

Faculty of Science and Engineering

Profile report: Computational Mathematics (Computationele Wiskunde)

- Discipline: Mathematics

- Level: tenure-track Assistant professor/Associate professor/Full professor

- Fte: Full time (1.0)

1. Scientific discipline

Computation in research, such as material science, is prominent. Computational mathematics involves mathematical research in areas of science and engineering where computing plays a central and essential role, emphasizing computational models, algorithms, and numerical analysis.

2. Vacancy

This position is opened by the Board of the Faculty (PT/dja/18/00153) as part of the new Center "Groningen Cognitive Systems and Materials", which aims to develop systems and materials for cognitive computing. The position will be embedded in the Bernoulli Institute and falls within the framework of 'Career Paths in Science 3' ('Bèta's in Banen 3'). Please see link for [criteria and conditions](#).

3. Selection committee (BAC)

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| Prof.dr. J.B.T.M. Roerdink | Scientific director Bernoulli Institute for Mathematics, Computer Science and Artificial Intelligence (Chair), and professor Scientific Visualization and Computer Graphics |
| Prof.dr. B. Noheda | Director Groningen Cognitive Systems and Materials and Professor Nanostructures of Functional Oxides |
| Prof.dr. R.W.C.P. Verstappen | Program director Mathematics and professor Computational and Numerical Mathematics |
| Prof.dr. A.J. van der Schaft | Professor Systems, Control and Applied Analysis |
| Prof.dr.ir. N.M. Maurits | Professor Clinical Neuroengineering |
| A.-M. Huijzer | Student member |
| Prof. dr. ir. B.J. Geurts | Professor Multiscale Modeling and Simulation, University of Twente |

Advisors:

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| Prof.dr. J. Top | Professor Algebra |
| Prof.dr. T. Müller | Professor Combinatorics and Probability |
| Prof.dr.ir. C.H. van der Wal | Scientific director Zernike Institute for Advanced Materials and professor Nanostructures of Functional Oxides |
| Dr. J.H.M. van der Velde | Scientific Coordinator Groningen Cognitive Systems and Materials and secretary of the selection committee |

HR advisor:
L.A. Boomsma

4. Research area

The computational sciences have revolutionized the process of scientific discovery by adding the virtual laboratory, often complementary to theoretical, observational, or experimental means. Computational science constitutes a broad interdisciplinary area between mathematics, its applications, and computer science, where new insights are obtained from numerical simulations. In part the impact of computation in research, such as material science, can be attributed to the rapid advancement of computing systems, which has made many problems computationally tractable. Moreover, computational mathematics plays a central, and often critical, role in the development of scientific computing. The problems of interest require numerical computations for their resolution. Conversely, the development of efficient computational approaches - which comprises numerical models and algorithms - requires an understanding of the mathematical properties of the problem considered. The research area can thus be characterized by a very close interaction between theoretical, computational and applied aspect of mathematics. The computational solution of today's highly complex problems of science and engineering involves questions ranging from the design of suitable, computationally tractable models, to the mathematical analysis of numerical algorithms. The candidate's contributions are to be geared towards improving the mathematical insight in this broad area of research. Diverse aspects of computational mathematics can be envisioned: algorithmic issues are tied together by numerical mathematics, which conceives and analyses computational techniques; challenging computational modelling issues can also be studied mathematically: some of the most exciting challenges for applying numerical simulation as an innovative design tool are in the development of self-learning materials.

5. Embedding: institute (and base unit)

The position will be embedded in the research unit Computational and Numerical Mathematics of the Bernoulli Institute, which has a strong track-record in computational fluid dynamics and numerical mathematics. It focusses on fundamental research. For transfer of the results and their implications the group maintains firm contacts with large national computational-technological centers (MARIN, NLR, IMAU, ECN, Deltares). The position will play a crucial role within the Center "Groningen Cognitive Systems and Materials" (CogniGron).

The Groningen Cognitive Systems and Materials Center is a joint venture between FSE-institutes Bernoulli Institute for Mathematics, Computer Science and Artificial Intelligence, and the Zernike Institute for Advanced Materials. It comprises researchers from materials science, physics, chemistry, mathematics, computer science and artificial intelligence. The center provides structure, coherence, and visibility for a joint research program in the direction of cognitive systems and materials. The main goal of the Groningen Cognitive Systems and Materials Center is to create self-learning materials that will perform the tasks that are now assigned to

thousands of transistors and complex algorithms in a more efficient and straightforward manner, hence, forming the basis for a new generation of computer platforms for cognitive applications, such as pattern recognition and analysis of complex data.

