

Extending GeoGebra with Automated Theorem Proving by using OpenGeoProver

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Keywords: *OpenGeoProver, GeoGebra, theorem proving, Java*

We present our project on extending GeoGebra, a widely used dynamic mathematical software, by OpenGeoProver, an automated geometry theorem prover. OpenGeoProver is implemented in Java and based on Wu's method, one of the most significant algebraic methods for automated theorem proving in geometry (and will be extended with the full Wu's method and the Gröbner bases method).

The integration posed both technical and usability challenges. In terms of technical issues, the integration is flexible, and the developed interface could also be used for linking OpenGeoProver to other dynamic geometry tools, or linking GeoGebra to other theorem provers. OpenGeoProver accepts an XML representation of a construction and a conjecture described in GeoGebra, and decides (if it can) whether the conjecture is valid. Alternative ways of communications are also subject of development. In addition to “yes” or “no” answer, OpenGeoProver also returns a report with more details, including non-degeneracy conditions (covering special cases in which the conjecture may not be true) in geometry form. On GeoGebra side, some changes had to be made in expression formatting by adding prefix notation of certain relations like ArePerpendicular or AreEqual, and on simplifying XML export for decreasing the data transfer overhead between GeoGebra and OpenGeoProver. Also a common XMLParser library had to be used for compatibility reasons.

In terms of usability, automated theorem proving within GeoGebra can give it new features and new power. For the very beginning, the **Prove[<Boolean Expression>]** command is the first available interface for the user. This is planned to be extended by the option to generally evaluate boolean expressions through the prover, and also a menu icon tool will be added for checking conjectures. The Relation tool (already built into GeoGebra) will also be capable of using the prover instead of or in addition to the current numerical approach. Finally, open exercises may also be verified with the prover facility.

Since the GeoGebra OpenGeoProver backend is planned to use just simple Java statements (without any 3rd party libraries), it will be easily extended to be a part of the GeoGebraWeb port of GeoGebra, by using the Google Web Toolkit Java to Javascript compiler.