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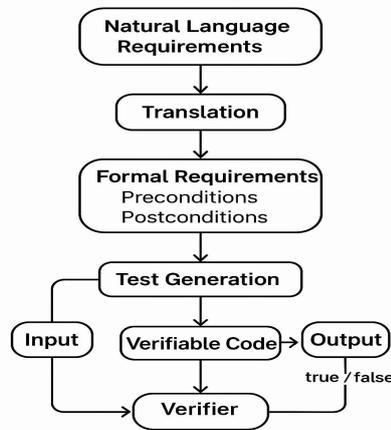
Introduction to VERIFAI Project

Software development faces challenges in requirements traceability and verification. Many specifications are written in natural language, which can be ambiguous. The VERIFAI project leverages Large Language Models (LLMs) to generate formal specifications, bridging the gap between informal requirements and verifiable code.

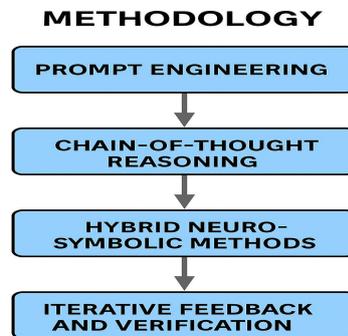
Motivation: Tackling Ambiguity in Software Requirements

Software requirements are generally written in natural language making them easy to write but hard to verify. Natural language can be vague and open to different interpretations. Misunderstandings at this stage can cause problems leading to bugs, safety issues and failed expectations. Another challenge is traceability where a requirement originates and undergoes varied interpretations and refinements.

Project Goal: From Language to Logic



Use of LLMs in VERIFAI Project: A hybrid reasoning-driven approach



Our method uses prompt engineering, chain-of-thought reasoning, and neuro-symbolic techniques. These help LLMs produce better, more logical results. Instead of long theory and definitions, we focus on the real problems and how we plan to solve them. We tune our prompts to reduce errors and make outputs easier to follow. The results are traceable and support feedback and testing at every step.

Work in Progress

- **Conference Submission:** A. Beg, D. O'Donoghue, and R. Monahan, "Formalising Software Requirements with Large Language Models," *Symposium on AI Verification*, Extended Abstracts, submitted Apr. 30, 2025.
- A more detailed and comprehensive survey paper is to be anticipated soon in ACM computing surveys.

Future Outlook: Enabling Traceability and Verification

- **Enhance accountability** by systematically tracking how requirements evolve and are tested throughout the software lifecycle.
- **Integrate formal verification tools** to enable precise error tracing and improve confidence in complex systems.
- **VERIFAI** project will pave the way to ensure transparent, verifiable development processes that support safety, legal compliance, and robust system design.

References

- [1] E. Mugnier, E. A. Gonzalez, R. Jhala, N. Polikarpova, and Y. Zhou, "Laurel: Generating dafny assertions using large language models," 2024. [Online]. Available: <https://arxiv.org/abs/2405.16792>
- [2] I. T. Leong and R. Barbosa, "Translating natural language requirements to formal specifications: A study on gpt and symbolic nlp," in 2023 53rd Annual IEEE/IFIP International Conference on Dependable Systems and Networks Workshops (DSN-W), 2023, pp. 259–262.
- [3] G. Granberry, W. Ahrendt, and M. Johansson, "Specify what? enhancing neural specification synthesis by symbolic methods," in *Integrated Formal Methods*, N. Kosmatov and L. Kovács, Eds. Cham: Springer Nature Switzerland, 2025, pp. 307–325.
- [4] L. Ma, S. Liu, Y. Li, X. Xie, and L. Bu, "Specgen: Automated generation of formal program specifications via large language models," 2024. [Online]. Available: <https://arxiv.org/abs/2401.08807>