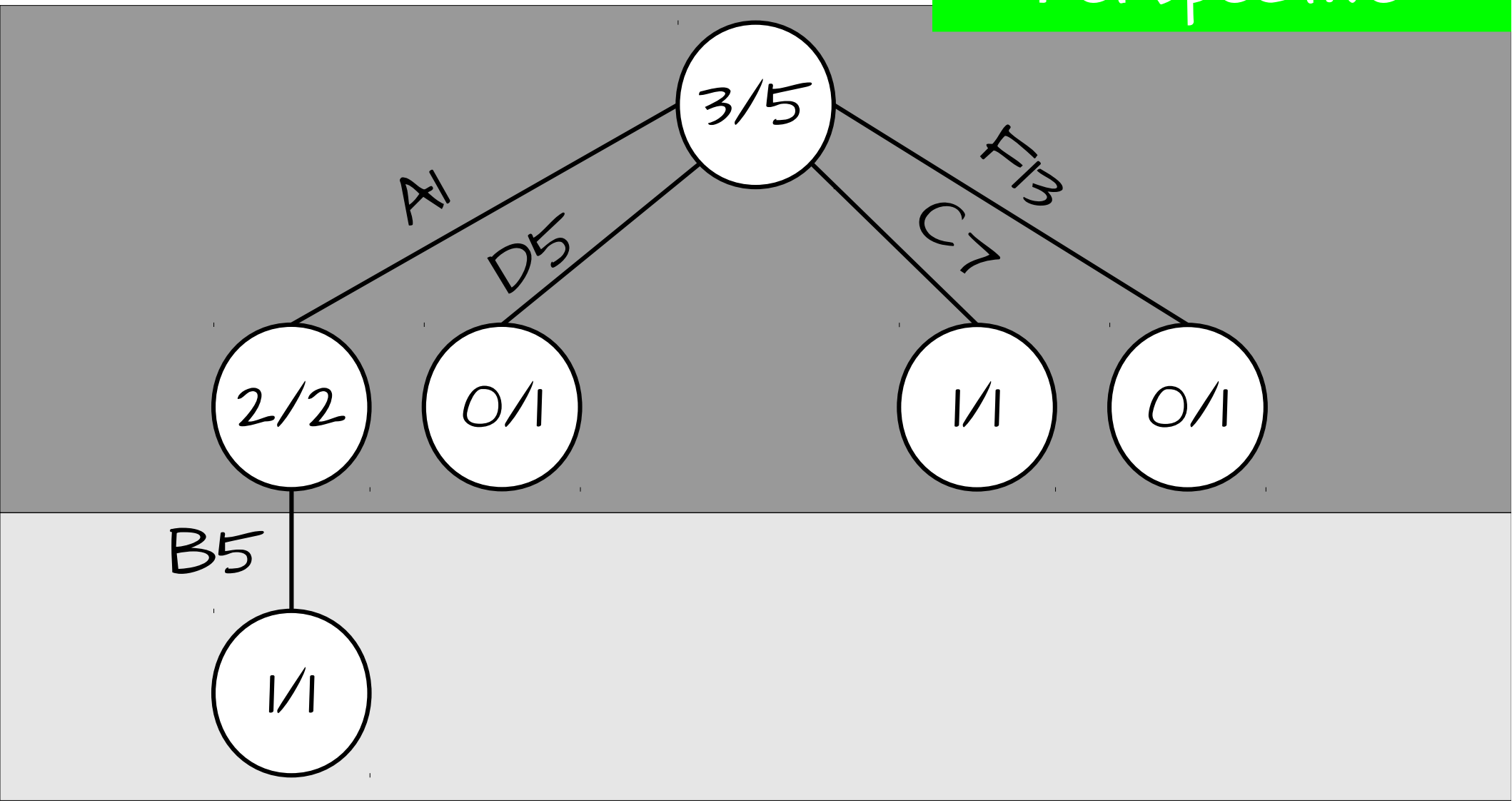
Simulation



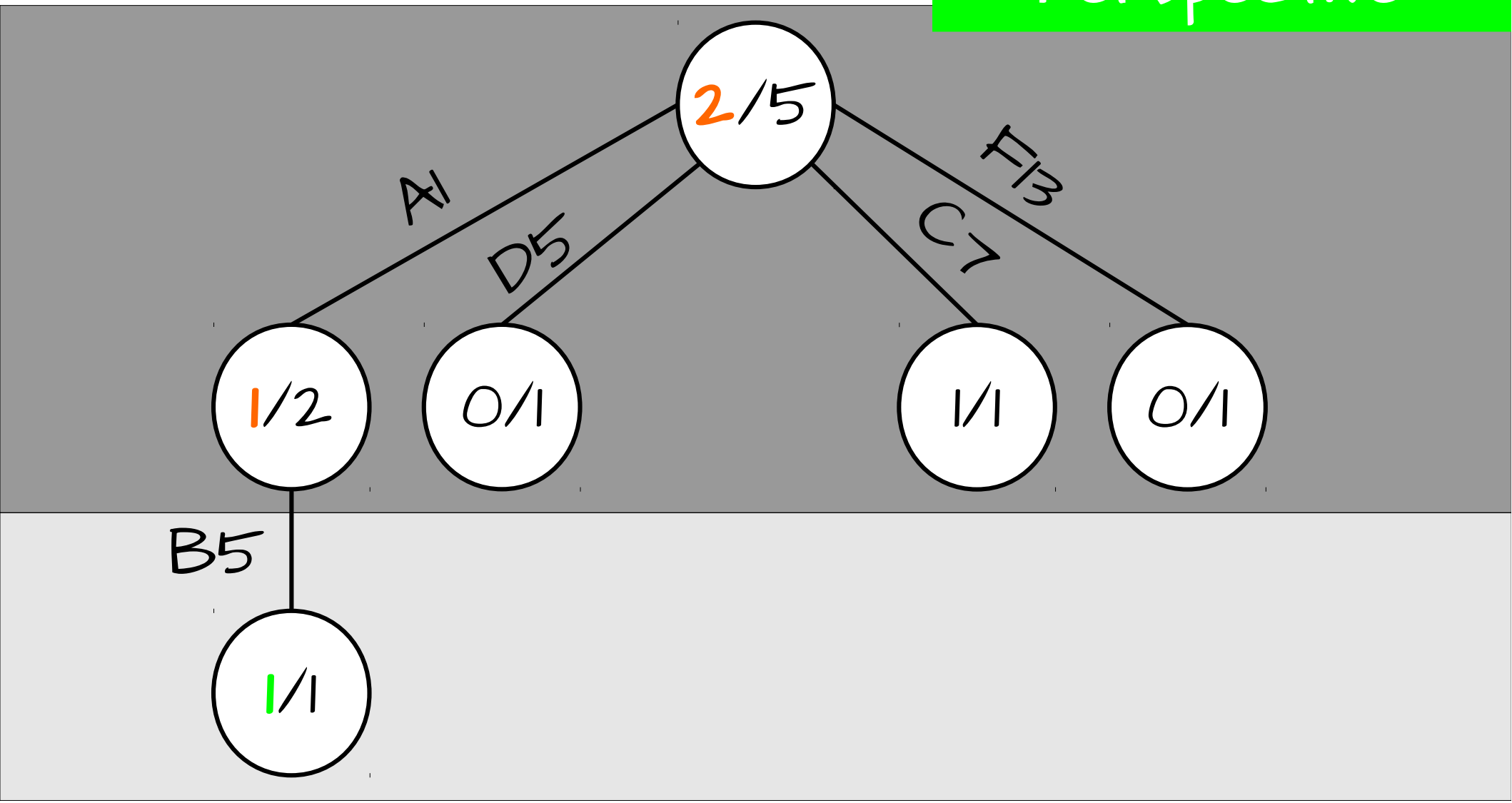
Backpropagation



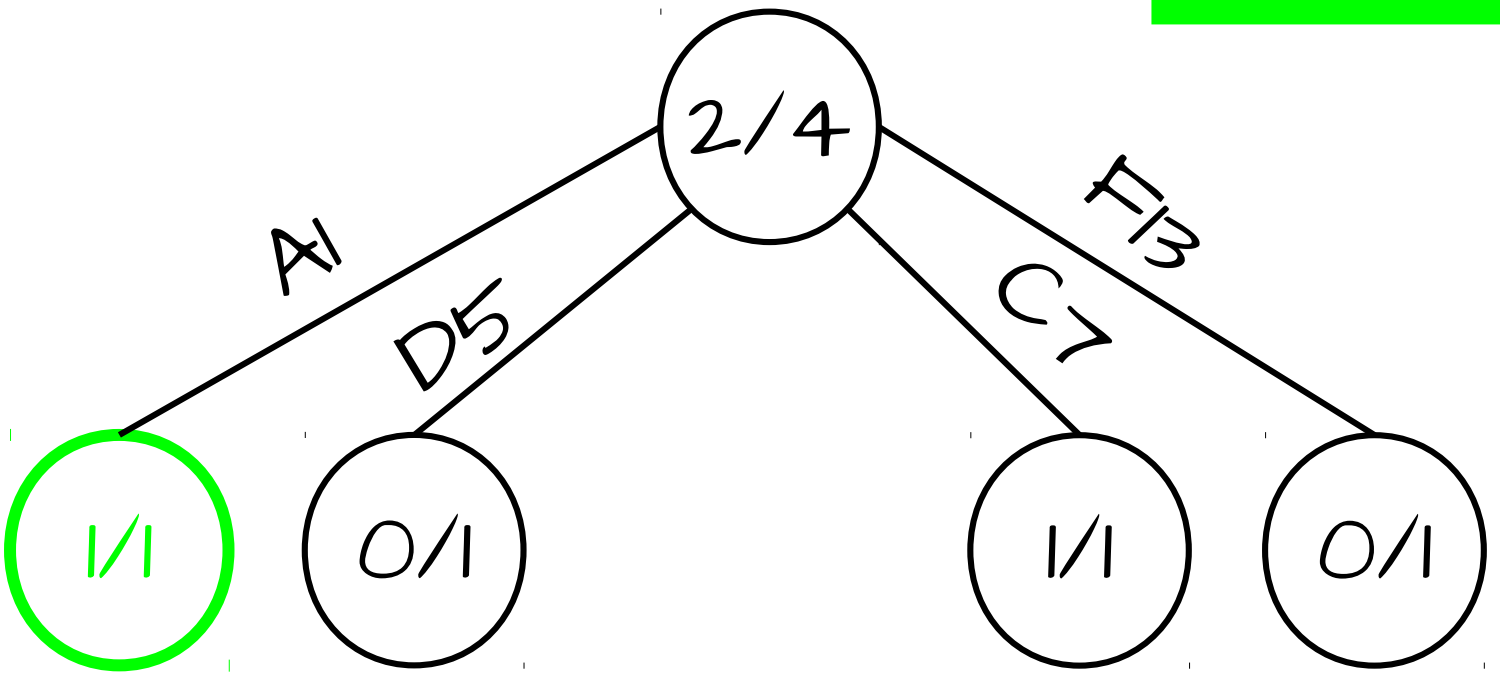
Perspective



