Workshop on

"Nonlinear optimisation and fast solvers for differential equations"

organised by Helmut Abels, Harald Garcke, and Balázs Kovács

supported by University of Regensburg, Faculty of Mathematics

and DFG-Research Training Group 2339 – *IntComSin*

Regensburg, 25–27 January, 2024

On the occasion of the **60th birthday of Luise Blank** we will enjoy interesting talks on nonlinear optimisation and fast solution of discretised differential equations, meeting old and new friends, and enjoy some social programme around this one-day workshop and colloquium the day before.

On Thursday the colloquium talk will take place in **lecture hall H 31**. The talks on Friday will take place in the seminar room **M 104**, while coffee breaks will be in the common room **M 201**. On Friday we will have lunch together at the university canteen.

In case you want to participate please register with an email to saskia.lindenberg@ur.de.

Preliminary Programme

Thursday, January 25, 2024

Thursday	
16:30 – 17:00	*Coffee break*
17:00 – 18:00	Colloquium talk by Volker Schulz
19:00	*Dinner at Rosarium*

Friday, January 26, 2024

We will have 45 minute talks (including discussion) by the following speakers.

Friday	
11:30 – 12:00	Registration M 104
12:00 – 13:30	*Lunch break*
13:30 – 14:15	Andrea Walther
14:15 – 15:00	Christian Kahle
15:00 – 15:45	*Coffee break*
15:45 – 16:30	Vanessa Styles
16:30 – 17:15	Martin Stoll
17:15 – 17:45	*Open discussions*
18:30	*Workshop dinner at Leerer Beutel*

Saturday, January 27, 2024

For those who wish to stay on Saturday, as a social programme we will enjoy a hike to "Alpiner Steig" near Eilsbrunn. Afterwards we will have lunch together in the oldest pub of the world (see https://www.gaststaette-roehrl.de/index.php/start_en.html?language=de), such that in the afternoon everyone has enough time to travel home. The departure from Regensburg to Eilsbrunn is planed for 9:30 and lunch around 12:00–12:30.

Colloquium talk – Thursday

Volker Schulz   (University of Trier)

Lecture hall H31, Thursday, 17:00–18:00
Title: **On Computational Shape Optimization**

Abstract: Shape optimization is a classical topic in mathematics, where several advances have been achieved recently in numerical approaches to this problem class. This talk focusses mainly on shapes as sharp interfaces and in particular discusses the simultaneous optimization of shapes together with the related surface and volume meshes. This leads to a linear interpretation of shape optimization delivering specific formulations of second shape derivatives and shape-Newton methods. Results in various application areas underline the practical importance of research in this domain

Detailed workshop programme – Friday

Andrea Walther   (Humboldt University of Berlin)

Friday, 13:30 – 14:15
Title: **On Nonsmooth Optimization Based on Abs-Linearization**

Abstract: For a so-called abs-smooth function, the concept of abs-linearization allows the generation of a piecewise linear local model that is provable of second order. Similar to the quadratic model generated by a truncated Taylor series in the smooth situation, this piecewise linear model can be used as a building block for optimization algorithms targeting nonsmooth problems of different kinds.

In this talk, first we define abs-smooth functions covering a wide range of applications like clustering, image restoration, and robust gas network optimization.

Also various mathematical models like complementarity problems or bilevel optimization tasks can be formulated as abs-smooth functions. Subsequently, the abs-linearization approach and the properties of the resulting local model will be illustrated. Then, we discuss the solution of piecewise linear optimization problems.

Joint work with: Franz Bethke, Sabrina Fiege, Andreas Griewank, and Timo Kreimeier

Christian Kahle (University of Koblenz)

Friday, 14:15 – 15:00
Title: **Topology optimization with phase fields**

Abstract: Phase fields are a convenient way to model multiphase systems. They can be easily interpreted as regularized (multi-)indicator functions for subdomais, which renders them an ideal tool for topology optimization.

We show how classical topology optimization problems can be modeled with the help of phase fields. This leads to problems in the form of optimization with PDE constraints, where the optimization variable is the phase field, that describs the saught optimal subdomains. The natural regularity of phase fields is $H^1 \cap L^\infty$. Thus classical Hilbertspace based descent methods can not be applied and tailored optimization algorithms have to be used. We briefly discuss the Variable Metric Projection Type method [Blank, Rupprecht, SICON, 2017], which turned out to be highly effective for such problems.

This is joint work with Harald Garcke, Claudia Hecht, Michael Hinze, Paul Hüttl, Patrik Knopf, Andrew Lam, and Tim Laux.

Vanessa Styles (University of Sussex)

Friday, 15:45 – 16:30
Title: **Applications of the Primal Dual Active Set method for solving Allen-Cahn variational inequalities with non-local constraints**

Abstract: We consider the primal-dual active set method for solving Allen-Cahn variational inequalities with non-local constraints and present applications including tumour growth and structural topology optimisation.

Martin Stoll (Technical University of Chemnitz)

Friday, 16:30 – 17:15
Title: **Learned from Luise: from Allen-Cahn to graph learning**

Abstract: I invited Luise to a minisymposium at the Strathclyde numerical analysis conference and she gladly accepted. This was the start of a wonderful collaboration on solving linear systems related to Allen-Cahn equations with constraints, which I will discuss in this talk. I will then illustrate my journey with phase-field models and linear systems all the way to the use of a graph Laplacian in the Allen-Cahn equation. I will illustrate the importance of efficient linear algebra in all these applications and show some pictures that underline the performance of our numerical solvers.