The Bernoulli Institute for Mathematics, Computer Science and Artificial Intelligence is part of the Faculty of Science and Engineering (FSE). The profile of the institute centers around modelling, computation, and cognition with a focus on science and technology, keeping a balanced mix of fundamental and applied aspects. The Bernoulli Institute comprises five mathematics programmes, six computer science programmes, and four artificial intelligence programmes. The constituting programmes participate in various national research schools and most of the PhD students are enrolled in an educational programme and take part in other activities offered by these schools. The Bernoulli Institute aims to strengthen the current research portfolio in Mathematics, Computer Science and Artificial Intelligence by expanding both in fundamental areas that have a prominent role in education as well as in directions that are essential for new technological and societal developments.

6. Local and (inter)national position

The research of the unit Computational and Numerical Mathematics (CNM) is embedded in the Data Science & Systems Complexity Center and the Groningen Engineering Center. Further CNM participates actively in the Dutch Research School for Fluid Dynamics (JM Burgers Center) and the Dutch-Flemish Scientific Computing Society (SCS). Good contact exists with Computational/Numerical Maths groups at the Dutch TU's, which have been formalized through a collaboration agreement with the applied mathematics institute 4TU-AMI. Internationally, CNM is part of the European Research Community on Flow, Turbulence and Combustion (ERCOFTAC). In the area of applications, the CNM group works indirectly together with international industry through strong, strategic collaborations with (inter)national technological institutes. The international orientation is also evidenced by an international exchange of PhD-students, double degrees and international bursary students.

At the national level the Bernoulli Institute participates in the Dutch mathematics Research Schools for Fluid Mechanics (J.M. Burgerscentrum) and the National Graduate School for Systems and Control (DISC). It is also involved in the NWO research clusters "Discrete, Interactive and Algorithmic Mathematics, Algebra and Number Theory" (DIAMANT), "Geometry and Quantum Theory" (GQT), "Nonlinear Dynamics of Natural Systems" (NDNS+) and "Stochastics – Theoretical and Applied Research" (STAR) and in the national research school WONDER.

Locally the Systems, Control and Applied Analysis research unit is part of the Jan C. Willems Center for Systems and Control, that furthermore consists of the control engineers in the Engineering institute ENTEG.

The Bernoulli Institute has a strong position in national and international mathematics, as evidenced by participation in NWO and EU projects (*e.g.* HYCON2, Cosmic Web, CA15109), publications in renowned journals and conferences, memberships of editorial boards, boards of mathematical societies, and program

committees, conference chairing (*e.g.* MTNS 2014, IWSM 2017, NecSys 2018), *etc.* Mathematics research in Groningen is strongly focused on mathematical systems, in particular, Nonlinear Dynamical Systems, Mathematical Physics and Systems & Control.

7. Expected contributions to research

The candidate is expected to initiate and develop an internationally leading research programme in the field of Computational Mathematics. The research should have a visibility on the national and worldwide level and lead to publications in top journals. Further it is expected, that the new professor will take a leading role in the field of Mathematics within the Netherlands. Obtaining substantial external funding for PhD projects is crucial. Supervision of PhD students is an important part of the research activities. The research is expected to strengthen the existing efforts in the field of Mathematics within the Bernoulli Institute and the Groningen Cognitive Systems and Materials center, and should lead to a strengthening of the international reputation of the group, the research center and the institute.

8. Expected contributions to teaching

The candidate is expected to contribute to the teaching programmes in the bachelor and master degree programs within the Undergraduate and Graduate Schools of Science and Engineering. She/he is expected to participate in the teaching programme of specialized courses in relation to Computational Mathematics and other related topics, *e.g.*, numerical analysis and mathematical modeling. Furthermore, the candidate will be involved in supervising bachelor, master and PhD students. Upon appointment, depending on experience and formal qualifications to date, the candidate may be required to enter a nationally standardized tertiary teaching skills certification trajectory (BKO or Basis Kwalificatie Onderwijs), successful completion of which is a condition for extensions and tenure.

9. Expected contributions to the organization

The candidate is expected to have an active interest and to provide a positive contribution to the management and organizational tasks of the institute. At the level of the FSE, the candidate will contribute to the organization of the faculty, for example by participating in working groups and committees, in the fields of teaching, research and management. The candidate will participate in relevant national and international organizations.