Faculty of Science and Engineering

Profile report: Distributed Systems

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

1. Scientific discipline
The domain of Distributed Systems covers various aspects of coordinating computer network-based applications that aim to achieve a common goal. The complexity of distributed systems comes from different sources: failure of components, lack of global trust, overhead of network communication, amount of data transferred between individual components, heterogeneity of the environment, etc. Since the emergence of the Internet and the Web the majority of applications have inherent requirements of being distributed in order to be able to continuously provide their services to the users. New research subfields are forming due to the continuously growing amount of data that can only be stored and processed in a distributed fashion.

2. Vacancy
This position is opened by the Board of the Faculty of Science and Engineering (ref: PT/gl/18/00255) and will be embedded in the Bernoulli Institute for Mathematics, Computer Science and Artificial Intelligence, basic unit Distributed Systems. The position 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. J.B.T.M. Roerdink	Scientific director Johann Bernoulli Institute for Mathematics and Computer Science (Chair) and professor Scientific Visualization and Computer Graphics
Prof.dr. N. Petkov	Program director master Computing Science and professor Intelligent Systems
Prof.dr. D. Karastoyanova	Professor of Information Systems
Prof.dr. A. Lazovik	Professor of Web Computing
Prof.dr. L. Steg	Professor of Environmental Psychology
T. Hoeksema	Student member
Prof.dr. M. Mecella	ext. member, Professor in Engineering in Computer Science, Sapienza Universita di Roma, Italy

HR advisor:
L.A. Boomsma

4. Research area

Recent prominent achievements in the area of data science would not be possible without our improved understanding on how to build distributed supporting infrastructures that let us process large amounts of data. Without knowing how to collect, store and process the data in a distributed fashion, many new algorithms that inherently require large amounts of data would not be possible to realize. This new field is often referred to as *"big data engineering"*. However, our knowledge on how to build such systems is still limited: the majority of such systems (while being distributed) are still controlled in a centralized fashion and put strict requirements on the availability of data, the location of processing nodes, the network latencies, etc. In practice, many assumptions taken for granted do not always hold. For example, there might be legacy data spread across several organizations or departments within the same organization forming independent "silos" that would require increased location-awareness for data processing. Or, to take another example, the network latency requirements may be stricter if sensor data will be immediately used in a control loop, e.g., when light is controlled via presence detection. Distributed and parallel algorithms in the areas of *discrete and hybrid optimization, AI planning,* or *constraint satisfaction* are also of particular interest for this position.

Additional domains of interest are the Internet-of-Things and pervasive computing; blockchain, smart contracts and their applications; Big Data processing; SOA and cloud computing; energy and water management.

5. Embedding: institute (and base unit)

The position will be embedded in the research group Distributed Systems. The group performs fundamental research and delivers education at the frontier of the state of the art in dynamic complex distributed systems using formal engineering tools and seeks applications with societal impact. The main research interests of the group are in the areas of AI planning, discrete optimization, large-scale distributed data processing in highly distributed environments, having as main application domains Internet-of-Things, building automation, large-scale data analytics, business processes and energy distributed infrastructures. The research results have been field-tested in collaboration with industry. One of such applications eventually led to founding the Sustainable Buildings company that applies the optimization algorithms in practice.

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.

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 Science and Engineering. 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. Healthy aging and energy are two other important university-wide research topics that the Bernoulli Institute is involved in.

6. Local and (inter)national position

Nationally, most universities have strong research efforts in distributed systems. In particular, there are strong groups at the VU University, TU Eindhoven, and University of Twente. The Distributed Systems group in Groningen is among the leaders in the field of Smart IoT and the AI methods supporting automated reasoning in distributed smart environments, e.g., planning and scheduling, discrete optimization, machine learning.

At the national level the group participates in the Dutch Research School in Programming and Algorithmics (IPA), the Advanced School for Computing and Imaging (ASCI), and the School for Information and Knowledge Systems (SIKS). The research group has established close collaboration and participated in joint projects with national research institutes (TNO, CWI, and Astron), and various Dutch companies (Philips, DNV GL, Enexis, Alliander, Vitens, Anchormen, Nerdalize). The group leader, Lazovik, was a co-founder of the Sustainable Building start-up company, whose business proposition was based on the research of the Distributed Systems group. At the international level the research group has been involved in several EU-funded research projects (e.g., Smart Homes, GreenerBuildings, Virtual Factories), has established collaborations with major international companies (IBM, Shell, Cognizant) and has cooperation and exchange programmes with many universities (e.g., Rome, Stuttgart, Vienna, Modena, Bournemouth).

In Computer Science, the Bernoulli Institute has a strong (inter)national 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 pervasive middleware and energy distribution infrastructures; architecting of software-intensive systems and object-oriented software design; information systems; intelligent systems, machine learning; data and information visualization, and visual analytics.

7. Expected contributions to research

The candidate is expected to develop an internationally leading research track record in Distributed Systems, leading to an autonomous research programme within the institute. The research should lead to publications in high impact scientific journals and to contributions to major conferences in the field of expertise. Supervision of PhD students and postdocs is an important part of the research activities. Obtaining substantial external funding for PhD and postdoc projects is crucial. A strong involvement in the research theme Data Science and Systems Complexity (DSSC) is expected. For this position we foresee collaboration with the Center for Cognitive Systems and Materials. New developments in the field of cognitive/neuromorphic computing would require new distributed algorithms and computer architectures that will significantly influence the research being performed in the area of distributed systems. Interaction with other domains that require support from distributed systems (e.g., astronomy, biology, medicine, data analytics companies, big data, smart energy systems), or provide relevant complementary expertise (mathematics, artificial intelligence) is very important.

8. Expected contributions to teaching

The successful candidate is expected to contribute to the teaching programmes of the bachelor and master programmes of Computer Science in the Undergraduate and Graduate Schools of Science of the FSE. He/she will contribute both to teaching existing courses, and to the development of new courses in the area of distributed systems. This includes the supervision of bachelor and master theses. The teaching tasks amount to at most 30% of the total time for a tenure-track assistant professor. For the positions of adjunct professor/full professor these tasks amount to 40%.

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.