REVIEW

THE DARK SIDE OF THE BOARD: ADVANCES IN CHESS KRIEGSPIEL

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Today, I am discussing a very nice PhD thesis on an intriguing game that deserves much wider attention. The game was invented more than 100 years ago, yet there are only a few people playing it. One reason might be that this two-person game needs an active referee throughout the entire game. This used to be a hassle, no doubt, but in the age of computers and internet the role of the referee can easily be performed by a computer.

Imagine playing Chess without seeing your opponent's pieces move. And unlike blindfold Chess, you are not told what moves your opponent makes. Initially, that sounds like an intellectual version of "pin the tail on the donkey", or even "break the piñata". But on closer inspection it provides a great challenge in both strategic and psychological warfare (game playing). Welcome to the world of Kriegspiel (the German word for 'war game').

Of course, to avoid total chaos, you need to receive some minimal information, for example on whether the move you want to make is legal, when one of your pieces is captured, and when your King is in check. That duty is performed by a referee who only communicates privately with each of the two players. Sound simple enough, but as Gian Piero Favini says in the introduction of his thesis: "Unfortunately, Kriegspiel is hardly a standardized game, which is both a cause and a consequence of its scarce popularity throughout the XX century, at least until more recent years."

I had never played Kriegspiel, and was curious to try it out. A Google search on 'play Kriegspiel against the computer' pointed me to play.chessvariants.org/erf/Kriegsp2.html where I played my first ever game of Kriegspiel. I won in four moves: e4, Bc4, Qh5, Qf7. With the game over, I was shown the final position. My computer opponent had played (in unknown order) e5, Na6 and Bd6. Not the best of moves, in the modest opinion of someone who has just played his first ever game of Kriegspiel.

There appears to be quite a lot of uncharted territory in the Kriegspiel domain. In Chapter 4 of his thesis, Favini describes his Kriegspiel-playing program DARKBOARD. He starts by explaining the concept of a metaposition, which is the superposition of different but equally likely game positions into one state (position). For example, the metaposition that Black faces upon his first move is the superposition of all 20 possible positions after White's opening move. Readers familiar with quantum physics will immediately spot the analogy to the description of a physical state as the superposition of the solutions to the Schrödinger equation. For that reason alone Kriegspiel is a fascinating game. As can be expected, the evaluation function is mainly concerned with the position and safety of the friendly pieces because of the lack of information about the opponent's pieces. The third major component is the notion of information: "DARKBOARD's notion of information gathering coincides with reducing a computable function, which the program calls chessboard entropy (E). This definition is not directly related to those used in physics or Information Theory, but its behavior resembles that of an entropy function".

In Chapter 5, Favini discusses the implementation of Monte Carlo Tree Search (MCTS) techniques in DARKBOARD and how that improved the playing strength. DARKBOARD 2.0, which uses the MCTS algorithm, requires only minimal domain knowledge and it is consistently stronger than DARKBOARD 1.0 which relies on the metaposition-based method. The algorithm can also be used for opponent modeling, which is much more important in Kriegspiel than it is in Chess.

Chapter 6 deals with the endgame in Kriegspiel. It is interesting to see how even the most trivial endgame in Chess becomes a major challenge in Kriegspiel. For example, in KRK the only concern in Chess is that you do not accidentally stalemate your opponent, while in Kriegspiel you also need to worry about keeping your Rook safe so that it cannot be captured. Not knowing exactly where the opponent King is, this is a real concern.

Also, obviously, it takes much longer to win such simple endgames. Neither side can play as optimally as in Chess, which means that it is hard to win endgames that are a sure and quick win in Chess. Alternatively, it may be possible to win endgames in Kriegspiel that cannot be won in Chess under optimal play from both sides.

Surprisingly, perhaps, it is possible to create a special kind of tablebases by means of retrograde analysis. Like in Chess, tablebases allow a Kriegspiel program to play such endgames 'perfectly': "Using a brute force retrograde analysis algorithm, a suitable data representation and a special lookup algorithm, one can achieve perfect play, with perfection meaning fastest checkmate in the worst case and without making any assumptions on the opponent." In Chapter 7, Favini investigates the KRK, KQK, KBBK and KBNK endgames. One serious problem is the 50-move rule which is no different than in regular Chess. This is especially a problem for the KBNK endgame. In Chess, the longest distance to mate in this endgame is 33 moves, but in Kriegspiel it is 89 moves. Favini observes that "Not much can be said about KBBK and KBNK because of their very low frequency, though the program never managed to checkmate a human player with a Bishop and a Knight." Another problem is threefold repetition, which is a strategy that humans employ frequently when playing against a computer. Favini notes that "on average, endings against human players last longer […]. Humans put up a better defense, which results in a higher ratio of games over the 50-move limit. A human expert will try to move back and forth between two squares and ask for a draw by threefold repetition on every move." One very nice result is Favini's discovery of an improvement to the solution to what is perhaps the most famous KBNK problem for Kriegspiel. In 1973, Lloyd Shapley first discussed this position (Ke1, Bc1, Nf3, Kg8) and argued that is was a mate in 22 moves. Favini's tablebase solution shows that it is, in fact, a mate in 21 moves.

Kriegspiel is really a fascinating game of strategy and psychology. Just a few games against the computer on the aforementioned website will certainly wet your appetite. It does put up a little bit of a better fight than in my first ever game, but it is very weak. Can it be replaced by DARKBOARD, please? After WWII the mathematician J.K. Wilkins was director of the RAND Institute and became intrigued by Kriegspiel. He developed his own set of rules (now known as the RAND rules) and used Kriegspiel as a means of training in the analysis of war scenarios. Also, famous game theorists such as John Nash and Lloyd Shapley became interested in Kriegspiel. Given all that, it is somewhat surprising that this game does not enjoy a wider following of players and computer programmers.

If you like Kriegspiel, you should definitely read this thesis. You can download a copy from www.cs.unibo.it/pub/TR/UBLCS/2010/2010-06.pdf. It is not every day that an authority like Gian Piero Favini writes a PhD thesis about his insights. DARKBOARD is currently the world's strongest Kriegspiel program and performs at an above-average human level. In 2006 it had played almost 6000 games on the Internet Chess Club (ICC) and achieved an Elo rating of 1814 which placed it in the top 20 of the ICC Kriegspiel players. DARKBOARD won the gold medal at the Computer Olympiads of 2006 and 2009 – the only two of 15 Computer Olympiads which had a Kriegspiel tournament. The 16th Computer Olympiad will be held in November 2011 in Tilburg. Will there be a Kriegspiel tournament? I certainly hope so. Kriegspiel is a fascinating game that deserves much more attention. It is a great challenge for ambitious programmers who feel that it may be too difficult to create a computer program that can seriously compete in traditional intelligent games like Chess and Go. There is a whole new world to be discovered in Kriegspiel. Let's face it: how hard can it be to write a computer program that can beat the current best Kriegspiel program in the world, considering that it has an Elo rating of only 1814?