Michel Steuwer

Informatics Forum — 1.02
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University Education

2010–2015 **PhD degree in computer science**, *University of Münster*, Germany.
Supervisor: Prof. Sergei Gorlatch

Thesis: *Improving Programmability and Performance Portability on Many-Core Processors*
Awarded with the highest possible grade: **Summa Cum Laude** (*with highest honor*)

Nominated as one of 34 candidates from all German, Austrian, and Swiss Universities for the prize for best dissertation awarded by the German Informatics Society.

2005–2010 **Diploma degree in computer science with a minor in mathematics**,
(equivalent to a combined MSc and UG degree) University of Münster, Germany.

Thesis: *SkelCL — A Portable Multi-GPU Skeleton Library*

Professional Experience

since Oct. 2014 **Postdoctoral Research Associate**, *The University of Edinburgh*, UK.

2010–2014 **Research Associate**, *University of Münster*, Germany.

Awarded Honours

○ PhD thesis honoured with the highest possible grade *Summa cum laude*
○ Nominated as one of 34 candidates for the prize for best dissertation completed in 2015 in Informatics at a German, Austrian, or Swiss University. This highly prestigious prize is awarded annually by the German Informatics Society (GI).

Awarded Grants

○ HiPEAC collaboration grants (2016 and 2013) and HPC-Europa2 visitor grant (2012) in total of approx. €15.000.
○ Nvidia GPU Grant Program (2011 and 2016) in total of approx. €12.500.
○ Intel Hardware Accelerator Research Program (2016) for privileged access to Intel's upcoming CPU+FPGA hardware.

Research Visits and Collaborations

2016 **Research Collaboration (3 Month)**, *dividiti Ltd.*, UK.
Funded by the HiPEAC Network of Excellence

2016 **Hosting of a visiting researcher (2 Month)**, *From the University of Münster*, Germany.
Funded by the EuroLab-4-HPC project

2014 **Visiting researcher (3 Month)**, *The University of Edinburgh*, UK.

2013 **Visiting researcher (4 Month)**, *The University of Edinburgh*, UK.
Funded by the EU HiPEAC Network of Excellence

2012 **Visiting researcher (3 Month)**, *The University of Edinburgh/EPCC*, UK.
Funded by the EU HPC-Europa2 project

Research Community Activities

Memberships and Participation in Research Networks

- Member of ACM and the German Informatics Society (GI: Gesellschaft für Informatik)
- Active participating member of the European Network on High Performance and Embedded Architecture and Compilation (HiPEAC)
- I represent the University of Edinburgh in the recent EU *EuroLab-4-HPC: Open source in high performance computing* initiative

Conference Organisation

- I was the main organiser of the 7th UK Many-Core Developer Conference on May 10th in Edinburgh with over 50 participants, a keynote and 10 talks spanning topics from the landscape of accelerated, heterogeneous and many-core computing.

Organisation

- I co-organise the seminar of the *Programming Language Research Programme* at the School of Informatics in Edinburgh together with James Cheney, an series of talks covering a broad range of topics related to programming languages.
- I organise the *Humble C++ Programmer Group*, a group discussing practical programming topics in C++ targeted at PhD students to improve their coding skills.

Program Committees

- 10th Int. Symposium on High-Level Parallel Programming and Applications (HLPP 2017)
- 9th Int. Symposium on High-Level Parallel Programming and Applications (HLPP 2016)
- 16th IEEE Int. Conference on Scalable Computing and Communications (ScalCom 2016)

Artifact Evaluation Committees

- The 25th Int. Conference on Parallel Architectures and Compilation Techniques (PACT 2016)
- The 15th Int. Symposium on Code Generation and Optimization (CGO 2017)

Reviewing

External reviewer for conferences:
- International Symposium on Code Generation and Optimization (CGO)
- International Conference on Parallel and Distributed Computing (Euro-Par)
- European MPI Users Group conference (EuroMPI)
- International Symposium on Cluster, Cloud and Grid Computing (CCGrid)
- International Parallel Computing Conference (ParCo)
- Parallel Computing Technologies (PaCT)

Reviewer for journals:
- ACM Computing Surveys (ACM)
- Science of Computer Programming Journal (Elsevier)
- The Journal of Supercomputing (Springer)
- Software: Practice and Experience (Wiley)

