

## Prof. Dr. Sebastian Sager

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### — Personal information —

- Born on march 7th, 1975 in Westerstede; German citizen

### — Education and Positions —

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| 4/2012–current  | • <b>W3 full professor</b> at the Faculty of Mathematics, Otto-von-Guericke-Universität Magdeburg   |
| 10/2008–3/2012  | • <b>Junior Research Group Leader</b> at the Interdisciplinary Center for Scientific Computing (IWR), Heidelberg  |
| 2/2008–9/2008   | • <b>Akademischer Rat auf Zeit</b> (former C1 assistant professor position, 3+3 years contract) at IWR, Heidelberg  |
| 4/2007–1/2008   | • <b>Postdoc</b> in the SIMUMAT research team on aerodynamic shape optimization, Universidad Autónoma, Madrid (E)   |
| 10/2006–3/2007  | • <b>Akademischer Rat auf Zeit</b> at IWR Heidelberg  |
| 2/2006–9/2006   | • <b>Postdoc</b> at the IWR Heidelberg  |
| 2/2002–2/2006   | • <b>PhD thesis</b> <i>Numerical methods for mixed-integer optimal control problems</i> in mathematics, supervised by G. Reinelt and H.G. Bock (grade: summa cum laude) |
| 2/2002–2/2005   | • Member of the International DFG Graduiertenkolleg 710   |
| 2/2004–4/2004   | • Research stays at the Universidad Carlos III de Madrid and the Universidad de Valladolid (E)  |
| 10/1995–12/2001 | • Studies at the Universität Heidelberg, <b>diploma</b> in mathematics with specialization in physics/astronomy (grade: excellent)                                      |
| 1/2000–5/2000   | • Exchange student at the University of Ho-Chi-Minh-City (VN)   |
| 9/1997–7/1998   | • Exchange student at the Université de Montpellier (F)   |
| 6/1994          | • Abitur at the Gymnasium Westerstede   |

### — Offers, Honors, and Awards —

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| 2011 | • Offer for a chair (W3 professor) at the University of Magdeburg  |
| 2007 | • Offer for tenure-track position as scientific investigator at IMDEA-Mathematics, Madrid, not realized        |
| 2007 | • Klaus Tschira Award for Achievements in Public Understanding of Science                                      |
| 2006 | • Dissertation prize of the German Operations Research Society   |
| 2004 | • Prize of exzellency for poster presentation at the French–German–Spanish conference on optimization, Avignon |
| 2002 | • 3 year scholarship of the Deutsche Forschungsgemeinschaft  |

## — Professional experience —

### Teaching (Universität Magdeburg)

- 2012
  - Lecture: *Mixed-Integer Nonlinear Optimization*
  - Compact course: *Optimization with Differential Equations*

### Teaching (Universität Heidelberg)

- 2011
  - Compact course (in Barcelona): *Optimization of Dynamic Processes*
  - Seminar: *Global and Stochastic Optimization*
- 2010–2011
  - Compact course (with S. Körkel): *Nonlinear Optimization*
- 2010
  - Compact course: *Mixed-Integer Nonlinear Programming*
- 2009–2010
  - Lecture: *Numerics 2*
- 2009
  - Compact course: *Optimization with Differential Equations*
  - Seminar: (with P. Bastian, B. Paech): *Scientific Software Engineering*
- 2008–2009
  - Lecture (with S. Körkel): *Introduction to Numerics*
- 2008
  - Lecture: *Mixed-integer Nonlinear and Dynamic Optimization*
  - Seminar: *Artificial Intelligence and Robotics*
- 2006–2007
  - Lecture (with G. Bock): *Optimization with differential equations*
- 2006
  - Seminar (with F. Kübler, U MA): *Optimal control in economics*
- 2005
  - Compact course: *Mixed-integer Programming*
- 2004
  - Compact course: *Dynamic Process Optimization*
- Since 2002
  - Tutoring in *Numerics, Optimization, and Computer Science*

### Academic work

- 2012
  - Scientific committee member of the *Global Optimization Workshop*
  - Guest editor of *Computational Science*
  - Series editor of the *Differential-Algebraic Equations Forum*, Springer
- 2011
  - Organizer of the ANLO11 workshop *Nonlinear Optimization*
  - Organizer of the OCE11 workshop *Optimal Control & Economics*
- 2010
  - Organizer of the SOCCER 2010 conference on *Commodities*
  - Organizer of the SCCS 2010 symposium  
*Scientific Computing for the Cognitive Sciences*
- 2009
  - Organizer of the  
*German-American Frontiers of Engineering Symposium 2009*
- 2008
  - Co-organizer of OPTEX2008 workshop on *Industrial Modeling*
- 2007
  - Participation in the conception of the *Heidelberg Graduate School of Mathematical and Computational Methods for the Sciences*
  - Organizer and co-chair of the  
*Czech–French–German Conference on Optimization 2007*
- 2005
  - Organization of a scientific contribution of the Universität Heidelberg to the *Science Picnic* in Warsaw (100,000 visitors)

