

A Web-Based Integral Evaluator:

**A Demonstration of the Successful
Integration of *WebEQ*, *Maple*, and *Java***



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Abstract

- Support for the manipulation and evaluation of mathematical expressions over the World Wide Web is currently limited. This work focuses on developing a Web-based interactive mathematics system and the difficulties involved in doing so. The goal of this initial investigation is the development of a tool to solve only a small-scale problem, namely that of evaluating indefinite integrals over the Web. The "Integral Evaluator," as the tool has been named, allows students to explore integration techniques, currently that of integration by substitution.
- The Integral Evaluator is a Java applet that supports the entry and evaluation of integrals over the Web. An equation editor implemented using WebEQ is embedded in the applet. Users either enter integrals manually or choose from a selection of stored ones. Requests by users to carry out various steps in the evaluation procedure are passed on to Maple for processing. WebEQ is used to render the MathML-encoded results. An on-line tutorial for using the Integral Evaluator is provided.

Abstract

- Preliminary results of the investigation indicate that providing interactive mathematics servers on the World Wide Web is currently "easier said than done." Tools exist for providing mathematical computation servers. However, constructing an interactive interface for a Web-based mathematical application of any complexity currently requires a great deal of time and effort. Deciding the best approach to take to implement the "interactive" feature (keyboard entry vs. a combination of keyboard and mouse entry, for example) is an important consideration, but implementing the interface once that decision has been made is the major hurdle that still must be overcome in the development of Web-based interactive mathematics systems. Currently available software such as WebEQ supports the implementation of complex interactive mathematical Web interfaces. However, extensive programming is required, which makes it difficult to generate such interfaces in a timely fashion. Investigating various approaches to solving the problem of constructing interactive interfaces for Web-based mathematical applications quickly and with a minimum amount of effort will be a primary focus of future work.

The Problem:

Develop a Tool to Enter and Evaluate an Integral over the WWW

- Required steps:
 - Implement a Web-based equation editor that will allow the user to do the following:
 - Enter the integral
 - Evaluate the integral
 - Select a substitution and replacement variable
 - Perform the substitution, using the chosen variable
 - Evaluate the resulting integral
 - Display the result of the evaluation

A Realizable Solution to the Problem

The required steps have been realized as follows:

- Implement a Web-based equation editor
 - Embed an equation editor in a Java applet that is embedded in a Web page
 - Implement the equation editor using WebEQ
- Enter the integral
 - Use the WebEQ equation editor to enter the integral encoded in MathML, or ...
 - Choose an integral from a collection of stored ones already encoded in MathML

A Realizable Solution to the Problem

The required steps have been realized as follows
(cont'd.):

- Evaluate the integral
 - Use Maple to evaluate the integral
(First translate the MathML-encoded integral into Maple syntax, if necessary)
- Display the result of the evaluation
 - Use WebEQ to display the result encoded in MathML
(First translate the Maple-encoded result into MathML, if necessary)

The Integral Evaluator Web Site

(snapshot next ...)

Welcome to the Integral Evaluator Web Site!

Click the button to enter.

[Enter Web Site](#)