Research Collaborations

- Sam Lindley, LFCS, University of Edinburgh
- Alan Gray, EPCC, University of Edinburgh
- Robert Atkey, University of Strathclyde
- Ryan Newton, University of Indiana Bloomington
- Sergei Gorlatch, University of Münster
- Alastair Murray, Codeplay
- Grigori Fursin and Anton Lokhmotov, dividiti Ltd.
- Mario Wolczko and Tim Harris, Oracle Labs
- Robert Hundt, Google

Publications

Journal Articles

2014 [J1] **M. Steuwer**, M. Haidl, S. Breuer, and S. Gorlatch. "High-Level Programming of Stencil Computations on Multi-GPU Systems Using the SkelCL Library". In: *Parallel Processing Letters* 24.3 (2014). SJR Ranking: Q3, **Featured article** and among top 10 **most read** articles on `www.worldscientific.com`.

[J2] M. Olejnik, **M. Steuwer**, J. N. Dybowski, S. Gorlatch, and D. Heider. "gCUP: Rapid GPU-based HIV-1 Coreceptor Usage Prediction for Next-Generation Sequencing". In: *Bioinformatics* 30.22 (2014). **SJR Ranking: Q1**.

[J3] **M. Steuwer** and S. Gorlatch. "SkelCL: A High-Level Extension of OpenCL for Multi-GPU Systems". In: *The Journal of Supercomputing* 69.1 (2014). SJR Ranking: Q3.

[J4] **M. Steuwer**, M. Friese, S. Albers, and S. Gorlatch. "Introducing and Implementing the Allpairs Skeleton for GPU Systems". In: *Int. Journal of Parallel Programming* 42.4 (2014). SJR Ranking: Q3.

2013 [J5] P. Kegel, **M. Steuwer**, and S. Gorlatch. "dOpenCL: Towards uniform programming of distributed heterogeneous multi-/many-core systems". In: *Journal of Parallel and Distributed Computing* 73.12 (2013). SJR Ranking: Q2.

Conference Proceedings

2017 [C1] J. Fumero, **M. Steuwer**, L. Stadler, and C. Dubach. "Just-In-Time GPU Compilation for Interpreted Languages with Partial Evaluation". In: *Proceedings of the 13th ACM SIGPLAN/SIGOPS International Conference on Virtual Execution Environments, VEE 2017, Xi'an, China, April 8-9, 2017*. **CORE 2014 Ranking: A**. Xi'an, China: ACM, 2017.

[C2] **M. Steuwer**, T. Remmelg, and C. Dubach. "Lift: A Functional Data-Parallel IR for High-Performance GPU Code Generation". In: *Proceedings of the 2017 International Symposium on Code Generation and Optimization, CGO 2017, Austin, TX, USA, February 4-8, 2017*. **CORE 2014 Ranking: A**, **Acceptance Rate 22%**. Austin, USA: IEEE, 2017.

2016 [C3] **M. Steuwer**, T. Remmelg, and C. Dubach. "Matrix Multiplication Beyond Auto-Tuning: Rewrite-based GPU Code Generation". In: *Proceedings of the 2016 International Conference on Compilers, Architecture, and Synthesis of Embedded Systems, CASES*. **CORE 2014 Ranking: A**. Pittsburgh, USA, 2016.

2015 [C4] **M. Steuwer**, C. Fensch, S. Lindley, and C. Dubach. "Generating Performance Portable Code using Rewrite Rules: From High-Level Functional Expressions to High-Performance OpenCL Code". In: *Proceedings of the 20th ACM SIGPLAN International Conference on Functional Programming, ICFP 2015*. **CORE 2014 Ranking: A***, **Acceptance Rate 29%**, **21 citations** on Google Scholar, **most cited paper** from ICFP 2015 and **3th most downloaded paper** from ACM's DL of ICFP 2015. Vancouver, Canada, 2015.

[C5] J. J. Fumero, T. Remmelg, **M. Steuwer**, and C. Dubach. "Runtime Code Generation and Data Management for Heterogeneous Computing in Java". In: *Proceedings of the Principles and Practices of Programming on the Java Platform, PPPJ 2015*. CORE 2014 Ranking: C. Melbourne, USA, 2015.

