Faculty of Science and Engineering

Profile report: Computational Neuroscience (computationele neurowetenschap)

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

1. Scientific discipline

Cognitive modeling is a discipline of Artificial Intelligence in which computer models of intelligent behavior and the underlying systems are constructed. It has two goals: to gain a better understanding of (human) intelligence, and to be able to construct better artificially intelligent systems. Research therefore entails system building, empirical research (both behavioral and neuroimaging), statistics and machine learning.

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. The position 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)

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. N.A. Taatgen	Professor Cognitive Modeling and Chair of the board of Bernoulli Institute for Mathematics, Computer Science and Artificial Intelligence
Prof. dr. L.C. Verbrugge	Professor Logic and Cognition
Prof. dr. B. Noheda Pinuaga	Director Groningen Cognitive Systems and Materials and professor Nanostructures of Functional Oxides
Dr. S.M. van Netten	Deputy programme director of Artificial Intelligence
Prof. dr. F. van der Velde	Professor Technical Cognition, University Twente
H. van Plateringen	Student

Advisors:

Prof. dr. L.R.B. Schomaker   Professor Artificial Intelligence

Prof. dr. C.H. van der Wal   Scientific Director Zernike Institute and professor Physics of Quantum Devices

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

Formalisms for cognitive models range from low-level neural network paradigms to high-level symbolic architectures. Several recent research discussions have made it clear that a new research challenge is to connect these different levels of abstraction (*e.g.*, AAAI Fall symposium on a standard model of the human mind; an Ernst Strüngmann Forum on interactive task learning). This has to be accomplished by showing how higher levels of abstraction emerge from lower levels, in enough detail to allow the construction of cognitive systems. This development is important for the "Persistent Cognition" theme of the Artificial Intelligence department of the Bernoulli Institute, which aims at building systems with a longer lifespan than a single task.

The Cognitive Modeling group has extensive experience in symbolic modeling at several levels of abstraction, and supporting such models with neuroimaging data, but lacks expertise in neural networks that aim to model cognition. The new position is therefore centered on spiking neural networks that simulate the human brain at a very low level of abstraction, while taking into consideration the functional requirements of cognitive systems. One requirement is that the developed networks function in real time, for which an implementation at the material level is required, for instance by using neuromorphic chips.

The final aim is to construct an overall architecture of cognition by linking the spiking neural networks to other levels of abstraction. A linkage to higher levels of abstraction will be sought in collaboration with other members of the cognitive modeling group, whereas a link to neuromorphic materials will be explored in collaboration with the Zernike Institute of Advanced Materials as part of the new center "Groningen Cognitive Systems and Materials" (CogniGron).

5. Embedding: institute (and base unit)

The position will be embedded in the basic unit Cognitive Modeling of the Bernoulli Institute. The goal of the Cognitive Modeling group is to develop formal models of cognition and methods to test their capacity to predict human behavior and neuroscience data. As such, they bridge the gap between brain processing on the one hand and intelligent human behavior on the other hand. Although models are primarily developed for theoretical goals, they also serve practical purposes in human-computer interaction, educational technology and agent development. If a full professor is selected and appointed, the candidate may also be offered to

establish and lead a new research unit on Computational Neuroscience within the Bernoulli Institute. 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 on computer science related to the area of computing architecture.

There is currently a significant international interest in the development of cognitive architectures with broad learning capacities. The CM group in Groningen collaborates with several international groups on this topic: the Centre for

Theoretical Neuroscience at the University of Waterloo, the ACT-R Group at Carnegie Mellon University, the Cogworks lab at Rensselaer Polytechnic Institute, the Artificial Intelligence Laboratory at the University of Michigan, the College of Computing and Informatics at Drexel University, the Sprachsignalverarbeitungs group of the Saarland University and the DFKI in Saarbrücken.

7. Expected contributions to research

The candidate is expected to initiate and develop an internationally leading research programme in the field of Cognitive Neuroscience. 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 Artificial Intelligence 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 Artificial Intelligence 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 Computational Neuroscience and other related topics, e.g. Neural Networks, Architectures of Intelligence and Cognitive Modeling. 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.