CHRIS CUMMINS

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EDUCATION

2019 (expected)

Ph.D, Informatics
University of Edinburgh, School of Informatics

Deep learning over programs. Developing novel machine learning methods for random program generation, compiler optimisations, and representative benchmarking. Applications for heterogeneous parallelism, compiler testing, and adaptive performance tuning. To date: 8 publications, 3 best papers, 9 invited talks, 7 posters, 5 conferences.

2015

MSc by Research, Pervasive Parallelism *(Distinction)*
University of Edinburgh, School of Informatics
Thesis: *Autotuning Stencil Codes with Algorithmic Skeletons* (grade: 85%)

Runtime adaptive tuning for heterogeneous parallel systems, targeting a high level DSL for multi-GPU stencil programs. Machine learning over distributed training sets.

2014

MEng Electronic Engineering & Computer Science *(First Class Honours)*
Aston University, School of Engineering & Applied Science
Thesis: *Protein Isoelectric Point Database* (grade: 90%)

Created a search engine and API for a novel molecular biochemistry dataset. Targeting bioinformatics research and released open source, with peak 854 monthly active users.

PROFESSIONAL EXPERIENCE

2018

Google, Mountain View, California, USA
Software Engineer Intern

Created a representative benchmark of Google's Protocol Buffer usage. Working in the Google Wide Profiling team to synthesise benchmarks for Google compute. The project involved company-wide workload characterization through to datacentre-scale low level performance analysis of profiles and hardware counters.

2016–2018

Codeplay Software, Edinburgh, UK
Software Engineer, Part Time

Developing OpenCL port of Tensorflow. Implemented GPU memory management for Eigen. Compile time scheduling and kernel fusion for expression trees on GPUs. Proposed and designed a Python interface for VisionCpp as lead developer. Extensive C++ meta-programming. Integrated compiler fuzzers into continuous testing tooling.

2012–2013

Intel Corporation, London, UK
Open Source Developer Intern

Patched `ioctl` subsystem in Linux kernel. Developed a novel SIMD register visualisation tool for Intel GPU assembly programming. Implemented GTK+ support for Wayland display server. Fixed memory and usability bugs in GNOME desktop applications. Developed particle effects engine for a 3D rendering program. Rapid prototyping of Android applications. Numerous contributions to open source projects.

2010–2017

Freelance Web Developer
Full-stack development for small businesses, including graphic design and branding. Clients included conferences, publishing houses, musicians, and a beauty parlour.

2008

Rolls Royce Holdings plc, Derby, UK
Work placement in the Design Methods & Improvements team.

PUBLICATIONS

2018 C. Cummins, P. Petoumenos, A. Murray, H. Leather. **Compiler Fuzzing through Deep Learning**. Distinguished Paper Award ISSTA'18 (28% acceptance rate), Amsterdam, Netherlands.

Unsupervised machine learning to derive program generators for compiler fuzz testing. Implemented in 100× less code than state-of-the-art program generator, and 3.03× faster. Found and reported 67 bug reports in OpenCL compilers.

2018 C. Cummins, P. Petoumenos, A. Murray, H. Leather. **DeepSmith: Compiler Fuzzing through Deep Learning** (extended abstract). ACACES'18, Fiuggi, Italy.

A novel approach to compiler fuzzing which offers to dramatically reduce the cost and human effort required to engineer a random program generator.

2017 C. Cummins, P. Petoumenos, Z. Wang, H. Leather. **End-to-end Deep Learning of Compiler Heuristics**. Best Paper PACT'17 (23% acceptance rate), Portland, Oregon.

Learning optimization heuristics directly from raw source code, without the need for feature extraction. 12% and 14% performance improvements over state-of-the art, with greatly reduced development costs and the ability to transfer learning across heuristics.

2017 C. Cummins, P. Petoumenos, Z. Wang, H. Leather. **Synthesizing Benchmarks for Predictive Modeling**. Best Paper CGO'17 (22% acceptance rate), Austin, Texas.

Deep learning over massive codebases from GitHub to generate benchmark programs. Automatically synthesizes OpenCL kernels which are indistinguishable from hand-written code, and improves state-of-the-art predictive model performance by 4.30×.

