Ontology-Driven Interaction with Large Language Models: A Semantic Framework for Structured Context Injection and External Reasoning

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Figure 1: Seattle Mariners at Spring Training, 2010.

Abstract

We present a framework for integrating ontological knowledge into the decision-making processes of large language models (LLMs) using the Model Context Protocol (MCP) as a structured communication layer. The prototype application provides on an ontology service grounded in the Basic Formal Ontology (BFO), extended through intermediate, application-specific ontologies that define roles, conditions, resources, actions, events, and capabilities. These intermediate ontologies vary according to the guidelines and standardized knowledge available for different domains. In one example, the ProEthica application structures a role-based decision-making environment where agents act under defined constraints and are required to act according to professional standards. In another example, the A-Proxy application applies a distinct ontology to simulate persona-driven web and chat interactions. In both cases, the ontology service transmits structured context to LLMs and supports external reasoning using ontology-related APIs, allowing results from formal inference processes to be incorporated into the conversational context. This approach enables the integration of symbolic semantic structures with the behavior of statistical models, providing a method for aligning LLM outputs with formally defined knowledge.

CCS Concepts

• **Information systems** → **Semantic web description languages**; • **Computing methodologies** → **Knowledge representation and reasoning**; **Natural language processing**.

Keywords

ontology-driven LLMs, Model Context Protocol, semantic web, knowledge representation, external reasoning, ethical decision-making

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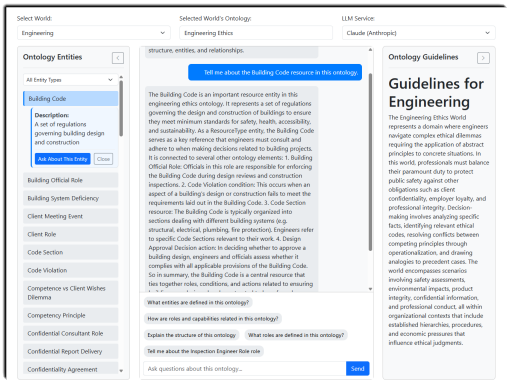

Figure 2: Interactive ontology-driven conversation enabling structured knowledge access through the Model Context Protocol. The interface allows users to explore ontological concepts and relationships while maintaining formal semantic constraints during LLM interactions.