

Bridge design pattern

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Intro

In short, Bridge design pattern is

- Structural design pattern
- Separates the Abstraction (interface) from the concrete Implementation, so that these two can vary independently, in two separate hierarchies.
It can be seen as **pimpl** idiom, since it hides the implementation at client side.

Usage example

We can define the universal factory method as

```
namespace details
{
    template <typename T>
    struct Factory final
    {
        /**
         * Universal factory method
         * Creates the std::unique_ptr<T> for an arbitrary arguments list
         * Advantage: the c-tor of type T after specialization, can be changed - but
         * the factory method remains the same
         */
        template <typename...Args>
        static std::unique_ptr<T>create (Args&&...args)
        {
            if constexpr (std::is_constructible_v<T, Args...>)
            {
                return std::make_unique<T>(std::forward<Args>(args)...);
            }

            return nullptr;
        }
    };
}
```

For the sake of arguments, let's define the Implementation common interface - using run-time virtual dispatching

```
struct IImplementation
{
    virtual ~IImplementation() = default;

    // Implementation common interface

    virtual void f() = 0;
};
```

We introduce the Abstraction as a class template - with an Implementation policy, as the way to inject the concrete implementation at compile-time: at client customization point side.

This is our Abstraction, with its own hierarchy (interface), that can vary independently from Implementation hierarchy.

```

template <typename Implementation>
struct Abstraction
{
    virtual ~Abstraction() = default;

    // Abstraction common interface

    virtual void g() = 0;
    virtual void h() = 0;

    explicit Abstraction(std::unique_ptr<Implementation> pimpl) noexcept:
        m_pimpl(std::move(pimpl))
    {}

    template <typename...Args>
    explicit Abstraction(Args&&...args) noexcept:
        m_pimpl(details::Factory<Implementation>::create(std::forward<Args>(args)...))
    {}

protected:
    std::unique_ptr<Implementation> m_pimpl;
};

```

Well, that's it - more than less everything.
In Implementation branch, we can have something like

```

// Concreate implementations

struct A1 : IImplementation
{
    void f() override { puts("A1::f()"); }
};

struct A2 : IImplementation
{
    explicit A2(int id) noexcept: m_id(id) {}

    void f() override { puts("A2::f()"); }
    int get() const { return m_id; }

private:
    int m_id;
};

```

On the client side, we can finally bridge these two as

```

struct Client1: public Abstraction<A1>
{
    using base = Abstraction<A1>;
    using base::base;

    virtual ~Client1() override = default;

    void g() override
    {
        printFunc();

        m_pimpl->f();
        puts("Client1::g()");
    }
};

```

```

    }

    void h() override
    {
        printFunc();

        m_pimpl->f();
        puts("Client1::h()");
    }
};

struct Client2: public Abstraction<A2>
{
    using base = Abstraction<A2>;
    using base::base; // base class c-tors

    virtual ~Client2() override = default;

    void g() override
    {
        printFunc();

        m_pimpl->f(); // from implementation "borrowed" functionality

        puts("Client2::g()");
        std::cout << "id=" << m_pimpl->get() << '\n';
    }

    void h() override
    {
        printFunc();

        m_pimpl->f();

        puts("Client2::h()");
        std::cout << "id=" << m_pimpl->get() << '\n';
    }
};

```

Code

The entire code is also available at: <https://godbolt.org/z/doxh136PM>