

## **Faculty of Science and Engineering**

## **Profile report: Cognitive & Behavioral Robotics (AI-gebaseerde robotica)**

- Discipline: Artificial Intelligence
  - Level: Tenure-track assistant professor
  - Fte: Full time (1,0)

## 1. Scientific discipline

This position focuses on the understanding and design of complex behavior control systems in robotics. Given that basic control systems are currently already well developed for low-level functions such as posture maintenance, the next challenge is in the area of AI-based robot control systems. Robotic systems need to learn how to produce complex, useful and efficient behaviors. The amount of detail that is needed here precludes the use of handcrafted algorithms for each individual behavior. Therefore, modern deep-reinforcement learning forms the basis for research in this domain. However, in actual working robotic systems other levels of (hybrid) processing are needed and issues of software architecture need to be addressed.

## 2. Vacancy

This position is opened by the Board of the Faculty in the context of the sector plans and will be embedded in the Bernoulli Institute, basic unit Artificial Intelligence, Cognitive Modeling group. 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 Bernoulli Institute and Professor Scientific Visualization and Computer Graphics
Dr. F. Cnossen	Program director Artificial Intelligence & Human Machine Communication
Prof. dr. L.R.B. Schomaker	Professor Autonomous Perceptive Systems
Prof. dr. H.B. Verheij	Head of AI department, associate professor Artificial intelligence and Argumentation
Prof. dr. R. Carloni	Professor in Robotics
Prof. dr. K. Hindriks	Professor Artificial Intelligence, Vrije Universiteit Amsterdam
Floris van Beers	Student of AI, Groningen

*Advisor:*

Prof. dr. M.K. Camlibel

Associate professor Systems and Control

*HR advisor;*

N.F. Clemencia-Lokai

#### **4. Research area**

Within the field of Artificial Intelligence, robotics plays an essential role as a test bed for theory. The confrontation with physical reality quickly teaches us where theories fail. In recent years, fast developments are occurring in the area of hardware and basic control methods for walking and navigation. New sensor technologies are helpful in estimating the current state of the external world. However, progress in models for learning complex behavior is advancing at a much slower pace. This means that very advanced service robots and 'cobots' (collaborative robots) can now be purchased, but they either perform repetitive machine tasks or are controlled by a human using external tools ('joysticks'). The idea of an autonomous robot that can plan complex behavioral sequences is old and the need for algorithms is currently very high: It is urgent to find solutions. Human programming of robot behavior is too costly and can provide only a fraction of the algorithms that are needed for robust performance. Therefore this position focuses on the research in high-level control mechanisms and generation of adaptive behavior. The application domain is in industrial and domestic service robotics. In such application areas, the behavioral diversity is large. It spans from robotic tending of legacy machines in industry to robots assisting human users in their daily activities. For the realization of such functions, the ideal candidate is able to cover the complete range of algorithms from deep reinforcement learning using neural networks to explainable, knowledge-based modeling that facilitates the communication between the robot and the human user.

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

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 programmes, seven 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 has a leading role in the cross-disciplinary research theme on Data Science and Systems Complexity (DSSC), in the Center "Groningen Cognitive Systems and Materials" (CogniGron) within the Faculty of Science and Engineering.

The candidate will work in the Autonomous Perceptive Systems group of the Department of Artificial Intelligence. The group leader is Prof. dr. L.R.B. Schomaker. The position is complementary to current robotics research and education. The level of systems & control is covered by the position of prof. R. Carloni. The new position will cover the area of *AI-based* robotics.

## **6. Local and (inter)national position**

The Bernoulli Institute has expertise in Cognitive Engineering, Visualization, Cognitive Modeling, Multi-agent systems and Machine Learning. The position in behavior-based robotics will allow for increased collaboration with the engineering research at the university of Groningen. Existing contacts with companies (Philips and Demcon) pave the way for joint projects, for instance in robot-based continuous industrial maintenance. Synergy is expected with the recently awarded Gravitation project Hybrid Intelligence (a collaboration between six Dutch universities, and with the Groningen AI department in a leading role). In addition, the EU and the Netherlands are expected to also invest heavily in this type of AI research. Internationally, the robotics collaborations (in joint projects and conference organization) are with: ETH Zurich (CH), the Intelligent Manipulation Lab (Univ. of Lincoln, UK); IRIS/IEETA (Univ. of Aveiro, Portugal); Computational Learning (Karlsruhe Institute of Technology - KIT, Germany); ICVL (Imperial College London, UK); Italian institute of technology; Univ. of Bologna (I); Univ. Napels (I); VU Brussels (B). Relations with industry are: Bosch GmbH; KIT Germany; Kuka GmbH; Philips N.V; German Aerospace Center (DLR).

## **7. Expected contributions to research**

The candidate is expected to set up a research group on the topic of cognitive & behavioral robotics, in close cooperation with the existing robot research staff in the topic of systems & control in robotics. The research should compete on a worldwide level and lead to publications in top journals. 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 within the Bernoulli Institute in the field of artificial intelligence, machine learning, embedded systems, non-linear dynamics, and systems & control.

## **8. Expected contributions to teaching**

The candidate is expected to contribute to the education programmes of the bachelor and master programs of Artificial Intelligence and Human-machine Communication. He/she will also be actively involved in the development of new courses related to the research area. Furthermore, he/she will supervise final research projects of bachelor and master students.

## **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.