Mathematics for AI Summer School

Batumi and Kutaisi, Georgia

September 1–9, 2026

Official Program and Lecture Information Booklet

Organized by

Batumi Shota Rustaveli State University
Kutaisi International University
Fields Institute for Research in Mathematical Sciences

Contents

Welcome

Welcome to the **Mathematics for AI Summer School**, taking place in Batumi and Kutaisi, Georgia, from September 1 to September 9, 2026.

The Summer School brings together leading researchers and students interested in mathematical foundations of artificial intelligence, including logic, algebra, learning theory, optimal transport, type theory, automated reasoning, and related areas.

This booklet contains the preliminary schedule, speaker information, lecture titles, lecture abstracts, and the list of listeners.

Organizers

- Batumi Shota Rustaveli State University
- Kutaisi International University
- Fields Institute for Research in Mathematical Sciences

Organizing Committee

- Anzor Beridze
- Besik Dundua
- Deirdre Haskell
- Messoud Efendiev
- Alexander Meskhi

Program Schedule

Batumi, Georgia

Date	Time	Speaker	Activity
September 1, Tuesday	10:00–11:30	Alexei Miasnikov	Lecture 1: AI and Search in Math Problems
	12:00–13:30	Vlad Stepanov	Lecture 2: Beyond Short-Term Reasoning: LMM–Agentic Math for Long-Horizon Mathematical Research
	17:00–19:00	Andrey Nikolaev	Problem Session: From Classical AI to Transformers: Models, Mathematics, and Practice
	19:30	Alexander Meskhi Deirdre Haskell	Welcome Speech
September 2. Wednesday	10:00–11:30	Greg Cousins	Lecture 1: Connections Between AI/ML and Logic
	12:00–13:30	Greg Cousins	Lecture 2: Connections Between AI/ML and Logic
	17:00–19:00		Problem Session
September 3, Thursday	10:00–11:30	Anastasis Kratsios	Lecture 1: A Simple Closed-Form Formula for Optimal Neural Network Regression on Metric Spaces
	12:00–13:30	Anastasis Kratsios	Lecture 2: A Simple Closed-Form Formula for Optimal Neural Network Regression on Metric Spaces
	17:00–19:00		Problem Session
September 4, Friday	10:00–11:30	Davit Gogolashvili	Lecture 1: Advances in the integration of LLMs and ITPs for Math
	12:00–13:30	Davit Gogolashvili	Lecture 2: Advances in the integration of LLMs and ITPs for Math
	17:00–19:00		Problem Session
September 5, Saturday	10:00–11:30	Elena Bunina	Lecture 1: Lean, Formal Mathematics, and AI
	12:00–13:30	Elena Bunina	Lecture 2: Lean, Formal Mathematics, and AI
	15:00–17:00		Problem Session

September 5/6, Saturday/Sunday: Transfer to Kutaisi.

Kutaisi, Georgia

Date	Time	Speaker	Activity
September 7, Monday	10:00–11:30	François-Xavier Vialard	Lecture 1: Optimal Transport, Gromov–Wasserstein Geometry, and Gradient Flows
	12:00–13:30	François-Xavier Vialard	Lecture 2: Optimal Transport, Gromov–Wasserstein Geometry, and Gradient Flows
	17:00–19:00		Problem and Puzzles Session
September 8, Tuesday	10:00–11:30	Furio Honsell	Lecture 1: A Brief History of Types
	12:00–13:30	Furio Honsell	Lecture 2: A Brief History of Types
	16:00–18:00	Mauricio Ayala Rincon and Nikson Ferreira	Lecture 3 (Online): Advances on the integration of LLMs and ITPs for Math
	17:00–19:00		Problem Session
September 9, Wednesday	10:00–11:30	Mariangiola Dezani	Lecture 1: Process Calculi, Types, and Session Types
	12:00–13:30	Mariangiola Dezani	Lecture 2: Process Calculi, Types, and Session Types
	17:00–19:00		Problem Session

