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Cognitive Complexity of Logical Reasoning in Games: Automated Theorem Proving Perspective

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Abstract

We use formal proof techniques from artificial intelligence and mathematical logic to analyse human reasoning in problem solving. We focus on the Deductive Mastermind game, as implemented in the Dutch massive online learning system for children, Math Garden. The game is formalised in propositional logic and the game-playing procedure is given a form of a logical proof. We use Resolution and Natural Deduction proof methods (implemented in JAVA). The difficulty of a particular logical reasoning step is associated with the computationally obtained parameters of the proofs, which are compared with each other, and against the empirical difficulty of the game. We show, among others, that the complexity parameters derived from Natural Deduction agree with the Analytical Tableaux parameters, and with the empirical difficulty as experienced by human subjects.

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