2014 [C6] S. Gorlatch and **M. Steuwer**. "Towards High-Level Programming for Systems with Many Cores". In: *Perspectives of Systems Informatics 9th International Andrei Ershov Memorial Conference (PSI 2014)*. CORE 2014 Ranking: B. St. Petersburg, Russia, 2014.

2013 [C7] **M. Steuwer** and S. Gorlatch. "High-Level Programming for Medical Imaging on Multi-GPU Systems using the SkelCL Library". In: *Proc. of the Int. Conference on Computational Science, (ICCS)*. Vol. 18. Procedia Computer Science. **CORE 2014 Ranking: A**. Barcelona, Spain, 2013.

[C8] **M. Steuwer** and S. Gorlatch. "SkelCL: Enhancing OpenCL for High-Level Programming of Multi-GPU Systems". In: *Parallel Computing Technologies 2013*. Lecture Notes in Computer Science. **24 citations** on Google Scholar. St. Petersburg, Russia, 2013.

2012 [C9] **M. Steuwer**, P. Kegel, and S. Gorlatch. "A High-Level Programming Approach for Distributed Systems with Accelerators". In: *New Trends in Software Methodologies, Tools and Techniques – Proceedings of the 11th SoMeT'12*. CORE 2014 Ranking: B. 2012.

Workshop Proceedings

2017 [W1] M. Haidl, **M. Steuwer**, H. Dirks, T. Hummernbrum, and S. Gorlatch. "Towards Composable GPU Programming: Programming GPUs with Eager Actions and Lazy Views". In: *PMAM'17: Proceedings of the 8th International Workshop on Programming Models and Applications for Multicores and Manycores*. Austin, USA: ACM, 2017.

2016 [W2] T. Remmelg, T. Lutz, **M. Steuwer**, and C. Dubach. "Performance Portable GPU Code Generation for Matrix Multiplication". In: *GPGPU'16: Proceedings of the 9th ACM Workshop on General Purpose Processing using GPUs*. Barcelona, Spain, 2016.

[W3] M. Haidl, **M. Steuwer**, T. Humernbrum, and S. Gorlatch. "Multi-Stage Programming for GPUs in Modern C++ using PACXX". In: *GPGPU'16: Proceedings of the 9th ACM Workshop on General Purpose Processing using GPUs*. Barcelona, Spain, 2016.

[W4] A. Harries, **M. Steuwer**, M. Cole, A. Gray, and C. Dubach. "Compositional Compilation for Sparse, Irregular Data Parallelism". In: *HLPGPGPU'16: Workshop on High-Level Prog. for Heterogeneous and Hierarchical Parallel Systems*. Prague, Czech Republic, 2016.

[W5] C. Cummins, P. Petoumenos, **M. Steuwer**, and H. Leather. "Towards Collaborative Performance Tuning of Algorithmic Skeletons". In: *HLPGPGPU'16: Workshop on High-Level Prog. for Heterogeneous and Hierarchical Parallel Systems*. Prague, Czech Republic, 2016.

[W6] C. Cummins, P. Petoumenos, **M. Steuwer**, and H. Leather. "Autotuning OpenCL Workgroup Size for Stencil Patterns". In: *ADAPT'16: Proceedings of the 2016 International Workshop on Adaptive Self-tuning Computing Systems*. Prague, Czech Republic, 2016.

2014 [W7] J. J. Fumero, **M. Steuwer**, and C. Dubach. "A Composable Array Function Interface for Heterogeneous Computing in Java". In: *ARRAY'14: Proceedings of the 2014 ACM SIGPLAN International Workshop on Libraries, Languages, and Compilers for Array Programming*. Edinburgh, Scotland, 2014.

[W8] S. Breuer, **M. Steuwer**, and S. Gorlatch. "Extending the SkelCL Skeleton Library for Stencil Computations on Multi-GPU Systems". In: *Proceedings of the 1st International Workshop on High-Performance Stencil Computations*. Vienna, Austria, 2014.

