GeoGebra, its community and future

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Abstract
GeoGebra is rapidly gaining popularity in the teaching and learning of mathematics around the world. Currently, GeoGebra is translated to 52 languages, used in 190 countries, and downloaded by approximately 300,000 users in each month. This increased use compelled the establishment of the International GeoGebra Insitute (IGI) that serves as a virtual organization to support local GeoGebra initiatives and institutes. In this paper, we offer a brief introduction to the history of the software, introduce its worldwide community, and outline GeoGebra's future of software and material development plans.

Introduction
The use of technology is slowly becoming a substantial part of today's education. Although due to the increased accessibility of affordable computing technologies in the 1980s and 90s it was predicted that computers would become rapidly integrated into mathematics teaching and learning (Kaput, 1992), technology uptake in schools has been considerably slow. The current expansion of technology use took a new unconventional direction: a bottom-up, community-based collaborative development, catalysed by Internet-based communities and increasingly available community-developed software packages.

During the past decades it has been demonstrated that a large number of enthusiasts can alter conventional thinking and models of development and innovation. The success of open source projects like Linux, Firefox, Moodle, and Wikipedia shows that collaboration and sharing can produce valuable resources in a variety of areas of life. While working on the open-source project GeoGebra we are witnessing the emergence of an enthusiastic international community around the software.

Although the community around GeoGebra is growing astonishingly fast, we realised that both members of the community, and teachers starting to use GeoGebra need extensive support. In addition, we wanted to offer a forum for the community to extend collaboration and communication. To be able to offer such assistance, we have established the International GeoGebra Institute (IGI). The aims of this non-profit organisation are to assist all members of the GeoGebra community based on their needs, as local members know best what their community needs. During the past two years, IGI and the GeoGebra community have been gaining substantial momentum. In this paper, we will offer a brief outline of the history, the current state of GeoGebra, and plans for future developments.

History of GeoGebra
The software GeoGebra originated in the master's thesis project of Markus Hohenwarter at the University of Salzburg in 2002. It was designed to combine features of interactive geometry software (e.g. Cabri Geometry, Geometer's Sketchpad) and computer algebra systems (e.g. Derive, Maple) in a single, integrated, and easy-to-use system for teaching and learning mathematics

(Hohenwarter & Preiner, 2007b). During the past years, GeoGebra has developed into an open-source project with a group of 15 developers and over 100 translators all over the world.

The current version, GeoGebra 3.2, offers dynamically linked multiple representations for mathematical objects (Hohenwarter & Jones, 2007) through its graphical, algebraic, and spreadsheet views. The software, which is currently available in 52 languages, has received several educational software awards in Europe and the USA (e.g. EASA 2002, digita 2004, Comenius 2004, eTwinning 2006, AECT 2008, BETT 2009 finalist, eureleA 2009 finalist, TechAwards 2009, NTLC 2010). Apart from the standalone application, GeoGebra also allows the creation of interactive web pages with embedded applets (Hohenwarter & Preiner, 2007a). These targeted learning and demonstration environments are freely shared by mathematics educators on collaborative online platforms like the GeoGebraWiki (www.geogebra.org/wiki). Since 2004, the number of visitors to GeoGebra's website has increased from 7,000 per month to currently over 600,000 per month (Figure 1) coming from 190 countries.

