

Inria Challenge: midterm summary

For all questions, do not hesitate to contact devis-contact@inria.fr

To be submitted to the DGD-S via the email address above.

Adaptation des Systèmes de preuve pour l'enseignement des mathématiques universitaires

LiberAbaci¹

<https://liberabaci.gitlabpages.inria.fr>

- **Project lead:** Yves Bertot **Project lead's email:** yves.bertot@inria.fr

Project lead's team: Stamp **Project lead's research center:** Sophia Antipolis

- **Internal partners (EP/CRI) and external partners**

Cambium (contact : Jean-Marie Madiot)

Camus (contact : Arthur Charguéraud)

Gallinette (contact : Nicolas Tabareau)

Spades (contact : Martin Bodin)

PiCube (contact: Hugo Herbelin)

TOCCATA (contact : Sylvie Boldo)

external partner

Laboratoire d'informatique de Paris Nord (contact: Micaela Mayero)

Highlights ($\frac{1}{2}$ page maximum)² During the first two years of this Inria challenge, the Toccata and Serena teams hosted two persons in teaching positions from University Sorbonne Paris-Nord, Micaela Mayero and Pierre Rousselin. These persons, together with another collaborator from the Laboratory at Paris-Nord, Marie Kerjean (CNRS researcher) have been experimenting for three years with courses introducing first year students to proof methodology using the Coq system. This work has been presented at the international workshop ThEDU (Theorem Provers in Education) and a paper should be published soon in the proceedings [[KerjeanMayeroRousselin2024](#)].

With the help of an engineer also hosted by the Toccata team, the two teams and their hosted collaborators prepared contents and a working environment to be used by students in the first university year, concentrating on divisibility and binomial numbers. This work was also presented at ThEDU and an extended version of the paper should be published in the workshop proceedings [[Boldo et al.2024](#)].

This is our most advanced result since it goes the whole way up to the classroom usage. Some of its contents was also an inspiration for other experiments done in other sites.

¹Everything that is in green explains what is expected and should be replaced with the appropriate text for your project.

²Everything that is in blue gives the size limits to be respected without cheating on the margins, font size, etc.

Research accomplished and progress on the Challenge

(1 page maximum) During the first two years, we produced the following elements:

- A pair of courses for first year students, used at University Paris-Nord, directly usable in the web-browser, thanks to JsCoq, [on divisibility](#), [on binomial numbers](#). A long presentation was given as [an invited talk in a French national conference \(JFLA24\)](#).
- A methodology to make the use of JsCoq more easily adopted by teachers (setting up the service and preparing contents). This project is called JsCoq-light. It restricts a functionality (peer2peer sharing) that does not seem good for a teaching context, and other functionalities have been added, so that content can be hidden (to provide definitions whose details are too difficult for student's comprehension), contents can be saved and restored, and some block can be made read-only. It is available [on a gitlab.inria.fr repository](#).
- A new version of Coq-LSP, an extension of visual studio code based the LSP protocol (acronym for Language Server Protocol), with a tight integration in the Fleche+pétanque ecosystem, together with a version of JsCoq based on Fleche, [JsCoq2](#), developed by E. Gallego Arias from the PICUPE team ([demo](#)).
- A new version of VsCoq, an extension of visual studio code based on the LSP protocol, [vscoq2](#).
- Work on reducing the number of “number types” available in type theory, as a means to make the language of proof systems closer to introductory mathematics, together with a study of how to make computation with real numbers comfortable, by Y. Bertot and T. Portet. A paper has been published in a national conference [[Bertot-Portet25](#)]. This work exhibits the need to establish correspondances between several types and subsets of types, reminiscent of the work on [Trocq](#).
- Julien Puydt worked on techniques to solve ambiguities using the context (inspired by A. Charguéraud and M. Bodin's work), techniques to make typing depend on local conditions, and the development of a semi-formal presentation of the mathematics program in CPGE (with regular meetings with Y. Bertot).
- A study of notations making overloading of notations between several operators comfortable to use. This work was the occasion of a collaboration between the teams CAMUS in Strasbourg and SPADES in Grenoble and lead to a publication in a national conference [[CharguéraudBodinRiboulet25](#)]. A longer version is being written with planned submission in a journal.
- A setting to have observational equality (with in particular, function extensionality and unicity of identity proofs), with a handy application to constructing quotient types, this work is published in two papers [[PujetTabareau24](#)] [[PujetLerayTabareau25](#)].
- Experiments with members of the department of research on mathematics education (IREM) in Grenoble, [focussing on Variation tables](#).

Changes made to the Challenge organization (½ page maximum)

Teams coming to or leaving the Challenge; changes to the partner "circles"; the implication levels of the teams, etc.

Cyril Cohen, involved on task 3, moved to the CASH team in Lyon. Quentin Vermande, who is co-supervised by Yves Bertot and Cyril Cohen, also moved to Lyon. Quentin is still a Ph.D. Student of the STAMP team in Sophia Antipolis (he is a Ph. D. of the Université Côte d'Azur, the funding for his Ph. D. was initially given by École Normale Supérieure). The work of Quentin contributes partially to LiberAbaci.

Martin Bodin established a strong collaboration with IREM (Institut de Recherche sur l'Enseignement des Mathématiques) in Grenoble.

Yves Bertot has established contacts with Julien Puydt, a professor in the *classe préparatoire des grandes écoles (CPGE)* system in France. They are working on implementing various kinds of notation resolution mechanisms as front-end to proof assistants and on developing a semi-formal description of the mathematical curriculum for CPGE.

Interactions between the Challenge teams (1 page maximum)

Explain the actions undertaken since the project's start, especially when they have established interactions between the partners and show the articulation of the different Challenge partners...

The highlight of the project is the result of a collaboration between members of Toccatà, Serena, and members of LIPN. It should be noted that these teams have a long tradition of collaborative and productive work.

There have been visits from the Lyon site to the Nantes site to work on various aspects of proof transfer, rewrite and unification. The [summary of the discussion](#) is available on the LiberAbaci web site.

Revised objectives for the remainder of the project (½ page maximum)**Future possibilities and the choices before you today** (1 page maximum)

Have you identified possible changes to your goals or your organization? Do you see specific risks associated to certain goals?

Appendices

Non-permanent staff working on the Challenge

List the doctoral students, postdoctoral researchers, and engineers working on the Challenge.

Other projects underway and planned (funded outside Inria) connected to the Challenge

As a bullet list, for each contract give the following information:

- *Project acronym, project title, duration*
 - *Coordinator's name*
 - *List of partners:*
 - * *Partner 1 (only give the names of the establishment, the laboratory, and the country)*
 - * *...*
 - * *Partner N (only give the names of the establishment, the laboratory, and the country)*

Give the link to the official web site for European projects.