Accelerating Legacy System Modernization: The Role of Generative AI in Automated Code Refactoring and Migration

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Abstract

Legacy software systems remain the backbone of critical industries such as banking, healthcare, and logistics, yet they pose significant risks due to technical debt, security vulnerabilities, and a shortage of developers skilled in outdated languages (e.g., COBOL, Fortran). A paradigm shift is emerging with the application of Large Language Models (LLMs) and Generative AI (GenAI) to automate the modernization process. This paper investigates how GenAI agents can autonomously analyze, document, and refactor legacy codebases into modern microservices architectures. Unlike traditional transpilers, AI-driven approaches utilize semantic understanding to preserve business logic while optimizing performance. Preliminary studies indicate that GenAI-assisted migration can reduce project timelines by 40% and testing overhead by 30%. However, challenges such as "hallucinations" in code generation and data privacy concerns remain. This study synthesizes current research to provide a comprehensive overview of AI-enabled software modernization.

Keywords

Generative AI, legacy modernization, automated refactoring, code migration, LLM, technical debt, software engineering, intelligent automation.

Introduction

Digital transformation is often stalled by the reliance on monolithic legacy systems. Maintaining these systems is costly and inefficient, yet rewriting them from scratch is fraught with operational risk. Traditional automated tools often fail to capture the nuances of business logic embedded in decades-old code. The advent of Generative AI, specifically models trained on vast repositories of code (such as Codex, StarCoder, and Llama 3), offers a novel solution. By treating code migration not as a translation task but as a semantic reconstruction task, AI tools can now suggest architecture improvements during the migration process. This paper explores the transition from manual rewriting to AI-augmented modernization, highlighting the efficiency gains and the shift towards "human-in-the-loop" verification workflows.

AI Mechanisms for Code Modernization

The integration of AI into software engineering workflows transforms modernization through three key mechanisms:

1. **Code Understanding and Documentation:** Before migration, understanding the "spaghetti code" is crucial. LLMs can ingest legacy files

and generate natural language documentation, explaining complex logic to modern developers.

2. **Automated Refactoring and Translation:** AI models go beyond syntax translation. They can identify design patterns in languages like COBOL and map them to object-oriented patterns in Java or Python, effectively modernizing the architecture while porting the code.
3. **Test Case Generation:** One of the biggest risks in migration is regression. Generative AI can automatically generate unit tests for the original legacy code and ensure the new modernized code passes the same logic gates, guaranteeing functional equivalence.

Challenges and Implementation Considerations

Despite the potential, deploying AI for critical infrastructure migration involves hurdles. **Accuracy and Reliability:** LLMs can produce syntactically correct but logically flawed code (hallucinations). Rigorous automated testing frameworks are required. **Security and Privacy:** Uploading proprietary banking or medical code to public AI models poses data leakage risks, necessitating the use of on-premise or private cloud LLMs. **Complexity Window:** Current LLMs have context window limits, making it difficult to process massive monolithic applications as a whole; strategies for modularizing the input are essential.

Conclusion

The application of Generative AI in legacy system modernization represents a significant leap forward in software engineering. By automating the tedious aspects of documentation, translation, and testing, organizations can unlock the value trapped in old systems. While human oversight remains essential to mitigate AI errors, the synergy between expert developers and AI agents is defining the future of enterprise IT sustainability.

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