Naums Mogers

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▬▬▬ Personal Statement

I am a second year PhD student in Computer Science at the Institute for Computing Systems Architecture at the University of Edinburgh. My **research interests** are deep neural networks (DNN), optimising compilation and optimisation of DNN for portable performance. I worked on these topics within my PhD project, as a research intern at **Microsoft Research** and **ARM Research** and in a yearlong collaboration with **Huawei**. My PhD work includes extension of a functional data-parallel language Lift, its IR and a compiler implemented in Scala to generate optimised ML kernels in OpenCL, in a proprietary BrainWave language and hardware accelerator designs in Spatial.

My past projects include OpenCL and Python-based neural network-accelerated ant swarm simulation (*Bachelor's project*) and programming microcontroller-driven robots in C and Python. I worked with FPGAs, Raspberry Pi, Arduino and Mbed microcontrollers; in my research, I have worked with NVIDIA and ARM GPUs. My research includes extending Caffe functionality for optimised execution on Android, using Tensorflow and PyTorch; in the **six internships** I did, I worked on an antivirus core in C, C++, Python and Bash, wrote websites using PHP, JavaScript and MySQL and developed accounting software in Visual Basic. I participate in **teaching** of algorithms, machine learning, Java and cognitive science.

▬▬▬ Education

Sep 2017 — Nov 2020 **PhD in Optimising Compilation of Machine Learning Models for Heterogeneous Hardware**
Supervisor: Dr Christophe Dubach, University of Edinburgh, UK
The focus of my research is rewrite rules-based compilation of the functional domain-specific language Lift for DNNs into OpenCL. The goal is to abstract DNNs from hardware without losing neither **device-specific optimisations**, nor **performance-preserving portability**. My approach involves expressing DNNs **functionally**, encoding parametrised optimisations as rewrite rules and exploring a huge search space of optimisations and their parameters. In addition to NVIDIA GPUs, I targeted ARM Mali GPUs for the yearlong collaboration with **Huawei**, where I cross-compiled DNN-code for HiKey.

Sep 2016 — Aug 2017 **MSc by Research in Optimisation of CNNs Using A Functional Data-Parallel Language**
Supervisor: Dr Christophe Dubach, University of Edinburgh, UK
For this project I expressed a CNN in the functional language Lift and explored the optimisational space of data **tiling** and **grouping** and weighting **sequentialization**, exploiting **coalesced memory accesses** and **data locality**. I presented a poster on this work at the Google PhD Summit in Munich.

Sep 2015 — Aug 2016 **MSc in Artificial Intelligence**
Supervisor: Dr Christophe Dubach, University of Edinburgh, UK
Dissertation title: *'Expressing Artificial Neural Networks In A Functional Data-Parallel Language For GPU Acceleration'*. The curriculum included courses in Machine Learning, Robotics and Cognitive Science.

Oct 2011 — Jul 2015 **BEng in Computer Science (with a year in industry)**
Supervisor: Dr Simon O'Keefe, University of York, UK
Dissertation title: *'Memory In Simulated Swarms'*. The curriculum was focused on system programming (schedulability analysis, embedded software, real-time systems, compilers) and artificial intelligence (neural computing, search algorithms, multi-agent systems, swarm intelligence). Several of my course projects are available on https://github.com/naummo .

▬▬▬ Research Internships & Collaborations

Sep 2019 — Dec 2019 **Research Intern, ARM, Cambridge, UK**
My project while at the ARM Architecture Research group is focused on using rewriting compilation to generate optimal hardware accelerator designs for a given application such as LSTM. To this end, I extended the intermediate representation and the compiler of the Lift compiler to generate HDL descriptions in the Spatial language.

Aug 2018 — Oct 2018 **Research Intern, Microsoft Research, Cambridge, UK**
I worked on the project **BrainWave**, extending the functional data-parallel Lift compiler to a specialized machine learning accelerator. This work included extensive changes to all parts of the compilation

chain including type checking, memory management, rewriting and code generation.

Sep 2017 — Dec 2018	**Collaboration with Huawei**, *University of Edinburgh, UK* Within this collaboration with Huawei, I focused on optimising CNNs for embedded devices, which included porting Caffe to the Android OS on the Huawei Kirin 960-based HiKey 960 board with ARM Mali G71 GPU.
Jul 2015 — Sep 2015	**Research Intern**, *York Centre for Complex Systems Analysis, University of York, UK* I designed a biologically inspired cellular model for a Wireless Sensor Network of Arduinos, capturing such biological properties as adaptivity, self-organization and fault-tolerance. Research topics covered include Artificial Epigenetic Regulatory Networks, Genetic Programming and Cell Signalling.

Awards

Sep 2016	**IBM & Swiss Re challenge first prize**, *HackZurich 2016, Zurich, Switzerland* At HackZurich 2016, my team won the IBM & Swiss Re challenge against 20 teams; we became **one of 25 finalists out of 152** teams in the main hackathon challenge. We developed a Machine Learning app for risk prediction using home IoT sensors and IBM analytic technologies.
Mar 2016	**Best Poster**, *National Student Research Conference 2016, UK* Mogers N, Trefzer, M, Lagos, D, **The Sensor Organism** (2015)
Sep 2015	**Best Poster**, *York Doctoral Symposium, UK* Mogers N, Trefzer, M, Lagos, D, **The Sensor Organism** (2015)
Jul 2015	**York Award**, *University of York, UK* In recognition of achievement of a significant programme of personal, working and educational activities.

