# Paulo Alexandre Canelas dos 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 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

## Work Experience

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

## Selected Publications

**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.

## Awards and Achievements

**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.

## Research Projects

**A Study on Auto-Merging Requirements for Agent-based PR's in GitHub** (On-going Work).

Preliminary work where I am conducting a quantitative study on AI-generated pull requests (PR) from tools like Copilot and Codex to understand what conditions allow maintainers automatically land AI-generated PRs.

**Architectural Evolution and Drift Analysis in Open Source Robotics** (On-going Work).

I am developing an automated cross-language evolution and drift analysis tool that (1) statically extracts architectural elements from ROS systems (C++ and Python), (2) infers documentation changes using LLMs, and (3) analyzes architectural evolution and detects documentation drift.

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

I developed a ROSpec, a language to verify component configurations and ensure correct component integration through communication properties. I evaluated rospec by specifying a warehouse robot, and implementing 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 types of misconfigurations developers make when developing ROS systems by manually analyzing thousands of ROS Answers questions. Furthermore, I performed a literature review to understand which techniques address the identified misconfigurations.

## 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) Object Oriented Design.

## Scientific Outreach

**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**

## Students Mentored

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

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