GeoGebra 4.4 – from Desktops to Tablets

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Abstract

The open source software GeoGebra is rapidly gaining popularity in the teaching and learning of mathematics around the world. Currently, GeoGebra is translated to more than 50 languages, used in 190 countries, and downloaded half a million times each month. In this paper, we offer a brief introduction to the history of the software, introduce its worldwide community, outline new features of the latest version GeoGebra 4.2, and share future software development plans, in particular about the upcoming release of the first GeoGebra Apps for tablet computers.

Keywords: dynamic mathematics software; mathematics education; GeoGebra

Resumo

O software *open source* GeoGebra está a ganhar popularidade no ensino e aprendizagem da matemática em todo o mundo. Atualmente, o GeoGebra está traduzido em mais de 50 idiomas, é utilizado em 190 países e o seu *download* é feito meio milhão de vezes por mês. Neste artigo, faz-se uma breve introdução à história do software, apresenta-se a sua comunidade mundial e as novas características da versão mais recente do GeoGebra 4.2 e avançam-se planos futuros de desenvolvimento do software, em especial, sobre o lançamento das primeiras Apps GeoGebra para computadores tablet.

Palavras-chave: software dinâmico de matemática; educação matemática; GeoGebra

Résumé

Le logiciel open source GeoGebra gagne rapidement popularité dans l'enseignement et l'apprentissage des mathématiques dans le monde. Actuellement, GeoGebra est traduit en plus de 50 langues, utilisé dans 190 pays, et est téléchargé un demi-million de fois chaque mois. Dans cet article, nous proposons une brève introduction à l'histoire du logiciel, présenter sa communauté dans le monde entier, esquisser de nouvelles fonctionnalités de la dernière version GeoGebra 4.2, et partager des futurs plans de développement, en particulier au sujet de la sortie prochaine de ses premières applications pour ordinateurs tablettes.

Mots-clés logiciel dynamique de mathématique; l'enseignement de mathématique; GeoGebra

Introduction

The software GeoGebra was 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, 2007). During the past years, GeoGebra has developed into a world-wide open-source project with 21 developers and over 200 translators involved in the creation of its latest version 4.2. Since 2004, the number of visitors to GeoGebra's website has increased from 7,000 per month to currently over 1 million unique visitors per month coming from 190 countries.

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 more than 140 local GeoGebra Institutes in over 80 countries (Figure 1) and all of them are doing valuable and diverse work for the GeoGebra community.

Figure 1: Map of local GeoGebra Institutes, http://www.geogebra.org/igi

The development of the international community has also been catalysed by the new GeoGebra website (http://www.geogebra.org) where local Institutes and community members can post their meetings and workshops. There are numerous GeoGebra talks offered at various conferences and specialised GeoGebra conferences in Europe, North and South America, as well as Asia. Furthermore, owing to the good work of local GIs, there are hundreds of well-trained and in many cases certified 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.

GeoGebra 4.2

The current version GeoGebra 4.2 was released in December 2011. For the 4.2 release, we have had a much bigger developer team - with 21 people making contributions, compared to 10 for GeoGebra 4.0 and 3 for GeoGebra 3.2. The main new features of GeoGebra 4.2 can be summarized as the following:

- CAS View -new symbolic view to work with fractions and letter variables;
- Perspectives sidebar at the right to easily adapt GeoGebra's interface;
- Speed -we have rewritten large parts of GeoGebra to make it much faster;
- GeoGebraTube worksheets now run on iPad, Android tablets and Chromebooks
- Drag a parabola while pressing the Alt-key to keep its vertex fixed;
- New and improved tools -Pen, Freehand Shape, Delete, Rigid Polygon;
- Many new commands, e.g. SlopeField, LocusEquation, SurdText, ...
- New languages -Arabic (Tunisia), Filipino, Indonesian, Yiddish, Dutch (Belgium and Netherlands variants), and others.

One of the interesting consequences of GeoGebra's Open Source model is that almost all developers and translators contribute to GeoGebra because they are already interested in it as a user. Generally, they also add something that they personally want, be it a missing feature, fixing a bug or translating the software into their language. Sometimes, people will work on just one feature but we now have several long-term developers who brought new ideas on board that have significantly affected the new version. In addition, we have a group of about 100 semi-official beta-testers who enjoy trying out the latest development builds even at an early stage.

