Working with *Mathematica*

1.   What is Mathematica?

Equation processors are truly ingenious computer programs. They can be used as powerful calculators, but they can also solve systems of equations and, more impressively, give you analytical solutions, i.e. formulas rather than numerical answers, to problems. Mathematica is the best-known of these programs. First available in 1988, it was hailed as a technological breakthrough. It is widely used by engineers and natural scientists, economists and financial theorists. It has been successfully applied to help undergraduate economics majors conceptualize and solve numerous economic problems.

2.   Examples Demonstrating Mathematica:

1. Mathematica is a super calculator with great precision:

    If you ask your pocket calculator to find 2^{100} the answer might be 1.26765 E^{30}
    In Mathematica enter 2^100 followed by Shift-Return and
    Mathematica responds with 1267650600228229401496703205376
    This may be more than you want to know.

2. Entering Solve[2*x^2+3x+6==0,x] and then pushing Shift-Return yields as the solution to the quadratic $2X^2 + 3X + 6 = 0$,

    $$\left\{\left\{x \to \frac{1}{4}\left(-3 - I\sqrt{39}\right)\right\}, \left\{x \to \frac{1}{4}\left(-3 + I\sqrt{39}\right)\right\}\right\}$$

    Mathematicaspeak Note: The symbol I denotes $\sqrt{-1}$.

3. Entering Solve[a*x^2 + b*x + c == 0,x] yields the familiar solution

    $$\left\{\left\{x \to \frac{-b - \sqrt{b^2 - 4ac}}{2a}\right\}, \left\{x \to \frac{-b + \sqrt{b^2 - 4ac}}{2a}\right\}\right\}$$

> Note:
> - Click on the Help icon, then try the Getting Started/Demos button; its Great!
> - Case, { },and [ ] are important to Mathematica. It recognizes Solve but not SOLVE. Two equals in Mathematica-speak, ==, means =.
> - To execute a command that you have entered, you must use Shift-Enter (Hold down the shift key while tapping Enter)
> - Instead of entering each command from scratch, you can move the cursor to it, edit it to incorporate the revisions, and then push Shift-Return to process it.
> - You can bring up *Palettes* under the File menu to see the syntax for more complicated commands; the Basic Calculations palette is particularly useful.
> - Sorry, while you can copy output back from Mathematica into a word document, it may be in bitmap form that cannot be edited in the way you would like. These example used Edit/CopyAs/Text for input and Edit/CopyAs/BitMap for output.

4. Differentiation: Entering D[1-E^(-3t),t] yields $3\,E^{-3\,t}$ as $d(1-e^{-3t})/dt$

5. Entering Integrate[x^2 + 3x^3, x] yields the indefinite integral $\dfrac{x^3}{3} + \dfrac{3\,x^4}{4}$

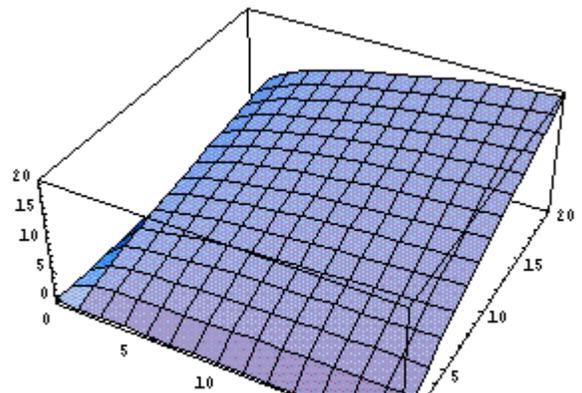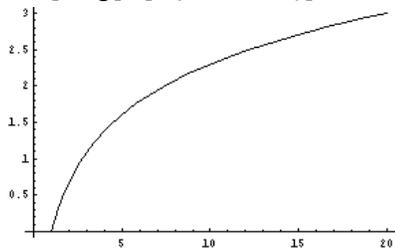6. Entering Integrate[x^2 + 3x^3, {x,0,2}] evaluates $\displaystyle\int_0^2 x^2 + 3x^3\,dx$ yielding 44/3

7. To solve the system of equations (3 equation macro model) $y = c + g$, $c = 90 + 0.9y$, $g = 50$ for unknowns c and y you enter

    Solve[{y == c + g, c == 90 + .9*y, g == 50},{c,y}] obtaining

    $$\{\{c \to 1350.0000000000008^{\backprime}\,,\, y \to 1400.0000000000017^{\backprime}\,\}\}$$

8. To plot U = lnC for C in the interval [0,20], you enter

    Plot[Log[C], {C, 1, 20}]

9. To plot the Cobb Douglas function in 3d one uses
    Plot3D[K^0.3*L^0.7,{K,0,20},{L,0,20}]
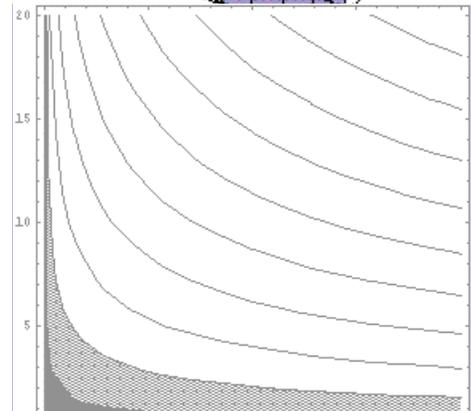
10. **ContourPlot[K^0.3*L^0.7,{K,0,20},{L,0,20}]** generated the Cobb-Douglas contour plot on the right.

