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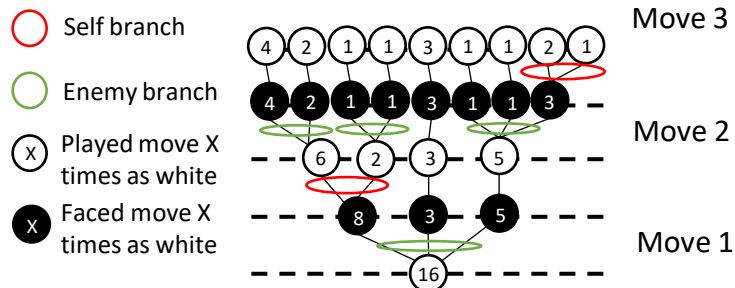
The Dependence of Chess Opening Network Structure on Playing Strength

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Gathering and Processing Game Data in Chess Opening Networks

- Data is taken from the April 2023 Lichess Database.
 - After removing players who played <200 games in the month and selecting just 1/10th of the remaining players, we are left with **4 million games** and about **10,000 players**
- We then process these games into a white network and a black network by calculating overlap:

First 3 Moves of an Example Opening Network For Playing as White



- “Self branches” capture a player’s variety in their repertoire while “enemy branches” capture the moves played by all opponents.

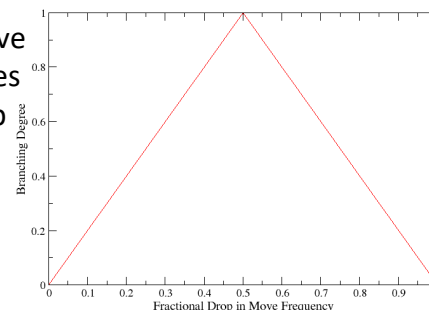
Quantifying the Degree of Opening Variety Through Branching

- Branch points do not all indicate the same degree of opening repertoire variety. Consider Y to quantify this variety:

$$Y = 1 - |1 - 2d|$$

- Where $d = (f_{last} - f_{current})/f_{last}$ is the fractional drop in move frequency f across the branch point.

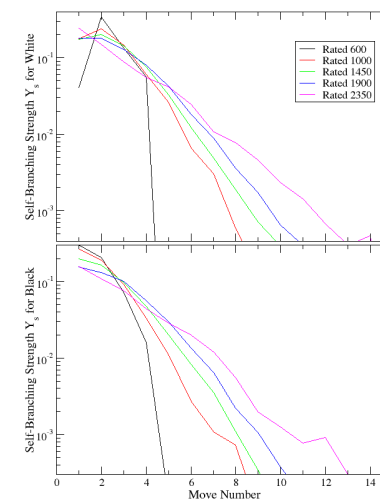
- As we see in the above plot of $Y(d)$, branches with a fractional drop of 50% contribute maximally to branching degree.



- While splits of 80/20 or 90/10 indicate less variety and therefore have lower branching degree, as there is one dominant move.
- 33/33/33 splits or other higher order even splits also contribute less, as this might indicate indecisiveness rather than planned variety.

How Does Opening Variety Change With Playing Strength?

- We calculate Y at each self-branch point for *each game*, averaging together the results for each move number.
- This plot shows players ranging from beginner to expert, though no professional-level players.



Discussion

- We see that, on average, higher rated players have slightly less opening variety early in the game than lower rated players, while they have more opening variety later in the game.
- This “opening variety” in later moves largely comes from move memorization.
 - Lower rated players arguably have more variety in *positions*, but that is because they have not memorized the moves and therefore see a new game every time.