CAS View

GeoGebra has been using a built-in a computer algebra system (CAS) for symbolic computation of derivatives and integrals for several years. Until now, this powerful component was merely used under the hood and not directly accessible to the user for symbolic manipulations of expressions. We have now opened this up by adding a CAS view to extend the symbolic features of GeoGebra 4.2 allowing students to work with fractions, equations, and formulas that include undefined variables.
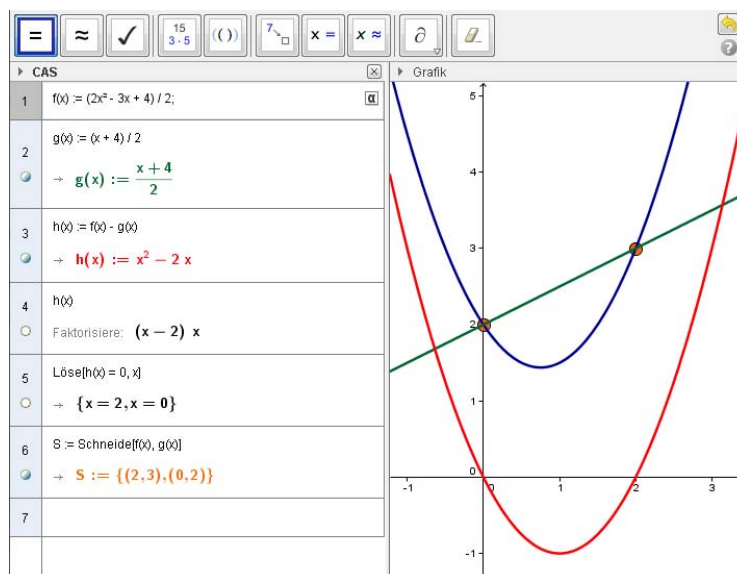
Figure 2: Computer Algebra System (CAS) View in GeoGebra 4.2

This new symbolic algebra view should be easy to use by students starting at age 12 and is fully integrated into 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 which 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".

The computer algebra system under the hood in GeoGebra 4.2 used to be Reduce. This is going to be replaced by the faster and more powerful system Giac with GeoGebra 4.4 in summer 2013. The important thing to mention here is that this change will not affect the use of GeoGebra's CAS view as all symbolic commands in GeoGebra are completely independent of the underlying system.

Layout Manager & Perspectives

In GeoGebra 3.2, the Views could be arranged either vertically or horizontally. Since GeoGebra 4,a much more flexible arrangement has become possible using the new drag & drop layout manager. Also, as a result of this, it is now possible to have two Graphics Views open simultaneously showing the same objects or different objects, at the same scale or at a different scale.
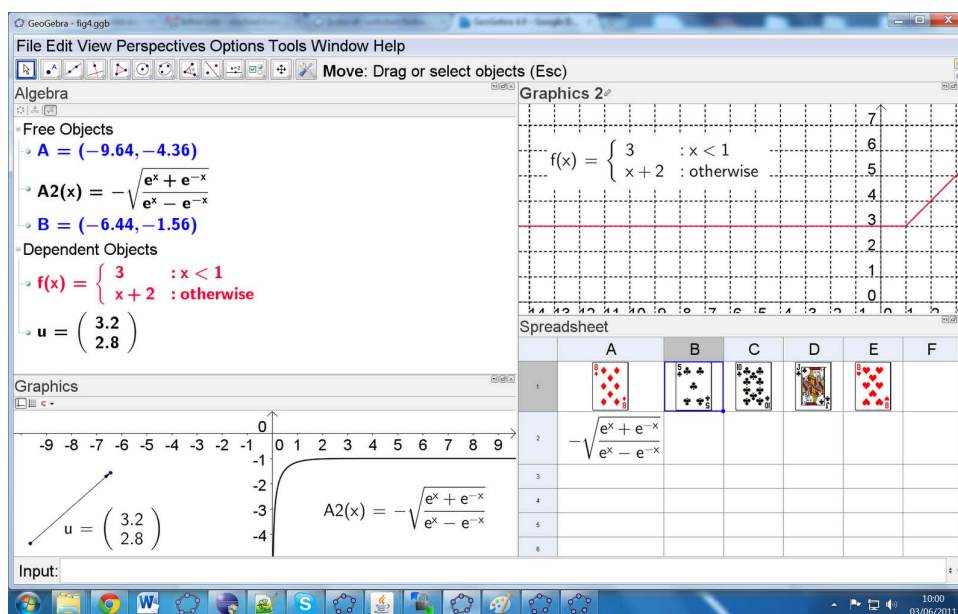
Figure 3: Flexible arrangement of Views in GeoGebra 4

There is a new Perspectives sidebar option at the right hand side which allows switching quickly to a pre-defined set of views and tools including the Basic Geometry perspective which is particularly useful for younger students.

