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AI-Augmented Mathematical Resolution of Chess Problems: A Neuro-Symbolic Framework for Research and Education

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Abstract

The author's prior work introduced a method that solves chess problems through purely mathematical analysis of their algebraic form. This paper extends that program by propos-ing an AI-augmented research agenda that joins symbolic mathematics, automated reason-ing, and modern learning systems. We present a neuro-symbolic framework that encodes chess problems as logical or algebraic constraints, solves them with constraint reasoning and search, verifies solutions in proof assistants, and generates human-centered explanations suitable for teaching. We describe how recent advances in large language models, tool-using agents, and satisfiability modulo theories can transform both research on mathematical en-codings of chess and the educational practice that motivated the original method. The paper proposes a pipeline, evaluation protocols, and open problems that together define a research program for AI-enhanced discovery, pedagogy, and the automated generation of novel chess problems with mathematical certificates.

Keywords: chess problems, mathematical encoding, neuro-symbolic AI, satisfiability modulo theories, theorem proving, education, explainability