

Florian Puchhammer

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PROFILE

A driven and dedicated statistician with international academic experience in Austria, Canada, and Spain. Expert for Monte Carlo and quasi-Monte Carlo methods, and their application in stochastic simulation. Currently focuses on probability density estimation, the efficient simulation of Markov chains (also combined with data-driven methods), and modern Markov chain Monte Carlo techniques. Applies his research to problems in finance, computational biology, geophysics, and many more. Extremely versatile, flexible, excellent communication and presentation skills, and a proactive nature. Looking for an assistant professor position to tackle interesting new challenges in a strong and active team.

CURRENT POSITION

Postdoctoral Fellow, Department of Statistics and Actuarial Science, University of Waterloo, Ontario, Canada.

RESEARCH INTERESTS

Primary Density Estimation ♦ Quasi-Monte Carlo ♦ Hamiltonian Monte Carlo ♦ Stochastic Simulation
Secondary Monte Carlo ♦ Probability ♦ Statistics ♦ Operations Research ♦ Numerical Mathematics

SUMMARY OF QUALIFICATIONS

- 10 papers published or accepted. In 2021, 3 in Q1 journals, 1 invited survey, and 1 further.
- Google Scholar, November 29, 2021: 53 citations.
- 12 conference/workshop talks (2 invited and 10 contributed), 2 further presentations at research institutes.
- Held lecture series on randomized quasi-Monte Carlo at the Basque Center for Applied Mathematics and 65 undergraduate university courses in the areas of probability and calculus.
- Assisted in supervision of one PhD student and two Master-level interns.
- Academic coordinator at international student workshop and former member of two departmental committees.

EDUCATION

- 05/2014–06/2017** **PhD (Mathematics)**, Johannes Kepler Universität, Linz, Austria.
Advisor: Gerhard Larcher.
Committee Members: Dmitriy Bylik (University of Minnesota), Evelyn Buckwar (Johannes Kepler Universität).
- Emphasis on (quasi-) Monte Carlo, probability, and analysis.
 - Thesis: *Discrepancy Estimates for Point Sets and Sequences*.
 - Grant: *Quasi-Monte Carlo Methods: Theory and Applications*.
- 09/2011–01/2014** **MSc (Mathematics)**, Johannes Kepler Universität, Linz, Austria.
Advisor: Friedrich Pillichshammer.
- Major in *Mathematics in the Natural Sciences*.
 - Externally funded thesis: *Monte Carlo Integration of Generalized Walsh Series Based on Digital Nets and Polynomial Lattices*.
 - Grants: *Analytic Combinatorics and Probabilistic Number Theory* and *Extremal L1 Problem for Entire Functions and Spectral Theory*.

- 10/2007–06/2011 **BSc (Mathematics)**, Johannes Kepler Universität.
Advisors: Gerhard Larcher, Friedrich Pillichshammer.
- Curriculum covered pure and numerical mathematics and computer science.
 - Theses: *Generation of Normally Distributed Random Numbers and Vectors*, and *Interrelations in the Existence of Orthogonal Latin Squares, Affine and Projective Planes, and (t, m, s) -Nets*.

