

MARGARIDA FERREIRA

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RESEARCH INTERESTS

I am broadly interested in **constraint programming**, and its application to **program synthesis**. Currently I am working on using program synthesis techniques to reverse engineer congestion control algorithms based on the behavior of the original implementation, and using SMT to automatically optimize Firewall rulesets.

EDUCATION

PhD. Computer Science • *Carnegie Mellon University | Instituto Superior Técnico* • 2021 – present
Advised by Professors Ruben Martins and Inês Lynce. Dual Degree PhD fellowship by CMU Portugal.

MSc. Computer Science and Engineering • *Instituto Superior Técnico* • 2018 – 2020
Coursework in Artificial Intelligence, Algorithms and Programming, completed mostly in Technical University of Munich, Germany. **Master Thesis:** *FOREST: An Interactive Multi-tree Synthesizer for Regular Expressions*, advised by Professor Inês Lynce and Dr. Miguel Neves.

BSc. Computer Science and Engineering • *Instituto Superior Técnico* • 2015 – 2018
GPA: 18/20.

PUBLICATIONS

Counterfeiting Congestion Control Algorithms. **M. Ferreira**, A. Narayan, I. Lynce, R. Martins, J. Sherry.
HotNets 2021.

FOREST: An Interactive Multi-tree Synthesizer for Regular Expressions. **M. Ferreira**, M. Terra-Neves, M. Ventura, I. Lynce, and R. Martins. **TACAS 2021.**

Under submission:

Automatic Optimization of Network Rulesets. H. Sadok, **M. Ferreira**, F. Pereira, S. Kandula, I. Marinos, J. Sherry.
Under submission at **NSDI 2023.**

RESEARCH TALKS

Jetstream:

- Open vSwitch and OVN Conference • Nov 2022
- Pigasus IDS Developers Meeting • Nov 2022
- Crossroads 3D-FPGA seminar • Oct 2022

CCA Synthesis:

- INESC-ID Automated Reasoning and Software Reliability group presentation • Jun 2022
- CMU Portugal Doctoral Symposium • Oct 2022
- Seminar talk at the Systems & Networking Group at CSAIL, MIT • Nov 2021
- Hotnets 2021 • Nov 2021

FOREST:

- TACAS 2020 • Mar 2021
- GOLEM project group meeting • Nov 2020

RESEARCH PROJECTS

Jetstream • 2021 – present

We developed Jetstream, a tool to simplify, restructure, and check equivalency of virtual switch rulesets. We use SMT to find and remove redundancies from the ruleset and to show that the transformations do not change the semantics of the original ruleset. Our analysis of production rulesets shows that JetStream is able to improve packet classification performance by up to 70% using state-of-the-art packet classifiers.

CCA synthesis • 2020 – present

We are using program synthesis to reverse-engineer congestion control algorithms implementations based on traces collected using the original implementation. Our synthesis procedure uses SMT to encode the space of candidate congestion control algorithms, and tries to find one whose behavior minimizes the error against the given trace. Using this approach, we can synthesize several basic CCAs including a simplified Reno using only a few traces.

FOREST • 2019 – 2020

We developed FOREST, a regular expression synthesizer for digital form validations. FOREST produces a regular expression that matches the desired pattern for the input values. The synthesis procedure uses an SMT solver to explore and prune the search space, and to synthesize capture conditions over capturing groups that ensure the validity of integer values in the input. To increase confidence in the synthesized regular expression, we use Z3's regular expressions theory to implement user interaction based on distinguishing inputs.

EXPERIENCE

Teaching Assistant

- Fall 2020 Artificial Intelligence (undergraduate), *Instituto Superior Técnico*.
- Spring 2021 Algorithms and Data Structures (undergraduate), *Instituto Superior Técnico*.
- Fall 2022 Automated Reasoning and Satisfiability (graduate), *Carnegie Mellon University*.

Early Stage Researcher • INESC-ID • 2020 – 2021

I worked on synthesis of regular expressions from examples, and later on reverse engineering congestion control algorithms, as part of the group Automated Reasoning and Software Reliability (ARSR).

Research Intern • OutSystems • 2019 – 2020

I worked on synthesis of regular expression form validations, under the supervision of Dr. Miguel Neves and Miguel Ventura, at Engineering Department, Artificial Intelligence division.

SKILLS

I program mainly in **Python3**, including:

- scientific libraries: **NumPy**, **SciPy**, **Matplotlib**,
- constraint solving frameworks: **Z3**, **CVC5**, and **Gurobi** APIs and **PySAT** library.

I am also proficient in **C**, **C++** and its standard libraries.

SCHOLARSHIPS | HONORS

Dual Degree PhD Fellowship • *CMU Portugal* • 2021

Excellent Teacher Award • *Instituto Superior Técnico* • 2021

Visiting Students Scholarship • *CMU Portugal* • 2020

New Talents in Artificial Intelligence Scholarship • *Calouste Gulbenkian Foundation* • 2017

Academic Excellence Certificates • *Instituto Superior Técnico* • 2015 – 2018, 2020