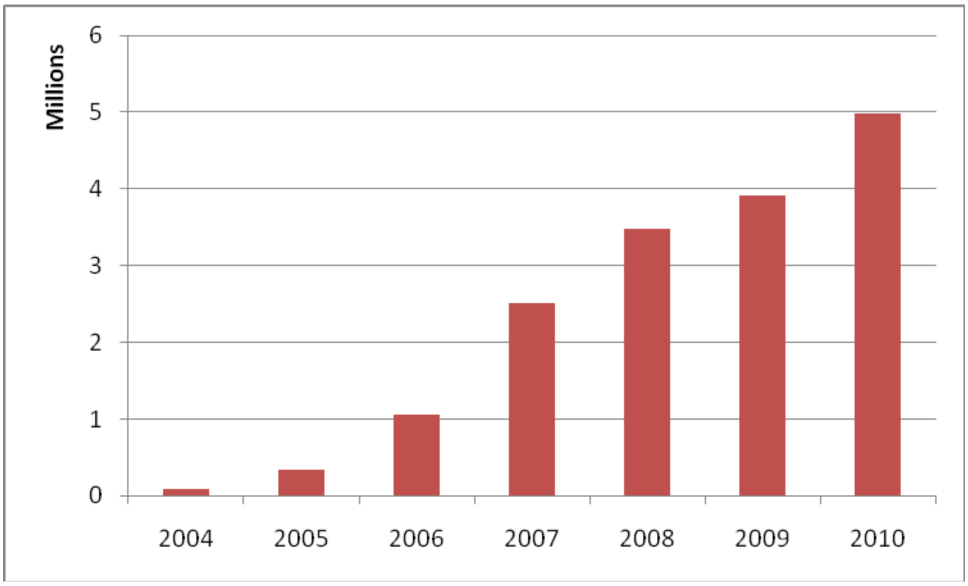

Figure 1: Visitors to www.geogebra.org per year

International GeoGebra Institute

To be able to better assist the GeoGebra community through its rapid growth we established the International GeoGebra Institute (IGI) at the end of 2007. The four principal aims of IGI are to

- offer teacher training and support;
- develop teaching materials and the software;
- conduct research;
- outreach to less well-off communities.

IGI is essentially an umbrella organisation for local GeoGebra Institutes (GI) established by teachers and researchers at universities and teacher education institutions (Hohenwarter & Lavicza, 2007). Local GeoGebra Institutes agree to follow the aims of IGI, but the emphasis of their work depends on their local needs, interests, and priorities. Currently, there are 42 local GeoGebra Institutes in 32 countries (Figure 2) and all of them are doing valuable and diverse work for the GeoGebra community.

Figure 2: Map of local GeoGebra Institutes, www.geogebra.org/community

The development of the international community has also been catalysed by the new GeoGebra website (http://geogebra.org) where local Institutes and community members can post their meetings and workshops. There are numerous GeoGebra talks offered at various conferences and there will be at least 15 specialised GeoGebra conferences in 2011 in Europe, North and South America, and Asia. Furthermore, owing to the good work of local GIs there are hundreds of well-trained (certified in most cases) GeoGebra trainers who support teachers in their communities. Local GeoGebra Institutes are also actively involved in projects, which are not only locally important, but contribute to the entire community.

Figure 3: Map of GeoGebra events, www.geogebra.org/events

Software Development

GeoGebra's open source developer community is currently working on GeoGebra 4 which is planned for official release at the International GeoGebra Conference in Hagenberg near Linz, Austria on 29-31 August 2011. In the following sections, we will describe the main new additions of this upcoming version. The latest beta version can already be tried at www.geogebra.org under "Roadmap".

GeoGebra 4 will have a flexible new user interface where views can be rearranged easily using drag and drop. Furthermore, optional formatting bars for each view will provide a quick way to change the colour, size or style of selected objects, for example. Predefined perspectives for e.g. primary school, algebra, or statistics will allow changing GeoGebra's user interface with a single click. Together with the addition of a pen tool and an onscreen keyboard, the software will also be better adapted to interactive whiteboards and tablet computers.

Furthermore, there will be support for implicit curves, inequalities, buttons with scripting, and many, many new commands to also support special features like e.g. Voronoi diagrams. All in all, GeoGebra 4 will be much more powerful and flexible, but also easier to use than earlier versions.

GeoGebraCAS

GeoGebra has been using a built-in a computer algebra system (CAS) for symbolic computation of derivatives and integrals since several years. However, so far this powerful component was merely used under the hood and not directly accessible to the user for symbolic manipulations of expressions. We are currently working on the addition of a CAS view to extend the symbolic features of GeoGebra allowing students to work with fractions, equations, and formulas that include undefined variables.

