Peter Mühlbacher

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SUMMARY

Ph.D. candidate trained in mathematics and physics, with strong interdisciplinary skills developed from extensive collaboration with international research groups and ability to work independently or as part of a team.

Special expertise in the following areas:

- Statistics
- Data Analysis
- Quantum Mechanics
- Monte Carlo Simulations
- Probabilistic Forecasting
- High-dimensional Probability Theory

EDUCATION

Warwick University, Coventry, UK
Ph.D, Mathematics — Expected July **2022**
Concentrations: Probability Theory, Quantum Spin Systems, Monte Carlo Simulations

Cambridge University, Cambridge, UK
MASt., Mathematics — **2017**
Concentrations: Probability Theory, Mathematical Physics

Vienna University, Vienna, Austria
BSc., Mathematics — **2016**

EXPERIENCE

Dissertation Research — **2018—2022**
Dissertation: "Probabilistic Methods for Quantum Spin Systems"
- Designed algorithms to efficiently sample from high-dimensional distributions
- Taught in part master's/Ph.D courses on Quantum Mechanics and Statistical Mechanics
- Collaborated & co-authored papers with groups based in Europe, America, and Asia
- Presented original research at international conferences with 50—500 attendees

Unicredit Bank Austria (risk management) — **2018**
- Analysed & advised on the implementation of an EU regulation
- Communicated amendments to this implementation to the Austrian Financial Market Authority

Institute for Science & Technology (Vienna) — **2016—2018**
- Awarded the OeAD research scholarship (€2200) and a paid internship (acceptance rate: 3%)
- Published a paper on Random Matrix Theory

Institute for Quantum Optics and Quantum Information (Vienna) — **2015—2016**
- Assisted with study design, to be carried out by the European Space Agency

Paramedic — **2013—2014**
- Full-time from July to March, on a voluntary basis afterwards

Webdesign and Databases — **2008—2012**
- Developed several companies' websites
- Deployed HTML, CSS, JavaScript, PHP, and SQL

Forecasting on Metaculus — **2021—present**
- Public track record of my probabilistic predictions on Covid, economics, etc.
- Investigated a potential "arbitrage" opportunity by analysing historical data

PUBLICATIONS AND PRESENTATIONS

P. Mühlbacher, *"Split-and-Merge in Stationary Random Stirring on General Graphs", pending publication.*
- Found a new way of sampling from high-dimensional distributions and used it to improve state-of-the-art results

P. Mühlbacher, *"A New Loop Algorithm with Theoretical Implications", pending publication.*
- Introduced a novel Monte Carlo algorithm for quantum spin systems and used it to prove new results
- Subject to further investigation with a group in Germany
- Presented in Mannheim (online)

J. Björnberg, P. Mühlbacher, B. Nachtergaele, D. Ueltschi, *"Dimerization in Quantum Spin Chains with O(n) Symmetry"*, Communications in Mathematical Physics volume 387, pages 1151–1189 (2021)
- Employed a delicate cluster expansion to prove surprising results about quantum spins
- "This is a fabulous paper. Congratulations" ~ Elliott Lieb (Princeton)
- Presented at ICMP, in Italy (and at Harvard by B. Nachtergaele)

P. Mühlbacher, *"Critical parameters for loop and Bernoulli percolation"*, ALEA volume 18, pages 289–308 (2021)
- Proved an open conjecture about comparisons between different probabilistic models
- Presented in Venice, Milton Keynes, Warsaw, Bristol

L. Erdős, P. Mühlbacher, *"Bounds on the Norm of Wigner-type Random Matrices"*, Random Matrices: Theory and Applications, volume 08 (2019)
- Used graphical representations & results from Computer Science to prove bounds on Random Matrices
- Presented in Montréal, Vienna, Warwick, Dortmund

P. Mühlbacher, *"Gaussian Free Field and Liouville Quantum Gravity"*, 2017
- Cambridge master's thesis, 87% (α-grade standard)

P. Mühlbacher, *"Diffusion Maps"*, 2015
- Bachelor thesis on dimensionality reduction and numerical methods for stochastic partial differential equations
- Awarded highest possible mark

P. Mühlbacher, *"High Dimensional Landscapes and Random Matrices"*, 2016
- Bachelor thesis on large deviations of spectral statistics and their applications to spin glasses & neural networks
- Awarded highest possible mark

P. Mühlbacher, *"Protein Docking"*, 2015
- Report with a focus on numerics and an efficient implementation

P. Mühlbacher, *"Elliptic Curves and their Applications in Public Key Cryptography"*, 2012 (in German)
- Won the Dr. Hans-Riegel award, worth €600

EXTRACURRICULARS

Languages
- English (fluent), German (native), French (basics), Russian (basics), Chinese (basics)
- Taught two German language courses to ~15 students for a year

Programming
- Python (NumPy, SymPy, Jupyter notebooks, dynamically fetching data from websites)
- Java (Processing)
- LaTeX
- Web (HTML, CSS, JavaScript, PHP, some SQL)
- Git

Other Activities
- Former gymnast
- Following developments in Machine Learning (set up a group of ~30 students in Cambridge to share materials)
- Peer-reviewed for Discrete Applied Mathematics