QFGB8960 Advanced C++ for Finance
Homework 1

Spring 2025

Problem 1 (40 points) C++ self-test

Answer the following questions without compiling the code. Assume `using namespace std` everywhere.

1. Sizes of data

   (a) How many bits is the size of a boolean?

   (b) How many bits is the size of a double?

2. Integer arithmetic: what will be printed on the screen from the code below?

```
int i = 3;
int l = i / -2;
int k = i % -2;
cout << l << " " << k;
```

3. Integers and logicals in arithmetic: what will be printed on the screen from the code below?

```
bool a = true;
bool b = false;
int x = 10;
int y = 5;
int p = ((x | y) + (a + b));
cout << p;
```

4. Pre/post increment: what will be printed on the screen from the code below?

```
int i = 1;
int j = (--i)++;
cout << i << " " << j;
```

5. Short-circuiting logical operations: what will the following two statements evaluate to?

```
int x{ 0 }, y{ 0 };
if (x > 0 && ++y) x++;
cout << x <<  " " << y;
```

6. Which of the following operators can be overloaded

   (a) ?:

   (b) %

   (c) ::

   (d) ==

7. What is the output of this code

```
int a = 9;
int& aref = a;
++a;
cout << aref;
```

8. Constructing/destructing the base: given the following code, what will be printed on the screen?

```
class A
{
public:
  A() { cout << 1 << endl; }
  ~A() { cout << 2 << endl; }
};

class B : public A
{
public:
  B() { cout << 3 << endl; }
  ~B() { cout << 4 << endl; }
};

int main()
{
  B b;
```

```
  return 0;
}
```

9. Lambdas: what will be the output from the code below

```
int x = 1;
auto check = [&]() -> bool
{
  --x;
  if (x == 0)
    return false;
  else
   return true;
};
cout << check() << " " << x;
```

10. Templetized functions: consider the code below:

```
template <typename T>
void fun(const T&x)
{
    static int count = 0;
    cout << x << " " << count;
    ++count;
    return;
}

int main()
{
    fun<int>(1);
    cout << endl;
    fun<int>(2);
    cout << endl;
    fun<double>(1.2);
    cout << endl;
    return 0;
}
```

What will be printed on the screen?

Problem 2 (60 points) Product of two polynomials

A polynomial of degree m has the form $p(x) = c_0 + c_1 x + \ldots + c_{m-1} x^{m-1} + c_m x^m$, with $c_m \neq 0$. It can be represented as a numeric vector of size $m+1$, with the coefficients $(c_0, c_1, \ldots c_{m-1}, c_m)$.

Implement a Python callable function `polyProd(p, q)`. This function takes as input two numerical vectors (lists or numpy 1D arrays), representing two polynomials of the same variable, and returns a vector representing their product.

For example, if $p = (0, 2)$ and $q = (1, 0, 3)$ the product is $p \cdot q = (0, 2, 0, 6)$.

Implement in C++ the Python callable function `pyQfPolyProd`.

Put your implementation in the file `pyorflib/pyfunctions0.hpp`, and register it in the file `pyorflib/pymodule.cpp`.

Expose the function in the package file `pyorflib/orflib/__init__.py`, using the name `polyProd`.

- If any input vector is empty (size 0) throw an invalid_argument exception, defined in the stdexcept header.
- Do not show any trailing zeros in the output vector, i.e. do not return $(0, 3.1, 2.5, 0, 0)$ but $(0, 3.1, 2.5)$. Only in the case when all coefficients are zero then return a single zero element.

In a Jupiter notebook initialize a Python list with two 1D numpy arrays, as

```
l = [np.array([1.]), np.array([1., 1.])]
```

By repeated application of `polyProd` add six more arrays to the list `l`, to form Pascal's triangle of eight rows. Print the final list.

You can reuse the example Jupyter notebook that comes with qflib version 0.1.0. Provide your source code and the notebook following the instructions on Blackboard.