Appendix A5. Sound Advice and Encouraging Words

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Save early, save often

This may be the best advice you will get for working with any computer application. This, and a heads up about Auto save. Maple's Auto save feature can be set from the opening panel in the **Preferences...** dialogue (**Maple 10** menu on a Macintosh, **Tools/Options...** on a PC). Use it. Set a save interval of 5 minutes and you will never loose more than 5 minutes of you time when Maple crashes, and Maple will crash. That's a promise.

We suggest that you also become accustomed to pressing **Command-S** (**Control-S** on a PC) every once and a while. This is the keyboard equivalent for **Save** on the **File** menu. Certainly you will want to "do a save" as you finish a major part of a worksheet or are about to embark on a doubtful computation.

What you see may not be what you get

When you look at a worksheet on the computer screen, you see what might be called the "visible state" of the worksheet. This is not the same as the "internal state", which we can think of as being what Maple sees in the worksheet. There are two kinds of problems that can arise.

Maple sees things that you cannot see

If the kernel mode is set to Shared instead of the default Parallel (**Preferences/General**), then the internal state of Maple may not be distinguishing between different worksheets that are active on the display. To see this, open the **Preferences...** dialogue and use the pop up menu to set the Kernel mode to Shared (it will probably be set to Parallel mode when you first see it). Then execute the following command.

```
> b := 2;
```

$$b := 2 \tag{1}$$

Now open a new worksheet (Command-N) and use it to execute the entry "b;". Maple will return a value of 2 for "b" even though the value was not assigned in that worksheet. This is referred to as "sharing the kernel". All open worksheets store their assignments in the same kernel and they immediately take effect in all open worksheets.

This used to be the default mode for Maple worksheets and can obviously cause confusion. On the other hand, shared kernel mode can be very useful in situations where you would like to make some separate computations and store them in a different worksheet. Fortunately, the default mode is no longer "shared kernel". The default for Maple 10 worksheets is "parallel kernels". That is, each worksheet that opens up has its own kernel for its assignments and calculations. I recommend that you stick with the parallel kernels.

Wait a minute. I just looked and I saw a third mode: "Mixed kernel", what's that all about?

Answer: When you choose Mixed kernel mode you will be asked to specify the kernel connection for each worksheet window when you open a new worksheet. Those worksheets that share a kernel will share variable assignments. Those using parallel kernels have independent variable assignments.
Our advice: Stay with parallel kernels until you have had plenty of Maple experience.

You see things that Maple cannot see

This can happen in two different ways.

First of all, the **restart** command clears all variable assignments, but it does not erase lines of output. Thus, if you execute **restart**, then you will still see the output of previous assignments even though they are not part of Maple's internal state.

Second, when you save a worksheet, all of the output regions are saved with it. Then, when you load that worksheet later, the output is still visible. However, the internal state of Maple does not include any of this visible output. The situation is similar to that effected by **restart**. One way to fix this is by executing all the inputs, top to bottom. Maple will do this for you if you choose **Execute/Worksheet** on the **Edit** menu. As an alternative consider thinking about what you want to accomplish (always a good idea), and then work your way through the newly opened worksheet executing only those entries that you will need to accomplish the task at hand. It may be as simple as loading the plots package and redefining a variable or two.

```
Whenever, during the course of worksheet development,
Maple seems to be unable, or unwilling, to obey an
input command, consider doing a "restart" and sorting
out exactly what other inputs are needed to
accomplish the task. Execute only those inputs, then
the troublesome input and hope for the best. If it
still fails to "work" then at least you know that the
visual state is also the internal state so the
problem is probably with that particular input. Ask
someone else take a look at it.
```

The famous "pi" pitfall (and others)

