Open Geometry Prover Community Project

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The Emergence of GATP

The emergence, in the last years, of computing and reasoning tools, in particular automated geometry theorem provers, has enriched our experience with mathematics immensely.

Building such tools and exploring their applicability require a coherent, well-organized community of researchers working in a collaborative way, to avoid disparate efforts, as recalled by Han et al. [2019].

Open Geometry Prover Community Project

The *Open Geometry Prover Community Project* (*OGPCP*) aims at the integration of the different efforts for the development of geometry automated theorem provers, under a common "umbrella".

A contribution to the larger goal of establishing a network of researchers working in the area of formal reasoning, knowledge-based intelligent software and geometric knowledge management, to explore efficient methodologies for the creation and reuse of electronic tools in geometry.

Open Geometry Prover Community Project Goals

1. to provide a common open access repository for the development of Geometry Automated Theorem Provers (GATP);
2. to provide an API to the different GATP in such a way that they can be easily used by users, stand-alone or integrated in other tools;
3. to develop portfolio strategies to allow choosing the best GATP for any given geometric conjecture;
4. to interface with repositories of geometric knowledge Quaresma et al. [2018] (e.g. *TGTP* Quaresma [2011], *TPTP* Sutcliffe [2017]);
5. to develop a GATP System Competition to be able to rate GATPs Baeta et al. [2020], Quaresma and Baeta [2019].

OGPCP, Implementation Status

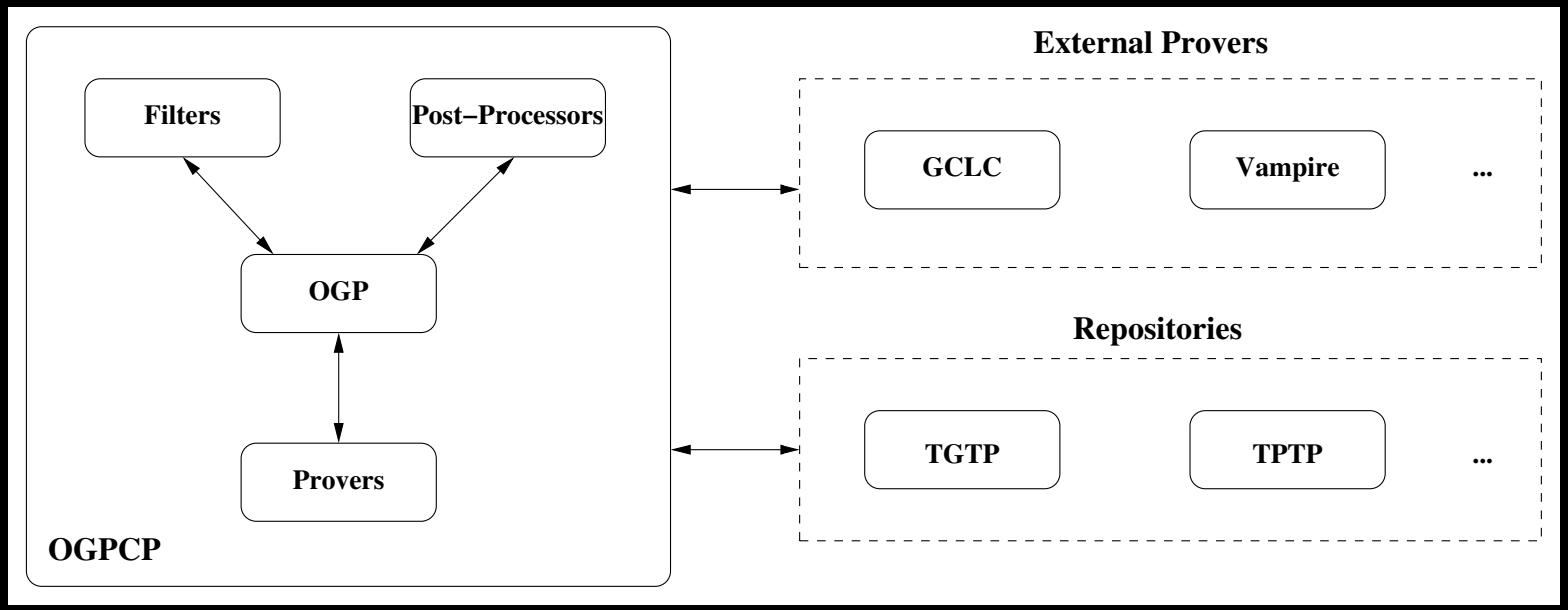

Figure: OGPCP Framework

OGPCP, Source Repository – 1

- The *OGPCP* is hosted at GitHub.[3]
- The code is made avaliable under the GNU General Public License 3 or later.
- *OGPCP* is available only as source-code and its installation in Unix systems is a straightforward process, provided that GNU Make, Apache Ant and OpenJDK are installed.

