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Exploring Unforeseen Causal Relationships in Fuzzy Cognitive Maps

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Abstract: Cognitive maps were first introduced to the academic community in the 1970s by the political scientist Robert Axelrod, and they are used to examine an individual's perception and interpretation of complex systems. Fuzzy cognitive maps (FCMs) extend Axelrod's innovation by taking causal reasoning into consideration. In particular, relationships between concepts are represented on a scale of zero to one, depending on the certainty of the connection. However, the effect of seemingly unconnected concepts is not explored; this research fills that void. Specifically, this paper examines the potential impacts of unforeseen internal causal relationships or "unknown unknowns" on an FCM's steady-state. We illustrate our approach on a small, theoretical example, as well as a more substantial, real-world FCM representing the degradation and deforestation of the Brazilian Amazon. We conclude our work by discussing the limitations of the approach and opportunities for future research.

Keywords: Fuzzy cognitive maps, sensitivity analysis, complex systems