An Alternative Approach for Playing Complex Games like Chess

Jan Lemeire JAN.LEMEIRE@VUB.AC.BE
ETRO Dept., Vrije Universiteit Brussel, Brussels, Belgium

Abstract

Computer algorithms for game playing rely on a state evaluation which is based on a set of features and patterns. Such evaluation can, however, never fully capture the full complexity of games such as chess, since the impact of a feature or a pattern on the game outcome heavily relies on the game's context. It is a well-known problem in pattern-based learning that too many too specialized patterns are needed to capture all possible situations. We hypothesize that a pattern should be regarded as an opportunity to attain a certain state during the continuation of the game, which we call the effect of a pattern. For correct game state evaluation, one should analyze whether the desired effects of the matched patterns can be reached. Patterns indicate opportunities to reach a more advantageous situation. Testing whether this is possible in the current context is performed through a well-directed game tree exploration. We hypothesize that this can be done more efficiently than traditional tree search. We argue that this approach comes closer to the human way of game playing. An implementation of this algorithm must, however, rely on a yet inexistent pattern engine.

1. Why the Evaluation Fails

Besides the abundant game playing research in optimizing the brute-force minimax search much work is done on learning algorithms. They try to mimic human game playing. Explanation-based algorithms offer such an approach. In explanation-based learning (EBL), prior knowledge is used to analyze, or explain, how each observed training example satisfies the target concept (Mitchell et al., 1986). This explanation is then used to distinguish the relevant features of the training examples from the irrelevant, so that examples can be generalized based on logical rather than statistical reasoning. A *pattern* denotes an advantageous situation. The explanations must give the sufficient and necessary conditions for a pattern to be successful.

However, for a complex game like chess, patterns that have to capture all aspects of a game become too complex. Consider the task of learning to recognize chess positions - the explanations - in which "one's queen will be lost within the next few moves" - the pattern (Mitchell & Thrun, 1996). In a particular example, the queen could be lost due to a fork, in which "the white knight is attacking both the black king and queen". A fork is, however, hard to define correctly. One has to capture all situations in which the pattern leads to a successful outcome. All counter-plans that are available to the opponent for saving both its threatened pieces have to be excluded (Fürnkranz, 2001, p. 25). A quasi-unlimited number of counter moves, generated by the context in which the pattern appears, exist that can neutralize the effects. Minton (Minton, 1984) and Epstein (Epstein et al., 1996) highlight the same problem of learning too many too specialized rules with explanation-based learning.

All game-playing algorithms rely in one way or another on an evaluation of game states. Either to measure the advantageousness of state or to select the most promising move The problem with complex games such as chess is that a correct evaluation cannot be cannot reduced to a linear (or non-linear) combination of features or patterns. Evaluation of pattern combinations heavily depends on game context. There will always be exceptions that contradict the evaluation. Our approach overcomes this problem.

2. Alternative Approach

Our analysis is based on the observation that the outcome of a game is determined by the exact interaction of the patterns and heavily depends on the context of the game state. Trying to describe all the interactions leads, by the complexity of the game, to an enormous amount of rules or patterns. We hypothesize that the influence of a pattern on the game outcome depends on the achievement of certain states during the continuation of the game. We call these states the *effects* of the pattern. The influence of a pattern on the game outcome is completely described by these effects. The game can be analyzed by the set of existing patterns and whether their effects can be achieved. The difference with the explanation-based approach is that we do not

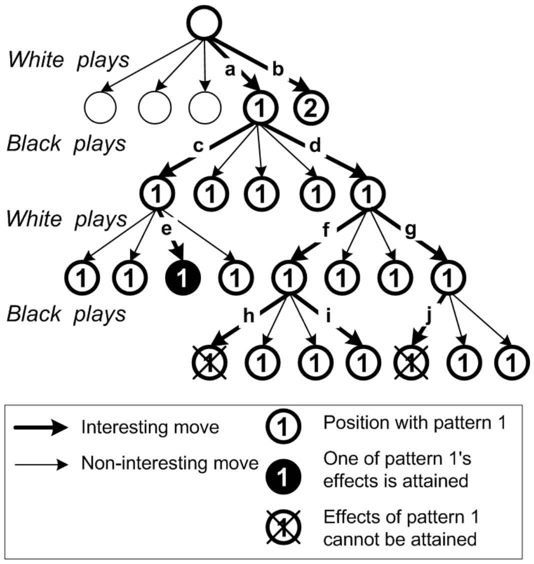

Figure 1. Game tree exploration by looking at patterns and their possible effects

expect the game always to reach the effect in the presence of the pattern.

Take the game tree of Fig. 1. Assume that the white player considers playing move a by which he arrives at a position in which pattern 1 is true. He hopes of achieving one of the advantageous effects of the pattern. The black player sees two possible counter moves. If he chooses for move c, however, white can collect the benefits of pattern 1 with move e. This is not possible if black chooses for move d. White can then play f or g, but in both cases black neutralizes the threat of pattern 1 with moves h and j respectively. Both moves bring the game in a state in which the positive effects of the pattern cannot be attained anymore.

The feasibility of this approach relies on a second hypothesis. We hypothesize that the moves 'interfering' with the pattern can be identified so that only those have to be explored. Other moves can be classified as being irrelevant; they do not approximate to the achievement or falsification of the pattern's effect. The game tree can be pruned effectively.

We thus have defined a new kind of generic knowledge; patterns together with their effects. However, an implementation of this approach needs a yet inexistent pattern engine. We do not have a genenic way to describe, recognize, learn and reason with patterns.

3. Human-like Game Playing

Psychological studies have shown that the differences in playing strengths between chess experts and novices are not so much due to differences in the ability to calculate long move sequences, but to which moves they start to calculate. Cowley and Byrne showed that chess experts rely on falsification (Cowley & Byrne, 2004). The results of the research show that chess masters were readily able to falsify their plans. They generated move sequences that falsified their plans more readily than novice players, who tended to confirm their plans. Our approach confirms this; it is based on plans and on falsification.

It's well-known that humans have difficulties formally defining the knowledge they use. Our approach can explain this. A pattern only denotes an opportunity. A precise description of the states in which it is successful is not necessary, a well-directed tree search is used to confirm or falsify the hypothesis. Our approach also explains why humans can reason about a game, why we can exactly pinpoint which actions were decisive in a game and why.

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