

December 16, 2019

From: Yale Yechiel N. Robinson, Patent Attorney
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To: United States Patent and Trademark Office (USPTO)
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Re: Request for Comments on Intellectual Property Protection for Artificial Intelligence Innovation, Docket number: PTO-C-2019-0038

To the USPTO and Members of the Public:

My name is Yale Robinson. In addition to my professional work as a patent attorney and in other legal matters, I have for years enjoyed the intergenerational conversation within the game of chess, which originated many centuries ago and spread across Europe and North America around the middle of the 19th century, and has since reached every major country in the world.

I will direct my comments regarding issues of intellectual property for artificial intelligence innovations based on the history of traditional western chess. Early innovators in computing, including Alan Turing and Claude Shannon, tried to calculate the value of certain chess positions using the 1950-era equivalent of a present-day handheld calculator. Their work launched the age of computer chess, where the strongest present-day computers can consistently (but not always) defeat or draw elite human grandmasters. The quality of human-versus-human play has increased in part because of computer analysis of opening and middle-game positions that strong players can analyze and practice playing on their home computer device before trying the idea against a human player in competition.

In addition to the development of chess theory for the benefit of chess players (human and electronic alike), the impact of chess computing has arguably extended beyond the limits of the game itself. Chess computing has been considered a test module for the ability of artificial intelligence software to make decisions in a situation where the theoretical value of a position is ontologically determinable, but the complexity of the search space prevents a solver of limited capability from determining the theoretical value and, therefore, the fallible player cannot find the best move to play on the chessboard in order to preserve the ideal theoretical value.

An interesting development in the search for ultimate truth in the chess context is the publication online of freely searchable endgame tablebases, where the term “tablebase” apparently developed as a compromise among chess computing experts in the 1980s who referred to the concept alternatively as “endgame table” or “endgame database.” Examples of pioneers in the field include the following researchers, who each hold a Ph.D. in a related field:

- Lewis Stiller,¹

¹ See, for example: “Multilinear Algebra and Chess Endgames” by Lewis Stiller. *Games of No Chance*, 1996. <http://library.msri.org/books/Book29/files/stiller.pdf>

- Guy Haworth,²
- Azlan Iqbal,³ and
- Harold van der Heijden.⁴

The key difference between an endgame tablebase and a traditional chess computing program is the direction and timing of the analysis. In a traditional chess computer program of the type pioneered by Turing and Shannon, algorithms such as alpha-beta and minimax are used to estimate the best move in a complex position by searching a limited number of moves from the current position on the chessboard into a hypothetical set of future positions that may occur several moves later. This forward search in real time is limited by the fact that it is usually not possible to analyze a complex position all the way to an ending position of checkmate or a determination that checkmate will never occur and the game will become a draw.

In contrast, an endgame tablebase is created by compiling the entire group of all theoretically possible positions with a given set of material, then identifying all positions in which the losing player has been checkmated. Working backwards, the next earlier move in a perfectly played game between two omniscient players would involve the losing player making his last move before the opponent will checkmate him. Working backwards further, a series of moves by both players can be discovered, in which checkmate can be foreseen ten or even one hundred moves before the checkmate will actually occur with perfect play.⁵ Some positions are excluded from the retrograde analysis tree of positions that will eventually lead to checkmate; instead, those unclassified positions are considered draws because neither player can force checkmate.

I have used endgame tablebases in the hobby of composing endgame study puzzles for publication in quarterly periodical magazines such as *The Problemist* (UK), *Variantim* (Israel), and *StrateGems* (USA).

The USPTO's request for comment concludes with question number 13, which is most relevant to the norms of chess problem composition in the era of computer chess and endgame tablebases:

13. Are there any relevant policies or practices from intellectual property agencies or legal systems in other countries that may help inform USPTO's policies and practices regarding intellectual property rights (other than those related to patent rights)?

² Haworth, G. (2017) Chess endgame news. *ICGA Journal*, 39 (2). p. 172. ISSN 1389-6911 Available at <http://centaur.reading.ac.uk/72281/>

³ "A Computer Composes A Fabled Problem: Four Knights vs. Queen" by Azlan Iqbal (2017). <https://arxiv.org/ftp/arxiv/papers/1709/1709.00931.pdf>

⁴ Dr. Heijden has compiled a database of all published endgame study puzzles that have been published in major chess periodicals during the last two hundred years approximately. The current 5th version of the database is available for purchase and download; it has been used to assist in composition and analysis of newly discovered chess positions. See: Harold van der Heijden Endgame Study Database V, available at: <http://hhdbv.nl/>

⁵ A forcing checkmate sequence lasting 549 moves was found in a 7-piece endgame tablebase. See Tim Krabbé, *Open Chess Diary*, Item 393: <https://timkr.home.xs4all.nl/chess2/diary.htm>

I respectfully suggest that chess endgame study composition is particularly well suited to provide an analytical framework precisely because money does not drive innovation in this field. Most chess composers (including me) have spent dozens of hours composing and solving puzzles as a hobby, where the reward of seeing your name alongside a chess diagram in a foreign language publication somehow justifies the pursuit of creativity in this quirky domain as an alternative to painting, music, or other creative arts.