Filling old Gaps

There have been some obvious gaps in what GeoGebra can do which have been remedied in version 4. For example: hatching as a fill option, compound paths, animation of a point on a path, inequalities (e.g., $y < \sin(x)$), missing transformations (shear, stretch), implicit curves (e.g., $x^3 + y^3 = 1$), functions of more than one variable (e.g., $f(a, b, c) = a + b^2 + c^3$), functions and parametric curves can now be transformed, a variable can now be entered for the minimum and maximum of both sliders and axes, lists are now draggable, loci can be now created from a slider, and text can have a background colour.
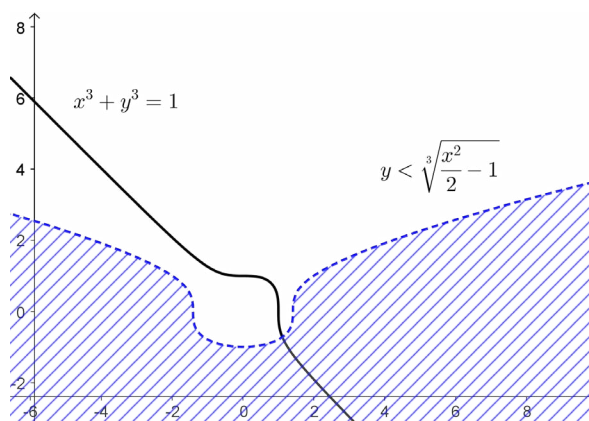
Figure 4: Implicit Curve, hatch filling, "Stick to Edge" option for axes, and improved equation rendering.

The spreadsheet now has its own Toolbar with One and Two Variable analysis and chart Tools. It also provides a Probability calculator which allows you to plot and calculate with more than a dozen common distributions.

New Commands

GeoGebra'scommand-based design allows us to add many powerful commands without making the program too complex (e.g. we don't have to keep adding more and more buttons into the Toolbar). Some examples for new commands in GeoGebra 4 are:

    • SolveODE -numerical solution of first- and second-order differential equations;
    • SlowPlot -actually a macro, which just creates a function whose drawing is controlled by a slider;
    • Voronoi -Draws a Voronoi Diagram for the given points;
    • Sample -takes a simple random sample from a list (with or without replacement);
    • Shuffle -shuffles a list;
    • StemPlot -Plots a Stem Plot in the Graphics View;
    • ComplexRoot -plots the complex roots of a polynomial (as points, on an Argand diagram);
    • PrimeFactors -eg returns {2, 2, 2, 3} for 24.

In addition, GeoGebra 4 now offers scripts (in JavaScript, or just comprising GeoGebra commands) which can be attached to objects including the new Buttons and Textfields.

GeoGebraTube

In parallel with the GeoGebra 4, we have launchedour new material sharing platform GeoGebraTube(http://www.geogebratube.org) in late 2011to replace the old GeoGebraWiki. It supports direct uploading of constructions from GeoGebra and offers easy searching as well as user ratings, tagging, and commenting of materials. As of Jun 2013, more than 35000 materials have been uploaded and shared by teachers via GeoGebraTube.
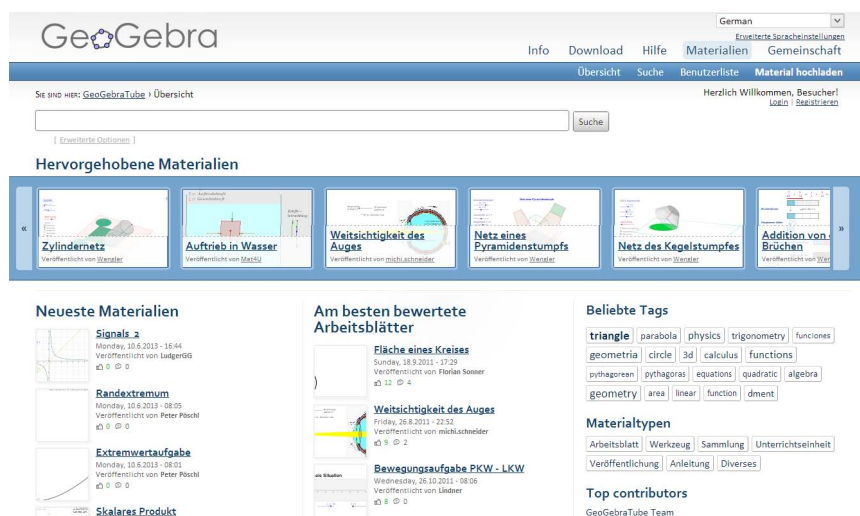

Figure 5: GeoGebraTube material sharing platform

GeoGebra's Future: Web, Tablets, and 3D

The GeoGebraWeb project (Hohenwarter, Ancsin, et al 2011) allows using GeoGebra in web browsers withtout a plugin like Java or Flash (try http://web.geogebra.org). To achieve this, we have ported parts of GeoGebra to the web programming language JavaScript. GeoGebraWeb is also used with GeoGebraTube, allowing the use of GeoGebra's online materials on tablet computers with touch support as well as on desktop and laptop computers.

