Maia Chess

A Human-Like Neural Network Chess Engine

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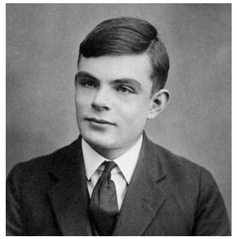
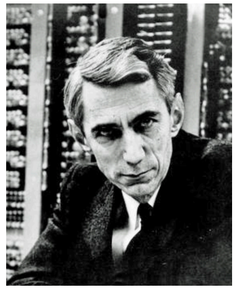
Chess and AI: A Long History



Alan Turing created the first chess-playing algorithm in 1948, before computers could run it

Claude Shannon described minimax in chess in 1949



Long-standing AI problem: "Chess is the drosophila of artificial intelligence" — John McCarthy, 1967

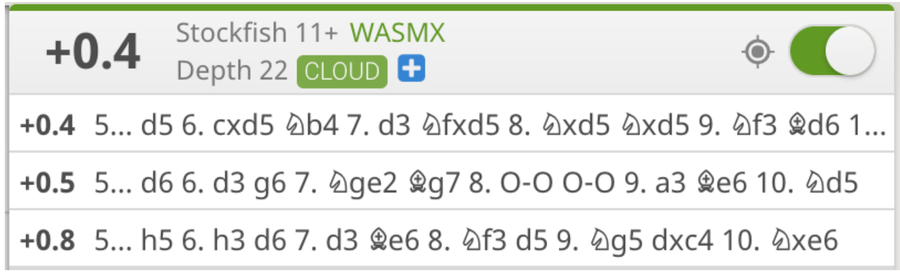
"**However**, computer chess has developed much as genetics might have if the geneticists had concentrated … on breeding racing Drosophila. We would have some science, but mainly we would have very fast fruit flies." — John McCarthy

Chess and AI: A Long History

Deep Blue defeats Kasparov in 1997

AlphaZero defeats Stockfish in 2017

Chess AI and People

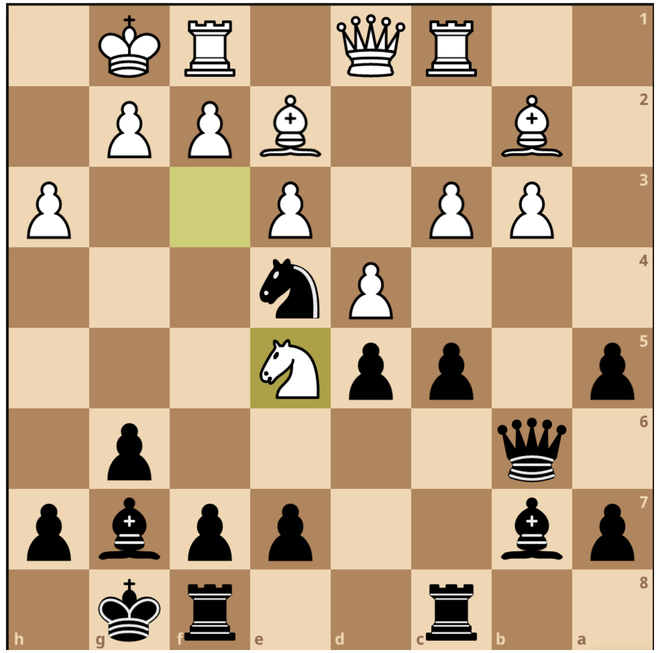


"Here's what I would do" —3400-rated calculation beast 🤖

"But what should I do?" —1100-rated human 😟

Chess AI and People

Stockfish level 4



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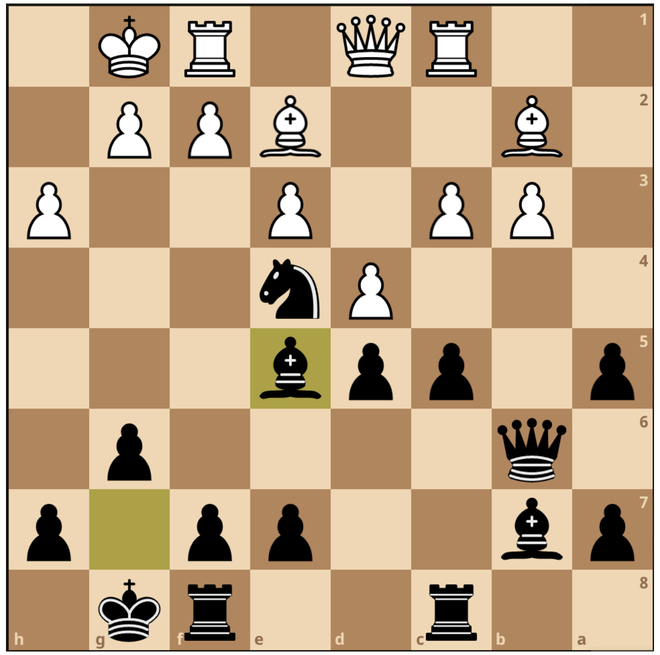
Chess AI and People

Stockfish level 4



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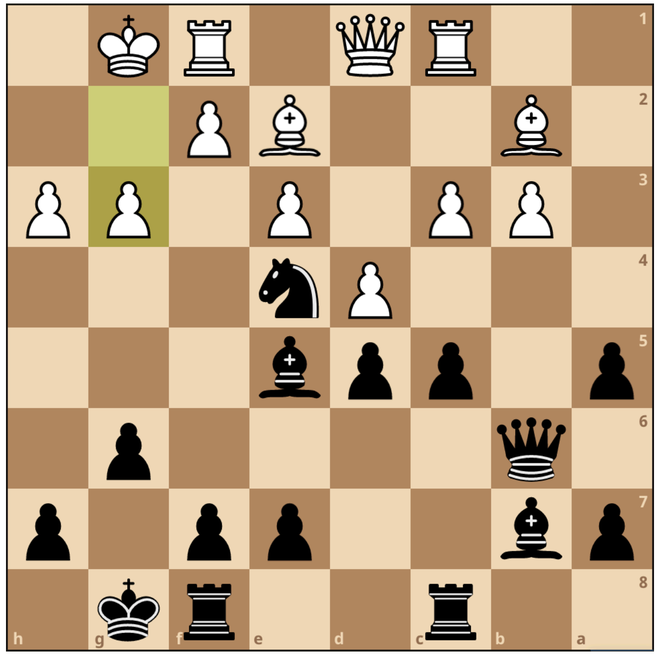
Stockfish level 4



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Chess AI and People

How do we bridge the gap between artificial and human intelligence?

