

Integration of ***OpenGeoProver*** with ***GeoGebra*** (ongoing project)

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AGENDA

- Short overview of OpenGeoProver
- Integration with GeoGebra – the main ideas
- Implementation details
- Future work

Short overview of OpenGeoProver

- ♦ OpenGeoProver is an improved Java reimplementatation of the prover from the GCLC tool
- ♦ Only the simple Wu's method has been implemented so far
- ♦ OpenGeoProver is developed to be used in various geometry tools
- ♦ OpenGeoProver project open-source:
[<http://code.google.com/p/open-geo-prover/>]

Short overview of OpenGeoProver

- ♦ JGEX is related system (but aimed only at one tool)
- ♦ Comparison of execution times (of final reminder calculation) for Wu's method between OpenGeoProver and JGEX:

(CPU times in ms)

Theorem	JGEX	OGP
Example 6 (variant of; Pascal's thereom for circle)	1077	138
Example 36 (butterfly)	1745	289
Example 133 (variant of; orthocenter is incenter of triangle formed of altitudes' feet)	7	7
Example 154 (incenter)	38	15
Example 173 (orthocenter)	9	6
Example 191 (Euler's line)	10	162
Example 196 (Euler's/nine-point circle)	9	50
Example 288 (Simson's theorem)	25	16
Example 336 (Gergonne's point)	58	51
Example 346 (Desargues' theorem)	21	221

Integration with GeoGebra – the main ideas

- ♦ Adding automated geometry theorem proving features to GeoGebra in collaboration with the GeoGebra team
- ♦ The prover within GeoGebra will check relationships among constructed objects
- ♦ The prover returns NDG conditions that could be used for examination of special cases of geometry theorems

Integration with GeoGebra – the main ideas

- ♦ Design choices:
 - Java programming language – OpenGeoProver compatible with GeoGebra
 - Construction set and organization similar to GeoGebra – Construction Protocol concept
 - Easy exchange of data between the core GeoGebra and OpenGeoProver through a set of API methods

Integration with GeoGebra – the main ideas

- ♦ “Light” (flexible) integration of prover and GeoGebra:
 - Easy replacement of a prover in GeoGebra
 - Easy maintenance of OpenGeoProver code
 - Integration with other dynamic geometry tools

Implementation details

- ♦ Defining and implementation of XML format for API methods used between OpenGeoProver and GeoGebra
- ♦ OpenGeoProver currently holds the internal XML format for representation of geometry constructions and theorem statements
- ♦ OpenGeoProver can act as a standalone application, although it is mainly intended for integration with other dynamic geometry systems

Implementation details

- Example of theorem representation in OpenGeoProver's internal XML format:

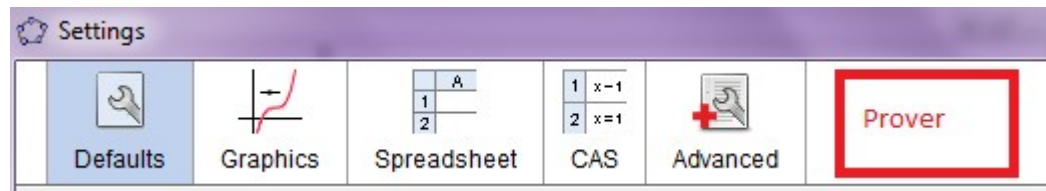
```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE geothm SYSTEM "geothm.dtd">
<geothm name="Orthocenter of triangle">
  <!-- In a triangle ABC, let h_a, h_b, and h_c be altitudes that -->
  <!-- correspond to the vertices A, B, and C and let H be the -->
  <!-- intersection of h_a and h_b. Then, H belongs to h_c. -->
  <constructions>
    <pfree label="A" />
    <pfree label="B" />
    <pfree label="C" />
    <ltwopts label="a" point1="B" point2="C" />
    <ltwopts label="b" point1="C" point2="A" />
    <ltwopts label="c" point1="A" point2="B" />
    <lperp label="ha" point="A" baseline="a" />
    <lperp label="hb" point="B" baseline="b" />
    <lperp label="hc" point="C" baseline="c" />
    <pintersect label="H" set1="ha" set2="hb" />
  </constructions>
  <statement>
    <pointonset set="hc" point="H" />
  </statement>
</geothm>
```

Implementation details

- ♦ GeoGebra's XML format should be able to:
 - express constructions from GeoGebra
 - express statements about relationships between constructed objects
 - pass prover parameters like the time and space limits, the log level, the selected prover etc.
 - pass results back to GeoGebra – whether theorem has been proved or not, prover reports, NDG conditions

Implementation details

- ♦ GeoGebra must provide way to express relationships among geometry objects (parallel lines, collinear points, congruent triangles etc.)
- ♦ GeoGebra GUI must be enhanced to support setting prover parameters



- ♦ Processing of NDGs – only textual description will be used in the first phase

Future work

- ♦ Implementation of complete Wu's method (JGEX can be used as a reference)
- ♦ Implementation of Gröbner basis method
- ♦ Improving prover efficiency

Future work

- ♦ Implementation of special requirements from GeoGebra about usage of prover (if any)
- ♦ Real-world applications of theorem proving within GeoGebra
- ♦ Supporting theorems about parametric objects (like conic sections)
- ♦ Supporting generic XML formats for representation of theorem statements, so OpenGeoProver could be easily integrated to any geometry system that supports such XML format



Thank you very much!