RESEARCH EXPERIENCE

- 08/2021–present **Postdoctoral Fellow**, University of Waterloo.
Waterloo, Canada Department of Statistics and Actuarial Science.
Supervisors: Christiane Lemieux, Marius Hofert.
- Develop unbiased probability density estimators for stochastic models based on likelihood-ratio approaches and investigate the efficiency improvement when combined with smoothing techniques and quasi-Monte Carlo.
 - Apply these methods to models with complex dependence structures and stochastic inverse problems (e.g., deep neural networks). Paper in preparation.
 - Derive mathematically convergence rates of a specialized quasi-Monte Carlo algorithm for the efficient simulation of Markov chains (Array-RQMC).
 - Assess the applicability of new and recently developed unbiased density estimators to Array-RQMC and identify further fields of application.
- 09/2019–07/2021 **Postdoctoral Fellow**, BCAM - Basque Center for Applied Mathematics.
Bilbao, Spain Centre of Modelling and Simulation in Life and Material Sciences.
Supervisors: Elena Akhmatskaya, David Pardo.
- Develop adaptive strategies for automated model-dependent parameter tuning for modified Hamiltonian Monte Carlo. Paper in preparation.
 - Apply modified Hamiltonian Monte Carlo to stochastic inverse problems in geophysics.
 - Co-develop and maintain in-house software package *Hamiltonians in Computational Statistics* written in C.
- 09/2017–08/2019 **Postdoctoral Fellow**, Université de Montréal.
Montréal, Canada Département d'Informatique et de Recherche Opérationnelle.
Supervisor: Pierre L'Ecuyer.
- Show when and how quasi-Monte Carlo and stratified sampling improve the performance of standard density estimators (e.g., kernel density estimators).
 - Develop new unbiased density estimators based on conditioning techniques and investigate their performance improvement under quasi-Monte Carlo.
 - Apply these methods to problems in finance, queueing systems, project management, maximum flow problems, and many more.
 - Increase efficiency of simulation of chemical reaction networks by applying Array-RQMC and combining it with data-driven methods.
 - Co-developer of the software library *Stochastic Simulation in Java* and of the quasi-random point set generator *LatNet Builder* in C++. One paper accepted and one in preparation.

- 05/2014–06/2017** **PhD Candidate**, Johannes Kepler Universität.
Linz, Austria
Department of Financial Mathematics and Applied Number Theory.
Supervisor: Gerhard Larcher.
- Tackled and contributed towards mathematically challenging and long-standing open problems in discrepancy theory, leading to 2 invited talks at international workshops.
 - Investigated the discrepancy of combinations of pseudo-random sequences and derived tight bounds for lacunary trigonometric products.
- 09/2012–01/2014** **Research Assistant (part time)**, Johannes Kepler Universität.
Linz, Austria
Department of Dynamical Systems and Approximation Theory.
Supervisor: Peter Yuditskii.
- Investigated problems in spectral theory and higher function theory.
- 09/2011–07/2012** **Research Assistant (part time)**, Johannes Kepler Universität.
Linz, Austria
Department of Financial Mathematics and Applied Number Theory.
Supervisor: Friedrich Pillichshammer.
- Wrote externally funded Master's thesis at the beginning of my Master's studies.

PUBLICATIONS

Refereed Journal Articles

10. P. L'Ecuyer, F. Puchhammer, and A. Ben Abdellah, *Monte Carlo and Quasi-Monte Carlo Density Estimation via Conditioning*. To appear in *INFORMS Journal on Computing*, 2021. [[arXiv](#)]
9. A. Ben Abdellah, P. L'Ecuyer, A. B. Owen, and F. Puchhammer, *Density Estimation by Randomized Quasi-Monte Carlo*. *SIAM/ASA Journal on Uncertainty Quantification*, 9(1), 280–301, 2021. [[Paper](#)] [[arXiv](#)]
8. F. Puchhammer, A. Ben Abdellah, and P. L'Ecuyer, *Variance Reduction with Array-RQMC for Tau-Leaping Simulation of Stochastic Biological and Chemical Reaction Networks*. *Bulletin of Mathematical Biology*, 83(91), 2021. [[Paper](#)] [[arXiv](#)]
7. F. Puchhammer, *On an Explicit Lower Bound for the Star Discrepancy in Three Dimensions*. *Mathematics and Computers in Simulation*, 143:158–168, 2018. [[Paper](#)] [[arXiv](#)]
6. R. Hofer and F. Puchhammer, *On the Discrepancy of Two-Dimensional Perturbed Halton–Kronecker Sequences and Lacunary Trigonometric Products*. *Acta Arithmetica* 180(4):365–392, 2017. [[Paper](#)] [[arXiv](#)]
5. G. Larcher and F. Puchhammer, *An Improved Bound for the Star Discrepancy of Sequences in the Unit Interval*. *Uniform Distribution Theory*, 11(1):1–14, 2016. [[Paper](#)]
4. B. Eichinger, F. Puchhammer and P. Yuditskii, *Jacobi Flow on SMP Matrices and Killip-Simon Problem on Two Disjoint Intervals*. *Computational Methods and Function Theory*, 16(1):3–41, 2016. [[Paper](#)]