Chess as a model system:

1) AI reached superhuman performance at least 15 years ago

2) There is voluminous data on human activity in chess

3) Wide range of human skill levels

How can we algorithmically capture human style in chess?

Predict the next move a human, at a specific skill level, will make in a real game

Data

lichess.org

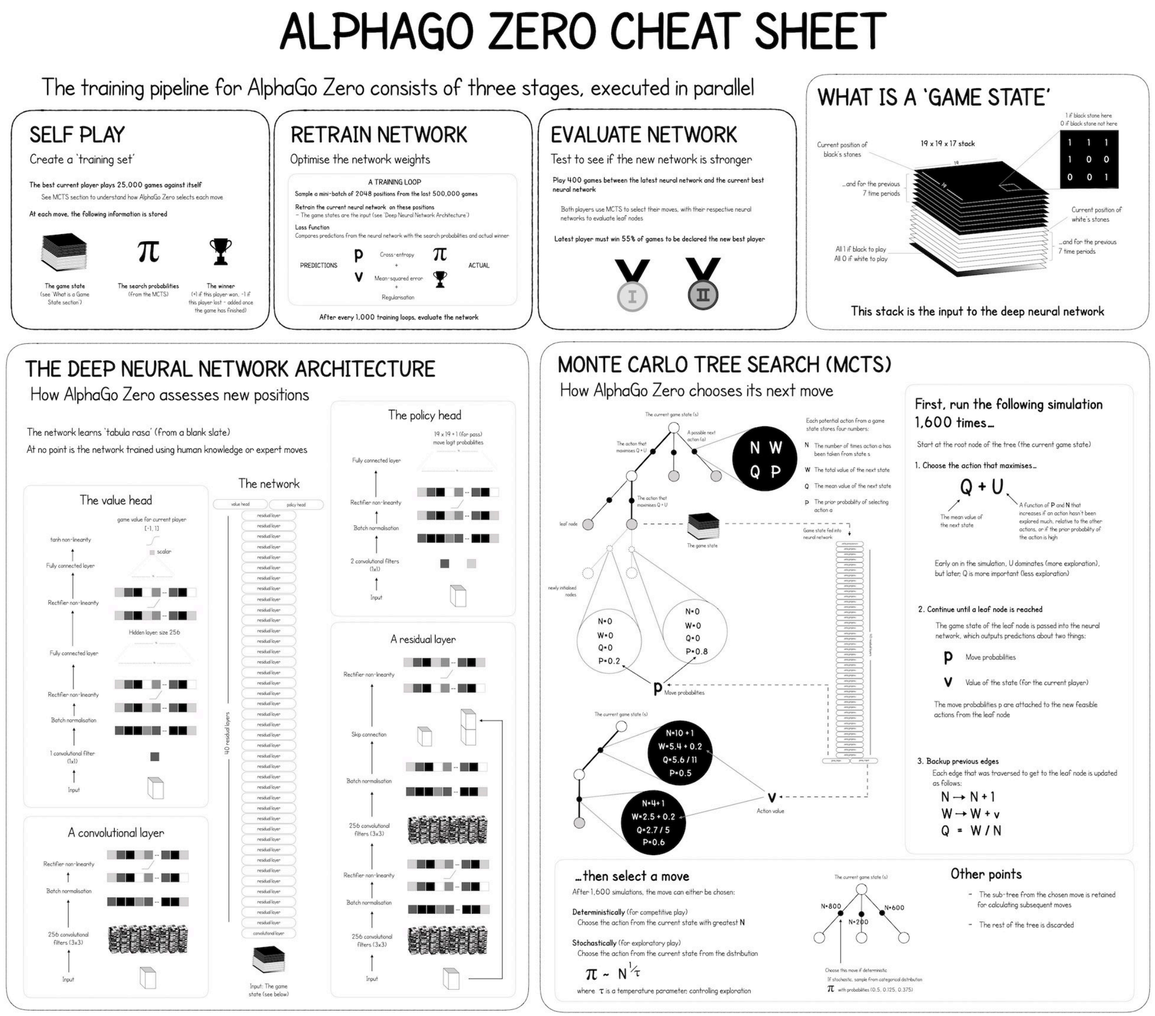
game database

The largest openly available dataset of human games

1.7B games and counting

Players, moves, move times, etc.

Background: AlphaZero and Leela



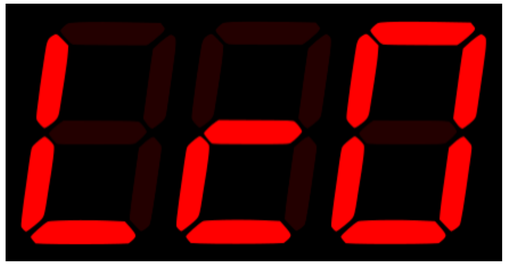
[1] https://medium.com/applied-data-science/alphago-zero-explained-in-one-diagram-365f5abf67e0

Background: Attenuated Engines

Depth-limited Stockfish

Limit search depth to simulate fallible thinking

Early Leela models



Take Leela versions early in their self-play training to simulate not-fully-evolved understanding

Do Attenuated Engines Perform Well?

Attenuated engines match aggregate human performance (**rating**)