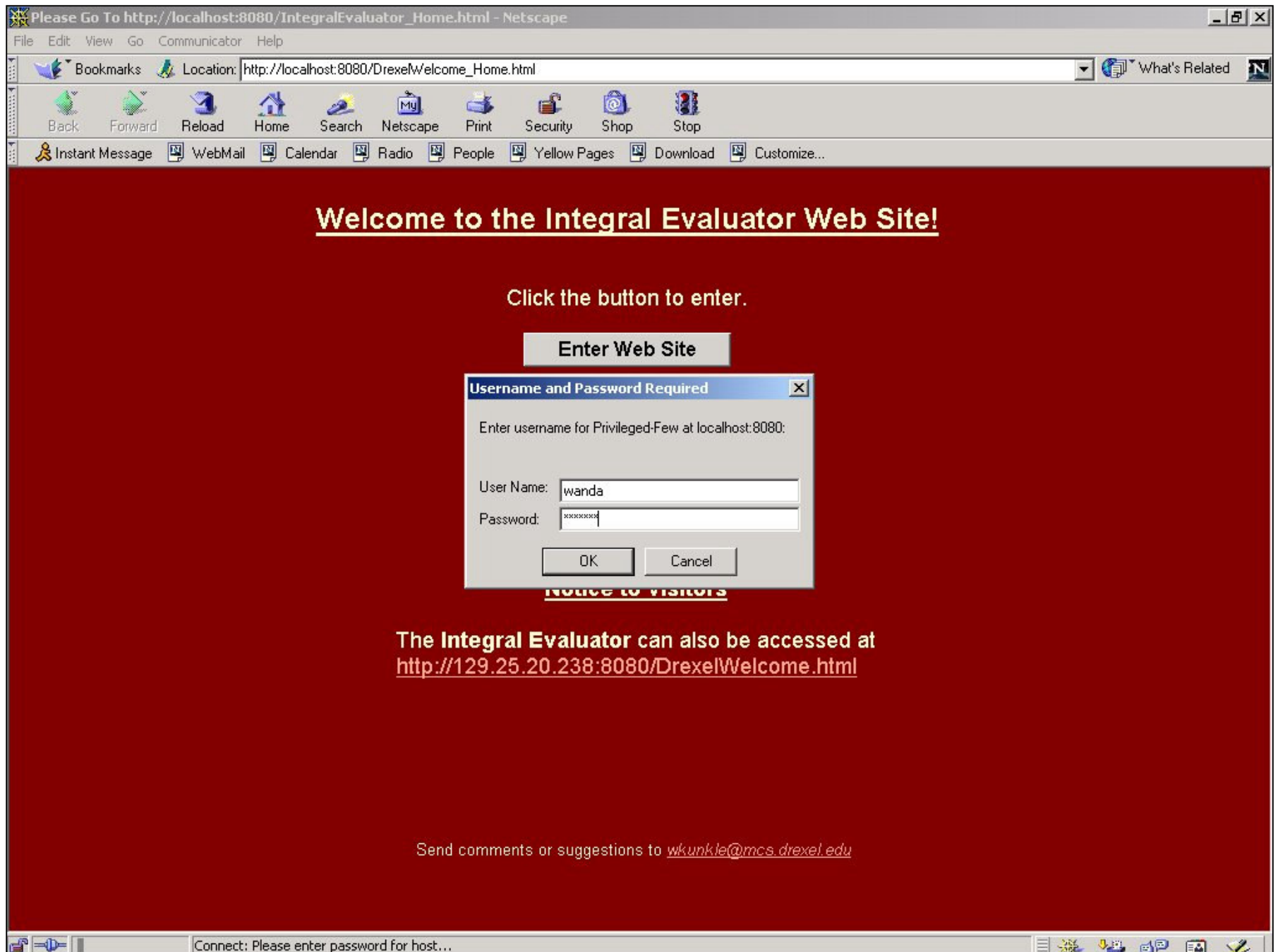
Notice to visitors

The **Integral Evaluator** can also be accessed at
<http://129.25.20.238:8080/DrexelWelcome.html>

Send comments or suggestions to wkunkle@mcs.drexel.edu

Login Procedure for the Web Site

(snapshot next ...)



The Integral Evaluator Main Page

(snapshot next ...)

Integral Evaluator - Netscape

File Edit View Go Communicator Help

Bookmarks Location: http://localhost:8080/IntegralEvaluator_Home3.html What's Related

Back Forward Reload Home Search Netscape Print Security Shop Stop

Instant Message WebMail Calendar Radio People Yellow Pages Download Customize...

Integral Evaluator

Enter a problem for integration, for example: $\int \frac{3x^2}{4+x^3} dx$ Click here for: [Tutorial](#)

Enter your integral or click to display a stored one: Generate Integral

Click to display a palette: Symbols Templates Functions

|
= ∫

Enter your replacement variable:

Highlight a substitution, then click the check box to confirm your selection:

Your substitution: $u =$

Your differential: $du =$

Extract MathML
Clear Display
Change Variable
Evaluate Integral

Applet EditorApplet started

Sample Integral Evaluated with Specified Substitution

(snapshot next ...)

Integral Evaluator - Netscape

File Edit View Go Communicator Help

Bookmarks Location: http://localhost:8080/IntegralEvaluator_Home3.htm What's Related

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Integral Evaluator

Enter a problem for integration, for example: $\int \frac{3x^2}{4+x^3} dx$ Click here for: [Tutorial](#)

Enter your integral or click to display a stored one: Generate Integral

Click to display a palette: Symbols Templates Functions

$$\int e^{4x} dx = \frac{1}{4} e^u$$

Enter your replacement variable:

Highlight a substitution, then click the check box to confirm your selection:

