**Faculty of Science and Engineering**

**Profile report:** Innovative Computer Architecture (Innovatieve computerarchitectuur)

- Discipline:   Computer Science
- Level:        tenure-track Assistant professor/Associate professor/Full professor
- Fte:          Full time (1.0)

## 1. Scientific discipline
Computer architecture concerns the hardware environment upon which all of computing is based, and the interface it provides to higher software layers. Of particular interest are innovative systems architectures that are modular, scalable, fault-tolerant, and flexible, such that they integrate computation, communication, and memory. Architectures that handle the generation, processing, storage and analysis of big data are also emphasized.

## 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)

| | |
|---|---|
| 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. N. Petkov | Program director master Computing Science and professor Intelligent Systems |
| Prof. dr. P. Avgeriou | Professor Software Engineering |
| Prof. dr. D. Karastoyanova | Professor Information Systems |
| A. Roman | Student member |
| Dr. A. Kokkeler | Associate professor Computer Architecture for Embedded Systems, University of Twente |

*Advisors*:

| | |
|---|---|
| Prof. dr. A. Lazovik | Professor Web Computing |
| Prof. dr. N. Taatgen | Professor Cognitive Modeling |
| 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

Computer architecture forms an important ingredient of computer systems. Computer architectures need to meet several challenges such as modularity, scalability, robustness, fault-tolerance, and flexibility. In addition to traditional architectures (serial, parallel, and distributed architectures), there are several alternative architectures such as neural networks, data flow architectures, or quantum computers. Other aspects concern embedded and cyber-physical systems, real-time systems, or dependable and fault-tolerant systems (ACM Computing Classification System, 2012 Revision).

For this position, the focus is on novel computing architectures. New computer architectures and corresponding compilers, software platforms, *etc.*, are needed, so that a performance improvement by several orders of magnitude becomes possible. New developments in this field include cognitive/neuromorphic computing, hardware-software co-design, large-scale GPU computing as well as embedded systems architectures.

## 5. Embedding: institute (and base unit)

The position will be embedded in one of the existing research units of the Computer Science department of the Bernoulli Institute, depending on the actual area of the selected candidate. If a full professor is selected and appointed, the candidate may also be offered to establish and lead a new research unit on Computer Architecture within the Bernoulli Institute. The position will play a crucial role within the Center "Groningen Cognitive Systems and Materials" (CogniGron). Within CogniGron, there are strong connections to research on new computer networks and cognitive architectures (Bernoulli Institute), and to neuromorphic circuit design (Zernike Institute).

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

At the Computer Science department of the Bernoulli Institute there are strong connections to the Software Engineering group, where joint work is envisioned in the field of hardware/software co-design. Nationally, most universities have strong research efforts in computer architecture. In particular, there are strong groups at the technical universities, particularly the Embedded Systems group at TU Eindhoven and the TNO Embedded Systems Institute in Eindhoven.

At the national level the department participates in the Dutch Research School in Programming and Algorithmics (IPA), which has a strong tradition in formal methods for embedded systems, as well as the Advanced School for Computing and Imaging (ASCI), the School for Information and Knowledge Systems (SIKS), and the Dutch Research School in Logic (OZSL).

At the international level the department is involved in several EU research projects with the high-tech industry (*e.g.*, PROMES - Process Models for Engineering of Embedded Systems, SDK4ED - Software Development toolKit for Energy optimization and technical Debt elimination), has established collaborations with major companies (Philips Research, ASML, Oce) and technological institutes (Astron, TNO, Software Engineering Institute at Carnegie-Melon University), and has cooperation and exchange programmes with many universities (*e.g.*, Vancouver, Leuven, Linnaeus, Milano, Gothenburg). In Computer Science, the Bernoulli Institute has a strong position (as evidenced by participation in NWO and EU projects, publications in renowned journals and conferences, memberships of editorial boards and program committees, conference chairing, *etc.*) in intelligent systems (biologically inspired computational modelling, machine learning, morphological image processing); pervasive middleware and energy distribution infrastructures; architecting of software-intensive systems and object-oriented software design; information systems; data and information visualization, and visual analytics.

## 7. Expected contributions to research

The candidate is expected to initiate and develop an internationally leading research programme in the field of Innovative Computer Architecture. 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 Computer Science 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 Computer Science 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 Innovative Computer Architecture and other related topics, *e.g.* computer networks, operating systems, information systems, parallel computing. 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.