

## Faculty of Science and Engineering, University of Groningen,

Name institute: Bernoulli Institute

Profile report: Probability Theory and Combinatorics

- **Discipline:** Mathematics
- **Level:** tenure track Assistant professor / Associate professor / Full professor
- **Fte:** 1,0 fte

### 1. Scientific discipline

Probability Theory is a central area of Mathematics, with strong interdisciplinary connections (Physics, Astronomy, Biology, Economy and more), as well as strong connections to other areas of Mathematics, including Analysis, Optimization and Discrete Mathematics. Recent developments include major results on Random Networks, Percolation Theory, Stochastic Geometry and modeling randomly evolving systems, with applications notably in Statistical Physics and Biology. Many of the developments involve random combinatorial structures, and Combinatorial Mathematics and Probability Theory have become increasingly intertwined in recent years. For this reason the field of Combinatorics is included in the desired profile.

### 2. Vacancy

This position is opened by the Board of the Faculty of Science and Engineering FSE (PT/gl/21/00625). 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 4' ('Bèta's in Banen 4'). Please see link for [criteria and conditions](#). (An update is expected in early 2022.)

### 3. Selection committee (BAC)

Prof. dr. N.A. Taatgen	Scientific director Bernoulli Institute and Professor, Cognitive Modeling
Prof. dr. ir. R.W.C.P. Verstappen	Education Director Bernoulli Institute and program director Mathematics & Applied Mathematics; Professor, Computational Science
Prof.dr. T. Müller	Professor, Combinatorics and Probability
Prof. dr. M.A. Grzegorzczak	Associate Professor Computational Statistics
M.J. (Marit) Onstwedder	Student member
Prof.dr. M.N.M. (Marie-Colette) van Lieshout	Professor, Probability Theory, University of Twente
Dr. W.M. (Wioletta) Ruszel	Assistant Professor Stochastics, University of Utrecht

*Advisors:*

Prof.dr. J. Top	Department head of Mathematics;
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Dr. P. Trapman

Professor, Number Theory & Algebraic  
Geometry  
Associate Professor, Probability Theory

*HR advisor:*

N.F. Clemencia-Lokai

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

A position in the general area of Probability Theory and Combinatorics will strengthen and expand the existing expertise in the Mathematical institute and open new opportunities for interdisciplinary research.

The following topics are especially relevant: random discrete structures, random processes on discrete and/or spatial structures; stochastic geometry and topology, stochastic analysis, probabilistic, extremal and enumerative combinatorics.

Probability theory and combinatorial mathematics made great strides in recent years, displaying an increasing interconnectedness with each other as well as with various seemingly distant areas of mathematics, and with other branches of science including Biology, Physics and Chemistry. Challenges that have arisen in recent years include obtaining a full understanding of the "scaling limits" of large random discrete structures (such as networks) and to rigorously establish "universality classes"; understanding the behaviour of random spatial objects such as point processes, tessellations or matrices in high and moderately high dimensions and over non-standard geometric spaces; description of the combinatorial objects that maximise a chosen quantity subject to constraints, and "stability".

Applications of probability theory and combinatorial mathematics are pervasive in the sciences. Ideas and techniques from probability and combinatorics have for instance been applied with great success in Bioinformatics, Finance, Medicine and Physics.

#### **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 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 numerous 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), and in the Center "Groningen Cognitive Systems and Materials" (CogniGron) within the Faculty of Science and Engineering.

The position will be embedded in the “Probability and Statistics” group, one of the mathematics programmes of the institute. This group has as its main focus research in random graphs, percolation, graph theory and combinatorics, as well as in Mathematical Statistics and its applications to Systems Biology and Bioinformatics.

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

Locally, research on Probability Theory and on Combinatorics is embedded mostly in the Probability & Statistics programme of Mathematics. There are connections to other Mathematics programmes; notably to Dynamical Systems, Geometry & Mathematical Physics and also to Systems, Control & Optimization.

The interdisciplinary character of many of the research topics allows various links with Bernoulli Institute programmes in Computer Science and in Artificial Intelligence. Through its impact on both (stochastic) geometry and on data science, the position connects two of the three research themes of the Bernoulli Institute: Computing & Cognition; Geometry and its Applications; Systems, Data and Society.

Within the universities and research institutes of the Netherlands there are many groups focusing on specific areas of Probability Theory. There is contact and collaboration between them, particularly in the framework of the NWO-cluster “Stochastics – Theoretical and Applied Research” (STAR). The current position helps to maintain the role of the Bernoulli Institute in this.

The research programme in Probability & Statistics is involved in a number of prestigious international collaborations, including with Carnegie Mellon University, Oxford University, Polytechnic University of Catalonia and Stockholm University.

The Center for Data Science & Systems Complexity (DSSC) of the Faculty of Science & Engineering offers a natural environment for research in Probability Theory; several scientists from the Kapteyn Astronomical Institute as well as from the Engineering and Technology institute Groningen (ENTEG) are involved in DSSC as potential co-supervisors of joint PhD projects.

The mathematics programmes within the Bernoulli Institute participate in the Dutch mathematics Research Schools for Fluid Mechanics (J.M. Burgerscentrum) and the National Graduate School for Systems and Control (DISC), as well as in the national master’s and graduate courses programme Mastermath. They actively participate in each of the four NWO research clusters “Discrete, Interactive and Algorithmic Mathematics, Algebra and Number Theory” (DIAMANT), “Geometry and Quantum Theory” (GQT), “Nonlinear Dynamics of Natural Systems” (NDNS+) and “Stochastics – Theoretical and Applied Research” (STAR). The Bernoulli Institute also cooperates at the national level with the Data Science Center Eindhoven (DSC/e), the Data Science Institute of Philips Research, IBM, and several institutes involved in data science (Astron, TNO, NLR, SARA, ECN, CWI).

The Bernoulli Institute has a strong (inter)national position, shown for example by regular publications in top journals and proceedings, participation in NWO and EU projects, memberships of editorial boards, boards of mathematical societies, and international conference committees and chairing.

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

The candidate is expected to continue and extend her/his research program in the field of Probability Theory and Combinatorics. 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 further strengthen the existing strong reputation within the Bernoulli Institute of the field of Probability Theory and Combinatorics.

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

The candidate is expected to contribute to the teaching programs of the bachelor and master programs within the Faculty of Science and Engineering.

She/he will also be actively involved in the development of new courses related to the relevant research area. Furthermore, she/he will supervise final research projects of bachelor and master students.

### **9. Expected contributions to the organisation**

The candidate is expected to contribute in an active manner to the management and organizational tasks of the institute. At the level of Faculty of Science and Engineering, 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. Moreover, she/he will participate in relevant national and international organizations.