2 MAPLE OVERVIEW

Sections

- 2.1   Maple Input and Output

- 2.2   Documentation

- 2.3   Execution Groups

- 2.4   Maple Features

- 2.5   Learning Tools

- 2.6   Application: Zebra Mussels

- Summary

- Key Terms

- Problems

Objectives

After reading this chapter, you should be able to:

- Use the Maple graphical user interface

- Describe the components of a Maple worksheet

- Enter input to produce output

- Collect input and output in an execution group

- Perform basic computations and plotting in Maple

- Use palettes and context-sensitive menus

PROFESSIONAL SUCCESS: LEARNING ABOUT MAPLE

No matter how exciting and engaging Maple, or any material, may be, nitty-gritty details might drag you down. But, learning need not bore you! Pique your interest and motivation with these tips:

❐ Familiarize yourself with the text:

Successful professionals never know everything – they just know where to look. Quickly flip though all chapters and appendices. Look for handy features, like solutions to problems and reference tables. You should also compare your course syllabus with the text's organization.

❐ Learn the notation:

Thoroughly understand all notation! Otherwise, lost shall you ever be!

❐ Set goals:

Carefully read your assignments and text, but never try to learn everything at once! Attempt only a few portions at a time. Taking small steps will improve your retention and prevent burn-out.

❐ Practice reading:

Learning requires both understanding and practice. Study the text by skimming the assigned readings a few times so you may gain a general understanding of the new material. Then, more carefully read smaller portions and practice the demonstrated examples. To stay focused, periodically remind yourself of chapter objectives.

❐ Practice implementing:

Follow the suggested examples in the book. Always try to understand the reasoning behind each exercise and predict the possible output before attempting the commands.

Read the text above and below each command for explanations of syntax and behavior.

❐ Be Patient!

Maple and other software sometimes confound students initially. So, you should expect some frustration that will eventually subside. But, with enough practice and patience, you can learn Maple as well as anything in this world.

2.1 Maple Input and Output

Maple provides a robust tool for mathematics, programming, and plotting. In general, you will fill Maple worksheets with a collection of commands that Maple will act upon. This section introduces basic methods of entering commands that will generate results in your worksheets.

2.1.1 Maple Input

Maple input consists of commands and mathematical expressions that you enter after the prompt, which is the right angle bracket (>):

> *Enter Maple input here. But, never type the Maple prompt (>)!*

Maple displays all executable input in red by default. Consult **?contextmaplein** in **?worksheet[reference]** for descriptions of Context Bar icons available when entering input.

2.1.2   Input Modes

Maple provides two input methods–*Maple Notation* and *Standard Math*–as demonstrated in Table 2-1:

- Maple Notation: Input is one-dimensional. Maple reproduces keyboard character input for mathematical expressions. Terminate this input by typing a semi-colon (**;**) or colon (**:**). To process the input, press Enter or Return (↵).

- Standard Math: Input is two-dimensional. Maple converts keyboard character input into typeset, textbook notation. To terminate and process input, press ↵ twice.

Note that you should never terminate help commands, like **?command**, with a semicolon or colon.

Table 2-1 Maple Input Modes

Input	Prompt	Example
Maple Notation	> |	**(a+b)/c**
Standard Math	> ▣	$\dfrac{a+b}{c}$

2.1.3   Choosing Input Modes

This text employs Maple Notation. You may switch input modes for a particular expression by first highlighting that expression with your mouse. You can then either:

- Select either the notation toggle-icon   , or

- Click the right mouse-button to select or deselect StandardMath.

You can also set a default mode with Options→InputDisplay:

- Choose either MapleNotation or StandardMathNotation.

- Then, press ↵ at the Maple prompt to activate the new mode.

Maple preserves your choice for future sessions if you have selected F̲ile→Au̲toSaveSetttings. Consult **?insertmenu** and **?worksheet[expressions]** for more information.

2.1.4   Maple Output

After you press enter ↵ after Maple input, Maple executes the input and produces results called *Maple output*. Maple output is shown in blue by default. Maple produces some output, like the symbols Σ, lim, and ∂, in black. To see an example of output produced by Maple, compute the sum $1 + 1$ using the Maple Notation **1+1**:

Step 1: Maple Input and Output

> **1+1;**↵   *Red Input: Type* **1+1;**, *and then press Enter. Evaluate the expression* $1+1$.

                 2   *Blue Output: Maple produces the output* 2 .

For descriptions of Context Bar icons available when manipulating, consult **?contextmapleout**.

2.1.5   Error Messages

Inevitably, everyone confronts complaints from a computer in the form of error messages. For instance, what happens if you forget a semicolon or colon? Maple will complain by reporting an error message as output.

Step 2: Error Messages

> **1+1**↵   *Enter* **1+1** *without a terminating semicolon or colon.*

>

Warning, premature end of input   *Maple reports a common error message.*

What should you do? Don't worry, and don't bang on the table in a fit of frustration! Trust me, I already tried that – it took a week before my computer was restored. Instead, you should satisfy Maple's demands by fixing the error. You may do this without deleting the mistake:

- Place the cursor *after* the input **1+1** or at the next prompt (>).

- Type a semicolon and then press ↵.

Maple will show the correct output 2. Now, Maple is "happy" once again. You should also try Maple's automatic correction mechanism by clicking on   , which sometimes helps.

2.1.6   Multiple Inputs

Semicolons and colons terminate input command statements:

- A semicolon (**;**) signals the end of input. Maple evaluates the input and *shows* the output.

