Personal information
Born March 16, 1990, in Helsinki, Finland. Personal homepage: https://www.iki.fi/vesakaar

Education
Doctor of Science (Technology)   August 2017
Aalto University, Department of Mathematics and Systems Analysis
Major: Mathematics

Master of Science   August 2013
University of Helsinki, Department of Mathematics and Statistics
Major: Applied mathematics

Bachelor of Science   June 2012
University of Helsinki, Department of Mathematics and Statistics
Major: Mathematics, Minors: Theoretical physics, Astronomy

Matriculation examination   May 2009
Helsinki Lyceum Coeducational gymnasium

Conferred academic titles
Adjunct Associate Lecturer   31.7.2020-31.7.2025
University of New South Wales, School of Mathematics and Statistics

Professional experience
Associate professor   1.7.2025-present
LUT University, School of Engineering Sciences

Wissenschaftlicher Mitarbeiter (Research Associate)   1.10.2024-30.6.2025
Free University of Berlin, Department of Mathematics and Computer Science   1.3.2022-31.3.2024

Substitute Professor of Numerical Mathematics   1.4.2024-30.9.2024
University of Potsdam, Institute of Mathematics

Researcher   3.8.2020-25.2.2022
LUT University, School of Engineering Sciences

Postdoctoral Fellow   5.10.2018-30.7.2020
University of New South Wales, School of Mathematics and Statistics

Akademischer Mitarbeiter (Research Associate)   1.10.2019-31.10.2019
University of Mannheim, Institute of Mathematics

Postdoctoral Researcher   9.7.2018-8.11.2018
Aalto University, Department of Mathematics and Systems Analysis

Finnish non-military service   18.9.2017-9.7.2018
University of Helsinki, Department of Mathematics and Statistics

Hourly-based Teacher   8.1.2018-29.3.2018
Aalto University, Department of Mathematics and Systems Analysis

Hourly-based Teacher   2.11.2017-11.12.2017
Aalto University, Department of Mathematics and Systems Analysis

Doctoral Candidate   16.10.2013-31.8.2017
Aalto University, Department of Mathematics and Systems Analysis

Substitute Teacher   Academic year 2012-2013
Helsinki Lyceum Coeducational and Kallio gymnasia

Teaching experience

Lecturer of the lecture courses Uncertainty Quantification and Quasi-Monte Carlo (17.10.2022-14.2.2023 and 15.4.2025-30.6.2025), Statistics for Data Science (16.10.2023-12.2.2024 and 14.10.2024-10.2.2025), and Inverse Problems (25.4.-18.7.2022 and 17.4.-18.7.2023) at Free University of Berlin. Lecturer of the autumn school course Quasi-Monte Carlo methods for PDE uncertainty quantification (10.-11.10.2024) at Centrum Wiskunde & Informatica (CWI). Lecturer of the lecture courses Bayesian Inference and Data Assimilation (10.4.-18.7.2024), Computational Mathematics I: Algorithmic Mathematics (9.4.-16.7.2024), and the seminar course Seminar on Inverse Problems and Uncertainty Quantification (10.4.-17.7.2024) at University of Potsdam. Lecturer of the winter school course Quasi-Monte Carlo methods for PDE uncertainty quantification (21.-22.2.2024) at Humboldt University of Berlin. Lecturer of the lecture course Special course on inverse problems (11.1.-24.2.2021 and 10.1.-25.2.2022) and seminar course Seminar on Mathematical Sciences (1.9.2020–25.2.2022) at LUT University. Lecturer of the minicourse Numerical methods for uncertainty quantification (6.10.-3.11.2020) held as part of the Seminar on Computational Engineering at LUT University. Lecturer of the block seminar course Sparse grid methods (7.10.-31.10.2019) at University of Mannheim. Assisting lecturer (Samuli Siltanen as primary lecturer) of the lecture course Applications of matrix computations (12.3.-4.5.2018) at University of Helsinki. Lecturer of the intensive course Introduction to R programming (20.-21.1.2018) at Aalto University.

