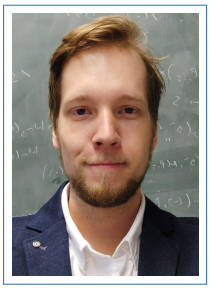

Ricardo Buring

Curriculum Vitae

Personal details

Full name	Ricardo Thomas Buring
E-Mail	ricardo.buring@gmail.com
Website	https://www.rburing.nl
GitHub	https://github.com/rburing
Nationality	Dutch

Experience

Software engineering

2025 – now **Project manager and software engineer**, *LIX, École polytechnique and CNRS*, France
Developing high-performance software libraries to support solving ordinary differential equations.
Member of the MAX team, working on the ODELIX project led by Joris van der Hoeven.

Research

2023 – 2025 **Postdoctoral researcher**, *Inria Saclay*, France
Developing efficient symbolic-numeric methods for the analytic continuation of D-finite functions.
Member of the MATHEXP team, working on the 10000 DIGITS project led by Pierre Lairez.

Teaching

2024 – now **Teaching assistant**, *École polytechnique*, France
2025/26: CSC_2F001_EP: Object-oriented Programming in C++ (computer science).
2024/25: CSC_2F001_EP: Object-oriented Programming in C++ (computer science).
2024: INF371: Mécanismes de la programmation orientée-objet (computer science).

2017 – 2021 **Teaching assistant**, *Johannes Gutenberg-Universität Mainz*, Germany
Sommersemester 2021: Computeralgebra (mathematics).
Wintersemester 2020/21: Geometrie, Algebra, und Zahlentheorie (mathematics).
Sommersemester 2020: Computeralgebra (mathematics).
Sommersemester 2019: Computeralgebra (mathematics).
Wintersemester 2018/19: Diskrete Mathematik für Informatiker (mathematics, first year).
Sommersemester 2018: Computeralgebra (mathematics).
Wintersemester 2017/18: Diskrete Mathematik für Informatiker (mathematics, first year).

2013 – 2021 **Teaching assistant**, *University of Groningen*, The Netherlands
2020 – 2021: Deformation quantization, graph complex, and number theory (mathematics, Mastermath).
2016 – 2017: Geometry & Differential Equations (mathematics, masters course).
2014 – 2015: Propaedeutic project (mathematics, first year).
2013 – 2014: Propaedeutic project (mathematics, first year).

2014 – 2015 **Mentor**, *University of Groningen*, The Netherlands
Mentoring a group of first year mathematics students.

2013 – 2019 **Private tutor** (freelance), The Netherlands and Germany
Teaching mathematics to students individually and in small groups.
2017 – 2019 at Johannes Gutenberg-Universität Mainz: discrete mathematics, computer algebra.
2013 – 2017 at University of Groningen: group theory, analysis on manifolds.

Software development

2018 – 2024 **Freelance software developer**, as *rburing* (KvK-nummer: 72761415), The Netherlands
Developing various software, including mobile web applications.

2022 – 2023 **Consultant for Godot Engine**, via *Software Freedom Conservancy, Inc.*, remote position
Work package on Godot Physics, to triage and fix physics bugs and improve cylinder shape support.

2010 – now **Volunteer contributor**, *various open source software projects*, remote position
FLINT (Fast Library for Number Theory), SageMath (the Sage Mathematics Software System), Godot Engine (game engine), and others.

Education

2017 – 2022 **Ph.D. in Mathematics**, *Johannes Gutenberg-Universität Mainz*, Germany
Dissertation: *The action of Kontsevich's graph complex on Poisson structures and star products: an implementation*.
Supervisors: Dr. A.V. Kiselev (Groningen), Prof. dr. D. van Straten (Mainz).
Grade: summa cum laude.

2013 – 2017 **Master of Science in Mathematics**, *University of Groningen*, The Netherlands
Thesis: *Kontsevich graphs and their weights in deformation quantization of Poisson structures*.
Supervisor: Dr. A.V. Kiselev.

