Nicky J. van den Berg

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PROFILE

I am a Ph.D. candidate in Mathematics who specializes in geometric image processing. My research focuses on automatic identification and tracking of vessels in images of the retina. Using mathematical techniques such as lifting the image to the space of positions and orientations (creating a 3D image out of a 2D image, based on the local orientations in the 2D image) and data-driven Cartan connections (also taking into account local orientation data), I was able to improve the existing models to follow the vessels. These models are important in preventing complications, such as blindness, in diabetic patients, among others. I have learned to work together with and combine the work of different researchers, both mathematicians and other scientists. My personal goal is to use image processing techniques to improve the quality of life.

EXPERIENCE

PhD Candidate, Eindhoven University of Technology (TU/e) *11 - 2021 – present*
Title Thesis: *Geometric Tracking and Grouping of Complex Vasculatures in Medical Images.*
Supervision: Remco Duits, Olga Mula, Tos Berendschot
Financed by the NWO Talent Programme VICI 2020 Exact Sciences (Duits, Geometric Learning for Image Analysis, VI.C 202–031).

Visiting Researcher, Emory *10 - 2024 – 10 - 2024*
Host: Lars Ruthotto
Financed by the EU REMODEL program (MSCA-SE 101131557).

Teaching Assistant, TU/e *09 - 2015 – 08 - 2021*
Supervising tutorials for students from various programs (group size between 8 and 120 students) and correcting homework exercises.

Student Mentor, TU/e *09 - 2015 – 02 - 2017*
Guiding freshmen in the transition to university.

EDUCATION

Eindhoven University of Technology (TU/e) *04 - 2018 – 07 - 2021*
Master Industrial and Applied Mathematics cum laude
Master Thesis: *Improved Computational Schemes for Geodesic Vessel Tracking in Orientation Scores*
Supervision: Remco Duits, Bart M.N. Smets

University of Western Ontario (UWO) *02 - 2020 – 06 - 2020*
Research Internship
Title Research Report: *The Blood Coagulation Process: A Mathematical Model*
Supervision: Mikko Karttunen, Barry Koren

Eindhoven University of Technology (TU/e) *09 - 2014 – 03 - 2018*
Bachelor Applied Mathematics with courses from Psychology & Technology
Bachelor Thesis: *Disease Dynamics in the Framework of Interacting Particle Systems: The Position Dependent SIS-model*
Supervision: Oliver Tse

Provinciale Secundaire School Voeren (PSS Voeren); High School *09 - 2008 – 06 - 2014*
Modern Languages - Science
Extra-curricular courses in mathematics and science (physics and chemistry)

ADDITIONAL WORK

Technical Author, Numworx *12 - 2019 – 06 - 2020*
Developing mathematics exercises at a high school and college level for a digital mathematics platform.

EXTRA-CURRICULAR ACTIVITIES

Founder and Board Member, Stichting Ada Alumni *04 - 2022 – present*
Founding a foundation for the Mathematics and Computer Science department alumni at TU/e and organizing activities for this audience.
Functions: Secretary (*04 - 2022 – 10 - 2022*), Treasurer (*10 - 2023 – present*).

Committee Member, E.P.A. Nexus (PhD association) *04 - 2023 – 11 - 2024*
Representation Committee (*04 - 2023 – 11 - 2024*)
Cash Control Committee (*11 - 2023 – 11 - 2024*)

Student Member Program Committee Mathematics, TU/e *09 - 2015 – 04 - 2021*
Checking the quality of education (in co-determination). Representing the program committee in various general meetings, accreditations, and the ITK (quality assurance institutional assessment, see website NVAO).

Student Member Department Counsil, TU/e *01 - 2018 – 12 - 2019*
Advising the department board.
Focusing on communication, well-being, and education.

Secretary, Study association GEWIS *07 - 2017 – 06 - 2018*
Responsible for the well-being of the association during the academic year 2017-2018.
Responsible for the member administration, minutes of board and general meetings, and all mail.

Various Committees, Study association GEWIS *09 - 2014 – 10 - 2021*
Including developing a multi-annual vision, corporate identity, revision of the bylaws and internal regulations, etc.

Activities in High School, PSS Voeren *09 - 2012 – 06 - 2014*
Chair and member of the student council.
Member of the school council.

OTHER ACTIVITIES

Organization of CASA outing, TU/e *05 - 2025 – 06 - 2025*
Organization of a day for the cluster consisting of a small activity, two museum visits, and lunch and dinner.

PROOF - PhD Development Sounding Board, TU/e *09 - 2023 – present*
Improving the experience and offer of PROOF-courses for PhD candidates.

Panel Discussion Research Day, TU/e *06 - 2023 – 06 - 2023*
On the impact of research.

Organization of CASA day, TU/e *06 - 2022 – 05 - 2023*
Organization of a day for the cluster where ongoing research is discussed, combined with a skill-session (e.g. workshop presenting skills, or a relevant lecture).

Curriculum Committee, TU/e *02 - 2022 – 07 - 2022*
Giving feedback on the newly developed curriculum for the bachelor Applied Mathematics.

Research Assessment, TU/e *03 - 2022 – 03 - 2022*
Part of the PhD candidate representation during interviews with the panel.

