# Hrutvik Kanabar

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PhD in Computer Science

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#### 2018-23 UNIVERSITY OF KENT

2018-23 Thesis title: Verified compilation of a purely functional language to a realistic machine semantics. Viva voce (defence) passed in Sep 2023 - external examiner (opponent): Prof Xavier Leroy. Supervised by Olaf Chitil (planning/dissertation) and Scott Owens (at Meta since late 2019). Project funded by the National Cyber Security Centre (NCSC) via the UK Research Institute in Verified Trustworthy Software Systems (VeTSS): Building Verified Applications in CakeML.

Education

#### 2015-18 UNIVERSITY OF CAMBRIDGE, King's College

2017-18 Computer Science, second/third year: Class I/Class I, Palantir Prize for Highly Commended Dissertation. Dissertation title: Implementing and verifying a compiler optimisation for CakeML.

Research

- Verified dead code elimination for two intermediate languages of the CakeML verified compiler.
- Supervised by Magnus Myreen and Anthony Fox (technical), Stephen Kell (planning/dissertation).

2016 Natural Sciences, first year: Class I, studying Mathematics, Physics, Chemistry, Computer Science.

## PureCake

Verified compilation of a lazy functional language to CakeML (itself a verified compiler for a subset of ML). Haskell-like syntax; interaction tree-based semantics; equational reasoning; constraint-based type inference (with monad for IO); optimisations for compiling non-strict code such as demand analysis and monadic reflection.

## Taming authoritative Arm ISA models

Verifying unofficial Armv8 ISA models against authoritative specifications; increasing assurances in L3 and CakeML. Extracted formal specifications from official Arm ISA descriptions using the Sail ecosystem (REMS, Cambridge); verified unofficial state of the art L3 specifications; re-verified the CakeML compiler with significantly increased trust.

## Semantic type soundness for CakeML

Using logical relations to prove semantic type soundness for CakeML.

- Semantic type soundness permits robust composition of typeable and untypeable but verified code (c.f. RustBelt).

- Potential use cases: faster array accesses by removing bounds-checks; safe composition of code compiled into

CakeML with code written in CakeML; reasoning about module boundaries and enforcement of type abstraction.

## Translation from higher-order logic into stateful CakeML

Augmenting the existing translator from the HOL4 logic into CakeML abstract syntax. I added support for parametric polymorphism, translation of non-obviously terminating functions, proof automation.

## Industry

#### 2022 Software Engineering Intern - GOOGLE

Increasing filesystem coverage in the syzkaller OS kernel fuzzing engine. Aug-Nov

#### 2022 Software Engineer Intern - META

May-Jul Augmenting taint analysis for the Infer (Pulse) static analyser to deliver a data lineage system.

#### 2020 Software Engineer Intern – FACEBOOK

Jul-Oct Improving type inference for Hack by generating constraints on method invocations.

## published in ITP 2022 🛥

published in PLDI 2023 🛥

(on hold)

published in JAR 2020 🛥

BA (Hons), MA

## 2020 Intern Research Engineer – ARM LTD

Apr–Jul Investigating the Sail language ecosystem's impact on mechanised reasoning about the Armv8 ISA.

## 2018 Software Development Intern – ENSOFT LTD

Jul-Sep Creating an open-source Python Linux profiling and visualisation tool in a small group of interns.

## **Teaching and communication**

### Assistant Lecturer - UNIVERSITY OF KENT

Leading undergraduate seminars

- Programming Languages: applications and design third year course language design and its trade-offs.
- Theory of Computing second year course logic and proof, regular languages, CFGs, computability.
- Functional and Concurrent Programming second year course Haskell and Erlang language semantics, actor model.
- Algorithms, Correctness, and Efficiency second year course data structures, sorting, graphs, big-O notation.
- Foundations of Computing first year course foundations in: algebra, statistics, proofs, and set theory.

## Research placement - RAINBOW RESEARCH GROUP, UNIVERSITY OF CAMBRIDGE

2017 Creating Java-based coursework for a first-year graphics course, with automated assessment in a VLE.

Rowing coach – KING'S COLLEGE BC and UNIVERSITY OF KENT RC RYA Powerboat Handling Level 2 qualified

- 2018–22 Volunteer coach at University of Kent for beginner and experienced crews, with many wins.
- 2015–18 Student coach at King's College for both beginners and experienced crews. Placed beginner crews 3<sup>rd</sup> and 5<sup>th</sup> out of ~70 intercollegiate crews, the most successful performances in club memory.

## Public speaking - CAROLS FROM KING'S

2017 Reader at *Carols from King's* on BBC Two, Christmas Eve.

Research community	
<b>Programming Design and Implementation (PLDI) – ORLANDO, USA</b> Presented a paper on PureCake (see above).	Jun 2023
Interactive Theorem Proving (ITP) – HAIFA, ISRAEL Presented a paper on taming authoritative Arm ISA specifications (see above).	Aug 2022
Subreviewer for Journal of Functional Programming (JFP)	Sep 2021
Artifact Evaluation Committee for International Conference on Functional Programming (ICFP)	Jun 2021
ACM Student Research Competition at the Symposium on Principles of Programming Languages (POPL) – NEW ORLEANS, USA Placed 2 <sup>nd</sup> in the competition after three rounds: an extended abstract submission, a poster show, and a part Aided operation of the conference as a Student Volunteer.	Jan 2020 resentation.
Programming Languages Mentoring Workshop (PLMW) at the International Conference on Functional Programming (ICFP) – BERLIN, GERMANY Awarded a scholarship to attend both PLMW and ICFP. Received mentoring and advice from PLMW on technical topics, research skills, and future careers.	Aug 2019
<b>CakeML Developers Meeting – GOTHENBURG, SWEDEN</b> Presented work on and future directions for stateful translation from HOL4 to CakeML at an annual meet	May 2019 ing for developers.
Google Compiler and Programming Language Summit – MUNICH, GERMANY	Dec 2018/2019

Funded to attend the summits by Google. Presented a poster on both occasions.

**Referees on request**