Even though chess composers do not work for pay, and are fully aware of that fact before undertaking an attempt at composing a work of mathematical art, there is still a framework of informal rules and standards for publication that the chess problem magazines enforce in order to assure that readers will receive high quality puzzles to justify the cost of the readers' annual subscriptions. In the words of *The Cat in the Hat*, as composed by Dr. Seuss: "It is fun to have fun, but you have to know how!"

A publishable chess endgame study must require the solver, who is usually given the white chess pieces in a hypothetical chess position, to attain a best-case outcome of either a win ("White to play and win") or draw ("White to play and draw"). The prompt to "win" or "draw" is similar to a player's goal in an actual chess game—either to win or to draw the game, regardless of how long it may take to achieve the desired result. Thus, endgame studies are distinguishable from time-limited problems, where $n \geq 2$:

- Directmates: "White to play and checkmate Black in n moves."
- Selfmates: "White to play and force Black to checkmate White in n moves."
- Helpmates: Both players cooperate to cause Black to be checkmated in n moves.

Chess endgame studies share aspects of both patent and copyright theory. In terms of patent theory, a chess endgame study must possess both utility and novelty.

- **Utility** means that the puzzle has one unique meaningful solution, although a trivial duality in a side variation is tolerated as long as the intended main-line solution is unique.
- **Novelty** means that the position has not been published in a prior publication. Although obviousness in patent law does not necessarily correlate to anticipation in chess puzzle composition, a publisher may reject a chess puzzle submission from appearing in print if the main-line solution has been published elsewhere, even if some side variations or introductory moves are newly composed.

A chess puzzle that lacks utility is considered "**cooked**" either because the original intended solution does not accomplish the intended goal or, conversely, because an unexpected second line of play renders the intended solution non-unique.

Similarly, a chess puzzle that has been published by another author is considered "**anticipated**"—the same term commonly used to reject patent applications for failure to satisfy the novelty criteria of 35 U.S.C. § 102.

In terms of copyright theory, it is considered in poor taste to submit a chess composition to multiple simultaneous tournaments or magazine publishers without first notifying each potential publisher of the duplicate submission. Just as a chess puzzle may be anticipated by a prior publication by another author, it may also be inappropriate because of a prior or simultaneous publication by the same author.

I have had personal experience with each of the issues identified above: “cooked” solutions, anticipation, and simultaneous publication.

“Cooked” Invalid Solutions

More than ten years ago, I submitted a chess composition to Grandmaster Dr. John Nunn for a composing tourney in honor of his birthday that year. Dr. Nunn kindly pointed out to me by email that my submission was incorrect because of a second solution that I had not noticed in my own analysis at home.

Subsequently, I made sure to run my chess puzzles through an endgame tablebase if possible,⁶ or alternatively through a traditional alpha-beta analysis program such as Stockfish, which can be queried for free on the Internet.⁷ After 6-piece tablebases became available online for free access around 2005, followed by 7-piece tablebases around 2015, I searched these tablebases for interesting positions that may constitute interesting ideas for a publishable chess endgame study.

Notably, my search process consisted entirely of trial and error by hand. Mr. Arpad Rusz and some other endgame study composers have also used artificial intelligence software to search for interesting positions in the tablebase data set.⁸

My personal view is that the endgame studies that Mr. Rusz discovered using his version of the software hold equal validity as if he discovered these positions by trial and error. If the purpose of publishing chess puzzles is to arouse the intellectual curiosity of composers and solvers, the path to finding an interesting chess position makes little difference to me. Furthermore, some of my compositions were aided by the fact that I already knew from the tablebase that a certain position has a unique best move. It was not necessary for me to undertake the human analysis that 20th-century composers had to attempt before publishing studies in the pre-tablebase era.

