

Maple 8 and Maplets: A New Use of Computer Algebra for Teaching Mathematics and Science

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Introduction

To begin this exploration of Maplets, you should be aware that some of the new features in Maple 8 are implemented as Maplets. The new interactive command in the plots package provides a more user-friendly interface to create a graph in Maple 8. Try, for example, entering the command: `plots[interactive](x*sin(x));`

More generally, Maplets are Maple-based applets. Most applets found on the WWW are written in Java. Maplets are written in Maple; each Maplet element is, in turn, a Java Swing class. Two reasons to implement an applet as a Maplet and not directly in Java are

- convenience of using the high-level Maple programming language
- access to full range of Maple's symbolic, numeric, and graphic capabilities.

Maplets can be executed within a Maple worksheet, from the "command line" with the MapletViewer, or via the WWW with MapleNet. (MapleNet is a new product of Waterloo Maple that allows users who do not have Maple on their local machine to access Maplets via the WWW. For detailed information, please visit <http://maplenet.maplesoft.com/>.)

Maplets, Worksheets, MapletViewer, and MapleNet

A Maple worksheet (`.mws` file) is the easiest format to use to develop a Maplet. The MapletViewer can be used to directly access a Maplet from the desktop, local file system, or the WWW. The only modification required to create this functionality is to save the worksheet as a file with type Maplet (file extension `.maplet`). For example, consider the simple Maplet contained in the Maple worksheet `demo1.mws`.

- Open the `demo1.mws` worksheet within Maple (clicking on the hyperlink suffices).
- To see the Maplet, execute the entire worksheet. (Note that the Maple worksheet is busy until the Maplet terminates.)
- Save the worksheet as `demo1.maplet` (on the desktop, if possible).
- Minimize Maple (you could terminate Maple, but you would lose your place in this worksheet).
- Double click on `demo1.maplet` (if not on the desktop, use explorer to locate the file). (Note that this does not tie up the Maple worksheet; a separate Maple kernel is running the Maplet.)

To demonstrate Maplet access via MapleNet, download the Maple 8 worksheet (URL above) and select one of the [maplenet] links in the list of Maplets. These Maplets were created in Fall 2002 for my Calculus I course at the University of South Carolina. (Firewall and other security issues might prevent access to these Maplets via MapleNet. If so, clicking on the link to the corresponding `.maplet` file should launch the Maplet in MapletViewer.)

Examples for Calculus I

Prior to learning some of the fundamentals of Maplet programming, please look at some of the following Maplets. The first set of 19 Maplets were created by Waterloo Maple, Inc., and can be obtained from the [MaplePrimes](#) website. The second set of Maplets are ones that I have created for use this semester in my [Calculus I](#) course at The University of South Carolina. (Note that some of the WMI-prepared Maplets cannot be accessed via MapleNet. Each of my Maplets is MapleNet-compatible.)

Calculus I Maplets prepared by Waterloo Maple

- Continuity - graphical exploration of the continuity of a function
- Limit - step-by-step application of limit properties
- TangentAndSecant - display/animate secant lines converging to tangent
- TangentLinePlot - compute and display the tangent line to a curve at a point
- Differentiation - step-by-step application of differentiation rules
- DerivativePlot - display a function and one or more specified derivatives
- AreaMaximization - optimization for rectangles under a parabola
- CurveAnalysis - display function, local extrema, in/decreasing, concavity
- MeanValueTheorem - symbolic, numeric, or graphic application of the MVT
- TaylorApproximation - display/animate Taylor polynomials
- NewtonsMethod - displays iteration in Newton's method
- Antiderivative - display one antiderivative or a family of antiderivatives
- ApproximateIntegration - graphical and numerical support for Riemann sums
- Integration - step-by-step application of integration rules
- FunctionAverage - display a function and its average value over an interval
- VolumeOfRevolution - display solid of revolution, find/evaluate integral for volume
- ArcLength - show definite integral; plots curve, integrand, and arclength
- SurfaceOfRevolution - like VolumeOfRevolution, except for surface area
- InverseFunction - reinforce graphical relationships between inverse functions

Many of the above Maplets are based on commands in the [Student\[Calculus1\]](#) package (new to Maple 8). The following Maplets were implemented before I learned about the [Student\[Calculus1\]](#) package. That is the reason these Maplets come from the first part of the course. Still, I like them and I believe they provide good examples of what can be done.

Calculus I Maplets prepared by Douglas Meade

- LimitCheck - evaluate limit of expression at a point (1- or 2-sided)
- DerivCheck - evaluate derivative of expression with respect to variable
- LinearMotion - evaluate derivative of expression with respect to variable
- RelatedRates - interface for related rate/implicit differentiation problems
- FunctionAnalyzer - similar to CurveAnalysis in previous list

Introduction to Maplet Programming

A six-lesson introduction to Maplet programming was provided. Topics discussed included: text fields, buttons, 2- and 3-d graphing, check boxes, sliders, selection from a list, pull-down menus, popup menus, and mathematically typeset output (using MathML).

Resources for Maplet Programmers

This workshop only scratched the surface of what can be done with Maplets. Maple's online help system contains extensive information about Maplets, including many examples. Two of the first places I suggest you visit are ?Maplets,Index and ?Maplets,Roadmap. These help documents contain similar information organized in different ways. (The [Maplets Style Guide](#) is also quite useful.) For a complete list of Maplets elements, see ?Maplets,Elements. A compact listing of all options available within each element is provided at ?Maplets,ElementOptions. A collection of Maplet examples is provided within Maple 8. For a complete listing, see the help document ?Maplets,Examples.

Additional Exploration

One of the best ways to learn Maplet programming is to modify an existing Maplet. Here are some ideas based on Maplets presented in this workshop to help you get started.

- modify the [LimitCheck](#) and [DerivCheck](#) Maplets to display the results with a [MathMLViewer](#) element;
- modify the [DerivCheck](#) Maplet to include a field where the user can specify the order of the derivative to be computed (default to first-order);
- create a Maplet that provides an interface for solving a user-specified equation for a specified variable (include a [CheckBox](#) to indicate if floating-point answers are requested);
- modify [FunctionAnalyzer](#) Maplet to have separate [Plotter](#) elements for the ordinary plot and sign plots;
- modify the [MeanValueTheorem](#) Maplet to properly handle the case when the hypotheses of the MVT are not satisfied (note that the [Student\[Calculus1\]\[MeanValueTheorem\]](#) procedure does check the hypotheses of the MVT, but the Maplet has not been programmed to handle this case);
- combine the [MeanValueTheorem](#) and [FunctionAverage](#) Maplets to create a Maplet for the MVT for Integrals.

References

This document presents only a summary of the content of the workshop. The actual materials used in the workshop are available via the WWW in a variety of formats:

- <http://www.math.sc.edu/~meade/bmcc-maplets/BMCC-Maplets.mws> Maple worksheet
- <http://www.math.sc.edu/~meade/bmcc-maplets/BMCC-Maplets.html> HTML file
- <http://www.math.sc.edu/~meade/bmcc-maplets/BMCC-Maplets.pdf> PDF file
- <http://www.math.sc.edu/~meade/bmcc-maplets/workshop.zip> ZIP archive

Only the ZIP archive contains the full set of files needed to guarantee all hyperlinks in the Maple 8 worksheet will function properly. Please download and explore the above materials. Questions and comments are encouraged.

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