Introduction to Mathematica

The ''Wolfram notebook''

Cells

The graphical or online Wolfram notebook contains programcode, text, graphics, or a combination of these.
The notebook consists of embeddable cells, the stucture of which can be found as the parentheses to the right. A double click on them closes or opens the given cell.

A new cell can be created by placing the cursor between two cells, a horizontal line will appear, clicking on the line and typing creates a new cells. By default this is a Wolfram program input. Clicking the plus sign on the left side of the horizontal line gives are more options for the cells. For example text. Executing programcode in a cell can be done with SHIFT+ENTER.

Wolfram input (default)

```
In[1]:= 1 + 1
Out[1]= 2
```

In[n] and Out[n] means the nth in- and output. The previous input is %, the kth is %k.

```
In[2]:= %1 + 2
Out[2]= 4
```

Basics:

1. The order of the basic mathematical operators is the same order used in mathematics.
2. Functions start with capital letters and the arguments are written inside [ ] brackets.
3. Lists are created with the { } brackets, the elements are seperated with commas.
4. List indices are written inside [[ ]] (double square brackets) .

```
In[3]:= 2^10 + Sin[Pi / 2]
Out[3]= 1025
```

```
In[4]:= {1, 3, 5, 7}[[3]]
Out[4]= 5
```

There is text completion:

```
In[5]:= Sin[Pi]
Out[5]= 0
```

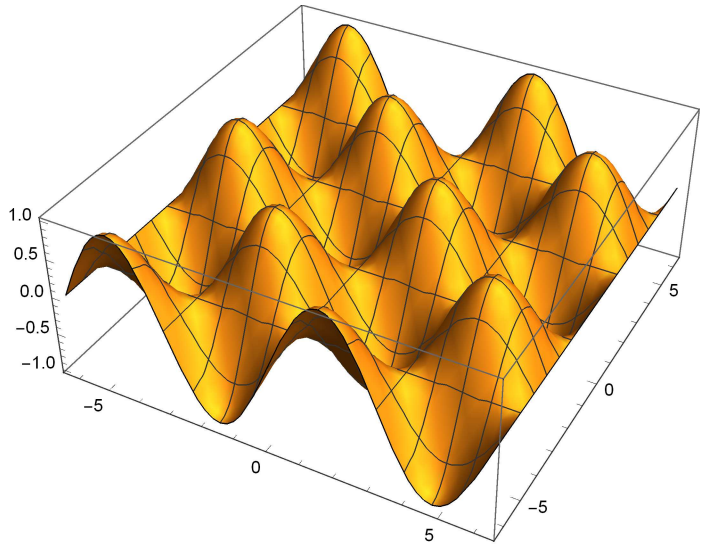
Palettes offer some more help. For example a simple limit can be written with the palettes:

```
In[6]:= Limit[Sin[x] / x, x → 0]
Out[6]= 1
```

The plot of a multi variable function!

In[7]:=
```
Plot3D[Sin[x] Cos[y], {x, -2 Pi, 2 Pi}, {y, -2 Pi, 2 Pi}]
```

Out[7]=



Mathematica as a numeric calculator

Numerical calculations

We can compute precise values, like a symbolic calculator:

In[8]:=
```
12345 / 3^10
```

Out[8]=
$$\frac{4115}{19683}$$

We can do numeric approximation with the N function:

In[9]:=
```
N[%, 30]
```

Out[9]=
```
0.209063658995071889447746786567
```

If the input is a floating point number then the output will be a float as well:

In[10]:=
```
12345.0 / 3^10
```

Out[10]=
```
0.209064
```

In[11]:=
$$\begin{pmatrix} 3 & 4 \\ 5 & 6 \end{pmatrix}$$

Out[11]=
```
{{3, 4}, {5, 6}}
```

In[12]:=
```
Det[%]
```

Out[12]=
```
-2
```

Variables

In[13]:=
```
a = 12345 / 3^10
```

Out[13]=
$$\frac{4115}{19683}$$

Mathematical symbols can be found on the palette, or with hotkeys (for example. CTRL-2 for square

root):

In[14]:=
```
a = √1234
```
Out[14]= $\sqrt{1234}$

In[15]:=
```
Expand[(a + b)^2]
```
Out[15]= $1234 + 2\sqrt{1234}\ b + b^2$

In[16]:=
```
Clear[a]
```

A lot more can be found on the Fast introduction for math students page.