Anticipation

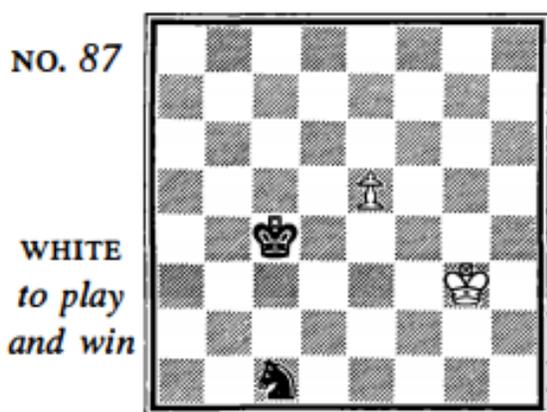
A fully anticipated study fails the requirement of originality that publishers demand from chess problem composers. However, a new twist on an old idea is sometimes acceptable for publication. An amusing example of improving on a classical work of art came to me when I

⁶ The be strongest current set of chess tablebases covers all positions with 7 or fewer chess pieces for both players combined (for example, White has four pieces, and Black has three other pieces). Any Internet user can input any chess position with 7 or fewer pieces to look up the theoretical result with best play according to the data stored in the Syzygy Tablebases, available at: <https://syzygy-tables.info/>

⁷ Stockfish chess engine website: <https://stockfishchess.org/>

⁸ Arpad Rusz, “Syzygy Endgame Explorer (SEE)” blog post: <http://ruszchessstudies.blogspot.com/2018/06/syzygy-endgame-explorer-see.html>

reviewed a well-known simple study published by Jan Marwitz in 1937, as explained below by Irving Chernev in his book *Practical Chess Endings* (New York, copyright 1961):⁹



MARWITZ 1937

1 P-K6! Kt-K7ch

WHITE must move out of check, and has choice of seven squares. One, and only one, is the right square, that assures White of a win. Moving to any of the others leads to a draw, as follows:

A] 2 K-B3, Kt-Q5ch, winning the Pawn

B] 2 K-R3, Kt-B5ch, winning the Pawn

C] 2 K-Kt4, Kt-B6 3 P-K7, Kt-Q4 4 P-K8(Q), Kt-B3ch, winning the Queen

D] 2 K-R4, Kt-B5 3 P-K7, Kt-Kt3ch, winning the Pawn

E] 2 K-B2, Kt-B6 3 P-K7, Kt-K5ch 4 K-K3, Kt-Q3, stopping the Pawn (and capturing it later with the King).

F] 2 K-Kt2, Kt-B5ch, winning the Pawn

How that Knight hops around!

2 K-R2!!

This is the right move, to which there is no reply.

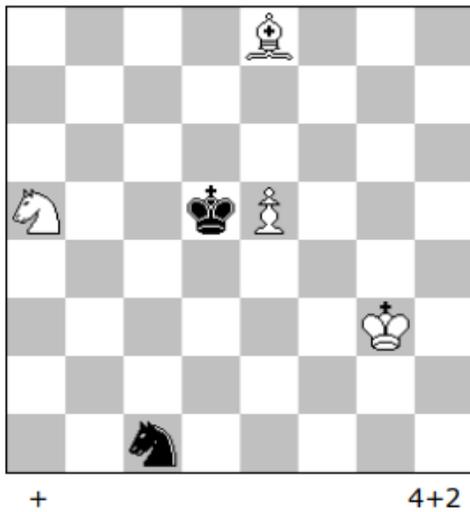
White wins

Working backwards from the Marwitz position shown above, I discovered a position where White could sacrifice a knight and a bishop in order to arrive at the Marwitz position.

An Italian chess magazine accepted my request to publish the variant study with attribution to Marwitz, using the standard authorship notation "Robinson after Marwitz." The diagrams on the next page are copied from *Sinfonie Scacchistiche* (January – March 2016, pages 13 and 21):

⁹ The image above of page 98 of Chernev's *Practical Chess Endings* is copied from the following website: https://indianchess.org/yahoo_site_admin/assets/books/Practical-Chess-Endings.pdf

107 – Y. Robinson [USA]



After Jan Marwitz

Sinfonie Scacchistiche

107 – Y. Robinson (Stati Uniti)

[after Jan Marwitz]

Soluzione:

Ra8

e4

**d6 Ce8≠
b6≠**

Rd6

1.Cc4! [1.Cc6?, Cd3!], **Rxc4** [1... Ce2+; 2.Rf2! Rxc4 (2... Cd4; 3.Af7+, Re4; 4.e6, Cxe6; 5.Axe6 with an elementary bishop and knight win. This is the longest depth to mate); 3.e6! (3.Rxe2?, Rd5. 3.Af7+?, Rd4; 4.e6, Cc3; 5.e7, Ce4+; 6.Rf3, Cd6), Cc3 (3... Rd5; 4.Af7! 3... Rc5; 4.Rxe2! White needed to play 2.Kf2 two moves ago so that he could capture the knight now); 4.Ac6!, Rc5; 5.e7, Rxc6; 6.e8D+. 1... Cd3; 2.Af7+]; **2.Af7+, Rc5: 3.Ac4!** [domination: if the knight moves, the bishop will capture it], **Rxc4** [We have reached the beginning of a classic endgame study by Jan Marwitz, published in 1937. 3... Ce2+; 4.Axe2, Rd5; 5.Rf4]; **4.e6, Ce2+; 5.Rh2!!** ["How that knight hops around". - Irving Chernev, *Practical Chess Endings*. 5.Rh3, Cf4+. 5.Rh4, Cd4; 6.e7, Cf5+. 5.Rg4, Cc3; 6.e7, Cd5; 7.e8D, Cf6+. 5.Rf3, Cd4+. 5.Rf2, Cc3; 6.e7, Ce4+; 7.Rg2, Cf6. 5.Rg2, Cf4+], **Cd4; 6.e7, Cf5; 7.e8D**. The position after Black's third move is identical to the position after Black's first move, except that White has cleared away the bishop, which was blocking the pawn's promotion square. Thus, the present endgame study is an economical example of the WCCT7 theme (passive removal of a white piece). **1-0**