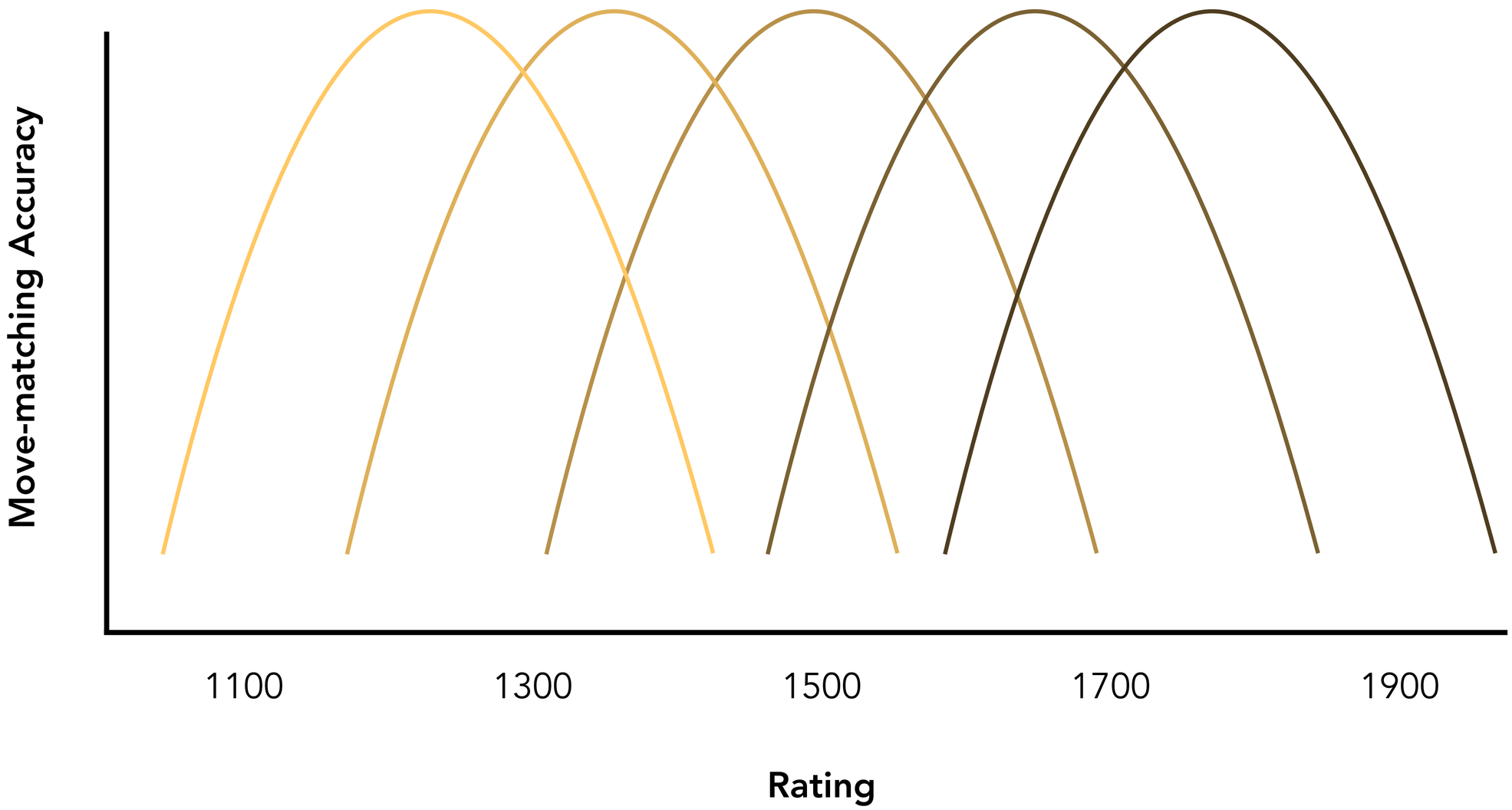
Do they match granular human decision-making (**moves**)?

Evaluation Set

From December 2019:

1. Create bins for each range of 100 rating points
2. Divide games into bins by rating of both players
3. Select 10,000 games from each bin between 1100 and 1900
4. Metric: **move-matching accuracy:** % of positions for which model's move matches the human move played in the game.

What Does It Mean to Perform Well?



