Analysis of chess games with 2D and 3D plots

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***Abstract*— This project shows how different visualization techniques can help understand chess games. Different colormaps, scales and dimensions are used in four tasks to visually understand weaknesses and statistics. The analysis is done on over 7000 games by Magnus Carlsen, the chess world champion in 2021.**

***Keywords*— Visualization – Visualization Techniques – Chess – Game Analysis**

I. Introduction

Multiple chess analysis books teach chess strategies for the students to develop an intuition to know which squares to move on a given turn. However, they rarely show statistics beyond the percentage of games won, drawn or lost for a given position[2]. This paper explores the display of statistics per-square and per-piece using different techniques for colormaps, scales and dimensionality. The dataset used was a PGN chess archive with 7000 games by Magnus Carlsen.

II. Tasks

Task 1. Average color of the piece at every square

In the first task, if a given square (e.g. the first square is a1) had white piece for 20/40 turns, a black piece for 10/40 turns, and no piece for 10/40 turns, it would get a score of +10, whereas if it had a black piece for 20/40 turns, a white piece for 10/40 turns and no piece for 10/40 turns, it would get a score of -10. The first game would then result in the following plots. Notice how choosing a diverging colormap (red representing the player using white pieces and blue representing the player using black pieces) tells us information about which player had control of any given square.

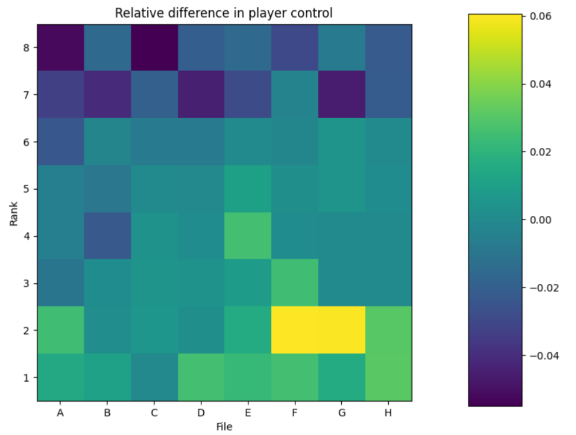

Fig 1. Plot for the first recorded game representing the square color throughout the match. Higher values have brighter tones. Values have been normalized over the sum of the absolute values for each square.

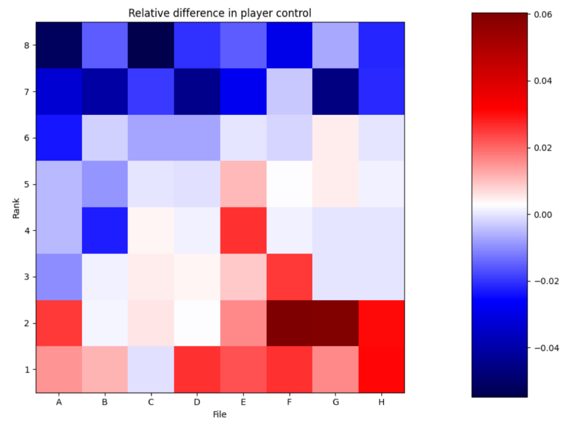

Fig 2. Plot for the first recorded game representing the square color throughout the match. Using a diverging colormap reflects better per-player control.

In the second plot we can see that the square c1 was controlled by a black piece for longer than a white piece.

When doing the analysis over the 700 games by Magnus in the database, we get interesting overall statistics. For example, that the squares b4 and g5 have relatively the same time controlled by either color. Also, plotting it in 3D can show better small differences on each square such as f7 and g7, which are very difficult to notice the color differences in the 2D plot.