2010 – 2013 **Bachelor of Science in Mathematics**, *University of Groningen*, The Netherlands
Thesis: *An explicit algebro-geometric proof of Poncelet's closure theorem*.
Supervisor: Prof. dr. J. Top.

2009 – 2010 **Propedeuse in Computer Science**, *Hanzehogeschool Groningen*, The Netherlands

2004 – 2009 **Higher General Secondary Education** (HAVO), *Zernike College*, The Netherlands

Other academic activities

January 27 – 31, 2025 **2025 FLINT development workshop**, *École polytechnique*, Palaiseau
Workshop for the development of FLINT: Fast Library for Number Theory.
Co-organized with Fredrik Johansson, Pierre Lairez and Marc Mezzarobba.

2014 – 2016 **Mathematics Programme Committee**, *University of Groningen*, The Netherlands
Served as a student member 2014 – 2015, and as student chairman 2015 – 2016.
Co-organized the *Mathematics Pizza Meeting on Motivation*, with $\approx$ 40 attendees.

2014 – 2015 **Mathematics Alumni Day Committee**, *FMF study association*, The Netherlands
Organized the *Mathematics Alumni Day 2015* at the University of Groningen.

Software

2025 – now **seaofpoisson.github.io** `https://github.com/seaofpoisson/seaofpoisson.github.io`
Database of universal deformations of Poisson structures obtained from graph cohomology classes. Written in the Rust programming language, using TOML configuration files and minijinja templates.

2024 – now **expand-n-contract** `https://gitlab.inria.fr/ricardo-thomas.buring/expand-n-contract`
Fast implementation of an expansion-contraction algorithm to obtain a representative of a wheel cocycle in the graph complex. Written in the Rust programming language.

2023 – 2025 **d-finite-fun** `https://gitlab.inria.fr/ricardo-thomas.buring/d-finite-fun`
Implementations of Newton iteration and divide-and-conquer to solve first-order systems of linear ordinary differential equations with polynomial coefficients. These can also be used for higher-order scalar linear ordinary differential equations with polynomial coefficients. Implemented using the generic rings interface offered by FLINT: Fast Library for Number Theory.

2020 – 2025 **gcaops:** *Graph Complex Action on Poisson Structures* `https://github.com/rburing/gcaops`
SageMath package implementing the action of Kontsevich's graph complex on Poisson structures and star products. Developed during my Ph.D. and used to obtain computational results therein.

2020 – 2025 **Godot Engine** `https://godotengine.org`

Contributor to Godot Engine (free and open source game engine) and member of the physics team:
- finalized the feature that allows custom physics engine integration via GDExtension,
- ported 2D & 3D fixed-timestep interpolation ("physics interpolation") from Godot 3 to Godot 4,
- fixed many bugs and improved documentation (mostly related to physics).

Merged pull requests (99):
`https://github.com/godotengine/godot/pulls?q=is%3Apr+author%3Arburing+is%3Amerged`

2016 – 2019 **kontsevich_graph_series-cpp** `https://github.com/rburing/kontsevich_graph_series-cpp`

Library for manipulation of Kontsevich graphs and sums and series of them (in C++11). Developed during my master's thesis and used to obtain computational results therein.

Awards and honors

August 21, 2023 **Winner of the game jam *"Do you WANNA Jam?! 2023"***

In a competition to make a video game with the theme "Freeze" within nine days (August 5–14), `https://itch.io/jam/do-you-wanna-jam-2023`, my team's entry *Frozen Leftovers* ranked first out of 80. This was a joint work with Azka C. (art) and Trash Tier Games (music, additional programming). As the lead programmer I implemented a rule-based dialogue system among other things.

January 12, 2023 **Dissertation prize for the year 2023**, *Johannes Gutenberg-Universität Mainz*, Germany

Dissertation prize for the year 2023 for the faculty of Physics, Mathematics and Computer Science. Awarded to my Ph.D. dissertation *The action of Kontsevich's graph complex on Poisson structures and star products: an implementation*, supervised by Dr. A.V. Kiselev and Prof. dr. D. van Straten.

