Numeric

The numeric library hosts several numeric functions. We'll look at a few of them in this lesson.

```
The numeric algorithms std::accumulate, std::adjacent_difference, std::partial_sum, std::inner_product, and std::iota and the six additional C++17 algorithms std::exclusive_scan, std::inclusive_scan, std::transform_exclusive_scan, std::transform_inclusive_scan, std::reduce, and std::transform_reduce are special. All of them are defined in the header <numeric>. They are widely applicable because they can be configured with a callable.
```

std::accumulate: Accumulates the elements of the range. init is the start value.

```
T accumulate(InpIt first, InpIt last, T init)
T accumulate(InpIt first, InpIt last, T init, BiFun fun)
```

std::adjacent_difference : Calculates the difference between adjacent
elements of the range and stores the result in result.

```
OutIt adjacent_difference(InpIt first, InpIt last, OutIt result)
FwdIt2 adjacent_difference(ExePol pol, FwdIt first, FwdIt last, FwdIt2 result)

OutIt adjacent_difference(InpIt first, InpIt last, OutIt result, BiFun fun)
FwdIt2 adjacent_difference(ExePol pol, FwdIt first, FwdIt last, FwdIt2 result, BiFun fun)
```

std::partial_sum: Calculates the partial sum of the range.

```
OutIt partial_sum(InpIt first, InpIt last, OutIt result)
OutIt partial_sum(InpIt first, InpIt last, OutIt result, BiFun fun)
```

std::inner_product: Calculates the inner (scalar) product of the two ranges
and returns the result.

```
T inner_product(InpIt first1, InpIt last1, OutIt first2, T init)
T inner_product(InpIt first1, InpIt last1, OutIt first2, T init, BiFun fun1, BiFun fun2)
```

std::iota: Assigns the first element of the range the value first and each subsequent element of the range is assigned a sequentially increasing value.

```
void iota(FwdIt first, FwdIt last, T val)
```

The algorithms are not so easy to get.

std::accumulate , without callable, uses the following strategy:

```
result = init;
result += *(first+0);
result += *(first+1);
```

std::adjacent_difference, without a callable, uses the following strategy:

```
*(result) = *first;

*(result+1) = *(first+1) - *(first);

*(result+2) = *(first+2) - *(first+1);
```

std::partial_sum, without callable, uses the following strategy:

```
*(result) = *first;
*(result+1) = *first + *(first+1);
*(result+2) = *first + *(first+1) + *(first+2)
```

The challenging algorithm variation inner_product(InpIt, InpIt, OutIt, T,
BiFun fun1, BiFun fun2) with two binary callables uses the following strategy:

```
#include <array>
#include <iostream>
#include <numeric>
#include <vector>

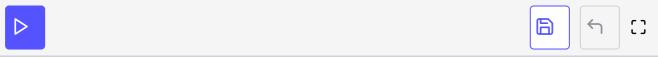
int main(){

   std::cout << std::endl;

   std::array<int, 9> arr{1, 2, 3, 4, 5, 6, 7, 8, 9};

   std::cout << "std::accumulate(arr.begin(), arr.end(), 0): " << std::accumulate(arr.begin() std::cout << "std::accumulate(arr.begin(), arr.end(), 1, [](int a, int b){ return a+b;}):
   std::cout << std::accumulate(arr.begin(), arr.end(), 1, [](int a, int b){ return a+b;}):
</pre>
```

```
std::vector<int> vec{1, 2, 3, 4, 5, 6, 7, 8, 9};
std::vector<int> myVec;
std::cout << "adjacent_difference: " << std::endl;</pre>
std::adjacent_difference(vec.begin(), vec.end(), std::back_inserter(myVec), [](int a, int back_inserter(myVec), []
for (auto v: vec) std::cout << v << " ";
std::cout << std::endl;</pre>
for (auto v: myVec) std::cout << v << " ";</pre>
std::cout << "\n\n";</pre>
std::cout << "std::inner_product(vec.begin(), vec.end(), arr.begin(), 0): "<< std::inner_pr</pre>
std::cout << std::endl;</pre>
myVec={};
std::partial_sum(vec.begin(), vec.end(), std::back_inserter(myVec));
std::cout << "partial_sum: ";</pre>
for ( auto v: myVec) std::cout << v << " ";</pre>
std::cout << "\n\n";</pre>
std::cout << "iota: ";</pre>
std::vector<int> myLongVec(100);
std::iota(myLongVec.begin(), myLongVec.end(), 2000);
for ( auto v: myLongVec) std::cout << v << " ";</pre>
std::cout << "\n\n";</pre>
```



Numeric algorithms

The second callable <code>fun2</code> is applied to each pair of the ranges to generate the temporary destination range <code>tmp</code>, and the first callable is applied to each element of the destination range <code>tmp</code> for accumulating them and therefore generating the final result.

In the next lesson, we'll solve an exercise related to std::accumulate.