Teaching assistant in the courses Computational inverse problems (spring terms 2014, 2016, and 2017), Differential and integral calculus 2 (spring 2015), Computational methods for differential equations (fall 2015), Differential and integral calculus 1 (fall 2016), Matrix algebra (fall 2017), and Introduction to Statistical Inference (spring 2018) at Aalto University. Teaching assistant of the N5TeAM summer school course Inverse Problems (summer 2014). Teaching assistant in the student tutoring lab of Aalto University (fall 2017).

Mathematics and physics teaching in gymnasia during the academic year 2012–2013.

Research visits (≥ 2 weeks)
University of New South Wales, 27.2.-10.3.2023 (host: Frances Kuo).
University of Mannheim, 27.9.-15.10.2021 (host: Claudia Schillings).
University of Mannheim, 1.10.-31.10.2019 (host: Claudia Schillings).

Scientific responsibilities
Reviewer for ANZIAM J. (1 manuscript), Inverse Probl. Imaging (2), J. Combin. Theory Ser. A (2), Numer. Linear Algebra. Appl. (2), Numer. Math. (2), SIAM/ASA J. Uncertain. Quantif. (3), SIAM J. Numer. Anal. (1), and Spec. Matrices (1).

Supervised theses
1. Advisor of Juhani Sipilä's Master's thesis at Aalto University (Pauliina Ilmonen as supervisor; completed June 2018).
2. Co-advisor of Jordan Van's Honours thesis at UNSW Sydney (Frances Kuo as supervisor; completed December 2019).
3. Co-advisor of Laura Bazahica's Master's thesis at FU Berlin (Claudia Schillings as supervisor; completed October 2023).

Organized minisymposia and special sessions
Kernel approximation and cubature. Special session held as part of *16th International Conference on Monte Carlo and Quasi-Monte Carlo Methods in Scientific Computing* (jointly organized with Ilja Klebanov). *University of Waterloo, Canada, August 22, 2024.*

Optimization under uncertainty. Special session held as part of *16th International Conference on Monte Carlo and Quasi-Monte Carlo Methods in Scientific Computing* (jointly organized with Philipp Guth and Claudia Schillings). *University of Waterloo, Canada, August 19, 2024.*

Forward and inverse domain uncertainty quantification. Minisymposium held as part of *11th Applied Inverse Problems Conference* (jointly organized with Claudia Schillings). *University of Göttingen, Germany, September 8, 2023.*

Recent advances in Bayesian optimal experimental design. Minisymposium held as part of *10th International Congress on Industrial and Applied Mathematics* (jointly organized with Claudia Schillings). *Waseda University, Tokyo, Japan, August 22, 2023.*

Uncertainty quantification and inverse problems. Satellite event held as part of *Bayes Comp 2023* (jointly organized with Andreas Rupp, Jana de Wiljes, and Martin Simon). *Levi, Finland, March 14, 2023.*

Uncertainty quantification. Special session held as part of *Finnish Mathematical Days 2022. Tampere University, Finland, January 4, 2022.*

Computational mathematics. Special session held as part of *Finnish Mathematical Days 2020. University of Oulu, Finland, January 3, 2020.*

Number theory and its applications. Special session held as part of *Finnish Mathematical Days 2018. University of Eastern Finland, Finland, January 4, 2018.*

Institutional responsibilities
Member of the PhD committee for the doctoral defense of Toyomu Matsuda at FU Berlin, Department of Mathematics and Computer Science (September 2023).

Co-organizer of the Research Seminar Numerical Analysis of Stochastic and Deterministic Partial Differential Equations at FU Berlin, Department of Mathematics and Computer Science (October 2022–October 2023).

Organizer of the Seminar on Computational Engineering at LUT University, School of Engineering Sciences (October 2020–February 2022).

Exam organization and invigilation at Aalto University throughout 2013-2017.
Grading of the national entrance examination in engineering mathematics (jointly organized by the Finnish universities of technology) in 2016 and 2017.

Grants
Travel scholarship of 1000 USD, Institute for Mathematical and Statistical Innovation (IMSI), 2025.

Travel grant of 2344 EUR, Deutscher Akademischer Austauschdienst (DAAD), 2023.

