




Rob Verheyen

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RESEARCH INTERESTS

- **Machine learning in particle physics**
Anomaly detection and event classification with graph neural networks and transformers
- **Deep generative models**
Normalizing flows; Variational autoencoders; Variational inference; Applications in particle physics
- **Computing**
Monte Carlo techniques; High-performance computing; Algorithmic efficiency

WORK EXPERIENCE

Postdoctoral researcher Theoretical high energy physics Oct 2019 - present

[University College London](#) / [University of Oxford \(visitor\)](#), United Kingdom

- Author and developer in the [PanScales](#) collaboration, a project involving leading theorists that aim to improve theoretical accuracy and understanding of Monte Carlo event generators.
- Research on deep generative models, anomaly detection and event classification with models such as normalizing flows, graph neural networks and transformers.
- Experience with high-performance computing and algorithmic efficiency.

EDUCATION

PhD Theoretical high energy physics 2015 - 2019

[Radboud University Nijmegen](#), the Netherlands

- Current author and developer in the [PYTHIA](#) collaboration, the leading particle physics Monte Carlo event generator and the most widely-used and cited software in the field.
- Research on deep generative models for particle collision events, a new and emerging field at the time.
- Strong emphasis on Monte Carlo algorithms and theoretical calculations used for the simulation of highly-energetic particle collisions.

MsC Theoretical high energy physics (*Summa cum laude/with highest honors*) 2013 - 2015

[Radboud University Nijmegen](#), the Netherlands

- Research with focus on numerical techniques in calculations for supersymmetric field theory.

BsC Physics and Astronomy (*Cum laude/with honors*) 2009 - 2013

[Radboud University Nijmegen](#), the Netherlands

SELECTED PUBLICATIONS

Full list of 24 publications on [Inspire](#) or [Google Scholar](#)

Machine learning

Climbing four tops with graph networks, transformers and pairwise features

L. Builtjes, S. Caron, P. Moskvitina, C. Nellist, R. Ruiz de Austri, [R. Verheyen](#), Z. Zhang, [\[arXiv\]](#)

Event Generation and Density Estimation with Surjective Normalizing Flows

[R. Verheyen](#), [SciPost Physics 2022](#) [\[arXiv\]](#) [\[code\]](#)

Rare and Different: Anomaly Scores from a Combination of Likelihood and Out-of-distribution Models to Detect New Physics at the LHC

S. Caron, L. Hendriks, [R. Verheyen](#), [SciPost Physics 2022](#) [\[arXiv\]](#) [\[code\]](#)

Event Generation and Statistical Sampling for Physics with Deep Generative Models and a Density Information Buffer

S. Otten, S. Caron, W. de Swart, M. van Beekveld, L. Hendriks, C. van Leeuwen, D. Podareanu, R. Ruiz de Austri, R. Verheyen, [Nature Communications 2021](#) [arXiv]

Phase Space Sampling and Inference from Weighted Events with Autoregressive Flows

B. Stienen, R. Verheyen, [SciPost Physics 2021](#) [arXiv] [code]

Monte Carlo generator development

A Comprehensive Guide to the Physics and Usage of PYTHIA 8.3

C. Bierlich, S. Chakraborty, N. Desai, L. Gellersen, I. Helenius, P. Ilten, L. Lönnblad, S. Mrenna, S. Prestel, C. Preuss, T. Sjöstrand, P. Skands, M. Uthelm, R. Verheyen, [SciPost Physics Codebases 2022](#) [arXiv] [code]

PanScales Parton Showers for Hadron Collisions: Formulation and Fixed-order studies

M. van Beekveld, S. Ferrario Ravasio, G. Salam, A. Soto-Ontoso, G. Soyez, R. Verheyen, [Journal of High Energy Physics 2022](#) [arXiv]

Spin Correlations in Final-state Parton Showers and Jet Observables

A. Karlberg, G. Salam, L. Scyboz, R. Verheyen, [The European Physical Journal 2021](#) [arXiv]

Competing Sudakov Veto Algorithms

R. Kleiss, R. Verheyen, [The European Physical Journal 2016](#) [arXiv] [code]

SELECTED TALKS

More complete list [here](#).

HP2 conference, Newcastle, United Kingdom Invited talk Sep 2022

An overview of the PanScales parton showers

Heidelberg University, Germany Invited seminar Jun 2022

Event Generation and Density Estimation with Surjective Normalizing Flows

Pittsburgh Loopfest conference, United States Invited talk May 2022

The PanScales parton showers for hadron collisions

University of Jyväskylä, Finland PYTHIA public seminar May 2020

Electroweak Corrections in the Vincia Parton Shower

Monash University, Australia Invited talk Mar 2019

Event Generation and Statistical Sampling with Deep Generative Models

OTHER PROJECTS

- Contributed to the development of an ML algorithm for fast diagnosis of SARS-CoV-2, led to publication in [Clinical Chemistry and Laboratory Medicine](#).
- Development of graph generative models for particle physics with F. Dreyer (ongoing).
- Normalizing flows for Monte Carlo integration (ongoing).

SKILLS

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|-----------------------|---|
| ML frameworks | PyTorch, TensorFlow, dgl |
| Programming languages | C++, Python (NumPy, Pandas, Matplotlib, SciPy), Mathematica |
| Software | LaTeX, git, svn, slurm |