Faculty of Science and Engineering

Profile report: Programming Languages and Systems

- Discipline: Computing Science
- Level: Tenure-track assistant professor with an education profile
- Fte: 0,8-1,0 fte

1. Scientific discipline
Computer programming is a process of creating a set of instructions for a computer in order to solve a given computational problem. The complexity of creating such sets of instructions (programs) is very high, and the field of computer programming as a discipline studies different programming techniques that could make the process of writing the programs manageable by people.

2. Vacancy
This position is opened by the Board of the Faculty (PT/gl/2100066) and will be embedded in the Bernoulli Institute, in a basic unit matching the profile of the selected candidate. The criteria and conditions pertaining to the position are described in the document 'Assistant professor with an education profile'.

3. Selection committee (BAC)

Prof.dr. A. Lazovik	Education Director for Computing science, chair
Prof.dr. D. Karastoyanova	Professor of Information Systems
Prof.dr. P. Avgeriou	Professor of Software Engineering
Prof.dr. N. Taatgen	Professor of Artificial Intelligence
	Bernoulli Institute Research Director
Prof. dr. ir. R. Verstappen	Education Director for Mathematics
Prof. dr. F. A. Fontana	Evolution of Software Systems and Reverse Engineering
	University of Milano Bicocca, Italy,
	External member
Floris Westerman	Student member

Advisors:

Prof. dr. H. Hansen	Professor of Formal Modeling

HR advisor:
M. Beuving

4. Area of expertise
Programming is an essential part of any computing science programme, and serves as a backbone to all the more specialized topics that follow. Software development is what uniquely defines the field of computing science, and learning programming is crucial and probably the most important learning goal of the CS programme, especially at the BSc level. Moreover, the Bernoulli Institute has identified

"Software" as one of their focus areas within the sector plans for Computer Science in the Netherlands. Given the importance of programming, and the increasing intake of students in computer science educational programs, the institute needs strengthening in software development and teaching in programming. In addition to teaching basic and advanced programming courses, the candidate will coordinate the development of a consistent learning trajectory in programming, including the introduction of novel teaching methods for learning programming. In addition, we expect the candidate to contribute to the software development research focus.

5. Embedding: institute (and base unit)

The position will be embedded in one of the research groups of the Bernoulli Institute. 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 research groups, seven computer science groups, and four groups in the field of artificial intelligence. The constituting research groups 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.

The Bernoulli Institute has a leading role in the recently established cross-disciplinary research theme on Data Science and Systems Complexity (DSSC) within the Faculty of Mathematics and Natural Sciences. This concerns a research cluster of 60+ researchers in a number of basic disciplines (mathematics, computer science, artificial intelligence, systems & control, engineering, astronomy) and various scientific application domains. The ambition is to understand and solve big data problems by exploiting the joint perspectives from both data science and complexity science. The institute is also heavily involved in the Groningen Cognitive Systems and Materials Center (CogniGron), which is a joint venture between the Bernoulli Institute 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.

Several research groups cover the different aspects of research in the field of computer programming. As such, the research group embedding of the candidate will depend on their profile. The following research groups provide a good potential match for the profile (taking into account both research and teaching): Software Engineering (computer programming has a strong link to software engineering courses), Distributed Systems (web and cloud computing, computer networks,

modern distributed systems development), Information Systems (complex information systems, databases, systems integration, information assurance and security, data mining), Computer Architecture (hardware programming, programming of embedded devices, parallel computing, GPU programming), and Fundamental Computing research group (theoretical foundations of programming languages, formal languages, correct and reliable programs).

6. Local and (inter)national position

At the national level the Bernoulli Institute participates in the Dutch computer science research schools Advanced School for Computing and Imaging (ASCI), Dutch Research School in Logic (OZSL), the School for Information and Knowledge Systems (SIKS), and the Dutch Research School in Programming and Algorithmics (IPA), the latter being the most relevant for the position. At the international level the BI is involved in several EU research projects (e.g., Human Brain Project, Smart Homes, Visual Analytics), has established collaborations with major companies (Philips Research, IBM) and technological institutes (Astron, TNO, NLR, ECN), and has cooperation and exchange programmes with many universities (e.g., Rome, Leipzig, Birmingham, Barcelona, Ghent, ESIEE-Paris, Tampere). In Computer Science, the BI 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; data and information visualization, and visual analytics.

At the national level, there are groups on "Software Technology" at UU (https://www.uu.nl/medewerkers/organogram/beta/87/849/858) and on "Programming Languages" at TUD (https://pl.ewi.tudelft.nl). Also, the group on "Software Analysis and Transformation (SWAT) at the CWI, Amsterdam (https://www.cwi.nl/sen1).

7. Expected contributions to teaching

Programming courses have been taught successfully in the same way for many years. Over recent years, new methods have been developed and applied in practice, e.g., using gamification techniques, flipped classroom, online teaching, to name a few. Given the importance and complexity of learning programming these new methods have to be more actively being used in CS education. One of the tasks of the selected candidate would be modernizing and further improving the quality of the CS education programmes by introducing new didactic methods.

The importance of Computing Science for modern society is unquestionable, and there is a huge demand from industry for more and more experts and specialists in the field of Computing Science. However, there seems to be a gap between high

school education and universities in terms of desired knowledge level in programming. One of the tasks of the candidates is to look at the different options for smoothing this transition from high school to university for prospective students (e.g., by involving in the educational activities at the high school level).

The candidate is expected to mainly contribute to teaching the courses of the programming cluster, either in a role of courses coordinator, or a lecturer, or as an examiner. One of the important tasks of the candidate is to ensure the high quality of education within the cluster, by overlooking all the related education activities. The programming education cluster consists of the following courses: Imperative Programming, Algorithms and Data Structures in C, Object-Oriented Programming, Advanced Object-Oriented Programming, Functional Programming, Web Engineering, Programming in C++, Advanced programming in C++.

8. Expected contributions to research

The candidate is expected to either carry out research in the field of education and develop new didactic methods used in teaching the discipline of Computer Programming or to contribute to the ongoing research activities of the research group in which they are embedded. In particular, we are interested in strengthening the research activities of our research groups as described next.

The candidate with a research profile within the field of Computer Architecture will focus on the topics Hardware/Software co-design and embedded systems.

In the area of Distributed Systems we are looking for candidates with an expertise in cloud computing, cloud native applications, microservices, big data, serverless computing.

A candidate whose profile is aligned with the Fundamental Computing will conduct fundamental research on issues underlying the specification, design, analysis, and implementation of programming languages and systems. This includes topics such as, for example, semantics of programming languages, programming language design and implementation, analysis and verification of programs, and mechanized proofs of program correctness.

In the area of Information Systems, we aim at strengthening the research activities related to IoT, Edge and Fog computing models and architectures, cyber security and information assurance with focus on distributed environments and mobile devices, data, process and text mining.

Research expertise in Intelligent Systems should be in the area of APIs for parallel programming, e.g. OpenMP, OpenACC, MPI, CUDA.

The candidates with a research profile relevant for the Scientific Visualization and Computer Graphics group will conduct research in (big) data visualization and analysis.

The research profile of candidates to be embedded in the group Software Engineering and Architecture should align with the topics: modern software engineering tools and techniques, continuous integration/delivery/deployment, DevOps, agile/lean methods, and human aspects in software development.

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 FSE, the candidate will contribute to the organization of the faculty, for example by participating in working groups and committees in the area of education. The candidate will participate in relevant national and international organizations.