Neapolis University Pafos

Course Code: IS509

Task 4: Research Questions and Hypotheses

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1 Introduction (Task 3 recap)

In Task 3, we explored the Agent-to-Agent (A2A) communication framework, which facilitates interaction among autonomous agents in distributed systems. A2A's extension mechanism allows agents to dynamically adapt their communication protocols based on context and requirements. However, while A2A provides a flexible structure for agent interactions, it lacks a formal semantic layer that ensures deterministic communication and verifiable coordination among agents. This gap presents challenges in scenarios where agents must reliably delegate tasks, negotiate roles, or coordinate actions without ambiguity.

This gap raises critical questions: How can agents achieve deterministic communication within A2A's extension mechanism? What formal semantics are necessary for verifiable multi-agent coordination? Can a typed semantic layer maintain A2A's flexibility while enabling reliable task delegation and negotiation?

2 Research Questions and Hypotheses

Refined questions **Goal:** Clarity + Feasibility + Relevance.
Strategy:

Attempt 1

1. How can agents achieve deterministic communication within A2A's extension mechanism?
2. What formal semantics are required for verifiable multi-agent coordination?
3. Can a typed semantic layer be integrated into A2A without compromising its adaptability?

Attempt 2

1. How can LLM-based agents achieve deterministic communication within A2A's extension mechanism?
2. Will the integration of a typed semantic layer improve task delegation and negotiation among LLM-based agents?
3. What formal semantics are required for verifiable and deterministic coordination of the LLM-based agents?
4. Can a typed semantic layer be integrated into A2A framework without compromising its adaptability?
5. Will the proposed semantic layer affect small and large scale MAS differently?
6. Will the proposed semantic layer affect MAS made of SLMs, LLMs, hybrid set differently?

Attempt 3

1. Will the integration of a typed semantic layer in A2A framework bring determinism into collaborative activities among LLM-based agents?
2. What formal semantics are necessary and sufficient for deterministic coordination of the LLM-based agents?
3. Will the proposed semantic layer affect various scale MAS (from 2 to 10 agents) differently?
4. Will the proposed semantic layer affect MAS made of different language model (small, foundation) types differently?

2.1 Topic1:

2.1.1 Research Question:

2.1.2 Hypothesis:

2.1.3 Explanation

A short explanation (300–400 words) justifying how the questions/hypotheses align with your research purpose and methodology.

2.2 Topic2:

2.2.1 Research Question:

2.2.2 Hypothesis:

2.2.3 Explanation

A short explanation (300–400 words) justifying how the questions/hypotheses align with your research purpose and methodology.

2.3 Topic3:

2.3.1 Research Question:

2.3.2 Hypothesis:

2.3.3 Explanation

A short explanation (300–400 words) justifying how the questions/hypotheses align with your research purpose and methodology.

References

[1] K. Naznin, A. Al Mahmud, M. T. Nguyen, and C. Chua, "Chatgpt integration in higher education for personalized learning, academic writing, and coding tasks: A systematic review," *Computers*, vol. 14, no. 2, p. 53, 2025.