Talks in scientific conferences and workshops
1. Revisiting the spectrum of lattice-theoretic matrices. In *From ICS to FDA and EVT – Pauliina Ilmonen's Birthday Workshop. Aalto University, Finland, February 22, 2025.*
2. Quasi-Monte Carlo methods for Bayesian shape inversion. In *30th Inverse Days Workshop. University of Oulu, Finland, December 11, 2024.*
3. Quasi-Monte Carlo for Bayesian design of experiment problems governed by parametric PDEs. In *Finland-Japan Workshop in Industrial and Applied Mathematics. University of Helsinki, Finland, August 27, 2024.*
4. Quasi-Monte Carlo methods for Bayesian optimal experimental design. In *16th International Conference on Monte Carlo and Quasi-Monte Carlo Methods in Scientific Computing. University of Waterloo, Canada, August 20, 2024.*
5. Quasi-Monte Carlo methods for Bayesian optimal experimental design. In *31st IFIP TC-7 Conference on System Modeling and Optimization. University of Hamburg, Germany, August 13, 2024.*
6. Quasi-Monte Carlo methods for Bayesian design of experiment problems governed by parametric PDEs. In *42nd Northern German Colloquium on Applied Analysis and Numerical Mathematics. University of Oldenburg, Germany, June 28, 2024.*
7. Quasi-Monte Carlo for Bayesian optimal experimental design problems governed by PDEs. In *SIAM Conference on Uncertainty Quantification 2024. Trieste, Italy, February 27, 2024.*
8. Doubling the rate for high-dimensional numerical integration. In *Finnish Mathematical Days 2024. Aalto University, Finland, January 4, 2024.*
9. Quasi-Monte Carlo for Bayesian optimal experimental design problems governed by PDEs. In *Chemnitz Symposium on Inverse Problems 2023. University of Würzburg, Germany, November 9, 2023.*
10. Quasi-Monte Carlo methods for Bayesian optimal experimental design problems governed by PDEs. In *11th Applied Inverse Problems Conference. University of Göttingen, Germany, September 7, 2023.*
11. Quasi-Monte Carlo approach to Bayesian optimal experimental design. In *10th International Congress on Industrial and Applied Mathematics. Waseda University, Tokyo, Japan, August 25, 2023.*
12. On the periodic model of uncertainty quantification with application to inverse problems. In *14th International Conference on Monte Carlo Methods and Applications. Sorbonne University, France, June 28, 2023.*
13. Quasi-Monte Carlo for optimal control and optimal experimental design problems governed by PDEs. In *9th Workshop on High-Dimensional Approximation. Australian National University. Canberra, Australia, February 22, 2023.*
14. Quasi-Monte Carlo for Bayesian optimal experimental design. In *28th Inverse Days Workshop. University of Eastern Finland, Finland, December 14, 2022.*

15. Quasi-Monte Carlo methods for optimal control problems subject to parabolic PDE constraints under uncertainty. In *28th Nordic Congress of Mathematicians. Aalto University, Finland, August 19, 2022.*

16. Revisiting the dimension truncation error of parametric elliptic PDEs. In *15th International Conference on Monte Carlo and Quasi-Monte Carlo Methods in Scientific Computing. RICAM, Austria, July 18, 2022.*

17. Higher-order quasi-Monte Carlo rules for domain uncertainty quantification using periodic random variables. In *SIAM Conference on Uncertainty Quantification 2022. Atlanta, USA, April 13, 2022.*

18. Modeling domain uncertainty using periodic random variables with application to elliptic PDEs. In *SIAM Conference on Imaging Science 2022. Berlin, Germany, March 24, 2022.*

19. High-dimensional kernel interpolation over lattice point sets with application to uncertainty quantification. In *Finnish Mathematical Days 2022. Tampere University, Finland, January 4, 2022.*

20. Quasi-Monte Carlo methods for optimal control problems subject to time-dependent PDE constraints under uncertainty. In *27th Inverse Days Workshop. Tampere University, Finland, December 16, 2021.*

21. On least squares approximation in linear inverse statistical learning problems. In *13th International Conference on Monte Carlo Methods and Applications. University of Mannheim, Germany, August 20, 2021.*