Certain names are reserved by Maple for specific uses. Examples include "sqrt", "sin", "cos", and "exp". Another important quantity is the famous number "Pi". The natural logarithm base e was given as "E" in older versions of Maple, but is now accessible only as "exp(1)" and never as "E" or as "e". Consider these examples.

```
> Pi;
  evalf(%);
```

$$\pi \tag{2}$$

$$3.141592654$$

```
> pi;
  evalf(pi);
```

$$\pi \tag{3}$$

$$\pi$$

```
> exp(1);
  evalf(%);
```

$$e \tag{4}$$

$$2.718281828$$

```
> e;
  evalf(%);
```

$$e \tag{5}$$

$$e$$

The "pi" pitfall

In order to make output more readable, Maple displays Greek characters when you indicate the Greek letter by name in the input. This feature is generally convenient, but it does lead to a common pitfall.

```
> Pi;
```

$$\pi \tag{6}$$

```
> pi;
```

$$\pi \tag{7}$$

Note that the Maple outputs for "Pi" and "pi" look exactly the same. However, the two quantities are not the same to Maple. "Pi" is the famous constant, but "pi" is a name that can be defined by the user or left unassigned. Examine the following input/output pairs.

```
> cos(Pi/4);
  evalf(%);
```

$$\frac{1}{2}\sqrt{2}$$

$$0.7071067810 \tag{8}$$

```
> cos(pi/4);
  evalf(%);
```

$$\cos\left(\frac{1}{4}\,\pi\right) \tag{9}$$

$$\cos\left(0.2500000000\,\pi\right)$$

See what we mean?

The "e" error

Similar problems arise when the unsuspecting user types e^x expecting Maple to understand that this is exp(x). Here are some examples involving errors with the use of the variable e.

```
> e^x;
  exp(x);
```

$$e^{x} \tag{10}$$

$$\mathrm{e}^{x}$$

Note that the outputs are slightly different. Unfortunately, the incorrect output for the exponential function (the first one) looks more like what is seen in a textbook than the correct output (the second one). Take a look a the following (incorrect) calculations that appear to be correct.

```
> diff(e^x,x);
```

$$e^{x}\ln\left(e\right) \tag{11}$$

In fact, this is a correct differentiation formula for base b = e. Unfortunately Maple does not return 1 for ln(e).

```
> evalf(%);
```

$$e^{x}\ln(e) \tag{12}$$

Here is how the incorrect input interacts with an integral.

```
> int( e^x, x=0..1);
```

$$\frac{-1+e}{\ln(e)} \tag{13}$$

This is also correct output, if Maple recognized e as the famous number the user thinks it is.

New Maple users sometimes try to plot the exponential function like this.

```
> plot(e^x, x=-1..1);
Warning, unable to evaluate the function to numeric values in the
region; see the plotting command's help page to ensure the calling
sequence is correct
Error, empty plot
```

Unfortunately, neither the warning nor the error message address the real issue which is this: Maple cannot evaluate e^x because e is an unknown variable, not the number the user expects it to be.

Moral: When you get a strange result or a syntax error and there doesn't seem to be anything wrong, look back in your worksheet to see if you used the wrong spelling for pi or perhaps entered exp(x) as e^x.

Some encouraging words

Help abounds. Maple's Help facility is top notch and you should become accustomed to using it. Anytime a procedure seems to be acting up, or you want to learn about a new process, check the examples on the Help page. Just click in the procedure name in the worksheet, pull down the Help menu, and choose the fifth item: **Help on ...** .

The Help system is set up like a browser encouraging you to explore related issues, feel free. You can navigate back and forth between Help pages by clicking on the arrow icons at the top of the Help browser window. The left pane of the Help window has search options that will list all folders and Help sheets for items typed into the search field.

A final word on interface modes

Maple 10 has two modes for the user interface, Worksheet Mode and Document Mode. This manual was written in Worksheet Mode and we believe that this is the best mode for doing the sort of things that are helpful in the study of differential equations. We would also discourage the use of Document Mode in any context for a new Maple user.

