TGTP - Thousands of Geometric problems for geometric Theorem Provers

Pedro Quaresma

CISUC, Department of Mathematics, University of Coimbra
3001-454 Coimbra, Portugal
pedro@mat.uc.pt

1 Extended Abstract

Automated theorem provers, applications, and libraries of problems are often developed separately. In some cases, joint efforts of many of researchers led to standards such as *DIMACS* (for propositional logic) [6] and *SMT* (for satisfiability modulo theory) [1] and libraries of problems such as *SAT-lib* (for propositional logic) [11], *TPTP* (for predicate logic) [18], *SMT-lib* (for satisfiability modulo theory) [1] etc. Such efforts, standards, and libraries are fruitful for easier exchange of problems, ideas, and even program code. However, this is often very demanding and there are not many systems smoothly integrating libraries of problems, theorem provers, and real-world applications.

The principal motivation in building *TGTP*[1] (Thousands of Geometric problems for geometric Theorem Provers) is to support the testing and evaluation of geometric automated theorem proving (GATP) systems, to help ensure that performance results accurately reflect the capabilities of the GATP system being considered.

TGTP is a library of problems, in geometry, for GATP systems. *TGTP* aims to supply the automated reasoning in geometry community with a comprehensive library of GATP test problems, in order to provide an overview and a simple, unambiguous reference mechanism. A common library of problems is necessary for meaningful system evaluations and comparisons, its size is important if the production of statistically significant results is intended.

TGTP problems are stored in an XML-based format for constructive descriptions of geometrical figures and geometrical proofs. The conversion of this format to the DGSs/GATPs format is done via XSLT files. A specific DTD document defines syntactical restrictions for constructing descriptions. This DTD document can then be used, in conjunction with the generic XML validation mechanism, for verifying whether a given description of a geometrical construction is legal [15].

The goal for building *TGTP* is, in a similar spirit of *TPTP* and other libraries, to provide the GATP community with a centralised problem collection with an easy access to all researchers.

TGTP tries to address all relevant issues. In particular:

[1] http://hilbert.mat.uc.pt/TGTP

– is Web-based and is thus easily available to the research community.
– is easy to use. Problems are presented in a specifically designed, easy to understand format. Automatic conversion to other known formats is being provided, thus eliminating the necessity for any other transcription.
– tries to cover the different forms of automated proving in geometry, e.g. synthetic proofs and algebraic proofs.
– aims to become large enough for statistically significant testing. In its current version it contains already over 120 problems.
– aims to become a comprehensive, up-to-date library.
– is independent of any particular GATP system.
– is well structured and documented. This allows effective and efficient use of the library. Useful background information, such as an overview of GATP application domains, is provided.
– documents each problem. This contributes to the unambiguous identification of each problem.
– provides a mechanism for adding new problems.

There are several systems integrating dynamic geometry softwares (DGS), GATPs, and a set of examples. For example:

Java Geometry Expert[2] (*JGEX*) is a new, Java version of *GEX*. *JGEX* is being developed from 2004, by Shang-Ching Chou, Xiao-Shan Gao, and Zheng Ye. *JGEX* combines dynamic geometry, automated geometry theorem proving, and, as its most distinctive part, visual dynamic presentation of proofs. *JGEX* implements the following methods for geometry theorem proving: Wu's method, the Gröbner basis method, the full-angle method, the deductive database method, the area method and the vector method are still under development. It contains a large set of examples of proofs.

GEOTHER is an environment for manipulating and proving geometric theorems implemented in Maple, with drawing routines and the interface in Java. *GEOTHER* can work with a menu-driven graphic user interface and contains a collection of theorems in both elementary and differential geometry [10,19].

Ludi Geometrici[3] has a vast library of problems in the area of classical constructive (ruler and compass only) Euclidean geometry. It does not provide an GATP. A user can only perform valid steps in the construction, using only a limited set of tools, and in this way the system is capable to recognise whenever a user has reach a solution of a problem. No formal proofs are provided.

GeoThms[4] is a Web workbench in the field of constructive problems in Euclidean geometry. It links dynamic geometry software, geometry automatic theorem provers, and a library of geometry problems (geoDB), providing a common web interface for all these tools [16]

Many of the DGSs (e.g. *GeoGebra*[5] [7], *Cabri*[6], *Cinderella* [13,17,5], etc.), DGSs/GATPs (e.g. *GCLC* [12], *GeoView* [2], *GeoProof* [14], *Geometry Explorer* [20],

[2] `http://www.jgex.net/`
[3] `http://www.polarprof.org/geometriagon/`
[4] `http://hilbert.mat.uc.pt/GeoThms/`
[5] `http://www.geogebra.org/cms/`
[6] `http://www.cabri.com/`

MMP/Geometer [9,8], *GEX* [8], *Discover* [3]), and also GATPs like *Theorema* [4] come with a (some times, large) set of examples. However none of them try to provide a common platform for meaningful system evaluations and comparisons.

In the *GeoThms* system the author of this article and Predrag Janičić already addressed some of the issues that are now being laid down for *TGTP*, namely the XML common format, and the list of problems. Where the *GeoThms* goal is to have a publicly accessible and widely used Internet based framework for constructive geometry with a strong integration of DGSs, GATPs and a library of problems to those tools, the *TGTP* goal is to provide the GATP community with a centralised problem collection, independent of any particular GATP system.

The development of *TGTP* problem library is an ongoing project, aiming to provide all of the desired properties described above.

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