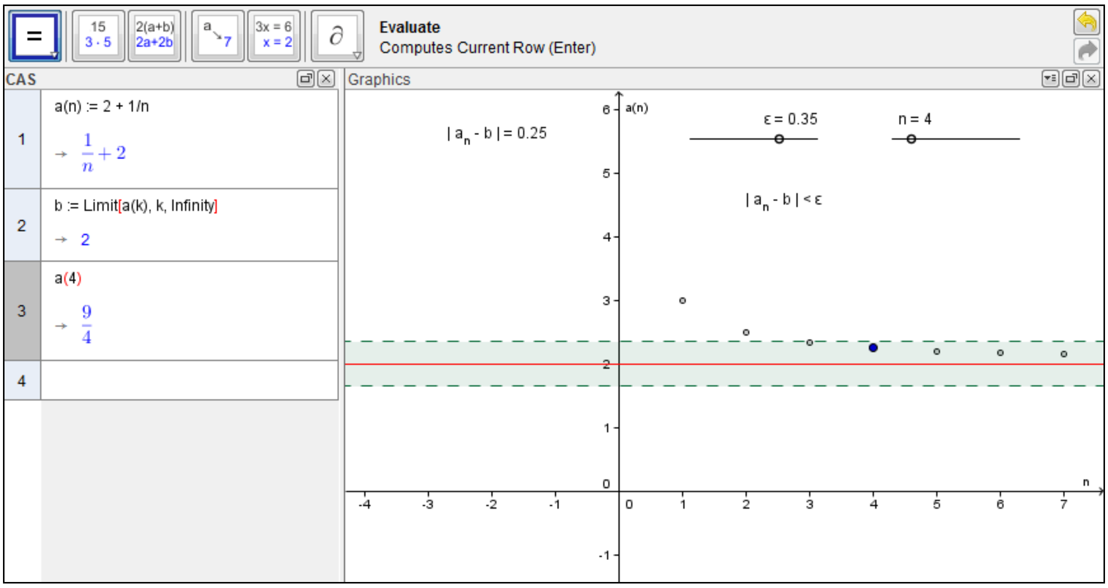

Figure 4: GeoGebra CAS view

This new symbolic algebra view should be easy to use by students starting at age 12 and fully integrated in the dynamic GeoGebra environment. Thus, basic features like expand and factor will be available by using toolbar buttons with the mouse from a specific CAS toolbar (see figure 4). This special toolbar is shown automatically, when the CAS view is clicked. An important feature is the possibility to manipulate only part of an expression by selecting it with the mouse and then clicking on a tool like "factor". First teaching materials for the CAS view have already been tested in Austrian classrooms.

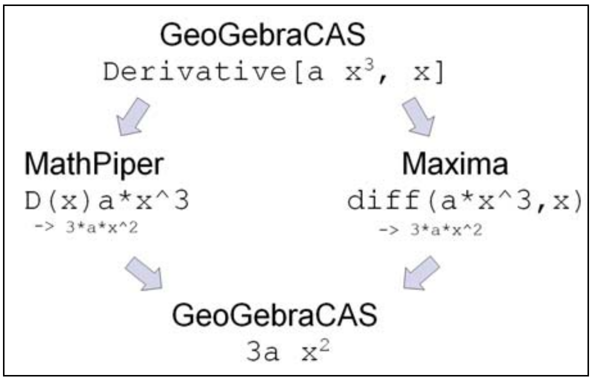

Figure 5: GeoGebra CAS engines

Technically, the CAS engines used within GeoGebra are MathPiper and Maxima. The MathPiper engine is small enough to be included in online Java applets whereas Maxima will only be used if preinstalled on a client computer. For the user, the underlying CAS engine is not visible: GeoGebraCAS always uses its own command syntax which is translated internally to the respective CAS engine and then back again (see figure 5). Thus, we can extend or replace the underlying CAS engines in the future if necessary.

GeoGebra Spreadsheet

As part of GeoGebra 4, we are also adding new capabilities to the existing spreadsheet view. In particular, it will get a specific toolbar for spreadsheet commands to allow easy use with the mouse. The possibility to include images and buttons will provide scripting possibilities for advanced users based on standard GeoGebra commands and JavaScript (see figure 6).

