## 640:192:01 Part IV: playing with graphs on `maple` 9/1/2005

The graphing capabilities of `maple` explored here will probably seem rather familiar to you after your experience with graphing calculators and possibly other programs or devices. I won't discuss polar plots or parametric plots – but even those are generally available on hand-held calculators now. `maple` does really lovely pictures with three-dimensional plots – but that's another course!
Let's begin with the simple command

*plot(x^3–6*x+1)* **RET**

After the program responds, move back and alter your command to read

*plot(x^3–6*x+1,x)* **RET**

Now a graph should appear.
There are some things to notice. For this kind of plot, the "default" interval for $x$ (what `maple` assumes unless advised otherwise) is $[-10, 10]$ Maybe this is o.k. for you (suggestion: try graphing $\frac{1}{\sqrt{x^2-100}}$ and see what happens) but you may want more control. The *plot* command has many options. Read about them during the first free week you have by typing *help(plot)* and following all the references!
Let's look at the graph we have. By the way, when I am graphing, I tend to foul things up a great deal and I frequently end up with 5 or 10 graphs sitting around at the same time. Try to be neat. You can get rid of those graphs you don't want by clicking on the plot and then invoking **Cut**. Of course, if they hang around until you *quit* `maple` entirely, these graphs will then disappear also. But you can try to diminish confusion!
Again, look at the graph. Note that the vertical and horizontal axes are very differently scaled. But `maple` is trained to "autoscale" so it will **distort** the picture to fill the rectangular screen. I wrote that word in a large and bold font because it's something that has repeatedly caused me confusion. Now go to the graph, right click, and click on **Scaling Constrained** that's the way it really looks, darn it: a very, very thin graph. O.k.: relax.
Let's draw another graph.

*plot(sin(100/x),x=.1..1)* **RET**

This graph is attempting to illustrate some well-known misbehavior since $\lim_{x\to 0^+} \sin(\frac{100}{x})$ doesn't exist. The graph should bounce around a lot when $x$ is close to 0. It certainly seems to, but notice (by pure thought) that between each root or $x$-intercept of the function, there must alternatively be a place where the function is $+1$ and where the function is $-1$. The graph doesn't show that! (Look carefully, please.) `maple` doesn't think. It plots points and connects the dots to produce the graph. The default performance is fairly simple-minded (more sophisticated alternatives can be specified) and the plotted points can be seen by clicking on **Style** and then on **Point** – you'll see just the computed points on the curve with no connections drawn. If you increase the number of points to be plotted, you will probably get a better picture, but computation time for the graph's creation increases.
Here's another type of bad picture. Please look closely at the graph resulting from

*plot(1/(10^3x),x=–1..1)* **RET**

and you can try to determine the range of the function based only on the appearance of the graph. The range, deduced from the displayed graph, seems approximately to be the interval $[-1, 2.5]$. Of course this is incorrect. I know that $\frac{1}{10^3 x}$ on $[-1, 1]$ is not

defined at 0 and is also unbounded. So `maple` may have difficulty graphing functions with discontinuities. Some of the options for *plot* may be useful. The *help* screen for *plot* is long and has many entries.
By the way, any of the programs (`Mathematica`, `Maple`, graphing calculators, etc.) can be "spoofed" and made to draw bad graphs. Devices with finite memories can hardly imitate all aspects of the real numbers accurately.
Try the command (but you may want to guess the result before completing the input):

*plot({x^2,x^3},x=4..5)* **RET**

Therefore you can plot collections of functions, certainly useful sometimes.
Define your own function and plot it: try to define $P(w) = \dfrac{e^w}{1+w^2}$ and then remember that `maple` finds the derivative function of $P$ with the character string *D(P)*. Try this:

*plot({P(t),D(P)(t)},t=–2..5)* **RET**

As long as the variable (here $t$) is used consistently, `maple` will have no difficulty. Compare the two graphs. Where *D(P)* is 0 then $P$ must have a horizontal tangent. What happens to the graph of $P$ when the graph of *D(P)* has a maximum?
We can graph curves implicitly defined by equations. For example, try

*implicitplot(x^3–5x*y^2=7,x=–5..5,y=–5..5)*

and notice the result: nothing happens! Well, `maple` is such a huge program that most of it is stored "asleep", and these parts must be specifically recalled to active memory. In this case, we need to load the routines in the *plots* package. This is done with the command

*with(plots)*

Now after you have loaded the *plots* package, please try again

*implicitplot(x^3–5x*y^2=7,x=–5..5,y=–5..5)*

the result should be a nice picture. Implicit curve plotting is very difficult and due to problems with discontinuities frequently may give pictures which are untrue. Look at

*implicitplot(x^3-5x*y^2=7,x=–50..50,y=–50..50)*

which asks for the same algebraic curve in a $100\times100$ window. The result seems to have some corners and wiggles which I doubt are correct.
Let's conclude by attempting to locate a root.

*plot(x*ln(x)–sin(x),x=0..3)* **RET**

This function seems to have a root. Right click on this graph and then investigate the **Manipulator**. The capabilities of **Point probe**, **Scale**, and **Pan** work very much like "zooming" and "tracing" with a graphing calculator. I can easily find an approximate location of the root (about 1.77, I think).
We can check the picture with a numerical computation:

*fsolve(x*ln(x)–sin(x),x)* **RET**

reports 1.75267781, fairly close to where we located the root graphically. You can, of course, read about *fsolve* with the *help* command.

Continue to explore, please. And thank you for working through this.