22. Quasi-Monte Carlo methods and application to inverse problems. In *26th Inverse Days Workshop. Finnish Meteorological Institute/University of Helsinki, Finland, December 17, 2020.*

23. Uncertainty quantification using periodic random variables. In *ANZIAM 2020. Macquarie University, February 3, 2020.*

24. Uncertainty quantification for partial differential equations using periodic random variables. In *Finnish Mathematical Days 2020. University of Oulu, Finland, January 3, 2020.*

25. Uncertainty quantification for PDE-constrained optimal control problems using quasi-Monte Carlo methods. In *25th Inverse Days Workshop. University of Jyväskylä, Finland, December 17, 2019.*

26. An improved lower bound on Hong and Loewy's numbers. In *63rd Annual Meeting of the Australian Mathematical Society. Monash University, Australia, December 6, 2019.*

27. Quasi-Monte Carlo methods for uncertainty quantification using periodic random variables. In *Uncertainty Quantification Workshop. Australian National University, Australia, November 25, 2019.*

28. Higher order QMC rules for uncertainty quantification using periodic random variables. In *8th Workshop on High-Dimensional Approximation. ETH Zurich, Switzerland, September 10, 2019.*

29. Uncertainty quantification for stroke EIT imaging using sparse grids. In *24th Inverse Days Workshop. Aalto University, Finland, December 11, 2018.*

30. Stochastic collocation for electrical impedance tomography with applications to stroke imaging. In *Computational Techniques and Applications Conference 2018. Newcastle, Australia, November 28, 2018.*

31. Composite surrogate solution of the stochastic planar elasticity problem using sparse grids and measurements. In *SIAM Conference on Imaging Science 2018. Bologna, Italy, June 8, 2018.*

32. On Hong and Loewy's numbers and the Ilmonen–Haukkanen–Merikoski numbers. In *Finnish Mathematical Days 2018. University of Eastern Finland, Finland, January 4, 2018.*

33. Computation of extremal eigenvalues of high-dimensional lattice-theoretic tensors in tensor-train format. In *14th U.S. National Congress on Computational Mechanics. Montreal, Canada, July 19, 2017.*

34. On the structure and eigenvalues of lattice-theoretic meet and join tensors. In *XI Number Theory Days. University of Tampere, Finland, June 5, 2017.*

35. Stochastic modulus of a quadrilateral as a benchmark problem for uncertain domains. In *SIAM Conference on Uncertainty Quantification 2016. Lausanne, Switzerland, April 5, 2016.*
36. Stochastic modulus of a quadrilateral as a benchmark problem for uncertain domains. In *Finnish Mathematical Days 2016. University of Turku, Finland, January 7, 2016.*

Poster presentations
1. Domain uncertainty quantification using periodic random variables with application to elliptic PDEs. In *Bayes Comp 2023. Levi, Finland, March 15, 2023.*
2. Quasi-Monte Carlo methods for optimal control problems subject to parabolic PDE constraints under uncertainty. In *Symposium on Inverse Problems: From experimental data to models and back. University of Potsdam, September 19, 2022.*