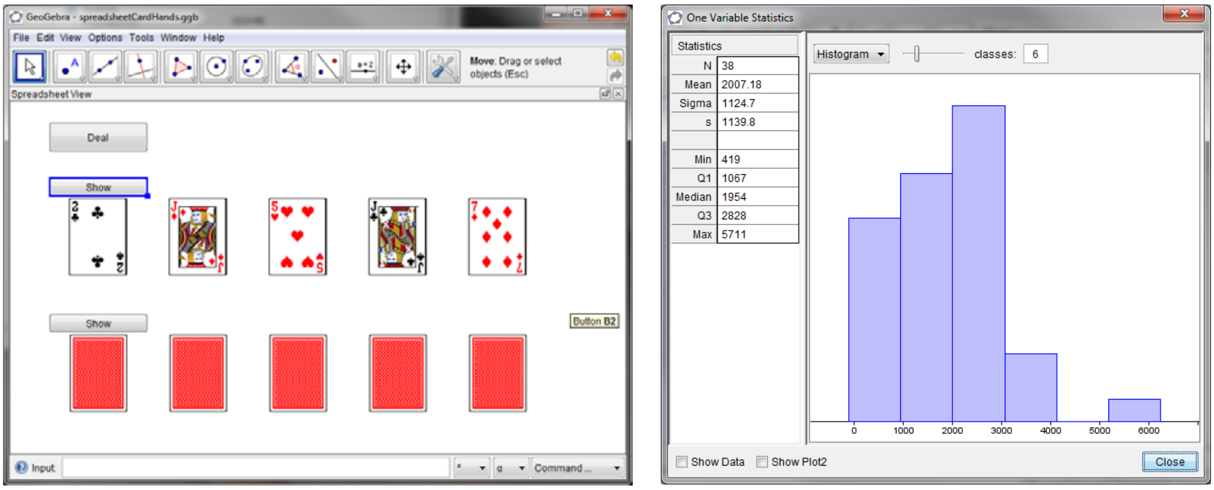

Figure 6: Spreadsheet View: buttons, images, and statistics wizards

For diagrams, we plan to have wizard dialogs that let you create diagrams like line graphs or bar charts by choosing from various options. The new file import feature will allow the user to load data from external online sources or local files. With this capability, data from science and mathematics textbooks can be brought easily into GeoGebra, ready to be explored by students.

GeoGebraMobile

The GeoGebraMobile project will allow to use GeoGebra web applets, so called *dynamic worksheets*, on a wide range of devices including smartphones like the iPhone or the Google Android platform. To achieve this, we are currently porting parts of GeoGebra to the web programming language JavaScript. This will allow the use of GeoGebra online materials in modern web browsers without the need for a Java plugin, both on mobile devices with touch support as well as on desktop and laptop computers. With GeoGebra 4, we plan to use GeoGebraMobile applets as the standard way to export dynamic worksheets that only show the graphics view.

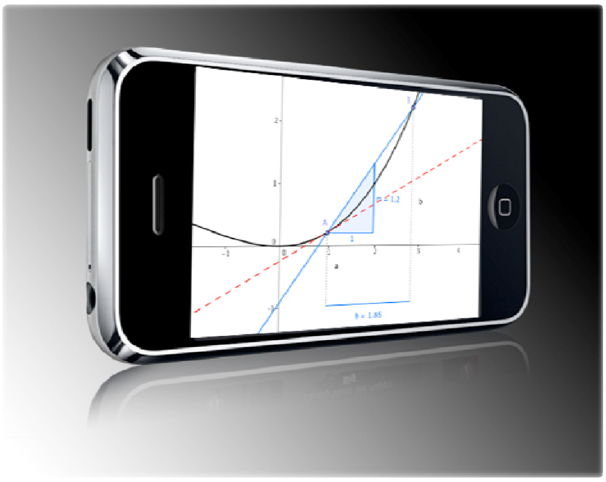

Figure 7: GeoGebraMobile applet on a smartphone

GeoGebra3D

GeoGebra3D aims to create a three dimensional Geometry and Graphics View in GeoGebra that is easy to use with the mouse. This view will allow the creation and interactive manipulation of 3D objects like points, lines, polygons, spheres, and polyhedrons as well as function plots of the form f(x,y). The 3D view should both be usable in the GeoGebra standalone application as well as offer the possibility to be embedded into interactive web pages.

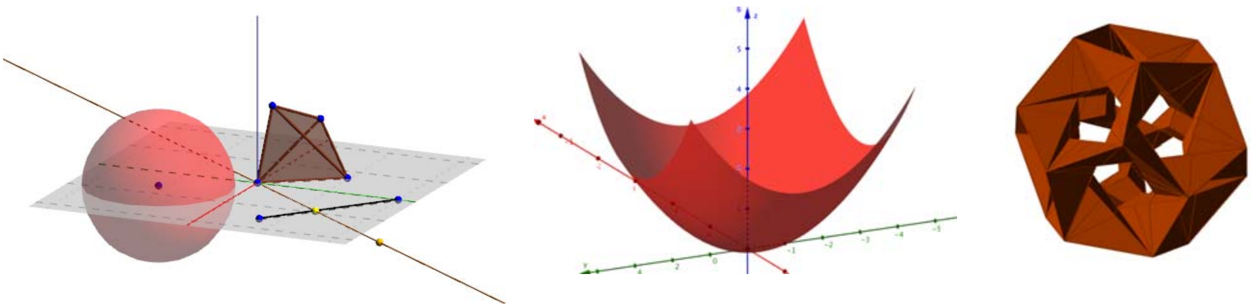

Figure 8: GeoGebra3D

The new 3D view will not be part of GeoGebra 4 yet, however early beta versions can already be tried on our developer website at www.geogebra.org/trac. The release of GeoGebra 3D is planned for 2012.

Open Educational Resources

The growth of the GeoGebra community necessitated the expansion and organization of open educational resources and ways to share materials within the community. The GeoGebraWiki (www.geogebra.org/wiki) already contains thousands of worksheets/exercises shared by teachers and students from all over the world. These resources are self organized by the community, but it would need a more rigorous system to make these more easily searchable.

