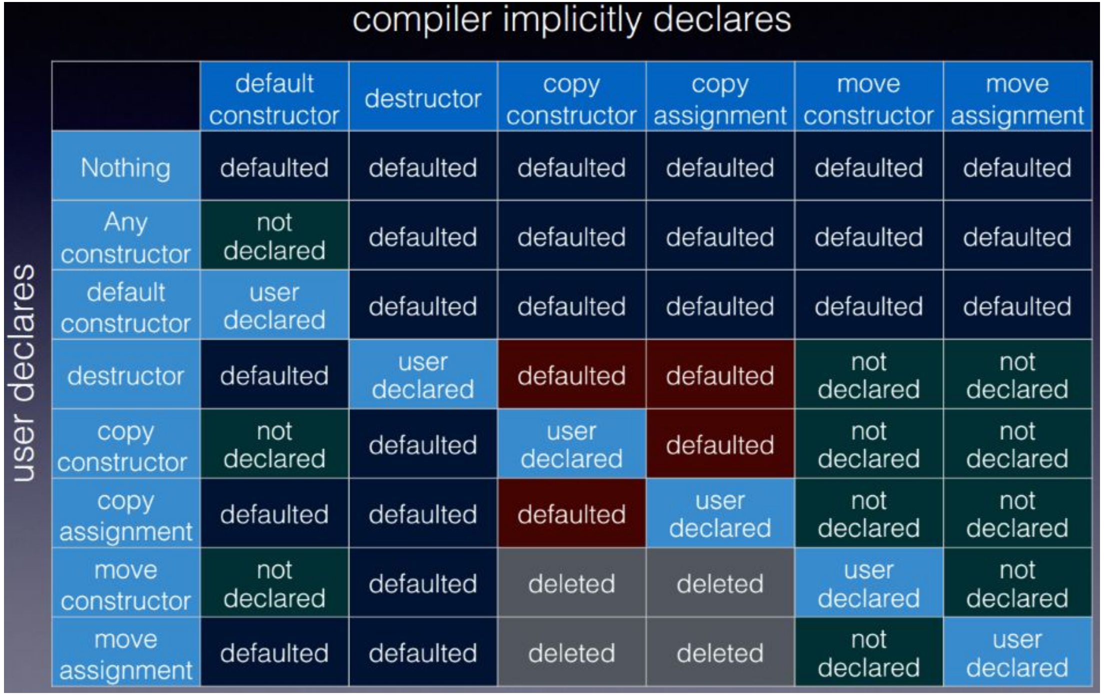
Объектно-ориентированное программирование

Object-oriented programming

VII. Жизнь и смерть объектов

Resource Acquisition Is Initialization

Правила конструирования объектов



compiler implicitly declares

user declares

	default constructor	destructor	copy constructor	copy assignment	move constructor	move assignment
Nothing	defaulted	defaulted	defaulted	defaulted	defaulted	defaulted
Any constructor	not declared	defaulted	defaulted	defaulted	defaulted	defaulted
default constructor	user declared	defaulted	defaulted	defaulted	defaulted	defaulted
destructor	defaulted	user declared	defaulted	defaulted	not declared	not declared
copy constructor	not declared	defaulted	user declared	defaulted	not declared	not declared
copy assignment	defaulted	defaulted	defaulted	user declared	not declared	not declared
move constructor	not declared	defaulted	deleted	deleted	user declared	not declared
move assignment	defaulted	defaulted	deleted	deleted	not declared	user declared

http://howardhinnant.github.io/classdecl.html

Первое правило (C.21)

“If you **define** or **=delete** *any* **copy**, **move**, or **destructor** function, **define or =delete *them all***.”

