# Type Comparisons and Modifications

Sometimes we need to manipulate or compare different types. We can use the type traits library for that!

WE'LL COVER THE FOLLOWING



## Type Comparisons #

The library supports three kinds of type comparisons.

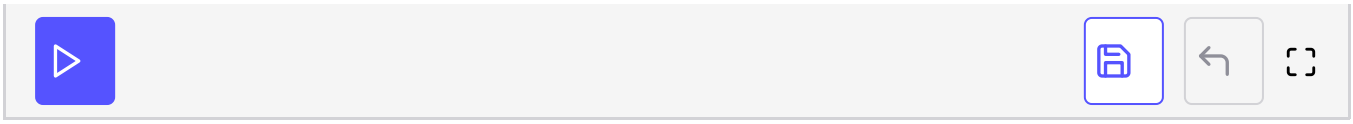
| Function | Description |
| --- | --- |
| `template class Base, class Derived>`<br><br>`struct is_base_of` | Checks if `Derived` is derived from `Base`. |
| `template <class From, class To>`<br><br>`struct is_convertible` | Checks if `From` can be converted to `To`. |
| `template <class T, class U>`<br><br>`struct is_same` | Checks if the types `T` and `U` are the same. |

**Type comparison**

## Type Modifications #

The type traits library enables you to modify types during compile time. So you can modify the constness of a type:

```
// typeTraitsModifications.cpp
#include <iostream>
#include <type_traits>
using namespace std;

//output 0 if the function returns false and 1 if the function returns true
int main(){
  cout << is_const<int>::value << "\n";                      // 0
  cout << is_const<const int>::value << "\n";                // 1
  cout << is_const<add_const<int>::type>::value << "\n";     // 1

  typedef add_const<int>::type myConstInt;
  cout << is_const<myConstInt>::value << "\n";               //1

  typedef const int myConstInt2;
  cout << is_same<myConstInt, myConstInt2>::value << "\n";  // 1

  cout << is_same<int, remove_const<add_const<int>::type>::type>::value << "\n";    // 1
  cout << is_same<const int, add_const<int>::type>::value << "\n"; // 1

  return 0;
}
```



Type modifications

The function `std::add_const` adds the constness to a type, while `std::remove_const` removes it.

There are a lot more functions available in the type traits library. So you can modify the const-volatile properties of a type.

```
template <class T> struct remove_const;
template <class T> struct remove_volatile;
template <class T> struct remove_cv;

template <class T> struct add_const;
template <class T> struct add_volatile;
template <class T> struct add_cv;
```

You can change at compile time the sign,

```
template <class T> struct make_signed;
template <class T> struct make_unsigned;
```

or the reference or pointer properties of a type.

```
template <class T> struct remove_reference;
template <class T> struct add_lvalue_reference;
template <class T> struct add_rvalue_reference;

template <class T> struct remove_pointer;
template <class T> struct add_pointer;
```

The three following functions are especially valuable for the writing of generic libraries.

```
template <class B> struct enable_if;
template <class B, class T, class F> struct conditional;
template <class... T> common_type;
```

You can conditionally hide with `std::enable_if` a function overload or template specialization from overload resolution. `std::conditional` provides you with the ternary operator at compile time and `std::common_type` gives you the type, to which all type parameter can be implicitly converted to. `std::common_type` is a variadic template, therefore the number of type parameters can be arbitrary.

> 🗝 **C++14 has a shorthand for ::type**
> If you want to get a `const int` from an `int` you have to ask for the type: `std::add_const<int>::type`. With the C++14 standard use simply `std::add_const_t<int>` instead of the verbose form: `std::add_const<int>::type`. This rule works for all type traits functions.

In the next lesson, we will move on to another utility in C++ – the time library.