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 interface to the higher software layers of a computing system as well as the hardware implementation of the basic computational functions. Of particular interest are innovative system   architectures that are modular, scalable, fault-tolerant, and adaptable, such that they integrate the required mix of computation, communication, and memory functions using conventional and non-conventional approaches. 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/gl/23/00102) as part of the "Groningen Cognitive Systems and Materials Center" (CogniGron), which aims to develop materials, systems and architectures 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 criteria and conditions.

3. Selection committee (BAC)

Prof. dr. N. Taatgen (chair)	Scientific director Bernoulli Institute for Mathematics, Computer Science and Artificial Intelligence, and professor Cognitive Modeling
Prof. dr. B. Noheda	Director Groningen Cognitive Systems and Materials and professor Nanostructures of Functional Oxides
Prof. dr. A. Lazovik	Program Director and Professor Distributed Systems
Prof. dr. P. Avgeriou	Professor Software Engineering
Prof. dr. D. Karastoyanova	Professor Information Systems
David Visscher	Student member
Prof. dr. Said Hamdioui	Professor on Dependable and Emerging Computer Technologies, Head of the Quantum and Computer Engineering department, and Head of the Computer Engineering Laboratory (CE-Lab) - Delft University of Technology, NL

Advisors:

Prof. dr. M. Tromp	Scientific director Zernike Institute for Advanced Materials and professor Materials Chemistry
Dr. J.H.M. van der Velde	Scientific Coordinator Groningen Cognitive Systems and Materials and secretary of the selection committee

HR advisor:
M. Laning

4. Research area

Computer architecture forms an important ingredient of all computer systems. Computer architectures need to meet several challenges such as modularity, scalability, robustness, fault-tolerance, and flexibility. In addition to traditional architectures (sequential, parallel, and distributed architectures), several alternative architectures are emerging, e.g., neural network based, data flow driven, adiabatic or quantum processing based approaches. 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, tools and methods, software platforms, *etc.*, are needed, so that improvements in performance and energy efficiency by several orders of magnitude become possible. New developments in this field include cognitive/neuromorphic computing, hardware-software co-design, large-scale accelerator based computing as well as embedded systems architectures.

5. Embedding: institute (and base unit)

The position will be embedded in the existing research unit Computer Architecture of the Computer Science department of the Bernoulli Institute.
The position plays 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 the Bernoulli Institute for Mathematics, Computer Science and Artificial Intelligence, and the Zernike Institute for Advanced Materials, both within the Faculty of Science and Engineering (FSE). 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 profile of the Bernoulli 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 Mellon 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 (adaptive information systems, middleware and service oriented architectures, security, information retrieval); 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 visibility on the national and worldwide levels and lead to publications in top journals and conferences. 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 School of Science and Engineering. The candidate is also 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, embedded systems and 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 contract 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 areas of teaching, research and management. The candidate will participate in relevant national and international organizations.