September 22 – 27, 2019 **7th Heidelberg Laureate Forum**, *Heidelberg*, Germany

Selected as one of 200 young researchers to participate, and as one of 10 to be interviewed.
Interview (online): *From diagrams to formulas via computers – Ricardo Buring loves teaching math*.

Talks and posters

July 7 – 11, 2025 **The XXIX International Conference on Integrable Systems and Quantum Symmetries (ISQS29)**, Prague, Czech Republic

Talk title: *The sea of Poisson Structures and its Graph Complex flows: a new online database*.

March 10, 2025 **Journées nationales de calcul formel (JNCF) 2025**,
Centre international de rencontres mathématiques (CIRM), Luminy, Marseille, France

Talk title: *Graph cohomology classes by successive approximation*.

July 1 – 5, 2024 **The XXVIII International Conference on Integrable Systems and Quantum Symmetries (ISQS28)**, Prague, Czech Republic

Talk title: *Efficient computation of graph cohomology and its action on Poisson brackets*.

November 15 – 17, 2023 **Combinatorics and Arithmetic for Physics: special days**, IHÉS, France

Talk title: *Graph complex action on Poisson structures: from theory to computation*.

July 18 – 22, 2022 **The 34th International Colloquium on Group Theoretical Methods in Physics**,
Strasbourg University, France

Talk title: *How Kontsevich's (affine) star product is associative up to order 6 (respectively 7)*.

June 5 – 10, 2022 **Poisson Geometry, Lie Groupoids and Differentiable Stacks**,
Banff International Research Station, Banff, Canada

Organized by Rui Loja Fernandes, Henrique Bursztyn, Brent Pym, Jiang-Hua Lu.
Poster title: *On the associativity of Kontsevich's (affine) star product up to order 7*.

July 1 – 3, 2019 **GQT Graduate School**, Den Dolder, The Netherlands

Organized by the Geometry and Quantum Theory (GQT) cluster.
Talk title: *Factorization problems in deformation quantization and Poisson bracket deformations*.

May 15, 2019 **Informal Seminar on Mathematical Aspects of Scattering Amplitudes**,
Johannes Gutenberg-Universität Mainz, Germany
Talk title: *A path integral approach to Kontsevich's quantization formula*.

February 1 – 3, 2019 **Ph.D. meeting Sonderforschungsbereich/Transregio 45**,
Universität Duisburg-Essen, Germany
Talk title: *Why graph cocycles yield deformations of Poisson structures*.

January 9, 2019 **Informal Seminar on Mathematical Aspects of Scattering Amplitudes**,
Johannes Gutenberg-Universität Mainz, Germany
Talk title: *Introduction to deformation quantization*.

December 22 – 23, 2018 **Symmetry and Integrability of Equations of Mathematical Physics**,
Institute of Mathematics of NAS of Ukraine, Kyiv, Ukraine
Organized by the Department of Mathematical Physics.
Talk title: *Tetrahedral symmetry of the Jacobi identity for Poisson structures*.

December 12, 2018 **Working group on Grothendieck-Teichmüller groups**,
Max-Planck-Institut für Mathematik (MPIM), Bonn, Germany
Talk title: *Isomorphism between* $\mathfrak{grt}$ *and the degree 0 cohomology of the graph complex*.

September 16 – 22, 2018 **Homotopy algebras, deformation theory and quantization**, Będlewo, Poland
Conference supported by Banach Center, Université du Luxembourg and Institute of Mathematics of the Polish Academy of Sciences.
Poster title: *Deformation quantization: expansion* $\star$ *mod* $\bar{o}(\hbar^4)$ *via graphs*.

July 9 – 13, 2018 **The 32nd International Colloquium on Group Theoretical Methods in Physics**,
Prague, Czech Republic
Organized by the Czech Technical University in Prague.
Talk title: *The orientation morphism: from graph cocycles to deformations of Poisson structures*.