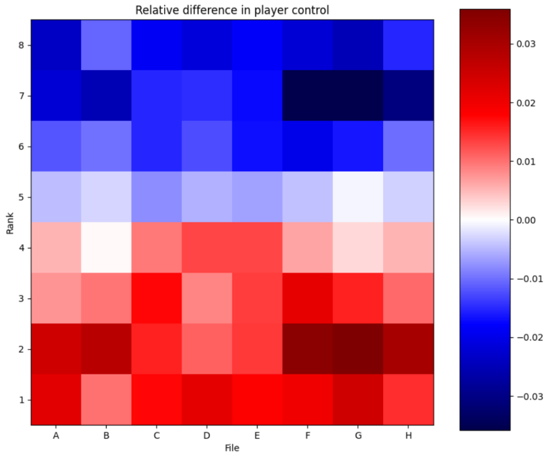

Fig 3. Plot for all games in a local database representing the square color throughout all matches.

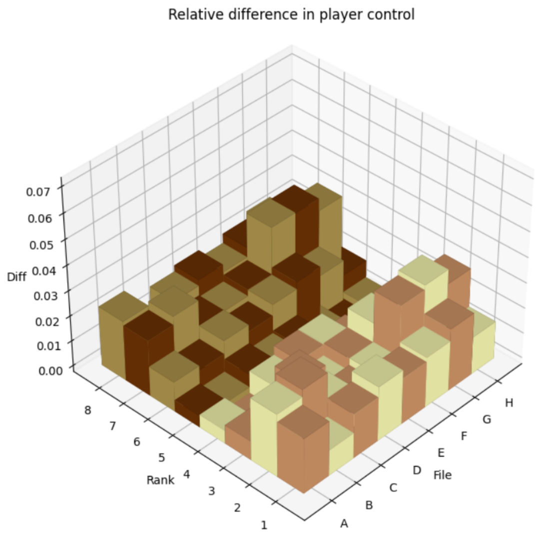

Fig 4. 3D plot for all games in a local database representing the square color throughout all matches.

Task 2 .Average color that attacks each square

Another way to define "controlling" a square is by being able to capture that square. So a square would have a score of +1 on a turn when a white piece could capture a black piece on that square, -1 on a turn when a black piece could capture a white piece on that square, and 0 if none or both colors could capture that square. Here is the result of the analysis for all games.

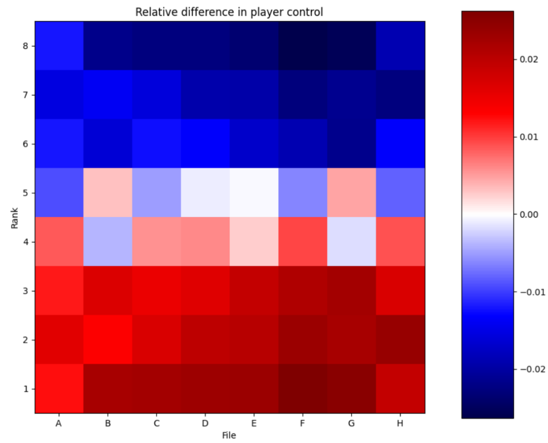

Fig 5. Plot for all games in a local database representing the average "control" by any player throughout all matches.

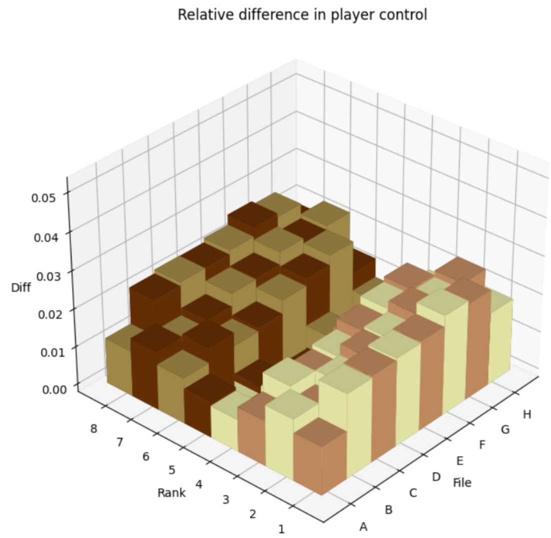

Fig 6. 3D plot for all games in a local database representing the average "control" by any player throughout all matches.

Notice how the b4, c5, f5 and g4 are "controlled" by black, since it aligns diagonally where the bishops are (c8 and f8) and similarly for white. Also, the 3 ranks on each side are controlled by the color very clearly, whereas the middle ranks are contested.

