C++11 tour
What will it change for library designers?

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Table of contents

Outline

The big picture: what could change?

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- Using C++11 feels like exploring a new language
- No "best pratices" set in stone yet
- C++1x (C++17?) is already in the tubes

Outline

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.

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What is a **generic** function?

- Generic on the **type** of its arguments
- Generic on the **number** of its arguments

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_ptr(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<Matrix> make_shared<Matrix>(10, 10);
```

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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');
}
```

Outline

Conclusion

"The pieces just fit together better than they used to and I find a higher-level style of programming more natural than before and as efficient as ever" — Bjarne Stroustrup

`http://www2.research.att.com/~bs/C++0xFAQ.html`

- 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

Questions ?