### Third Party Funding

- 2012-2015
  - Project on *Revenue Management* with Air Berlin
- 2010–2013
  - EU project EMBOCON with ETH, ICL, Leuven, Bucharest, industry
- 2009-2012
  - Project on *Revenue Management* with Deutsche Lufthansa
- 2009-2012
  - one of three applicants for DFG SPP 1253 project
- 2009-2012
  - HD internal: 4 DFG Graduate School stipends

## — Supervision (as first advisor) —

### Ongoing PhD theses

- Diedam, H.: *Optimization methods to determine commodity prices*
- Engelhart, M.: *Optimization-based training of human decision making*
- Fräsch, J.: *Numerical methods for nonlinear embedded optimization*
- Huschto, T.: *Numerical methods for the optimal control of stochastic DEs*
- Jung, M.: *Combinatorial structures in mixed-integer optimal control*
- Kehrlé, F.: *Optimization-based analysis of atrial tachycardia*
- Rauch, J.: *Approximations for the dynamic pricing problem*

### Completed master/diploma theses

- 2011 • Burgdörfer, H.: *QP-Löser für gemischt-ganzzahlige Steuerungsprobleme*
- 2010 • Buchner, A.: *Auf Dynamischer Programmierung basierende NMPC für LKW*
- Janka, D.: *Multiple shooting for optimum experimental design*
  - Kehrlé, F.: *Optimal control of vehicles in driving simulators*
  - Müller, M.: *Modellierung & Optimale Steuerung von Trinkwassernetzwerken*
- 2009 • Engelhart, M.: *Modeling, simulation, and optimization of chemotherapies*
- Schäfer, A.: *On scaling techniques and termination criteria for SQP methods*

## — Publications —

### Patents

- 2010 • Patent application (Offenlegungsschrift): Gehring, O., Kauffmann, F., Bock, H.G., Kirches, C., Sager, S., Schlöder, J.P., *Verfahren zum Steuern des Betriebs eines Fahrzeugs*, DE102009030784A1, 04.02.2010, **Patentblatt**.

### Books

- 2005 • Sager, S., *Numerical methods for mixed-integer optimal control problems*, Der Andere Verlag, Tönning, Lübeck, Marburg, ISBN 3-89959-416-9, available at <http://mathopt.de/PUBLICATIONS/Sager2005.pdf>

### Book contributions

- 2012 • Gerdts, M., Sager, S., *Mixed-Integer DAE Optimal Control Problems: Necessary conditions and bounds*, SIAM, accepted
- Sager, S., *A benchmark library of mixed-integer optimal control problems*, Springer, Eds. Lee, J., Leyffer, S., *Mixed Integer Nonlinear Programming, The IMA Volumes in Mathematics and its Applications*, Vol. 154, ISBN 978-1-4614-1926-6, pp. 631–670
- 2011 • Potschka, A., Bock, H.G., Sager, S., Schlöder, J.P., *On the connection between forward and optimization problem in one-shot one-step methods*, Springer, Eds. Leugering, G. et al., *Constrained Optimization and Optimal Control for Partial Differential Equations, International Series of Numerical Mathematics Vol. 160*, ISBN 978-3-0348-0132-4
- 2010 • Grüne, L., Sager, S., Allgöwer, F., Bock, H.G., Diehl, M., *Predictive planning and systematic action – on the control of technical processes*, Springer, Eds. Grötschel, M., Lucas, K., Mehrmann, V., *Production Factor Mathematics*, ISBN 978-3-6421-1247-8, pp. 9–38

## — Publications (continued) —

- Kirches, C., Wirsching, L., Sager, S., Bock, H.G., *Efficient numerics for nonlinear model predictive control*, Springer, Eds. Diehl, M., Glineur, F., Jarlebring, E., Michiels, W., Recent Advances in Optimization and its Applications in Engineering, ISBN 978-3-6421-2597-3, pp. 339–359
- 2009 • Sager, S., Bock, H.G., Diehl, M., Reinelt, G., Schlöder, J.P., *Numerical methods for optimal control with binary control functions applied to a Lotka-Volterra type fishing problem*, Springer, Eds. Seeger, A., Recent Advances in Optimization, ISBN 978-3-5402-8257-0, pp. 269–289
- 2008 • Grüne, L., Sager, S., Allgöwer, F., Bock, H.G., Diehl, M., *Vorausschauend planen, gezielt handeln – über die Regelung und Steuerung technischer Prozesse*, acatech, Eds. Grötschel, M., Lucas, K., Mehrmann, V., Produktionsfaktor Mathematik, ISBN 978-3-8167-7642-0, pp. 27–62