Perspective



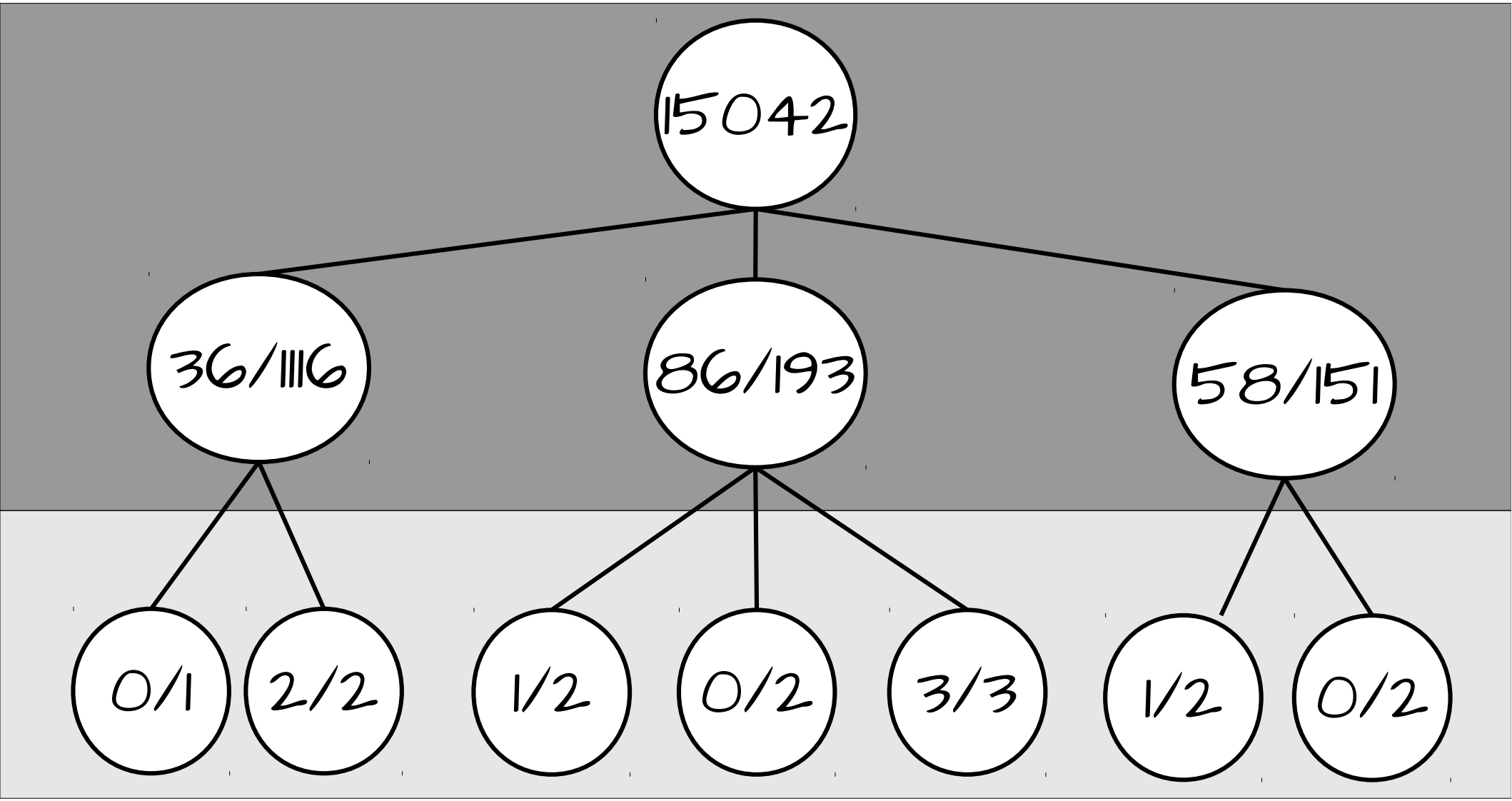
Selection




Multi Armed Bandit
LittleRed
WITH NUDGING WILDS !
SPARTACUS
GLADIATOR OF ROME
FORBIDDEN DRAGONS
WMS

