Universidade do Minho
Escola de Engenharia

Work proposal

Cursos/Courses	Engª de Eletrónica Industrial e Computadores, Engenharia de Informática, Engenharia Eletrotécnica e Computadores
Alunos/Students	Alunos que frequentam o 3º e 4º ano do respetivo curso (dá-se preferência a alunos que pretendam continuar a grabalhar posteriormente nesta temática). Possibilidade de ter **bolsa após 6 meses de experiência**
Título/Title	A Practical Exploration of Compiler Frontend for Simplified Image Processing
Proponente/Proposer	Adriano Tavares (atavares@dei.uminho.pt)

Enquadramento e Motivação/Background and Motivation (150 - 200 palavras)

This project offers an immersive exploration of the frontend of compiler construction, equipping the student with a comprehensive understanding of various compiler phases, their outputs, and interconnections. By creating a specialized external Domain Specific Language (DSL) for simplified image manipulation operations, the student will delve into the intricacies of designing a language with distinct syntax and semantics. The DSL is engineered to encapsulate fundamental image processing tasks, from basic operations like filtering and contour detection to more advanced functionalities such as text recognition. Through the construction of custom lexing and parsing programs, the student will gain hands-on experience in breaking down the source code of the DSL into tokens and constructing an abstract syntax tree (AST). Subsequent stages involve semantic analysis to enforce rules and constraints of the DSL, followed by code generation in a target language based on the validated AST (decorated syntax tree). The goal is to produce an executable that embodies the translated DSL representation, showcasing the DSL's capability to abstract complexities in image processing for users unfamiliar with underlying frameworks. This project may be continued by leveraging the LLVM infrastructure, employing MLIR in the middle-end, and further optimizing the image processing for a target backend.

Objetivos e Resultados Esperados/ Objectives and expected results (150 - 200 palavras)

1. DSL design: Design the syntax and semantics of the external DSL. Specify the language constructs and operations that the DSL should support.
2. Lexer and Parser: Implement a lexer and parser for the DSL. The lexer breaks the input code into tokens, and the parser constructs an abstract syntax tree (AST) based on the grammar of the DSL.
3. Semantic Analysis: Perform semantic analysis on the AST to ensure that the program adheres to the specified rules and constraints of the DSL.
4. Code Generation: Generate code in a target language based on the validated AST.
5. Output: Produce the executable based on the translated representation.

Tasks

Task1 Study of image processing operations

Task2 Study and testing of image processing techniques with the OpenCV library

Task3 Design of the DSL

Task4 Implementation of the Lexer and Parser for the DSL

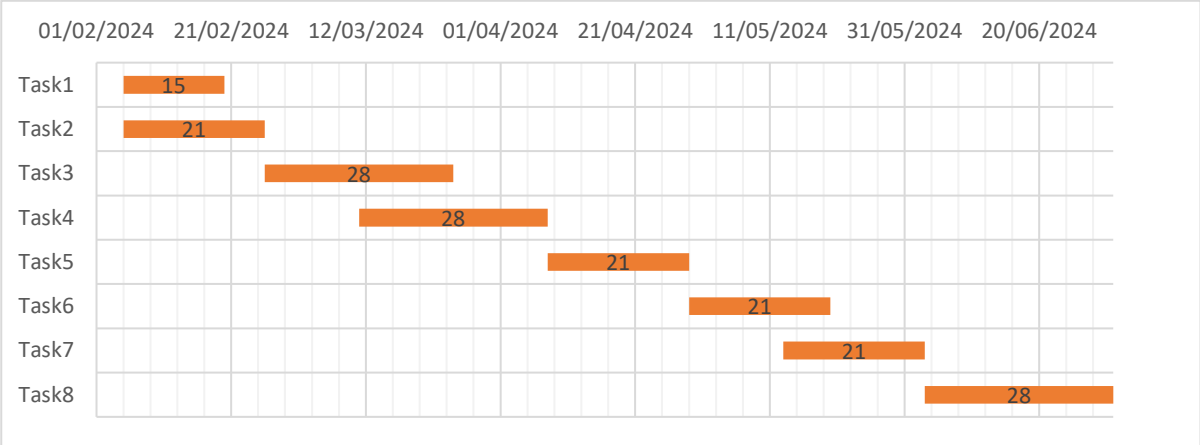
Task5 Implementation of the Semantic Analyser

Task6 Generation of code in the target language

Task7 Testing and validation

Task8 Report writing and video-documentation

Calendarização/Schedule



Referências Bibliográficas/Bibliography (5 - 10 referências)

J. C. Russ, “The Image Processing Handbook”, vol. 5, 2006.

R. Membarth, O. Reiche, F. Hannig, J. Teich, M. Körner and W. Eckert, “HIPAcc: A Domain-Specific Language and Compiler for Image Processing”, in IEEE Transactions on Parallel and Distributed Systems, vol. 27, no. 1, pp. 210-224, 2016, doi: 10.1109/TPDS.2015.2394802.

Maaz Bin Safeer Ahmad, Jonathan Ragan-Kelley, Alvin Cheung, Shoaib Kamil, “Automatically translating image processing libraries to halide”, Authors Info & ACM Transactions on GraphicsVolume 38, Issue 6, Article No.: 204pp 1–13, 2019, doi: 10.1145/3355089.3356549.

Celeste Barnaby, Qiaochu Chen, Roopsha Samanta, Işıl Dillig, “ImageEye: Batch Image Processing using Program Synthesis”, Proceedings of the ACM on Programming Languages, Volume 7, Issue PLDI, Article No.: 134pp 686–711, doi: 10.1145/3591248.

Alfred V. Aho, Monica S. Lam, Ravi Sethi, and Jeffrey D. Ullman, “Compilers: Principles, Techniques, and Tools (Second Edition)”, 2006.

Andrew W. Appel, “Modern Compiler Implementation in ML”, 2004.

3, de outubro de 2023

Orientador(es) / Supervisor(s):

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