Speakers

Alexei Miasnikov, jointly with Vlad Stepanov and Andrey Nikolaev

Stevens Institute of Technology, USA

Lecture Series: AI and Search in Math Problems

Abstract

Lecture 1: This talk presents mathematical problem solving as a search for proofs, counterexamples, patterns, etc. in vast, often infinite spaces. While classical algorithms aim to solve every instance, many major open problems concern a few rare and exceptionally difficult inputs—the mathematical analogue of finding a needle in a haystack. Examples from algorithmic group theory, including the word problem, the finiteness of B(2,5), and the Andrews–Curtis conjecture, illustrate how generic instances may be easy even when decisive challenge cases remain inaccessible. The talk explores how AI, machine learning, and reinforcement learning can adapt general search procedures to particular challenges by generating, combining, and training specialized algorithms. It also introduces the geometry and stratification of search spaces, together with Challenger–Solver complexity, which measures both the size of a specialized solver and the cost of producing it. This framework points toward a new form of experimental mathematics, supported by Large Mathematical Models and shared computational environments in which conjectures and algorithms can be investigated at scale.

Lecture 2: Current LLMs struggle with research that unfolds over months or years. We'll examine why and introduce LMM–Agentic Math, our early-stage system for longhorizon research work. Attendees will get early access to try it on their own projects.

Problem Session: This session traces the evolution of artificial intelligence from classical models to modern transformer architectures powered by attention mechanisms. Using elementary mathematical tasks, we compare representative models and examine their accuracy, reasoning behavior, strengths, and characteristic failure modes. We then address practical questions that arise when working with these systems, including model selection, prompt design, verification, and the reliable evaluation of mathematical outputs. The session offers both an accessible introduction to contemporary AI models and concrete guidance for using them effectively in mathematical work.

Greg Cousins

McMaster University, Canada

Lecture Series: Connections Between AI/ML and Logic

Abstract

The overarching theme of the workshop is on connections between ML ("AI") and mathematical logic. This session will have three sessions:
Session 1: In this session, we discuss a classical NP-complete problem in propositional logic, the boolean satisfiability problem (SAT) and examine some recent attempts to apply ML techniques to solve, or approximate solutions, various SAT problems. SATs appear in many practical applications, and so efficiently solving them has high industrial importance.
Session 2: A well-studied notion of learnability is that of "probably approximately correct" learnability. A classic (fundamental) theorem is that a concept class is PAC learnable if and only if it has finite VC-dimension, essentially meaning that the class cannot "distinguish too much". In logic, specifically model theory, several notions of logical tameness were introduced solely to classify first-order theories by their internal combinatorics (stability, NIP-ness). It was later observed that such combinatorial restrictions are exactly equal to all uniformly definable families of concept classes having finite VC dimension. The connections to ML have been known for some time in the logic community, but only recently is the ML community beginning to appreciate that restricting one-self to an appropriate "definable" setting is often a convenient way to enforce a uniform tameness on the objects being studied. As a working example, we will introduce the concept of o-minimality, and discuss how most functions studied in ML fall into this category. We will also discuss some notable exceptions. All technical concepts will be defined, no knowledge of model theory will be assumed.

Anastasis Kratsios

Computational Sciences and Engineering, Vector Institute, Canada

Lecture Series: A Simple Closed-Form Formula for Optimal Neural Network Regression on Metric Spaces

Abstract

Kernel ridge regression is both computationally convenient and analytically tractable largely because its estimator admits a simple closed-form expression; no analogous representation is generally available for neural networks. We address this problem by introducing a simple closed-form "two-layer" formula $f\hat{}$, with $\mathcal{O}(N)$ parameters, for reconstructing an unknown real-valued Lipschitz function f on a metric space (χ, ρ) from N i.i.d. noisy observations. Our main result is a high-probability uniform (L_∞) recovery guarantee, jointly controlling approximation, statistical, and optimization errors; not merely establishing convergence of the population risk.