Refereed Conference Proceedings

3. P. L'Ecuyer and F. Puchhammer, *Density Estimation by Monte Carlo and Quasi-Monte Carlo*. Invited survey article to appear in *Monte Carlo and Quasi-Monte Carlo Methods 2020*, Springer Verlag, 2021. [[arXiv](#)]
2. P. L'Ecuyer, P. Marion, M. Godin, and F. Puchhammer, *A Tool for Custom Construction of QMC and RQMC Point Sets*. To appear in *Monte Carlo and Quasi-Monte Carlo Methods 2020*, Springer Verlag, 2021. [[arXiv](#)]
1. A. Ben Abdellah, P. L'Ecuyer, and F. Puchhammer, *Array-RQMC for Option Pricing Under Stochastic Volatility Models*. *Proceedings of the 2019 Winter Simulation Conference*, IEEE Press, 440–451, 2019. [[Paper](#)]

In Preparation

4. F. Puchhammer and P. L'Ecuyer, *Likelihood Ratio Density Estimation for Simulation Models*.
3. F. Puchhammer, E. Akhmatskaya, J. Alvarez-Aramberri, D. Pardo, T. Radivojević, and W. I. T. Uy, *Solving the 1D Inverse Magnetotelluric Problem with Modified Hamiltonian Monte Carlo Methods*.
2. E. Akhmatskaya and F. Puchhammer. *Adaptive Splitting Integrators for Efficient Sampling with Modified Hamiltonian Monte Carlo Methods in Computational Statistics*.
1. P. L'Ecuyer, M. Godin, A. Jemel, J. Keutchayan, P. Marion, and F. Puchhammer, *LatNet Builder: A Factory for Quasi-Random Point Sets*.

Translations

1. N. I. Akhiezer, *A Generalization of a Minimal Problem of Korkin–Zolotarev Kind*. German to English. [[arXiv](#)]

PRESENTATIONS

Invited Talks

- *Lower Bounds for the Discrepancy of Point Sets and Sequences*. Opening workshop of the SAMSI program “Quasi-Monte Carlo and High-Dimensional Sampling Methods for Applied Mathematics”, Duke University, Raleigh, USA (August 2017).
- *Explicit Lower Bounds for the Star Discrepancy of Sequences and Point Sets*. Workshop on Discrepancy Theory, Varenna, Italy (June 2016).

Contributed Talks

- *Monte Carlo and quasi-Monte Carlo Probability Density Estimation for Simulation Models*. SIAM Conference on Uncertainty Quantification (UQ 22), to be held in Atlanta, USA (April 2022).
- *Probability Density Estimation for Simulation Models*. Waterloo Student Conference in Statistics, Actuarial Science, and Finance, virtual conference, Waterloo, Canada (November 2021).
- *Simulating Chemical Reaction Networks with Tau-Leaping and Array-RQMC*. 13th International Conference on Monte Carlo Methods and Applications (MCM 2021), virtual conference, Mannheim, Germany (August 2021).
- *Hamiltonian Monte Carlo Applied to Inverse Problems in Imaging the Earth's Subsurface*. 14th International Conference in Monte Carlo & Quasi-Monte Carlo Methods in Scientific Computing (MCQMC 2020), virtual conference, Oxford, Great Britain (August 2020). [[Youtube](#)]
- *Variance Reduction for Chemical Reaction Networks with Array-RQMC*. 12th International Conference on Monte Carlo Methods and Applications (MCM 2019), Sydney, Australia (July 2019). [[Slides](#)]
- *Simulating Chemical Reaction Networks with Array-RQMC*. Optimization Days, Montréal, Canada (May 2019).
- *Density Estimation by Randomized Quasi-Monte Carlo*. 13th International Conference in Monte Carlo & Quasi-Monte Carlo Methods in Scientific Computing (MCQMC 2018), Rennes, France (July 2018).
- *Monte Carlo and (Randomized) Quasi-Monte Carlo Simulations with Lattice Builder and SSJ*. SAMSI QMC Program Transition Workshop, Durham, USA (May 2018).
- *Sharp General and Metric Bounds for the Star Discrepancy of Perturbed Halton-Kronecker Sequences*. 12th International Conference in Monte Carlo & Quasi-Monte Carlo Methods in Scientific Computing (MCQMC 2016), Stanford, USA (August 2016).
- *An Improved Bound for the Star Discrepancy of Sequences in the Unit Interval*. Information Based Complexity, Bedlewo, Poland (April 2015).