In the summer of 2013 we are going to release the first version of specific GeoGebra Apps for tablet computers (Windows 8, Android, iPad) that will also allow creation of materials on touch devices that can be shared via GeoGebraTube.
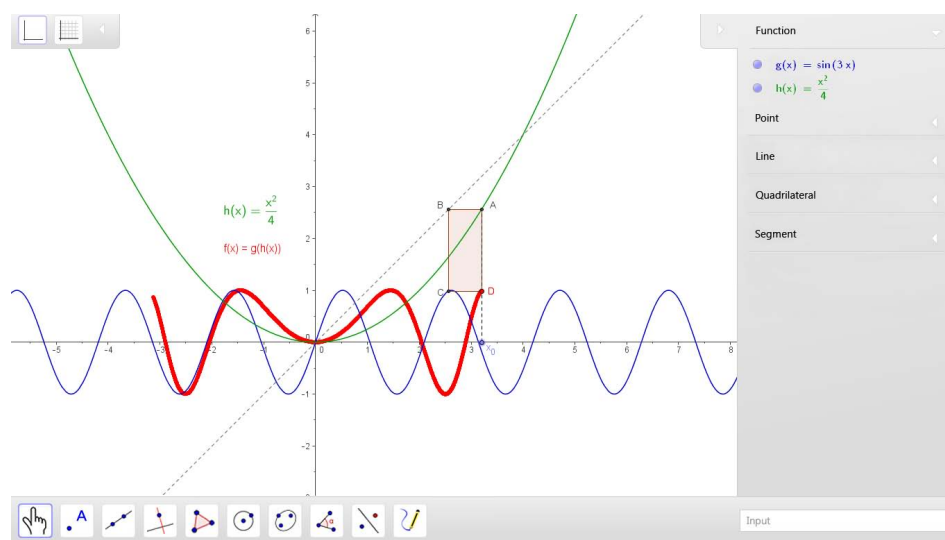

Figure 6: GeoGebra Tablet Apps

GeoGebra3D

With the upcoming version of GeoGebra 5, we are planning to include a fully dynamic 3D for three dimensional geometry and graphics. This view will allow the creation and interactive manipulation of 3D objects like points, lines, polygons, spheres, and polyhedrons as well as 3D function plots. 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. A key feature is that you will be able to take a (dynamic) slice through the 3D construction to create a new 2D view which will be displayed alongside using the layout manager from GeoGebra 4.
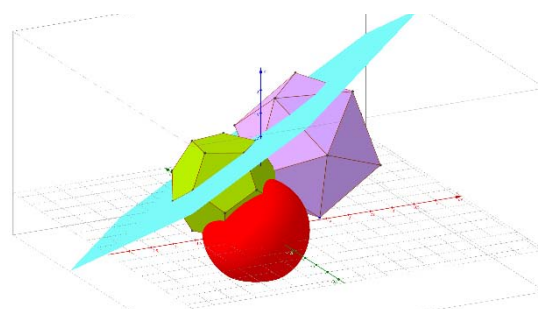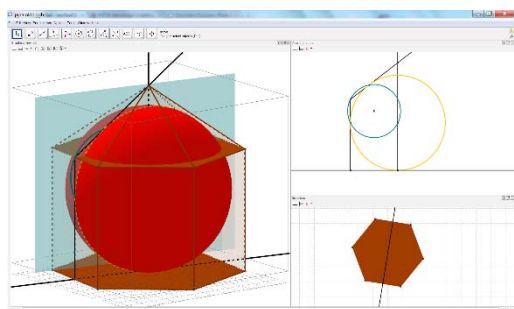
Figure 7: GeoGebra3D as part of GeoGebra 5 Beta

Conclusion

GeoGebra has grown from a small student project to an international phenomenon. Due to the involvement of many of teachers, researchers and developers, we hope that it will offer a new way to teach mathematics around the world and contribute to the education of students.The latest version of GeoGebra can be found at http://www.geogebra.org. Beta versions including the 3D viewcanbe found on our website under "Roadmap".We invite everyone to join our efforts, help to develop new ideas and share experiences at www.geogebra.org/forum.

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