Davit Gogolashvili

Federal University of Goiás/University of Brasília

Lecture Series: Advances in the integration of LLMs and ITPs for Math

Abstract

Abstract: This talk will present a personal perspective on integrating generative AI frameworks with Human-Interactive Theorem Provers (ITPs). The history of the fruitful human-ITP collaboration started with the famous de Nicolaas Govert de Bruijn's 'Automath Project' more than half a century ago, culminating in the first mechanization of a significant piece of mathematical knowledge: the computational verification of the correctness of Edmund Landau's Foundations of Analysis. The development of the Automath project used, reinvented, and consolidated mathematical formalisms in fundamental areas, such as logical and equational deduction, proof theory, typed lambda calculus, term rewriting, and explicit substitutions, thereby influencing the technology implemented in today's leading theorem provers. The talk will illustrate this human-ITP collaboration through a one-hour demo of our work in the Prototype Verification System (PVS). Including the power of Large Language Models in this human-ITP collaboration adds a third, prolific but uncertain, actor to the formalization process, which may accelerate the interactive theorem-proving exercise, but only safely under specialist, responsible supervision. The talk will discuss preliminary advances toward integrating the power of Large Language Models into the PVS mechanization process.

joint work with Mariano Moscato

Elena Bunina

Bar-Ilan University, Israel

Lecture Series: Lean, Formal Mathematics, and AI

Abstract

These lectures introduce Lean as a language and proof assistant for formal mathematics. We will discuss how mathematical statements and proofs are represented in Lean, how interactive proof development works, and why formal verification is important for AI-assisted mathematics. In the practical session, participants will write and check their first Lean proofs. No previous experience with Lean is required.

François-Xavier Vialard

Université Paris-Saclay, France

Lecture Series: Optimal Transport, Gromov–Wasserstein Geometry, and Gradient Flows

Abstract

This lecture introduces probability measures and optimal transport through the Monge and Kantorovich formulations. Wasserstein distances provide a geometric framework for comparing and interpolating distributions. We also briefly present Gromov–Wasserstein distances that extend this framework to structured data without a common ambient space. We briefly address computational methods, including entropic regularization and Sinkhorn algorithms. Finally, Wasserstein gradient flows and the JKO scheme connect variational optimization with nonlinear evolution equations. Lecture 2: Mean-Field Learning Dynamics, ResNets, and Attention This lecture presents neural-network training as a dynamical system in parameter space. For shallow networks, we show the interest of the mean field limit that yields a measure-valued evolution governed by a Wasserstein gradient flow. Then, we explain why the architecture of residual networks is key to providing a good optimization landscape. We also describe a mean-field limit residual network where Wasserstein gradient flows intervene. Last, attention is introduced as well as its mean-field limit. We conclude by studying how the sample complexity of attention depends on context length, dimension, noise, and architecture.

Furio Honsell

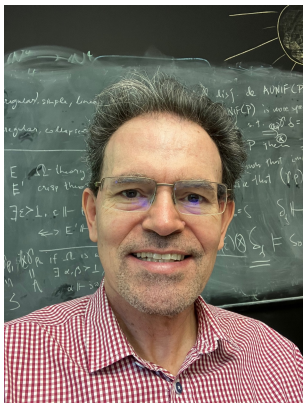
University of Udine, Italy

Lecture Series: A Brief History of Types

Abstract

Types play a crucial role in our understanding of the foundations of Mathematics since the *Principia*, as well as in the foundations of Computation since Church and Martin-Löf. One may consider types in dual ways. Types can be seen either to arise once the notion of computation is given, namely as invariants, wherefrom the ditto "Typed Programs cannot go wrong" which is at the core of program verification and certification since LCF. Or they can originate *per se* as in the "Proposition as Types paradigm" whereby computations, in the form of λ-terms, play the role of constructive proofs, thus providing the underpinning of all modern proof development environmensts such as Rocq, Agda, Lean. We will give examples and recall the basic results which pertain to each view, namely normalization on one hand and program extraction on the other hand. We conclude with some recent results on intersection type disciplines and fuzzy automata.

