Skill Endowments and Status Formation in LLM Agent Networks

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Keywords: Skill endowments · Social capital · LLM agent networks

Extended Abstract

Large language model (LLM) agents are increasingly equipped with modular skills: reusable capability packages for searching information, calling tools, verifying outputs, coordinating workflows, writing documents, or interacting with external systems. In multi-agent environments, such skills are not only individual capabilities but also relational resources that may shape which agents become trusted, depended upon, consulted, or routed around. Recent work studies LLMs as components of collective intelligence and human–machine collaboration systems [1], while LLM-based social simulations show that language agents can generate plausible social behavior and participate in artificial societies [2]. Much of this literature uses LLMs as behavioral engines. We ask a complementary structural question: **how do heterogeneous skill endowments shape status and social capital in an LLM agent network?**

We study this question with a task-free agent-based simulation grounded in a large empirical skill universe. From Agent-Skills.md[1], a public marketplace of agent skills, we collect 74,277 entries and deduplicate them to 60,178 unique skills from 4,234 GitHub repositories and 3,579 owners. Building on affordance theory, we code each skill by its social affordance: the type of agent-to-agent interaction it enables. The coding scheme contains ten non-mutually exclusive categories: information access, knowledge transformation, verification, coordination protocol, routing/delegation, communication, memory/record keeping, tool action, creation/design, and general capability.

In the baseline simulation, we initialize 300 agents with 10 uniformly sampled skills each. Skills remain fixed, with no diffusion or learning, so network outcomes reflect initial endowments. Across 8,000 rounds, agents interact through endogenous social needs such as information seeking, validation, routing, coordination, and tool gaps. Partner choice depends on affordance–need fit and prior ties; successful interactions update directed ties of trust, dependency, reputation, knowledge exchange, and coordination. We measure status using centrality-based network outcomes aggregated into a social capital score. Affordance effects are estimated as standardized lifts averaged across 20 random seeds.

[1] https://agent-skills.md/

Baseline results show that social capital concentrates around knowledge transformation, information access, coordination protocol, and verification. Tool action and creation/design rank lower despite being common in the skill universe. Robustness checks vary the theory-driven mapping between needs and affordances using equal auxiliary weights, perturbed weights, and one-hot primary-affordance matching. Knowledge transformation, information access, and coordination protocol remain top-ranked except in the one-hot condition, where tool action ranks first. This suggests that epistemic and coordination affordances are most stable when social needs are modeled as multi-affordance interactions (Fig. 1).

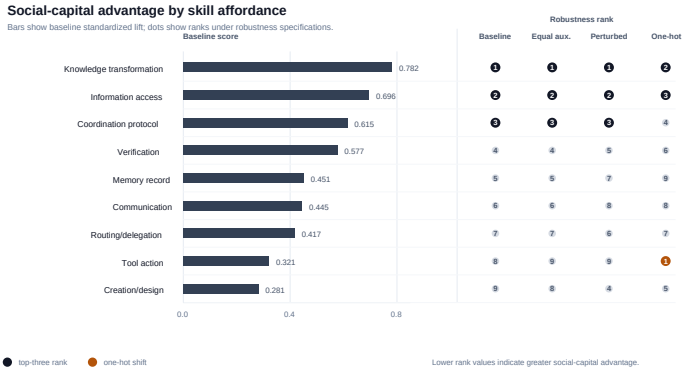

Fig. 1. Baseline social-capital scores and robustness ranks across model specifications.

This study contributes a large empirical skill universe for studying artificial agent networks, an affordance-based representation of skills as relational resources, and a transparent rule-based model for isolating how skill endowments shape status in multiplex networks. Unlike LLM-driven society simulations and social-intelligence benchmarks that generate or evaluate behavior directly [3], our approach focuses on the network consequences of capability distributions.

References

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