

# SIMON WOLFGANG FUNKE

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## PERSONAL INFORMATION

Date of birth: 17.10.1983

Sex: Male

Nationality: German

## POSITIONS

2019 - today   **Research Director, Simula Research Laboratory, Oslo, Norway.**

2015 - today   **Senior Research Scientist, Simula Research Laboratory, Oslo, Norway.**

2018 - 2019   **Head of Department, Simula Research Laboratory, Oslo, Norway.**

2015 - 2017   **Adjoint Associate Professor, University of Oslo, Norway.**

2013 - 2015   **Postdoctoral Fellow, Simula Research Laboratory, Oslo, Norway.**

In addition, a 20% adjoint PostDoc position in 2014 at Imperial College London, UK.

2014 - 2015   **Consultant, Kalkulo AS, Oslo, Norway.**

2013 - 2014   **Consultant, E.ON AG, Düsseldorf, Germany.**

2011 - today   **CTO, RedHotRails LLP, UK.**

## EDUCATION

2009 - 2013   **PhD, Computational science, Imperial College London, UK.**

- Thesis title: *The automation of PDE-constrained optimisation and its applications.*
- Department of Earth Science and Engineering.
- Supervisors: M.D. Piggott, P.E. Farrell, P.A. Allison, G.J. Gorman.
- Date of approved disputation: 01.03.2013.

2007   **Erasmus, École normale supérieure de Lyon, France.**

2004 - 2009   **Diplom, Mathematics, Technische Universität München, Germany.**

- Passed with high distinction (1.0).
- Thesis title: *Fast solvers for the Navier-Stokes equations on high Reynold numbers.*
- Department of Mathematics.
- The German Diplom is equivalent to a Master degree.
- Supervisor: M. Ulbrich.

## AWARDS AND PRIZES

- **Wilkinson Prize for Numerical Software, 2015**

The Wilkinson prize for Numerical Software is a prestigious prize in scientific computing, awarded every four years to the authors of an outstanding piece of numerical software. In 2015, the prize was awarded to Funke and his co-authors P.E. Farrell, D.A. Ham and M.E. Rognes for the high-level AD tool dolfin-adjoint.

- Best Poster Award, FEniCS 2017
- Best Poster Award, CSE 2015
- Imperial College Startup Venture Catalyst Award, 2013
- Google Interactivism Award, 2011
- Imperial College Excellence Award, 2010
- Grantham Institute for Climate Change and Fujitsu CASE Studentship, 2009
- Hurwitz-Association Award for an excellence diploma thesis, 2009

## FUNDING

- PI on NOK 12M RCN Research project “Data-driven models for physical simulations”, (#303362), 2020–2023
- CoPI on NOK 12MNOK RCN IKTPLUSS project “SciML - Scientific computing and machine learning”, 2019–2023
- PI on NOK 7MNOK FRIPRO Young Research Talent “Simulation-based optimisation with dynamic domains”, (#251237/F20), 2016–2019
- EU Horizon 2020 SME instrument, IMERSO AS, 2015

## MOBILITY

Studied and worked in research institutions in **Germany, France, UK and Norway** (> 6 months).

Shorter research visits:

- Heidelberg Laureate Forum, Germany (2016)
- Texas A&M University, USA (2015)
- Humboldt University of Berlin, Germany (2013)
- Simula Research Laboratory, Norway (2012)
- Isaac Newton Institute, Cambridge, UK (2012)
- Institut of Atmospheric Physics, Beijing, China (2011).

## SUPERVISION

**PostDocs:** August Johannsson (Simula).

**PhD students:** Jorgen Dokken (Simula), Dave Culley (Imperial College, co-supervisor).

## TEACHING ACTIVITIES

2015 - today    **Lecturer**, INF3331/INF4331 Higher-level programming, University of Oslo, Norway.

2017 - today    **Python Workshop** NTNU Trondheim (2017, 2 days).

2014 - today    **FEniCS/dolfin-adjoint Workshop** UNISA Johannesburg (2016, 1 day), Technical University of Munich (2016, 5 days), SUURPH workshop, Simula (2016, 1 day), Simula (2016, 2 days), Simula (2014, 1 day), Zhejiang University (2014, 5 days).