- A colon (**:**) tells Maple not only to perform the computations, but to *suppress* the results.

To place separate commands on the same input line, you may use semicolons and colons. For example, try evaluating $1 + 1$ and $1 + 2$ on the same input line, but only show the results of $1 + 2$:

Step 3: Multiple Inputs

> **1+1: 1+2;**↵	*Compute* 1+1 *but do not show output. Next, compute and show* 1+2 *.*
	3 *The colon suppresses the output of* 1+1 *.*

Yes, Maple really did compute $1 + 1$, even though you do not see output. When you learn about assignments, reasons for suppressing output become more apparent. (Yes, a little faith is required when learning software.) Consult **?separator** for more information.

Practice!

1.   Find Maple's on-line glossary inside the Help Browser.

2. Enter $\frac{1}{2}$ in both Maple Notation and Standard Math. (Hint Try the forward-slash key to create the fraction.)

3. Ensure Maple Notation is the default input option.

4. Evaluate $1 + 2 + 3$ with Maple.

5. Evaluate $1 + 1$ and 1×2 on the same input line. Repeat this problem, but suppress the output of $1 + 1$.

2.2 Documentation

Why should you document your work? Today your worksheet might seem entirely clear, but what about a year from now? And what about colleagues/graders/bosses that need to review your work? Not only should your work be accurate, but clear as well – this section helps you with basic elements of adding commentary to your worksheets. Also, Maple provides many word-processing functions. For more information, consult **?worksheet[documenting]**, **?comments**, or try the menu options in Format.

2.2.1   Text

You may document your work with *text*, which is composed of inert, non-executable input.[‡]

Maple displays text in black by default, though you may change the appearance as discussed in

?styles. To enter text, try the following three methods:

- Move the cursor one space to the left of the prompt, as shown in Figure 2-1. The worksheet is now primed for text entry, so start typing.

- Select Insert→TextInput and type your text.

- Click the text icon   and type your text.

When finished, click on   to get a Maple prompt. If you use the first method, you may also

press ↵. See **?instext** for more methods of text entry. Also, note that while in text mode, the

Context Bar changes with new fields and icons, as shown in Figure 2-1. Refer to
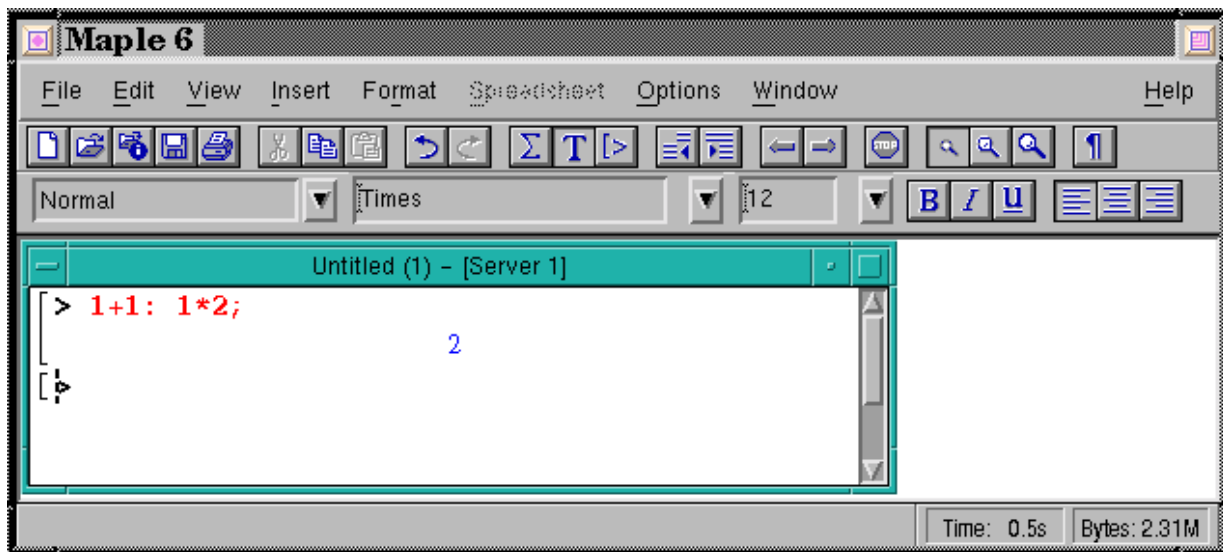
?contexttext for more information.

Figure 2-1 Entering Text

[‡].   Beware that *text* differs from *Maple text*, a format in which you may save entire worksheets.

Now you will enter text, using the methods described above. Each time you press ↵, a prompt

will appear:

Step 4: Entering Text

I am text!↵	*Move the cursor left one space. Enter this line.*
I am text, <u>too</u>!↵	*Move the cursor left one space. Enter this line.*
>	*The prompt reappears each time you press ↵.*

To underline the "too,"

- Highlight the word with your mouse

- Click the underline icon   in the Context Bar while still in text mode

2.2.2   Comments

You may also document your work by mixing commentary and Maple input. To create a comment

on an input line, use the number sign symbol (**#**). Maple ignores all input following the **#**:

Step 5: Maple Comments

> **1*2; # multiply 1 and 2**↵	*Evaluate* 1×2 *and include a comment.*
2	*Maple produced output* 2 *but ignored the comment.*

Consult **?comment** for more information.

