

GeoSVG: A Web-based Interactive Plane Geometry System for Mathematics Education

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 - Complete Web orientation
 - Manipulative enhancement by the Web
- Implementation
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Motivation

- To provide support for the *WME (Web-based Mathematics Education)* system
 - Online Geometry manipulative authoring and running
 - Drawing capability for different components of the WME system
 - Lesson page contents composition
 - Assessment question composition
 - Bulletin Board message posting
- Existing *DGS (Dynamic Geometry Software)* cannot meet all the requirements
 - *Geometer's SketchPad (JavaSketchPad), Cabri Geometry II (CabriJava), Cinderella, C.a.R., etc.*

Goals of GeoSVG

- GeoSVG authoring environment can be run on the Web via a browser
- A generated manipulative can be directly embedded in a Web page
- A manipulative may contain none or all of the authoring supports
- A manipulative can be interoperable with the enclosing page
- Manipulatives can be easily shared, modified, and reused

Usage Scenarios

- GeoSite alone
 - Authoring manipulative on GeoSite
 - Learning directly from GeoSite
- Cooperation between GeoSVG and other Web sites
 - Adding drawing capability to your Web Site
 - Simple embedding of manipulative from GeoSite into your Web pages
 - Advanced embedding of manipulative from GeoSite to allow interaction between the manipulative and your Web pages

Usage Scenarios

- Adding drawing capability to your site

- Install the GeoSVG library to your Web site
- Include a javascript library GDrawing.js to your pages
- GDrawing interacts with the GeoSVG library and provides several APIs:
 - *newDrawing, editDrawing, displayDrawing, replaceDrawing, removeDrawing*
- Example: A math bulletin board using the GeoSVG allows users to post text along with interactive drawing.

Usage Scenarios

- Simple embedding of manipulative from GeoSite

- Add this html codes to your Web page:

```
<embed
```

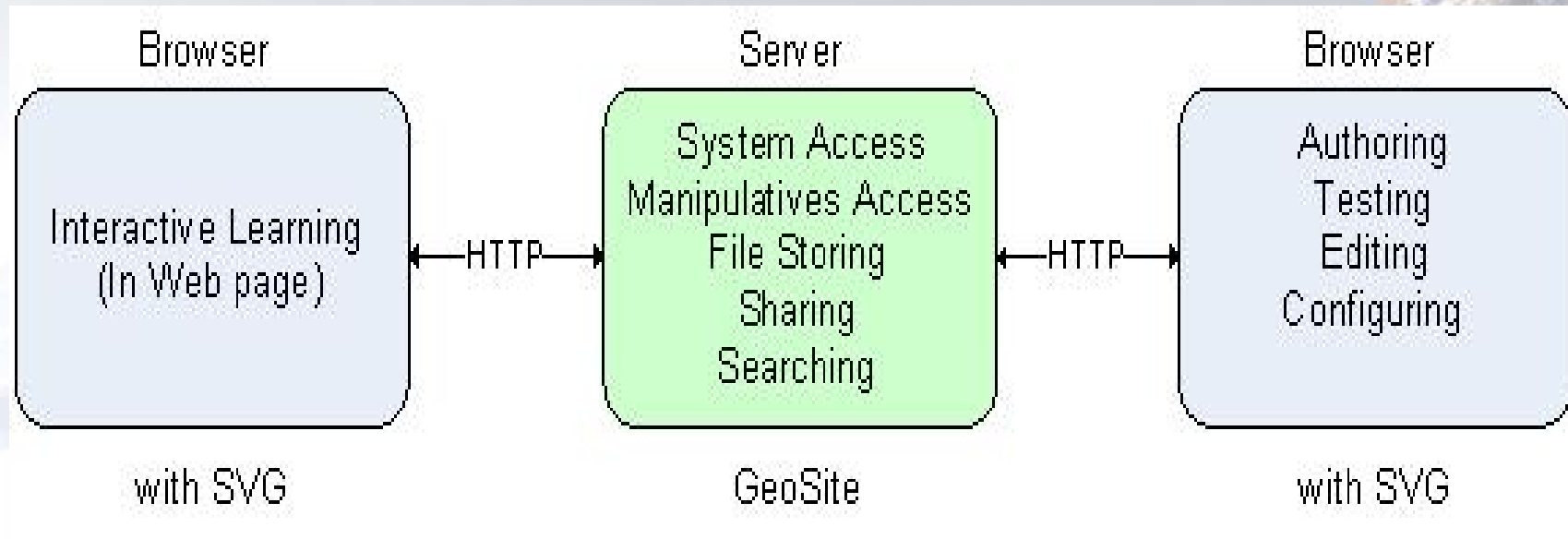
```
src="http://GeoSite-server-name
```

```
  /username/path/manipulative name.svg">
```

```
type="image/svg+xml" width=".." height=".." />
```

