SPECIES Scholarship 2022 Proposal

Alcides Fonseca is an Assistant Professor at the University of Lisbon, and the Reliable Software Systems research line leader at LASIGE. He has a PhD in automatic optimization of parallel programs by the University of Coimbra.

Alcides leads the LASIGE side of the CAMELOT project, that aims to improve the machine learning development process in collaboration with Feedzai, U. Coimbra, IST and CMU. He is also the PI of Resource Aware Programming, a project that aims to give programmers immediate feedback on the energy consumption of their code. He is also a consultant with Genomed, a genetics diagnosis company and a mentor at Decipad, a company that is re-inventing spreadsheets as computable documents.

More information can be found at http://alcidesfonseca.com

Research Group

LASIGE is the research center for Computer Science and Engineering in the Faculty of Sciences of the University of Lisbon. LASIGE had the highest score in the Portuguese evaluation of research centers with 15/15. Our motto is driven by excellence.

In the *Reliable Software Systems* line we apply several formal methods techniques to guarantee that we can trust software. Many of these techniques (grammars, type systems) have been applied to evolutionary computation (and Genetic Programming in particular).

The research group is led by Alcides Fonseca (Assistant Professor) and is currently comprised of:

- Pedro Barbosa - PhD student on Grammar-guided interpretable surrogate models for Deep Learning-based genetic variant pathogenicity prediction.
- Guilherme Espada - PhD Student on Probabilistic Modeling of Software Resource Usage (using GP to predict energy and time consumption)
- Paulo Santos - PhD Student on Evolutionary Architecture Repair of Robotics System
- Catarina Gamboa - PhD Student on the Usability of Advanced Type Systems
- Leon Ingelse - MSc Student on Interpretable Multimodal Genetic Programming

- Afonso Rafael, Miguel Tavares, Pedro Silva and Ricardo Cordeiro - MSc Students on Application of Type Systems and Specifications
- Sara Silva (http://gplab.sourceforge.net/sara/) is a frequent collaborator and office neighbor.

Description of the work to be carried out by the student:

The student will work on the implementation of Dependent Types in a Genetic Programming framework. We are developing two sister prototypes: Genetic Engine, a pure-Python framework that only uses object-orientation to express grammars; and Aeon, a programming language compiler that uses GP for interactive synthesis of programs.

Both projects make use of Dependent Types (something like {x:Int | x > 3} to refine the type Integer with a more custom predicate. This expressive power can be used in GP to eliminate invalid solutions from ever being explored (such as dividing by 0), increasing the performance of the search. In a sense it's an upgrade over Strongly-Typed GP and Context-Free Grammar-Guided GP.

The goal is to finish the implementation, conduct an empirical evaluation (using PonyGE2 as the baseline) and write a paper.

Other relevant information:

This work is being conducted as part of two funded projects:

- CAMELOT: https://www.youtube.com/watch?v=oknCkhX51nM&list=PLcrJ_usmN1eP3S3wjrXU5bms14qddYi5u&index=7
- RAP: https://www.lasige.pt/project/rap

These projects can support the travel arrangements to Evo* to present the paper, a complementary grant, as well as necessary hardware. We also have other funded projects solely for High Performance Computing resources that can be used in the context of this work.

About Lisbon

Lisbon was considering the Leading City Destination (and Portugal the leading Destination) by the World Travel Awards in recent years. It is also mentioned as one of the best cities for foreigners to live. https://www.visitlisboa.com/en