2.2.3   Inert Math

You may also convert any executable, Maple input into *inert input*, a non-executable form of

Maple input shown in black. To do so, highlight the Maple input shown in red, and either:

- Click on the leaf icon   , or

- Click the right mouse-button and deselect Maple Input

- To return input to an active, executable state select   , or right-click your mouse and

  select Maple Input.

Practice!

6.   Enter **1+1** along with the comment **# I am a comment** on the input line.

7.   How do you convert inert input into executable Standard Math?

8.   Can you convert text to Maple input? If so, how?

2.3   Execution Groups

Have you noticed how Maple collects input and output together with range brackets on the left

side of a worksheet? Maple is trying to help you document your work. This section introduces

further techniques for helping you produce clear reports by collecting input, text, and output

together.

2.3.1   Paragraphs

Maple considers each line of text, input, and output as separate *paragraphs*:

- Add lines by selecting Insert→Paragraph followed by either Before or After.

- Delete lines with Edit→DeleteParagraph or the Del and Backspace keys.

Lines that contain graphical items, like spreadsheets and plots, are also paragraphs. To display where Maple terminates paragraphs, select the ¶ icon or View→ ShowInvisibleCharacters. Maple will identify individual paragraphs using the symbol ¶ and show other normally invisible characters.

2.3.2   Creating Execution Groups

Execution groups collect paragraphs together. Execution groups can consist of one or more paragraphs. Typically, input lines are followed by output lines inside one execution group. Range brackets connect input and output paragraphs, as shown in Figure 2.4. Common tasks you may perform with execution groups include

- Selecting View→ShowGroupRanges to show or remove brackets.

- Pressing ↵ or the icon   to create a new execution group.

- Selecting Insert→ExecutionGroup followed by BeforeCursor or AfterCursor to insert a new group before or after the cursor.
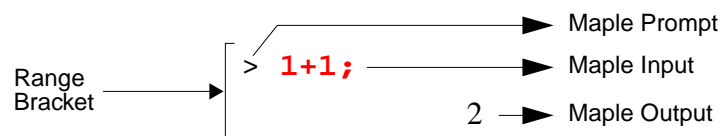

Figure 2-2 Execution Group

2.3.3　Joining Execution Groups

I strongly suggest you practice "playing" with software as a learning approach. So, this section demonstrates steps that help you create execution groups that help you organize your work. You will create two individual execution groups and then connect them to create the worksheet shown in Figure 2-3.
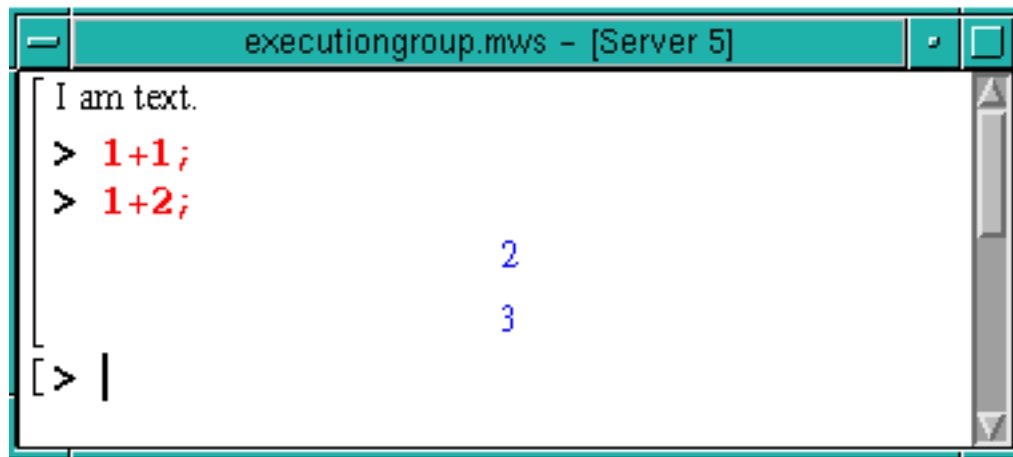
Figure 2-3 Example Execution Group

Step 6: Create First Group

I am text.↵	*First, add a line of text.*
> **1+1;**↵	*Next, enter input.*
2	*Maple generates and includes output in the group.*

At the next prompt that appears, enter **1+2**:

Step 7: Create Second Group

| > **1+2;**↵ | *Enter input.* |
| 3 | *Maple generates and includes output in the group.* |

To join the groups in Steps 6 and 7,

- Place the cursor in the first execution group (Step 6), which has the input **1+1**.

- Select Edit→Split or Join→Join Execution Groups.

Now, you will see the execution group:

Step 8: Joined First and Second Groups

I am text.   *This execution group is joined from the previous two groups.*
> **1+1;**   *This input is from Step 6.*

2   *This output is from Step 6.*

> **1+2;**   *This input is from Step 7.*

3   *This output is from Step 7.*

Now, click anywhere inside the group and press ↵ to reorganize the input and output lines. Maple

places all input paragraphs together and evaluates each input in sequence, from top to bottom:

Step 9: Reorganize Input and Output Lines

I am text.
> **1+1;**
> **1+2;**

2

3

Refer to **?joingroup** and **?executiongroups** for more fun things you can do with

execution groups.

Practice!

9. Select <u>V</u>iew→Show<u>I</u>nvisibleCharacters or the ¶ icon. What do you see? Now turn off the

    invisible-character display.

