An Introduction to Maple - Part 1

Maple is a complete mathematical problem-solving environment that supports a wide variety of mathematical operations such as numerical analysis, symbolic algebra, and graphics. In this session, you will explore some of the basic arithmetic and algebraic commands.

Arithmetic

Maple can be used as an ordinary calculator.

```
> 2+3;
> 2*3;
> 2-3;
> 2^3;
> 2**3;
```

The exponentiation symbol is equivalent to the double star symbol.

```
> 2/3;
> 2/3.0;
```

Notice the difference between the last two results. We see that Maple calculates results exactly unless we indicate that we want to use decimal approximations. There is another way to find the decimal approximation to a number:

```
> evalf(2/3);
```

The evalf command evaluates a number using ''floating point arithmetic''. If we want a decimal approximation with a greater or lesser degree of accuracy we can include the number of digits of accuracy as an option to the evalf command:

```
> evalf(2/3,3);
> evalf(2/3,30);
```

If we do not tell Maple the number of digits of accuracy we are interested in, then Maple assumes that we want to use the number of digits of accuracy that we are using in all of our calculations. By default this number is 10 digits, but the default can be changed with the Digits command:

```
> Digits:=5;
> 2/3.0;
> Digits:=15;
> 2/3.0;
```

From now on we will have 15 digits of accuracy in floating point arithmetic, unless we decide to change it again.

How can one find out what options are available for use with the evalf command, and what is the proper syntax for their use? Maple will tell us, if we ask!

```
> ?evalf
```

We have just learned the MOST IMPORTANT Maple command: how to ask for help! The only problem with this version of help is that we must have some idea of what to ask for. Another way to get help, which can be used when we don't know what to ask for, is to use the mouse and click on the Help button on the menu bar. So, if we did not know that the command name is ''evalf'', but we did know that we wanted to evaluate an expression in some way, then we would go to the Help button, click on Topic Search, and then try typing the word ''evaluation'' letter by letter and see if there are any topics related to evaluation that might be useful.

We will end this section by looking at how Maple handles the precedence of arithmetic operations. The simple rule is: Maple does this in the standard way.
(Exponentiation is handled before multiplication/division, which is handled before addition/subtraction.) When in doubt, use parentheses to eliminate ambiguity.

```
> 5^2*3+1;
> ((5^2)*3)+1;
> 5^(2*3)+1;
```

```
> 5^((2*3)+1);
> 5^2*(3+1);
```

Initially Known Mathematical Functions and Constants

Maple has a large library of mathematical functions. You can guess the names for most of these functions.

```
> sqrt(64);
> root[2](64);
> root[3](64);
> abs(x);
> abs(-5);
> sin(0);
> cos(Pi);
> cos(2Pi);
```

(How do we fix this error?)

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

What's wrong???

```
> tan(x)+cot(x)+sec(x)+csc(x);
> exp(x);
> exp(1);
```

Note: the number e is known to Maple as exp(1), NOT as just ‘‘e’’. The difference between e and exp(1) is the same as the difference between pi and Pi.

```
> ln(exp(1));
> log[10](100);
> eval(%);
```

The percent key (%) is a symbol which denotes the output of the previous calculation.

Algebra

Maple is handy at manipulating algebraic expressions.

```
> 2x + 3x;
> 2*x + 3*x;
> (x+2)*(2*x+1);
> expand(%);
> factor(%);
```

When one calculates with algebraic expressions it is often necessary to assign names to input values and output values so that these values can be used in further calculations.

```
> f:=a*x^2+b*x+c;
> a:=3;
> b:=2;
> c:=1;
> f;
> a:=1;
> f;
```

We use the restart command to clear Maple's memory of all previous assignments.

```
> restart;
> a;
> f;
```

In this example it might have been desirable to clear Maple's memory of the values assigned to (some or all of) a, b and c without clearing the value for f. We can do this as follows.

```
> f:=a*x^2+b*x+c;
> a:=3;
> b:=2;
> c:=1;
> f;
> a:='a': b:='b': c:='c':
```

```
> f;
```

Until this point everything has been elementary, and we could probably do these things by hand just as easily as with a computer. Now we will look at a Maple command that allows us to do many things that would be difficult to do by hand.

```
> solve(f=0,x);
> solve(x^3-x^2+x-1=0,x);
> solve(x^2-1>0,x);
> solve(x^2-2=0,x);
> fsolve(x^2-2=0,x);
> fsolve(x^2-2=0,x,0..10);
> solve(x^5+3*x+1,x);
> fsolve(x^5+3*x+1,x);
```

One thing to remember about the difference between the solve command and the fsolve command is that solve operates symbolically and can produce the exact answer even when unknown values are present while fsolve operates numerically and will not produce an answer if unknown values are present.

```
> solve(a*x+b=0,x);
> fsolve(a*x+b=0,x);
```

Practice Exercises

Let's practice what we have learned.

1. Which number is bigger: $2^{\left(2^{\left(2^{(2^2)}\right)}\right)}$ or $6^{(6^6)}$?

2. Which is bigger: the 100th digit of π or the 100th digit of **e**? (Consider the ''100th digit'' to be the 100th digit past the decimal point. Beware of roundoff error!)

3. Square the polynomial $x+1$. Multiply the result by $x-2$. Add 7. Call the result f. Now solve $f = a\,x + b$. Solve the same equation in the situation where $a = 6$ and $b = 17$. Solve the same equation in the situation where $a = 1$ and $b = 5$.