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Emergence of Communication: A Comparative Study of Instance-Based Learning in ACT-R and PyIBL

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Abstract

This study investigates the role of memory mechanisms in the emergence of communication by comparing two instance-based learning models: one implemented using the ACT-R cognitive architecture and the other using PyIBL, a lightweight framework based on Instance-Based Learning Theory. Both models were tested on a simulated communication task requiring agents to coordinate actions message exchange using abstract symbols. The ACT-R model, featuring an explicit goal-representation module and precise memory structure, led to faster formation of communication system and more successful task performance. In contrast, the PyIBL model showed delayed emergence of communication system, attributed to its simplified memory representation and difficulty in imitation during the task. These results suggest that detailed goal representation and mechanisms for self-other distinction play a critical role in communication development. The study also demonstrates the potential of cognitive modeling for connecting individual-level processes with large-scale simulations of social behavior.