- Pro: simple
- Con: no interaction between the manipulative and the enclosing page due to security restriction
- An advanced embedding technique will be introduced in the Conclusions and Future Work section

GeoSVG Architecture and Components



GeoSVG Architecture and Components (cont.)

- The GeoSVG toolkit:
 - a. An SVG-coded *Plane Geometry Engine* for authoring and viewing manipulatives (creating, moving, and animating geometric objects).
 - b. GUI for the authoring environment providing authoring logic, a variety of dialogs assisting authoring, publishing, and communications with the server side.
- The GeoSite (<http://wme.cs.kent.edu/geosite/main.html>)
 - A Web site that makes the GeoSVG toolkit available as well as stores manipulatives and education pages for access, searching, and sharing.

GeoSite

The screenshot shows a Mozilla Firefox browser window displaying the GeoSite & GeoSVG web application. The browser's address bar shows the URL `http://localhost:8080/ge`. The application header includes the logo and the text "GeoSite & GeoSVG" along with a welcome message for "tester1" and navigation links for "My Folders", "My Account", and "Log Out".

The interface is divided into several sections:

- My folders:** A list of folders including Algebra, Percentage, Plane Geometry (highlighted), and Integral.
- User you want to visit:** A search box with a "GO" button.
- Search:** A search box with a "Search" button.
- Most visited manipulatives:** A section that is currently empty.
- Plane Geometry:** The main content area, featuring a "New Manipulative" and "New Folder" button, a table of manipulatives, and "Edit", "Configure", "Manipulate", and "Remove" buttons.

The table of manipulatives is as follows:

<input type="checkbox"/>	Name	Author	Date Modified	Size
<input type="checkbox"/>	Triangles	tester1	Dec. 19, 2005 2:21 PM	
<input type="checkbox"/>	Area of a circle	tester1	Dec. 22, 2005 4:29 PM	1K
<input type="checkbox"/>	Construct a triangle	tester1	Dec. 21, 2005 1:30 AM	4K
<input type="checkbox"/>	tester2's submission	tester2	Dec. 26, 2005 1:00 AM	4K
<input type="checkbox"/>	tester3's submission	tester3	Dec. 28, 2005 10:23 AM	4K
<input type="checkbox"/>	Parallelogram	tester1	Dec. 22, 2005 4:29 PM	4K
<input type="checkbox"/>	Trapezoid	tester4	Dec. 27, 2005 11:44 AM	2K

GeoSVG Authoring Environment

The screenshot displays a web browser window titled "http://wme.cs.kent.edu - Mozilla Firefox". The browser's menu bar includes "File", "Edit", "Display", "Tools", "Construct", "Measure", "Graph", and "Calculation". Below the menu bar is a toolbar with icons for selection, point creation, line drawing, and other geometric tools, along with a "M - P" button. The main content area shows a geometric diagram illustrating the proof of the Pythagorean theorem. A right-angled triangle with legs of length a and b , and hypotenuse of length c , is shown. Two squares are constructed on the legs: a red square on the side of length a and a red square on the side of length b . A larger blue square is constructed on the hypotenuse of length c . The diagram is labeled "Step 1" and "Proof of $a^2 + b^2 = c^2$ ". The browser's status bar at the bottom left shows "Done".