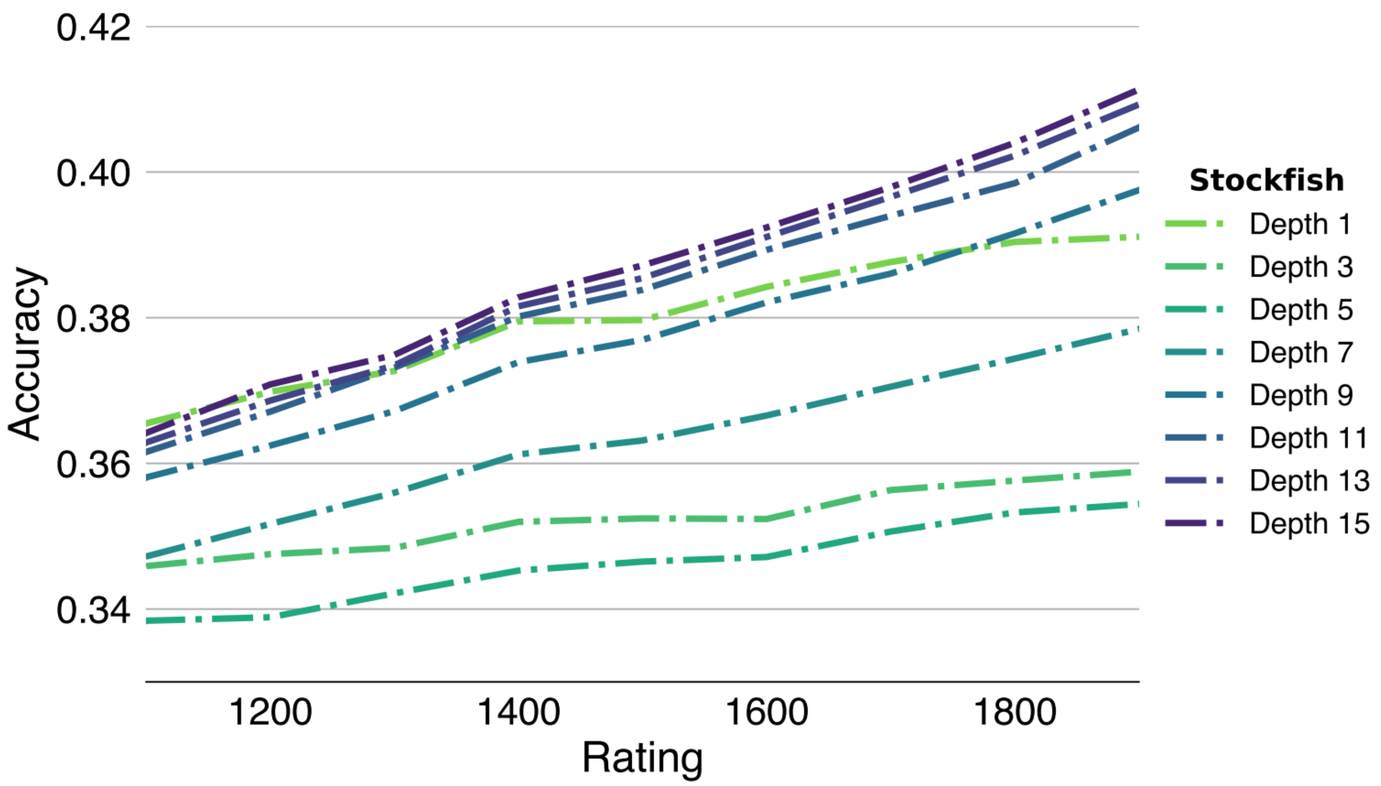
Stockfish

Attenuated Stockfish: limited to various depths

Move-matching accuracy increases with rating of players being predicted

Relatively low accuracy, no skill-level targeting

Interesting non-monotonicity: d1 and d15 both more accurate than d5

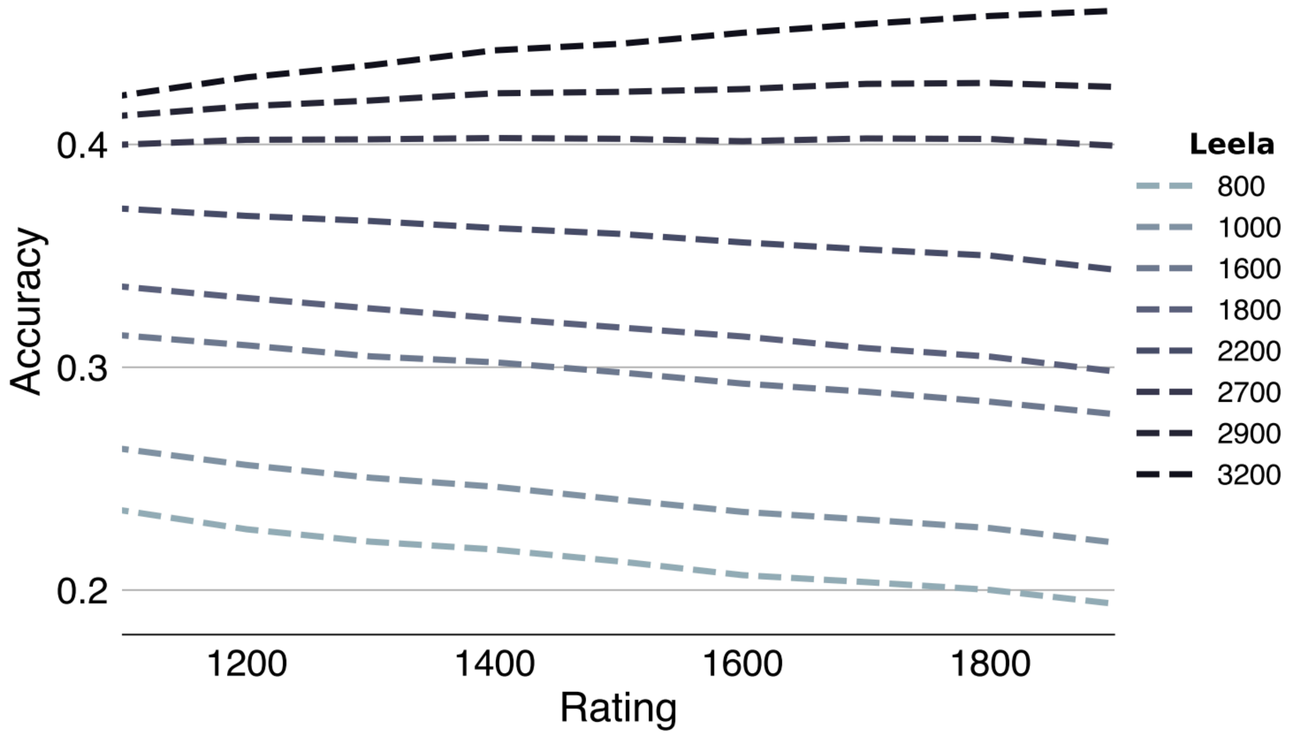


Leela

Attenuated Leela: versions at different points in training

Move-matching accuracy flat across ratings of players being predicted

Somewhat higher accuracy, no skill-level targeting

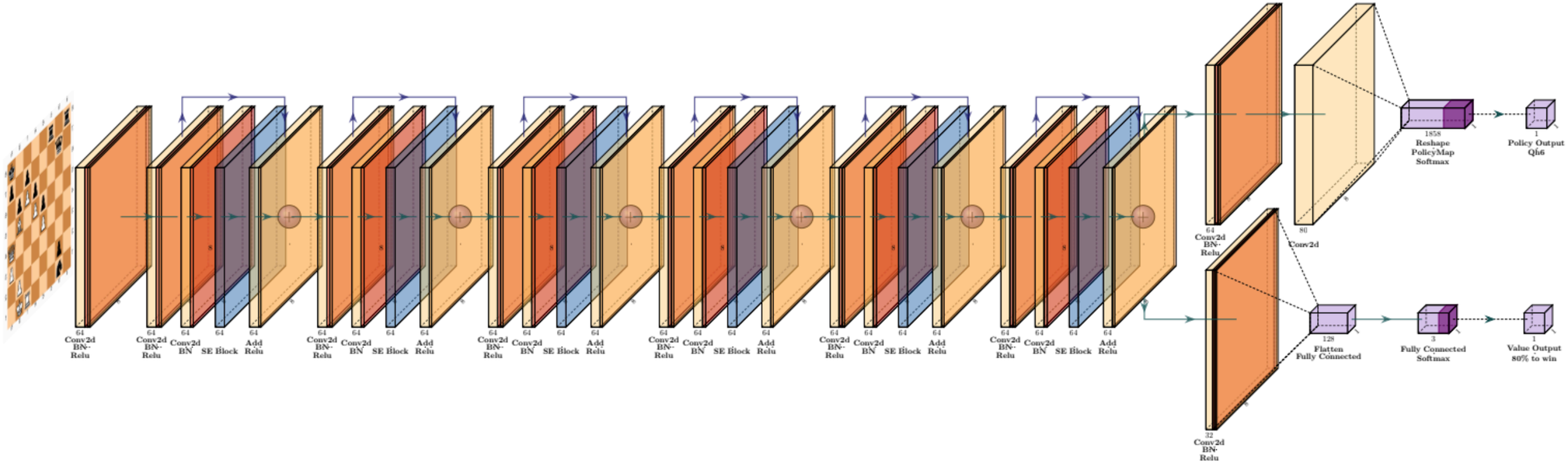


Maia

Key idea:

Learn from human play instead of self-play

Goal: predict the next move a human will play



Maia–Leela Comparison

	Leela	Maia
Data	Self-play games	Human games
Goal	Optimal play	Human-like play
Method	Reinforcement learning	Classification
Tree search	Monte-Carlo tree search	No tree search
Policy	Optimal moves	Human moves
Value	Probability of winning given optimal play	Probability of human winning