Mathematica can do a host of other computations of complex problems. It can solve polynomials up to the 5th degree, it will do matrix algebra. Consult HELP

3. Running Mathematica at Wesleyan.

Wesleyan current license allows no more than 10 users to access the program at any one time. When you start Mathematica by clicking on its icon in Start/Programs, the KeyServer routine informs you if it is currently available or is already being utilized by ten users.
.
Mathematica runs in two parts, a *user interface* program which you start and a *kernel*, which does the computations and returns the output to the interface.

To begin the program, double-click on the Mathematica icon on any computer on which the program has been installed.

Then you just type something that you want Mathematica to solve and enter Shift-Enter.

For example, 2+2 yields
>   In[1]:=
>   2+2
>   Out[1]=

Mathematica will continue to number successive pairs of inputs and outputs, and you will see brackets on the right part of the screen encasing each pair:
.
Never retype: You can edit earlier input and reprocess with Shift-Enter. Or copy an earlier input line, paste it at the bottom of your worksheet and then modify for your next calculation.

4. Basic mathematical commands

Mathematica uses the basic mathematical symbols: +, -, *, /, ^, !, and maintains the usual
syntax rules regarding parentheses (). You can also use a space to symbolize multiplication, e.g., x*y or x y both mean multiplication of x by y, but xy will be understood by Mathematica to mean a variable called "xy".

All Mathematica functions use square brackets to hold the mathematical expression x being operated upon. Simple functions include:

Sqrt[x]	for square root ($\sqrt{x}$)
Log[x]	for natural log ($\log_e x$)
Exp[x]	for exponential (e^x)
Abs[x]	for absolute value
Round[x]	for the closest integer to x
Max[$x,y,..$]	maximum from the list x, y, ...
Min[$x,y,...$]	minimum from the list x, y, ...

Remember, Mathematica is case-sensitive. Every built-in Mathematica function begins with a capital letter.
There are also built-in mathematical constants, each beginning with a capital letter:

Pi $p = 3.14159...$

E $e = 2.71828...$
I $i = \sqrt{-1}$ (note that I therefore cannot be used as a variable name)
Infinity ∞

Because Pi, E, I and Infinity are reserved words; they cannot be used as variable names.

You can specify how many digits you want to see for an infinite decimal:
N[*expr*] gives the approximate numerical value of *expr*
N[*expr*, *n*]   gives the numerical value of *expr* to *n* decimal digits
For example, Sqrt[2] = $\sqrt{2}$ but N[Sqrt[2], 6] yields 1.41421

5.   Potential error messages

If you set up a formula using incorrect syntax, Mathematica will give you error messages that are meant to be helpful, and will also beep at you during formula editing if you are missing a bracket or some other symbol that it thinks you need.

6.   Moving text and graphics from Mathematica to Word

You can copy and paste (selecting the area, and then using the edit menu or shortcut keys) from Mathematica into a word processor or other program. Unfortunately, much of the output is in graphics that cannot be edited or formatted easily. Graphics must be transported separately from text. Copy complicated expressions using the Edit/CopyAs Command; trying text for text and bitmap for graphics. You may position the image better by right clicking it, clicking format object; then experiment by turning off the Position/Float Over Text check; or try wrapping both sides.
        You can also save a Mathematica file in a form readable by another program by using the Save as Special... command under the File menu. For instance, you can save a text file that is readable by a word processor (however, the graphics will be lost from a text file).

7.   More Info About Mathematica

Try HELP first. Then consult the manual *Mathematica: A System for Doing Mathematics by Computer*, by Stephen Wolfram, which may be on reserve. Also, search for Mathematica on the Web for information from other users.

Please email suggestions for improving this introduction to Mathematica to mlovell@wesleyan.edu

Running Mathematica on the G3-Macintosh

In order to run Mathematica in SC72 you must log in on the Mac, not virtual PC! Proceed as follows:
1.   Click on the tre icon in the upper right hand corner of the screen and select "Log In"
2.   Type in your name and password just as on the corresponding virtual PC Window.
3.   Now the tree icon in the upper right should appear in full bloom!
4.   Start the Mathematica program by clicking on the Apple Icon in the upper left hand corner of the screen, highlight Instructional Software, to the new menu that opens on the right, and select "Microsoft Word."
5.   To copy your Mathematica output into Microsoft Word you must start Microsoft Word on the Macintosh. To do this you click on that upper right hand corner Apple Icon, selecting "Applications," then "Microsoft Office 98," and finally "Microsoft Word." Now copy from Mathematica to Word as explained in Topic 6.
Note: To switch among programs (e.g. from Mathematica to Word) click the icon in the upper right screen corner and select your program.
6.   To Save your word file on the H:drive you must first click on the Apple in the upper left hand corner and highlight Login to either FS3 (Sophomores) or FS4 (Juniors). Close the box that pops up, return to Word,and save your file on your H drive.
7.   To logout, close your Macintosh programs by clicking Quit from their File Menus; then click on the Tree Icon and select "Logout Completely.