Features of GeoSVG

- Geometry manipulative authoring support
- Complete Web orientation
- Manipulative enhancement by the Web
 - Configurable GUI for Learning
 - Input and output interface of a manipulative
 - Page composition
 - Submittable manipulative
 - Keywords and search

Geometry manipulative authoring support

- Drawing primitives
- Geometric object construction
- Measurement
- Loci and Envelops
- Animation
- Calculation
- Graphing
- Geometric transforms
- Defining Macros
- Defining GUI Operations

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Complete Web Orientation

	Non-Web-based DGS System	GeoSVG
Software installation	Per Computer installation required	Use through browser, no installation required for authoring or learning
Manipulative sharing	Difficult because manipulatives are stored on individual computers	Easy because manipulatives are stored and searchable on the Web
Publishing manipulatives	Authors need to include Java applets in Web pages which are then deployed on servers	Saving a manipulative automatically publishes it on the Web
Download speed	Applets are binary, large and slow to download	Files are textual, smaller and can be compressed for fast download
Open Standards	Use proprietary technologies	Use W3C standard Web Technologies
Interoperable with the enclosing page	No	Can be driven by data outside, and output data

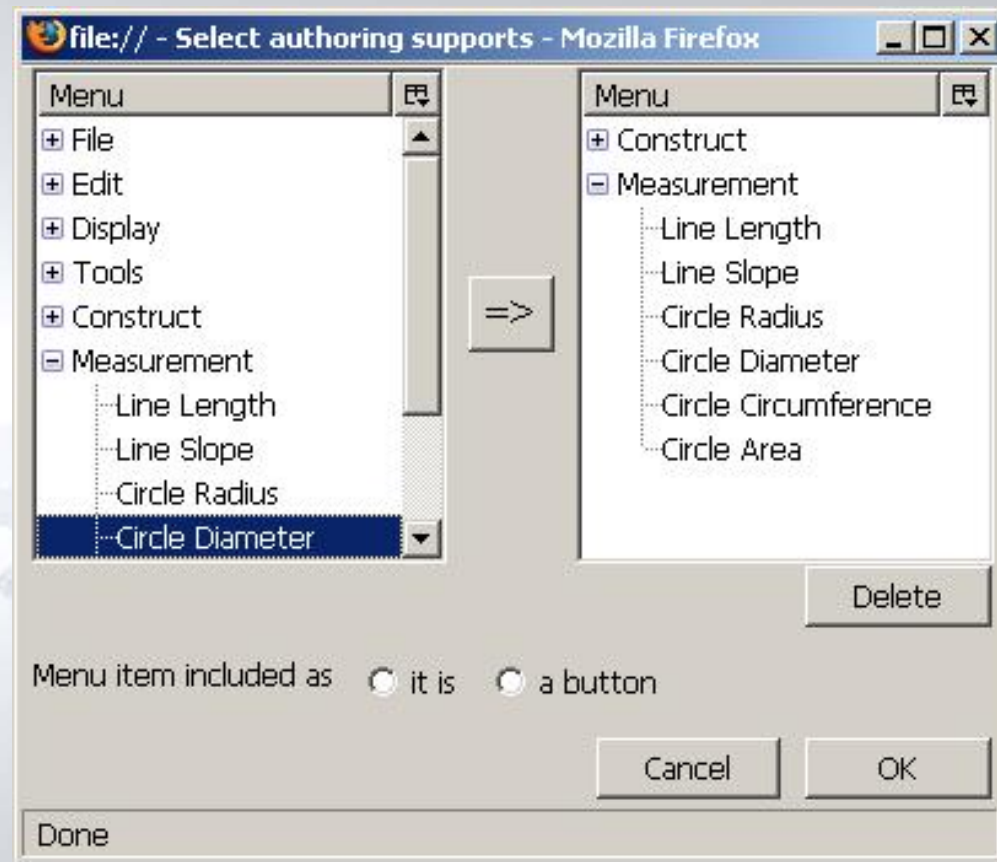
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Configurable GUI for Learning

