**Faculty of Science and Engineering**

**Profile report:** Continuous machine learning (continu machineleren)

- Discipline:   Artificial Intelligence
- Level:        tenure-track Assistant professor/Associate professor/Full professor
- Fte:          Full time (1,0)

**1. Scientific discipline**
Machine learning has become a primary focus in artificial intelligence research. In this position there are strong relations with biologically inspired computation on the one hand and materials science on the other hand, in order to aim at persistent cognitive systems.

**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 for Mathematics, Computer Science and Artificial Intelligence 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)**

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| 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. L.R.B. Schomaker | Professor Artificial Intelligence |
| Prof. dr. B. Noheda | Director Groningen Cognitive Systems and Materials and professor Nanostructures of Functional Oxides |
| Prof. dr. N.A. Taatgen | Professor Cognitive Modeling and Chair of the board of Bernoulli Institute for Mathematics, Computer Science and Artificial Intelligence |
| Dr. S.M. van Netten | Deputy programme director of Artificial Intelligence |
| Dr. K. Bunte | Assistant Professor Intelligent Systems |
| Prof. dr. F. van der Velde | Professor of Technical Cognition, University Twente |
| Danny Rogaar | AI Student |

*Advisors:*

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| Prof. dr. ir. C.H. van der Wal | 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*
F. Broekhans

## 4. Research area

Current results in machine learning are impressive in many applications but the results are realized through a combination of tremendous human effort, large computing resources and the availability of (mostly labeled) big data. Training proceeds in a series of human-guided attempts and there is a separation between a training stage and an operational stage. None of these preconditions are conducive for the development of autonomous 'always-on' cognitive systems. Rather than starting 'from scratch' for each new task or task variant, cognitive systems need to exploit the available functionality, saving valuable computing time. New developments in machine learning aim at exploitation of compositionality, as in, *e.g.*, Hinton's neural capsules. Dynamic routing and incremental learning will characterize future generations of deep-learning neural networks. The candidate should have affinity with non-standard neuron models (*e.g.*, spiking neurons) and be able to collaborate with the Zernike Institute for Advanced Materials in order to facilitate the translation of successful deep-learning models to new neuromorphic materials, which is a central research goal in the new center "Groningen Cognitive Systems and Materials" (CogniGron).

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

The position will be embedded in the Autonomous Perceptive Systems group of the Bernoulli Institute. The Autonomous Perceptive Systems group has a strong experience in large-scale pattern-recognition problems, in reinforcement learning and robot behavior control. The experimental and application platforms span a wide spectrum, ranging from  image-based retrieval in historical documents, machine learning in service robots, intelligent control of prosthetic legs and the development of linear sensors for underwater object detection. If a full professor is selected and appointed, the candidate may also be offered to establish and lead a new research unit on Continuous Machine Learning. The Position will play a crucial role within the Center "Groningen Cognitive Systems and Materials" (CogniGron).

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

Within the Netherlands, the Artificial Intelligence department of the Bernoulli Institute is the largest integrated, comprehensive AI department, covering both research and teaching (BSc/AI and MSc/AI and MSc/Human-Machine Communication). The fields of logic, cognitive modeling, as well as perceptual and computational intelligence are addressed.

A new collaboration is currently developing: the researchers of the AI department will be partners in the Groningen Cognitive Systems and Materials center, together with the researchers from the Computer Science and Mathematics and the Zernike Institute for Advanced Materials. The current position will play an important role in the new Center, especially on the interface between AI and Materials Science, focusing on Spiking Neural Networks, but also in Computer Science topics related to the area of computing architectures.

International collaboration includes a large-scale facility for on-line machine learning in historical manuscript collections, Monk. This system functions as a label-harvesting engine for machine-learning researchers while offering text clustering, dating and search to humanities researchers, worldwide, such as the Radcliffe Institute, Harvard, the Israel Antiquities Authority and many others. Collaboration in robotics concerns the universities of Twente, Nijmegen, Bologna and others (H2020 project MyLeg). Industrial collaborations are with Liebherr and several other companies, in the area of predictive maintenance (H2020 project Mantis). The development of lateral-line sensing arrays is done in H2020 project Lakhsmi, together with Tallinn university of technology, Estonia, Heriot-Watt university and several companies.

## 7. Expected contributions to research

The candidate is expected to initiate and develop an internationally leading research programme in the field of continuous machine learning. 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 machine learning 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 candidate will be involved in current PhD-projects and will need to acquire new projects. The research is expected to strengthen the existing efforts in the field of machine learning 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 continuous machine learning and other related topics, *e.g.* Neural networks. 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.