

std::variant

```
std::variant<int, double> v
{12};

std::get< int >(v); // == 12
std::get< 0 >(v); // == 12
v = 12.0;
std::get< double >(v); // ==
12.0
std::get< 1 >(v); // == 12.0
```

The class template std::variant represents a type-safe union. An instance of std::variant at any given time holds a value of one of its alternative types (it's also possible for it to be valueless).

std::optional

```
std::optional<std::string>
create(bool b) {
    if (b) {
        return " Wonder Woman";
    } else {
        return {};
    }
}

create(false).value_or("empty"); // == "empty"
create(true).value(); // ==
" Wonder Woman"

// optional returning factory
functions are usable as
conditions of while and if
if (auto str = create(true)) {
    // ...
}
```

The class template std::optional manages an optional contained value, i.e. a value that may or may not be present. A common use case for optional is the return value of a function that may fail.

std::any

```
std::any x {5};
x.has_value() // == true
std::any_cast< int >(x) // ==
5
std::any_cast< int >(x) = 10;
std::any_cast< int >(x) // ==
10
```

A type-safe container for single values of any type.

std::string_view

```
// Regular strings.
std::string_view cppstr {"foo"};
// Wide strings.
std::wstring_view wcstr_v
{L"baz"};
// Character arrays.
char array[3] = {'b', 'a', 'r'};
std::string_view array_view(array, std::size(array));
std::string str (" trim me");
std::string_view v {str};
v.remove_prefix(std::min(
    v.find_first_of(" "), v.size()));
str; // == " trim me"
v; // == "trim me"
```

A non-owning reference to a string. Useful for providing an abstraction on top of strings (e.g. for parsing).

Parallel algorithms

```
std::vector<int> longVector;
// Find element using parallel
execution policy
auto result1 = std::find(st - d::execu - ion::par, std::begin(longVec - tor), std::end(lon - gVec - tor), 2);
// Sort elements using
sequential execution policy
auto result2 = std::sort(st - d::execu - ion::seq, std::begin(longVec - tor), std::end(lon - gVec - tor));
```

Many of the STL algorithms, such as the copy, find and sort methods, started to support the parallel execution policies: seq, par and par_unseq which translate to "sequentially", "parallel" and "parallel unsequenced".

std::invoke

```
template <typename Callable>
class Proxy {
    Callable c;
public:
    Proxy(Callable c): c(c)
    {}
    template <class... Args>
    decltype(auto) operator - or((Args&&... args) {
        // ...
        return std::inVOKE(c,
            std::forward<Args>(ar - gs)...);
    }
    auto add = [](int x, int y) {
        return x + y;
    }
};
```



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std::invoke (cont)

```
> };
Proxy<decltype(add)> p {add};
p(1, 2); // == 3
```

Invoke a Callable object with parameters.
Examples of Callable objects are std::function or std::bind where an object can be called similarly to a regular function.

std::apply

```
auto add = [](int x, int y) {
    return x + y;
};

std::apply([](int x, int y) {
    return x + y;
}, std::make_tuple(1, 2)); // == 3
```

Invoke a Callable object with a tuple of arguments.

std::filesystem

```
const auto bigFilePath
{"bigFileToCopy"};
if (std::filesystem::exists(bigFilePath)) {
    const auto bigFileSize
    {std::filesystem::file_size(bigFilePath)};
    std::filesystem::path tmpPath {"tmp"};
    if (std::filesystem::exists(tmpPath) & !bigFileSize > bigFileSize) {
        std::filesystem::create_directory(tmpPath);
        std::filesystem::copy_file(bigFilePath, tmpPath);
    }
}
```

std::filesystem (cont)

```
> }
}
```

The new std::filesystem library provides a standard way to manipulate files, directories, and paths in a filesystem.

Here, a big file is copied to a temporary path if there is available space.

std::byte

```
std::byte a {0};
std::byte b {0xFF};
int i = std::bit_or(a, b); // 0xFF
std::byte c = a & b;
int j = std::bit_and(c, b); // 0
```

The new std::byte type provides a standard way of representing data as a byte. Benefits of using std::byte over char or unsigned char is that it is not a character type, and is also not an arithmetic type; while the only operator overloads available are bitwise operations.

Note that std::byte is simply an enum, and braced initialization of enums become possible thanks to direct-list-initialization of enums.

Splicing for maps and sets

```
// Moving elements from one map
// to another:
std::map<int, std::string> src {{1,
"one"}, {2, "two"}, {3, "three"}};
std::map<int, std::string> dst {{3,
"three"}};
```

Splicing for maps and sets (cont)

```
> dst.insert(src.extract(src.find(1)));
dst.insert(src.extract(2));
// dst == {{1, "one"}, {2, "two"}, {3, "three"}};
// Inserting an entire set:
std::set<int> src {1, 3, 5};
std::set<int> dst {2, 4, 5};
dst.merge(src);
// src == {5}
// dst == {1, 2, 3, 4, 5}
// Inserting elements which outlive the
// container:
auto elementFactory() {
    std::set<...> s;
    s.emplace(...);
    return s.extract(s.begin());
}
s2.insert(elementFactory());
// Changing the key of a map element:
std::map<int, std::string> m {{1, "one"}, {2, "two"}, {3, "three"}};
auto e = m.extract(2);
e.key() = 5;
m.insert(std::move(e));
// m == {{1, "one"}, {3, "three"}, {5, "two"}}
```

Moving nodes and merging containers without the overhead of expensive copies, moves, or heap allocations/deallocations.



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