2016 C. Cummins, P. Petoumenos, M. Steuwer, H. Leather. **Autotuning OpenCL Workgroup Sizes** (extended abstract). ACACES'16, Fiuggi, Italy.

Machine learning-enabled autotuning of multi-GPU OpenCL workgroup sizes. Static tuning achieves only 26% of the maximum performance, our approach achieves 92%.

2016 C. Cummins, P. Petoumenos, M. Steuwer, H. Leather. **Towards Collaborative Performance Tuning of Algorithmic Skeletons**. HLPGPU'16, HiPEAC, Prague.

A distributed framework for dynamic prediction of optimisation parameters using machine learning. Automatically exceeds human experts by 1.22×.

2016 C. Cummins, P. Petoumenos, M. Steuwer, H. Leather. **Autotuning OpenCL Workgroup Size for Stencil Patterns**. ADAPT'16, HiPEAC, Prague.

Three methodologies to autotune stencil patterns using machine learning. Speedups of 3.79× over the best possible static size, 94% of the maximum performance.

2015 E. Bunkute, C. Cummins, F. Crofts, G. Bunce, I. T. Nabney, D. R. Flower. **PIP-DB: The Protein Isoelectric Point Database**. Bioinformatics, 31(2), 295-296. Chicago.

An open source search engine of protein isoelectric points. Provides public access to bioinformatics data from the literature for comparison and benchmarking purposes.

INVITED TALKS

2018 **Codeplay Software**, Edinburgh, UK. "Compiler Fuzzing through Deep Learning."

2018 **ISAGT**, Amsterdam, Netherlands. "Machine Learning for Compilers."

2018 **Facebook**, Menlo Park, USA. "Using Deep Learning to Generate Human-like Code."

2018 **Google**, Mountain View, USA. "End-to-end Deep Learning of Compiler Heuristics."

2018 **Google**, Sunnyvale, USA. "End-to-end Deep Learning of Compiler Heuristics."

2017 **Scottish Programming Languages Seminar** (SPLS), St. Andrews, UK. "Using Deep Learning to Generate Human-like Code."

2016 **Codeplay Software**, Edinburgh, UK. "Machine Learning & Compilers."

2016 **Ocado Technology**, Hatfield, UK. "Building an AI that Codes."

2016 **Amazon Development Center**, Edinburgh, UK. "All the OpenCL on GitHub: Teaching an AI to code."

AWARDS

2018 **Distinguished Paper Award Winner, ISSTA'18**
ACM SIGSOFT International Symposium on Software Testing and Analysis
Top tier conference with 112 submissions, 28% acceptance rate.

2017 **Best Paper Winner, PACT'17**
26th International Conference on Parallel Architectures and Compilation Techniques
Top tier conference with 109 submissions, 23% acceptance rate.

2017 **Best Paper Winner, CGO'17**
IEEE/ACM International Symposium on Code Generation and Optimization
Top tier conference with 116 submissions, 22% acceptance rate.

2014 **Institute of Engineering & Technology Prize**
Annual prize for top engineering student at Aston University.

2009 **Arkwright Scholarship, Rolls Royce Holdings plc**
Funded scholarship awarded to less than 250 students nationwide.

2009 **Engineering Education Scheme of England**
R&D for a (now patented) supermarket trolley mounted shopping aid.

2008 **AESSEAL Design Innovation Award**
Cash prize for first place in an industrial 3D CAD competition.

POSTERS

2018 ISSTA'18, Amsterdam, Netherlands.

2018 ACACES'18, Fiuggi, Italy.

2016 Google PhD Student Summit, Munich, Germany.

2016 ACACES'16, Fiuggi, Italy.

2016 PLDI'16, Santa Barbara, USA.

2016 HiPEAC'16, Prague, Czech Republic.

2015 Google PhD Student Summit, Munich, Germany.

ACADEMIC ACTIVITIES

Conferences PACT 2018 HotCRP Chair, CGO 2018 Web Chair, ParCo 2015 Student Volunteer.

Peer reviews CGO 2018, ACM TACO 2016, LCTES 2016, CGO 2016.

TECHNICAL SKILLS

Languages Python, C++, SQL, Bash, JavaScript, C, OpenCL, Java, various LISP dialects.

Tools Git, GNU/Linux, LaTeX, TensorFlow, Jupyter, GNU autotools, gdb, Linux perf, Bazel.