Introduction to *Mathematica*: Overview

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■ *Mathematica* or *Maple*?

Both *Mathematica* and *Maple* are excellent software packages, with strengths and weaknesses. Learning one package will help you understand both packages. Developing a working knowledge of either program is well within the abilities of the interested student. Becoming a master at either package will require both time and effort.

■ Help

There is an extensive online help feature. Help with individual commands can be accessed using **?*command name*** and the options for a command can be accessed using **Options[*command name*]**. The results will come up within your document.

```
In[1]:= ? Plot

In[2]:= Options[Plot]
```

■ Restart

It sometimes becomes necessary to clear the entire *Mathematica* memory. To do this, choose **Kernel->Quit Kernel->Local**

■ Syntax

Mathematica uses an upper case letter for the start of built-in functions and square brackets for the arguments of functions.

```
In[3]:= Sin[Pi / 4]
```

Parentheses are used only for a grouping symbol. Curly braces are used to indicate intervals, as in the domain of plot statement.

```
In[4]:= Plot[x^2, {x, -2, 2}];
```

No punctuation is required at the end of a statement. Using a semicolon will suppress the output of a command.

```
In[5]:= 3 + 4

In[6]:= 4 + 5;
```

Multiplication does not require a multiplication sign but an asterisk can be used. Spaces will also work for multiplication. Lack of a space indicates a new variable. Multiplication by a number does not require a space.

```
In[7]:= x = 3;
        y = 4;
        x y
        xy
        10 x
```

■ Expressions

Expressions are the types of equations you normally see in a math course, such as

In[12]:=
```
z = x^2 + 3
```

Note that **z[2]** does not work since z is not considered a function.

In[13]:=
```
z[2]
```

We could let $x = 2$ and then find the value of z but this means that x will no longer be a variable. We need to clear x to restore its status as a variable.

In[14]:=
```
x = 2
z
6 x
Clear[x]
6 x
```

Instead of letting $x = 2$, use the substitution command **/.**

In[19]:=
```
z /. x → 2
```

■ Functions

Functions are declared using the notation **f[x_]:=*expression***

In[20]:=
```
f[x_] := 2 x - 7
f[10]
```

■ Substitutions

Substitution is most readily done using the **/.** operation.

In[22]:=
```
x^2 /. x → 4
```

What went wrong? We used $x = 3$ in an earlier statement. We should first use `Clear`

In[23]:=
```
Clear[x]
x^2 /. x → 4
```

■ Numerical Values

To get a numerical value, use **N[*expression*]** or **//N**

In[25]:=
```
N[Pi]
N[Pi, 50]
Pi // N
```

Another way to get a decimal value is to include it in the original problem. This method is more consistent in *Mathematica* than it is in *Maple*.

In[28]:=
```
1 / 3 + 7 / 17
1. / 3 + 7 / 17
Pi / 4
Pi / 4.
```

■ Solving Equations

Mathematica will solve equations with one or more variables and, if possible, return an exact answer. Note that you need a double equal sign (**==**) to create the equation.

In[32]:=
```
answer1 = Solve[a * x + b == c, x]
```

Mathematica will also return multiple answers where appropriate.

In[33]:=
```
answer2 = Solve[x ^ 2 - 5 x - 7 == 0, x]
```

To verify that these are solutions, we can use **/.** command to substitute the values back into the equation. Note that both solutions are checked simultaneously.

In[34]:=
```
checkthis = x ^ 2 - 5 x - 7 /. answer2
```

Since this does not seem to work, try simplifying the results.

In[35]:=
```
Simplify[checkthis]
```

If you want a decimal value, use the "NSolve" command.

In[36]:=
```
answer2 = NSolve[x ^ 2 - 5 x - 7 == 0, x]
```

It is also possible to specify the interval containing the answer but you use the **FindRoot** command. Unfortunately, unlike *Maple*, *Mathematica* does not give all the solutions in the indicated interval.

In[37]:=
```
eqn = x ^ 3 - 8 * x ^ 2 - 35 * x + 150
answer = NSolve[eqn == 0, x]
posanswer = FindRoot[eqn == 0, {x, {0, 100}}]
neganswer = FindRoot[eqn == 0, {x, {-100, 0}}]
```

When there are multiple answers,you can access the one you want by using *name*[[*answer number*]]. Note that these are double brackets **[[]]**.

In[41]:=
```
answer[[2]]
```

In some cases,Maple is unable to give the exact solution.Instead,it leaves the answer in the form "Root".

In[42]:=
```
firsttry = Solve[x ^ 5 - x ^ 3 + 2 x - 9 == 0, x]
```

Use the **//N** command to get the decimal values.

In[43]:=
```
secondtry = firsttry // N
```

We could make this look nicer by using the **ColumnForm** command.

In[44]:=
```
secondtry // ColumnForm
```

Using **NSolve** we get all the solutions. *Maple* couldn't do this.

In[45]:=
```
NSolve[x ^ 5 - x ^ 3 + 2 * x - 9 == 0, x] // ColumnForm
```

It is also possible solve a system of equations in x and y. First, clear out the variable x and y.

In[46]:=
```
Clear[x, y]
e1 = 3 * x + 5 * y == 1
e2 = 2 * x - 8 * y == 11
```

Solve the equations with the **Solve** command. Be sure to enclose both the equations and the variables in set notation { }.

In[49]:=
```
answer = Solve[{e1, e2}, {x, y}]
```

As is true in *Maple*, unfortunately simply typing "x" will not give the x value.

In[50]:=
```
x
```

Instead, we use the **/.** command.

In[51]:=
```
x2 = x /. answer[[1]]
y2 = y /. answer[[1]]
```

In[53]:=
```
x2
```

■ You Try It!

(1) Create an expression $y = x^2 + 6x - 81$. Set $y = 0$ and solve for bothe exact and decimal values of x.

(2) Determine the value of x in the interval $0 \le x \le 12$ that are solutions to
$2x^5 - 29x^4 - 108x^3 + 1611x^2 - 3240x = 0$.

(3) Create a function $y = x^2 + 6x + 9$ and find the value of $f(x + h) - f(x)$.

(4) Solve the system of equations

$3x + 5y - 8z = 10$

$2x - 8y + z = 12$

$x - 3y + 7z = 13$