Part II: playing with algebra on maple  9/1/2005

The most attractive feature of maple may be its ability to do intricate symbolic computations. Just try this:

\[(x+2*y)^5\] RET

Darn it: lazy maple! There are ways of telling maple not to be so lazy, but we want to go slowly. Just type:

```
expand(%) RET
```

and see what happens. Type

```
x=2 RET
```

and see what happens. Then type

```
x RET
```

Now try

```
x:=2 RET
```

followed by

```
x RET
```

and appreciate the difference. The character string := assigns the value on the right to the name on the left. Now type

```
x^3 RET
```

Did you expect that? Try to evaluate \((x + 1)^8\) when \(x\) has value 2. After doing that, type

```
restart RET
```

then try

\[(x+1)^8\] RET

again and “expand” it. Is the result unexpected? What do you think restart does, and (more importantly!) how could you check that restart has that function? Hint: try help(almost any word!) when you’re curious or confused.

Please assign \(x\) the value 17 and then type the following character string exactly as written here but don’t hit RET yet!

```
x;2x;x^2;x^2;2;x^2;x^2;x^2;2^x
```

The semicolon ; is used to separate several maple statements on the same input line. Think about what’s here and try to predict what will happen. Now hit RET and fix up any problems and hit RET again. Were you correct?

**Warning!** In older maple implementations and even in maple’s current command line version, the character string 2x will be rejected (with the message syntax error, missing operator or ‘;’ :). The graphical interface to maple 10 will accept 2x as an implied 2*x. People are sometimes reluctant to use long variable names, but I think this can be a very useful maple feature. Long names can help you remember what entries represent during complicated computations. For example, try

```
sumsqrts:=sqrt(x)+sqrt(y)+sqrt(x) RET
```

followed by

```
expand(sumsqrts^3) RET
```

I agree that more letters take more time to type (and increase the chance for error), but remember this freedom exists: you can call something by a character string close to its real name or with some important attribute recognized. This can reduce confusion.

OVER
Here are a few other algebraic things:

```
factor(y^4-16) RET
```

We can tell maple to use imaginary numbers. See the help information about `factor`. Specifically, try the command `factor(y^4-16,I) RET`. maple is born knowing some constants. \( I \) is a number whose square is \(-1\). You may be able to guess what \( Pi \) is. And the constant `infinity`. In older maple systems, \( E \) was the number whose decimal approximation begins 2.71828... but the latest releases of maple don’t have this. If you do need \( E \), you can define it with the command `E:=exp(1) RET`.

Work with a typical expression occurring at the beginning of calculus:

\[
\frac{(W + \Delta W)^5 - W^5}{\Delta W}
\]

I used the variables \( W \) and \( deltaW \) in my maple analysis and (after expanding!) got the usual calculus mess involving both \( W \) and \( \Delta W \). Notice now (if you haven’t already) that maple is “case-sensitive”. Therefore \( x \) and \( X \) need not be the same. Be careful!

You can now have fun doing algebraic things which no sane human being would ever think of doing “by hand”. For example, what is the coefficient of \( r^7 \) in \((r^2 + 3r + 4)^{10}\)? Please remember all the necessary parentheses and \(^'\)'s. (I think the answer is 175173120.) maple can also substitute in algebraic expressions. Try

```
subs(a=t,5*a^3+3*t*a+2*sqrt(a)) RET
```

This command changes \( a \) to \( t \). It isn’t equality. Try the following command with no * between \( t \) and \( a \):

```
subs(a=t,5*a^3+3*t*a+2*sqrt(a)) RET
```

maple will compute exactly what you ask! In \( 3t*a \) the initial \( 3 \) will multiply the product of the variables \( t \) and \( a \). \( 3ta \) is interpreted as a request to multiply the variable \( ta \) by \( 3 \). Braces or curly brackets, \( \{ \) and \( \} \), are used to create a list of variables for the `subs` command. Please try to predict what the result of the following will be before hitting `RET`:

```
subs({a=t,b=t^2,c=t^3},a*b^2*c^3) RET
```

maple can solve some equations. Try

```
solve(x^3=7*x+1,x) RET
```

and

```
solve({a*b+3=2,a+b=0}) RET
```

followed by

```
solve({a*b+3=2,a+b=1}) RET
```

and I don’t know why there’s such a difference in the answer (hey, maple will tell you the roots of quadratics using the quadratic formula – just ask it). You could always try `help(solve)` which brings up a huge amount of information, and probably the reason for the difference is explained there somewhere!

maple will also find approximate numerical solutions. You could explore the difference in the answers to the command

```
solve(x^7-x+1); RET
```

(maple assumes you mean to ask for a root of the equation obtained by setting the expression \( x^7 - x + 1 \) equal to 0) and the command

```
fsolve(x^7-x+1); RET
```

which gives an approximate numerical solution.

Let’s go on to calculus.