Exploitation vs Exploration

$$\frac{wins}{visits} + explorationFactor \sqrt{\frac{\ln(totalVisits)}{visits}}$$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3/3
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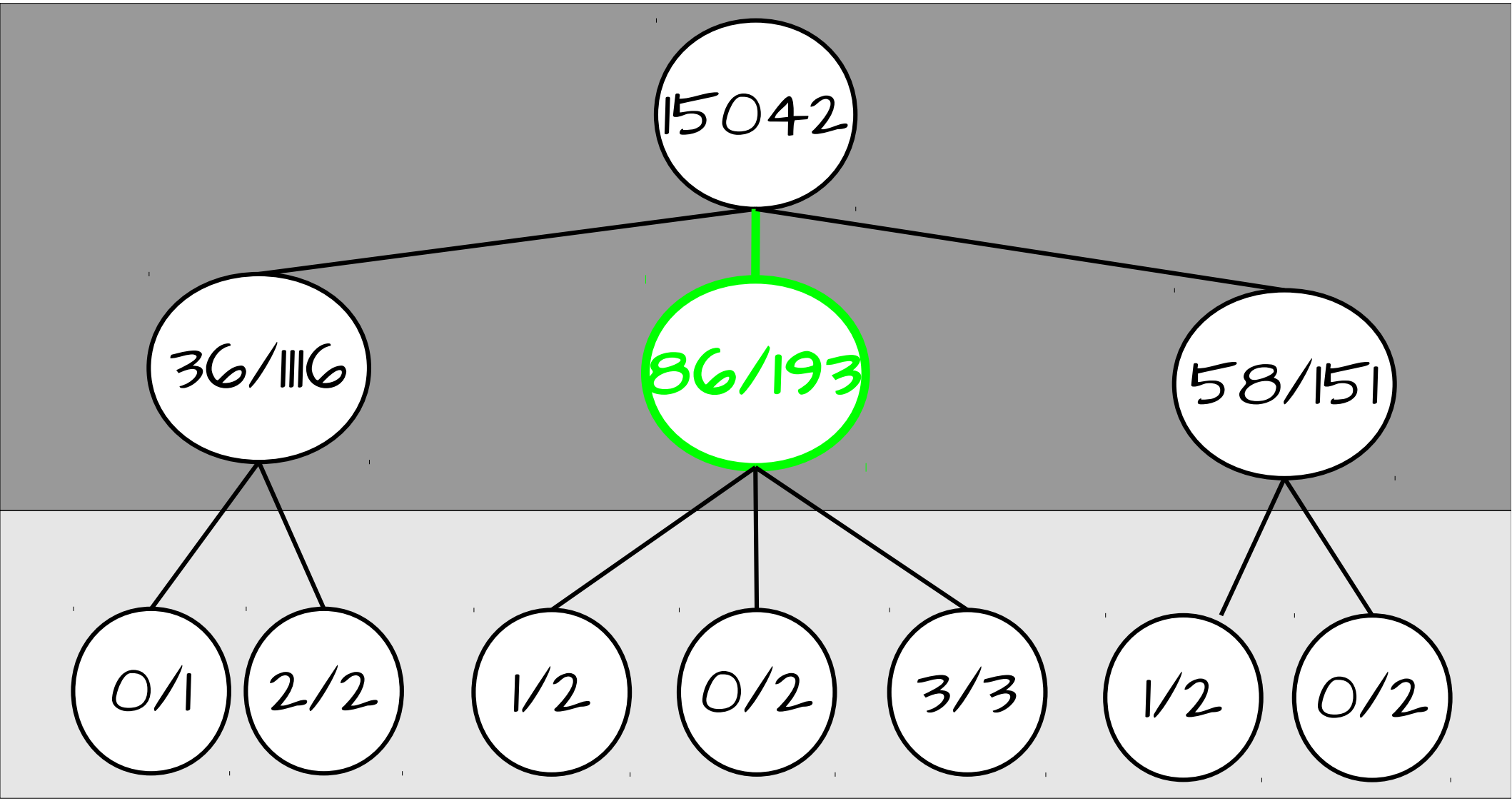
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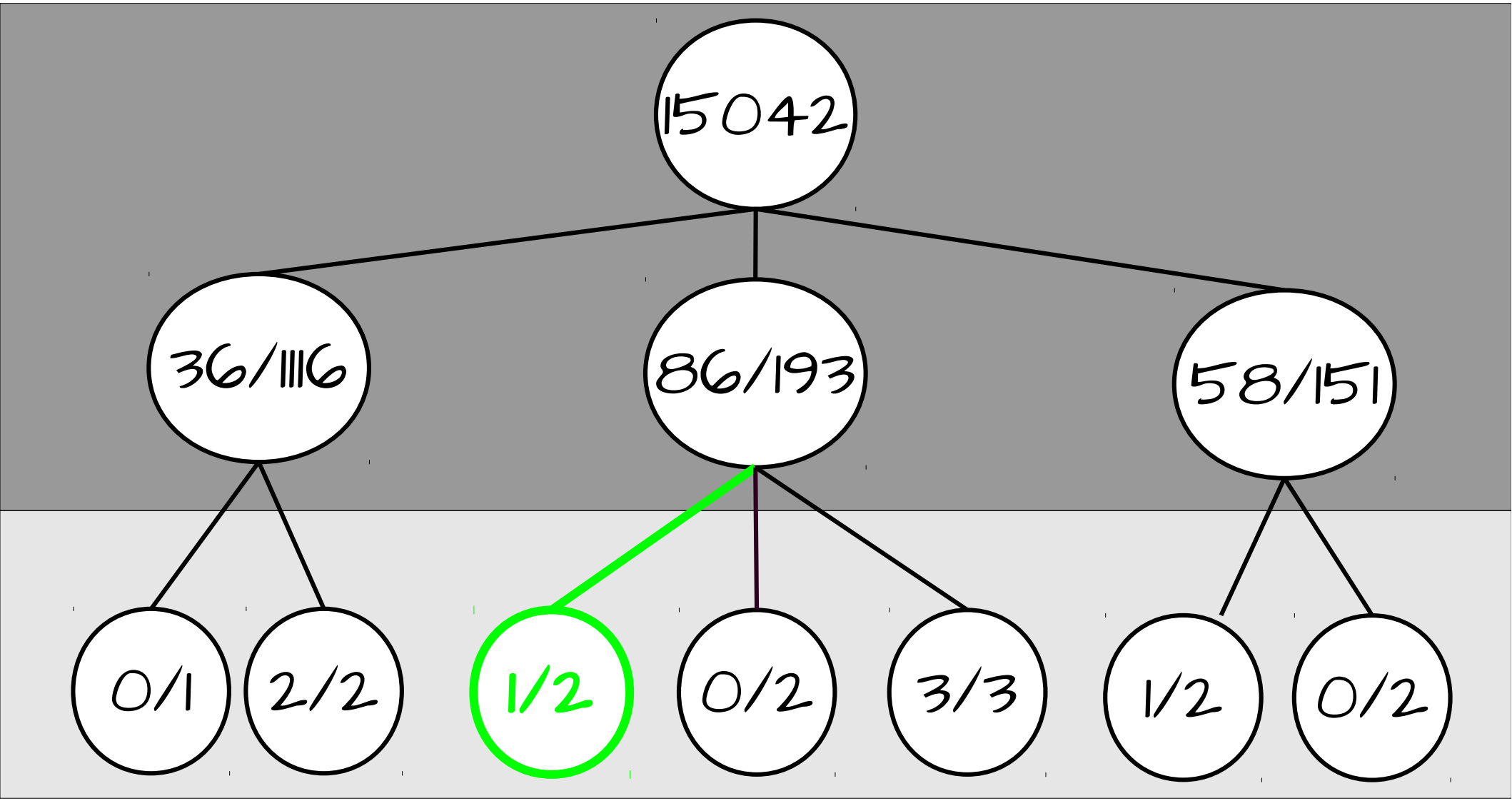
15042
36/1116
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58/151
0/1
2/2
1/2
0/2
3/3
1/2
0/2