Teaching Experience

2017—2019	**Algorithms, Data Structures and Learning**, *Teaching Assistant / Marker, University of Edinburgh*
2017—2019	**Object-Oriented Programming**, *Teaching assistant, University of Edinburgh*
2017—2018	**Introductory Applied Machine Learning**, *Marker, University of Edinburgh*
2008—2019	**Machine Learning; Microcontrollers**, *Tutor, Facultative School For Talented Children, Latvia* I wrote and taught two courses on Neural Networks and Decision Trees, and a course on maze solving and construction algorithms. In 2016, I taught a workshop on Arduino-based auto-aiming catapult construction.
2017	**Software Testing**, *Tutor, University of Edinburgh*
2016	**Raspberry Pi / Raspbian / Windows 10 IoT workshop**, *Tutor, University of Edinburgh*
2016	**Compiling Techniques**, *Demonstrator, University of Edinburgh*
2016	**Processing Formal and Natural Languages**, *Marker, University of Edinburgh*

Scholarships

Sep 2016 — Aug 2020	**CDT Pervasive Parallelism**, *University of Edinburgh, UK* Four-year scholarship sponsored by the UK Engineering and Physical Sciences Research Council.
Feb 2014 — May 2014	**Raspberry Pi project funding**, *Department of Computer Science, University of York, UK* I designed and developed a Raspberry Pi-related project promoting technology in schools. The project included microcontroller programming in Python and actuator system design.

Presentations

Dec 2019	**Poster: Accelerator Design Optimisation Using a Functional Data-Parallel Language** *Google Compiler and Programming Language Summit 2019, Munich, Germany*
Sep 2019	**Talk: Functional Interface for Performance Portability on Parallel Accelerators** *ARM Research Summit, Renegotiating Accelerator Abstractions (Post-Moore's Law) workshop.*
Jan 2019	**Talk: Towards Mapping Lift to Deep Neural Network Accelerators** *Workshop on Emerging Deep Learning Accelerators (HiPEAC), Valencia, Spain.*
Apr 2018	**Tutorial: Lift: Performance Stencil Code Generation with Lift**

International Symposium on Performance Analysis of Systems and Software (ISPASS), Belfast, UK

Dec 2017 Poster: Optimisation of Neural Computations Using a Functional Data-Parallel Language
Google Compiler and Programming Language Summit 2017, Munich, Germany

Oct 2017 Invited Talk: Computational Optimisation of CNNs Using a Functional Data-Parallel Language
Glasgow Systems Seminar, University of Glasgow, UK

Jun 2017 Poster: Optimisation of Neural Computations Using a Functional Data-Parallel Language
The Scottish Informatics and Computer Science Alliance, University of Dundee, UK

Attended Academic Events

Sep 2019 ARM Research Summit, *Austin, Texas, USA*
Gave a talk on functional interface for Post-Moore's Law hardware accelerators.

Oct 2018 Facebook PhD London Tech Talk, *London, UK*
I was selected by Facebook to attend a Tech Talk targeting PhD researchers from across the UK.

Aug 2017 Google Inside Look, *London, UK*
I was selected from thousands of applicants to participate in two days of lectures, workshops and panels inside the Google's London office.

Jul 2017 EPSRC CDT Student Showcase, *Edinburgh, UK*

I gave a talk and presented a poster to the industry partners of my doctoral programme.

Work Experience

Sep 2016 News Annotator, *Thomson Reuters, UK*
— Jun 2017 News article annotation with semantic tokens for a research project in natural language processing.

Jul 2013 Engineering Intern, *Sophos, Abingdon, UK*
— Jul 2014 My responsibilities included antivirus engine development in C/C++/Python, manual and automated testing, code reviews, debugging, documentation maintenance and software release preparation. My team employed Agile Development practices including pair programming and daily planning meetings.

Jul 2012 IT and Digital Summer Intern, *EDF Energy, Brighton, UK*
— Sep 2012 Full-time internship at R&D department in C++ OCR software development and IT support.

Feb 2012 Web Design Intern, *Stockholm Environment Institute York, York, UK*
— Aug 2012 Part-time internship in web development.

Jun 2009 System Administrator / Software Developer, *M2 Ltd, Riga, Latvia*
— Dec 2014 Part-time during the academic year and full-time during summers, my responsibilities included PHP and Visual Basic development, and IT support.

Publications

Feb 2020 (Under review) Mogers N, Li, L, Dubach, C (2019). *Rewrite Rule-based Optimisation of Deep Neural Networks for Embedded Platforms*, IACM SIGPLAN 2020 International Conference on Compiler Construction (CC 2020). San Diego, 2020.

Jan 2019 Mogers, N, Smith, A, Vytiniotis, D, Steuwer, M, Dubach, C, Tomioka, R (2019). *Towards Mapping Lift to Deep Neural Network Accelerators*, Workshop on Emerging Deep Learning Accelerators (HiPEAC).

Oct 2015 Mogers, N, Trefzer, M, Lagos, D. (2015). *The Sensor Organism*. In C. Paterson (Ed.), Proceedings of the Eighth York Doctoral Symposium on Computer Science & Electronics (p. 88). York: The University of York.

Skills

Programming languages	C (expert), OpenCL (expert), Python (expert), Scala (advanced), Java, PHP, MATLAB
Frameworks	Caffe, PyTorch, Tensorflow
Hardware	GPU, FPGA, Huawei HiKey, Arduino, Raspberry Pi
Languages	English (fluent), Russian (native), Latvian (intermediate), German (basic)