2010 - 2012    **Teaching assistant** for courses on computational science, programming and mathematics. Department of Earth Science and Engineering, Imperial College London, UK.

## COMMISSIONS OF TRUST

2019    **Organiser Committee** ECCOMAS, Young Investigators Conference.

2015-today    **Examiner** for 2 Master projects.

2015    **Organiser** of a Workshop on Advanced Techniques in Biomedical Computing, *Center for Biomedical Computing*.

2015    **Organiser** of a Mini-symposium on Efficient Solvers for PDE-constrained Optimization, *SIAM CSE15*.

2014 - today    **R&D Advisor** IMERSO AS, Oslo, Norway.

2013 - today    **Reviewer** for SIAM Journal on Scientific Computing (SIAM), Computer Physics Communications (Elsevier), Energies (MDPI) and European Wave and Tidal Energy Conference Series and Geoscientific Model Development (GMD), Applied Energy.

## RESEARCH INTEREST/RESEARCH PROFILE

Funke's research interests center around optimisation problems governed by partial differential equations, with a focus on their numerical solution. In particular, he is interested in the automated derivation of adjoint and tangent linear models and their use in optimal control, data inversion and design optimisation. He is a founder of the dolfin-adjoint project, a software which automatically derives adjoint models from complex computer models solving partial differential equations based on a high-level symbolic problem specification language that mimics mathematical notation.

Funke applies these advances to applications in a wide variety of different domains including renewable energy and bioengineering. For the renewable energy sector, he developed OpenTidalFarm, an open-source software for optimising of tidal turbine farms, such as the optimal position of turbines within the farm. In bioengineering, he develops data assimilation techniques for blood flow simulations, with the aim to tune high-fidelity numerical blood flow models to match with MRI measurements.

## Books

1. *T Schwedes, DA Ham, SW Funke, MD Piggott*. Mesh dependence in PDE-constrained optimisation - An Application in Tidal Turbine Array Layouts, *Springer Research Brief*, ISBN 978-3-319-59483-5, 2017.

## JOURNAL PUBLICATIONS

2019

20. *R Feu, SK Kramer, MD Piggott, J Hill, SW Funke*. The trade-off between tidal-turbine array yield and environmental impact: a habitat suitability modelling approach, *Renewable Energy*, , 2019.
19. *PE Farrell, JE Hake, SW Funke, ME Rognes*. Automated adjoints of coupled PDE-ODE systems, *SIAM Journal on Scientific Computing*, 10.1137/17M1144532, 2019.
18. *X Lai, OM Geier, T Fleischer, Ø Garred, E Borgen, SW Funke, S Kumar, M Zucknick, ME Rognes, T Seierstad, A-L Børresen-Dale, VN Kristensen, L Engebraaten, A Köhn-Luque, A Frigessi*. Towards the personalized computer simulation of breast cancer treatment: a multi-scale pharmacokinetic and pharmacodynamic model informed by multi-source patient data, *Cancer Research*, accepted, 2019.

2018

17. *G Balaban, H Finsberg, SW Funke, TF Håland, E Hopp, J Sundnes, S Wall, ME Rognes* In vivo estimation of elastic heterogeneity in an infarcted human heart, *Biomechanics and Modeling in Mechanobiology*, Springer, 10.1007/s10237-018-1028-5, 2018.
16. *SW Funke, M Nordaas, Ø Evju, MS Alnæs, K-A Mardal*. Variational data assimilation for transient blood flow simulations, *International Journal for Numerical Methods in Biomedical Engineering*, doi:10.1002/cnm.3152, 2018.