- On the Web, it's possible to present a manipulative in two mode: authoring mode and learning mode
 - Under learning mode, any unnecessary authoring support is removed.
 - The author can decide to include as little or as much as needed authoring supports into the manipulative

Configurable GUI for Learning (cont.)



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Input and output interface of a manipulative

- Input interface can make sources outside to change a manipulative.
- Output interface defines what measurements in a manipulative can be used outside.
- APIs to access the interface are provided if the manipulative is to be embedded in a page outside the GeoSite
- GeoSite itself also provides GUI to authors to compose education pages that access the manipulative interface (next slide).

Page composition

- A page can embed any number of manipulatives
- Quantities (shown as html text) associated with an expression can be updated instantly
- User input (from html input box) can update manipulatives or quantities instantly
- Html button can invoke the evaluation of an associated expression
- Expressions in terms of manipulative interface, quantities, and user input are created via a dynamic calculator.

GeoSite - tester1 - Mozilla Firefox

File Edit View Go Bookmarks Tools Help

http://localhost:8080/geositeWithM

My folders

- Algebra
- Percentage
- Plane Geometry
 - Triangles
 - Area of a circle
 - Construct a triangle
 - Parallelogram
 - Trapezoid
- Integral

User you want to visit

GO

Search

Search

Area of a Circle

Define Output Interface New Question

Radius = 1.25

1. The measured radius of the circle is 1.25. Please calculate the area of a semi-circle: Check it

Done

Manipulative with question

file:// - Calculator - Mozilla Firefox

Expression:

Math.PI*<4>^2/2-\$i1

$$\frac{\pi r^2}{2} - \$i1$$

Clear Backspace Values

1 2 3 + ^

4 5 6 - (

7 8 9 *)

0 . PI / x

Cancel OK

Done

Dynamic calculator

file:// - Define Output Interface - Mozilla Firefox

Measurement Index	Object Measured	About	Output Name
4	2 Circle	Radius	r

Output Name: Add to Output Interface

Remove from Output Interface

Done

Define output interface

file:// - Define Output Interface - Mozilla Firefox

The measured radius of the circle is \$q1.
Please calculate the area of a semi-circle: \$i1 \$c1

Add Quantity

Add Input Box

Add Check Button

Cancel OK

Done

Paragraph composition

Features of GeoSVG

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Implementation

- Geometry Engine
 - for manipulative rendering and interaction
 - in SVG (*Scalable Vector Graphics*) from either browser's native support (Firefox or Opera) or plug-in (Adobe SVG Viewer)
- GUI
 - menus, toolbars and a variety of dialogs
 - in XHTML, XUL & XBL (Mozilla specific)
- Math Expressions
 - to be rendered in MathML

Conclusions and Future Work

- Performance of SVG is still not ideal. Fortunately, the support from browsers such as Firefox and Opera is improving.
- More authoring support is under development, and hopefully GeoSVG will eventually be as good as existing DGS systems.
- Cooperation between GeoSVG and other sites such as WME sites is under development and test (next slide).

Usage Scenarios

- **Advanced embedding of manipulative from GeoSite**

- This part is still under development. The main workflow is:
 - Install the GeoSVG library to your Web site
 - Embed an svg file named view.svg from within the GeoSVG library
 - Retrieve from GeoSite the data describing the manipulative via Web service
 - The GeoSVG library will interpret the data and display the manipulative
 - Security restriction is removed and interaction between the manipulative and the enclosing page is possible now. You can use the manipulative input/output interface APIs.