Le notazioni in blu sono state riportate esattamente come l'Autore ha scritto.

Simultaneous Publication

Finally, as to simultaneous publication in two different magazines, I fell afoul of this norm about three years ago when I submitted two similar or identical endgame studies featuring the motif of two white knights preventing a black rook from escaping a restricted area on the back rank of the chessboard. A friend in Europe emailed me to express gently his displeasure at the fact that I

had submitted to him a study that duplicated my previous study published elsewhere. Apparently the duplication escaped his notice until after his magazine had already published my study. The friend invited me to withdraw my study from eligibility to receive an honorary award at the end of the year. This was effectively a symbolic gesture because my study probably would not have qualified for an award in deference to studies by other composers. Furthermore, any award would have been only for honor but not money.

However, if the purpose of engaging in a creative hobby is to make friends and enjoy conversations with people across the world that I might not otherwise encounter, I learned the lesson to follow the good graces of what those people desire in a relationship.

Conclusion

Referring back to my modification of the Marwitz study, I used a printed publication to start the thought process of working backwards and finding three introductory moves that would enhance the pleasure of a hypothetical solver who would read the magazine. Then, I used an endgame tablebase to confirm that my 6-piece ending was consistent with the requirement that a study must hold one unique solution. You can play through the solution of my version of the study (which leads to the Marwitz position after the first three moves) by clicking on the hyperlink in the footnote for the interactive tablebase web application.¹⁰

Despite using both a previously published study for inspiration and a tablebase to confirm technical accuracy, I believe—and the publisher, Valerio Agostini, agreed—that my version of the Marwitz study would enhance the experience of at least a few distant readers and solvers. It was a creative work of art, regardless of the assistance from the original composer Jan Marwitz, the commentator Irving Chernev, the tablebase program and its software programmers, and Mr. Agostini.

Suggestion on Policy Outlook

I respectfully suggest the USPTO should try, where possible, to bifurcate the questions of “is this work a product of human creativity” and the ancillary question of “who has financial property rights to it.” Chess composition allows us to consider the first question without being blinded by the second question.¹¹

If, hypothetically, my composition shown above were to have financial value, it might be necessary to assign some formula to distribute profits to the Italian magazine, the estate of Jan Marwitz, the tablebase software developer, and to me. Thankfully, we don’t need to consider that question.

¹⁰ https://syzygy-tables.info/?fen=4B3/8/8/N2kP3/8/6K1/8/2n5_w_-_0_1

¹¹ I use the word “blinded” by analogy with the Biblical teaching that bribery blinds the eyes of a wise judge and can lead to a perversion of justice (Exodus 23:8; Deuteronomy 16:19). Clearly, the complexity of intellectual property disputes prevents a broad characterization of any particular view as bribery. However, a clear-eyed analysis of what constitutes property should begin with a conceptual framework that does not rely exclusively on whether an item holds a large quantity of financial value.

I could not have composed the sequential sacrifice of a knight followed by a bishop without some help from predecessors and contemporaries. But similarly, I could not have composed the present document without access to a computer with an Internet connection that enabled me to download and copy images from certain websites. I wonder: is there really any difference between using the Internet for research and writing, and using artificial intelligence to help a human evaluate whether his work is publishable?

I am not advocating for or against any particular policy. I started typing on a blank computer screen without a clear idea or agenda, and I remain in an unresolved state of mind. However, I think it may be helpful to consider the questions of creative value and financial profit as distinctly as possible.

Acknowledgment

I acknowledge the encouragement of Robert Barr, USPTO Deputy Commissioner, whom I met in Boston at an event sponsored by the American Intellectual Property Law Association (AIPLA) and in part by the Boston Patent Law Association (BPLA) on December 10, 2019. Mr. Barr responded favorably to my offer to write about chess composition as an alternative form of intellectual property where artificial intelligence plays a role. I hope he and his colleagues will find the preceding comments helpful.

Sincerely,

Yale N. Robinson