10. Create an execution group with three paragraphs of text and no Maple input.

11. Evaluate $1 + 1$, $1 - 1$, and 1×2 on separate paragraphs in the same execution group.

2.4   Maple Features

If you have not taken Maple's online tour yet, perhaps you have only witnessed Maple's

arithmetic skills. But, Maple is much more than a grandiose calculator! Maple offers you

powerful tools for solving complicated problems. Before solving those problems, however, you need to continue developing your skills as a Maple user. So, try the features in this section before continuing further. You should also consult **?worksheet** or BasicFeatures… for online overviews.

2.4.1 Case Sensitivity

Maple distinguishes between upper and lower case letters: Maple is *case sensitive*! For instance, never enter **a** when you mean **A**!

2.4.2 Expressions

A mathematical *expression*, like $2x + y$, combines numbers and symbols with *operators*. You have already used basic arithmetic operators **+**, **-**, *****, and **/**. Maple denotes symbols, like the variables x and y, as *names*. Chapter 3 reviews names and operators. Refer to **?manipulation** for tips on selecting and editing expressions.

2.4.3 Functions

Maple *functions* help build expressions and have the structure **func(arg1,arg2,…)**:

- **func** is the function name

- **arg1**, **arg2**, … are arguments that the function acts upon.

Suppose you want to take the square root of a number using Maple. Surely, someone working for Maple has already programmed this for you. So, how do you find the function? Try the following problems to find out.

Practice!

12. Perform a search for the text *square root*.

---

13.   Scroll down the suggested help topics. How do you open one? Select **sqrt**.

Once you know the name of the function ***func***, find help by entering **?*func*** at the Maple prompt, as discussed in Section 1.5.6. For example, enter **?sqrt** for help on **sqrt**:

Step 10: Find Help on Function

> **?sqrt**↵   *Find help on* **sqrt**. *Maple opens a window that discusses* **sqrt**.

To find the square root of an expression ***expr***, enter **sqrt(*expr*)**:

Step 11: Using a Function

> **sqrt(4);**↵   *Find the square root of* 4 *.*

                           2   *Maple succeeded! For more fun, enter* **sqrt(x^2)**.

Later chapters introduce many helpful functions for a variety of tasks. Appendix K summarizes all the functions used in this text. For further information on how Maple stores and access functions, refer to Appendix D.

2.4.1   Assignments

An *assignment* stores an expression "inside" a Maple variable name. Maple assignments have the syntax ***name := expr***, where ***name*** stores ***expr*** inside Maple's memory.For instance, if I told you to store the value of 72 in a variable called x, you would enter **x:=72** at a worksheet prompt. Then, every time Maple sees x, Maple really uses 72. So, a name resembles a variable which acts as a placeholder for another expression. When entering assignments,

- Always put a colon (:) before the equals sign (=) with no space between them!

- Never use a lone equals sign (=)!

Try the following assignment, where you store the expression $1 + 1$ using variable Var:

Step 12: Introducing Assignments

> `Var := 1+1;↵`   *Compute* $1+1$ *and store the value "inside" Var* .

$$Var := 2$$ *Maple reports your assignment.*

Maple first performs computations required by the expression $1+1$ before performing the assignment. (Later on you will discover why.) Maple now considers all future occurrences of Var as the value 2. Thus, you can check the value of Var by entering the name as input:

Step 13: Checking Assigned Values

> `Var;↵`   *What value does Var contain?*

2   *Maple reports the value of Var* .

A new worksheet opened during a session might actually "know" previously assigned variables, as discussed in Chapter 3. So, to erase assignments from Maple's memory, enter **restart** at the prompt in the worksheet in which you are working.

Practice!

14. Store the value 2 in x. Store the value 1 in X.

15. Check the values of x and X. Why should x and X report different output?

16. Now, enter **restart**. Check the values of x and X. What happened?

2.4.1   Graphics

A picture says a thousand words…when speaking of equations, think of graphs, or as Maple calls them, *plots*. When analyzing a model, a plot demonstrates qualitative behaviors not readily apparent in the mathematics.

Maple provides an excellent tool for generating plots of expressions. For instance, try plotting the equation, $y = f(x) = 2x + 3$ on $0 \le x \le 5$. To plot y as a function of x, use a function of the form **plot(*expr*,*ranges*,*options*)** with the following arguments:

- ***expr***: enter the expression $2x + 3$ as **2*x+3**. If you previously entered **y:=2*x+3**, you may enter **y**, instead. But, never enter **y=2*x+3** because **plot** cannot handle expressions that include the equal sign.

- ***range***: enter the interval of the independent variable $0 \le x \le 5$ as the range **x=0..5**.

- ***option***: display a title using the option **title="*plot title*"**.