Seminar and colloquium talks
1. Quasi-Monte Carlo methods for Bayesian inverse problems. In *Research Seminar Numerical Analysis and Stochastics. FU Berlin, June 19, 2025.*
2. Quasi-Monte Carlo for Bayesian inverse problems governed by PDEs. In *Research Seminar Numerical Analysis of Stochastic and Deterministic Partial Differential Equations. FU Berlin, June 12, 2025.*
3. Quasi-Monte Carlo for Bayesian inverse problems governed by PDEs. In *Optimization and Optimal Control Seminar. RICAM, March 4, 2025.*
4. Bayesian shape recovery using quasi-Monte Carlo. In *Oberseminar Numerik. Saarland University, December 18, 2024.*
5. High-dimensional kernel approximation of parametric PDEs over lattice point sets. In *Seminar in Numerical Analysis. University of Basel, April 14, 2023.*
6. Modeling domain uncertainty using periodic random variables with application to elliptic PDEs. In *Oberseminar Wissenschaftliches Rechnen. University of Würzburg, October 7, 2022.*
7. Fast kernel interpolation over lattice point sets with application to uncertainty quantification. In *Zurich Colloquium in Applied and Computational Mathematics. ETH Zurich, October 5, 2022.*
8. Quasi-Monte Carlo methods for domain uncertainty quantification using periodic random variables. In *Seminar on Computational Engineering. LUT University, August 17, 2022.*
9. QMC and kernel interpolation. In *Research Seminar Numerical Analysis of Stochastic and Deterministic Partial Differential Equations. FU Berlin, June 3, 2022.*
10. Modeling random domains using periodic random variables. In *Mathematical Optimization Research Seminar. University of Mannheim, October 14, 2021.*
11. Higher order quasi-Monte Carlo rules for uncertainty quantification using periodic random variables. In *Probability & Statistics Seminar. University of Mannheim, October 23, 2019.*
12. Higher order QMC rules for uncertainty quantification using periodic random variables. In *Seminar on Applied Mathematics. Aalto University, April 26, 2019.*
13. Higher order QMC rules for uncertainty quantification using periodic random variables. In *Computational Mathematics Seminar. University of New South Wales, April 2, 2019.*
14. On the structure and eigenvalues of lattice-theoretic tensors. In *Doctoral Student Talks Seminar. Aalto University, March 8, 2017.*
15. Eigenvalue problems for high order meet and join tensors. In *Seminar on Applied Mathematics. Aalto University, November 7, 2016.*
16. Stochastic modulus of a quadrilateral as a benchmark problem for uncertain domains. In *Seminar on Applied Mathematics. Aalto University, March 7, 2016.*

Submitted manuscripts
1. V. Kaarnioja and A. Zepernick. New upper and lower bounds on the smallest singular values of nonsingular lower triangular $(0,1)$-matrices. Preprint 2025. https://arxiv.org/abs/2503.14180

2. A. Djurdjevac, V. Kaarnioja, M. Orteu, and C. Schillings. Quasi-Monte Carlo for Bayesian shape inversion governed by the Poisson problem subject to Gevrey regular domain deformations. Preprint 2025. https://arxiv.org/abs/2502.14661

3. A. Djurdjevac, V. Kaarnioja, C. Schillings, and A. Zepernick. Uncertainty quantification for stationary and time-dependent PDEs subject to Gevrey regular random domain deformations. Preprint 2025. https://arxiv.org/abs/2502.12345

4. V. Kaarnioja, I. Klebanov, C. Schillings, and Y. Suzuki. Lattice rules meet kernel cubature. Preprint 2025. https://arxiv.org/abs/2501.09500

5. V. Kaarnioja and C. Schillings. Quasi-Monte Carlo for Bayesian design of experiment problems governed by parametric PDEs. Preprint 2024. https://arxiv.org/abs/2405.03529

Peer-reviewed publications

6. P. A. Guth and V. Kaarnioja. Quasi-Monte Carlo for partial differential equations with generalized Gaussian input uncertainty. Accepted for publication in *SIAM J. Numer. Anal.*, 2025. Preprint: https://arxiv.org/abs/2411.03793

7. L. Bazahica, V. Kaarnioja, and L. Roininen. Uncertainty quantification for electrical impedance tomography using quasi-Monte Carlo methods. *Inverse Problems*, 41:065002, 2025. https://doi.org/10.1088/1361-6420/add6d0

8. I. H. Sloan and V. Kaarnioja. Doubling the rate: improved error bounds for orthogonal projection with application to interpolation. *BIT Numer. Math.*, 65:10, 2025. https://doi.org/10.1007/s10543-024-01049-2

9. V. Kaarnioja. Explicit solutions of Genz test integrals. *Appl. Math. Lett.*, 163:109444, 2025. https://doi.org/10.1016/j.aml.2024.109444

10. V. Kaarnioja and A. Rupp. Quasi-Monte Carlo and discontinuous Galerkin. *Electron. Trans. Numer. Anal.*, 60:589–617, 2024. https://doi.org/10.1553/etna_vol60s589

