


# PAULO ALEXANDRE CANELAS DOS SANTOS

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## Research Interests

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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

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**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 Detection of Misconfigurations in ROS-based 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

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### **ROSpec: A Domain-Specific Language for ROS-based Robot Software**

Proceedings of the ACM on Programming Languages at OOPSLA. 2025. *(Core A)*.

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

### **Are Large Language Models Memorizing Bug Benchmarks?**

LLM4Code Workshop at International Conference in Software Engineering (ICSE). 2024. **Best Paper Award**.

Daniel Ramos, Claudia Mamede\*, Kush Jain\*, **Paulo Canelas\***, Catarina Gamboa\*, and Claire Le Goues.

### **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.**

International Conference on Software Engineering (ICSE). 2023. *(Core A\*)*.

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

### **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

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**PhD Software Engineer Intern, Uber Technologies Inc. - Sunnyvale, CA** Summer 2024  
Research Group: Programming Systems Group.  
Mentors: Stefan Heule, Yuxin Wang and Yun Li.

## Awards and Achievements

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**LASIGE Best PhD Researcher Award - Honorable Mention.** 2025

**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.

## Scientific Outreach

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**Invited Reviewer at Transactions of Software Engineering (TSE).** 2025

**Invited Reviewer at Human-Robot Interaction (HRI).** 2025

**Artifact Evaluation Committee at International Conference on SE (ICSE).** 2025

**LASIGE Summer of Research Organizer.** 2025

Responsible for the co-creation and management of a funded Research Experience in Undergraduate program to promote research at the undergraduate level at University of Lisbon.

**Invited Reviewer at International Conference on Robotics and Automation (ICRA).** 2024

**FormaliSE Conference Social Media & Web Chair.** 2024

**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

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**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) Object Oriented Design.

## Students Mentored

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Márcio Caetano.

**Summer 2025**

Summer of Research/Research Experience for Undergraduates in University of Lisbon. Márcio worked on Synthesis of specification synthesis for Java from documentation using Large Language Models.

Eduardo Pareja Lema.

**Summer 2023**

Research Experience for Undergraduates in Software Engineering (REUSE) at CMU. Eduardo worked on Collaborative Oracle Inference for Robotic Systems.

## Technical Skills

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

## Research Projects

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### **ROSpec: A Domain-Specification Language for Robot Software.**

I developed a ROS domain-specific language for specifying and verifying component configurations and integration. ROSpec verifies component configurations, ensures correct component integration through communication properties, and validates configurations against deployment constraints.

I demonstrate rospec's effectiveness by modeling a 19-component warehouse robot, and implementing partial specifications for components from 182 misconfiguration questions from prior work.

### **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, I 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.