

JOHANN BREHMER, PHD

Researcher at the intersection of machine learning and physics

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EXPERIENCE

Center for Data Science, New York University

Moore-Sloan postdoctoral researcher

09/2017 – present

New York, USA

- Developed machine learning algorithms for statistical inference in models described by computer simulations and turned them into a widely used open-source Python library
- Applied this research to particle physics problems, enabling up to 90% more efficient measurements of the fundamental properties of nature
- Introduced first-ever scalable method to analyze satellite images for the almost imperceivable effects of Dark Matter clumps based on deep convolutional networks and Bayesian statistics
- Designed a new type of flow-based generative neural network, improving state-of-the-art performance in density estimation, manifold learning, and inference tasks
- Led interdisciplinary and international research teams, supervised students, managed projects from idea to publication / release

Heidelberg University

Graduate research and teaching assistant

07/2014 – 08/2017

Heidelberg, Germany

- Pioneered statistical metrics for sensitivity forecasting and feature selection in particle physics experiments
- Analyzed theoretical models of the newly discovered Higgs boson
- Taught undergraduate and graduate physics students

CERN

Summer student

06/2012 – 09/2012

Geneva, Switzerland

- Won the prestigious CERN summer student programme scholarship
- Designed and deployed a neural network-based signal-noise classifier for the LHCb experiment, which made hundreds of studies more efficient

EDUCATION

PhD in Physics	Heidelberg University, Germany	summa cum laude*	07/2014 – 08/2017
Master of Science in Physics	Heidelberg University, Germany	1.0*	02/2012 – 06/2014
Bachelor of Science in Physics	Heidelberg University, Germany	1.0*	09/2008 – 02/2012
Visiting student	Imperial College, London, UK		09/2010 – 07/2011
Abitur	Ökumenisches Gymnasium, Bremen, Germany	1.0*	06/2007

*German grading scale: from 1.0 (best) to 6.0 (worst), PhD grades from summa cum laude (best) to rite (worst)

SKILLS

Programming: Python, git, bash, Docker, SLURM; C++ basics

Libraries: PyTorch, scikit-learn, NumPy, SciPy, pandas, Matplotlib

Machine learning: Deep learning (convolutional neural networks, graph neural networks), probabilistic and generative models (normalizing flows, VAEs), reinforcement learning, unsupervised learning, density estimation, anomaly detection

Statistics: Likelihood-based methods, hypothesis tests, Bayesian techniques, MCMC, variational inference

Organizational: Team leadership, project management, workshop / seminar organization

Communication: Technical writing, LaTeX, data visualization, presentations to experts and non-experts, teaching

Languages: German (native), English (fluent)

PUBLICATIONS

Summary

- 27 publications overall, cited 1736 times
- 12 first-author publications in top peer-reviewed journals including PRL and PNAS
- 4 peer-reviewed workshop papers at NeurIPS, ICML

see bit.ly/jb-pub

Selected publications

- Johann Brehmer and Kyle Cranmer:
"Flows for simultaneous manifold learning and density estimation"
ICML workshop on Invertible NNs, Normalizing Flows & Explicit Likelihood Models (2020), [arXiv:2003.13913](https://arxiv.org/abs/2003.13913)
- Johann Brehmer, Gilles Louppe, Juan Pavez, and Kyle Cranmer:
"Mining gold from implicit models to improve likelihood-free inference"
Proceedings of the National Academy of Science 117 (2020), [arXiv:1805.12244](https://arxiv.org/abs/1805.12244)
- Kyle Cranmer, Johann Brehmer, and Gilles Louppe:
"The frontier of simulation-based inference"
Proceedings of the National Academy of Science (2020), [arXiv:1911.01429](https://arxiv.org/abs/1911.01429)
- Johann Brehmer, Felix Kling, Irina Espejo, and Kyle Cranmer:
"MadMiner: Machine learning-based inference for particle physics"
Computing and Software for Big Science 4 (2020), [arXiv:1907.10621](https://arxiv.org/abs/1907.10621)
- Johann Brehmer, Siddharth Mishra-Sharma, Joeri Hermans, Gilles Louppe, and Kyle Cranmer:
"Mining for Dark Matter substructure: Inferring subhalo population properties from strong lenses with machine learning"
The Astrophysical Journal 886 (2019), [arXiv:1909.02005](https://arxiv.org/abs/1909.02005)
- Johann Brehmer, Kyle Cranmer, Gilles Louppe, and Juan Pavez:
"Constraining Effective Field Theories with Machine Learning"
Physical Review Letters 121 (2018), [arXiv:1805.00013](https://arxiv.org/abs/1805.00013)
- Isaac Henrion, Johann Brehmer, Joan Bruna, Kyunghun Cho, Kyle Cranmer, Gilles Louppe, and Gaspar Rochette:
"Neural Message Passing for Jet Physics"
NeurIPS workshop on Deep Learning for the Physical Sciences (2017)
- Johann Brehmer, Kyle Cranmer, Felix Kling, Tilman Plehn:
"Better Higgs Measurements Through Information Geometry"
Physical Review D 95 (2017), [arXiv:1612.05261](https://arxiv.org/abs/1612.05261)
- Johann Brehmer, Ayres Freitas, David Lopez-Val, Tilman Plehn:
"Pushing Higgs Effective Theory to its Limits"
Physical Review D 93 (2016), [arXiv:1510.03443](https://arxiv.org/abs/1510.03443)

ACCOMPLISHMENTS

Talks:	16 invited talks (26 total) at international conferences / seminars Keynote speaker at ACAT 2019	see bit.ly/jb-talk
Software:	Lead developer of the open-source Python library MadMiner	see bit.ly/jb-madm
Leadership:	Organizer of workshops and seminars with up to 150 participants	
Reviewer:	NeurIPS, ICML, Nature Communications, PRL, ...	
Awards:	Spotlight, ICML workshop on Invertible NNs, Normalizing Flows & Explicit Likelihood Models Otto Haxel prize for best MSc thesis (out of 150) Prestigious German Studienstiftung scholarship (top 0.5% of all German students)	
Press coverage:	Physics, physics.org , Frankfurter Allgemeine Zeitung	