2017

15. *DM Culley, SW Funke, SC Kramer, MD Piggott*. A surrogate-model assisted approach for optimising the size of tidal turbine arrays, *International Journal of Marine Energy*, 10.1016/j.ijome.2017.05.001, 2017.
14. *RJ du Feu, SW Funke, SC Kramer, DM Culley, J Hill, BS Halperne, MD Piggott* The trade-off between tidal-turbine array yield and impact on flow: A multi-objective optimisation problem, *Renewable Energy*, 10.1016/j.renene.2017.07.081, 2017.
13. *ME Rognes, PE Farrell, SW Funke, JE Hake, MMC Maleckar* cbcbeat: an adjoint-enabled framework for computational cardiac electrophysiology, *The Journal of Open Source Software*, 10.21105/joss.00224, 2017.
12. *SW Funke, PE Farrell, MD Piggott*. Reconstructing wave profiles from inundation data, *Computer Methods in Applied Mechanics and Engineering*, 10.1016/j.cma.2017.04.019, 2017.
11. *MM Noack, SW Funke*. Hybrid Genetic Deflated Newton Method for Global Optimisation, *Journal of Computational and Applied Mathematics*, 10.1016/j.cam.2017.04.047, 2017.
10. *SD Parkinson, SW Funke, J Hill, MD Piggott, PA Allison*. Application of the adjoint approach to optimise the initial conditions of a turbidity current (AdjointTurbidity 1.0), *Geoscientific Model Development (GMD)*, doi:10.5194/gmd-10-1051-2017, 2017.

2016

9. *SW Funke, SC Kramer, MD Piggott*. Design optimisation and resource assessment for tidal-stream renewable energy farms using a new continuous turbine approach, *Renewable Energy*, doi:10.1016/j.renene.2016.07.039, 2016.

8. *DM Culley, SW Funke, SC Kramer, MD Piggott*. Integration of cost modelling within the micro-siting design optimisation of tidal turbine arrays, *Renewable Energy*, doi:10.1016/j.renene.2015.06.013, 2016.

2015

7. *S Rao, H Xue, M Bao, SW Funke*. Determining tidal turbine farm efficiency in the Western Passage using the disc actuator theory, *Ocean Dynamics*, doi:10.1007/s10236-015-0906-y, 2015
6. *PE Farrell, A Birkisson, SW Funke*. Deflation techniques for finding distinct solutions of nonlinear partial differential equations, *SIAM Journal on Scientific Computing*, doi:10.1137/140984798, 2015.
5. *R Venell, SW Funke, S Draper, C Stevens*. Designing Large Arrays of Tidal Turbines: a synthesis and review, *Renewable & Sustainable Energy Reviews*, doi:10.1016/j.rser.2014.08.022, 2015.

2014

4. *SW Funke, PE Farrell, MD Piggott*. Tidal turbine array optimisation using the adjoint approach, *Renewable Energy*, doi:10.1016/j.renene.2013.09.031, 2014.
3. *PE Farrell, CJ Cotter, SW Funke*. A framework for the automation of generalised stability theory. *SIAM Journal on Scientific Computing*, doi:10.1137/12090074, 2014.

2013

2. *PE Farrell, DA Ham, SW Funke, ME Rognes*. Automated derivation of the adjoint of high-level transient finite element programs, *SIAM Journal on Scientific Computing*, doi:10.1137/120873558, 2013.

2011

1. *SW Funke, CC Pain, SC Kramer, MD Piggott*. A wetting and drying algorithm with a combined pressure/free-surface formulation for non-hydrostatic models, *Advances in Water Resources*, doi:10.1016/j.advwatres.2011.

## CONFERENCE PUBLICATIONS

6. *JS Dokken, SW Funke, A Johannsson, S Schmidt*. Shape Optimization with Multiple Meshes, *FEniCS 2017 Conference*, PDF, 2017
5. *CT Jacobs, SC Kramer, MD Piggott, SW Funke*. On the validity of tidal turbine array configurations obtained from steady-state adjoint optimisation, *ECCOMAS Congress 2016*, PDF, 2016.
4. *DM Culley, SW Funke, SC Kramer, MD Piggott*. Tidal stream resource assessment through optimisation of array design with quantification of uncertainty, *EWTEC 2015 proceedings*, PDF, 2015.
3. *T Roc, SW Funke, KM Thyng*. Standard methodology for tidal array project optimisation: An idealized study of the Minas Passage, *EWTEC 2015 proceedings*, PDF, 2015.
2. *SC Kramer, SW Funke, MD Piggott*. A continuous approach for the optimisation of tidal turbine farms, *EWTEC 2015 proceedings*, PDF, 2015.
1. *DM Culley, SW Funke, SC Kramer, MD Piggott*. A hierarchy of approaches for the optimal design of tidal turbine arrays, *Proceedings of the 5th International Conference on Ocean Energy*, PDF, 2014.

