We already learned how to perform basic arithmetics in Python. We covered addition, subtraction, multiplication, division and several other built-in operations. But if we want to do more complex operations on numbers we can use built-in mathematical functions or functions from the math module.

math module provides useful mathematical functions and constants. This module is available on every platform in the standard library.

## Advanced arithmetics

There are built-in functions abs, round, pow, max and min:

* **abs(x)** returns the absolute value of **x** (i.e. value without a regard to its sign);
* **round(x, ndigits)** returns **x** rounded to **ndigits** number of decimal part digits;
* **pow(x, y)** returns **x** raised to the power of **y**;
* **max(a, b, c, ...)** returns the largest argument;
* **min(a, b, c, ...)** returns the smallest argument.

abs\_integer = abs(-10)  # 10  
abs\_float = abs(-10.0)  # 10.0  
  
round\_integer = round(10.0)      # 10, returns integer when ndigits is omitted  
round\_float = round(10.2573, 2)  # 10.26  
  
pow\_integer = pow(2, 10)  # 1024  
pow\_float = pow(2.0, 10)  # 1024.0  
  
largest = max(1, 2, 3, 4, 5)   # 5  
smallest = min(1, 2, 3, 4, 5)  # 1

abs() and pow() functions have equivalents in the math module. The key difference of math.fabs() and math.pow() is that they always return floats:

import math  
  
fabs\_integer = math.fabs(-10)  # 10.0  
fabs\_float = math.fabs(-10.0)  # 10.0  
  
pow\_integer = math.pow(2, 10)  # 1024.0  
pow\_float = math.pow(2.0, 10)  # 1024.0

Remember that in order to use definitions from math, you should import the module first.

Suppose you raised x to the power y, and then forgot y. You can recover it using the math.log() function:

import math  
  
x = 2  
y = 10  
pow = math.pow(x, y)    # 1024.0  
log = math.log(pow, x)  # 10.0

math.log(pow, x) returns z such that x raised to the power z equals pow. If the second argument x (called the base of the logarithm) is omitted, it is considered equal to a special number e (approximately 2.718):

import math  
  
natural\_log = math.log(1024)  # 6.931471805599453

Besides the round() function, we can use floor() and ceil() from the math module to obtain integer values from floats:

* **math.floor(a)** returns the nearest integer less than or equal to **a**;
* **math.ceil(a)** returns the nearest integer greater than or equal to **a**.

The math module also provides the sqrt function to calculate the square root of a number.

import math  
  
result = math.sqrt(100)  # 10.0

## Geometry

The number π\piπ is often used in geometry and other mathematical fields. It is the ratio of the circumference of a circle to its diameter. It can be found in the math module as pi.

The next example shows how to calculate the circumference of a circle:

import math  
  
r = 3.5  
circumference = 2 \* math.pi \* r  # 21.991...

There are also common trigonometric functions available in the math module:

* **math.cos(a)** returns the cosine of **a** radians;
* **math.sin(a)** returns the sine of **a** radians;
* **math.degrees(a)** returns angle **a** converted from radians to degrees;
* **math.radians(a)** returns angle **a** converted from degrees to radians**.**

import math  
  
deg = 60.0  
x = math.radians(deg)  # 1.047...  
  
cos = math.cos(x)  # 0.500...  
sin = math.sin(x)  # 0.866...  
  
degrees = math.degrees(x)  # 59.999...

As you can see, due to a limited precision of floats the value of degrees is actually 59.99999999999999 instead of expected 60.0.

It is impossible to cover all the math module in this topic so you can learn more from its [documentation](https://docs.python.org/3/library/math.html).

## The volume of a cylinder

Let's assume we have a cylinder with the height h = 5 and the radius of the base r = 3. The formula for the volume of a cylinder is V=πr2hV = \pi r^2 hV=πr2h. This is how we can calculate the volume using Python:

import math  
  
h = 5  
r = 3  
  
volume = math.pi \* math.pow(r, 2) \* h  # 141.3716...  
  
print(round(volume, 1))  # 141.4

In the code above, we used the round function to get a prettier value for printing.

## Summary

In this topic, we've learned several new advanced arithmetic operations, familiarized ourselves with arithmetics and geometry in math module, and calculated the volume of a cylinder. As you can see, it is possible to round a number or find a maximum value in Python using just built-in functions. However, now you can use functions from the math module for more advanced tasks.