B. Stroustrup

“CppCoreGuidelines”

https://github.com/isocpp/CppCoreGuidelines/blob/master/CppCoreGuidelines.md#Rc-five

Правило “трех” (rule of three)

```
class vector {
public:
    vector() = default;
    vector(size_t len) :
        p(new int[len]), n(p + len), cap(n) {}
private:
    int *p{nullptr};
    int *n{nullptr};
    int *cap{nullptr};
};
```

Правило “трех”

```
int main(int argc, char const *argv[])
{
    vector a;
    // ...
    {
        vector b(4);  // memory leak
        vector c = a; // double free
        c = b;        // memory leak
    }
    // ...
}
```

Правило “трех”

```
class vector {
public:
    // ...
    ~vector() { delete[] p; }
    vector(const vector &other) :
        p(new int[other.n - other.p]),
        n(p + (other.n - other.p)),
        cap(n)
    {
        std::copy(other.p, other.n, p);
    }
```

```
    vector& operator=(
        const vector &other)
    {
        if(&other != this) {
            delete[] p;
            p = new int[
                other.n - other.p];
            n = p + (other.n - other.p);
            cap = n;
            std::copy(
                other.p, other.n, p);
        }
        return *this;
    }
    // ...
};
```

“Умные” указатели (smart pointers)

```
try {
    vector *d = new vector;
    // throw here
    delete d;                   // memory leak
} catch(const std::exception& e) {
    std::cerr << e.what() << '\n';
}
```

https://en.cppreference.com/w/cpp/memory

“Умные” указатели

```
class unique_ptr {
public:
    ~unique_ptr() { delete[] p; }
    unique_ptr(int *ptr) : p(ptr) {}
    unique_ptr() = delete;
    unique_ptr(const unique_ptr&) = delete;
    unique_ptr& operator=(
        const unique_ptr&) = delete;
private:
    int *p{nullptr};
};
```

“Умные” указатели

```
try {
    unique_ptr p = new int[4];
    // throw here
} catch(const std::exception& e) {
    std::cerr << e.what() << '\n';
}
```

Правило “нуля” (rule of zero)

“Code that is **not written** cannot be wrong.”

P. Sommerlad

“Introducing the rule of DesDeMovA”, 2019

https://safecpp.com/2019/07/01/initial.html

Правило “нуля”

```
class queue {
public:
    ~queue() = default;
    queue() = default;
    queue(const queue&) = default;
    queue& operator=(const queue&) = default;
    void push(int v) {
        data.push_back(v);
    }
private:
    std::vector<int> data;
};
```

Правило “нуля”

```
try {
    queue p;
    p.push(1);
    // throw here
} catch(const std::exception& e) {
    std::cerr << e.what() << '\n';
}
```

Категории значений (l-values/r-values)

```
void f(int&);
void g(int&&);
void h(const int&);
```

```
int i = 0;
f(i);
g(i); // an rvalue reference
cannot be bound to an lvalue
h(i);
```

```
f(42); // initial value of
reference to non-const must
be an lvalue
g(42);
h(42);
```

Категории значений при перегрузке функций

```
void f(const vector&); // #1
void f(vector&&);      // #2

int main(int argc, char const *argv[])
{
    vector a = {1, 2, 3, 4};
    f(a);            // #1
    f({1, 2, 3, 4}); // #2
    f(std::move(a)); // #2
}
```

Конструктор переноса по умолчанию

```
template <typename _Tp>
constexpr typename std::remove_reference<_Tp>::type&&
move(_Tp&& __t) noexcept {
    return
        static_cast<typename std::remove_reference<_Tp>::type&&>(__t);
}
/* Convert a value to an rvalue.
   Parameters:
   __t - A thing of arbitrary type.
   Returns:
   The parameter cast to an rvalue-reference to allow moving it. */
```

Правило “пяти” (rule of five)

```
class vector {
public:
    // ...
    vector& operator=(
        const vector &other)
    {
        if(&other != this) {
            // copy-and-swap:
            vector tmp(other);
            tmp.swap(*this);
        }
        return *this;
    }
```

