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

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Overview

This workshop is designed to

- present an introduction to Maplets,
- demonstrate several examples of Maplets suitable for use with Calculus,
- provide a list of the most relevant and useful Maple help documents for Maplet users and authors, and
- enable participants to begin to program their own Maplets.

There is not enough time to completely address everything in this worksheet. I will attempt to highlight the essentials. You are encouraged to let your interests guide your exploration.

Please stop me at any time to ask questions. I do not mind repeating myself or providing additional explanations. My goal is for you to learn as much about Maplets as you want -- within the time constraints.

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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. For example, the new interactive command in the plots package:

```
> restart;  
> plots[interactive]( x*sin(x) );  
>
```

As seen above, a Maplet can be used to provide an intuitive graphical user interface to Maple. 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
- power derived from interaction with 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 Demonstration

– 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 should suffice).
- 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, select one of the [maplenet] links in the list of Maplets in the next section. These Maplets were created earlier this semester for my current [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

- [\[mws\]](#) [\[maplet\]](#) [\[maplenet\]](#) Continuity function at a point -- graphical exploration of the continuity of a function at a point
- [\[mws\]](#) [\[maplet\]](#) [\[maplenet\]](#) Limit -- step-by-step application of limit properties
- [\[mws\]](#) [\[maplet\]](#) [\[maplenet\]](#) TangentAndSecant converging to the tangent line at a point -- displays/animates sequence of secant lines
- [\[mws\]](#) [\[maplet\]](#) [\[maplenet\]](#) TangentLinePlot curve at a point -- computes and displays the tangent line to a curve at a point
- [\[mws\]](#) [\[maplet\]](#) [\[maplenet\]](#) Differentiation rules -- step-by-step application of differentiation rules
- [\[mws\]](#) [\[maplet\]](#) [\[maplenet\]](#) DerivativePlot derivatives -- displays a function and one or more specified derivatives
- [\[mws\]](#) [\[maplet\]](#) [\[maplenet\]](#) AreaMaximization -- optimization for rectangles under a parabola
- [\[mws\]](#) [\[maplet\]](#) [\[maplenet\]](#) CurveAnalysis where function is in/decreasing, and concave up/down -- displays function, local extrema, intervals
- [\[mws\]](#) [\[maplet\]](#) [\[maplenet\]](#) MeanValueTheorem symbolically, numerically, or graphically -- points where MVT is satisfied are shown
- [\[mws\]](#) [\[maplet\]](#) [\[maplenet\]](#) TaylorApproximation approximating a given function -- display/animate Taylor polynomials
- [\[mws\]](#) [\[maplet\]](#) [\[maplenet\]](#) NewtonsMethod -- displays iterations in Newton's method
- [\[mws\]](#) [\[maplet\]](#) [\[maplenet\]](#) Antiderivative family of antiderivatives -- displays a single antiderivative or an entire family of antiderivatives
- [\[mws\]](#) [\[maplet\]](#) [\[maplenet\]](#) ApproximateIntegration Riemann sums -- provides graphical and numerical support for Riemann sums
- [\[mws\]](#) [\[maplet\]](#) [\[maplenet\]](#) Integration -- step-by-step application of integration rules
- [\[mws\]](#) [\[maplet\]](#) [\[maplenet\]](#) FunctionAverage an interval -- displays a function and its average value over an interval
- [\[mws\]](#) [\[maplet\]](#) [\[maplenet\]](#) VolumeOfRevolution evaluates integrals for volume -- displays solid of revolution, finds and
- [\[mws\]](#) [\[maplet\]](#) [\[maplenet\]](#) ArcLength curve, integrand, and arclength function -- displays definite integral for arclength, plots
- [\[mws\]](#) [\[maplet\]](#) [\[maplenet\]](#) SurfaceOfRevolution evaluates integrals for surface area -- displays aolid of revolution, finds and
- [\[mws\]](#) [\[maplet\]](#) [\[maplenet\]](#) InverseFunction between inverse functions -- reinforcement of the graphical relationships

Many of the above Maplets provide convenient interfaces to 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

- `[mws] [maplet] [maplenet] LimitCheck` -- evaluates the limit of a user-entered expression at a specified point (1- or 2-sided)
- `[mws] [maplet] [maplenet] DerivCheck` -- evaluates the derivative of a user-entered expression with respect to specified variable
- `[mws] [maplet] [maplenet] LinearMotion` -- evaluates the derivative of a user-entered expression with respect to specified variable
- `[mws] [maplet] [maplenet] RelatedRates` -- convenient interface for related rate and implicit differentiation problems
- `[mws] [maplet] [maplenet] FunctionAnalyzer` -- useful tool for performing the analysis of a function in preparation of creating a graph

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These Maplets demonstrate the use of a few of the features available with the Maplets module, including:

- pull-down menus
- popup menus
- buttons
- check boxes
- sliders
- selection from a list
- 2- and 3-d graphing
- mathematically typeset output (using MathML).

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– Resources for Maplet Programmers

This workshop has 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  
> ?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 are provided within Maple 8. For a complete listing, see the help document

```
> ?Maplets, Examples
```

```
>
```

```
> with( Maplets[Examples] );
```

```
>
```

```
> Integration();
```

```
>
```

```
> Integration( sin(x^3)*x^2 );
```

```
>
```

– Introduction to Maplet Programming

+ **Lesson 1. A First Maplet: *Calculus is Great!***

+ **Lesson 2. The TextField and ComboBox Elements**

+ **Lesson 3. Communicating with the Maple Kernel**

+ **Lesson 4: Plots**

+ **Lesson 5: MathML output**

+ **Lesson 6: Examining the Interactive Plot Builder**

```
>
```

```
>
```

– Additional Exploration

Please use the remaining time (if any) in this workshop to begin to implement a Maplet for a topic of interest to you.

Here are a few suggestions for Maplet programming projects involving modifications to Maplets presented in this worksheet:

- modify the LimitCheck and DerivCheck Maplets to display the results with a MathMLViewer element
- modify the DerivCheck Maplet to have 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

A common way to start writing a Maplet is to find an existing Maplet with a similar layout or functionality. In addition to the Maplets encountered previously in this worksheet, take a look at the Maplets in Maplette.mws (created by Sylvain Muise and Doug Harder for a course at the 2002 Maple Summer Workshop).

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