Naums Mogers

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Personal Statement

I am a third 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 performance portability. 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 extending functional data-parallel language Lift and its Scala-based compiler to generate optimised ML kernels in OpenCL and the BrainWave accelerator-specific language; his recent work focuses on generating FPGA designs for efficient LSTMs 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 – Sep 2022 **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 – Jun 2017 **News Annotator**, *Thomson Reuters, UK*
News article annotation with semantic tokens for a research project in natural language processing.

Jul 2013 – Jul 2014 **Engineering Intern**, *Sophos, Abingdon, UK*
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 – Sep 2012 **IT and Digital Summer Intern**, *EDF Energy, Brighton, UK*
Full-time internship at R&D department in C++ OCR software development and IT support.

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

Jun 2009 – Dec 2014 **System Administrator / Software Developer**, *M2 Ltd, Riga, Latvia*
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)