Not Human like?
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Characteristics

Aheuristic

Generate a valid random move

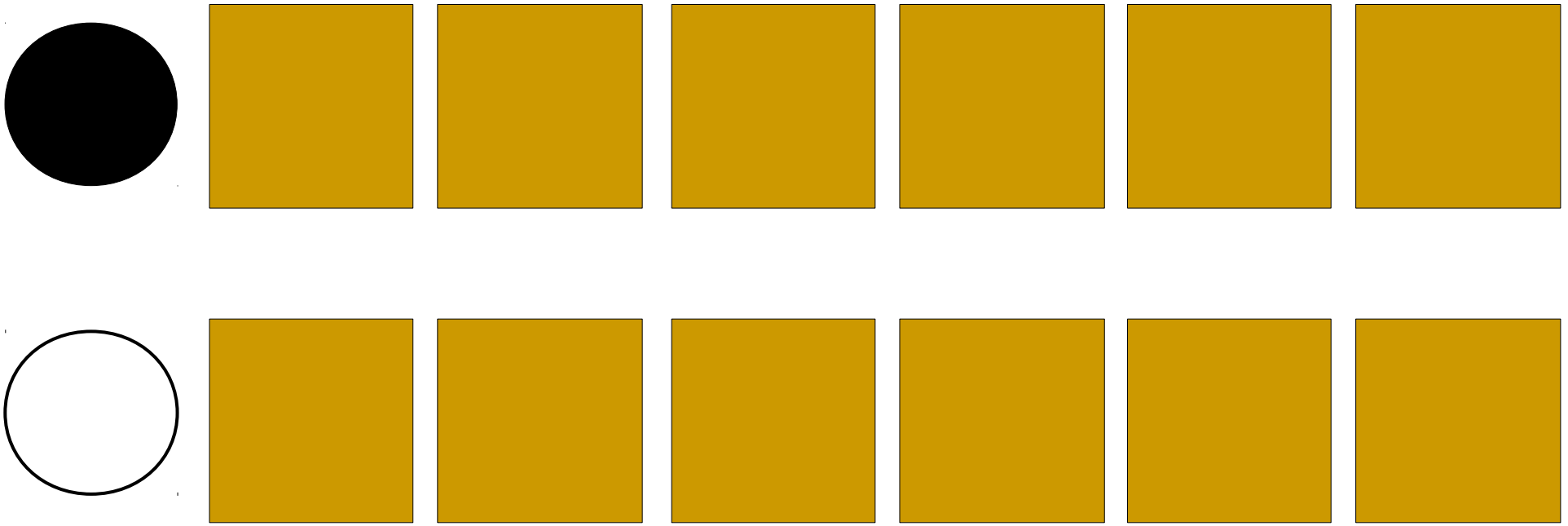
Who has won?

