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Proceedings of the Annual Meeting of the Cognitive Science Society

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Journal

Proceedings of the Annual Meeting of the Cognitive Science Society, 47(0)

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Publication Date

2025

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Peer reviewed

A Computational Cognitive Model for Processing Repetitions of Hierarchical Relations

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Abstract

Patterns are fundamental to human cognition, enabling the recognition of structure and regularity across diverse domains. In this work, we focus on structural repeats, patterns that arise from the repetition of hierarchical relations within sequential data, and develop a candidate computational model of how humans detect and understand such structural repeats. Based on a weighted deduction system, our model infers the minimal generative process of a given sequence in the form of a Template program, a formalism that enriches context-free grammar with repetition combinators. Such representation efficiently encodes the repetition of sub-computations in a recursive manner. As a proof of concept, we demonstrate our model's capability on short sequences from music and action planning. The proposed model offers broader insights into the mental representations and cognitive mechanisms underlying human pattern recognition.