Thinking in Strategic Board Games: Calculation and Intuition

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What is thinking? This is a very big and general question. In order to say something useful about this cognitive process, we need to limit the discussion. We can consider problem solving, which is reaching some goal in a situation by choosing suitable actions from a range of possibilities. To make it even more concrete, we restrict our attention to traditional board games like Chess and Go. In these, the goal is clearly defined, and the possible actions, the legal moves, are also indisputable.

Chess and Go are two player games. They are *abstract*: they do not directly model reality. Even Chess pieces are quite removed from how a real army in historical times looked like. They are *strategic*: the outcome is determined by the decisions of the players. There are no secrets, no hidden information. The position on the board is all that's needed for making decisions. Chance is not involved, only the decisions matter. Therefore, these games are like personal laboratories for the decision making process (Kasparov, 2008), with all possibly confusing factors removed.

What is the problem to be solved? To win the game. *What are the possible choices?* All legal moves in a position, allowed by the rules of the game. Winning is about making good decisions in choosing moves. There are basically two different ways to achieve successful move selection: *calculation* and *intuition*.

What is calculation? It is working out a desired result by following some rules of computation. It is a step-by-step process. At each stage we know exactly where we are, and how we got there. Therefore, the steps can be verified. The prime example is arithmetic calculation, but it is not the only one. In board games, it is natural to consider not just the next move, but the opponent's possible next moves. And the next moves after the opponent's move, and so on. Trying to maximize the gain for our moves, and minimize the opponent's benefit. This is also a standard adversarial search technique in classical artificial intelligence , called minimax (Russell & Norvig, 2009).

There are limits to this method. The number of combinations of moves and countermoves gets huge quickly. Therefore, it is most useful for local tactical fights in Go, or in endgame situations in Chess, where the number of pieces to move is small. Then the question arises, how do we make strategic decisions involving the whole position on the board? We rely more on our intuition.

What is intuition? As we keep playing these games, insights about the next

move starts to happen. We suddenly have the right idea, we just "see" the solution, but cannot explain why. We feel that a move is a good one. But, we do not have a calculation proving that it is indeed the right choice. Is this some magical talent? Not really. It is just that our brain has very efficient information retrieval capabilities from previous memories.

How to improve thinking in games? To play well we need a mix of calculation and intuition. Both can be improved by practice.

The challenge in calculation is that we have to use our short term memory excessively. We cannot put the variation on the board, thus we have to play it out in our head. We have to imagine the sequence of moves. This is a very good memory exercise. No one doubts that calculation skills can be learned. By doing similar calculation exercises repeatedly, the process gets automated. Some patterns become familiar, so we do not need to calculate them. Consequently, we can do longer calculations.

On the other hand, intuition is often thought as a gift. A talent that people simply have or they do not. The opposite is true. Intuition can be trained. it is the natural consequence of calculation practice. Just by playing games, exposing the brain to the patterns on the board we can improve intuition. The brain does the clever pattern storage, but we have to constantly feed it with data. Either by playing, or replaying famous games. Intuition originates from a network of internalized and interconnected knowledge, and its creativity comes from the swift navigation of this network (Waitzkin, 2008). Roughly speaking, it is a very efficient and inventive database search.

In reality, the distinction between calculation and intuition is not that clear cut. Repeated calculation becomes second nature, turning into intuition; while we try to turn intuition into a more calculable method, or at least more verifiable. Getting stronger is not a linear process. It is a messy interplay between the two basic modes of thinking. The development has the following stages (again, not so well separated).

1. applying simple "rules of thumbs"; they often work in beginner games
2. accumulating expertise by making observations on how the simple rules succeed or fail; this could happen without conscious thinking, simply by exposure,
3. extracting 'deep', statistical rules from intuition, often in the form of proverbs

There seems to be no shortcut in the learning process. We may be tempted to ask an advanced player, to give us a summary of the essence of her expertise, a list of deep rules. The trouble is that these rules are statistical. Simple tactical advice comes in sharp 'if condition then action' form. But for statistical rules, the condition is difficult to recognize, thus expertise is not directly transferable.

Are there deep laws of precision at all? Is the perfect strategy expressible in a compact way, or does it have to be an exploding list of positions? Fully solved games are probably just vast enumeration of positions and winning moves.

How do computers think? Artificial intelligence follows the same development. Deep Blue mastered calculation (Kasparov, 2017), and AlphaGo intuition (Silver et al., 2016). Now, AIs are stuck at the same problem of extracting deep rules. It is

not clear how to understand intuition in a step by step calculative manner, how to interpret the knowledge distributed in the connection weights of an artificial neural network. Through self-playing, a powerful computer can recreate and surpass all human Go wisdom in three days (Silver et al., 2017). Still, that knowledge is not directly transferable. We can play the engine, just like learning from a human master player.

To end with a philosophical note, we observe that strategic board games are lot easier than life itself. In human life we simply don't have time to build up expertise, as the situation keeps changing. Literature can offer some shortcuts. We can experience other people lives by reading novels, training our intuition for the challenges of human existence.

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