## PHD PROJECTS

2016-today Jorgen Dokken, *PDE-constrained optimisation with dynamic domains*, Simula Research Laboratory

2013-2016 Dave Culley, *The modelling and design optimisation of tidal stream turbine arrays*, Imperial College London

## MASTER PROJECTS

2016-2017 Andreas Thune, *Parareal-based preconditioner for optimal control problems constrained by differential equations*, Simula Research Laboratory

2016-2017 Magnus Elden, *Interactive visualization of scientific data using the Oculus Rift*, Simula Research Laboratory

2015-2016 Shifteh Sherafat, *Model identification for remodelling blood vessels using a PDE-constrained optimisation approach*, Simula Research Laboratory

2012-2012 Kartik Upadhyaya, *Numerical optimisation of tidal energy arrays in the Orkney Islands*, Imperial College London

2011-2011 Yiqun He, *Suitability of 3D modelling in urban flooding*, Imperial College London

## BACHELOR PROJECTS

2013 George Barnett, *Hybrid global-local optimisation algorithms for the layout design of tidal turbine arrays*, Imperial College London

## SUMMER/UROP PROJECTS

2016 Håkon Taskén, *Implementaion of dynamic turbine controls in OpenTidalFarm*, Imperical College London

2013 George Barnett, *Global optimisation methods for optimising tidal turbine farms*, Imperial College London

2013 Alex Lozinski, *Comparative study of the OpenTidalFarm and the MIKE ocean models*, Imperial College London

## DISSEMINATION

Simon Funke attended various national and international conferences. The following list presents a selection of presentations:

**Plenary lecture**, The Power of Python in Science and Education, *Fysikermøte*, Tromsø, Norway, 2017

**Best poster award**, A new algorithmic differentiation tool (not only) for FEniCS, *FEniCS 2017*, Luxembourg, Luxembourg, 2017

Machine learning with expert systems, *Simula COMMONS seminar*, Oslo, Norway, 2017

Automatic Adjoints of Multimesh Finite Element Discretisations, *SIAM Conference on Computational Science & Engineering*, Atlanta, USA, 2017

**Invited talk** Introduction to FEniCS and dolfin-adjoint, *Symposium on the Application of Finite Elements in Physics and Engineering*, Johannesburg, South Africa, 2016

Designing Tidal Turbine Arrays With PDE-constrained Optimisation, *ESCO2016*, Plzeň, Czech Republic, 2016

**Best poster award**, dolfin-adjoint, automated adjoint models for FEniCS, *SIAM Conference on Computational Science*, Salt Lake City, USA, 2015

Tidal Farm Layout Optimisation and Resource Assessment based on PDE-constrained optimisation, *International Conference on Ocean Energy*, Halifax, Canada, 2014

**Invited talk**, Introduction to FEniCS and automated adjoints, *Norwegian Meteorological Institute*, Oslo, Norway, 2014

PDE-constrained optimisation in Hilbert spaces, *FEniCS'14*, Paris, France, 2014

**Invited talk** An introduction to libadjoint, Institut of Atmospheric Physics, Beijing, China, July 2011

## OTHER PRIZES

Attended the General Electrics CX hackathon as a tech-expert, London, August 2017.

Winner of BigDataHackthon for developing a machine learning algorithm that predicts the influence of people, May 2013.

Winner of the Rewired State Hack, for novel developments for a charity to improve surgical care in Africa, December 2012.

Invitation to OpenITP & Rio de Janeiro RightsCon with the goal to develop realtime censorship detection, May 2012.

Google Interactivism Award for developing a NHS health care web application to improve waiting times in hospitals, 2012.

Winner of WaterHackathon London for developing a reporting platform for managing sanitation complaints in Tanzania. The project received media attention and was featured on the BBC, Africa, October 2011.

## PERSONAL DEVELOPMENT

Attended 2 day course on professional development for project leaders, 2016-2017.