AI-Assisted Programming with Test-based Refinement*

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Abstract. Neural program synthesis, based on Large Language Models (LLMs) which are trained on open source code, are quickly becoming a popular addition to the software developer's toolbox. Services like, for instance, Open AI's GPT4, Google's Bard, and GitHub's Copilot, can generate code in many different programming languages from natural language requirements entered as "prompts". However, prompt-based programming seems to work best for development of smaller programs. It currently appears infeasible to generate large and complex programs from natural language prompts. We refer to this as the *complexity problem*. Furthermore, neural systems do not come with guarantees of producing correct, safe, or secure code, what we shall refer to as the *verification problem*. We propose test-based refinement to address these two problems. Specifically, to approach the *complexity* problem, we propose a method based on program *refinement*, where a program is developed in a stepwise manner, starting with a very high level abstract program, and then refining it iteratively, towards a final implementation. At each refinement step, the LLM can provide assistance by generating code suggestions and refining existing code snippets. To approach the program *verification* problem, we suggest to apply automated *testing* to test that each refinement implements the previous step. Literature on program refinement usually approaches the verification problem as a deductive proof problem. Proofs are, however, hard to carry out for humans, even with automated proof tools. The experiments are carried out by developing a classical bridge controller in the Scala programming language using the ScalaCheck property-based testing library.

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