Talks at Research Institutes

- *Density Estimation for Simulation Models Using Monte Carlo and Quasi-Monte Carlo Methods*. Queen's University Belfast, virtual talk, Belfast, UK (May 2021).
- *An Introduction to Quasi-Monte Carlo and Randomized Quasi-Monte Carlo Methods*. University of Waterloo, 2 talks for reading group on Monte Carlo methods in financial engineering, Waterloo, Canada (November 2021).

Session Chair

- *Methods for Acceleration and Variance Reduction* at the MCM 2019 conference in Sydney, Australia, 2019.

TEACHING EXPERIENCE

Special Lecture Series

- An Introduction to Randomized Quasi-Monte Carlo and Its Applications: BCAM Course, 10 hours (5 sessions), Basque Center for Applied Mathematics, Bilbao, Spain (03/2020). [[Course page](#)] [[Slides](#)]
- Approximation theory: Bi-weekly 1.5-hour presentations on elliptic functions during a seminar led by Prof. Peter Yuditskii, Johannes Kepler Universität, Linz, Austria (03/2013–06/2013).

Instructor

- Probability. Course on probability and basic statistics. University of Waterloo (fall term 2021).
- Mathematics 3 for Mechatronic Engineers. Problem classes on ordinary differential equations. Johannes Kepler Universität (winter semester 2016/2017).
- Analysis 2. Problem classes on higher calculus. Johannes Kepler Universität (summer semester 2016).
- Analysis 1. Problem classes on calculus. Johannes Kepler Universität (winter semester 2015/2016).
- Analysis for Physicists 2. Problem classes on calculus and differential equations. Johannes Kepler Universität (summer semester 2015).
- Analysis 1. Problem classes on calculus. Johannes Kepler Universität (winter semester 2014/2015).

MANAGEMENT EXPERIENCE

- Academic coordinator and advisor of a group of students at the *150th European Study Group with Industry* (ESGI 150), Bilbao, Spain (2019).
- Assistance in supervision of PhD student at the Department of Computer Science and Operations Research, Université de Montréal, Montréal, Canada.
- Assistance in supervision of 2 interns from École Polytechnique de Paris at Université de Montréal.

ACADEMIC SERVICE

Peer Reviewer

- SIAM Journal on Scientific Computing.
- Monatshefte für Mathematik.

Participation in Committees

- Academic coordinator at the *150th European Study Group with Industry* (ESGI 150), Bilbao, Spain.
- Elected former representative of PhD students in a nation-wide grant funded by the Austrian Science Fund.
- Nominated student representative in a habilitation committee.

Volunteering

- Campus Housing Move-in Volunteer at University of Waterloo (September 2021)

PARTICIPATION IN RESEARCH PROJECTS AND GRANTS

- *Geometric Numerical Integrators for Quantum Problems, Celestial Mechanics and Monte Carlo* Spanish Ministry for Science and Innovation. PIs: E. Akhmetkaya, A. Murua (Basque Center for Applied Mathematics, Bilbao, Spain). Participation: 06/2020 – present.
- *Real-Time Inversion Using Deep Learning Methods (DEEPINVERSE)*. Spanish Ministry for Science and Innovation. PI: V. Nava (Basque Center for Applied Mathematics, Bilbao, Spain). Participation: 06/2020 – present.
- *Integral and Transversal Proposal for the Design and Implementation of Reliable Systems Based on Artificial Intelligence*. ELKARTEK. PI: M. Xose Rodriguez (Basque Center for Applied Mathematics, Bilbao, Spain). Participation: 03/2020 – present.
- *Monte Carlo and Quasi-Monte Carlo Methods for Optimization and Machine Learning*. IVADO Fundamental Research Program. PIs: P. L'Ecuyer, L. Devroye, and S. Lacoste-Julien (Université de Montréal, Dpt. of Computer Science and Operations Research, Montréal, Canada). Participation: 09/2017 – 08/2019.
- *Improved Discrepancy Estimates for Various Classes of Sequences*. One of 11 subprojects of the Special

Research Program (SFB) “Quasi-Monte Carlo Methods: Theory and Applications” supported by the Austrian Science Fund (FWF). PI: G. Larcher (Johannes Kepler Universität, Dpt. of Financial Mathematics and Applied Number Theory, Linz, Austria). Participation: 05/2014 – 06/2017.

