January 24, 2000

Math 103:99 Meeting `Maple`

Each student should find the answers to the two questions below and e-mail them to me. Each student must send me a separate e-mail message before the next class. Students may work together. If they work together each student's e-mail message should acknowledge any help they have gotten, either from other students in the course or from other people.

Question #1: How many digits does 13^{13} have and what is the middle digit?

Question #2: 2634^8 has a bunch of 0's in it. How many?

People should not even attempt to answer either of these questions by hand, or even with a standard calculator. A standard calculator can't answer these questions because exact answers are requested, not approximations. Standard calculators can't deal with large enough integers. Something stronger is necessary: I suggest the program, `Maple`, which is available on most Rutgers computer systems, including `eden`.

Step 0 In order to effectively use `Maple` with the `xmaple` interface students need to get *out* of the menu system which they have with their default `eden` login. To do this they need to find the command `revert` on their menu system, enable this command, and logoff and logon again. They will then get a `unix` prompt and will be able to begin the sequence of exercises described here which will familiarize them with `Maple`.

Now begin What I'd like you to type at the terminal will be in *this typeface* with numbers that look like this *1 4 7 9* and these suggestions will be indented about an inch. I'll ask you to hit the "enter" key (new line) with the request RET. Now, please, log in to `eden` and get a prompt in an x-window. Then type

xmaple & RET

The system should respond with a `Maple` screen on your display. There are standard ways for you to move or resize the screen, and various `Maple`-specific command possibilities. `Maple` is a huge program with a great many capabilities. We'll just explore a few of them. Right now I'd like you to move your mouse into the `Maple` window. You'll see this, which is the "command line":

> |

The symbol for your cursor is | and it is currently at an input line, indicated by the > sign. Please type

3+2; RET

Something should happen. You should get 5 and a new input line. You can move your cursor up and down. Do this, and see the word "Input" on the `Maple` screen change in succession to "Separator" and then to "Output" and then to "Input" when your cursor gets back to the original line.

Now move your cursor back to your new input line. Type

*17*3;* RET

and see what the result is. At the next input line type

%+5; RET

and explain the result. What do you think the meaning of the symbol % is?

Now type the following to learn what ^ means.

2^3; RET

But ... I made a mistake! I wanted you to calculate the 300$^{\text{th}}$ power of 2! Please do the following: move your cursor back to the input line with 2^3 and position it in the following place: > 2^3|; and now type *00* and immediately hit RET. What happened? Please compute 3^{300} in the same fashion by moving your cursor to a new input line. What are the first 5 and last 5 decimal digits of this number? 13689 and 66001

A little more: please type (look carefully here – I'm asking for a **colon**, *not* a semicolon!)

5+6: RET

You should immediately get another input line. Type (for example)

%+7;

and deduce what `Maple` does when an input line ends with a *:* (that is, a colon). Note that computations might and do occur which have results that are huge and silly to print out if you don't need them — 2^(2^(2^(2^2))), for example. Try that sometime on your own, please, with ";" rather than a ":" and see what happens. 19,729 digits, I think! Onward: please type

20; RET

and see the result. Go back with your cursor and put a space between the 2 and the 0 and hit RET. What's the result? You haven't broken anything – just go on!

Now let's try

*2*3+7;* **RET**

and observe that `Maple` follows the usual rules of precedence. Can you put parentheses in so that `Maple` will compute two times the sum of three plus seven instead? Remember to hit **RET** after you make the alterations. You should have gotten 20 as your answer, of course. If you did **not** make an error inserting the parentheses, go back and take one out (create an intentional **error**!) and then hit **RET**. What happens? You haven't broken anything. Let's keep exploring. Please get a new input line and try these commands in succession to learn how to do more arithmetic and to explore more features of `Maple`.

2/3; **RET**

`Maple` computes "exactly" and can do some (fourth grade?) arithmetic:

*%*300;* **RET**

Now try

sqrt(2); **RET**

and now

%^2; **RET**

so `Maple` knows the "meaning" of fractions and square roots – or at least how to manipulate them. And now try (remember, if you mess up with a parenthesis or something else, just go back and do it again – nothing is broken!):

(sqrt(2)-1)^5; **RET**

This result is puzzling. Sometimes `Maple` is lazy. Let's urge it to work by writing

expand(%); **RET**

That's better. But what if we want or need decimal approximations? Try

evalf(sqrt(2)); **RET**

Parentheses need to be matched – always a source of anxiety as more and more complex expressions and commands are typed.

What if we want more digits of $\sqrt{2}$? We can coax *evalf* to do this with informed use. To see how, type

help(evalf); **RET**

Another screen should pop up. When I use `Maple` I tend to need a lot of help so the help screens accumulate on my display. You can "click" them on and off, and eliminate them entirely if you like. Read the evalf screen (I usually skip to the examples on any help screen first!) until you can figure out how to get the first 100 digits of $\sqrt{2}$. What is the one-hundredth digit after the decimal point? It is 7 – be slightly careful since that second number in evalf gives the total number of digits, and the 1 before the decimal point counts as one of the digits! Can you tell me the three-hundredth digit after the decimal point of $17^{1/3}$? This should be 5. Use lots of parentheses, even in exponents, to inform `Maple` clearly what you want.

Now try

1400/24; **RET**

and we learn that `Maple` knows how to factor integers automatically. Can you get `Maple` to factor your social security number? How would you find a factoring command in `Maple`? If the first thing you try with the *help* command doesn't work, look at the references on the SEE ALSO line and check one of them.

You can stop your `Maple` session at any time in a variety of ways. One way that is polite to the system and also simple for you is to type

quit **RET**

and your `Maple` window will disappear after you answer the question about storing your work. That's probably not necessary right now!

Important assertion You can't break the program. `Maple` will, however, compute exactly what you type, not what you think you've typed!

Honest admission Almost every time I work with `Maple` I forget to type the darn *;* so I sit and watch the screen, wondering why my computation doesn't work. The semicolon signals the program that you've finished typing and that it should start computing.

Irritating note All `Maple` programs should behave the same way, but the `Maple` versions I have at home and in the Math Department use " instead of % for "the previous expression". So I may forget and confuse the symbols sometimes when I talk to you or respond to e-mail questions.