Maia Training

Train a Maia for each rating level between 1100 and 1900

Maia 1100	12M games between 1100s
Maia 1200	12M games between 1200s
Maia 1300	12M games between 1300s
Maia 1400	12M games between 1400s
Maia 1500	12M games between 1500s
Maia 1600	12M games between 1600s
Maia 1700	12M games between 1700s
Maia 1800	12M games between 1800s
Maia 1900	12M games between 1900s

Maia Move-Matching Performance

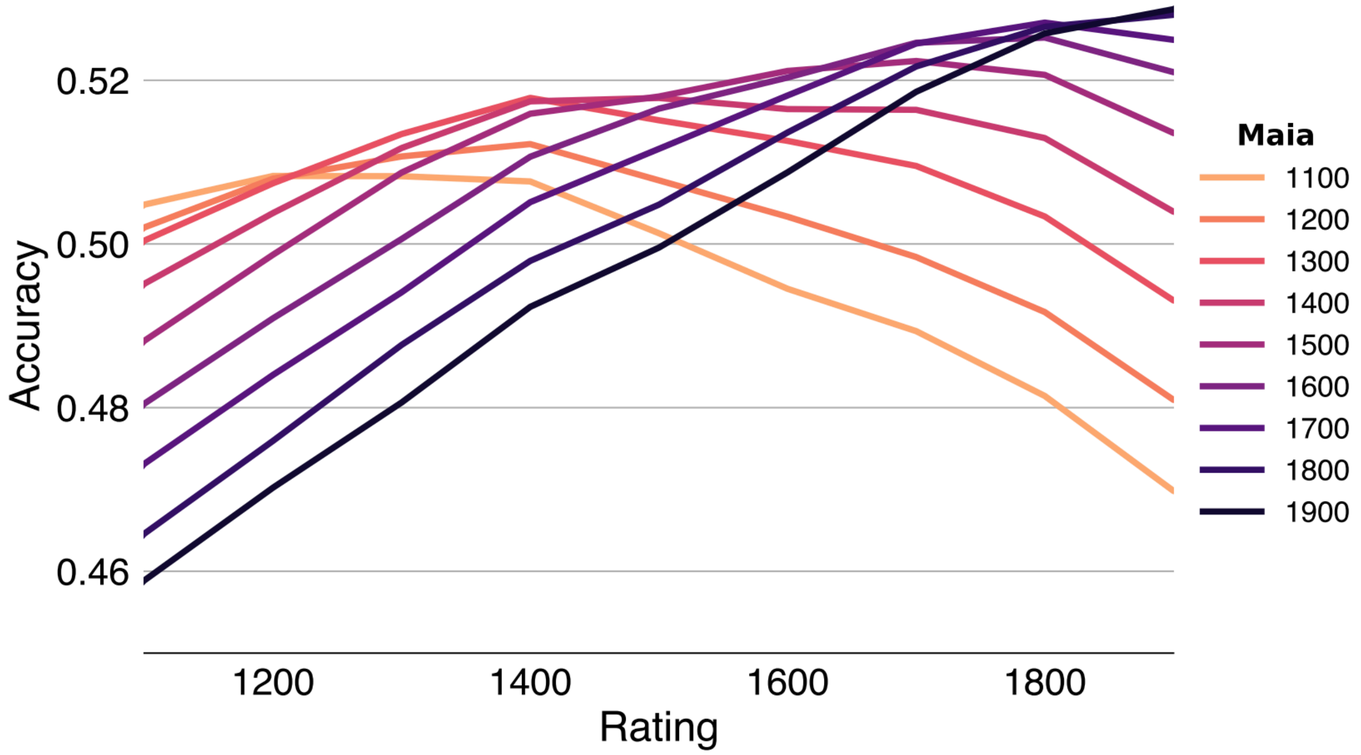
Maia: versions trained on different rating levels

High accuracy: best performance >50%

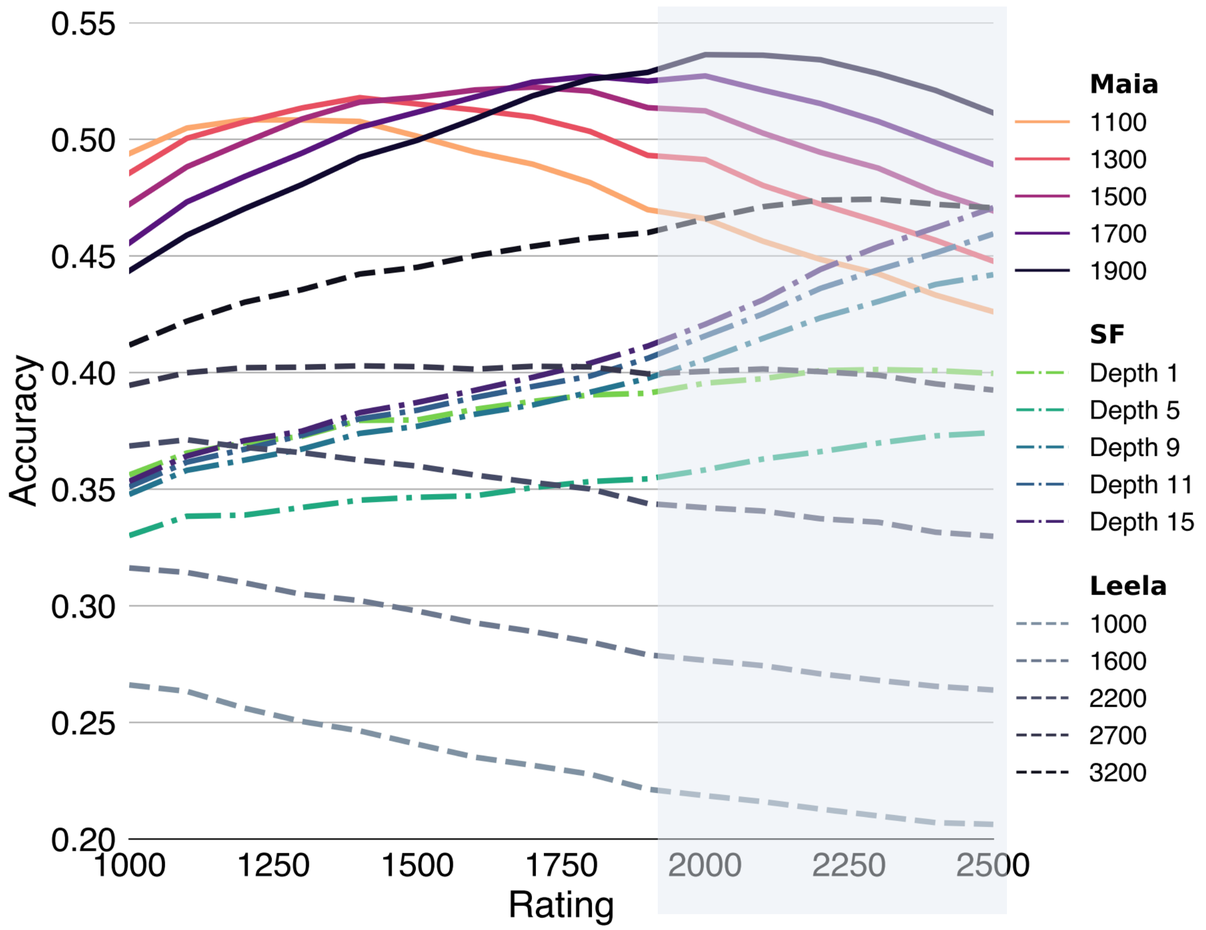
Move-matching accuracy maximised at target rating level

