Final MC Meeting: WG 5 Machine Learning in Proofs

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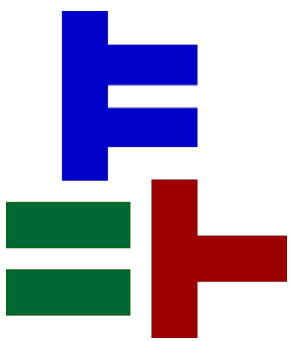

Work Group 5: Goals

Contribute to the field of machine-learning-based methods to improve the efficiency of automated theorem proving systems in terms of further development of techniques for proof guidance and premise selection. Furthemore, the group will explore how and to what extent tasks of computer-assisted reasoning can be extended to proofs that are represented in (controlled) natural languages.

Working Group 5: Past Events

- AITP 2022 europroofnet.github.io/wg5-aitp22/
- Prague Workshop 2023 europroofnet.github.io/Prague23/
  - Practical Aspects of Machine Learning in Theorem Proving
  - Datasets Generation for Data-Deficient Domains
- Workshop on Natural Formal Mathematics europroofnet.github.io/cambridge-2023/
  - Joint WG4-WG5 meeting (Part of CICM 2023)
- Vienna Workshop 24: Alignment of Proof Systems and Machine Learning europroofnet.github.io/wg5-vienna24/
  - Location: Technical University of Vienna
- Summer School on AI for Reasoning and Processing of Mathematics europroofnet.github.io/Kutaisi24/
  - Location: Kutaisi International University, Georgia

Working Group 5: Past Events

- Edinburgh 25: Theorem Proving and Machine Learning in the age of LLMs: SoA and Future Perspectives
  europroofnet.github.io/wg5-edinburgh25/
  - Location: Heriot-Watt University,
- EuroProofNet School on Natural Formal Mathematics
  naproche.github.io/school/
  - Location:Mathematics Centre, Bonn, Germany

Working Group 5: Past Events





Working Group 5: This year

Accepted STSMs

- Red $\Rightarrow$ visitor contributed to the publication list of the action.

- Tree Transformers for Symbolic Mathematics application
- Informalization and Autoformalization with Dedukti and GF application
- Higher-Order Equational Unification and Anti-Unification for Program Verification
- Exploring anti-unification over typed languages and equational theories
- Evaluation and development of the Alk platform for enhancing students' algorithm design and analysis skills application report
- Using Coq to formalise differentiable logics for neural networks
- Machine-learned premise selection for Agda: the prover's infrastructure
- Conjecture and proof search in Agda with large language models
- Neural Premise Selection for Agda
- Automated Translation of Mizar Declarative Proof
- A bootstrapping verified compiler for a concurrent functional language: the design

Deliverable One

Learning Guided Automated Reasoning: A Brief Survey

Lasse Blaauwbroek[1,2], David Cerna[3], Thibault Gauthier[1], Jan Jakubův[1,4], Cezary Kaliszyk[4], Martin Suda[1], and Josef Urban[1]

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Abstract. Automated theorem provers and formal proof assistants are general reasoning systems that are in theory capable of proving arbitrarily hard theorems, thus solving arbitrary problems reducible to mathematics and logical reasoning. In practice, such systems however face large combinatorial explosion, and therefore include many heuristics and choice points that considerably influence their performance. This is an opportunity for trained machine learning predictors, which can guide the work of such reasoning systems. Conversely, deductive search supported by the notion of logically valid proof allows one to train machine learning systems on large reasoning corpora. Such bodies of proof are usually correct by construction and when combined with more and more precise trained guidance they can be boostrapped into very large corpora, with increasingly long reasoning chains and possibly novel proof ideas.
In this paper we provide an overview of several automated reasoning and theorem proving domains and the learning and AI methods that have been so far developed for them. These include premise selection, proof guidance in several settings, AI systems and feedback loops iterating between reasoning and learning, and symbolic classification problems.

- *D12 (or D8) - Detailed technical report on the evaluation of techniques for learning proof search guidance and premise selection in automated theorem provers.*
  europroofnet.github.io/publications/

Second Deliverable, Publications

- **Deliverables:**
  - White paper on including restricted natural language proof formats to existing proof libraries (Month 48).
  - Title: Integration of (controlled) natural language in formal mathematics systems
  - Covering:
    - LLMs for Interactive Theorem Proving (Ekaterina Komendantskaya *et al.*).
    - Naproche (Peter Koepke and Adrian De Lon, naproche.github.io/)
    - Informath (Aarne Ranta, www.youtube.com/watch?v=UG6RUFS5esk)
- **Publications:**
  - So far 150 publications associated with EPN europroofnet.github.io/publications/
  - 22 are associated with Working Group 5. (rough count)