Mauricio Ayala Rincon, jointly with Nikson Ferreira



University of Brasília (UnB), Brazil

Lecture Series: A Brief History of Types

Abstract

This talk will present a personal perspective on integrating generative AI frameworks with Human-Interactive Theorem Provers (ITPs). The history of the fruitful human-ITP collaboration started with the famous de Nicolaas Govert de Bruijn's 'Automath Project' more than half a century ago, culminating in the first mechanization of a significant piece of mathematical knowledge: the computational verification of the correctness of Edmund Landau's Foundations of Analysis. The development of the Automath project used, reinvented, and consolidated mathematical formalisms in fundamental areas, such as logical and equational deduction, proof theory, typed lambda calculus, term rewriting, and explicit substitutions, thereby influencing the technology implemented in today's leading theorem provers. The talk will illustrate this human-ITP collaboration through examples of our work in the Prototype Verification System (PVS). Including the power of Large Language Models in this human-ITP collaboration adds a third, prolific but uncertain, actor to the formalization process, which may accelerate the interactive theorem-proving exercise, but only safely under specialist, responsible supervision. The talk will discuss preliminary advances toward integrating the power of Large Language Models into the PVS mechanization process.

Mariangiola Dezani

University of Turin, Italy

Lecture Series: Process Calculi, Types, and Session Types

Abstract

In modelling distributed systems where processes interact by means of message passing, one soon realises that many interactions are meant to occur following disciplined protocols. The ability to describe complex interaction protocols by means of a formal, simple and yet expressive type language can have a profound impact on the way distributed systems are designed and developed. This is witnessed by the fact that some important standardisation bodies for web-based business and finance protocols have recently investigated design and implementation frameworks for specifying message exchange rules and validating business logic based on the notion of sessions, where session types are "shared agreements" between teams of programmers developing possibly large and complex distributed protocols or software systems.

Aim of this course is to provide a gentle introduction to session type theory, enlightening aspects which are at the core of the current research in this subject.

Listeners

No.	Name and Surname	Affiliation
1	Sabir Ahmad	The G. Zaldastanishvili American Academy
2	Nurana Aliyeva	ADA University
3	Maia Artmeladze	Batumi Shota Rustaveli State University
4	Murtaz Babunashvili	Kutaisi International University
5	Mariam Barbakadze	Kutaisi International University
6	Andria Beridze	Kutaisi International University
7	Guri Botchorishvili	Kutaisi International University
8	Ivan Buchinskiy	
9	Mikheili Dadiani	Kutaisi International University
10	Saba Dumbadze	Kutaisi International University
11	Alex Dunaykin	
12	Tatia Dundua	Universitat Politècnica de València
13	Liza Dzirkvadze	Batumi Shota Rustaveli State University
14	Anatolii Evtiagin	
15	Mariami Garuchava	Kutaisi International University
16	Ravan Isaevi	Tbilisi state university, Mathematical department
17	Mariam Karseladze	Kutaisi International University
18	Mariam Katamashvili	Kutaisi International University
19	Karina Khachaturian	Redcore
20	Davit Khantadze	Kutaisi International University
21	Evgeny Kuznetsov	Andrea Razmadze Mathematical Institute
22	Demetre Labadze	Akaki Tsereteli State University
23	Konstantine Machavariani	Kutaisi International University
24	Giorgi Machitidze	Ivane Javakhishvili Tbilisi State University
25	Davit Maisuradze	Kutaisi International University
26	Priyanka Majethiya	SVNIT
27	Archil Margvelashvili	Kutaisi International University
28	Luka Nakashidze	Kutaisi International University
29	Mariam Nebieridze	Kutaisi International University
30	Giorgi Nizharadze	Batumi Shota Rustaveli State University
31	Jumber Pkhakadze	Kutaisi International University
32	Saba Tchitchinadze	Kutaisi International University
33	Mariam Tchubabria	Kutaisi International University

34	Mariam Tevdorashvili	Kutaisi International University
35	Luka Tsintsadze	Batumi Shota Rustaveli State University
36	Lado Turmanidze	Kutaisi International University
37	Megi Vekua	Kutaisi International University

Practical Information

Venues. The first part of the Summer School will take place in Batumi, Georgia, from September 1 to September 5. The second part will take place in Kutaisi, Georgia, from September 7 to September 9.

Transfer. The transfer from Batumi to Kutaisi is planned for Sunday, September 6.

Further information. Additional information about accommodation, local transportation, and social events will be provided to participants separately.

We look forward to welcoming you to Georgia.