Maia's lowest accuracy, Maia 1900 tested on 1100-rated players (46%), is still higher than any Stockfish or Leela model we tested

High accuracy and skill-level targeting



Maia Move-Matching Performance



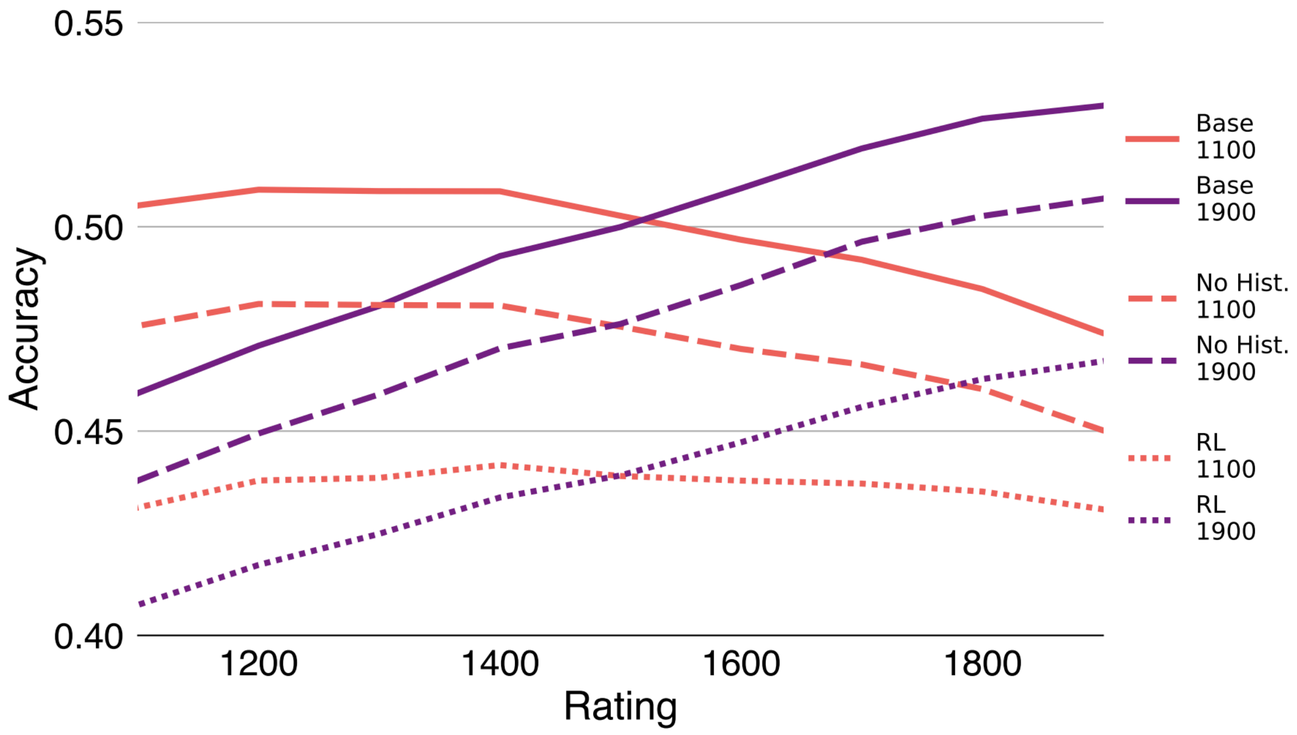
Shaded region: rating levels not explicitly targeted (2000+)

Maia: Architecture Decisions

Base Maia vs. a version with no history and a version with Leela-style rollouts (calculation)

Including calculation hurts move-matching performance by ~5–8% (moves become too strong)

Dropping history hurts performance by 2–3%



Maia Bots

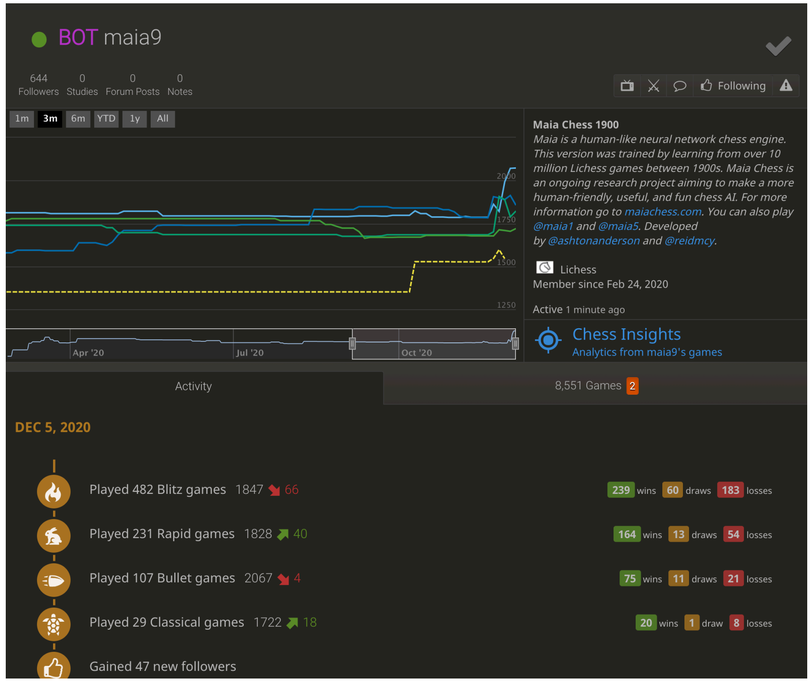
@maia1: Maia 1100

21,000+ games

@maia5: Maia 1500

8,000+ games

@maia9: Maia 1900



8,000+ games

Playing Maia 1100 is like playing a committee of 1100-rated players, etc.

