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Toward Building Behavioral Testbeds for Security and Privacy: LLM-Driven Personas as Crash Dummies

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Motivation

- Technology development outpaces regulatory frameworks and security measures[1]
- LLM agents can simulate diverse user behaviors through personas[2]
- AI personas serve as digital crash dummies for security testing
- Scenario-Based Design[3] provides structured input and output for LLM Data Generation

Example Persona

Adapted from [4]

Anticipated Outcomes

Practical Contribution

- Insights for Building a Testbed for Proactive Threats & Vulnerability Identification
- Optimization Framework for Persona Simulation of Security and Privacy Scenarios

Theoretical Contribution

- Extend the Scenario-based Design Methodology to Develop LLM-Based Usability Studies

Research Questions

1. **To what extent do LLMs adhere to persona characteristics in roleplaying security and privacy scenarios?**
2. **To what extent do different LLMs exhibit diverse behavioral patterns when simulating various personas?**
3. **To what degree does simulating personas in a scenario reveal new vulnerabilities?**
4. **To what extent do LLM persona simulations match human analysts in vulnerability detection?**

Experiment Overview

Regular Users | **Threat Actors** | **Security Practitioners**

→ **Role Playing with LLMs**

→ **Test Scenarios**

Each scenario will be tested several times per LLM-persona combination

→ **Hybrid Evaluation**

Persona Fidelity	*Behavioral Diversity*	*Vulnerability Detection*
• Human validation • LLM self-evaluation	• Behavioral variation metrics • Semantic similarity analysis	• Known vulnerability comparison • Diversity of Vulnerability

→ ***Analysis Report for Testbed***

Rating of Vulenrabilities, Summary of Threats

Method

Systematic Literature Review:

- 128 Personas Identified in ACM, IEEE, Scopus

Example Scenario: Corporate Email Management

Persona Fidelity Experiment

- Intended persona characteristics vector vs. Simulated characteristics vector
- LLM grades and generate these vectors by grading, and the cosine similarity of scores

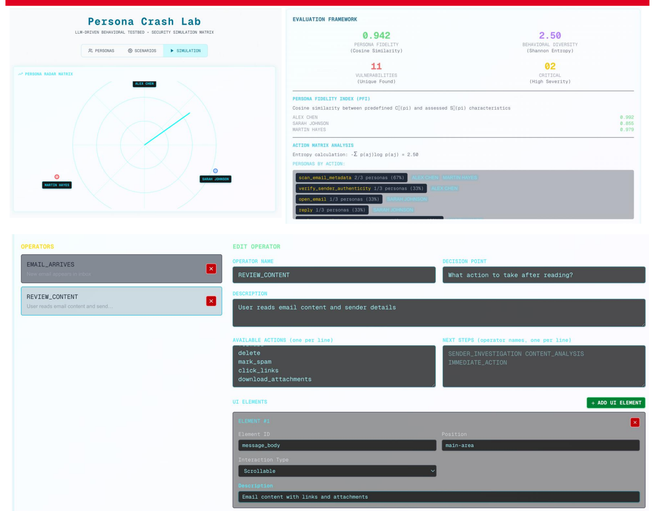
Behavioral Diversity Experiment

- Entropy calculation of persona-action matrix
- Cosine similarity of vector embeddings of actions

Vulnerability Detection Experiment

- Automated vulnerability extraction from scenario transcripts
- Unique vulnerabilities found / scenarios tested

Proof of Concept



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