

Chess Reveals Differences Between Human and AI Strategies

Chess grandmasters move toward a less complex game faster than AI players, suggesting different approaches for balancing short- and long-term prospects.

By **Mark Buchanan**

Diplomats and others handling strategic situations need to balance potential short-term gains against long-term opportunities or challenges. Now researchers have explored this trade-off in the simplified setting of chess, finding a difference between human and AI styles of play [1]. AI systems manage to navigate highly complex sets of potential moves and consequences over long times, whereas human players generally work to simplify games once they are past the opening phase that is dominated by memorized moves. The findings may help researchers understand how individuals delay gains in other complex systems such as economic

markets or geopolitical negotiations.

“Living things, institutions, and algorithms, all face this trade-off,” says Vito D. P. Servedio of the Complexity Science Hub in Austria. “When do you cash in a short-term gain, and when do you keep things open to preserve options you might need later?”

The complexity of real-world situations makes it hard to study this trade-off, but chess, Servedio notes, offers a simplified testing ground, as the players always have complete information on the current state of the game and future possibilities. Moreover, researchers have access to millions of recorded moves from historical games and can also watch both humans and machines face the same problem.

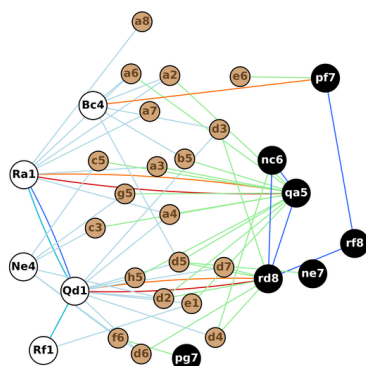
Physicist Marc Barthelemy of the University of Paris-Saclay recently studied how the fragility of a chess position—how susceptible it is to major cascading piece exchanges—evolves in games played by both humans and computers [2]. Servedio says that he wanted to explore a related question: “Is an artificial player, with much more computing power than a human, willing to live with more unresolved tension than we are?”

To find out, he and colleagues defined a mathematical measure that they call the strategic tension, which quantifies the complexity of the board layout represented as an abstract network. The locations of two opposite-color chess pieces are



Game of trade-offs. Chess players need to balance potential short-term gains against long-term opportunities or challenges. Researchers find that humans and AI players use distinct strategies, with computers maintaining more complex positions over longer periods of time.

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Visualizing the tension. In this network, a link connects two squares on the board if a piece on one square can capture a piece on the other; if a piece on one square defends a piece on the other, by threatening to take any opponent's piece landing on that square; or if a piece on one square directly threatens an empty square. The researchers calculate a property of this network that represents the number of pieces expected to be lost in a flurry of captures triggered by the taking of the first piece in a chain of connections within the network.

Credit: A. Cerioli *et al.* [1]

linked in this network if one can capture the other in the next move. The locations of two same-color pieces are linked if one is positioned to threaten an opponent's piece that captures the defended piece. A long chain of these links can lead to a cascade of piece exchanges triggered by a single capture, and the longer these chains, the higher the strategic tension. The researchers then analyzed the evolution of this quantity using data from roughly 1200 grandmaster games and 1200 elite AI matches, as well as chess simulations using Stockfish, an open-source chess-playing program.

They found that these games generally followed a consistent trajectory. During the first phase, as pieces begin interacting, the tension naturally increases. Eventually, there's a peak in tension around moves 15 to 30. A gradual decline in tension follows as piece trades simplify the board, before play enters a low-tension phase with fewer remaining pieces toward the end.

Expert human players reach slightly higher peaks of tension than computers early on because they have memorized sequences of highly effective opening moves known from

historical games. But after this phase, they then rapidly reduce the game complexity and resolve piece conflicts. This approach reduces the cognitive burden they face, the researchers suggest. In contrast, top AI engines remain comfortable navigating highly complex, densely interconnected positions and sustain elevated strategic tension over much longer durations.

The researchers also compared the evolution of tension in games in which one player ultimately won with that of games ending in draws. They found that the tension trajectories typically diverge around move number 15, when the strategic tension was generally still rising.

"The winner is decided during the buildup of complexity," Servedio says, "and the simplification that follows is a consequence of an already-decided game, not its cause." This result holds for both humans and computers and goes against the intuition of many chess experts, who believe that games are decided during the phase of maximum complexity.

"The finding about AI sustaining tension longer makes intuitive sense," says mathematician Steven Strogatz of Cornell University, an accomplished chess player who has also done research in this area. "As a person playing the game, you really feel the tension. It's tough to stay calm and concentrate, and it's natural to want to resolve the tension, just to reduce the cognitive load and stress."

Servedio suspects that these insights apply to the larger world too, although he is cautious about making the leap. In particular, he notes, the study suggests that humans often simplify strategic challenges simply because we can only hold a limited amount of complexity in our heads.

"Our findings prove nothing about international relations," he says, "as real conflicts have imperfect information and shocks that chess does not, but chess lets us see the mechanism cleanly."

Mark Buchanan is a freelance science writer who splits his time between Abergavenny, UK, and Notre Dame de Courson, France.

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