JOHANN **BREHMER**

Researcher at the intersection of machine learning and physics

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WORK EXPERIENCE

Moore-Sloan Postdoctoral Researcher 09/2017 – now

Center for Data Science & Physics Department, New York University, USA

- Developed machine learning algorithms for statistical inference in models described by computer simulations
- Turned these algorithms into an open-source Python library
- Applied this research to particle physics problems, enabling up to 90% more efficient measurements
- Introduced first-ever method to analyze satellite images for Dark Matter substructure at scale, using Bayesian statistics and deep convolutional networks
- Designed a new type of flow-based generative neural network
- Led interdisciplinary and international research teams, supervised students, managed projects from idea to publication / release

Research and Teaching Assistant 07/2014 – 08/2017

Institute for Theoretical Physics, Heidelberg University, Germany

- Introduced statistical metrics to guide particle physics experiments
- Studied the phenomenology of the Higgs boson
- Taught undergraduate and graduate physics students

Summer Student 06/2012 – 09/2012

CERN, Switzerland

- Won the competitive CERN summer student programme scholarship
- Designed and deployed a neural network-based signal-noise classifier for the LHCb experiment, used in hundreds of analyses

EDUCATION

PhD in Physics 07/2014 – 08/2017

Heidelberg University, Germany

- Graduated summa cum laude (best possible)

Master of Science in Physics 02/2012 – 06/2014

Heidelberg University, Germany

- Proposed a new data analysis strategy for particle physics experiments
- Graduated with 1.0 (best possible), won Otto Haxel prize for best thesis

Bachelor of Science in Physics 09/2008 – 02/2012

Heidelberg University, Germany

- Developed a numerical simulation tool for particle physics
- Was awarded the prestigious German Studienstiftung scholarship
- Won Erasmus stipend to study at Imperial College London, UK, for one year
- Graduated with 1.0 (best possible)

Abitur 06/2007

Ökumenisches Gymnasium Bremen, Germany

- Graduated with 1.0 (best possible), won Karl-Nix-Stiftung award

RESEARCH RESULTS

Publications see page 2

13 first-author publications in top peer-reviewed journals (PRL, PNAS, ...)
4 workshop papers at NeurIPS, ICML
24 publications in total, 1700 citations

Talks bit.ly/jb-talk

16 invited talks (26 total) at international conferences / seminars in several fields
Keynote speaker at ACAT 2019

Software bit.ly/jb-madm

Lead developer of the open-source Python library MadMiner, now used in several cutting-edge research efforts

Research community engagement

Organizer of workshops and seminars with up to 150 participants
Reviewer for NeurIPS, ICML, PRL, ...

SKILLS

Programming

5 years experience designing, developing, and maintaining Python software
Python, Jupyter, git, Docker, SLURM, Unix; C++ basics

Machine learning

Deep learning (convolutional neural networks, graph neural networks), probabilistic / generative models (normalizing flows, VAEs), reinforcement learning
PyTorch, scikit-learn; TensorFlow basics

Statistics and data science

Probability theory, frequentist / Bayesian statistics (MCMC, variational inference), data processing, visualization
NumPy, SciPy, pandas, Matplotlib

Writing and communication

Technical writing, presentations to experts and non-experts, teaching
LaTeX

Languages

German (native), English (fluent)

SELECTED PUBLICATIONS

For a full list of all 24 publications and 1700 citations, please see my Google Scholar profile at bit.ly/jb-pub.

Probabilistic / generative models

Johann Brehmer and Kyle Cranmer
Flows for simultaneous manifold learning and density estimation
Submitted to NeurIPS 2020, arXiv:2003.13913

Johann Brehmer and Kyle Cranmer
NOTAGAN: Flows for the data manifold
Spotlight presentation, ICML workshop on Invertible Neural Networks, Normalizing Flows & Explicit Likelihood Models (2020)

Simulation-based (likelihood-free) inference

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

Kyle Cranmer, Johann Brehmer, and Gilles Louppe
The frontier of simulation-based inference
Proceedings of the National Academy of Science (2019), arXiv:1911.01429

Johann Brehmer, Kyle Cranmer, Siddharth Mishra-Sharma, Felix Kling, and Gilles Louppe
Mining gold: Improving simulation-based inference with latent information
NeurIPS workshop on Machine Learning and the Physical Sciences (2019)

Markus Stoye, Johann Brehmer, Gilles Louppe, Juan Pavez, and Kyle Cranmer
Likelihood-free inference with an improved cross-entropy estimator
NeurIPS workshop on Machine Learning and the Physical Sciences (2019), arXiv:1808.00973

Simulation-based inference for particle physics

Johann Brehmer, Felix Kling, Irina Espejo, and Kyle Cranmer
Constraining Effective Field Theories with Machine Learning
Physical Review Letters 121 (2018), arXiv:1805.00013

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

Simulation-based inference for cosmology

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

Statistical metrics for particle physics

Johann Brehmer, Kyle Cranmer, Felix Kling, Tilman Plehn
Better Higgs Measurements Through Information Geometry
Physical Review D 95 (2017), arXiv:1612.05261

Graph neural networks for particle physics

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)

Particle physics theory

Johann Brehmer, Ayres Freitas, David Lopez-Val, Tilman Plehn
Pushing Higgs Effective Theory to its Limits
Physical Review D 93 (2016), arXiv:1510.03443