



Working Group 4 Libraries of Formal Proofs

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1. WG1 Tools on Proof Systems Interoperability
2. WG2 Automated Theorem Provers
3. WG3 Program Verification
4. WG4 Libraries of Formal Proofs
5. WG5 Machine Learning in Proofs
6. WG6 Type Theory



Objectives:

1. investigate various approaches to efficiently **maintain** libraries of formal proofs
2. to make a collection of proofs that can be **modified, extended, and queried** ...
3. ...by users who **do not have expert knowledge of the entire collection nor of the system** that was used to develop the proofs.



Tasks:

1. discuss challenges of **maintaining and using** existing libraries of formal proofs;
2. contribute to creating **database** of already formalised mathematics;
3. develop the **tool for querying** libraries of formal proofs with respect to the semantic of search object;
4. that the tool can be efficiently **used** with Dedukti and within software formalisation efforts.



Deliverables:

1. (month 12): **Database** gathering **proofs** from Coq, HOL-Light and Matita and **their translations**.
2. (month 24): Tools for managing the **dependencies** between proofs, and **querying** and **searching** the database.
3. (month 48): Extension of the database and associated tools to **other systems** like Agda, Minlog, PVS, Lean, Mizar, Atelier B, TLAPS.

Report First Year

Events:

- ▶ WG4 meeting part of Computational Logic Autumn Summit, co-located with CICM 2022 (GE, September 23-24 2022, 15 talks, 1 round table, 47 participants)

STSM:

- ▶ last call for STSM with a focus on WP4
- ▶ notably: an STSM on the transfer and reuse of contextual procedural knowledge from one system (Coq) to another (LambdaPi)

Hiring:

- ▶ INRIA has tried to hire on its budget an ingénieur de recherche to take care of engineering issues (e.g. for WP4 deliverable 1)
- ▶ no applicant was suitable for the position
- ▶ Abdelghani Alidra was hired the next year

Report Second Year

Events

- ▶ Inter-WG developers meeting (FR, July 25-28, 2023, 14 participants)
- ▶ Joint WG4-WG5 meeting (UK, September 6-8, 2023, 24 participants)
- ▶ WG1+4 meeting (FR, September 26-27, 2023, 21 participants)
- ▶ Inter-WG developers meeting (FR, 23-25 April 2024, 11 participants)
- ▶ Workshop: Libraries of Digital Math (July 29 - August 2, 2024) (not EuroProofNet organized, but large participation of EuroProofNet members)
- ▶ Meeting of WG1+WG2+WG4 (FR, September 26-27, 2024, 15 participants)
- ▶ WG4 meeting/2nd workshop on the development, maintenance, refactoring and mining of large libraries of proofs, in co-location with ITP'24 (GE, September 13-14, 2024)

STSMs

- ▶ Learning for Automated Theorem Proving Based on Proof Structures in the Presence of a Large Proof Library (HU \mapsto DE)
- ▶ Conjecture and proof search in Agda with large language models (UK \mapsto SE)

ITGCs

- ▶ Term Search in Rust (EE \mapsto IT, 2024 Workshop on Type-Driven Development)

Participation: 185 members (35%), +18%

Report Third Year

Events

- ▶ 15-16 September 2025: EuroProofNet Workshop on Proof Libraries, part of EuroProofNet Symposium, Institut Pascal, Orsay, (FR, 16 talks, 40 participants)

STSMs

- ▶ Indexing and web search for cross libraries Proofs (FR \mapsto IT)
- ▶ Proof mining libraries for Lean (RO \mapsto UK)
- ▶ Translation templates for Dedukti (FR \mapsto DE)
- ▶ Centralized indexing and search for LambdaPi/Dedukti (IT \mapsto FR)

Participation: 202 members (33%), +9%



Search Engines and tools

- ▶ **FindFacts**: search tool for Isabelle
- ▶ **SErAPIS**: search tool for Isabelle
- ▶ **LeanExplore**: search tool for Lean
- ▶ **Loogle**: search tool for Lean
- ▶ **Moogle**: search tool for Lean
- ▶ **LeanSearch**: search tool for Lean
- ▶ **LeanCopilot**: copilot for Lean
- ▶ **LeanStateSearch**: search tool for Lean
- ▶ **LeanFinder**: search tool for Lean
- ▶ **LambdaPi**: integrated search tool + stand-alone web server
- ▶ <https://lambdapi.saclay.inria.fr/>
Indexed online HOL library ($\text{HOL} \mapsto \text{Lambdapi} \mapsto \text{Rocq}$)

Discussion

- ▶ Continuous effort on **maintenance** by various groups, often not visible scientifically
 - ▶ it leads to the development of **tools** (e.g. Lean Blueprint, Rocq HierarchyBuilder, ...)
 - ▶ applicability to multiple systems is still a promise, but **cross-fertilization** happens
- ▶ Emphasis on **quality of libraries** and best practices on **management of libraries**
 - ▶ Enormous **cultural differences** between the various systems
 - ▶ Scarce cross-fertilization
- ▶ **Indexing and searching** is becoming an hot topic again
 - ▶ Greatly **impacted by the AI wave**: best for users without expert knowledge
 - ▶ There is still space for **other approaches** (e.g. to integrate in proof search)
 - ▶ **Heterogenous libraries** are interesting (e.g. need for alignments, indexing up to translation) but **lack of aligned libraries**