Mathematica - quick start

Spring semester 2023

https://www.phys.uconn.edu/~rozman/Courses/P2400_23S/

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1. *Mathematica* uses capitals for the first letter of its built-in functions, commands, options, etc. (and first letter of additional words that are part of built-in items). There are no spaces in the command names.

   `Plot[…], Sin[…], Sqrt[…], N[…], Integrate[…]`

2. Natural log base e is `E`, imaginary unit i is `I`, π is `Pi`, and ∞ is `Infinity`.

3. Power: x^y — `x^y`

4. (a) *Mathematica* uses `[]` to enclose the argument of a function: `Sin[x]`

   (b) *Mathematica* uses `{}` to enclose the contents of a list:

   `{x, 0, Infinity}` `{Sin[t], Cos[t]}`

   (c) `()` are only used for grouping expressions: `Sin[x/(x+3)]`

   (d) `[, {, (` must be used in balanced pairs.

5. (a) `N[expression]` finds the numerical value of the `expression`.

   (b) `NSolve[equation, {variables}]` finds the roots of the `equation`:

```
sol = NSolve[x^2 + 2 == x]    (* numerical solution *)
```

```
s = x /. sol[[1]]   (* assign the 1st root to variable s; note [[..]] *)
```

   An equality must have 2 equal signs, ==, an assignment – only one, =.

(c) `NIntegrate[function[var],{var, from, to}]` evaluates the numerical value of the integral.

```
NIntegrate[Sin[x], {x, 0, Pi}]
```

6. Plot Command: `Plot[functions, {x, xmin, xmax}]`

```
Plot[Sin[x], {x, 0, 2Pi}]     (* one graph *)
```

```
Plot[{Sin[x], Cos[x]}, {x, 0, 2Pi}, GridLines -> Automatic,
                                    PlotLegends -> "Expressions"]  (* two graphs *)
```

7. You can define your own function with `:=`. The definition must include the underscore after the variable:

```
addTwo[x_] := x + 2
Plot[addTwo[x], {x, -1, 1}, Frame -> True, GridLines -> Automatic]
```

8. Derivative: using the `D` command or prime notation

```
D[Sin[x], {x, 3}]     (* third derivative with respect to x *)
Sin'[x]
```

9. Integration: `Integrate[function[var], {var, from, to}]`

$$f(x) = \int_{-x}^{x} e^{-y^3}\,\mathrm{d}y;$$

```
f[x_] := Integrate[Exp[-y^3], {y, -x, x}]
```

```
Plot[f[x], {x, 0, 3/2}, Frame -> True, GridLines -> Automatic]
```

10. Series expansion: `Series[function[var], {var, var0, nterms}]`

```
res = Series[Sin[x]/(x + 2), {x, 0, 4}]
```

Truncate higher order terms:

```
Normal[res]
```

11. Numerical solution of differential equations:

$$y'' + y + y^3 = 0, \quad y(0) = 1, \quad y'(0) = 0;$$

```
sol = NDSolve[{y''[x]+y[x]+y[x]^3 == 0, y[0]==1, y'[0]==0}, y[x], {x, 0, 20}]
```

```
Plot[y[x] /. sol, {x, 0, 20}, GridLines -> Automatic]
```

12. Factorization:

```
Factor[-2/3 - x^3/3 + x]
```

13. Simplification:

```
Simplify[Sin[2*x]/Sin[x]]
```

```
Simplify[(x^3 - 1)/(x -1)]
```