

# Computing for Mathematics: Handout 2

This handout contains a summary of the topics covered and an activity to carry out prior or during your lab session.

At the end of the handout is a specific coursework like exercise.

For further practice you can do the exercises available at the algebra chapter of Python for Mathematics.

## 1 Summary

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The purpose of this handout is to cover Algebra which corresponds to the Algebra chapter of Python for Mathematics.

The topics covered are:

- Creating symbolic numeric values
- Getting numerical value of a symbolic expression
- Factorising an expression
- Expanding an expression
- Simplifying an expression
- Solving an equation
- Substituting values in to expressions

## 2 Activity

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We will be tackling the problem from the tutorial of the Algebra chapter of Python for Mathematics.

1. Rationalise the denominator of  $\frac{1}{\sqrt{2}+1}$
2. Consider the quadratic:  $f(x) = 2x^2 + x + 1$ :
  - (a) Calculate the discriminant of the quadratic equation  $2x^2 + x + 1 = 0$ . What does this tell us about the solutions to the equation? What does this tell us about the graph of  $f(x)$ ?
  - (b) By completing the square, show that the minimum point of  $f(x)$  is  $(-\frac{1}{4}, \frac{7}{8})$

There are instructions for how to do all of this in the Algebra chapter of Python for Mathematics.

1. Create the variable `expression` which has value  $\frac{1}{\sqrt{2}} + 1$ .
2. Use the `sympy.simplify` command to rationalise the denominator.
3. Create the variable `expression` which has value the quadratic from the second part of the question:  $f(x) = 2x^2 + x + 1$ .
4. Use the `sympy.equation` and `sympy.solve` command to find the roots of  $f$ .
5. Create the variable `expression` which has value the expression  $a(x - b)^2 + c$ .
6. Solve the various equations that give the correct values of  $a, b$  and  $c$  to be able to complete the square for  $f(x)$ .

### 3 Coursework like exercise

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Consider the equation:  $x^2 + 4 - y = \frac{1}{y}$ :

1. Create a variable `general_solution` which has value the set of solutions to the equation for  $x$  (as a function of  $y$ ).
2. Create a variable `specific_solution` which has value the set of solutions when  $y = 5$ .

### 4 Summary examples

Create the symbolic value  $1/3$

```
import sympy
value = 1 / sympy.S(3)
```

Get the numeric value of a symbolic variable  $1/3$

```
import sympy
float(value)
```

Factor an expression

```
import sympy
x = sympy.Symbol("x")
sympy.factor(x ** 2 - 81)
```

Expand an expression

```
import sympy
x = sympy.Symbol("x")
sympy.expand((x - 1) * (x + 1))
```

How to simplify an expression

```
import sympy
x = sympy.Symbol("x")
sympy.simplify((x - 3) * (x - 3))
```

Solve an equation

```
import sympy
x = sympy.Symbol("x")
equation = sym.Eq(x + 4, x ** 2)
sympy.solve(equation, x)
```

Substitute a value in to an expression

```
import sympy
x = sympy.Symbol("x")
expression = x ** 2 - 4
expression.subs({x: -2})
```