Week 2 — C++ starter: Manipulating floating point numbers

The goal of the present exercises is to manipulate the floating point numbers in C++

Exercise 1: Casting integers and float

• Execute the following program:

```
int a = 0.5;
std::cout << a << std::endl;</pre>
```

- Launch the program and describe what you observe. How could this be avoided.
- Execute now

```
double a = 1/2;
std::cout << a << std::endl;</pre>
```

- Please explain again what happened.
- Can this happen in Python language?

Exercise 2: Overflow

• The exponential function can be computed using the following function:

```
double x = 10.;
double a = exp(x);
std::cout << a << std::endl;</pre>
```

(use the manual if you seek for information about the exp function)

• Create a function which computes the following hyperbolic tangent:

$$\tanh(x) = \frac{\exp(x) - \exp(-x)}{\exp(x) + \exp(-x)} \tag{1}$$

- Make a loop to compute 10 points of the curve tanh(x) for $x \in [0, 1000]$.
- Try to factor the $\exp(x)$ to find an expression avoiding the overflow.

Exercise 3: Underflow

• Find (and program) the best way to evaluate the function

$$\tanh(x) - 1 = \frac{\exp(x) - \exp(-x)}{\exp(x) + \exp(-x)} - 1 \tag{2}$$

• Let us now consider the motion of two photons moving at the velocity $v = 3 \cdot 10^8$ m/s in the same direction. Their position evolution can be computed with:

$$p_i(t) = p_i(0) + tv \tag{3}$$

with $p_i(t)$ (*i* being 0 or 1) their position at time *t*.

If we discretize time we can provide the time integration scheme:

$$p_i^{n+1} = p_i^n + dt \cdot v \tag{4}$$

• Program the function

double evolution(double pn, double v, double dt);

which returns the new position provided the position at the previous step (pn), the velocity (v) and the time step (dt)

- Make a program which sets the initial position of the two photons being $p_0(0) = 0$ and $p_1(0) = 10^{-3}$. Thus they are distant by one millimeter.
- Then compute the positions evolution during 40 time steps with dt = 1000 seconds (less than 1 hour).
- Compute the distance $p_1(t) p_0(t)$. Explain what you see.