2012 [W9] **M. Steuwer**, P. Kegel, and S. Gorlatch. "Towards High-Level Programming of Multi-GPU Systems Using the SkelCL Library". In: *IEEE International Symposium on Parallel and Distributed Processing Workshops*. **17 citations** on Google Scholar. 2012.

[W10] **M. Steuwer**, S. Gorlatch, M. Buß, and S. Breuer. "Using the SkelCL Library for High-Level GPU Programming of 2D Applications". In: *Euro-Par 2012: Parallel Processing Workshops*. Lecture Notes in Computer Science. Rhodes Island, Greece, 2012.

[W11] P. Kegel, **M. Steuwer**, and S. Gorlatch. "dOpenCL: Towards a Uniform Programming Approach for Distributed Heterogeneous Multi-/Many-Core Systems". In: *IEEE International Symposium on Parallel and Distributed Processing Workshops*. **28 citations** on Google Scholar. 2012.

2011 [W12] **M. Steuwer**, P. Kegel, and S. Gorlatch. "SkelCL - A Portable Skeleton Library for High-Level GPU Programming". In: *IEEE International Symposium on Parallel and Distributed Processing Workshops*. **99 citations** on Google Scholar. 2011.

Thesis

2015 [T1] **M. Steuwer**. "Improving Programmability and Performance Portability on Many-Core Processors". Grade: *Summa Cum Laude*, Supervied by Prof. Sergei Gorlatch, Nominated for the **prize for best dissertation** awarded by the German Informatics Society. PhD thesis. University of Münster, 2015.

Book Chapter

2016 [B1] **M. Steuwer**. "Verbesserung der Programmierbarkeit und Performance-Portabilität von Manycore-Prozessoren (Improving Programmability and Performance Portability on Many-Core Processors)". In: *Ausgezeichnete Informatikdissertationen 2015 (Distinguished Dissertations in Informatics 2015)*. Ed. by S. Hölldobler. Lecture Notes in Informatics. German Informatics Society, 2016.

2014 [B2] C. Kessler, S. Gorlatch, J. Emmyren, U. Dastgeer, **M. Steuwer**, and P. Kegel. "Skeleton Programming for Portable Many-Core Computing". In: *Programming Multi-core and Many-core Computing Systems*. Wiley, 2014.

2013 [B3] P. Kegel, **M. Steuwer**, and S. Gorlatch. "Uniform High-Level Programming of Many-Core and Multi-GPU Systems". In: *Transition of HPC Towards Exascale Computing*. Vol. 24. Advances in Parallel Computing. IOS Press, 2013.

Papers currently in submission

2017 [S1] P. Ginsbach, T. Remmelg, **M. Steuwer**, C. Dubach, and M. O'Boyle. "Idioms, Constraints and Rewrite Rules for Heterogeneous Systems". In: *Proceedings of the 38th ACM SIGPLAN Conference on Programming Language Design and Implementation, PLDI 2017, Barcelona, Spain, June 18-23, 2017*. **CORE 2014 Ranking: A***. Barcelona, Spain: ACM, 2017.

Talks and Presentations

02/2017 Talk: *Lift: A Functional Data-Parallel IR for High-Performance GPU Code Generation*
International Symposium on Code Generation and Optimization (CGO) 2017 in Austin, USA.

02/2017 Talk: *Towards Composable GPU Programming: Programming GPUs with Eager Actions and Lazy Views*
International Workshop on Programming Models and Applications for Multicores and Manycores (PMAM) 2017 in Austin, USA.

12/2016 Invited Talk:
The Lift Project: Performance Portable GPU Code Generation via Rewrite Rules
Computer Laboratory Systems Research Group Seminar, University of Cambridge, UK.

08/2016 Invited Talk:
Structured Parallel Programming — From High-Level Functional Expressions to High-Performance OpenCL Code
Center for Advanced Electornics Dresden, Dresden University of Technology, Germany.

05/2016 Invited Talk:
Improving Programmability and Performance Portability on Many-Core Processors
Colloquium of candidates nominated for the *prize for best dissertation* awarded by the German Informatics Society, Schloss Dagstuhl, Germany.

04/2016 Invited Talk: *The lift Project: Performance Portability via Rewrite Rules*
Saarland University, Germany.

01/2016 Invited Talk: *Performance Portable GPU Code Generation*
Imperial College London, UK.