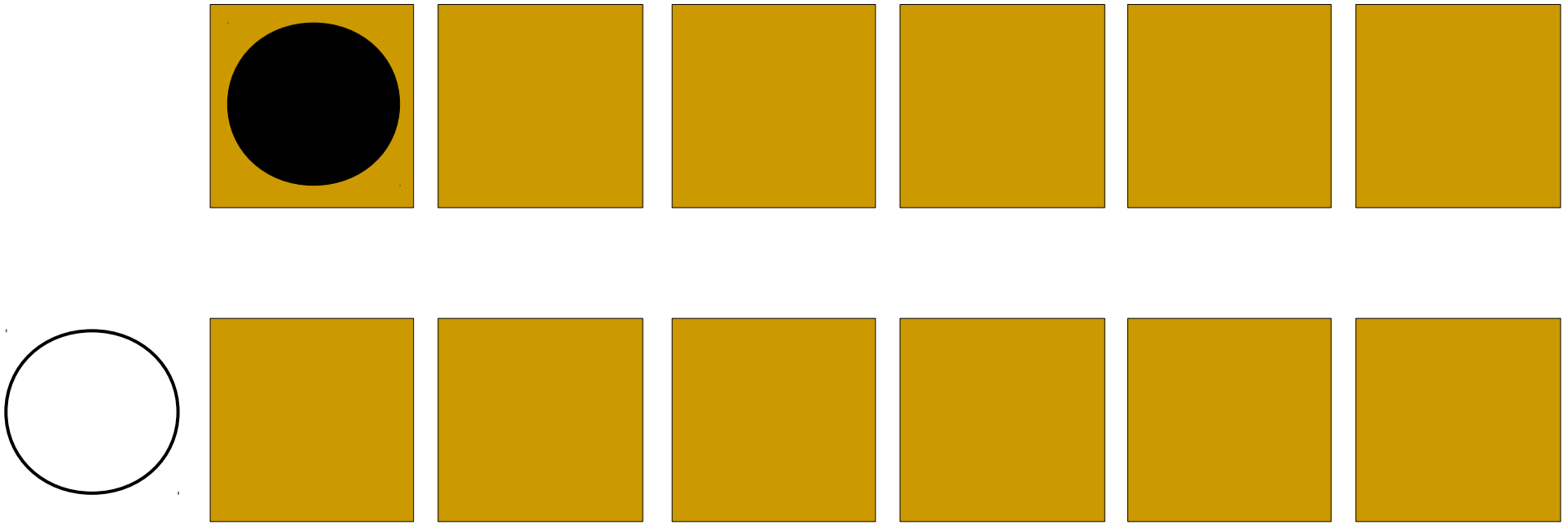

COMEDY
CENTRAL

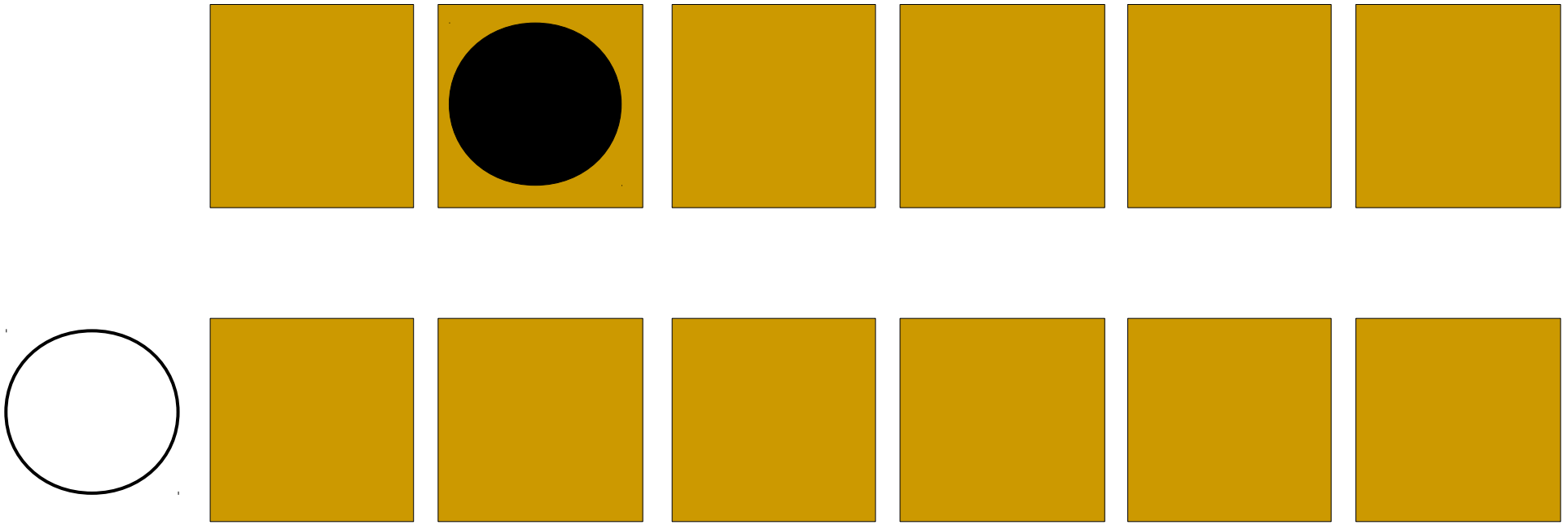
General Game Playing

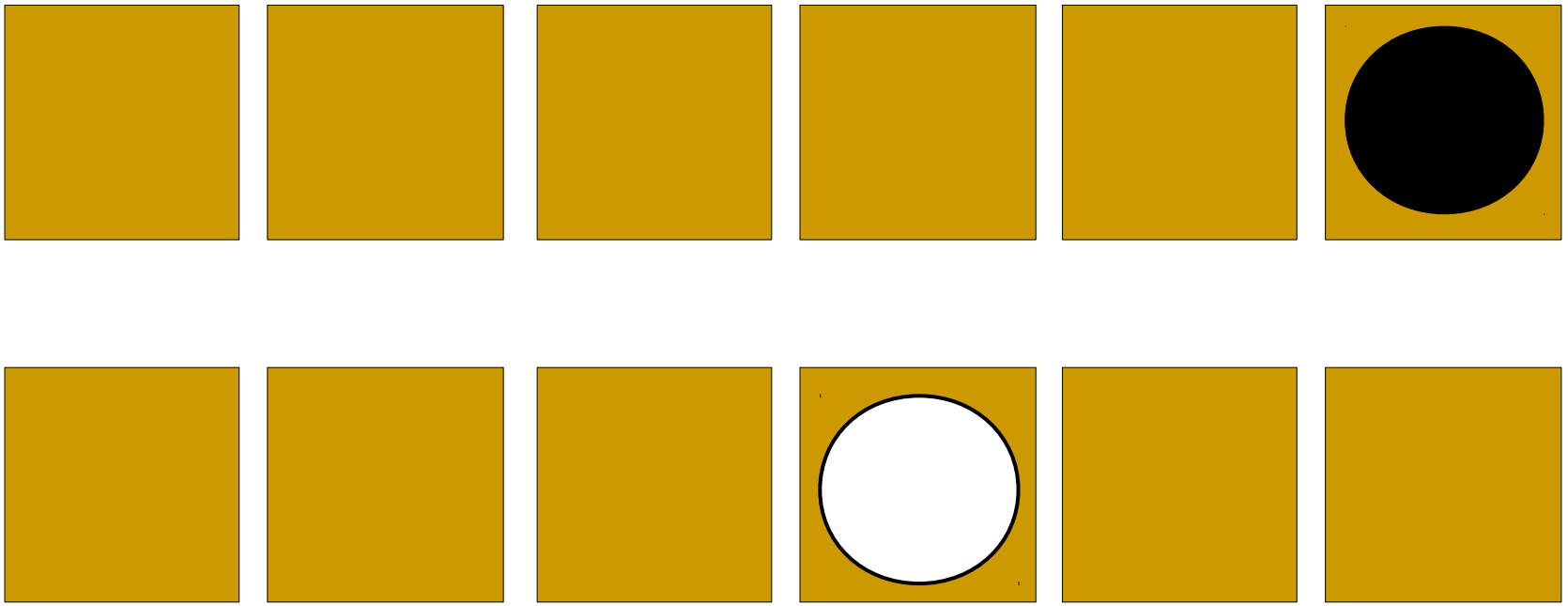
Anytime

Lazy









	-2	-1	0	1	2
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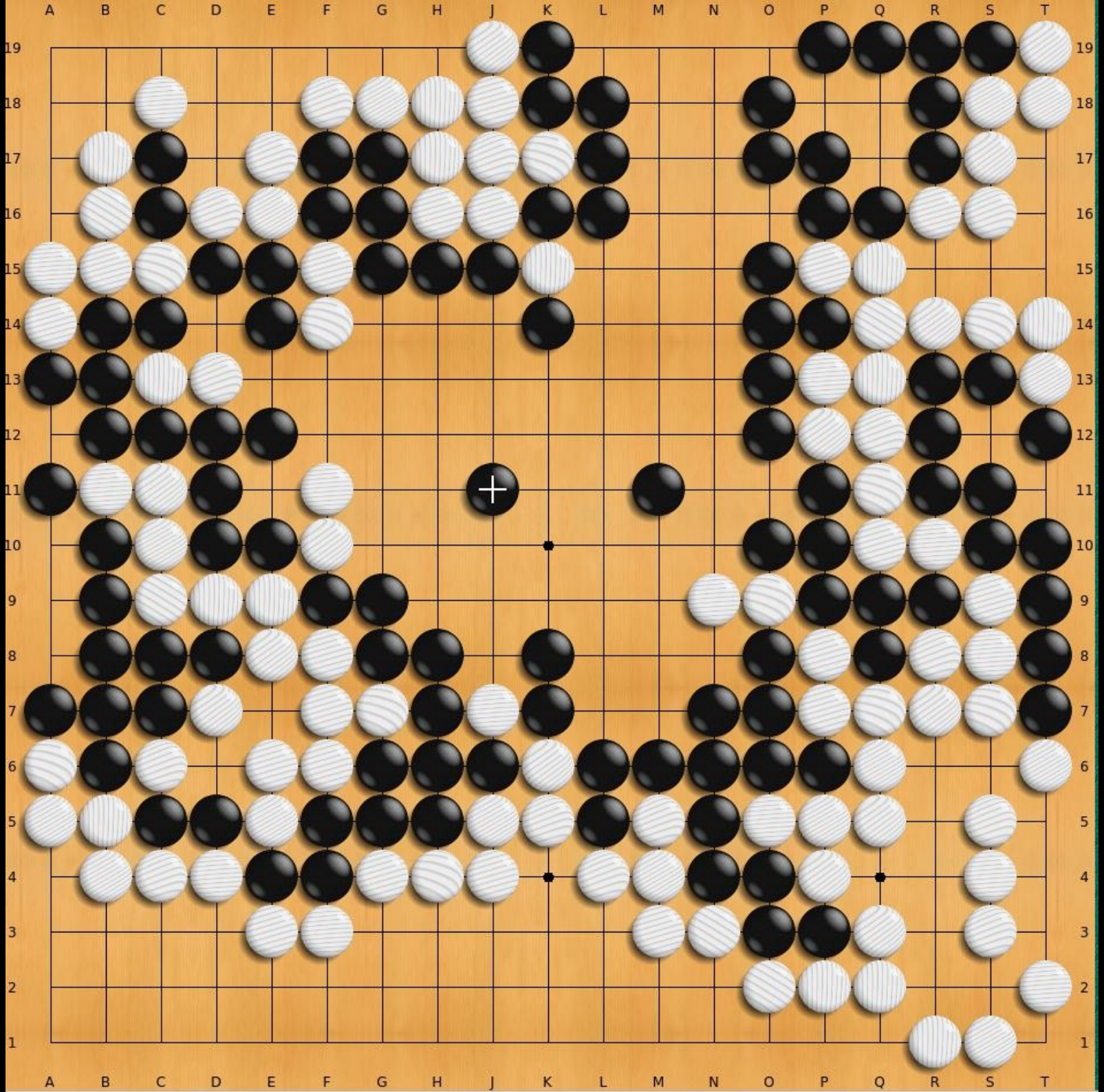
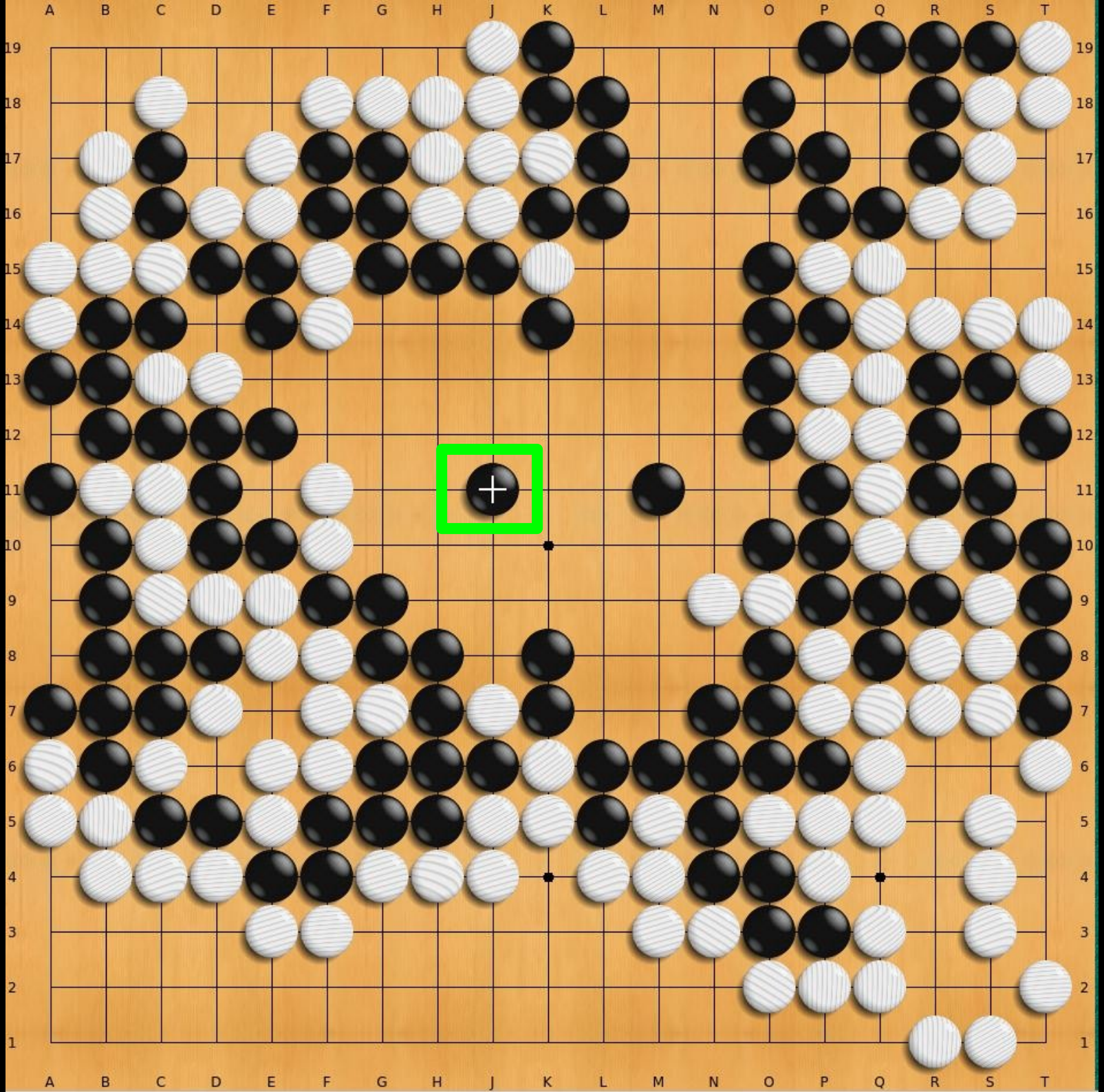
16	86%	92%	94%	94%	96%
32	94%	96%	98%	96%	95%
64	98%	99,6%	99,9%	99,4%	96%
100	99,8%	99,9%	100%	99,99%	98%

	-2	-1	0	1	2
8	86%	88%	90%	94%	98%
16	86%	92%	94%	94%	96%
32	94%	96%	98%	96%	95%
64	98%	99,6%	99,9%	99,4%	96%
100	99,8%	99,9%	100%	99,99%	98%

	-2	-1	0	1	2
8	86%	88%	90%	94%	98%
16	86%	92%	94%	94%	96%
32	94%	96%	98%	96%	95%
64	98%	99,6%	99,9%	99,4%	96%
100	99,8%	99,9%	100%	99,99%	98%

	-2	-1	0	1	2
8	86%	88%	90%	94%	98%
16	86%	92%	94%	94%	96%
32	94%	96%	98%	96%	95%
64	98%	99,6%	99,9%	99,4%	96%
100	99,8%	99,9%	100%	99,99%	98%


A B C D E F G H J K L M N O P Q R S T
19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1


A B C D E F G H J K L M N O P Q R S T
19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

