02393 C++ Programming Exercises

Assignment 7

To be handed in via Autolab — `https://autolab.compute.dtu.dk/courses/02393-E23/assessments`

1 Fun with vectors

The goal of this assignment is to implement a class for two-dimensional vectors. Note that here "vector" refers to pairs of double values, not to the class `vector` of the standard C++ library. We use the mathematical notation $\binom{x}{y}$ for vectors.

In the zip archive `ex07-code.zip` (available on DTU Learn) you can find:

- a header file `vector2d.h` containing the declaration of the class `v2d`, which represents vectors in two-dimensional space;
- a file `main.cpp` containing a program which uses the `v2d` class (you can run and edit it to do some tests).
- a file `vector2d.cpp` which contains a skeleton of the solution.

You should implement the class in the file `vector2d.cpp` above, as follows:

1. The constructor `v2d(double a, double b)` should build a vector $\binom{x}{y}$.
2. The constructor `v2d(const v2d & v)` should build a vector that is exactly like vector `v`.
3. The destructor ∼`v2d()` does not need to do anything special.
4. The assignment operator `v2d & operator=(const v2d &v)` updates a vector to make it exactly like vector `v`.
5. The vector addition method `v2d & operator+(const v2d &v)` updates a vector by adding another vector `v` to it. Remember that vector addition is defined as:
$$\binom{x_1}{y_1} + \binom{x_2}{y_2} = \binom{x_1 + x_2}{y_1 + y_2}$$
6. The scalar multiplication method `v2d & operator*(double k)` updates a vector by multiplying it by a scalar factor `k`. Remember that scalar multiplication is defined as:
$$k \cdot \binom{x}{y} = \binom{k \cdot x}{k \cdot y}$$
7. The scalar product method `double operator*(const v2d &v)` multiplies a vector by another vector `v` and returns the result *without updating the vector*. Remember that the scalar product of vectors is defined as:
$$\binom{x_1}{y_1} * \binom{x_2}{y_2} = x_1 \cdot x_2 + y_1 \cdot y_2$$
8. Method `double length()` computes the length of the vector. Remember that the length of a vector $w = \binom{u}{v}$ is $\sqrt{w * w}$.

You need to upload on Autolab your updated files inside a zip archive. Note that only `vector2d.cpp` should be changed.

Hints.

- Most of the *operator* methods you need to implement (`=`, `*`, etc.) do not need to generate a new vector, but change the vector for which the method was called. For example, if `u` and `v` are vectors then `u + v` will update `u` (with the addition of `u` and `v`).
- Most of the *operator* methods you need to implement (`=`, `*`, etc.) need to return the very same vector (by reference). One of the consequences is that `(u + v) + w` will have the effect of updating `u` (with the addition of `u`, `v` and `w`). Recall that the object for which the object was invoked is accessed with `*this`. Many of your methods, hence, will need to finish with `return *this;` which returns the current object by reference (not a pointer!).

Challenge. Can you use templates to make class parametric with respect to the datatype of the elements (e.g. `double`, `float`, etc.)? Can you use templates to generalize the class to arbitrary dimentions (n-dimensional vectors)?