Faculty of Science and Engineering

Profile report: Computational Mathematics
- Discipline: Mathematics
- Level: Tenure-track Assistant professor/Associate professor/Full professor
- Fte: Full time (1.0)

1. Scientific discipline

Scientic computing has become the third mode for research and development in many areas of science and engineering. Along with theory and experiment, and working in tandem with them, numerical simulations play a key role in the quest for knowledge and the advancement of technology. 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 4' ('Bèta's in Banen 4'). Please see link for criteria and conditions.

3. Selection committee (BAC)

Prof. dr. N.A. Taatgen	Scientific director Bernoulli Institute (Chair) and Professor Cognitive Modeling
Prof.dr. B. Noheda	Director CogniGron and Professor Nanostructures of Functional Oxides
Prof.dr.ir. R.W.C.P. Verstappen	Program director Mathematics and Adjunct Professor Computational Mathematics
Prof. dr. J. Top	Department head of Mathematics Professor, Number Theory & Algebraic Geometry
Prof.dr.ir. N.M. Maurits	Professor Clinical Neuro-engineering
J. Norden	Student member
Prof. dr. ir. B.J. Geurts	Professor Multiscale Modeling and Simulation, University of Twente

Advisors:

Dr. J.H.M. van der Velde	Scientific Coordinator CogniGron and secretary of the selection committee

HR advisor:
N. Clemencia-Lokai

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 trackable. 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 compromises 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 aspects 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 Bernoulli Institute for Mathematics, Computer Science and Artificial Intelligence (BI) 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. In all three disciplines of the institute and particularly in Mathematics, we strive at maintaining a balanced mix of fundamental and applied research. The Bernoulli Institute comprises five mathematics groups, seven computer science groups, and four artificial intelligence groups. The constituting groups participate in various national research schools. Most of the PhD students are enrolled in an educational program and take part in a number of activities offered by these schools. The Bernoulli Institute has a leading role in the cross-disciplinary research theme on

Data Science and Systems Complexity (DSSC), and in the Groningen Cognitive Systems and Materials Center (CogniGron) within the Faculty of Science and Engineering.

The position will be embedded in the basic unit Computational and Numerical Mathematics (CNM) of the Bernoulli Institute. The basic unit CNM 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, TNO, Deltares).

6. Local and (inter)national position

The position will play a crucial role within the Groningen Cognitive Systems and Materials Center. CogniGron is a joint venture between FSE-institutes BI 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.

At the national level candidate is expected to participate in the Dutch Research School for Fluid Mechanics (J.M. Burgerscentrum) and the NWO research cluster Nonlinear Dynamics of Natural Systems (NDNS+), which both include computational mathematics research.

The broad range of applications of the research area offer ample opportunities for collaborations with research groups in Mathematics, Computer Science and Artificial Intelligence. In particular, applications of computational mathematics in image processing and scientific visualization strengthen the relations with Computer Science. Machine learning-based numerical algorithms for solving high dimensional PDEs, for instance, open a host of opportunities for collaboration with Artificial Intelligence. Within Mathematics the new position has direct links to mathematical systems, in particular Dynamical Systems, Stochastics, Systems & Control and Analysis.

7. Expected contributions to research

The candidate is expected to initiate and develop an internationally leading research programme in the field of Computational Mathematics, acting as a link between the Bernoulli Institute and (inter)national research activities. The research should have a visibility on the national and worldwide level and lead to publications in top journals. The research is also expected to cross-fertilize the existing research within

the Groningen Cognitive Systems and Materials center and should lead to a strengthening of the international reputation of the research group, the research center and the research institute. Obtaining substantial external funding for PhD projects is pivotal. Supervision of PhD students is an important part of the envisioned research activities and of establishing a local research group. Nationally as well as internationally, he/she should establish or maintain strong connections with other research groups in related areas.

8. Expected contributions to teaching

The candidate is expected to contribute to the bachelor and master programs of the Faculty. She/he will also be actively involved in the development of new courses related to the research area, also in relation with the national Mastermath program. Furthermore, he/she will supervise final research projects of bachelor and master students.

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.