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КАК КОМПЬЮТЕРЫ ДУМАЮТ, КОГДА ИГРАЮТ В ШАХМАТЫ
HOW COMPUTERS "THINK" IN CHESS

Over time, a number of people have raised interesting questions about computer (artificial) intelligence and chess, what chess engines really do and how far that technology could reach in comparison to human intelligence. I would like to offer some thoughts and pointers for those of you who are interested in exploring this topic deeper or even just knowing how engines "think".

Chess engines recognize a number of patterns (typical chess positions); the more patterns and the more refined those patterns are, the higher the quality of the engine. Some of those are endgame patterns (for example, Nalimov tablebase), while others are middlegame patterns (e.g., good moves to play against isolated pawns, etc.). They also have vast opening databases (right part), so they "know" what has been played by strong players before, and how those games have continued and ended.

Chess engines evaluate a position in part based on the material balance where each piece has a preset value, which may change based on how developed and active each piece is in the specific game. The base material unit is 1 pawn, which is

approximately equal to 1.00, so if you see an engine give an evaluation of +1.00, that means it deems the position of white as equivalent to one where that side has 1 extra pawn. Typically, an advantage of +1.00 is sufficient for that side to win the game.

Each move has two parts - white's move and black's move. Each of those two is a called half-move. This "half-move" term is useful in chess engines when the engine does what is called "alpha-beta search and pruning". They build a tree of possibilities and each half-move corresponds to one level of depth of your tree. At a given level, the engine attempts to maximize the evaluation function (which corresponds to picking a move that is as strong as possible for you), while at the next level it attempts to minimize that function (because the engine searches the opponent's best move).

Modern engines are not primitive, so they cut out some variations early and do not waste time to explore them in depth. On the contrary, they save a huge amount of time, which can be better spent on evaluating other potentially useful moves. Since once the engine throws away a given possibility, it clears up and reuses that memory, while retaining only an encoding of the potentially fruitful continuations.

Finally, engines use heuristics (principles that may or may not be true, but most of the time are true), and the more these heuristics they know about (for example, difference between passed pawns and backward pawns) the stronger the engines can be. This also includes knowledge of typical patterns, which is why computers are good at solving typical chess puzzles.

Engines can get better over time. They will be able to think deeper and to see and recognize more patterns beyond raw calculation. It's interesting to note that humans learn and act based purely on pattern matching that are programmed in our psyche.

The depth of exploration of a chess engine depends on the processing speed of your computer: a more powerful computer is able to compute more in a given chunk of time. Although chess software can't be compared to human player it is good at raw calculation.

To understand the similarities and differences between human chess players and modern computer engines, we can assume that a modern chess computer/engine resembles a human chess player who has the following characteristics:

-highly disciplined (i.e., reliably consistent in the decisions it makes);

-completely unemotional (engine can play a lot of games equally strongly and consistently);

-extremely knowledgeable (i.e., has full and unclouded knowledge of openings, endgame positions, middle game strategic heuristics, and other patterns had been programmed into it);

-very strong (i.e., capable of beating even GMs, for the most advanced engines);

-makes almost no calculation errors, except those due to the limited window of how many moves ahead it's programmed;

-reliant solely on logical inferences based on pre-existing heuristics and memory, but has no substitute for human intuition

-generally unable to learn from own mistakes by itself, or to derive new knowledge without explicit new programming by humans.

These last couple of aspects are the humans' greatest enduring advantage over computers chess programs. They are the fundamental reasons allowing the strongest GMs to still beat computers occasionally

You may think that chess engines are much stronger than humans grandmasters, but they don`t have a human intuition, so nowadays grandmasters are also trying to fight with artificial intelligence.

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