constexpr Additions to the Standard Library

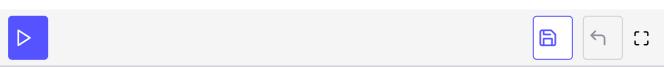
C++17 brings a diverse range of new methods to the constexpr class. We'll talk about them below.

With this enhancement you can work with iterators, std::array, range-based
for loops in constexpr contexts.

The main referencing paper is P0031 - Proposal to Add Constexpr Modifiers to reverse_iterator, move_iterator, array, and Range Access.

Have a look at a basic example that shows a basic implementation of the accumulate algorithm as constexpr (C++11/14/17 version of std::accumulate
is not constexpr):

```
#include <array>
#include <iostream>
template<typename Range, typename Func, typename T>
constexpr T SimpleAccumulate(const Range& range, Func func, T init) {
 for (auto &&obj : range) // begin/end are constexpr
    init += func(obj);
  return init;
constexpr int square(int i) { return i*i; }
int main() {
  constexpr std::array arr{ 1, 2, 3 }; // class deduction...
 // with constexpr lambda
 static_assert(SimpleAccumulate(arr, [](int i) constexpr { return i * i;}, 0) == 14);
  // with constexpr function
  static_assert(SimpleAccumulate(arr, &square, 0) == 14);
  std::cout << arr[0] << '\n';
  return arr[0];
}
```



C++14 compilers would not compile the above example, but it's now possible with C++17 support.

There are several features used in this code:

- SimpleAccumulate is a constexpr template function and uses range access (hidden in range based for loop) to iterate over the input range.
- arr is deduced as std::array<3, int> class template deduction works
 here.
- the code uses a constexpr lambda.
- static_assert without any message.
- std::begin() and std::end() are also constexpr since C++17

You can also see another example of **constexpr** additions in Chapter about General Language Features: Constexpr Lambda.

Each C++ Standard allows more and more code to be constexpr. In C++17 we can start using basic containers in constant expressions. In C++20 we'll get more standard algorithms that are declared as constexpr.

Extra Info: The main referencing paper is P0031 - Proposal to Add Constexpr Modifiers to reverse_iterator, move_iterator, array and Range Access

C++ has also added a way of locking a variadic number of mutexes simultaneously. Find out more in the next lesson.