

PAULO SANTOS

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Research Interests

My research focuses on developing program analysis techniques to detect errors in software systems. Previously, I worked on evolutionary program synthesis using refinement types, and I am currently closely researching the application of software engineering techniques to the robotics field (Software Engineering for Robotics). Overall, I am primarily interested in the following topics:

- Program Analysis
- Program Synthesis & Repair
- Evolutionary Computation
- Robot Software

Education

Carnegie Mellon University - School of Computer Science **2020 – 2026 (expected)**
Dual Degree Ph.D. in Software Engineering, with the University of Lisbon. Pittsburgh, Pennsylvania
Thesis: Specification-Driven Repair of Robotic Systems.
Advisors: Alcides Fonseca, Sara Silva and Christopher S. Timperley.

Faculdade de Ciências, University of Lisbon **2018 – 2020**
M.Sc. Software Engineering Lisbon, Portugal
Thesis: Towards the Conceptualization of Refinement Typed Genetic Programming.
Advisor: Alcides Fonseca.

Faculdade de Ciências, University of Lisbon **2015 – 2018**
BSc. in Computer Science. Lisbon, Portugal

Selected Publications

Understanding Misconfigurations in ROS: An Empirical Study and Current Approaches.

International Symposium on Software Testing and Analysis (ISSTA). 2024. *(Core A)*

Paulo Canelas, Bradley Schmerl, Alcides Fonseca, and Christopher S. Timperley.

Is it a Bug? Understanding Physical Unit Mismatches in Robot Software.

International Conference on Robotics and Automation (ICRA). 2024. *(Core A*)*.

Paulo Canelas, Trenton Tabor, John-Paul Ore, Alcides Fonseca, Claire Le Goues, and Christopher S. Timperley.

Usability-Oriented Design of Liquid Types for Java.

45th IEEE/ACM International Conference on Software Engineering (ICSE). 2023. *(Core A*)*.

Catarina Gamboa, **Paulo Canelas**, Christopher S. Timperley, and Alcides Fonseca.

An Experience Report on Challenges in Learning the Robot Operating System.

Robotics Software Engineering Workshop at the International Conference on Software Engineering (ICSE) 2022.

Paulo Canelas, Miguel Tavares, Ricardo Cordeiro, Alcides Fonseca, and Christopher S. Timperley.

The Usability Argument for Refinement Typed Genetic Programming.

Parallel Problem Solving from Nature (PPSN) 2020. *(Core A)*.

Alcides Fonseca, **Paulo Canelas**, and Sara Silva.

Work Experience

PhD Software Engineer Intern, Uber Technologies Inc. - Sunnyvale, CA **Summer 2024**

Research Group: Programming Systems Group.

Mentors: Yun Li, Yuxin Wang and Stefan Heule.

Scientific Outreach

FormaliSE Conference Social Media & Web Chair. **2023**

LASIGE Ph.D. Commission Member. **2022**

Responsible for the co-creation and management of a funded commission that promotes the inclusion and culture between Ph.D. Students.

Ph.D. Student Representative, at Faculdade de Ciências, University of Lisbon. **2021-2022**

Teaching Experience

Teaching Assistant | Carnegie Mellon University. **2023-2024**

(Mar 2024 - May 2024) 17-643 Quality Management.

(Oct 2023 - Dec 2023) 17-623 Quality Assurance.

Teaching Assistant | Faculdade de Ciências, University of Lisbon. **2021-2022**

(Sep 2021 - Feb 2022) Programming.

(Jan 2021 - Jun 2021) Objected Oriented Development.

Students Mentored

Eduardo Pareja Lema. **Summer 2023**

Research Experience for Undergraduates in Software Engineering at CMU. Eduardo and I worked on Collaborative Oracle Inference for Robotic Systems.

Awards and Achievements

LASIGE Workshop'20 - Best Poster Award. **2020**

In the annual gathering of the LASIGE research group, MSc. and Ph.D. students compete to create and present a poster on their current work. I presented my work on Evolutionary Program Synthesis using Refinement Types.

EDP University Challenge, Top 15/1152. **2020**

The national energy provider, Energias de Portugal (EDP), organized a competition for university students where I achieved the top 15 out of 1152 teams (4138 students) with the project ecoServer: a system to optimize the energy impact of servers in data centers.

Technical Skills

- Proficient in Python, Golang, Java, and C.
- Frameworks: Z3, Comby, Pandas, Numpy, LLVM, and Robot Operating System (ROS).

Research Projects

ROSpec: A Domain-Specification Language for Robot Software (*In Progress*).

Currently, I am developing a domain-specific language that allows developers to describe the interaction between robot software components, preventing misconfigurations.

Detecting NavStack Misconfigurations in ROS using Language Models (*In Progress*).

In collaboration with Kush Jain, Claire Le Goues and Christopher S. Timperley, we are using language models to help detect navigation misconfigurations in robot software.

Collaborative Oracle Inference for Robotic Systems.

This is a work in collaboration with Eduardo Lema. This work aims to study the human impact in the inference of oracles (e.g., specifications) that describe the system's behavior.

We expect the human-in-the-loop in the oracle inference to improve the oracle's accuracy.

Taxonomy of Misconfigurations in ROS-based Robotic Systems.

I conducted a qualitative study to understand the categories of misconfigurations developers perform when developing robotic systems using ROS by manually analyzing thousands of questions from ROS Answers, the Stack Overflow for ROS.

Furthermore, we performed a literature review to understand which techniques address the identified misconfigurations. This study is the basis for future directions in developing novel analysis techniques to address misconfigurations in ROS.

ÆON: A Programming Language for Refinement Typed Program Synthesis.

ÆON is a programming language with polymorphism and refined types used as the basis for Refined Typed Genetic Programming (RTGP), allowing the complete synthesis of programs.

I was responsible for developing the language syntactic sugar frontend, the evolutionary approach, and developing and optimizing the non-deterministic synthesizer from the refinement types.