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Authors

Colas, Cédric

Mocherla, Akhilesh

Perez, Jérémy

et al.

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Discovering Adaptive Transmission Programs for Collective Innovation

Cédric Colas¹, Akhilesh Mocherla², Jérémy Perez¹ & Eleni Nisioti³

¹Flowers AI & CogSci Lab, Inria, France

²Independent Researcher

³IT University of Copenhagen, Denmark

Abstract

Human collective intelligence depends on cultural transmission: who shares what with whom, how, and when. These processes emerge from individual cognition but can also be directed by top-down rules. Prior work has studied how network structure — who connects to whom — shapes collective outcomes. Yet such networks cannot adapt transmissions to what agents know. Here, we formalize top-down transmission rules as *state-aware programs* that route information based on agent and collective states, and use LLM-guided evolutionary search to design them in a collective discovery task. Evolved programs increase performance over standard baselines by up to 37%. Ablations confirm state-awareness drives this advantage: removing content-dependence while preserving network topology and timing eliminates gains. Evolved programs also transfer across domain variations and agent populations. Effective transmission programs can thus be discovered in simulations, suggesting a path toward AI-assisted design of coordination infrastructure for human collective intelligence.

Keywords: collective intelligence; transmission protocols; cultural evolution; program search