March 25 – 31, 2018 **Enumerative Invariants from Differential Graded Lie Algebras and Categories**,
Montegufoni, Italy
Spring School organized by Helge Ruddat (Johannes Gutenberg-Universität Mainz, Germany).
Talk title: *Feynman diagrams and Kontsevich graphs*.

January 26 – 29, 2018 **Ph.D. meeting Sonderforschungsbereich/Transregio 45**,
Physikzentrum Bad Honnef, Germany
Talk title: *Deformations of Poisson structures via graphs*.

July 3 – 7, 2017 **GQT Graduate School**, Den Dolder, The Netherlands
Organized by the Geometry and Quantum Theory (GQT) cluster.
Talk title: *The Kontsevich graph calculus in deformation quantization of Poisson structures*.

May 3, 2017 **Junior Geometry and Topology seminar**, Oxford, United Kingdom
Organized by the Mathematical Institute of the University of Oxford.
Talk title: *Integrating without integrating: weights of Kontsevich graphs*.

April 7, 2017 **Intercity Number Theory Seminar**, Groningen, The Netherlands
Organized by the Dutch mathematics cluster DIAMANT.
Talk title: *Relations among Kontsevich graph weight integrals*.

October 19 – 21, 2016 **Symposium on Advances in Semi-Classical Methods in Mathematics and Physics**,
Groningen, The Netherlands
Organized by the Johann Bernoulli Institute for Mathematics and Computer Science (JBI) and the Van Swinderen Institute for Particle Physics and Gravity (VSI) of the University of Groningen.
Talk title: *The Hunting of the Star-product*.

June 12 – 17, 2016 **Group Analysis of Differential Equations and Integrable Systems**, Larnaca, Cyprus
Workshop organized by the Department of Mathematics and Statistics of the University of Cyprus and the Department of Applied Research of the Institute of Mathematics of the NAS of Ukraine.
Talk title: *The explicit associativity mechanism for Kontsevich's* $\star$*-product up to orders 3 and 4*.

August 3 – 7, 2015 **Symmetries of Discrete Systems and Processes III**, Děčín, Czech Republic
Conference organized by the Czech Technical University in Prague.
Talk title: *Deformation quantization of variational Poisson structures: examples*.

Schools attended

October 7 – 11, 2019 **Deformations and Rigidity in Algebra, Geometry and Analysis**, Würzburg, Germany
Organized by the Institute of Mathematics at the Julius Maximilian University Würzburg.
Courses taken:
- *Deformations of Poisson structures* by I. Marcut,
- *Deformation Quantization and Symmetries* by S. Gutt,
- *The Yang-Baxter equation, operator algebras, and braid group characters* by G. Lechner,
- *An Introduction to Noncommutative Topology* by F. Arici,
- *Noncommutative Geometry and Differential Calculus* by B. Tsygan.

July 1 – 3, 2019 **GQT Graduate School**, Den Dolder, The Netherlands
Organized by the Geometry and Quantum Theory (GQT) cluster.
Courses taken:
- *D-modules on Riemann surfaces* by C. Lazda,
- *Curves, jacobians and the double ramification cycle* by D. Holmes,
- *The stable module category* by S. Sagave.

September 16 – 22, 2018 **Homotopy algebras, deformation theory and quantization**, Będlewo, Poland
Conference supported by Banach Center, Université du Luxembourg and Institute of Mathematics of the Polish Academy of Sciences.
Courses taken:
- *Derived representation schemes and supersymmetric gauge theory* by G. Felder,
- *Deformation theory and group actions* by S. Gutt,
- *Graph complexes in algebra and geometry - recent advances* by S. Merkulov,
- *Dg manifolds, formality theorem and Kontsevich-Shoikhet conjecture* by P. Xu.