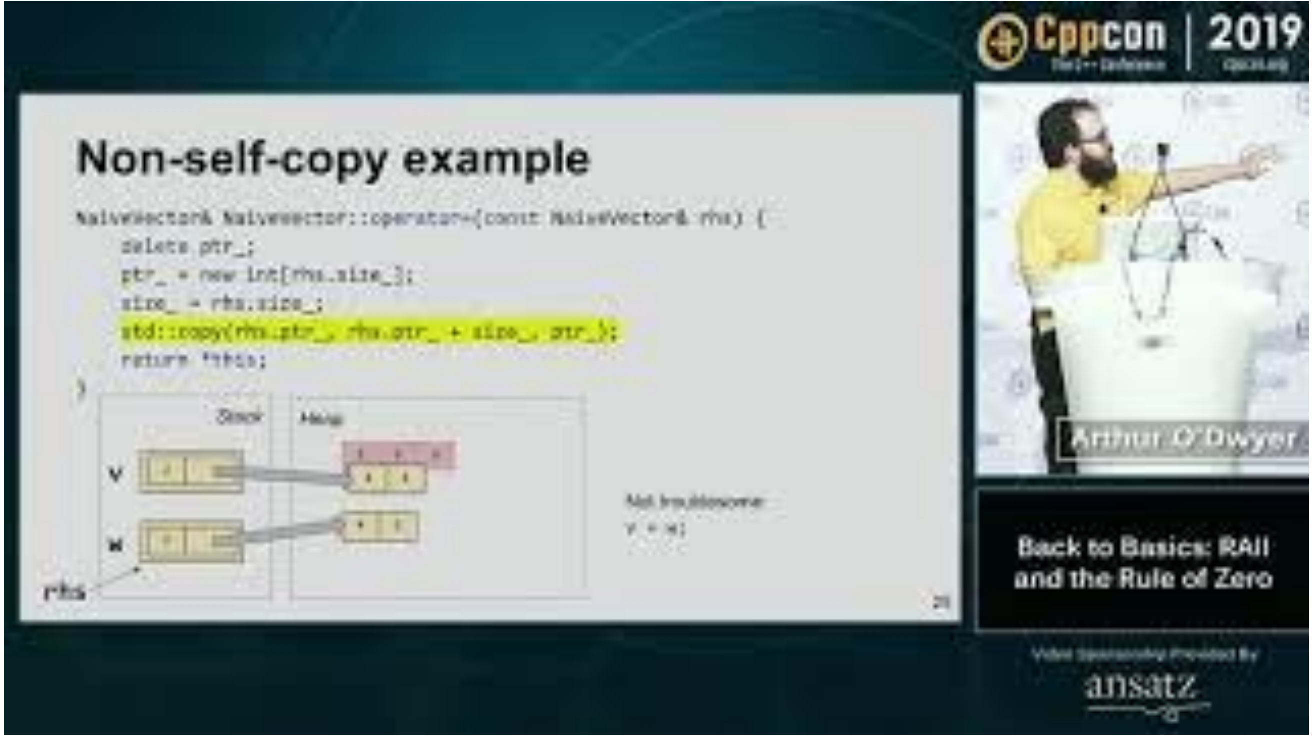
```
    vector(
        vector &&other) noexcept :
        p(std::exchange(other.p, nullptr)),
        n(std::exchange(other.n, nullptr)),
        cap(std::exchange(
            other.cap, nullptr)) {}
    vector& operator=(
        vector &&other) noexcept
    {
        vector tmp(std::move(other));
        tmp.swap(*this);
        return *this;
    }
    // ...
};
```

Правило “четырех с половиной”

```
class vector {
    unique_ptr<int[]> p;
public:
    ~vector() = default;
    vector() = default;
    vector(const vector &other) :
        p(make_unique<int[]>(
            other.n - other.p.get())),
        n(p.get() + (
            other.n - other.p.get())),
        cap(n)
    {
        std::copy(
            other.p.get(),
            other.n,
            p.get());
    }
```

```
    vector(vector &&other)
        noexcept = default;
    void swap(vector &other) noexcept {
        std::swap(p, other.p);
        std::swap(n, other.n);
        std::swap(cap, other.cap);
    }
    vector& operator=(vector other) {
        other.swap(*this);
        return *this;
    }
    friend void swap(
        vector &left, vector &right)
        noexcept
    {
        left.swap(right);
    }
};
```

https://www.youtube.com/watch?v=7Qgd9B1KuMQ



Non-self-copy example

```
NaiveVector& NaiveVector::operator=(const NaiveVector& rhs) {
    delete ptr_;
    ptr_ = new int[rhs.size_];
    size_ = rhs.size_;
    std::copy(rhs.ptr_, rhs.ptr_ + size_, ptr_);
    return *this;
}
```

Not troublesome:

```
v = w;
```

Stack
Heap
v
w
rhs
CppCon | 2019
Arthur O'Dwyer
Back to Basics: RAII and the Rule of Zero
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ansatz