

# André Uschmajew



## Academic career

2013	Dr. rer. nat., TU Berlin
2013 - 2014	Postdoc, École polytechnique fédérale de Lausanne (EPFL), Switzerland
Since 2014	Professor (W2, Bonn Junior Fellow), University of Bonn

## Honours

2013	16th IMA Leslie Fox Prize in Numerical Analysis (second place)
2013	2013 Tiburtius Prize of the Berlin universities (second place)

## Research profile

My research is on different aspects of low-rank tensor decomposition and approximation, that is, on multilinear and data-sparse representations of high-dimensional objects. For example, one may think of large arrays of numbers arising from data acquisition or the discretization of a multivariate functions. Low-rank tensor approximation aims at generalizing low-rank matrix approximation, which turns out to be a highly nontrivial task. This relatively new field of numerical mathematics connects to other branches of mathematics, such as approximation theory, algebraic/differential geometry, and nonlinear optimization. Its areas of application include high-dimensional partial differential equations, statistics, signal processing and (big) data analysis. It hence offers research possibilities in several directions. For example, in scientific computing, low-rank tensor techniques make it possible to treat some problems of very high dimension for which classical discretization schemes are unmanageable. In data analysis and signal processing, low-rank methods are used for identification of principal components and hidden sources. Personally, I have worked on the convergence analysis of nonlinear low-rank tensor optimization methods, as well as on more fundamental questions regarding low-rank approximability of functions and solutions to tensor structured equations.

Accordingly, the future research aims at the derivation of novel theoretical methods and concepts to acquire a more fundamental understanding of the mechanisms that make low-rank tensor approximation possible. This is important for identifying the problem classes for which these techniques can be successfully applied. The theoretical investigations go hand in hand with the design and analysis of innovative computational methods for dealing with problems that require the processing or approximation of higher-order tensors and multivariate functions.

## Selected publications

- [1] Markus Bachmayr, Reinhold Schneider, and André Uschmajew. Tensor networks and hierarchical tensors for the solution of high-dimensional partial differential equations. *Found. Comput. Math.*, 16(6):1423–1472, 2016.
- [2] Reinhold Schneider and André Uschmajew. Convergence results for projected line-search methods on varieties of low-rank matrices via Łojasiewicz inequality. *SIAM J. Optim.*, 25(1):622–646, 2015.
- [3] André Uschmajew. A new convergence proof for the higher-order power method and generalizations. *Pac. J. Optim.*, 11(2):309–321, 2015.
- [4] Daniel Kressner, Michael Steinlechner, and André Uschmajew. Low-rank tensor methods with subspace correction for symmetric eigenvalue problems. *SIAM J. Sci. Comput.*, 36(5):A2346–A2368, 2014.
- [5] Reinhold Schneider and André Uschmajew. Approximation rates for the hierarchical tensor format in periodic sobolev spaces. *J. Complexity*, 30(2):56–71, 2014.
- [6] Thorsten Rohwedder and André Uschmajew. On local convergence of alternating schemes for optimization of convex problems in the tensor train format. *SIAM J. Numer. Anal.*, 51(2):1134–1162, 2013.
- [7] André Uschmajew and Bart Vandereycken. The geometry of algorithms using hierarchical tensors. *Linear Algebra Appl.*, 439(1):133–166, 2013.

- [8] Andr'e Uschmajew. Local convergence of the alternating least squares algorithm for canonical tensor approximation. *SIAM J. Matrix Anal. Appl.*, 33(2):639–652, 2012.
- [9] Andr'e Uschmajew. Regularity of tensor product approximations to square integrable functions. *Constr. Approx.*, 34(3):371–391, 2011.
- [10] Andr'e Uschmajew. Well-posedness of convex maximization problems on stiefel manifolds and orthogonal tensor product approximations. *Numer. Math.*, 115(2):309–331, 2010.