March 25 – 31, 2018 **Enumerative Invariants from Differential Graded Lie Algebras and Categories**, Montegufoni, Italy
Spring School organized by Helge Ruddat (Johannes Gutenberg-Universität Mainz, Germany).

July 3 – 7, 2017 **GQT Graduate School**, Den Dolder, The Netherlands
Organized by the Geometry and Quantum Theory (GQT) cluster.
Courses taken:
- *Topological field theories* by A. Ros Camacho,
- *Knot invariants* by R. van der Veen,
- *Derived categories in algebraic geometry* by M. Shen.

November 28 – 30, 2016 **GQT Graduate School**, Den Dolder, The Netherlands
Organized by the Geometry and Quantum Theory (GQT) cluster.
Courses taken:
- *Toric varieties and equivariant vector bundles* by M. Kool,
- *Noncommutative geometry and gauge theories* by W. van Suijlekom & F. Arici,
- *Modular forms* by G. van der Geer.

September 8 – 12, 2014 **The 3rd Summer School on Geometry of Differential Equations**, Malenovice, CZ
Organized by the Mathematical Institute of Silesian University in Opava.
Courses taken:
- *Differential Invariants* by V.V. Lychagin,
- *Riemann Surfaces and Soliton Equations* by A.E. Mironov.

Languages

English Fluent.

German	C1 level.
French	A2/B1 level.
Dutch	Native.

Computer skills

OS	Linux (various distributions), FreeBSD, Windows.
Programming	Rust, Python, Julia, C++, C, SQL, PHP, JavaScript, Google Apps Script.
Databases	PostgreSQL, MySQL, SQLite, Neo4j.
Scientific	SageMath, Maple, Mathematica, MATLAB, Excel.
Revision ctrl.	Git.
Web design	HTML, CSS, JavaScript, jQuery, React.
Web dev.	Django, PHP, Node.js.
Game dev.	Godot Engine, Unreal Engine.
Video editing	Kdenlive, ffmpeg.
Typesetting	LaTeX.
2D Graphics	Krita, GIMP.
3D Graphics	Blender.

List of publications

Publications

[1] A. Bouisaghouane, R. Buring, and A.V. Kiselev. The Kontsevich tetrahedral flow revisited. *J. Geom. Phys.*, 119:272–285, 2017. Preprint `arXiv:1608.01710` [q-alg] — 29 p.

[2] R. Buring and A. V. Kiselev. Universal cocycles and the graph complex action on homogeneous Poisson brackets by diffeomorphisms. *Physics of Particles and Nuclei Letters*, 17(5):707–713, 2020. Supersymmetry and Quantum Symmetries 2019. Preprint `arXiv:1912.12664` [math.SG] — 8 p.

[3] R. Buring, A. V. Kiselev, and N. J. Rutten. The heptagon-wheel cocycle in the Kontsevich graph complex. *J. Nonlin. Math. Phys.*, 24:157–173, 2017. Suppl. 1 'Local & Nonlocal Symmetries in Mathematical Physics'. Preprint `arXiv:1710.00658` [math.CO] — 17 p.

[4] R. Buring, A. V. Kiselev, and N. J. Rutten. Poisson brackets symmetry from the pentagon-wheel cocycle in the graph complex. *Physics of Particles and Nuclei*, 49(5):924–928, 2018. Supersymmetry and Quantum Symmetries 2017. Preprint `arXiv:1712.05259` [math-ph] — 4 p.

[5] R. Buring and A.V. Kiselev. The expansion $\star$ mod $\bar{o}(\hbar^4)$ and computer-assisted proof schemes in the Kontsevich deformation quantization. *Experimental Math.*, 31(3):701–754, 2022. Preprint `arXiv:1702.00681` [math.CO] — 77 p.

[6] R. Buring and A.V. Kiselev. Kontsevich's star-product up to order 7 for affine Poisson brackets: where are the Riemann zeta values? *Open Commun. Nonlinear Math. Phys.*, 10:190–233, 2024. Preprint `arXiv:2209.14438` [math.QA] — 44 p.