## Journal publications

- 2011 • Engelhart, M., Lebiedz, D., Sager, S., *Optimal control for cancer chemotherapy ODE models: Potential of optimal schedules and choice of objective function*, **Mathematical Biosciences**, Vol. 229(1), pp. 123–134
- Huschto, T., Feichtinger, G., Kort, P., Hartl, R.F., Sager, S., Seidl, A., *Numerical solution of a conspicuous consumption model with constant control delay*, **Automatica**, Vol. 47(9), 1868–1877
- Kirches, C., Bock, H.G., Schlöder, J.P., Sager, S., *Block structured quadratic programming for the direct multiple shooting method for optimal control*, **Optimization Methods and Software**, Vol. 26(2), 239–257
- Kirches, C., Bock, H.G., Schlöder, J.P., Sager, S., *A factorization with update procedures for a KKT matrix arising in direct optimal control*, **Mathematical Programming Computation**, Vol 3(4), pp. 319–348
- Sager, S., Barth, C., Diedam, H., Engelhart, M., Funke, J., *Optimization as an analysis tool for human complex problem solving*, **SIAM Journal on Optimization**, Vol. 21(3), pp. 936–959
- Sager, S., Bock, H.G., Diehl, M., *The Integer approximation error in mixed-integer optimal control*, DOI 10.1007/s10107-010-0405-3, online first in **Mathematical Programming A**
- Sager, S., Jung, M., Kirches, C., *Combinatorial integral approximation*, **Mathematical Methods for Operations Research**, Vol. 73(3), pp. 363–380
- 2010 • Logist, F., Sager, S., Kirches, C., Van Impe, J.F., *Efficient multiple objective optimal control of dynamic systems with integer controls*, **Journal of Process Control**, Vol. 20(7), 810–822
- Kirches, C., Sager, S., Bock, H.G., Schlöder, J.P., *Time-optimal control of automobile test drives with gear shifts*, **Optimal Control Applications and Methods**, Vol. 31(2), 137–153
- 2009 • Sager, S., Reinelt, G., Bock, H.G., *Direct methods with maximal lower bound for mixed-integer optimal control problems*, **Mathematical Programming**, Vol. 118(1), pp. 109–149
- Sager, S., *Reformulations and algorithms for the optimization of switching decisions in nonlinear optimal control*, **Journal of Process Control**, Vol. 19, pp. 1238–1247

## — Publications (continued) —

- 2008
- Brandt-Pollmann, U., Winkler, R., Sager, S., Moslener, U., Schlöder, J.P., *Numerical solution of optimal control problems with constant control delays*, **Computational Economics**, Vol. 31(2), pp. 181–206
  - Shaik, O.S., Sager, S., Slaby, O., Lebiedz, D., *Phase tracking and restoration of circadian rhythms by model-based optimal control*, **IET Systems Biology**, Vol. 2, pp. 16–23
- 2007
- Slaby, O., Sager, S., Shaik, O.S., Kummer, U., Lebiedz, D., *Optimal control of self-organized dynamics in cellular signal transduction*, **Mathematical and Computer Modelling of Dynamical Systems**, Vol. 13, pp. 487–502
  - Sager, S., Brandt-Pollmann, U., Diehl, M., Lebiedz, D., Bock, H.G., *Exploiting system homogeneities in large scale optimal control problems for speedup of multiple shooting based SQP methods*, **Computers & Chemical Engineering**, Vol. 31, pp. 1181–1186
- 2006
- König, R., Schramm, G., Oswald, M., Seitz, H., Sager, S., Zapatka, M., Reinelt, G., Eils, R., *Discovering functional gene expression patterns in the metabolic network of *Escherichia coli* with wavelet transforms*, **BMC Bioinformatics**, 7:119
- 2005
- Lebiedz, D., Sager, S., Bock, H.G., Lebiedz, P., *Annihilation of limit-cycle oscillations by identification of critical perturbing stimuli via mixed-integer optimal control*, **Physical Review Letters**, 95, 108303
  - Brandt-Pollmann, U., Lebiedz, D., Diehl, M., Sager, S., Schlöder, J.P., *Real-time nonlinear feedback control of pattern formation in (bio)chemical reaction-diffusion processes: A model study*, **Chaos**, 15, 033901, selected for online-publication in **Virtual Journal of Biological Physics Research**, July 15, 2005

