

## **Workshop: AI, Formalization and Mathematics, 16-17 June, 2026**

Workshop as part of the Collaborative Research Grant on “On Proofs and Partnerships: How AI, Big Data, and Proof Assistants are Transforming Mathematical Practices”

Organizers: Michael Friedman (Bonn University), Deborah Kent (University St. Andrews)

### Location:

Lipschitz-Saal, Endenicher Allee 60, 53115 Bonn

### Schedule:

#### **Workshop Schedule:**

##### **Tuesday, 16 June, 2026**

- 08:45-9:00      Arrival and coffee
- 09:00-9:30      Introduction (Friedman, Kent)
- 9:30-10:15      Floris van Doorn  
**Lean: Collaboration using Formalization**
- 10:15-11:00     Christopher Birkbeck  
**Formalising sphere packings in Lean**
- 11:00-11:30      Coffee break
- 11:30-12:15      Edwin Brady  
**Type-driven Programming and Reasoning with Idris**
- 12:15-13:00      Markus Pantsar  
**No human in the loop: considering autonomous theorem proving AI systems**
- 13:00              Lunch break [self-paid]
- 14:00-14:45      Hannes Junker  
**Vision in Medicine: The Pre-History of Artificial Intelligence in Diagnostic Imaging**
- 16:00: guided tour at the Arithmeum: <https://www.arithmeum.uni-bonn.de/en/arithmeum.html>
- 19:00 Restaurant [self-paid]

##### **Wednesday, 17 June, 2026**

- 9:30-10:15      Daniel Wenz  
**Building mathematical practice on shaking grounds - internal and external grounding in AI assisted proofs**

10:15-11:00	Deniz Sarikaya <b>Explications in Mathematics: Meaning Shifts and Theorem Provers</b>
11:00-11:30	Coffee break
11:30-12:15	Jim Portegies <b>Formalization and AI in teaching mathematics</b>
12:15-13:00	Ursula Martin <b>Will machines change mathematics?</b>
13:00-13:30	Conclusion

## Abstracts:

Floris van Doorn

### **Lean: Collaboration using Formalization**

Lean is a proof assistant which has a large mathematical library containing results from most areas of mathematics. It contains a good foundation to verify current research problems in various areas of mathematics, and enables new collaborative projects.

In this talk I will describe a finished project formalizing a generalization of Carleson's 1966 theorem in harmonic analysis, about the pointwise convergence of Fourier series. This is a major result in harmonic analysis with a difficult proof, and this result has been fully verified in Lean. The formalization was a large collaborative project with 17 main contributors.

Christopher Birkbeck

### **Formalising sphere packings in Lean**

I will discuss joint work on formalising Maryna Viazovska's Fields Medal-winning paper, which proves that the optimal sphere packing in 8 dimensions is given by the E8 lattice. I will describe the work by both humans and AI agents that has gone into this, and what future projects of this scale may look like.

Edwin Brady

### **Type-driven Programming and Reasoning with Idris**

Idris is a functional programming language with dependent types, which allow precise specification of programs and reasoning about how those programs behave at run-time. It encourages "type-driven development" in which we state a program's type in advance, and arrive at complete programs by refining definitions interactively. I will give an overview of programming and reasoning in this style, covering the history of dependently typed programming and proof assistants and discussing possible future research directions involving formally based, semantics driven proof and program search.

Markus Pantsar

### **No human in the loop: considering autonomous theorem proving AI systems**

In 2025, both Google DeepMind and OpenAI reported that their large language model (LLM)-based AI systems had achieved gold medal level performance in the International Mathematical

Olympiad. In addition, together with research mathematicians, DeepMind has made reported progress in solving research-level mathematical problems with their AI system. These developments suggest that in the near future important parts of mathematical theorem proving may be outsourced to LLM-based AI systems. This is potentially transformative to the use of proof assistants in mathematical research by fundamentally changing the dynamics of interactive computer-assisted theorem proving. But could such a system even become an *autonomous automated theorem prover* (AATP), effectively cutting the human mathematician from the loop? In this talk, I consider that scenario based on recent advancements in mathematical AI. I will focus on the epistemological question of AATP use in mathematical knowledge production, but my analysis will also extend to mathematical practice and its future in a field increasingly influenced by AI systems.