12/2015 Talk: *Functional Programming in C++*
Programming Language Interest Group at Edinburgh University, UK.

10/2015 Invited Talk: *Generating Performance Portable Code using Rewrite Rules*
PENCIL Developer Meeting at Imperial College London, UK.

09/2015 Talk: *Generating Performance Portable Code using Rewrite Rules: From High-Level Functional Expressions to High-Performance OpenCL Code*
International Conference on Functional Programming (ICFP) 2015 in Vancouver, Canada.

06/2015 Talk: *Generating Performance Portable Code using Rewrite Rules*
Scottish Programming Languages Seminar in St. Andrews, UK.

05/2014 Invited Talk: *SkelCL: High-Level Programming of Multi-GPU Systems*
Institute for Computational and Applied Mathematics, University of Münster, Germany.

05/2014 Invited Talk: *SkelCL: High-Level Programming of Multi-GPU Systems*
Workshop on Fast Data Processing on GPUs in Dresden, Germany.

01/2014 Talk: *Extending the SkelCL Library for Stencil Computations on Multi-GPU Systems*
HiStencils 2014 workshop in Vienna, Austria.

12/2013 Invited Talk: *SkelCL: High-Level Programming of Multi-GPU Systems*
Research group on elementary particle physics, University of Wuppertal, Germany.

07/2013 Talk: *Introducing and Implementing the Allpairs Skeleton for GPU Systems*
HLPP 2013 workshop in Paris, France.

06/2013 Talk: *High-Level Programming for Medical Imaging on Multi-GPU Systems using the SkelCL Library*
ICCS 2013 conference in Barcelona, Spain.

08/2012	Talk: *Using the SkelCL Library for High-Level GPU Programming of 2D Applications* ParaPhrase 2012 workshop held in conjunction with Euro-Par 2012 in Rhodes, Greece.
06/2012	Talk: *High-Level Programming for Heterogeneous Systems with Accelerators* PDESoft 2012 workshop in Münster, Germany.
05/2012	Talk:*Towards High-Level Programming of Multi-GPU Systems Using the SkelCL Library* AsHES 2012 workshop held in conjunction with IPDPS 2012 in Shanghai, China.
04/2012	Invited talk: *A Skeleton Library for Heterogeneous Multi-/Many-Core Systems* NAIS workshop in Edinburgh, UK.
01/2012	Talk: *Towards a High-Level Approach for Programming Distributed Systems with GPUs* COST Action IC0805 ("ComplexHPC") meeting in Timisoara, Romania.
12/2011	Invited talk: *SkelCL — A High-Level Programming Library for GPU Programming* Jülich Supercomputing Centre (JSC), Germany.
05/2011	Talk: *SkelCL — A Portable Skeleton Library for High-Level GPU Programming* HIPS 2011 workshop held in conjunction with IPDPS 2011 in Anchorange, Alaska, USA.
09/2008	Invited talk: *Development of an Online Game as a Student Project* ITSoftTEAM workshop in Chernihiv, Ukraine.

Teaching Experience

Fall Term 2016	○ Guest Lecture on *DSLs and rewrite-based optimizations for performance-portable parallel programming* in the *Elements of Programming Languages* course held by James Cheney. ○ Guest Lecture in the *Compiling Techniques* course given by Christophe Dubach. ○ Assistance in the tutorials of the *Compiling Techniques* course held by Christophe Dubach.
Fall Term 2015	○ Organiser and Lecturer of the C++ programming course *The Humble C++ Programmer* aiming to improve PhD students coding skills. ○ Guest Lecture on *DSLs and rewrite-based optimizations for performance-portable parallel programming* in the *Elements of Programming Languages* course held by James Cheney. ○ Assistance in the tutorials of the *Compiling Techniques* course held by Christophe Dubach.
Fall Term 2014	○ Guest Lecture in the *Compiling Techniques* course given by Christophe Dubach.
Summer Term 2014	○ Supervised MSc student project: *Design and implementation of a high-level API for programming heterogeneous clusters.*
Winter Term 2013/2014	○ Supervised MSc student project: *High-level programming of online games in future generation networks.*
Summer Term 2013	○ Course Design and Lecturer: *Introduction to programming with C and C++.* ○ Teaching assistant: *Multi-core and GPU: Parallel Programming.*
Winter Term 2011/2012	○ Teaching assistant: *Operating Systems.*
Summer Term 2012	○ Supervised MSc student project: *High-level programming of heterogeneous systems.* ○ Teaching assistant: *Multi-core and GPU: Parallel Programming.*

