

■ 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:

$$3 + 62 + 1$$

$$66$$

- Symbolic computation:

$$3x + x + 2$$

$$2 + 4x$$

(b) Second illustration:

$$x^4 + 3x + 2x^3 + xxx - x^5/x + 2$$

$$2 + 3x + 3x^3$$

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

$$\text{Together}\left[\frac{a}{b} + \frac{c}{d}\right]$$

$$\frac{bc + ad}{bd}$$

$$\text{Together}\left[e^{-\text{Log}\left[2 + \frac{y}{3}\right] + \text{Log}\left[\frac{y}{3}\right]}\right]$$

$$\frac{y}{6 + y}$$

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

$$e1 = \{x + y == 1, x - y == 2\}; \text{Solve}[e1, \{x, y\}]$$

$$\left\{\left\{x \rightarrow \frac{3}{2}, y \rightarrow -\frac{1}{2}\right\}\right\}$$

```
e2 = {x + y == a, x - y == b}; Solve[e2, {x, y}]
```

```
{{x -> (a + b)/2, y -> (a - b)/2}}
```

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

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

Example:

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

```
{1, 4, 9, 16, 25}
```

Another (2D) example:

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

```
{{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:

```
TableForm[ex2]
```

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

(3) Effect of Flatten

```
Flatten[ex2]
```

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

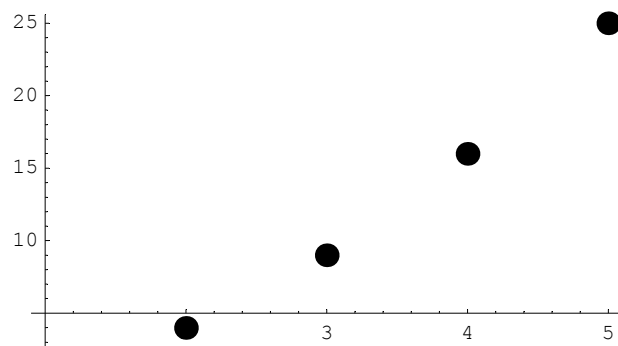
(4) Use of **Apply** and **Plus** to add the elements of a list:

```
{Apply[Plus, ex1], Apply[Plus, Flatten[ex2]]}
```

```
{55, 245}
```

(5) ListPlot

```
ListPlot[ex1, PlotStyle -> PointSize[0.04]]
```



- Graphics -

(6) "Do" iteration construct

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

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