Paul Swoboda

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Career

Current position	**Max Planck Institute of Informatics** Junior group leader, Department D2, Computer Vision and Machine Learning	since 03/2018
Previous positions	**Institute for Science and Technology, Austria** PostDoc in Prof. Vladimir Kolmogorov's group	02/2016 - 02/2018
	University of Heidelberg University Assistant in Prof. Christop Schnörr's group	12/2011 - 02/2016
Education	**University of Heidelberg** PhD in Mathematics Thesis: "New Convex Relaxation and Global Optimality in Variational Imaging", Grade: summa cum laude	12/2011 - 02/2016
	University of Heidelberg Diploma in Mathematics (Dipl.-Math.) Thesis: "Copositive representation of complementarity constraints", Grade: 1.0	10/2006 - 12/2011
Awards	**Best Student Paper Award** Conference on Computer Vision and Pattern Recognition (CVPR)	2014

Teaching

Saarland University	Machine Learning	WS 2018/19
	Probabilistic Graphical Models	WS 2018/19
University of Heidelberg	Higher Mathematics for Physics II	SS 2015
	Mathematical Optimization for Digital Image Analysis	SS 2014
	Mathematical Methods of Image Analysis	SS 2013
	Introduction to Computer Science	WS 2012/13
	Convex Analysis and Probabilistic Modelling	SS 2012
	Seminar Image Analysis and Pattern Recognition	SS 2012 -SS 2015

	Advanced Seminar Probabilistic Graphical Models & Semidefinite Optimization	SS 2012 -SS 2015
	Laboratory Image Analysis and Pattern recognition	SS 2012 -SS 2015
co-supervision PhD students	Ahmed Abbas, MPI-INF	2020-
	Andrea Hornakova, MPI-INF	2018 -
	Stefan Haller, University of Heidelberg	2017 -
	Jan-Hendrik Lange, MPI-INF	2018 - 2020
	Jan Kuske, University of Heidelberg	2014 - 2019
Master theses	Ahmed Abbas, Saarland University Title: Bottleneck Potentials in Markov Random Fields	02/2019
	Jan Kuske, University of Heidelberg Title: Discrete tomography with sparse gradients	11/2013
Invited talks	TU Graz	2020
	Center for Machine Perception Prague	2019
	TU Braunschweig	2019
	University of Heidelberg, HCI	2019
	TU Munich	2018
	HHMI, Janelia Farm	2017
	Max Planck Institute for Informatics	2017
	Max Planck Institute for Molecular Cell Biology and Genetics	2016
	TU Dresden	2015
Area chair	NeurIPS 2020	
Reviewer	CVPR(2014-2020), NeurIPS(2017-2020), ICML(2018-2020), ICCV(2017-2020), ECCV(2018-2020), TPAMI, CVIU	

Research experience

Large scale discrete optimization

Solving contextual decision problem in computer vision and machine learning as integer linear programs. Development of algorithm design paradigms that are widely applicable for many structured inference problems. Implementation of flexible high-performance libraries providing optimization routines. Implementation of specific solvers for Markov Random Fields, tracking, graph matching, multi-graph matching, multicut, max-cut and discrete tomography.

Partial optimality

Identifying in polynomial time subsets of variables for which a globally optimal solution can be computed in NP-hard problems. Applications in Markov Random Fields, multicut and max-cut.

Global optimality methods
Speeding up exact methods for NP-hard problems. Our method works by decomposing the original problem into easy and hard parts that can be solved with fast approximative and slower exact methods respectively. Solutions of each part are recombined to yield a globally optimal solution.

Correspondence problems
Finding correspondences between multiple objects to be registered with each other. Developed theoretically justified high-performance methods for the graph matching and multi-graph matching problem. Applications in computer vision, computer graphics and biological image analysis.

Graph decomposition problems
Decomposing a graph into fixed or unknown number of components. Developed theoretically well-grounded high-performance algorithms for multicut and max-cut. Applications in computer vision, machine learning and biological image analysis.

Tracking problems
Tracking multiple objects across timeframess. Developed mathematical formulations and efficient algorithms for multiple object tracking and cell tracking. State of the art performance on MOT challenge.

