

## ■ Example 1: Symbolic Computation

In computation, we usually think in terms of *numerical computation* where the result is a numerical constant. However, there are systems that provide *symbolic computation*.

### (a) First illustration:

- Numerical computation:

In[1]:= 3 + 62 + 1

Out[1]= 66

- Symbolic computation:

In[3]:= 3 x + x + 2

Out[3]= 2 + 4 x

### (b) Second illustration:

In[4]:=  $x^4 + 3x + 2x^3 + xxx - x^5/x + 2$

Out[4]=  $2 + 3x + 3x^3$

### (c) Third illustration using Mathematica's *Together* function:

In[5]:= **Together** $\left[\frac{a}{b} + \frac{c}{d}\right]$

Out[5]=  $\frac{bc + ad}{bd}$

In[6]:= **Together** $\left[e^{-\text{Log}\left[2+\frac{y}{3}\right]} + \text{Log}\left[\frac{y}{3}\right]\right]$

Out[6]=  $\frac{y}{6 + y}$

### (d) Fourth illustration - Mathematica's *Solve* function - e1 is numerical, e2 is symbolic

In[7]:= **e1 = {x + y == 1, x - y == 2}; Solve[e1, {x, y}]**

Out[7]=  $\left\{\left\{x \rightarrow \frac{3}{2}, y \rightarrow -\frac{1}{2}\right\}\right\}$

In[8]:= **e2 = {x + y == a, x - y == b}; Solve[e2, {x, y}]**

Out[8]=  $\left\{\left\{x \rightarrow \frac{a+b}{2}, y \rightarrow \frac{a-b}{2}\right\}\right\}$

**(e) (*LATE EXTRA!*)** Brief explanation of *some* of the *Mathematica* functions used in later examples:

(1) **Table** is used to generate lists.

Example:

```
In[23]:= ex1 = Table[i^2, {i, 5}]
```

```
Out[23]= {1, 4, 9, 16, 25}
```

Another (2D) example:

```
In[24]:= ex2 = Table[i^2 + j, {i, 5}, {j, 0, i - 1}]
```

```
Out[24]= {{1}, {4, 5}, {9, 10, 11}, {16, 17, 18, 19}, {25, 26, 27, 28, 29}}
```

(2) **TableForm** is used to output lists in a readable form:

Example:

```
In[25]:= TableForm[ex2]
```

```
Out[25]//TableForm=
```

1				
4	5			
9	10	11		
16	17	18	19	
25	26	27	28	29

(3) Effect of **Flatten**

```
In[26]:= Flatten[ex2]
```

```
Out[26]= {1, 4, 5, 9, 10, 11, 16, 17, 18, 19, 25, 26, 27, 28, 29}
```

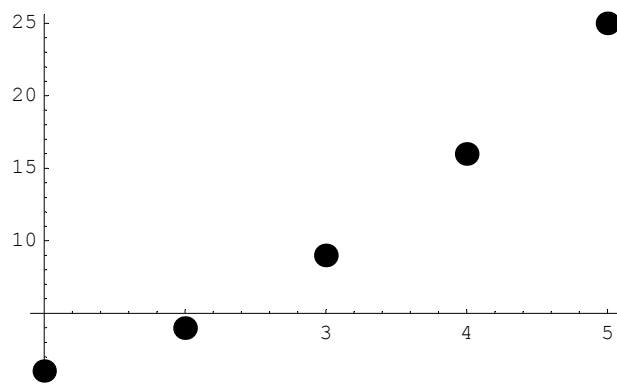
(4) Use of **Apply** and **Plus** to add the elements of a list:

```
In[27]:= {Apply[Plus, ex1], Apply[Plus, Flatten[ex2]]}
```

```
Out[27]= {55, 245}
```

(5) **ListPlot**

```
In[30]:= ListPlot[ex1, PlotStyle -> PointSize[0.04]]
```



```
Out[30]= - Graphics -
```

(6) "Do" iteration construct

```
In[31]:= sum = 0; Do[sum += i, {i, 1000}]; sum
```

```
Out[31]= 500500
```