

C++11 tour

What will change for library designers?

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https://github.com/mvannop/cpp11_tour

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Outline

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- Product value should increase

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- C++1x (C++17?) is already in the tubes

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Problem

```
template <typename T>
Matrix<T> operator+(const Matrix<T>& rhs,
                   const Matrix<T>& lhs)
{
    Matrix<T> res;
    /* ... */
    return res;
}
```

- Copying a temporary might be very expensive
- No easy solution
- We have to hope that "return value optimisation" (RVO) kicks in
- What happens with complex formulas mixing a lot of operators?

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- Simply recompiling code with a move-enabled STL may increase performances

- Create a move constructor

```
template <typename T> class Matrix
{
    public:
        Matrix(int n, int m) : data(new T[n * m]) { }
        ~Matrix() { delete[] data; }
        Matrix(Matrix&& tmp)
        {
            data = tmp.data;
            tmp.data = 0;
        }

        T* data;
};

Matrix<double> m(3, 3);
// m.data == 0x9973008
Matrix<double> n = std::move(m);
// m.data == 0
// n.data == 0x9973008
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Challenge: write a 'min' function which takes an arbitrary number of arguments of any type and returns the smallest in C++03.

To support up to N arguments there needs to be N overloads...

Introducing variadic templates

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```
template <typename T>  
const T& min(const T& a, const T& b)  
{  
    return a < b ? a : b;  
}
```

```
template <typename T, typename... Args>  
const T& min(const T& a, const T& b, const Args&... args)  
{  
    return min(a, min(b, args...));  
}
```

- Very efficient thanks to inlining

A typesafe printf!

```
template <typename T>
void print(const T& t)
{
    std::cout << t;
}

template <typename T, typename... Ts>
void print(const T& t, const Ts&... tail)
{
    print(t);
    print(tail...);
}

print("There are ", 3, " arguments!", std::endl);
```

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Writing a generic "make_shared" function which **constructs** the object.

Either:

- Create **a lot** of overloads. . .
- Add constraints on the type, typically being default constructible
- . . . don't construct the object but take a pointer to an already constructed object. . .

```
boost::shared_ptr<std::string> sptr =  
    boost::make_shared(new std::string("..."));
```

Perfect forwarding to the rescue!

- Rvalue references + variadic templates = perfect forwarding

```
template <typename T, typename... Args>
std::shared_ptr<T> make_shared(Args&&... args)
{
    std::shared_ptr<T> p(new T(std::forward<Args>(args)...));
    return p;
}

std::shared_ptr<std::string> sptr =
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```

- Used in the STL to create `emplace_*` methods

```
int main()
{
    std::vector<std::string> strings;
    strings.emplace_back("This is a test!");
    strings.emplace_back(42, 'a');
}
```

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As library designers:

- More powerful and safe interfaces
- Better performances with simpler designs
- And this with a better maintainability

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There is much more!

- We only scratched the surface of C++11
- Code bloat should decrease while features should increase
- We will see new paradigms emerge from the new core features

Bibliography

- C++ Now! (former BoostCon) <http://cppnow.org>
 - **Leor Zolman**: A Whirlwind Overview of C++11
 - **Alisdair Meredith**: Lessons Learned Developing the C++11 Standard Library
 - **Howard Hinnant**: What's new with C++11 containers?
 - **Scott Schurr**: C++11: New Tools for Class and Library Authors
 - <http://cppnow.org/schedule-table/>
- **Bjarne Stroustrup**: <http://www2.research.att.com/~bs/>
- **C++Next**: <http://cpp-next.com/>

Questions?

Mixins

```
struct HasPosition
{
    double path_cost(int dest) const { /*...*/ }
    int position;
};

struct HasShape { /* ... */ };

template <typename... Mixins>
class Object : public Mixins...
{
};

int main()
{
    Object<HasPosition> waypoint;
    Object<HasPosition, HasShape> building;
}
```

Type inference

```
template <template <class...> class Cont,  
         typename Fun, typename... Args>  
auto map(const Cont<Args...>& c, Fun f)  
-> Cont<decltype(f(*c.begin()))>  
{  
    typedef decltype(f(*c.begin())) map_type;  
    Cont<map_type> out;  
    for (const auto& e : c)  
        out.emplace_back(f(e));  
    return std::move(out);  
}  
  
int main()  
{  
    std::vector<int> v{ 42, 51 };  
    auto s = map(v, [](int n) { return std::to_string(n); });  
}
```