Hence, the GeoGebraTube project aims to create a new online platform that would make it easier to share, rate, and comment interactive GeoGebra web pages and constructions: a kind of YouTube for free GeoGebra materials.

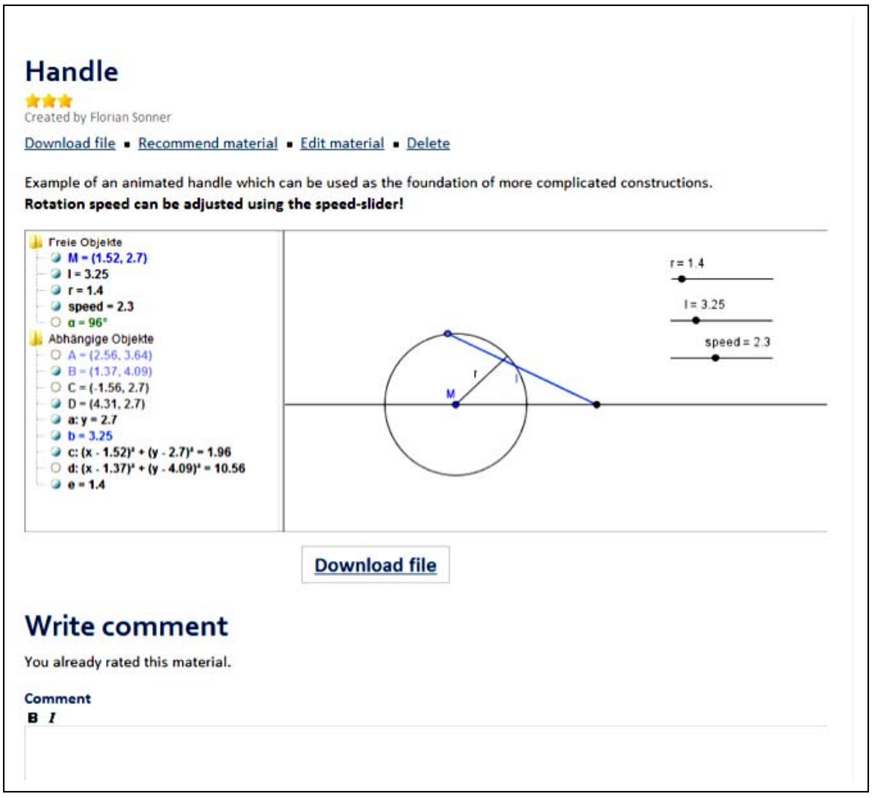

Figure 9: GeoGebraTube website prototype

GeoGebraTube will be closely connected to GeoGebra 4 by making it possible to upload materials directly from within the GeoGebra software to our webserver. This should make it very easy for our users to share free content. By using simple metadata that will mostly rely on tagging, uploading applets should be quick and painless. Other users will be able to easily embed existing applets into their own webpages. By relying on the GeoGebraMobile technology, this will allow the use of community created materials both on mobile devices as well as standard computers. The first test runs of GeoGebraTube are planned for early 2011.

Outreach

As an open source project, GeoGebra tries to specifically reach out to users in developing countries who may not be able to afford to pay for software. Together with colleagues in Argentina, Costa Rica, Egypt, the Philippines, and South Africa we are currently investigating possibilities of setting up user groups, GeoGebra Institutes, and how to best support local projects. Involving colleagues in our international network could open new opportunities for supporting countries with limited resources and help to exchange educational resources and experiences. In addition, we are working with organisations and governments in different countries who are distributing laptops to students.

For instance, Argentina has just started to distribute 3 million laptops with GeoGebra to students. The training of teachers is under way led by the Centro Babbage GeoGebra Institute in Buenos

Aires. In addition, a GeoGebra XO package was created to allow users in Africa and South America to run our software on the one-laptop-per-child machines in various countries.

Figure 10: XO laptop (one laptop per child)

Figure 11: Netbooks in Argentina

Summary

GeoGebra has grown from a small student project to an international organisation. Due to the involvement of thousands of volunteers we hope that it will offer a new way to teach mathematics around the world and contribute to the education of students. We invite everyone to join our efforts, help to develop new ideas and share experiences with the community. If you are interested in getting involved, please join our mailing lists, Facebook page, YouTube channel, get involved in a local GeoGebra Institute, or come to one of the local conferences in the upcoming years.

http://www.geogebra.org
http://facebook.com/geogebra
http://youtube.com/geogebrachannel
http://www.geogebra.org/community
http://www.geogebra.org/ events

Acknowledgements

We would like to thank the many volunteers and supporters of the GeoGebra community for their work and enthusiasm in supporting mathematics education around the globe.

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