TEACHING

Tutor/teaching assistant for the following courses:

Numerical Linear Algebra *2024 – 2024*
Applied Mathematics students

Complex Analysis *2022 – 2024*
Applied Mathematics students

Calculus *2022 – 2024*
Built Environment students

Mathematics 1 *2018 – 2021*
Electrical Engineering and Industrial Engineering students

Calculus *2017 – 2019*
Applied Physics students

Data Analytics for Engineers *2017 – 2018*
Electrical Engineering, Applied Mathematics, and Psychology & Technology students

Introduction to Modeling: From Problems to Numbers and Back *2016 – 2017*
Psychology & Technology students

Calculus *2015 – 2017*
Mechanical Engineering, and Medical Sciences & Technology students

SUPERVISION

Bachelor Project, Franciska Asma *02 - 2024 – 11 - 2024*
Title Thesis: *Curvature Estimation and Adaptation for Chip Components Segmentation in SEM Images*

Graduation Project, Leanne Vis *09 - 2023 – 07 - 2024*
Title Thesis: *Automatic Edge-detection and Grouping of Possibly Overlapping Components in SEM Images of Silicon Wafers*

Modeling Week Project *11 - 2023 – 11 - 2023*
Title Report: *Geodesic Tracking of Blood Vessels in Wide-Field Retinal Images* (in SO(3))

Research Topic, Leanne Vis *03 - 2023 – 06 - 2023*
Title Research Report: *Connected Components*

Research Internship, Romain Dugast *04 - 2022 – 08 - 2022*
Title Research Report: *Geometric Tracking in SE(2) and PDE-G-CNNs for the Classification of Arteries and Veins*

PRESENTATIONS

Real World Applications of Geometry and Algebra (RAGA) 2025, Eindhoven University of Technology *27 - 05 - 2025*
Title: *Geodesic Tracking of Vascular Trees in Retinal Images*

CASA Day, Eindhoven University of Technology *16 - 04 - 2025*
Title: *Geodesic Tracking on Retinal Images*

Opthalmology Seminar, Maastricht University *14 - 03 - 2025*
Title: *Image Analysis on Retinal Images*

Algebra Seminar, Georgia Tech *07 - 10 - 2024*
Title: *Lie Groups and Applications to Multi-Orientation Image Analysis*

Research Talk, Emory *01 - 10 - 2024*
Title: *Lie Groups and Applications to Multi-Orientation Image Analysis*

Geometry and Machine Learning, Conference *19 - 06 - 2024*
Title: *Geodesic Tracking via Data-Driven Geometry for Vascular Tree Tracking*

Opthalmology Seminar, Maastricht University *31 - 03 - 2023*
Title: *Geodesic Tracking of Retinal Vascular Trees with Optical and TV-Flow Enhancement in the Lifted Space of Positions and Orientations SE(2)*

CASA Day, Evoluon *13 - 04 - 2022*
Title: *Geodesic Tracking via New Data-Driven Cartan Connections for Vascular Tree Tracking*

POSTERS

Crossing-Preserving Geodesic Tracking on Spherical Images, SSVM 2025 *05 - 2025*
Geodesic Tracking of Retinal Vascular Trees with Optical and TV-Flow Enhancement in SE(2), NMC 2024 *04 - 2024*
Geodesic Tracking of Retinal Vascular Trees with Optical and TV-Flow Enhancement in SE(2), SSVM 2023, CASA day 2024 *05 - 2023*, *11 - 2023*

PUBLICATIONS

van den Berg, N.J., Vis, L., Mula, O., Duits, R. (submitted). Connected Components on Lie Groups and Applications to Multi-Orientation Image Analysis. `https://arxiv.org/abs/2409.18002`

García-Castellanos, A., Wessels, D.R., **van den Berg, N.J.**, Duits, R., Pelt, D.M., Bekkers, E.J. (submitted). Equivariant Eikonal Neural Networks: Grid-Free, Scalable Travel-Time Prediction on Homogeneous Spaces. `https://arxiv.org/abs/2505.16035`

van den Berg, N.J., Sherry, F.M., Berendschot, T.T.J.M., Duits, R. (2025). Crossing-Preserving Geodesic Tracking on Spherical Images. In: Bubba, T.A., Gaburro, R., Gazzola, S., Papafitsoros, K., Pereyra, M., Schönlieb, CB. (eds) Scale Space and Variational Methods in Computer Vision. SSVM 2025. Lecture Notes in Computer Science, vol 15668. Springer, Cham. `https://doi.org/10.1007/978-3-031-92369-2_15`

van den Berg, N.J., Smets, B.M.N., Pai, G., Mirebeau, J.-M., Duits, R. Geodesic Tracking via New Data-Driven Connections of Cartan Type for Vascular Tree Tracking. J Math Imaging Vis (2024). `https://doi.org/10.1007/s10851-023-01170-x`

van den Berg, N.J., Zhang, S., Smets, B.M.N., Berendschot, T.T.J.M., Duits, R. (2023). Geodesic Tracking of Retinal Vascular Trees with Optical and TV-Flow Enhancement in SE(2). In: Calatroni, L., Donatelli, M., Morigi, S., Prato, M., Santacesaria, M. (eds) Scale Space and Variational Methods in Computer Vision. SSVM 2023. Lecture Notes in Computer Science, vol 14009. Springer, Cham. `https://doi.org/10.1007/978-3-031-31975-4_40`

Kompanets, A., Duits, R., Leonetti, D., **van den Berg, N.**, Snijder, H.H. (2024). Segmentation Tool for Images of Cracks. In: Skatulla, S., Beushausen, H. (eds) Advances in Information Technology in Civil and Building Engineering. ICCCBE 2022. Lecture Notes in Civil Engineering, vol 357. Springer, Cham. `https://doi.org/10.1007/978-3-031-35399-4_8`

SKILLS

Programming Languages and Frameworks Python, Mathematica, MATLAB, LaTeX
Languages Dutch (native), English (fluent), French (intermediate), German (intermediate)