Approximating Human Chess with Neural Nets

A tale to find out
by Ethan Gee, Nate Stott

Humans vs Bots

| Thing	Humans	Chess Bots
Thinking	Intuition, patterns, planning	Brute-force calculation, search algorithms
Mistakes	Brain farts, lose focus for a second	What's that?
Time Use	Can spend too much or too little	Never takes more than a second
Learning	Study, coaches, experience with other players	Self play
Future	Has some guesses	Practically knows everything that could happen

How do Normal Bots work?

- Traditionally, Rule Based Evaluation Metrics
  - Fun fact Allan Turing did this in 1948
- MiniMax Search over possible boards
  - Play my best possible move and investigate their best response
- Neural Net based board evaluation
  - Boards are evaluated through modern deep learning techniques
- Reinforcement Learning
  - Bots play against themselves and find new strategies.

As a result, bots differ significantly in how they evaluate boards, and play chess.

The dataset

- Every month, Lichess posts games played on lichess.com and other chess sites.
  - More than 7 billion games and counting.
  - Hundreds of GBs of data.
- Portable Game Notation (PGN).
  - A text based representation of a chess game.
- What's in the PGN files?
  - ELO scores
    - How good you are, e.g. (500 you suck, 1900 you're real good).
  - Who won?
  - All the moves from both players in Chess Algebraic Notation.
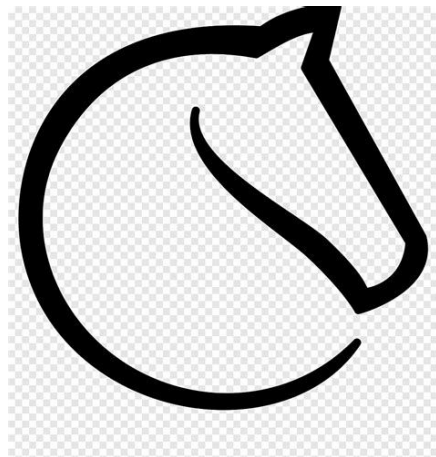
PGN file example

[Event "Live Chess"]

[Site "Chess.com"]

[Date "2020.03.25"]

[Round "-"]

[White "pdrpnht"]

[Black "ColinStapczynski"]

[Result "0-1"]

[WhiteElo "1543"]
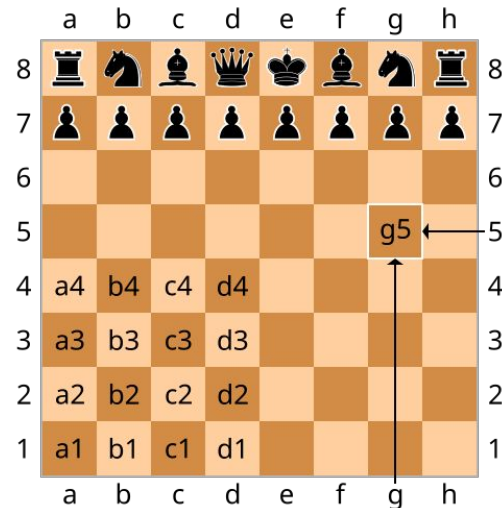
[BlackElo "2241"]

[TimeControl "180"]

[Termination "ColinStapczynski won by resignation"]

1. e4 d5 2. exd5 Qxd5 3. Nc3 Qa5 4. d4 c6 5. Nf3 Bf5 6. Bd3 Bxd3 7. Qxd3 e6 8.
O-O Nf6 9. Bg5 Nbd7 10. Ne5 Qc7 11. Ne2 Nxe5 12. dxe5 Qxe5 13. Bxf6 gxf6 14.
Rfe1 Bd6 15. Ng3 Qd5 16. Rad1 Qxd3 17. Rxd3 O-O-O 18. Red1 Be7 19. Ne4 Rxd3 20.
Rxd3 Rd8 21. Rh3 f5 0-1

The base paper (Maia 1 and 2)

- They use the Lichess dataset.
- They did transfer learning to AlphaZero.
- Model only looks at current board state.
- They made 9 models that cover 1100-1900.
- In a follow-up paper, they combined all models into the distilled model.
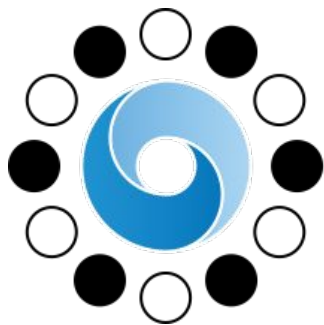
Where to go from here

- The size of the model restricts access
    - AlphaZero is big and requires GPU access
- Smaller models such as Stockfish show competitive performance.
    - Stockfish can run on Chromebooks
    - Stockfish can beat even advanced players
- MAIA has a fairly limited range of ELOs (1100-1900)
    - Intermediate to advances players
    - Can we expand the ELO range?

Sources

Dataset: https://database.lichess.org/

McIlroy-Young, R., Sen, S., Kleinberg, J., & Anderson, A. (2020, August 22). *Aligning superhuman ai with human behavior: Chess as a ...* University of Toronto. https://www.cs.toronto.edu/~ashton/pubs/maia-kdd2020.pdf

Silver, D., Hubert, T., Schrittwieser, J., Antonoglou, I., Lai, M., Guez, A., Lanctot, M., Sifre, L., Kumaran, D., Graepel, T., Lillicrap, T., Simonyan, K., & Hassabis, D. (2018). A general reinforcement learning algorithm that Masters Chess, Shogi, and go through self-play. *Science*, *362*(6419), 1140–1144. https://doi.org/10.1126/science.aar6404

Stockfish or leela chess zero? A comparison against endgame tablebases. (n.d.). https://webdocs.cs.ualberta.ca/~mmueller/ps/2023/ACG_2023_Stockfish.pdf

Tang, Z., Jiao, D., McIlroy-Young, R., Kleinberg, J., Sen, S., & Anderson, A. (2024, October 31). *Maia-2: A unified model for human-AI alignment in chess*. arXiv.org. https://arxiv.org/abs/2409.20553

Other:

- https://www.chess.com/terms/chess-pgn
- https://www.chess.com/terms/chess-notation