Winter Term 2011/2012	○ Teaching assistant: *Technical aspects of cloud computing.* ○ Teaching assistant: *Operating Systems.*
Summer Term 2011	○ Supervised UG/MSc student project: *Internet- and GPU-based Cloud Computing.* ○ Course Design and teaching assistant: *Multi-core and GPU: Parallel Programming.*
Winter Term 2010/2011	○ Supervised UG student project: *High-level GPU programming.*

Supervised Students

The following students are co-supervised with Sergei Gorlatch at the University of Münster.

since 10/2016	PhD studies of Bastian Hagedorn on *Efficient GPU Code Generation for Stencil Computations in Lift*
since 06/2015	PhD studies of Ari Rasch on *Parametric Algorithmic Skeletons*
since 06/2015	PhD studies of Michael Haidl on *PACXX: A GPU programming model embedded in C++*

The following students are co-supervised with Christophe Dubach at the University of Edinburgh.

since 09/2015	PhD studies of Larisa Stoltzfus on *Stencil-based Acoustic Applications*
since 10/2014	PhD studies of Adam Harries on *Sparse and Irregular Data-Parallel Applications on GPUs*
since 10/2014	PhD studies of Toomas Remmelg on *Automatic Performance Optimisations via Provably Correct Rewrite Rules*
since 10/2014	PhD studies of Juan José Fumero on *Heterogeneous Computing in Managed Languages*

The following students have been co-supervised with Sergei Gorlatch at the University of Münster.

09/2016	MSc thesis of Bastian Hagedorn on *Efficient GPU Code Generation for Stencil Computations via Parallel Patterns*
07/2014	Bachelor thesis of André Lüers on *Evaluation of the Skeleton Library FastFlow*
07/2014	Bachelor thesis of Lars Klein on *A Parallel Implementation of the T-CUP Software using the SkelCL Library*
01/2014	Master thesis of Michael Olejnik on *A GPU-based Classification Framework for HIV Resistance Prediction*
01/2014	Master thesis of Stefan Breuer on *Extending the SkelCL Library for Stencil Computations*
11/2013	Diploma thesis of Wadim Hamm on *Development of a Divide & Conquer Skeleton for SkelCL*
07/2013	Bachelor thesis of Matthias Droste on *Evaluation of the Skeleton Library SkePU*
06/2013	Bachelor thesis of Kai Kientopf on *Implementation of the Needleman-Wunsch Algorithm and the Breath-First-Search with SkelCL*

06/2013   Master thesis of Florian Quinkert on
A Model for Predicting Work Distribution in Heterogeneous Systems and its Implementation in SkelCL

03/2013   Master thesis of Malte Friese on
Extending the Skeleton Library SkelCL with a Skeleton for Allpairs Computations

03/2013   Bachelor thesis of Sebastian Mißbach on
Implementing the LU-Decomposition and the Mersenne-Twister with the SkelCL Library

03/2013   Bachelor thesis of Patrick Schiffler on
Performance Analysis of SkelCL using B+ Tree Traversal and 3D Jacobi Stencil Computation

01/2013   Diploma thesis of Markus Blank-Burian on
Simulation and Analysis of Two-Dimensional Turbulences on Parallel Computer Architectures

06/2012   Diploma thesis of Matthias Buß on
Adding Multidimensional Data Types to the Multi-GPU Skeleton Library SkelCL

09/2011   Bachelor thesis of Michael Olejnik on
Investigating the Use of GPUs for Radix Sort

09/2011   Bachelor thesis of Jan Gerd Tenberge on
Extending the SkelCL Library with Iterators

08/2011   Bachelor thesis of Stefan Breuer on
Enhancing SkelCL's MapOverlap Skeleton

08/2011   Bachelor thesis of Tobias Günnewig on
Developing a Library for Manipulating Source Code of C-based Languages