Your substitution: $u = 4x$

Your differential: $du = 4 dx$

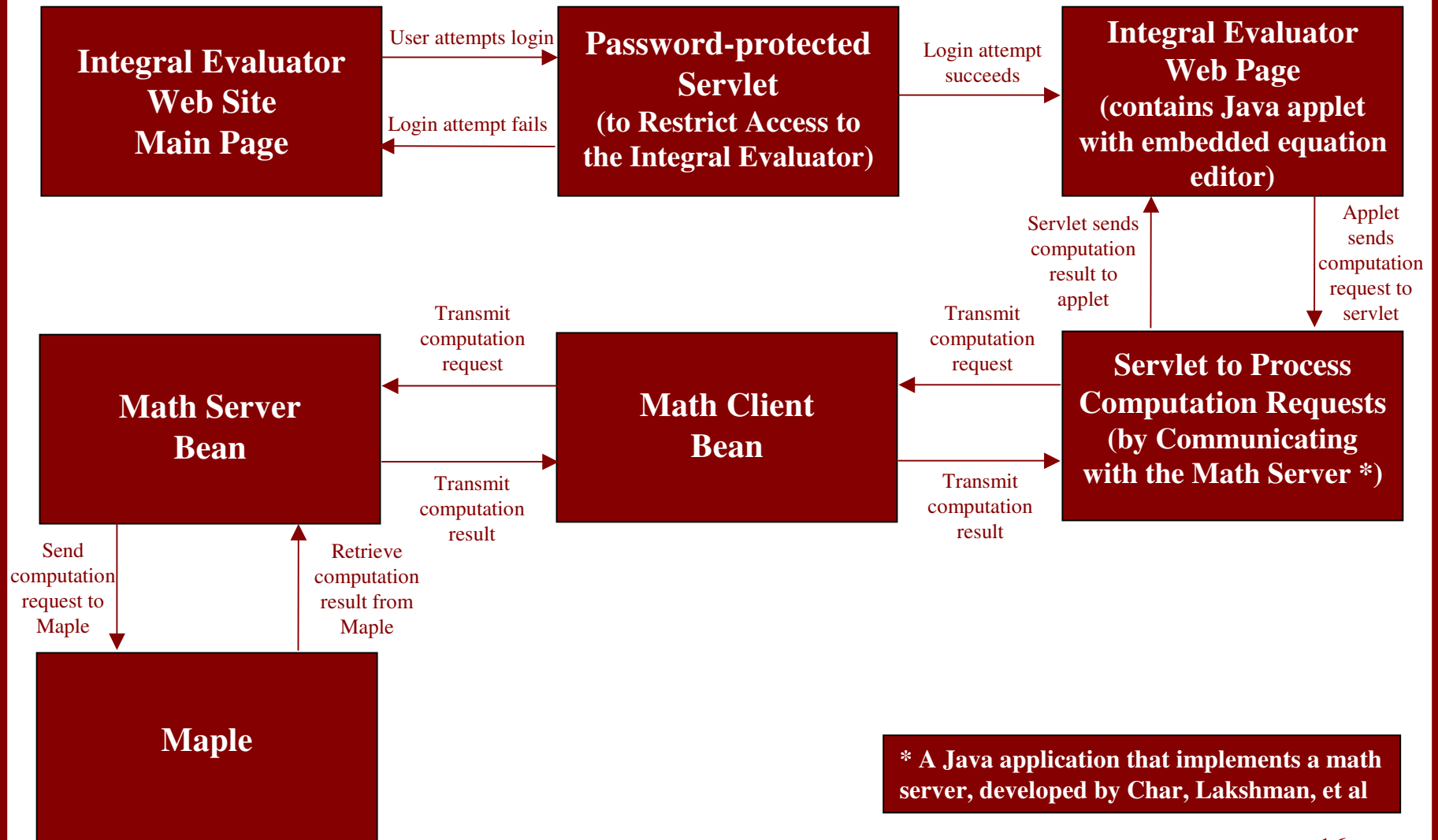
Extract MathML Clear Display Change Variable Evaluate Integral

Document: Done

Click here for a Demo ...

(technology permitting ...)

Structure of Software



Implementation Difficulties

- Early versions of WebEQ were very unstable, making it difficult to use as a development tool.
- Documentation for the WebEQ Developer API (Application Programmer Interface) is minimal, making it necessary to rely heavily on WebEQ Technical Support for the resolution of problems.

Planned Enhancements

- Modification of the Java code to take advantage of Maple 7.0's ability to import Maple expressions from MathML and export Maple expressions to MathML
- Modification of the internal documentation (comments) to facilitate processing by the *javadoc* utility
 - *javadoc* is a tool that comes with the Java SDK that generates HTML documentation from Java source code files.

Acknowledgements

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- Ron Perline and his students for “trying out” the initial version of this software and for providing valuable feedback regarding improvements that either already have been made or will be made in future implementations of the software.
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- Robert Miner, without whose invaluable technical support this software would never have become a reality!

References

Paper(s):

- Char, B., Johnson, J., and Lakshman, Y. N. “Software Components Using Symbolic Computation for Problem Solving Environments.” Dept. of Mathematics and Computer Science, Drexel University, Philadelphia, PA.

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- “WebEQ Developers Suite Features,” Design Science, Inc. <http://www.mathtype.com/webmath/webeq/features.stm>
- “Welcome to the Waterloo Maple Web Site,” Waterloo Maple, Inc. <http://www.maplesoft.com/flash/index.html>