

MARSAD: Multi-Agent Requirements System for Anomaly Detection in Software Engineering

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Abstract:

Software requirements anomalies significantly impact system quality and development costs, yet existing detection approaches often focus on single anomaly types or lack automated correction capabilities. This paper presents MARSAD, a novel multi-agent requirements system that leverages Large Language Models (LLMs) to systematically detect and correct five critical anomaly types: ambiguity, non-testability, incompleteness, redundancy, and inconsistency. The system employs a hierarchical architecture with five specialized detection agents operating in parallel, five targeted correction agents, and a coordination layer that synthesizes results using confidence-weighted scoring. Each agent utilizes the Qwen 2.5 7B Instruct model with carefully engineered prompts and agent-specific confidence thresholds optimized for precision-recall trade-offs. Evaluation on 388 software requirements (272 for few-shot examples, 116 for testing) using the pre-trained model without finetuning demonstrates varying performance across anomaly types: the Ambiguity Detector achieved the highest F1-score of 0.662 (precision: 0.517, recall: 0.918), while the system overall achieved 71.2% recall and 30.3% precision on the test set. Correction quality assessment using LLM-as-judge methodology showed an average quality score of 0.784, with 75% of corrections scoring 0.8 or higher. These results demonstrate the feasibility of automated requirements anomaly detection and correction, while highlighting both the benefits of specialized multi-agent architectures and the challenges in achieving high precision across diverse anomaly types. The system's ability to provide both detection and actionable correction suggestions addresses critical gaps in existing requirements analysis tools, offering practical value for requirements engineering workflows. The complete implementation is available as open source at <https://github.com/ae1707/marsad>.

Keywords:

Multi-Agent Systems, Large Language Models, Few-Shot Learning, Requirements Engineering, Anomaly Detection, Natural Language Processing.