Step 14: Basic Plotting

> **plot(2*x+3,x=0..5,title="Test Plot");↵**   *Plot $f(x) = 2x+3$ along $0 \le x \le 5$.*
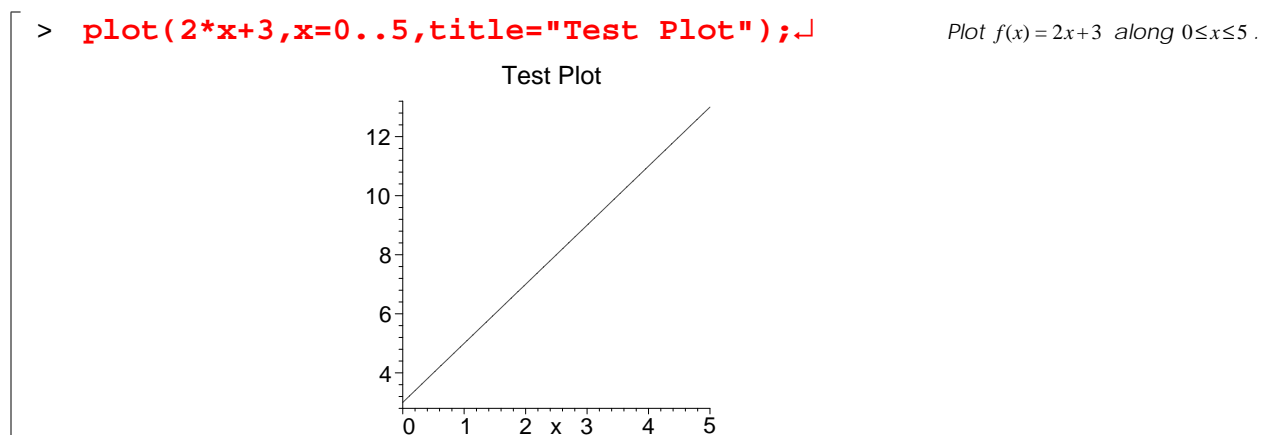
Maple's default setup has plots appear in an execution group. To place plots in a separate window, select the menu O̲ption→P̲lotDisplay→W̲indow. Review Chapter 8 and Graphics… to explore more of Maple's plotting features.

Practice!

17. Assign to y the expression $2\sqrt{x}$.

18. Plot y for $0 \le x \le 100$. Title your plot "Hello, I am a plot".

2.4.1 Spreadsheets

When working with multiple expressions, Maple provides tools for creating and accessing spreadsheets in your execution groups. Review Appendix F for a thorough discussion.

2.4.2 Worksheet Management

Worksheet management consists of operations performed on entire worksheets including the workspace. You should consult Appendix C and **?workspace[managing]** for detailed explanations of operations, like opening and closing. Beware that saving work in Maple Worksheet "mws" format creates a file only Maple understands. Never print these files!

2.4.3 Miscellaneous

Various appendices in this book demonstrate other features, such as programming and MATLAB, that you might find useful after gaining more experience with Maple.

Practice!

19. Save an open worksheet as **test1.mws**.

20. Open a new worksheet. Save it as **test2.mws**.

21. Print **test1.mws** to a PostScript file **test1.ps**. Can you load **test1.ps** into Maple? Can you directly print **test1.mws**?

2.5 Learning Tools

Sometimes learning new software can be overwhelming – there's so much to learn. With Maple, memorizing the thousands of commands might seem insurmountable. Thankfully, online

documentation explains most everything you will need to do. Maple also provides other tools that help you learn. In time, you might drift away from some of these features as you become more experienced. But for now, review the tips in this section and use them in your early Maple explorations.

2.5.1   Palettes

Maple's *palettes* are "clickable" windows that provide templates for choosing common commands that you might wish to enter. If Maple does not show any palette windows, select View→Palettes→ShowAllPalettes. Inside the Maple workspace, three palettes will appear: the expression, symbol, and matrix palettes. Figures 2-4 and 2-5 show the symbol and expression palettes. Chapter 10 will demonstrate the matrix palette. You will find online documentation in **?worksheet,expressions,palettes**.
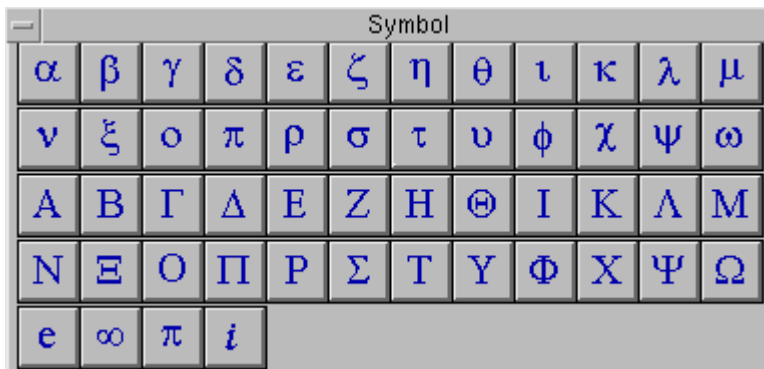

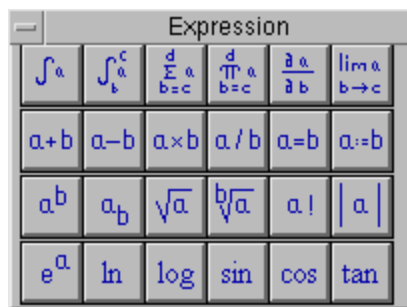**Figure 2-4** Symbol Palette

Figure 2-5 Expression Palette

2.5.2   Symbol Palette

Using a palette resembles ordering a meal at a restaurant. First, you identify what you want to "eat," or enter. Then you "order," or select it. Suppose you're "hungry" to enter the symbol ξ but can't figure out what it's really called other than "squiggle". Well, to "order squiggle" from your palette,

- Move your cursor to the position you wish to insert a symbol in your worksheet.

- Click on the symbol in the palette.