Maia Bots

7,000+ unique human opponents in 4 days

Max # of games started in an hour: 1,491

"I've been playing engines for over 15 years. This is the first time I'm playing an engine that feels like a person. When it makes mistakes, they are natural mistakes, like missing something in the midst of tricky tactics."

Top opponent by # of games: 149

"this is amazing to practice against…Definitely a 9.9/10 from me"

agadmator vs Maia || A Human-like Neural Network…

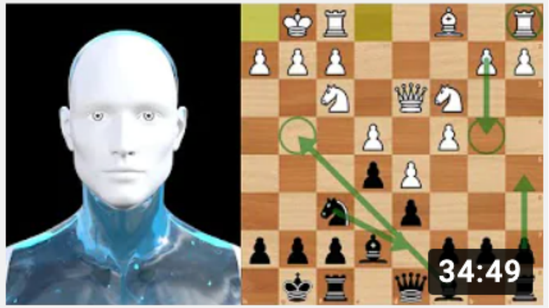
agadmator's Chess Chann…

115K views • 3 days ago

Meet Maia Chess || A Human-like Neural Network Chess…

agadmator's Chess Chann…

103K views • 3 days ago



Maia Chess: A human-like neural network chess engine

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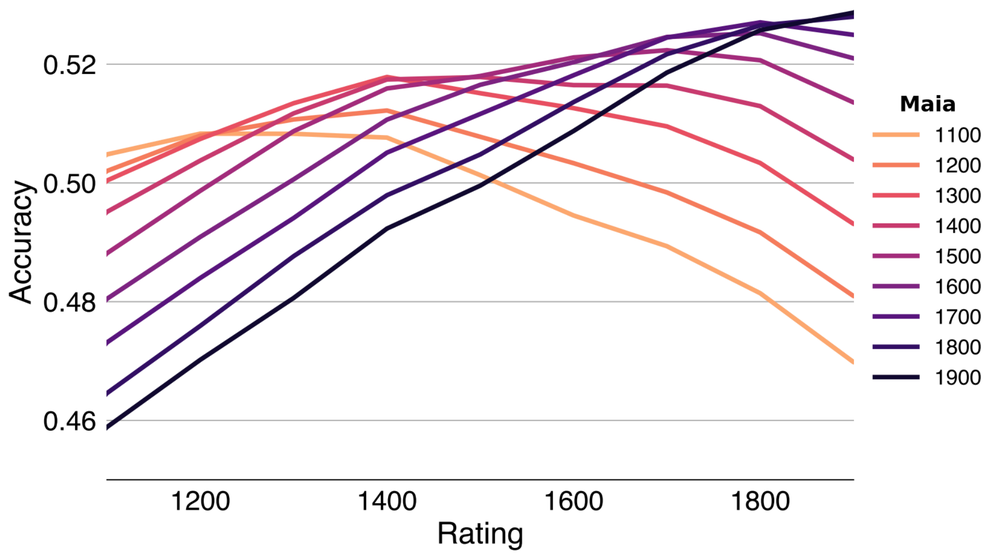
Maia: A Framework to Understand Human Play

Since we can predict human play at different levels, there is a reliable, predictable, and maybe even **algorithmically teachable difference** between one human skill level and the next

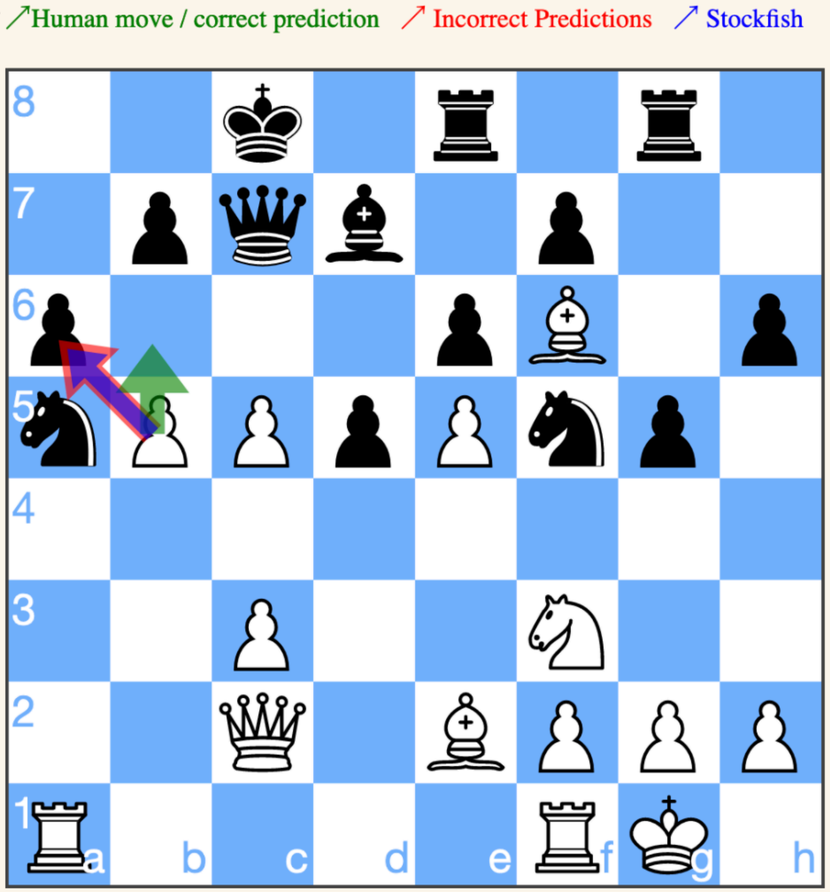


Maia: A Framework to Understand Human Play

In this position, Maia levels 1100–1400 correctly predict White will play the tempting but wrong move b6 (the move played in the game)

Maia levels 1500–1900 predict that, on average, players rated 1500 and above will play the correct bxa6, forcing the Queenside open to decisive effect