11. V. Kaarnioja, F. Y. Kuo, and I. H. Sloan. Lattice-based kernel approximation and serendipitous weights for parametric PDEs in very high dimensions. In: Monte Carlo and Quasi-Monte Carlo Methods 2022, A. Hinrichs, P. Kritzer, F. Pillichshammer (eds.), Springer Verlag, pp. 81–103, 2024. https://doi.org/10.1007/978-3-031-59762-6_4

12. P. A. Guth and V. Kaarnioja. Application of dimension truncation error analysis to high-dimensional function approximation in uncertainty quantification. In: Monte Carlo and Quasi-Monte Carlo Methods 2022, A. Hinrichs, P. Kritzer, F. Pillichshammer (eds.), Springer Verlag, pp. 297–312, 2024. https://doi.org/10.1007/978-3-031-59762-6_14

13. P. A. Guth and V. Kaarnioja. Generalized dimension truncation error analysis for high-dimensional numerical integration: lognormal setting and beyond. *SIAM J. Numer. Anal.*, 62(2):872–892, 2024. https://doi.org/10.1137/23M1593188

14. P. A. Guth, V. Kaarnioja, F. Y. Kuo, C. Schillings, and I. H. Sloan. Parabolic PDE-constrained optimal control under uncertainty with entropic risk measure using quasi-Monte Carlo integration. *Numer. Math.*, 156:565–608, 2024. https://doi.org/10.1007/s00211-024-01397-9

15. H. Hakula, H. Harbrecht, V. Kaarnioja, F. Y. Kuo, and I. H. Sloan. Uncertainty quantification for random domains using periodic random variables. *Numer. Math.*, 156:273–317, 2024. https://doi.org/10.1007/s00211-023-01392-6

16. V. Kaarnioja, Y. Kazashi, F. Y. Kuo, F. Nobile, and I. H. Sloan. Fast approximation by periodic kernel-based lattice-point interpolation with application in uncertainty quantification. *Numer. Math.*, 150:33–77, 2022. https://doi.org/10.1007/s00211-021-01242-3

17. P. A. Guth, V. Kaarnioja, F. Y. Kuo, C. Schillings, and I. H. Sloan. A quasi-Monte Carlo method for optimal control under uncertainty. *SIAM/ASA J. Uncertain. Quantif.*, 9(2):354–383, 2021. https://doi.org/10.1137/19M1294952

18. V. Kaarnioja. Bounds on the spectrum of nonsingular triangular (0,1)-matrices. *J. Combin. Theory Ser. A*, 178:105353, 2021. https://doi.org/10.1016/j.jcta.2020.105353

19. V. Kaarnioja, F. Y. Kuo, and I. H. Sloan. Uncertainty quantification using periodic random variables. *SIAM J. Numer. Anal.*, 58(2):1068–1091, 2020. https://doi.org/10.1137/19M1262796

20. H. Hakula, V. Kaarnioja, and M. Laaksonen. Cylindrical shell with junctions: uncertainty quantification of free vibration and frequency response analysis. *Shock and Vibration,* vol. 2018, Article ID 5817940, 16 pp., 2018. https://doi.org/10.1155/2018/5817940

21. P. Ilmonen and V. Kaarnioja. Generalized eigenvalue problems for meet and join matrices on semilattices. *Linear Algebra Appl.*, 536:250–273, 2018. https://doi.org/10.1016/j.laa.2017.09.023

22. N. Hyvönen, V. Kaarnioja, L. Mustonen, and S. Staboulis. Polynomial collocation for handling an inaccurately known measurement configuration in electrical impedance tomography. *SIAM J. Appl. Math.*, 77(1):202–223, 2017. https://doi.org/10.1137/16M1068888

23. H. Hakula, V. Kaarnioja, and M. Laaksonen. Approximate methods for stochastic eigenvalue problems. *Appl. Math. Comput.*, 267:664–681, 2015. https://doi.org/10.1016/j.amc.2014.12.112

Theses

V. Kaarnioja. On sparse tensor structures in lattice theory and applications of the polynomial collocation method based on sparse grids. Doctoral dissertation, Aalto University, 2017. https://urn.fi/URN:ISBN:978-952-60-7519-8

V. Kaarnioja. Smolyak quadrature. Master's thesis, University of Helsinki, 2013. https://hdl.handle.net/10138/40159