

# Jochen Garcke



## Academic career

2004	Dr. rer. nat., University of Bonn
2004 - 2006	Postdoctoral Research Fellow, Australian National University, Canberra, ACT, Australia
2006 - 2011	Postdoctoral Research Fellow / Junior Research Group Leader, DFG Research Center Mathem / TU Berlin
Since 2011	Professor (W2), University of Bonn and Fraunhofer Institute for Algorithms and Scientific Computing (SCAI), Sankt Augustin

## Research Projects and Activities

BMBF VAVID - Vergleichende Analyse von ingenieurrelevanten Mess- und Simulationsdaten  
ITEA3/BMBF Flex4Apps – Plattform für Anwendungsflexibilität in Cyber-Physical Systems

BmWi - MathEnergy

BMBF - P3ML - Projektgekoppelter, Potentialorientierter und Praxisintegrierter Erwerb von ML Engineering Wissen

## Research profile

My research area is numerical mathematics with emphasis on high-dimensional problems and machine learning. On the one hand the numerical treatment of high-dimensional applications, often in the form of partial differential equations from physics, chemistry, biology, or finance, with sparse grids and low rank tensor approximations and on the other hand the application of modern methods from computational mathematics into machine learning and data mining are the focal points of my research. For high-dimensional data analysis I am investigating nonlinear dimensionality methods.

The further investigation of machine learning approaches from a numerical mathematics viewpoint will provide additional insights for these algorithms, while recent probabilistic views on numerical methods from a machine learning viewpoint will extend the understanding on that side. The analysis of big data from numerical simulations with machine learning approaches will be another focal point, for many practical applications more sophisticated data analysis approaches for the complex numerical simulation data are needed. Furthermore, recent results provide a new mathematical way to integrate domain knowledge into the data analysis, further research on this is necessary, in particular for data arising from the natural sciences and engineering.

**Research Area J** One focus of my research area is scientific computing with emphasis on high-dimensional problems. This includes the numerical treatment of high-dimensional applications, often in the form of partial differential equations from physics, chemistry, biology, or finance, with sparse grids and low rank tensor product approaches.

## Selected publications

- [1] Jochen Garcke and Axel Kröner. Suboptimal feedback control of pdes by solving hjb equations on adaptive sparse grids. *J. Sci. Comput.*, 70(1):1–28, 2017.
- [2] Dustin Feld, Jochen Garcke, Jia Liu, Thomas Soddemann, and Yong Xue. Multi-core processors and graphics processing unit accelerators for parallel retrieval of aerosol optical depth from satellite data: Implementation, performance and energy efficiency. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, 8(5):2306–2317, 2015.
- [3] Jochen Garcke and Thomas Vanck. Importance weighted inductive transfer learning for regression. In Toon Calders, Floriana Esposito, Eyke Hüllermeier, and Rosa Meo, editors, *Proceedings of ECMLPKDD 2014, Nancy*, volume 8724 of *Lecture Notes in Computer Science*, pages 466–481. Springer Berlin Heidelberg, 2014.

- [4] Olivier Bokanowski, Jochen Garcke, Michael Griebel, and Irene Klompaker. An adaptive sparse grid semi-lagrangian scheme for first order hamilton-jacobi bellman equations. *J. Sci. Comput.*, 55(3):575–605, 2013.
- [5] Jochen Garcke and Alexander Paprotny. On a connection between maximum variance unfolding, shortest path problems and isomap. In *15th International Conference on Artificial Intelligence and Statistics (AISTATS 2012)*, pages 859–867, La Palma, Canary Islands, Spain, 2012.
- [6] Gregory Beylkin, Jochen Garcke, and Martin J. Mohlenkamp. Multivariate regression and machine learning with sums of separable functions. *SIAM J. Sci. Comput.*, 31(3):1840–1857, 2009.
- [7] S. Börm and J. Garcke. Approximating gaussian processes with  $H^2$ -matrices. In Joost N. Kok, Jacek Koronacki, Ramon Lopez de Mantaras, Stan Matwin, Dunja Mladen, and Andrzej Skowron, editors, *Proceedings of 18th European Conference on Machine Learning, Warsaw, Poland, September 17-21, 2007. ECML 2007*, volume 4701, pages 42–53, 2007.
- [8] Vivien Challis, Jochen Garcke, and Markus Hegland. The combination technique and some generalisations. *Linear Algebra Appl.*, 420(2-3):249–275, 2007.
- [9] J. Garcke, M. Griebel, and M. Thess. Data mining with sparse grids. *Computing*, 67(3):225–253, 2001.
- [10] Jochen Garcke and Michael Griebel. On the computation of the eigenproblems of hydrogen and helium in strong magnetic and electric fields with the sparse grid combination technique. *J. Comput. Phys.*, 165(2):694–716, 2000.