[3] `https://github.com/opengeometryprover/OpenGeometryProver`

OGPCP, Application Programming Interface – 2

OGPCP API is a combination of several command-line tools, e.g., native and external provers, filters, post-processors, prepared to seamlessly work together or with independent tools.

Native *OGPCP* provers must:

- use *TPTP*'s first-order format (FOF) syntax as their default conjecture format;
- accept the same command-line arguments;
- provide the same output.

External provers will be developed by other teams.

- External provers conjecture's format may not adhere to TPTP's FOF syntax;
- Filters to/from the FOF syntax must be written, as well as post-processors to interpret the output of those provers.

OGPCP, Filters & PostProcessors

A set of filters are already ready to be used.

`filterGCLtoFOF` GCL language to FOF

`filterGEOGEBRAtoFOF` GeoGebra[4] to FOF

`filterJGEXtoFOF` JGEX to FOF

for the moment all these filters, `filter*toFOF`, assume the inclusion of the axioms of the deductive database full-angle method Chou et al. [2000], given that these are already converted to FOF syntax.

Post-processors are to be used in conjunction with independent provers. They are used to obtain information about the proof's result, e.g., if the proof was successful or not, time, file with the proof steps, if any, etc.

[4] `https://www.geogebra.org/`

OGPCP External/Internal GATP

A set of external GATP are already part of the OGPCP. These are autonomous open source projects that recognise the *OGPCP* and from which filters to/from the native syntax and FOF are already implemented, or will be implemented in a near future.

- GeoGebra Automated Reasoning Tools
- GCLC Automated Reasoning Tools.
- CoqAM
- JGEX

Apart from these ATP, specific to geometry (GATP), the generic ATP can also be used (e.g. Vampire, Prover9).

Internal GATP, from the project *OpenGeoProver*, *Wu's method*, *Area Method* (both with problems); new Deductive database method (implementation stage); new Deductive Graphs Method (research stage).

OGPCP, Portofolio – 3

Portfolio problem solving is an approach in which for an individual instance of a specific problem, one particular, hopefully the most appropriate, solving technique is automatically selected among several available ones and used.

Already some work in the area of geometric automated theorem proving has been done, namely in the prover mechanism implemented in GeoGebra Kovács [2014, 2015], Mladen Nikolić [2019]. It is expected that this research can be incorporated into the *OGPCP*.

OGPCP, Interface with Repositories – 4

A server/client architecture to connect *OGPCP* and *TGTP* is already available. On the side of the *TGTP* repository a query-server is already implemented, always listening to client requests.

The code for the clients is open-source and available as part of the *OGPCP* project.

The implementation of new clients to other GATP it is easy and opens the use of the information contained in *TGTP* from any GATP.

OGPCP, GASC – 5

To be able to compare the different methods and implementations, a competition will have the virtue of pushing towards the standardization of the input language, the standardization of test sets, the direct comparability and the easier exchange of ideas and algorithmic techniques.

The results of such a competition will also constitute a showcase, where potential users will look for the best GATP for their goals, Baeta et al. [2020], Quaresma and Baeta [2019].

. . . . . GASC 0.9 . . . later in ADG2021.

Conclusions and Future Work

The problems related to the integration between different geometry provers are hard (maybe without an overall solution).

Different algorithms/provers do not assume all the same mathematical setting:

- Different axiomatizations exist, e.g. Tarski's, Hilbert's, von Plato's; Area method.
- Different kinds of geometry, e.g. euclidean 2D or 3D, non-euclidean.
- Different types of approaches, geometric, e.g. area method, algebraic, e.g. Wu's method.

More than a, maybe unrealistic, full integration, the *OGPCP* should aim to: give a simple, documented, open source, API to allow the use of GATP by experts and non-experts and to constitute itself as a forum, a space of discussion, about the deductive tools for geometry.

Obrigado / Gracias / Merci / Danke

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