[7] R. Buring, D. Lipper, and A.V. Kiselev. The hidden symmetry of Kontsevich's graph flows on the spaces of Nambu-determinant Poisson brackets. *Open Commun. Nonlinear Math. Phys.*, 2:186–215, 2022. Preprint `arXiv:2112.03897` [math.SG] — 27+iii p.

[8] A.V. Kiselev and R. Buring. The Kontsevich graph orientation morphism revisited. *Banach Center Publications*, 123:123–139, 2021. Preprint `arXiv:1904.13293` [math.CO] — 18 p.

[9] Buring R. and A.V. Kiselev. Associativity certificates for Kontsevich's star-product $\star$ mod $\bar{o}(\hbar^k)$: $k \leqslant 6$ unlike $k = 7$. *J. Phys.: Conf. Ser.*, 2667, 2023. Paper 012080, 8 p. Preprint `arXiv:2309.16664` [math.QA] — 8 p.

Preprints

[10] R. Buring. Graph cohomology classes by successive approximation, 2025. *Work in progress.* `https://www.rburing.nl/expand-n-contract/expand-n-contract.pdf`.

Conference proceedings

[11] R. Buring, A. V. Kiselev, and N. J. Rutten. Infinitesimal deformations of Poisson bi-vectors using the Kontsevich graph calculus. *J. Phys.: Conf. Ser.*, 965, 2018. Proc. XXV Int. conf. 'Integrable Systems & Quantum Symmetries' (6–10 June 2017, CVUT Prague, Czech Republic), 012010. Preprint `arXiv:1710.02405` [math.CO] — 12 p.

[12] R. Buring and A.V. Kiselev. The table of weights for graphs with ≤ 3 internal vertices in Kontsevich's deformation quantization formula. (3rd International workshop on symmetries of discrete systems & processes, 3–7 August 2015, CVUT Děčín, Czech Republic) — 3 p.

[13] R. Buring and A.V. Kiselev. On the Kontsevich $\star$-product associativity mechanism. *Physics of Particles and Nuclei Letters*, 14(2):403–407, 2017. Preprint `arXiv:1602.09036` [q-alg] — 4 p.

[14] R. Buring and A.V. Kiselev. Formality morphism as the mechanism of $\star$-product associativity: how it works. 2019. (Symmetries & integrability of equations of mathematical physics, 22–24 December 2018, IM NASU Kiev, Ukraine) Preprint `arXiv:1907.00639` [math.QA] — 16 p.

[15] R. Buring and A.V. Kiselev. The orientation morphism: from graph cocycles to deformations of Poisson structures. *J. Phys.: Conf. Ser.*, 1194, Paper 012017:1–10, 2019. (The 32nd International Colloquium on Group Theoretical Methods in Physics, 9–13 July 2018, CVUT Prague, Czech Republic) Preprint `arXiv:1811.07878` [math.CO] — 12 p.

[16] R. Buring and A.V. Kiselev. The tower of Kontsevich deformations for Nambu-Poisson structures on $\mathbb{R}^d$: dimension-specific micro-graph calculus. *SciPost Phys. Proc.*, 14, 020, 2023. (The 34th International Colloquium on Group Theoretical Methods in Physics, 18–22 July 2023, Strasbourg) Preprint `arXiv:2212.08063` [math.CO] — 11 p.

Theses and dissertation

[17] R. Buring. An explicit algebro-geometric proof of Poncelet's closure theorem. Bachelor's thesis, University of Groningen, 2013 — 36 p.

[18] R. Buring. Kontsevich graphs and their weights in deformation quantization of Poisson structures. Master's thesis, University of Groningen, 2017 — 100 p.

[19] R. Buring. The action of Kontsevich's graph complex on Poisson structures and star products: an implementation. Ph.D. dissertation, Johannes Gutenberg–Universität Mainz, 2022 — 660 p.

Date: September 30, 2025.