640:192:03 **Part II: playing with algebra on `maple`** **10/14/96**

The capability of `maple` to do intricate symbolic computations is its most attractive feature. Just try this:
*(x+2*y)ˆ5;* **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 to the name on the left, the value on the right. Now type
xˆ3; **RET**
Did you expect that? Try to evaluating $(x+1)^8$ when x has value 2. After doing that, type
restart; **RET**
then try
(x+1)ˆ8; **RET**
again and "expand" it. Is that 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 this string **exactly** as written here **but** don't hit **RET** yet!
*x;2x;x2;x*2;xˆ2;2*x:2ˆx;*
Think about this line and try to predict what will happen. Now hit **RET** and fix up any problems and hit **RET** again. Were you correct?
A useful `maple` feature that people are sometimes reluctant to use is that variable names can be long. This can be a good way to remember what entries represent during a lengthy session. For example, try
sumsqrts:=sqrt(x)+sqrt(y)+sqrt(x); **RET**
followed by
expand(sumsqrtsˆ3); **RET**
I agree that more letters take more time to type (and increase the chance for error), but do 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 really reduce confusion when you're doing some elaborate computation.
Here are a few other algebraic things:
factor(yˆ4-16); **RET**
We can actually tell `maple` about imaginary numbers. See the *help* information about *factor* if you like. Specifically, try the command *factor(yˆ4-16,I);* **RET**. `maple` is born knowing some constants. I is a number whose square is -1. You may be able to guess what E and Pi are. What about the constant *infinity*?
Let's see if we can simplify a typical expression occurring in a beginning calculus course: $\dfrac{(W+\triangle W)^5 - W^5}{\triangle W}$.
I used the variables W and $deltaW$ in my `maple` analysis and got the usual calculus mess involving both W and $\triangle W$. By the way, 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 childish fun doing all the 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 and ˆ's.

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`maple` can also substitute in algebraic expressions. Try

*subs({a=t}, 5*a^3 + 2sqrt(a));* **RET**

This command changes a to t, of course. It is not equality. Note the important use of braces or curly brackets, the { and }. Now first type and then 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^3 +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 - just ask it). You could always try *help(solve)* which is long but probably explains the behavior. That *help* screen also has references to many other commands on its SEE ALSO line, some of which work numerically if there are no symbolic methods. You could explore the difference in the answers to the command

solve(x^7 -x^2+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^2+1); **RET**

Let's go on to calculus.

Disclaimer! Non-advertisement!! Important information!!!

Symbolic manipulation programs such as `maple` are becoming increasingly available. Other popular programs with about the same capabilities are `derive` and `mathematica` and there are many special purpose programs in various fields of science, engineering, and mathematics which have extensive "intelligence" to analyze models. We're considering `maple` here because Rutgers has a site license for this program, and it should be generally available on Rutgers systems. The specific instructions won't be the same from program to program, but many of the same ideas will be present. Students should expect to have a machine do tiresome or elaborate symbolic computations as well as numerical computations.