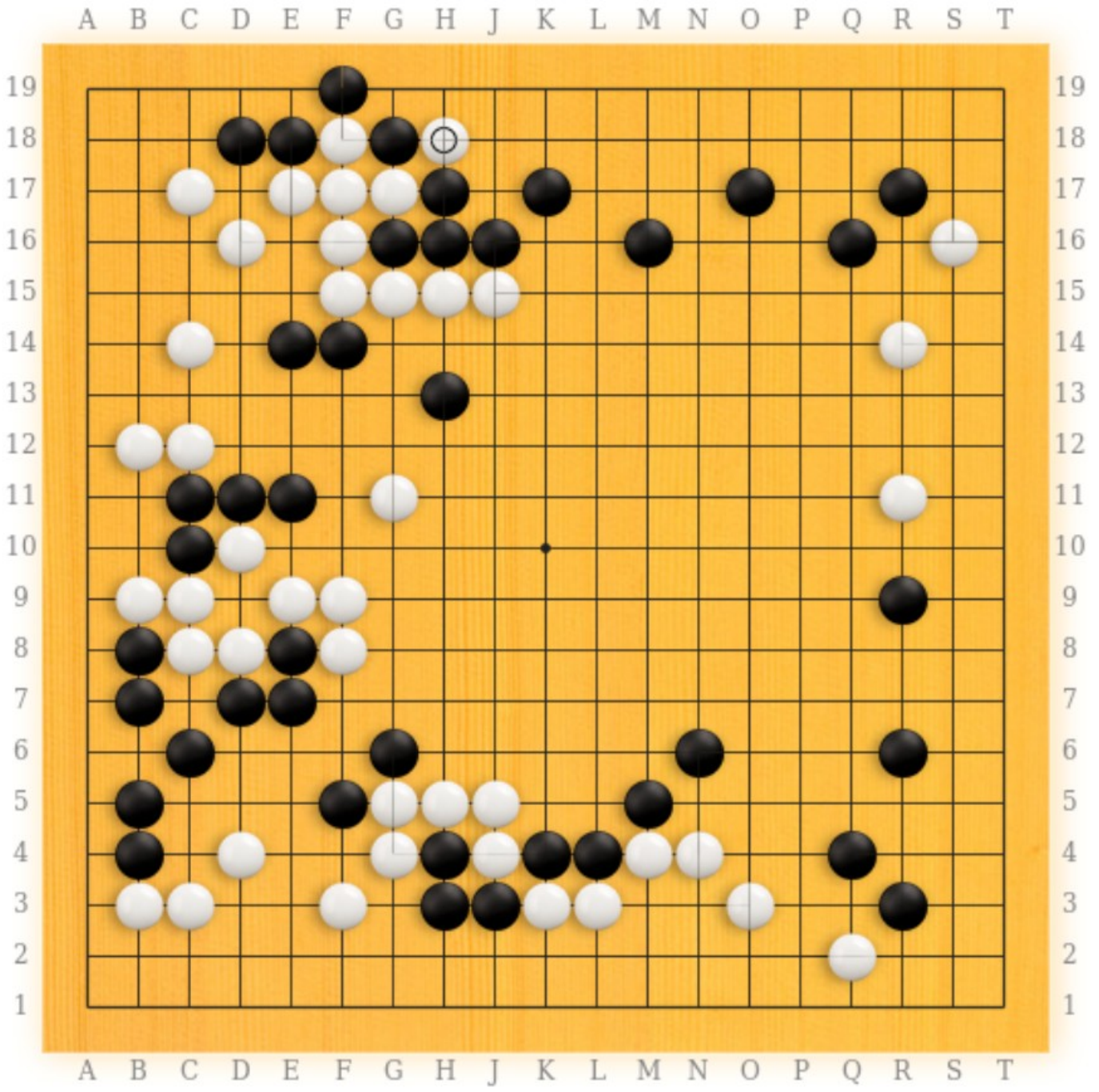
Enhancements

All Moves As First

RAVE

Expert Knowledge

Play Go Against a Deep Neural Network



Auto Move

Show Analysis

Make Move

Black captures: **0**
White captures: **1**

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Training Deep Convolutional Neural Networks to Play Go

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Allen Institute for Artificial Intelligence*, 2157 N Northlake Way Suite 110, Seattle, WA 98103, USA

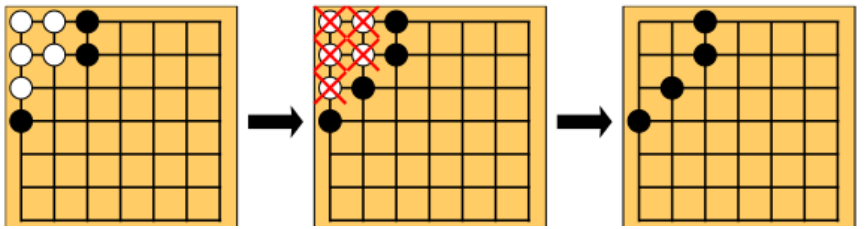
Amos Storkey A.STORKEY@ED.AC.UK
School of Informatics, University of Edinburgh, 10 Crichton Street, Edinburgh, EH9 1DG, United Kingdom

Abstract

Mastering the game of Go has remained a long-standing challenge to the field of AI. Modern computer Go programs rely on processing millions of possible future positions to play well, but intuitively a stronger and more 'humanlike' way to play the game would be to rely on pattern recognition rather than brute force computation. Following this sentiment, we train deep convolutional neural networks to play Go by training them to predict the moves made by expert Go

an interesting and challenging machine learning task, and has immediate applications to computer Go. In this section we provide a brief overview of Go, previous work, and the motivation for our deep learning based approach.

1.1. The Game of Go



MOVE EVALUATION IN GO USING DEEP CONVOLUTIONAL NEURAL NETWORKS

Chris J. Maddison
University of Toronto
cmaddis@cs.toronto.edu

Aja Huang[1], **Ilya Sutskever**[2], **David Silver**[1]
Google DeepMind[1], Google Brain[2]
{ajahuang,ilyasu,davidsilver}@google.com

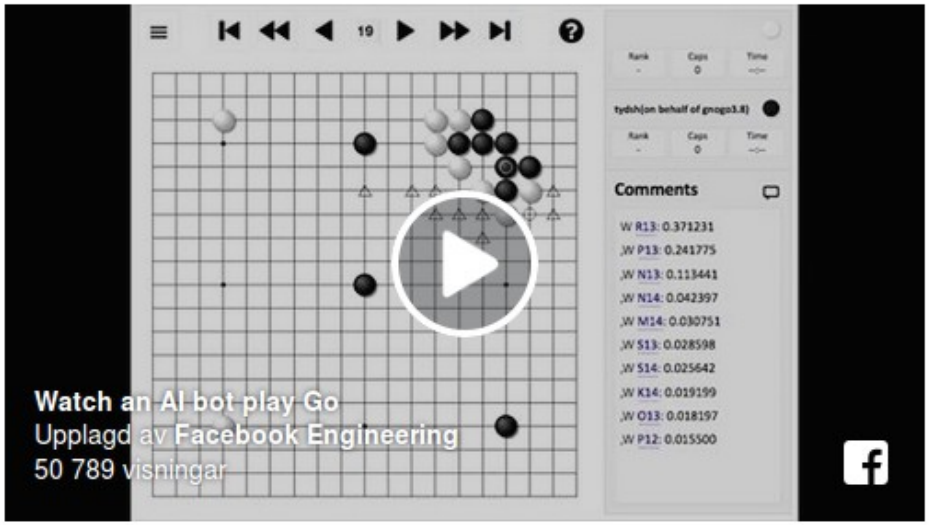
ABSTRACT

The game of Go is more challenging than other board games, due to the difficulty of constructing a position or move evaluation function. In this paper we investigate whether deep convolutional networks can be used to directly represent and learn this knowledge. We train a large 12-layer convolutional neural network by supervised learning from a database of human professional games. The network correctly predicts the expert move in 55% of positions, equalling the accuracy of a 6 dan human player. When the trained convolutional network was used di-

Selection

Another area of longer-term research is teaching our systems to plan. One of the things we've built to help do this is an AI player for the board game Go. Using games to train machines is a pretty common approach in AI research. In the last couple of decades, AI systems have become stronger than humans at games like checkers, chess, and even Jeopardy. But despite close to five decades of work on AI Go players, the best humans are still better than the best AI players. This is due in part to the number of different variations in Go. After the first two moves in a chess game, for example, there are 400 possible next moves. In Go, there are close to 130,000.

