

Faculty of Science and Engineering

Profile report: Data Science and Systems Complexity

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

1. Scientific discipline

Data Science and Systems Complexity is a multidisciplinary area combining researchers from different fields interested in handling of Big Data and Complexity (mathematics, statistics, computer science, artificial intelligence, engineering, astronomy, physics, bioinformatics) who address three broad topics: Adaptive Models and Big Data, Complex Systems and Engineering and Advanced Instrumentation and Big Data.

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. M. Biehl	Professor of Machine Learning
Prof.dr. N. Taatgen	Professor of Artificial Intelligence Bernoulli Institute Research Director
Dr. F. Cnossen	Education Director for Artificial Intelligence
Prof. dr. B. Hammer	Professor of Machine Learning Bielefeld University, Germany External member
Floris Westerman	Student member

Advisors:

Prof. dr. J. Perez Professor of Software Foundations

HR advisor:

M. Beuving

4. Area of expertise

The demand from society for expertise in Data Science has been increasing over the last decade. In response, the Bernoulli Institute has designated Data Science as one of its focus areas, and participates, together with the astronomy and engineering institutes, in the Center for Data Science and Systems Complexity (DSSC). The Center

combines a long Groningen tradition in Control of Complex Systems with novel methodology from Data Science.

Within the Center, the computing science department plays a major role in developing the theoretical foundations, algorithms and related infrastructure. Over the last several years, the DSSC achieved influential research results with high societal impact.

The success of the Center has led to an increasing demand from students for courses and projects in that area. The goal of this position is to strengthen and organize education on the topic within the institute, and to develop or contribute to research within the scope of the Center. In particular, it is a primary goal of the position to integrate cutting edge achievements in research into challenging but rewarding innovative education. In addition,

The programme as a whole would greatly benefit from oversight on all the educational activities in the area of data science and systems complexity, not just of those within the computer science curriculum, but also those in Mathematics, Artificial Intelligence, Astronomy and Industrial Engineering.

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.

Several research groups cover the different aspects of research in the field of data science and systems complexity. 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): Intelligent Systems (with a focus on machine learning), Distributed Systems (with a focus on Big Data), Software Engineering and Information Systems (with a focus on data engineering, system engineering for data science pipeline, processing and assurance), Computer Architecture (with a focus on HPC and HTC systems).

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.

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.

7. Expected contributions to teaching

The research center of Data Science and Systems Complexity aims at addressing three broad topics: Adaptive Models and Big Data, Complex Systems and Engineering and Advanced Instrumentation and Big Data, and all three topics have a strong relation to the Computing Science education programmes. Currently there is a Master's specializations in Data Science and Systems Complexity, mainly focusing on data science and related fields. Given the importance of DSSC, we wish to increase the covered topics and strengthen connections with courses throughout the curriculum within CS programmes., e.g., Information Systems, Scalable Computing, Information Retrieval. The candidate is expected to mainly contribute to

teaching the courses in the fields related to data science and systems complexity, either in a role of courses coordinator, a lecturer, or as an examiner. One of the important tasks of the candidate is to ensure the high quality of education in the field of data science and systems complexity, also by overlooking all the related education activities. One of the tasks of the selected candidate would be also modernizing and further improving the quality of the CS education programmes by introducing new didactic methods in the related fields.

DSSC center is involving many researchers from Computing Science who are also teaching different courses in CS programmes. As such, some of the research results are naturally transferring to the new generation of students. The role of the selected candidate is to establish a consistent and systematic knowledge transfer between the DSSC center and education in Computing Science, aiming at making the education in the area of data science and systems complexity and related fields to be one of the best in the world.

The importance of data science and related disciplines for modern society is unquestionable, and there is a huge demand from industry for more and more experts and specialists in this field. However, there seems to be a gap between high school education and universities in terms of desired knowledge level in data-intensive computation. 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).

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 disciplines related to Data Science and Systems Complexity, or to contribute to the ongoing research activities of the corresponding research group. There are a number of DSSC disciplines we would like to strengthen that we outline below.

A candidate with a research profile within the field of Computer Architecture will focus on application- and data-centric computer design and energy-aware computing 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 design and analysis of complex systems, from a computational perspective, including topics such as, analysis and design of algorithms, data structures, computational complexity, computational aspects of combinatorics and graph theory, computational geometry, information retrieval, and parallel algorithms.

In the area of Information Systems, we aim at strengthening the research activities related to IoT, Edge and Fog computing models and architectures in order to support the data science and analytics lifecycles, architectures and models for

automated data processing and analytics pipelines, cyber security and information assurance with focus on distributed environments and mobile devices, process mining, text mining and information retrieval.

Research activities in Intelligent Systems should be in the area of machine learning and/or pattern recognition. The candidate should have experience and a strong interest in interdisciplinary applications and the analysis of complex datasets in, for instance, life sciences, astronomy or engineering and industry.

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

The research profile of candidates to be embedded in the group Software Engineering and Architecture should align with the topics software engineering for AI systems, mining software repositories, software analytics, AI techniques for software engineering, architecting large and complex systems.

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.