Maple's name for the symbol will appear in your worksheet. For instance, try inserting "squiggle" using the palette:

Step 15: Entering a Symbol

> *Place the cursor in a new input paragraph, find the Symbol Palette, and click on the ξ symbol.*
>
> **xi;**↵   *The Maple input* **xi;** *will appear.*
>
>   ξ   *After you press* ↵ *Maple shows the symbol in the correct font.*

Want to discover more names for other symbols? Use the Symbol Palette or check out Appendix A. See also **?symbols**.

2.5.3   Expression Palette

What if you want to enter an expression but you do not know Maple's command names? As you used the symbol palette, you will select items from the expression palette using your mouse. But, unlike the symbol palette, the expression palette entries are *patterns* that you will fill in at the prompt. For example, clicking on the **a+b** pattern will not actually use an **a** and **b**. Rather, Maple inserts placeholders which have the form **%?** for Maple Notation or **?** for Standard Math. For expressions with multiple placeholders, press the Tab key to move to a new placeholder.

For instance, suppose you need to evaluate the expression $4x^{\sqrt{2}}$. Using Maple Notation, perform the following instructions:

Step 16: Entering a Symbol

Select **a×b** *, press Tab, select* **a**$^{\text{b}}$ *, press Tab, select* $\sqrt{\text{a}}$ *from the Expression Palette.*

> `((%?)*(%?^sqrt(%?)));`   *Maple automatically types this expression as you select palette items.*

To fill in the values, use the Tab key to jump between placeholders and then type your input:

Step 17: Filling in placeholders

Move cursor to beginning of input, press Tab, enter **4** *, press Tab, enter* **x** *, press Tab, and enter* **2** *.*

> `((4)*(x^sqrt(2)));↵`   *You may also manually delete any placeholder (***%?***).*

$$4x^{(\sqrt{2})}$$ *Maple generates the output you expected.*

When using Standard Math, the Context Bar will show a box called the *edit field*, which contains the expression in Maple Notation. Using the edit field along with the palette is another great way to learn Maple commands.

2.5.4   Context Sensitive Menu

What should you do when you are looking for a particular function but you do not know the exact name? You could perform a topic or text search, as described in Appendix B. For an even quicker search,

- Highlight the expression you wish to manipulate.

- Right click the expression.

Maple will display a *context-sensitive menu* which contains selections for "common" commands used with expressions that resemble the one you highlighted. By selecting a menu option, Maple will figure out the input for you and type it in a new execution group. For example, try manipulating the expression $x^2 + 4x + 4$:

Step 18: Context-sensitive menu

> `x*x + 4*x + 4;`   *Trying the expression palette, instead, gives*
`((%?^%?)+(((%?)*%?))+%?);`.

$$x^2 + 4x + 4$$ *Everything is OK here.*

Select the output x^2+4x+4 *with the left mouse-button, then right-click the mouse, and select* Factor.

> `(x+2)^2;`   *Maple automatically factors the expression for you.*

So, what was the function Maple used? Try entering `factor(x*x + 4*x + 4)` to produce

the same result. Although Maple won't tell you the function name, the function name tends to

match its equivalent in the context-sensitive menu. For more information, consult Basic

Features...Mathematics...context-sensitive menus or `?manipulatecsm`. What if you don't like the

choices provided to you? Adventurous students should investigate `?context` and

`?examples[context]` to create their own menus.

2.5.5   Smartplots

Sometimes some expressions require a lot of tinkering with options to obtain a useful plot. To

save time, you may want to let Maple hazard a few guesses on its own using a smartplot. A

smartplot is a plot automatically generated by Maple where you let Maple select the options. You

may then use context-sensitive menus to manipulate the plot. To generate a smartplot, follow the

same steps for getting a context-sensitive menu and select Plots. You should choose a type of plot,

like two- or three-dimensional, from a sub-menu. For instance, you can generate a three-

dimensional (3-D) plot:

Step 19: Smartplot

> `x*cos(y)-sin(y);`   *Enter the expression. Using two different variables will make the plot 3-D.*

$$x\cos(y) - \sin(y)$$ *You may also use the expression palette.*

Select the output, right-click, and select Plots→3-D Plot→x,y.

> **`smartplot3d[x,y](x*cos(y)-sin(y));`**   *Maple automatically enters this expression and*

generates the plot as output in this execution group.

Maple indicates that the plot is a smartplot using the word Live.

Live
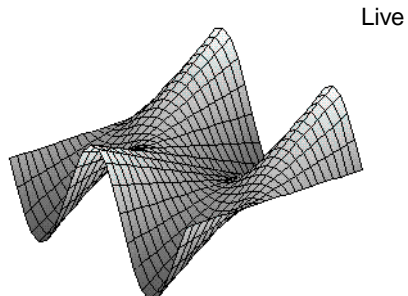
To alter features of the plot, as shown in Figure 2-6,

- Click on the plot – the outer box indicates that the plot may be altered

- Right-click to see a variety of menu options

Although "normal" plots have context-sensitive menus, the smartplots have additional options, like adjusting the plot ranges with Axes→Ranges. For more information, consult **`?contextmenu`** and **`?smartplot`**.
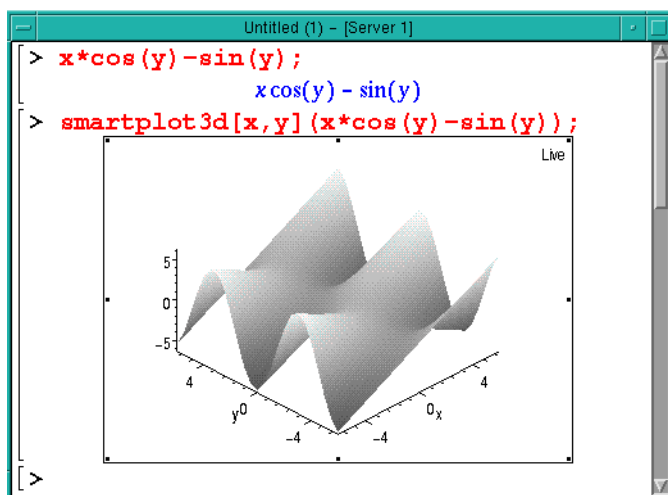