Hannes Junker

### **Vision in Medicine: The Pre-History of Artificial Intelligence in Diagnostic Imaging**

In recent times, discussions about the role of imaging techniques in medicine have often focused on the role of artificial intelligence. However, the mechanization of vision has a long prehistory that dates back at least to the emergence of X-ray technology at the end of the 19th century. The medical role of the physician's gaze was challenged early on by the use of mathematical methods in the localization of foreign bodies and the determination of the size of anatomical structures. While parts of the medical profession enthusiastically welcomed the possibilities of X-ray technology, others expressed concerns about a curtailment of medical expertise. Later, when tomography (from the 1930s onward) and sonography (since the 1960s) opened up new perspectives for clinical practice and medical research, debates among physicians about the value of imaging techniques for medical work re-emerged. More recently, the use of machine vision in the diagnostic classification of medical images has sparked controversy.

The lecture argues that not all of the problems associated today with the application of machine vision in medicine are new. Rather, by tracing discussions in medical and technical journals, it shows that recent debates about the role of imaging techniques in medical diagnosis—as well as the use of mathematical methods in the visualization of medical data—have a longer history. The central thesis is that the ongoing integration of artificial intelligence into medical work is the result of a historical process that has required a continuous adjustment of mathematical and medical perspectives.

Daniel Wentz

### **Building mathematical practice on shaking grounds - internal and external grounding in AI assisted proofs**

Mathematics has a long, winded history that includes many transformations concerning its topics, methods, notations, criteria of exactness and even the notion of what counts as mathematics at all. The impression that there lies a perennial science behind all these changes seems to originate in the peculiar relationship that consists between the method, the medium and the object of mathematical research. In mathematics the method and the medium not only open up a space for epistemic exploration of something given, but the given seems in some way to be grounded in the method and the medium. From this point of view the ongoing changes that occur in mathematics can be described through a story of an ongoing emancipation from (and the emergence of new) external grounding strategies. Immanuel Kant's mediating approach to ground mathematics via "pure forms of intuition" and David Hilbert's countermove to define geometry as "the logical

analysis of our spatial intuition" can be seen as different ways to deal with the tensions that emerge from this emancipation. In this presentation I will ask the question if theorem provers and other AI tools that begin to reshape the face of mathematical practice could lead to an intrinsic change of the topic of mathematical research through new methodologies they introduce and the new medium they depend on. The focus will not be on proof techniques but on specific means of exploration and discovery that the new technologies grant the mathematician. I will discuss examples from SAT-solver heuristics and look at two applications of tools (AlphaEvolve, PatternBoost, AlphaProof) that depend on going back and forth between different kinds of mathematical notation, natural language, code and formal logic. I will argue that this kind of doing mathematics implicitly rests on an oscillation between external and internal grounding strategies.

Deniz Sarikaya

### **Explications in Mathematics: Meaning Shifts and Theorem Provers**

Carnap introduced his notion of explication to arrive at concepts that are precise enough for scientific purposes. As Carnap wants to precisify concepts, his notion of explication targets less precise concepts so that explications within mature mathematics are not possible. We argue that explications of mature mathematical concepts are both possible and widespread. We focus on foundational work, especially as done in the context of interactive theorem proving. Taking foundational work seriously necessitates explicit decisions which are generally ignored in mathematical practice—and such developments are not captured by our usual notions of explication. We then discuss how common views on the semantics of programming language could motivate an even stronger reading of those changes up to challenging commensurability. (based on joint work with Jonas Raab (MCMP, LMU Munich))

Jim Portegies

### **Formalization and AI in teaching mathematics**

To help students with learning how to prove mathematical statements, we have developed the educational software Waterproof. Waterproof is built on top of a proof assistant and recently we have augmented it with an artificial, LLM-based tutor called Waterproof River. Waterproof has been used since 2019 in the Analysis courses in Eindhoven, and recently it has been piloted in an introduction-to-proof course in Utrecht. I will reflect on my experiences teaching mathematics with the help of proof assistants and AI, and hopefully place it into the context of the broader rapid developments around mathematics and AI.

Ursula Martin

### **Will machines change mathematics?**

A 2024 collection of articles in the Bulletin of the AMS asked "Will machines change mathematics?", suggesting that "Pure mathematicians are used to enjoying a great degree of research autonomy and intellectual freedom, a fragile and precious heritage that might be swept aside by a mindless use of machines", and challenging readers to "decide upon our subject's future direction." This talk will be a high-level approach to thinking about the factors, whether technical, social or economic, leading to the ongoing adoption, or otherwise, of computational interventions in mathematical practice, with examples drawn from contemporary AI and 20th century computational group theory. We address these issues through a framing of risks, infrastructure, and governance, to consider how the mathematical community might respond to the extraordinary exuberance around current developments in AI.