André Duarte

Curriculum Vitae

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Education

2018–2023 **PhD in Computer Science**, *University of Manchester*, United Kingdom
Automated Theorem Proving, Formal Methods Group

Four-year research project in the field of automated logical reasoning, culminating in a written thesis and defence. Developed new theoretical results which improved the state of the art in the field, and solved long-standing open problems; applications include software and hardware verification. Implemented my ideas into a production-ready software. Collaborated with international teams. Work was peer-reviewed and published in high-impact venues. Received an award at an international conference (FLoC 2022). Thesis graded A(ii).

2015–2017 **MSc in Physics**, *Universidade de Coimbra*, Portugal
Specialization in Computational Modelling and Simulation

Two-year cycle of studies conferring the degree of Master of Science, comprising one year of classes and one year of research, culminating in a written thesis and defence. Researched models of dense stellar matter. Implemented high-performance code for a large computing cluster. Pursued extra classes in mathematics. Thesis graded at 19 out of 20.

2012–2015 **BSc in Physics**, *Universidade de Coimbra*, Portugal

Three-year cycle of studies conferring the degree of Bachelor of Science, comprising lectures, lab work and projects. Pursued extra classes in mathematics. Organised student activities. Joined a research group on biophysics in order to gain research experience.

Professional Experience

2023–present **Software developer**, *IMC Trading*, Amsterdam, Netherlands

Worked in high-performance, high-reliability distributed systems for trading financial derivatives, in the execution team for the Europe desk of a high-frequency trading firm. Worked all across the tech stack: from high-level architectural planning, or ancillary tools (e.g. data pipelines, data visualisation), down to ultra-low latency software, specialised networking, and integration with custom hardware. Assumed a high degree of autonomy, with responsibilities around optimising low-level implementation of trading on the Eurex® exchange (order and market feed protocols).

2018–2022 **Teaching assistant**, *University of Manchester*, United Kingdom

Worked as a graduate teaching assistant at the University of Manchester concurrent with my PhD. This involved teaching tutorial and lab sessions, face-to-face assignment marking, offline marking, office hours, and giving written feedback. During the pandemic, this shifted to online learning over many different platforms. Classes included mathematics, imperative programming, functional programming, algorithms, AI, and software verification.

2013–2023 **Tutoring**

I have thousands of hours of experience tutoring students in online and in-person settings – mostly in physics, mathematics, and programming – at levels from middle school to Master's. I find this work extremely rewarding, and I have received praise from students over the years.

2018–2023 **Doctorate researcher**, *Formal Methods Group*, Department of Computer Science, University of Manchester

Researcher in the field of automated reasoning. Studied efficient equational reasoning in automated theorem proving for first-order logic.

Automated theorem provers can be thought of as general-purpose tools for solving any problem which can be described in a given logical language. However, if they only rely on logical deductions from axioms, they may be prohibitively slow even for apparently "easy" problems (such as simple arithmetic). We investigate the possibility of combining *general-purpose* logical deduction with *domain-specific* knowledge about select theories, in a way that does not compromise that full generality. This is of crucial importance in many practical problems, such as verifying properties of software. Our work has resulted in theoretical advancements over the state of the art which settled long-standing open questions in the field, as well as practical results that have already been adopted by the community. Our work has been peer-reviewed and published in top venues in the field, and received recognition in the form of awards (see publications). We have implemented these and other algorithms in iProver, a joint project for a production-ready theorem prover for first-order logic (written in OCaml).

2016–2017 **Master's researcher**, *Compact Stars Research Group*, Physics Department, University of Coimbra

Researcher in the field of compact stars in a Master's thesis project. Studied hybrid models of neutron stars and proto-neutron stars.

Conditions inside neutron stars are unique and do not happen anywhere else in the universe. Therefore, studying their behaviour gives theoretical researchers invaluable information to rule out or confirm theories of fundamental physics. In this work, we formulated effective field models of QCD with bound and unbound quarks, in phase equilibrium, and calculated which models of neutron stars (at different stages of life) they implied. Implemented in C++ and run in a super-computing cluster.

2014–2016 **Assistant researcher**, *Computational Biology Group*, Physics Department, University of Coimbra

Researcher in a group doing work on topics related to computational biology. Studied phase-field models of sprouting angiogenesis.

Diseases such as diabetic retinopathy (the leading cause of blindness in people aged 20 to 64) are caused when problems in blood vessels lead to insufficient blood flow to tissues, causing cells to die. In this work we developed a phase-field model of blood vessels in the eye and of the surrounding tissue. By refining this model in close collaboration with biologists, we were able to run the physical–chemical simulation to "perform experiments" in the computer, such as predicting how the blood vessels react to different drugs or to the stimulation of production of certain biochemicals.

Selected projects

TAU-800B Super	*An anachronic fantasy computer capable of time-travel*
quantum-tptp	*Automated verification of quantum circuits*
ocaml-posit	*A library for using Type III unums in OCaml*
LibriVox	*Narrating audiobooks for the public domain*

Publications

André Duarte. 'Efficient reasoning in equational theories'. Doctorate thesis. University of Manchester, 2023. URL: https://pure.manchester.ac.uk/ws/portalfiles/portal/280559728/FULL_TEXT.PDF.

André Duarte and Konstantin Korovin. 'Ground Joinability and Connectedness in the Superposition Calculus'. In: *IJCAR: 11th International Joint Conference on Automated Reasoning (part of FLoC: 8th Federated Logic Conference), Haifa, Israel*. **Awarded "Best Paper by a Student"** (link). 2022. URL: https://link.springer.com/content/pdf/10.1007/978-3-031-10769-6.pdf#page=178.

André Duarte and Konstantin Korovin. 'AC Simplifications and Closure Redundancies in the Superposition Calculus'. In: *TABLEAUX: 30th International Conference on Automated Reasoning with Analytic Tableaux and Related Methods, Birmingham, UK*. 2021. URL: https://arxiv.org/pdf/2107.08409.pdf.

André Duarte and Konstantin Korovin. 'Implementing Superposition in iProver (System Description)'. In: *IJCAR: 10th International Joint Conference on Automated Reasoning, Paris, France*. 2020. URL: https://andrepd.eu/pubs/ijcar20.pdf.

André Duarte and Konstantin Korovin. 'Experimenting with superposition in iProver'. In: *ARW: 26th Automated Reasoning Workshop, London, UK*. 2019. URL: https://andrepd.eu/pubs/arw19.pdf.

André Duarte. 'Two Phase Model for Warm Stellar Matter: an Equation of State for Compact Stars'. Master thesis. Universidade de Coimbra, 2017. URL: https://andrepd.eu/pubs/msc.pdf.