Oh yeah



We've been working on our Go player for only a few months, but it's already on par with the other AI-powered systems that have been published, and it's already as good as a very strong human player. We've achieved this by combining the traditional search-based approach — modeling out each possible move as the game progresses — with a pattern-matching system built by our computer vision team. The best human Go players often take advantage of their ability to recognize patterns on the board as the game evolves, and with this approach our AI player is able to mimic that ability — with very strong early results.

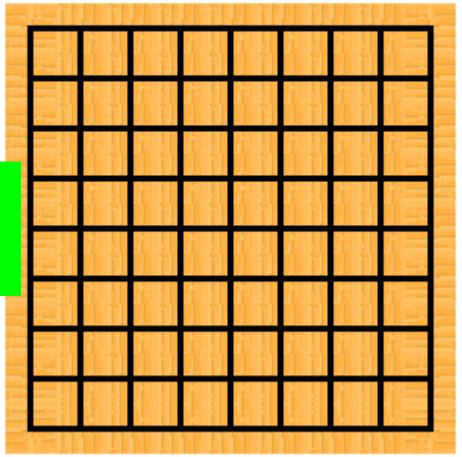
So what happens when you start to put all this together? Facebook is currently running a small test of a new AI assistant called M. Unlike other machine-driven services, M takes things further: It can actually complete tasks on your behalf. It can purchase items; arrange for gifts to be delivered to your loved ones; and book restaurant reservations, travel arrangements, appointments, and more. This is a huge technology challenge — it's so hard that, starting out, M is a human-trained system: Human operators evaluate the AI's suggested responses, and then they produce responses while the AI observes and learns from them.

```
white's turn to move!'
Make a move in the form XY, e.g. A19, D7 as the labels indicate!
> F8
    A B C D E F G H J
  9 . . . . . . . . .  9
  8 . X . . . O X . .  8
  7 . O O . . . O . .  7
  6 . . . . O . . . .  6
  5 . O O X . . . O .  5
  4 . X X . . . . . .  4
  3 . . X . . X . . .  3
  2 . . . . . . . X .  2
  1 . . . . . . . . .  1
    A B C D E F G H J
white played at F8
black's turn to move!'
Rubykon is thinking...
D2 => 0.4881516587677725
C8 => 0.4827586206896552
F4 => 0.4827586206896552
F5 => 0.47761194029850745
G4 => 0.47474747474747475
E8 => 0.4744897959183674
G6 => 0.47150259067357514
D6 => 0.46875
D4 => 0.4627659574468085
F7 => 0.46236559139784944
    A B C D E F G H J
  9 . . . . . . . . .  9
  8 . X . . . O X . .  8
  7 . O O . . . O . .  7
  6 . . . . O . . . .  6
  5 . O O X . . . O .  5
  4 . X X . . . . . .  4
  3 . . X . . X . . .  3
  2 . . . X . . . X .  2
  1 . . . . . . . . .  1
    A B C D E F G H J
black played at D2
white's turn to move!'
Make a move in the form XY, e.g. A19, D7 as the labels indicate!
> F5
    A B C D E F G H J
  9 . . . . . . . . .  9
  8 . X . . . O X . .  8
  7 . O O . . . O . .  7
  6 . . . . O . . . .  6
  5 . O O X . O . O .  5
  4 . X X . . . . . .  4
  3 . . X . . X . . .  3
  2 . . . X . . . X .  2
  1 . . . . . . . . .  1
    A B C D E F G H J
white played at F5
black's turn to move!'
Rubykon is thinking...
```

PragTob/Rubykon

Welcome to web-go

This is work in progress, please enjoy your game.
Counting rules are chinese /area counting.



PragTob/web-go

pasky / michi

Watch

Minimalistic Go MCTS Engine

117 commits | 2 branches | 0 releases | 5 contributors

Branch: master | michi / + | Fork this project and create a new file

pasky Merge pull request #5 from traveller42/master ... Latest commit 2f22d84 18 days

.gitignore	Keep only repository specific entries in repository .gitignore	a month
README.md	Update links to michi-c and michi-c2	a month
michi.py	Test for Pass in the GTP code was too strict	18 days

pasky/michi

Michi --- Minimalistic Go MCTS Engine

Michi aims to be a minimalistic but full-fledged Computer Go program based on state-of-art methods (Monte Carlo Tree Search) and written in Python. Our goal is to make it easier for new people to enter the domain of Computer Go, peek under the hood of a "real" playing engine and be able to learn by

ujh / iomrascalai

Watch

Iomrascálaí is an AI for the game of Go/Weiqi/Baduk written in Rust

1,094 commits | 3 branches | 13 releases | 6 contributors

Branch: master | iomrascalai / +

ujh Merge pull request #194 from ujh/confidence-intervals ... Latest commit c561503 2 da

bin	Use Binomial proportion confidence interval for the error calculation	2 da
fixtures/sgf	Allow matching white stones in the patterns	a mon
src	Remove feature flag for a feature that's now stable	6 da
	output files in the root directory	6 mont
.projectile	Emacs projectile config file	10 mont
.travis.yml	Use rust nightly on travis	6 mont
AUTHORS	adding myself to authors and gitignoring the eclipse project stuff	8 mont
CHANGELOG.md	CHANGELOG entry for 0.2.4	2 mont
Cargo.lock	Update to the latest dependencies	6 da
Cargo.toml	Make hamcrest a normal dependency so that the docs are generated	a mon

ujh/iomrascalai

What have I learned?

Making x faster

vs

Doing less of x

Modularizing small components

Benchmark everything

Solving problems the human way

vs

Solving problems the computer way

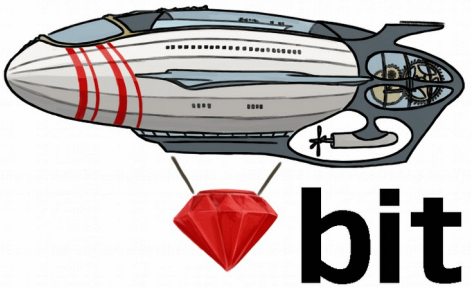
Joy of Creation

Beating Go thanks to the power of randomness

Tobias Pfeiffer

@PragTob

pragtob.info



bitcrowd

Photo Credit

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- https://en.wikipedia.org/wiki/Zuo_Zhuan#/media/File:Li_Yuanyang_Zuo_zhuan_first_page.png
- https://en.wikipedia.org/wiki/Four_arts#/media/File:The_Eighteen_Scholars_by_an_anonymous_Ming_artist_2.jpg
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