Shortest Path Algorithms Verification with Idris

Thesis Outline

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1 Introduction

- State the problem: Dijkstra's and Bellman-Ford algorithms are widely used in real-life applications, however existing work for verifying shortest path algorithms are limited
- Contributions
- Structure of thesis

2 Motivation

- Show the importance of verification in assisting people to ensure the behavior of programs
- Given the significance of Dijkstra's and Bellman-Ford in real-life applications, it is important to verify their correctness
- Present algorithm verification as a programming issue: with programming languages such as Idris, we can implement programs that verify other programs

3 Background

- Introduce Idris programming languages and its features (dependent types etc.)
- Brief introduction of Dijkstra's and Bellman-Ford algorithms

4 High-level Contribution

- Pseudocode for Dijkstra's and Bellman-Ford, followed up by overview of the implementation of both algorithms in Idris
- Theoretical proofs of Dijktra's and Bellman-Ford based on the Idris implementation

5 Low-level Contribution

- Details on the implementation of Dijkstra's and Bellman-Ford in Idris: data structures, functions, program control flow, and assumptions
- Assumptions of the proof (expected qualities of input data etc.)
- Overall structure of our verification, and details on the proof: provide type signatures and interpretation of types for key lemmas

6 Discussion

- Progress on verification versus initial expectations
- Things that have been tried but failed to achieve
- Reflection on the process of program verification: useful tips and advices etc.

7 Related Work

- Present existing work of Dijkstra's verification
    1. Verifying Dijkstra's Algorithm with KeY: `https://kola.opus.hbz-nrw.de/opus45-kola/frontdoor/deliver/index/docId/420/file/DA_KLASEN.pdf`
    2. Verifying Dijkstra's algorithm in Jahob: `http://lara.epfl.ch/w/_media/dijkstra.pdf`
- Comparison with existing works
    1. Verifying in Idris versus other languages or proof assistance
    2. Different approaches taken during verification

8 Conclusion

- Briefly conclude motivations, goals, and contributions