Title : KGs-Augmented Testsuite Generator Framework

Author(s) : **1.** Mr. Chaipat Jainan **Student ID :** 650510606
2. **Student ID :**
3. **Student ID :**

Major : Computer Science

Advisor(s) : **1.** Assistant Professor Dr Areerat Trongratsameethong
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ABSTRACT

Ensuring the safety of Autonomous Driving Systems (ADS) necessitates rigorous testing using simulated scenarios derived from real-world accident reports. While Large Language Models (LLMs) offer a promising approach for generating these scenarios, their direct application in discovering elusive edge-cases is often inefficient and unreliable. This inefficiency stems primarily from the inconsistent nature of the source reports and the LLMs' tendency to generate numerous irrelevant scenarios, leading to an unnecessarily high number of reconstruction efforts before a novel test case is found.

To address this challenge, this study proposes a novel **KGs-Augmented Testsuite Generator Framework** designed to create reliable and goal-oriented test suites. The framework employs a **schema-guided LLM** to accurately extract structured accident data from unstructured reports. This data is then modeled as a **Knowledge Graph (KG)**, which serves as a semantic backbone, enabling robust inference of missing information and maintaining the causal continuity between events

Crucially, the framework integrates the **Operational Design Domain (ODD)**, utilizing constraints defined by JAMA, directly into the KG structure. The integration of ODD acts as a powerful filter and guideline, controlling the

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scenario generation process to focus exclusively on test cases that violate or push the boundaries of the defined operational limits. This targeted approach is the key to the framework's effectiveness, which aims to significantly reduce the number of reconstructed scenarios required to discover a new, challenging edge-case. The resulting structured scenarios are highly reliable and compliant with industry standards (e.g., ASAM OpenSCENARIO), marking a substantial improvement in the efficiency and quality of ADS safety evaluation.

Keywords: Autonomous Driving Systems, ADS, Large Language Models, LLMs, Knowledge Graphs, Scenario Generation, Edge-Case Discovery, Schema-Guided Extraction, Accident Reconstruction, Test Suite Generation

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