## Submitted journal publications

- 201?
- Engelhart, M., Funke, J., Sager, S., *A Decomposition Approach for a New Test-Scenario in Complex Problem Solving*, submitted to **Journal of Computational Science**
  - J.V. Frasch, H.J. Ferreau, S. Sager, M. Diehl, *An Auto-generated Nonlinear MPC Algorithm for Real-Time Obstacle Avoidance of Ground Vehicles*, submitted to **CDC 2012**
  - Hante, F., Sager, S., *Relaxation Methods for Mixed-Integer Optimal Control of Partial Differential Equations*, submitted to **Mathematical Methods and Applications**
  - Jung, M., Reinelt, S., Sager, S., *The Lagrangian Relaxation for the Combinatorial Integral Approximation Problem*, submitted to **Optimization Methods and Software**
  - Kirches, C., Potschka, A., Bock, H.G., Sager, S., *A Parametric Active Set Method for a Subclass of Quadratic Programs with Vanishing Constraints*, submitted to **Pacific Journal of Optimization**
  - Körkel, S., Potschka, A., Bock, H.G., Sager, S., *A Multiple Shooting Formulation for Optimum Experimental Design*, submitted revisions to **Mathematical Programming B**

## — Publications (continued) —

- Sager, S., *Sampling Decisions in Optimum Experimental Design in the Light of Pontryagin's Maximum Principle*, submitted to **SIAM Journal on Control and Optimization**

### Peer-reviewed proceedings publications

- 201? • Kirches, C., Bock, H.G., Schlöder, J.P., Sager, S., *Complementary Condensing for the Direct Multiple Shooting Method*, accepted for Proceedings **HPSC09**
- 2011 • Kehrle, F., Frasch J.V., Kirches, C., Sager, S., *Optimal control of Formula 1 race cars in a VDrift based virtual environment*, **IFAC World Congress 2011**, Paper ThB21.2, Milano
- 2010 • Sager, S., Barth, C., Diedam, H., Engelhart, M., Funke, J., *Optimization to measure performance in the Tailorshop test scenario — structured MINLPs and beyond*, Proceedings **EWMINLP10**, pp. 261–269, April 12–16, CIRM, Marseille
- 2008 • S. Sager, C. Kirches, H.G. Bock, *Fast solution of periodic optimal control problems in automobile test-driving with gear shifts*, **IEEE CDC08 Proceedings**, ISBN: 978-1-4244-3124-3
- 2007 • Sager, S., Diehl, M., Singh, G., Küpper, A., Engell, S., *Determining SMB superstructures by mixed-integer optimal control*, Proceedings OR 2006, Eds. K.-H. Waldmann, U.M. Stocker, Springer, pp. 37–44
- 2006 • Lebiedz, D., Sager, S., Shaik, O.S., Slaby, O., *Optimal control of self-organized dynamics in cellular signal transduction*, Proceedings of the 5th Vienna Symposium of Mathematical Modeling, Vienna, Argesim Rep. 30
- 2005 • Körkel, S., Qu, H., Rücker, G., Sager, S., *Derivative Based vs. Derivative Free Optimization Methods for Nonlinear Optimum Experimental Design*, Proceedings of HPCA2004 Conference, pp. 339–345, Springer, Shanghai

### Popular science publications

- 2011 • Frasch, J., Janka, D., Kircheis, R., Sager, S., *Das Rucksackproblem der Bundesligamanager*, **OR News**, 43, pp. 6–9
- 2007 • Sager, S., *Von diskreten Mathematikern und Wanderungen im Gebirge*, **Bild der Wissenschaft plus**, Vol. 11, pp. 12–15, available at [http://www.klaus-tschira-preis.info/download/2007/BDW\\_KTP\\_2007.pdf](http://www.klaus-tschira-preis.info/download/2007/BDW_KTP_2007.pdf)
- 2006 • Sager, S., *Numerische Methoden für Probleme der gemischt-ganzzahligen Optimalen Steuerung*, **OR News**, 28, pp. 30–31

### Reviewing activities

- CDC, Environmental Modelling and Software, European Journal of Operational Research, IEEE TAC, IFAC, Industrial & Engineering Chemistry Research, INFORMS Journal on Computing, Journal of Process Control, MMOR, Mathematical Programming, Open Applied Mathematics Journal, OCAM, Optimization and Engineering, SICON
- Klaus Tschira Foundation
- Alexander von Humboldt Foundation
- Dutch National Science Foundation
- Series Editor of the *Differential-Algebraic Equations Forum*, Springer