Journal publications

1 Jörg Hendrik Kappes, Paul Swoboda, Bogdan Savchynskyy, Tamir Hazan, and Christoph Schnörr. Multicuts and perturb & MAP for probabilistic graph clustering. *Journal of Mathematical Imaging and Vision (JMIV)*, 56(2)

2 Paul Swoboda, Alexander Shekhovtsov, Jörg Hendrik Kappes, Christoph Schnörr, and Bogdan Savchynskyy. Partial optimality by pruning for MAP-inference with general graphical models. *IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI)*, 38(7)

3 Paul Swoboda and Christoph Schnörr. Convex variational image restoration with histogram priors. *SIAM Journal on Imaging Sciences*, 6(3)

Conference publications

CVPR oral acceptance rate: $\sim 5\%$, ICCV oral acceptance rate: $\sim 4\%$

1 Michal Rolínek, Paul Swoboda, Dominik Zietlow, Anselm Paulus, Vít Musil, and Georg Martius. Deep graph matching via blackbox differentiation of combinatorial solvers. In *Proceedings of the IEEE European Conference on Computer Vision (ECCV)*, 2020

2 Andrea Hornakova, Roberto Henschel, Bodo Rosenhahn, and Paul Swoboda. Lifted disjoint paths with application in multiple object tracking. In *Proceedings of the International Conference on Machine Learning (ICML)*, 2020

3 Stefan Haller, Mangal Prakash, Lisa Hutschenreiter, Tobias Pietzsch, Carsten Rother, Florian Jug, Paul Swoboda, and Bogdan Savchynskyy. A primal-dual solver for large-scale tracking-by-assignment. In *Proceedings of the International Conference on Artificial Intelligence and Statistics (AISTATS)*, 2020

4 Ahmed Abbas and Paul Swoboda. Bottleneck potentials in Markov Random Fields. In *Proceedings of the IEEE International Conference on Computer Vision (ICCV)*, 2019, **oral**

5 Florian Bernard, Johan Thunberg, Paul Swoboda, and Christian Theobalt. Higher-order projected power iterations for scalable multi-matching. In *Proceedings of the IEEE International Conference on Computer Vision (ICCV)*, 2019

6 Paul Swoboda, Ashkan Mokarian, Christian Theobalt, Florian Bernard, et al. A convex relaxation for multi-graph matching. In *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, **oral**

7 Paul Swoboda and Vladimir Kolmogorov. MAP inference via block-coordinate Frank-Wolfe algorithm. In *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, **oral**

8 Jan-Hendrik Lange, Bjoern Andres, and Paul Swoboda. Combinatorial persistency criteria for multicut and max-cut. In *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*

9 Stefan Haller, Paul Swoboda, and Bogdan Savchynskyy. Exact MAP-inference by confining combinatorial search with LP relaxation. In *Thirty-Second AAAI Conference on Artificial Intelligence*, 2018

10 Vera Trajkovska, Paul Swoboda, Freddie Åström, and Stefania Petra. Graphical model parameter learning by inverse linear programming. In *International Conference on Scale Space and Variational Methods in Computer Vision (SSVM)*

11 Jan Kuske, Paul Swoboda, and Stefania Petra. A novel convex relaxation for non-binary discrete tomography. In *International Conference on Scale Space and Variational Methods in Computer Vision (SSVM)*

12 Paul Swoboda, Carsten Rother, Hassan Abu Alhaija, Dagmar Kainmuller, and Bogdan Savchynskyy. A study of Lagrangean decompositions and dual ascent solvers for graph matching. In *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*

13 Paul Swoboda and Bjoern Andres. A message passing algorithm for the minimum cost multicut problem. In *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*

14 Paul Swoboda, Jan Kuske, and Bogdan Savchynskyy. A dual ascent framework for Lagrangean decomposition of combinatorial problems. In *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*

15 Alexander Shekhovtsov, Paul Swoboda, and Bogdan Savchynskyy. Maximum persistency via iterative relaxed inference with graphical models. In *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*

16 Jörg Hendrik Kappes, Paul Swoboda, Bogdan Savchynskyy, Tamir Hazan, and Christoph Schnörr. Probabilistic correlation clustering and image partitioning using perturbed multicuts. In *International Conference on Scale Space and Variational Methods in Computer Vision (SSVM)*

17 Paul Swoboda, Bogdan Savchynskyy, Jörg H Kappes, and Christoph Schnörr. Partial optimality by pruning for MAP-inference with general graphical models. In *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, **oral**

18 Paul Swoboda and Christoph Schnörr. Variational image segmentation and cosegmentation with the Wasserstein distance. In *International Workshop on Energy Minimization Methods in Computer Vision and Pattern Recognition (EMMCVPR)*

19 Bogdan Savchynskyy, Jörg Hendrik Kappes, Paul Swoboda, and Christoph Schnörr. Global MAP-optimality by shrinking the combinatorial search area with convex relaxation. In *Advances in Neural Information Processing Systems (NeurIPS)*

20 Paul Swoboda, Bogdan Savchynskyy, Jörg Kappes, and Christoph Schnörr. Partial optimality via iterative pruning for the Potts model. In *International Conference on Scale Space and Variational Methods in Computer Vision (SSVM)*