Model	Move	Agreed
Stockfish	bxa6	✗
Maia 1100	b6	✔
Maia 1200	b6	✔
Maia 1300	b6	✔
Maia 1400	b6	✔
Maia 1500	bxa6	✗
Maia 1600	bxa6	✗
Maia 1700	bxa6	✗
Maia 1800	bxa6	✗
Maia 1900	bxa6	✗

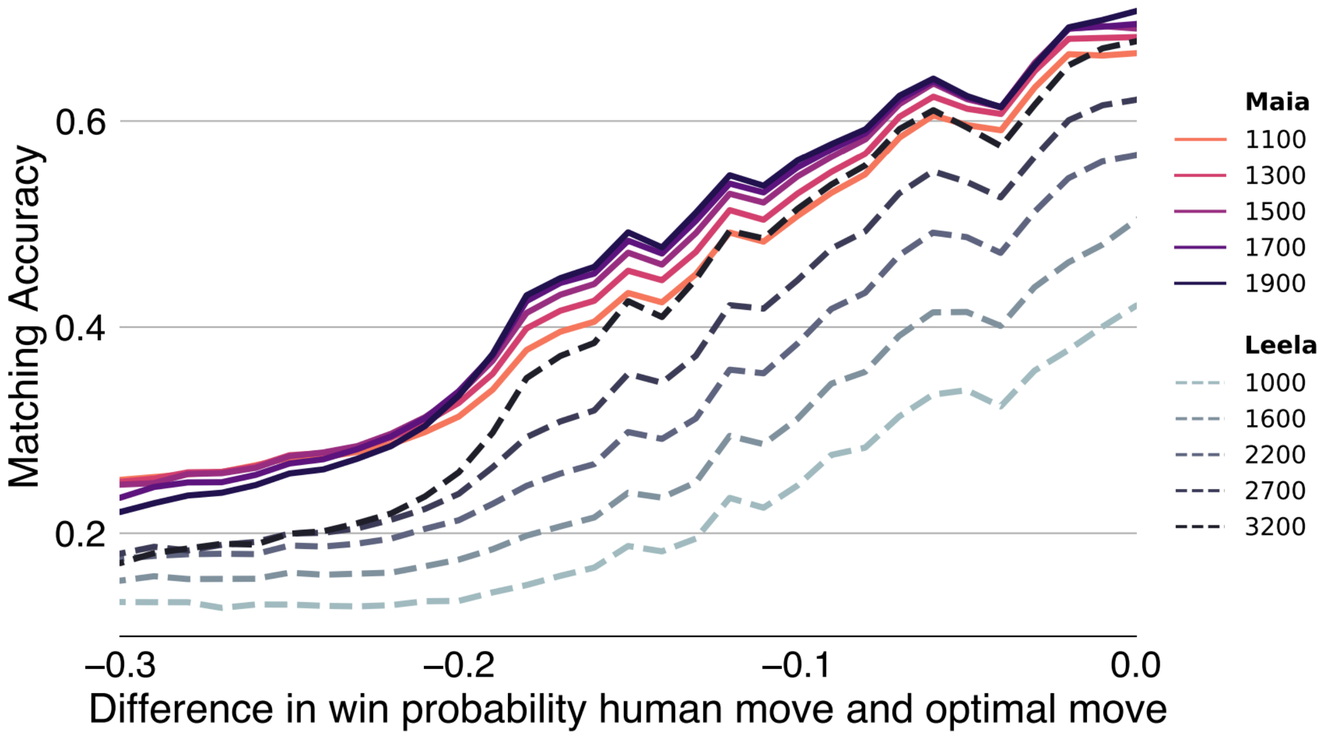


Maia: A Framework to Understand Human Play

Maia predicts mistakes surprisingly well

When players make even the most glaring blunders, Maia predicts the exact move >25% of the time

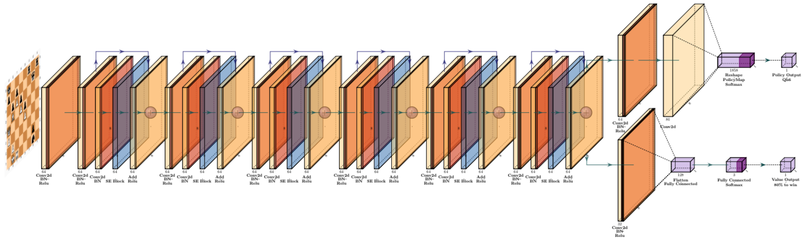
Performance increase relative to other models is larger for blunders

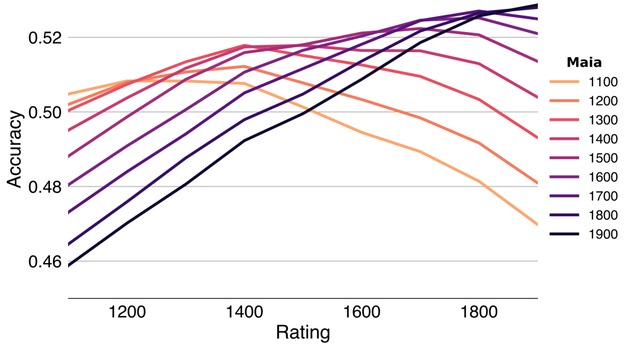


Horrific blunders ⟷ **Correct moves**

Summary

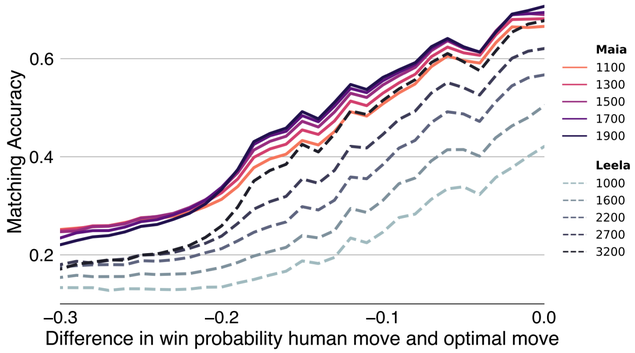
Maia is a human-like neural network chess engine





Maia captures human style in chess at targeted skill levels

You can play Maia online now!



Next: algorithmic and data-driven improvement tools

Thanks!

"Aligning Superhuman AI with Human Behavior: Chess as a Model System"
Knowledge Discovery and Data Mining (KDD), 2020.
http://www.cs.toronto.edu/~ashton/pubs/maia-kdd2020.pdf

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