Laboratory 12 : Classes

In this laboratory, we create a class for three dimensional vectors. A three dimensional vector consists of three fields, x, y, and z. Vectors can be added and subtracted, they can be tested for equality and inequality, and they have a length.

Implement the following standard methods and test them.

__add__ (self, other) : $(a, b, c) + (x, y, z) = (a + x, b + y, c + z)$
__iadd__(self, other)
__sub__ (self, other)
__isub__(self, other)
__str__ (self)
__repr__(self)
__eq__ (self, other)
__ne__ (self, other)
__len__(self): $|(x, y, z)| = \sqrt{x^2 + y^2 + z^2}$

You should also implement

Vectors can also be multiplied by a scalar. For example, if v is a vector (a, b, c) and x is a scalar (a floating point number), then $x(a, b, c) = (xa, xb, xc)$ is a vector. When Python sees an expression such as `x*vector` it first looks to the type of x and determines whether there is a definition of the multiplication for this class. Since `x` is a floating point number, there is none. After this, Python looks for the dunder `__rmul__` (for right multiplication) in the class definition of the right object. The implementation of `__rmul__` just needs to return a vector object.

Vectors can also be multiplied using the dot product. The result is not another vector but rather a scalar. There is nothing that prevents us to use the `__mul__` dunder function in order to implement the dot product. The formula is

$$\begin{pmatrix} a_1 \\ a_2 \\ a_3 \end{pmatrix} \cdot \begin{pmatrix} b_1 \\ b_2 \\ b_3 \end{pmatrix} = a_1 b_1 + a_2 b_2 + a_3 b_3 .$$

Finally, three dimensional vectors can be multiplied using the vector product. Since the * -symbol is taken by the much more common scalar multiplication and the dot product, we use sign of the remainder operation, namely the percentage symbol % . It corresponds to the dunder function __mod__. The vector product of two vectors is defined by

$$\begin{pmatrix} a_1 \\ a_2 \\ a_3 \end{pmatrix} \times \begin{pmatrix} b_1 \\ b_2 \\ b_3 \end{pmatrix} = \begin{pmatrix} a_2 b_3 - a_3 b_2 \\ -a_1 b_3 + b_1 a_3 \\ a_1 b_2 - a_2 b_1 \end{pmatrix}.$$

Implement and test all multiplications.