Maple 10 defaults to Document Mode both when it first opens up and when a new file is requested. You are encouraged to change this by making the appropriate selections in the **Preferences/Interface** panel. Moreover, you are encouraged to use the **Maple Notation** mode for input as opposed to the **2-D Math** mode. This will also require you to go to **Preferences...**, this time to the **Display** panel.

Input modes

Having said this about input mode, let us conclude by pointing out that if you are solving lots of differential equations, then there is one major advantage to using **2-D Math** mode for input in Worksheet Mode. (You can do it by pressing **Command-R** at the input prompt). It is illustrated in the next input.

> $dsolve(\ y'' + 2\,y' + y = sin(x)\ )$

$$y(x) = e^{-x}\_C2 + e^{-x}x\,\_C1 - \frac{1}{2}\cos(x) \tag{14}$$

Did you see what just happened? **2-D Math** mode in the input allowed us to enter an ordinary differential equation (y as a function of x is the default) using the traditional prime notation *without* having to resort to the **diff** procedure, or the **D** operator, and *without* having to refer to the independent variable y as y(x) all the time. This is automatically understood in **2-D Math** input mode. Note also that

The trailing semi-colon is not required.

Here is another example illustrating the fact that the initial values for the derivatives in an IVP are also entered naturally, using prime notation.

> $dsolve(\ \{y'' + 2\,y' + y = sin(x),\quad y(0) = 0,\ y'(0) = 1\}\ )$

$$y(x) = \frac{1}{2}e^{-x} + \frac{3}{2}e^{-x}x - \frac{1}{2}\cos(x) \tag{15}$$

Note that the prime notation is *not* used in output displays.

> $DE\ :=\ y'' + 2\,y' + y = sin(x)$

$$DE := \frac{d^2}{dx^2}y(x) + 2\left(\frac{d}{dx}y(x)\right) + y(x) = \sin(x) \tag{16}$$

And here is an alternate (and more natural) way to define a function when using **2-D Math** input.

> $f(x) :=\ x\ sin(x)$

$$f := x \to x\sin(x) \tag{17}$$

The prime notation can be also be used for the derivative of f.

> $f'(x)$

$$\sin(x) + x\cos(x) \tag{18}$$

And here is how to enter an integral.

> $\int f(x)\ \ dx$

$$\sin(x) - x\cos(x) \tag{19}$$

Question: How did you do that? Answer: It was easy. See below.

First type "int" and press the *command completion* key combination: **Command-[shift]-[space]** on a Macintosh, **Ctrl-[space]** on a PC. This brings up a list of integral templates. Chose the first

one by pressing the **[return]** key. (To choose one of the others use the down arrow.) Then type "f(x)" **[space]** "d" followed by anther *command completion*, and **[return]** to choose the "differential d". Then type x and press the **[return]** key.

Of course, this is "easy" only if you have done it several times and are not afraid to experiment.

The following definite integral was entered as follows: Press **Command-R**, type "int" and *command completion* **[return]** to choose the first integral. Then press the *underscore* key: _ (**[shift]-minus**), and enter the lower limit, 0. Press the right arrow to return to the base line and press the exponentiation key: ^ , and enter the upper limit, 1. Another right arrow moves the cursor to the baseline and the integral is completed as above.

$$> \int_0^1 f(x)\ \mathrm{d}x$$

$$\sin(1) - \cos(1) \tag{20}$$

This made a funny-looking upper limit on the integral. To get nicer-looking limits use the fourth template on the list of *command completion* integrals. You can **[tab]** your way around the template to enter each item. See below.

$$> \int_0^1 \mathrm{e}^x cos(x)\ f(x)\,\mathrm{d}x$$

$$-\frac{2}{25} - \frac{3}{25}\,\mathrm{e}\cos(2) + \frac{4}{25}\,\mathrm{e}\sin(2) \tag{21}$$

Note that the e for the exponential function was entered in the integral by typing e, *command completion*, [**return**].