- *Extremal L1 Problem for Entire Functions and Spectral Theory*. Stand-Alone Project by the Austrian Science Fund (FWF). PI: P. Yuditskii (Johannes Kepler Universität, Dpt. of Dynamical Systems and Approximation Theory, Linz, Austria). Participation: 09/2012 – 01/2014.
- *Analytic Combinatorics and Probabilistic Number theory*. National Research Network (NFN) supported by the Austrian Science Fund (FWF). PI: F. Pillichshammer (Johannes Kepler Universität, Dpt. of Financial Mathematics and Applied Number Theory, Linz, Austria). Participation: 09/2011 – 06/2012.

PROFESSIONAL DEVELOPMENT

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|------|--------|---|
| 2019 | 10 hrs | <i>Processes for Anomalous Diffusion in Biological Systems</i> , with G. Pagnini (BCAM, Spain), Bilbao, Spain. |
| 2019 | 10 hrs | <i>Decisions, Data, and Machine Learning</i> , with S. Mazuelas (BCAM, Spain), Bilbao, Spain. |
| 2019 | 10 hrs | <i>Introduction to Machine Learning</i> , with A. Pérez, E. Irurozki, and C. Ernesto Hernández (BCAM, Spain), Bilbao, Spain. |
| 2017 | 15 hrs | <i>Dynamical Systems in Number Theory</i> , with V. Bergelson (Ohio State University, USA), Salzburg, Austria. |
| 2015 | 35 hrs | <i>Winter School on Complexity and Discrepancy</i> , with D. Bilyk (University of Minnesota, USA), J. Dick (University of New South Wales, Australia), A. Hinrichs (JKU, Austria), Traunkirchen, Austria. |
| 2015 | 15 hrs | <i>Career Development</i> , Johannes Kepler Universität, Linz, Austria. |
| 2015 | 15 hrs | <i>Stage Performance</i> , Johannes Kepler Universität, Linz, Austria. |
| 2014 | 15 hrs | <i>Scientific Writing</i> , Johannes Kepler Universität, Linz, Austria. |

SKILLS

Languages

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|----------------|---------------------------|-----------------|---------------------------------------|
| German: | Mother tongue. | English: | Advanced proficiency (IELTS 8.5/9.0). |
| French: | Intermediate proficiency. | Spanish: | Basic proficiency. |

Computational Skills

- Coding languages C, C++, Java and technical computing systems Matlab, Mathematica, R.
- Basics in Python and TensorFlow.
- Co-developer of *Hamiltonians in Computational Statistics* for (modified) Hamiltonian Monte Carlo samplers. Written in C and maintained at the Basque Center for Applied Mathematics.
- Co-developer of *Stochastic Simulation in Java* for stochastic simulation with Monte Carlo or quasi-Monte Carlo and random number generation. Written in Java and maintained at Université de Montréal. [GitHub]
- Strategic contributor to *LatNet Builder*, providing the efficient search for optimal quasi-Monte Carlo point sets by using state-of-the-art methods at a high level of generality. Written in C++ and maintained at Université de Montréal. [GitHub]

Softskills

Curiosity ♦ Problem Solving ♦ Analytic Thinking ♦ Communication (written, verbal) ♦ Teamwork ♦ Flexibility ♦ Critical Thinking ♦ Versatility ♦ Result Orientation ♦ Quality Awareness

NON-ACADEMIC VOLUNTEER WORK

- Assistance in animal sanctuary [Lima's Tierparadies](#) (2020–2021) and fostering of dogs (2015–2017).

HOBBIES AND PERSONAL INTERESTS

Travelling (road trips, long distance hikes) ♦ Outdoors (hiking, jogging, training with my dogs, forest work, gardening) ♦ Cooking ♦ Music (listening, playing, watching live shows) ♦ Billiards (Snooker, Pool)