Task 3. Piece movement

The following plot shows the total movement (in king steps) that a piece does over a game. For the first game we have the following plots, both in linear and logarithmic scale. Notice how log is much better because one piece moved much more than all the other ones in the game.

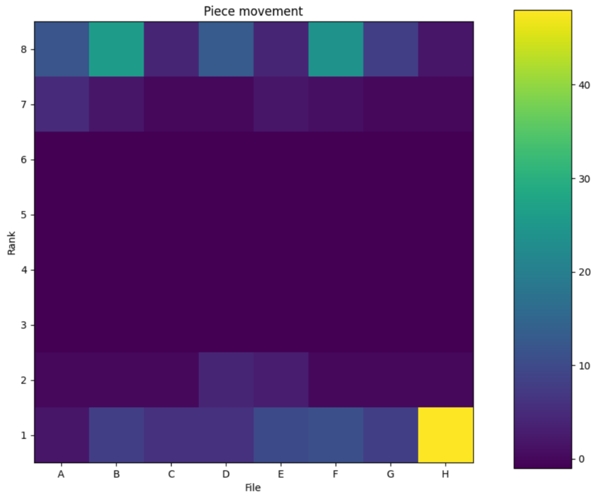

Fig 7. Plot showing the per-piece movement for the first recorded game representing the number of squares moved throughout the match, in "king steps".

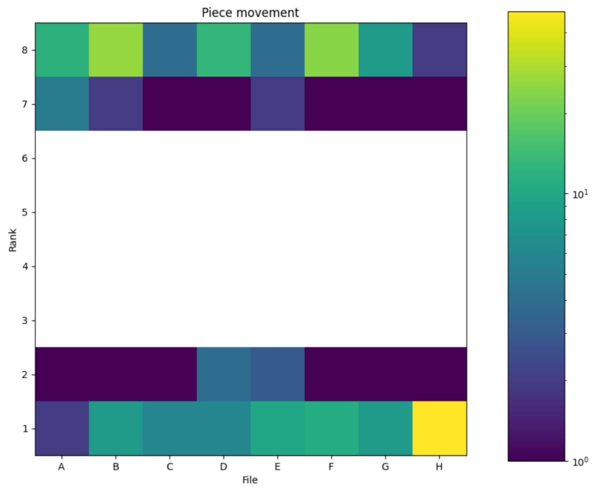

Fig 8. Logarithmic plot showing the per-piece movement for the first recorded game representing the number of squares moved throughout the match, in "king steps".

And now the plots for the average per-game piece movement for all games.

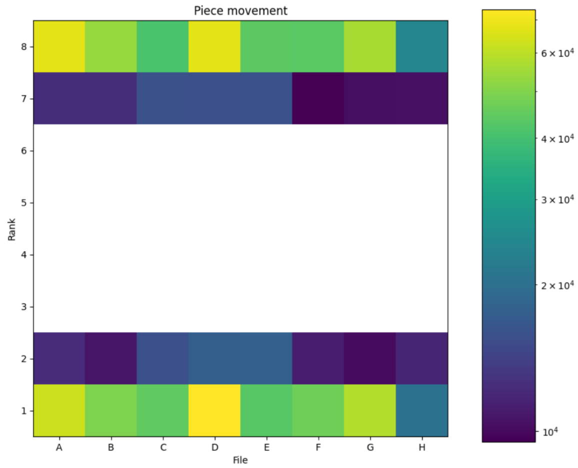

Fig 9. Plot for all games in a local database representing the total movement by every piece throughout all matches.