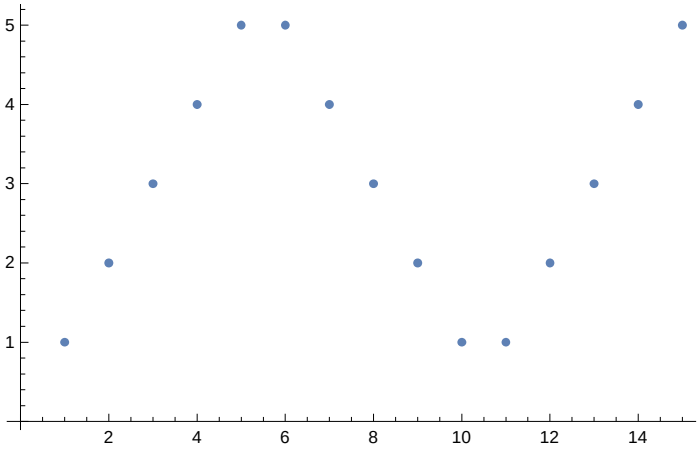
Lists

The most important constructs in Mathematica are lists.

In[17]:=
```
Range[5]
```
Out[17]= {1, 2, 3, 4, 5}

In[18]:=
```
Range[3, 16, 4]
```
Out[18]= {3, 7, 11, 15}

In[19]:=
```
ListPlot[Join[Range[5], Reverse[Range[5]], Range[5]]]
```
Out[19]=



In[20]:=
```
Join[{1, 3, 5}, Range[4]]
```
Out[20]= {1, 3, 5, 1, 2, 3, 4}

Elementry operations:

In[21]:=
```
{1, 3, 5} + 2
```
Out[21]= {3, 5, 7}

In[22]:=
```
a = {1, 3, 5} * {2, 3, 1}
```
Out[22]= {2, 9, 5}

In[23]:=
```
Sort[a]
```
Out[23]= {2, 5, 9}

In[24]:=
```
Length[a]
```
Out[24]= 3

In[25]:=
```
Total[a]
```
Out[25]= 16

In[26]:=
```
Part[a, 2]
```
Out[26]= 9

In[27]:=
```
Min[a]
```
Out[27]= 2

In[28]:=
```
Table[2, 5]
```
Out[28]= {2, 2, 2, 2, 2}

In[29]:=
```
Table[n^3, {n, 10}]
```
Out[29]= {1, 8, 27, 64, 125, 216, 343, 512, 729, 1000}

In[30]:=
```
Table[{1, x, x^2, x^3}, {x, 4}]
```
Out[30]= {{1, 1, 1, 1}, {1, 2, 4, 8}, {1, 3, 9, 27}, {1, 4, 16, 64}}

In[31]:=
```
RandomInteger[5, 20] + 1
```
Out[31]= {1, 6, 3, 4, 6, 5, 5, 4, 3, 4, 2, 4, 6, 1, 6, 2, 2, 2, 5, 4}

In[32]:=
```
b = Range[10]
```
Out[32]= {1, 2, 3, 4, 5, 6, 7, 8, 9, 10}

In[33]:=
```
b[[2 ;; 4]]
```
Out[33]= {2, 3, 4}

In[34]:=
```
b[[2 ;; 9 ;; 3]]
```
Out[34]= {2, 5, 8}

Mathematica as a symbolic calculator

Defining functions

A := delayed evaluation, the _ is the symbol for the variable that will be subtituted:

In[35]:=
```
f[x_] := x^3 - x
```

In[36]:=
```
f[3]
```
Out[36]= 24

In[37]:=
```
f[1.5]
```
Out[37]= 1.875

In[38]:=
```
f[abc]
```
Out[38]= $-abc + abc^3$

In[39]:=
```
Solve[f[x] == 24, x]
```

Out[39]= $\left\{\{x \to 3\}, \left\{x \to \frac{1}{2}\left(-3 - i\sqrt{23}\right)\right\}, \left\{x \to \frac{1}{2}\left(-3 + i\sqrt{23}\right)\right\}\right\}$

In[40]:=
```
Factor[f[x] - 24]
```

Out[40]= $(-3 + x)\left(8 + 3x + x^2\right)$