Figure 2-6 Altered Smartplot

2.5.6   Maple Application Center

Formerly, Maple provided a share-library which contained a collection of worksheets. Now, Maple has combined the entire share-library with an online collection of worksheets covering a vast array of applications. Consult **?share** for more information. Remember, also, to check out example worksheets listed in **?examples[index]**.

Practice!

22.   What Maple input will generate the output $\delta\iota\sigma$?

23.   What Maple input will generate the output $\dfrac{x}{\sqrt{y+2}}$?

24.   Generate the plot shown in Figure 2-6. Hint: Use the context-sensitive menus.

2.6   Application: Zebra Mussels

This section demonstrates a brief example from environmental engineering and science that illustrates key Maple commands.

2.6.1   Background

Sometimes, big engineering problems come in small packages…perhaps millions of them. Zebra mussels have infested some North-American waterways. Check out the image in Figure 2-7! These remarkably sturdy aquatic creatures clog pipes and foul water. Much research is devoted to dealing with these pests.
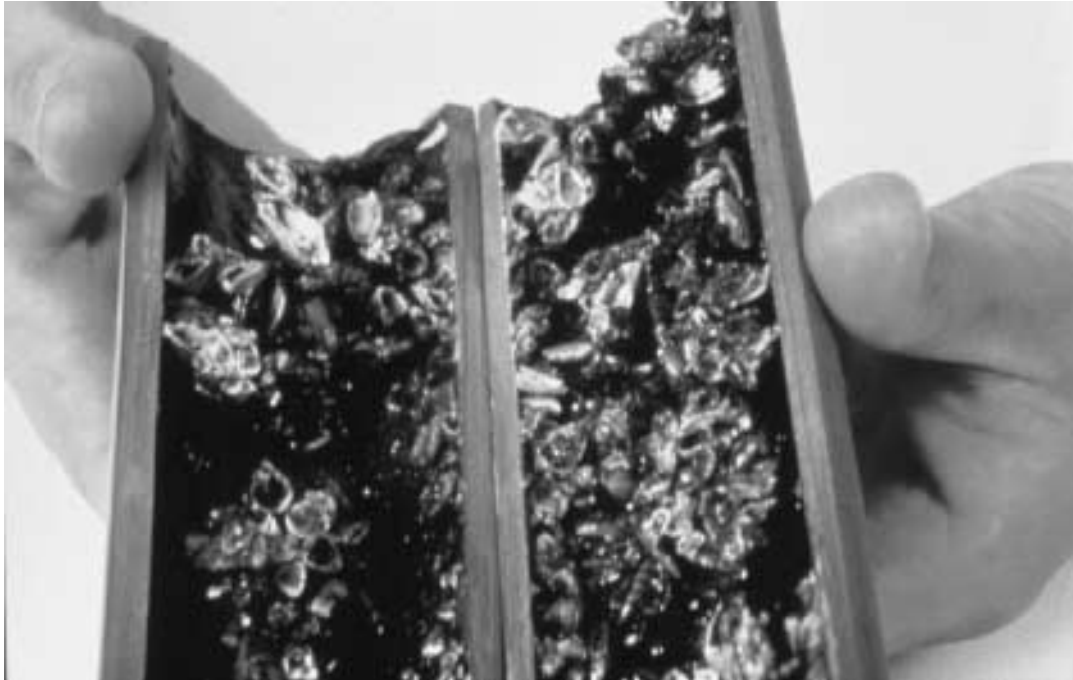
Figure 2-7 Zebra Mussels (Courtesy of U.S. Geological Survey, Great Lakes Science Center)

Assume that the exponential-growth equation

$$P = P_0 \exp(rt) \tag{2-1}$$

governs the zebra-mussel population in a given body of water. Parameter P_0 represents the initial

size of the colony, which has a growth rate r over time period t.

2.6.2 Problem

Given a growth rate $r = 0.9$ (years^{-1}), what relative population growth P does the model in Eq.

2-1 predict in a span of ten years?