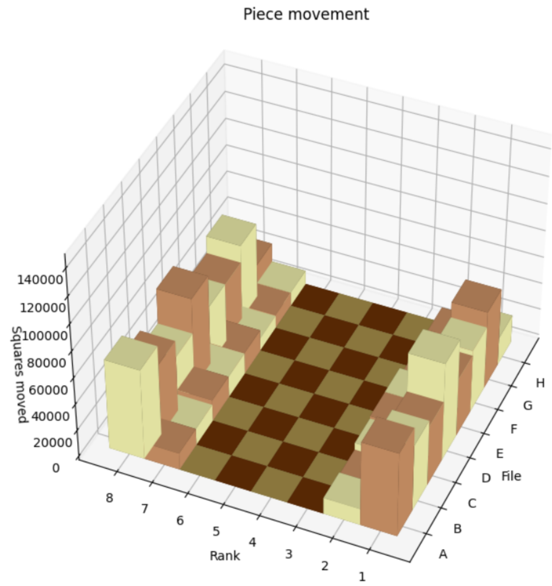

Fig 10. 3D plot for all games in a local database representing the total movement by every piece throughout all matches.

Notice how while the 3D plot obscures visibility, the actual values are easier to read from that plot, and it's also easier to measure the relative difference in movement. One learning from the 2D plot is that the 3 pawns in files c, d and e move more than all the others, which makes sense because they're in the center and they don't weaken the king (like f pawns do when they move early).

Task 4. Piece tension

We define tension when a piece can be captured in a given turn but isn't. These plots add up the number of turns they were in "tension".

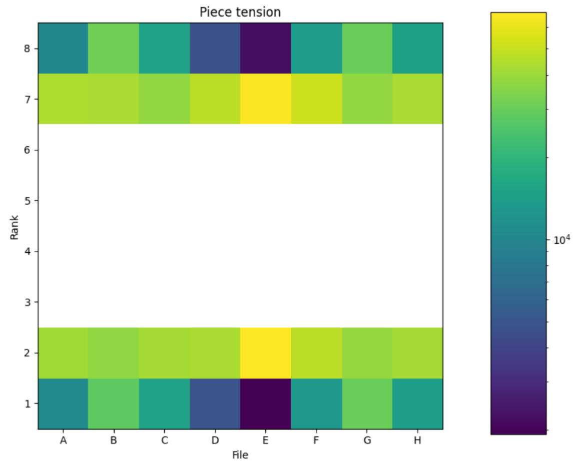

Fig 11. Logarithmic plot for all games in a local database representing the total number of turns in tension of every piece throughout all matches.

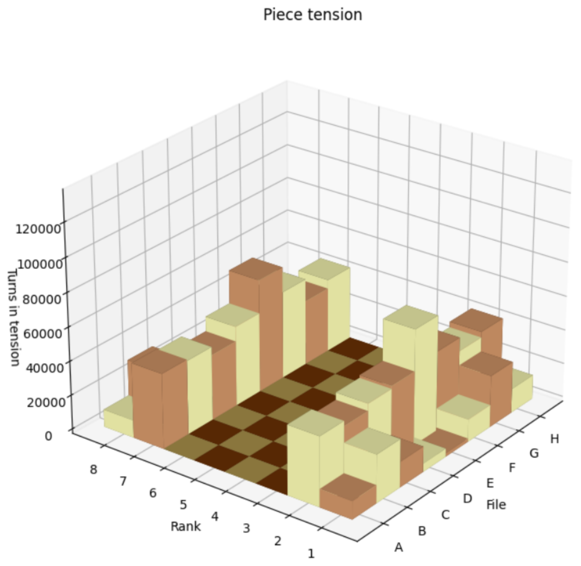

Fig 12. 3D plot for all games in a local database representing the total number of turns in tension of every piece throughout all matches.

Notice how:

- The pawns had the most turns in tension.
- The e pawns, which are in front of the kings, had the most tension.
- The king wasn't ever in tension because that would be checkmate, by definition.
- The queen was very rarely in tension, probably because it is the most valuable piece.
- The rooks and knights (e.g. a1 and c1) are in tension less time on average than the bishops.

IV. Conclusion

In conclusion, different statistics for chess games can be displayed in 2D and 3D plots by using varying colormaps (sequential or diverging), accumulation techniques (average per game, relative per piece, sum throughout games, etc), and different scales (linear and logarithmic).

References

[1] Code, documentation and game database used for this paper can be found at https://github.com/rm36/VisualizationProject

[2] FIDE ratings and statistics can be found in https://ratings.fide.com/