2.6.3 Methodology

Inside Maple, retype pertinent parameters and data:

Step 20: Zebra Mussel – Restate

> P = population and *P0* = initial population (units=critters/m^2)↵   *Enter text.*
>
> r = growth rate (1/year) and t = time (year)↵   *Enter text.*

Next, state your known data, and assign Maple variables to these values:

Step 21: Zebra Mussel – Separate

> `r:=0.9;`↵   *Assign to the name* r *the value* 0.9 *.*
>
> $$r := .9$$ *Maple reports your assignment.*

Now, assign the model in Eq. 2-1. Using an assignment statement, place the unknown variable P

on the left and the function on the right. Express the function e^{rt} as $\exp(rt)$:

Step 22: Zebra Mussel – Model

> `P:=(P0)*(exp(r*t));`↵   *Assign to the name* P *the expression* $P_0\exp(rt)$ *.*
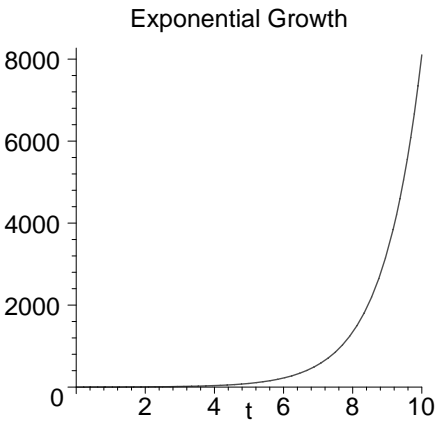>
> $$P := P0\mathbf{e}^{.9t}$$ *The function* $\exp(x)$ *is written as* e^x *, as discussed in Chapter 6. For now, just duplicate the input written here.*

Since the problem has not provided an initial zebra mussel count, divide the equation by P_0, and

plot P/P_0 for the given time interval $0 \le t \le 10$ years:

Step 23: Zebra Mussel – Solve

> `plot(P/P0,t=0..10,title="Exponential Growth")`↵

Wow…that looks like a lot of pesky zebra mussels! Finally, find the relative increase at ten years:

Step 24: Zebra Mussel – Report

> **`t:=10: P/P0;`**↵   *Assign to t the value 10, but suppress the output.*

In the same input line, evaluate the relative increase.

$$8103.083928$$ *Maple's evaluation of the expression $\frac{P}{P_0}$.*

2.6.4   Solution

After 10 years, the zebra-mussel population will have grown to about 8000 times the original population, according to the chosen model. The exponential function models rapid and compounding changes, as that of zebra-mussel reproduction. However, this model provides only a crude approximation. Numerous factors that were not represented in the model contribute to the growth and death of zebra mussels.

Summary

- The Maple worksheet contains computations and documentation.

- A user may find online help with the help operator **?**.

- The user enters Maple input to evaluate output.

- Execution groups collect input and output.

- Many Maple commands consist of expressions which contain variables, functions, and values.

- Assignments store values inside variables.

- Maple provides useful tools, like palettes and context-sensitive menus, that help users learn the software.

- Maple creates graphs of expressions with plots.

Key Terms

active input

assignment

case sensitive

context-sensitive menu

expression

execution group

inert input

Maple input

Maple Notation

Maple output

palette

paragraph

plot

smartplot

Standard Math

text

Problems

Write your answers to the problems inside a Maple worksheet. Be neat and beware of case-sensitive variable names! Use the following the format, unless instructed otherwise:

Problem 0.1
Solve for $1 + 1$.
> `1+1;`

2

1.   Enter the following information on the top of your worksheet:

> HOMEWORK 1
> Name:
> Section:
> Date:

2.   What is Maple?

3.   Specify three uses of Maple.

4.   What is an execution group?

5.   Indicate the menu selections to insert both a section and a subsection.

6.   How do active and inert input differ?

7.   How do Maple input and output differ?

8.   How do Standard Math and Maple Notation differ?

9.   Find help on Maple "help" and using the **?** command.

10.   Find help on Maple names.

11.   Suppose that you save your worksheet to **hw1.mws** using the menu-selection sequence File→SaveAs…. Assume that you then exit Maple. How can you print the contents of **hw1.mws**?

12.   Assign to the name *B1* the value 10.

13.   Assign to the name *B2* the expression $1 + \frac{1}{2}$.

14.   Evaluate $1 + 2$, $1 - 2$, 1×2, and $1 \div 2$ using Maple.

15.   Start a fresh Maple session. Enter the following Maple input:

> `>  A:=2:`

Generate output from the following input:

```
>  A; a;
```

Does Maple report the same values for *A* and *a* ? Why or why not?

16. Assign to *B3* the expression $\dfrac{100}{10}$, but prevent Maple from showing the output. Next, display the value of *B3* in a new execution group.

17. Find help on the sine function. Next, demonstrate that Maple evaluates $\sin\left(\dfrac{\pi}{2}\right)$ to the value of 1. Hint: Use the symbol palette to enter π.

18. Plot $y = x^2$ for $0 \le x \le 2$. Label your plot "Parabola."

19. Plot $y = mx + b$ for $m = 1$ and $b = -1$ over the domain $-2 \le x \le 2$.

20. Produce execution groups in Maple that look like what you see written below:

Problem 20a.
```
>  1+1:
>  `Hello`;
>  EQN := y=m*x+b:
>  A:=10:
```
$$Hello$$

Problem 20b.
Hello, I am just text.
Now, try **boldface** and *italic* styles.
```
>  # I am just a happy comment :-)
```

Problem 20c.
Use the backslash (\) as a continuation character for Maple input:
```
>  1 + 2 +\
>  3 + 4;
```
$$10$$

Problem 20d.

Here is an embedded inert equation $\dfrac{a+b}{c}$. Hint: Investigate the ⌊nsert menu selections.

Here is the same equation, $\dfrac{a+b}{c}$, but now it's active input. Hint: Investigate the icons on the context bar.

$$\frac{a+b}{c}$$

Problem 20e. Hint: See **?structuring2**.

⊟ **I am a section**

    ⊟ **I am a subsection**
        > `1+1;`
                2

    ⊟ **I am another subsection**
        > `1-1;`
                0