Modern C++: 11 and up

Neil Moore

Department of Computer Science
University of Kentucky
Lexington, Kentucky 40506

neil@cs.uky.edu

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Outline

- About C++ and C++ standards
- (Some) new features of C++11 and later
  - Range-based for loops
  - Type inference with `auto`
  - Lambdas
  - `constexpr`
  - Move semantics
- Where to find more information

Guiding principles of C++

- C++ is a "general purpose programming language with a bias towards systems programming" (Stroustrup `http://www.stroustrup.com/C++.html`)
- *Supports* object-oriented programming, doesn't force it.
- "You don't pay for what you don't use"
- "Zero-overhead abstractions"
- This talk will focus on new features of C++11 and up.

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- 2011: Huge revision: **C++11**
  - Took forever: was *C++0x* in development.
  - Still almost entirely backwards-compatible with C++98.
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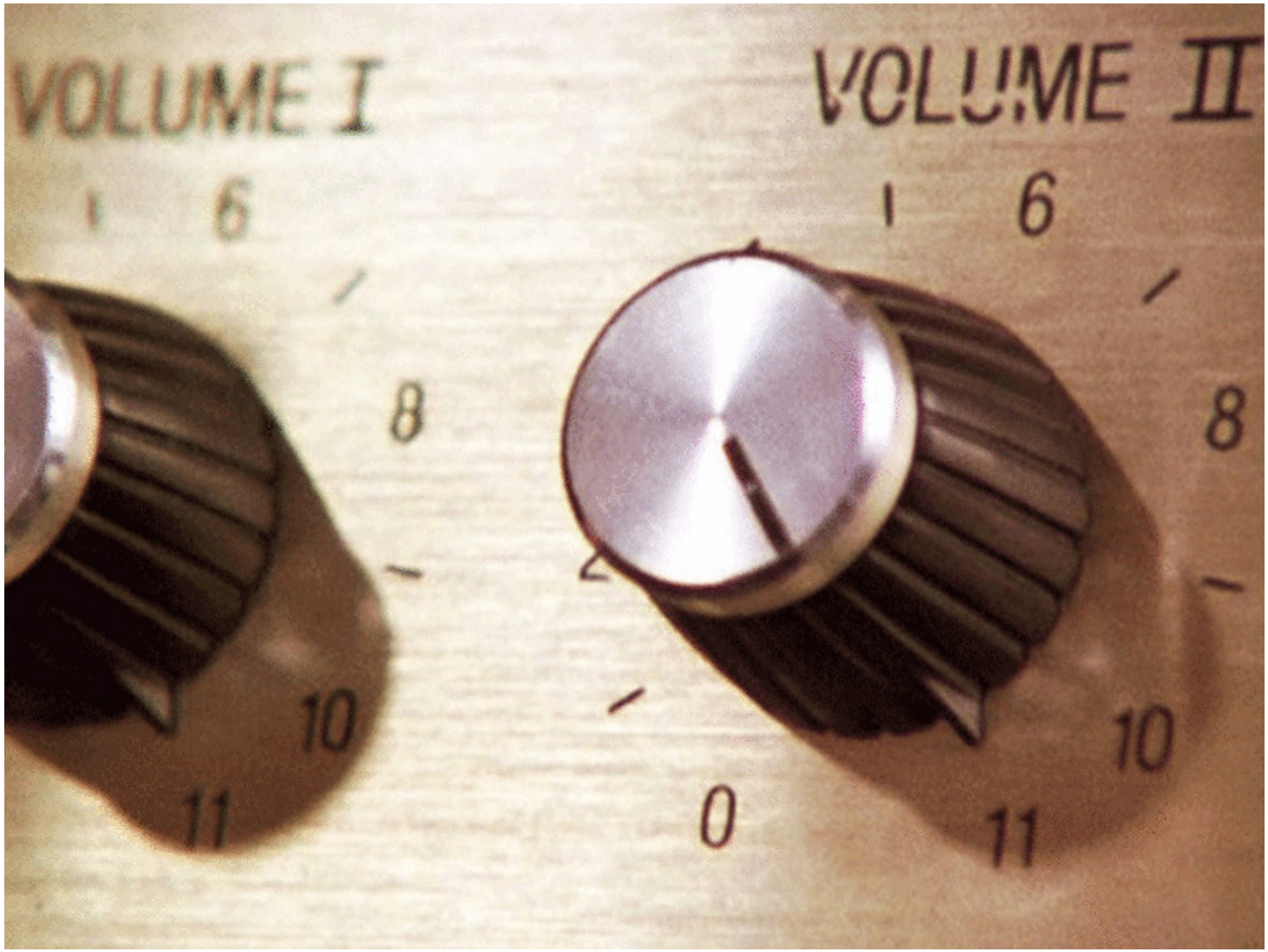
- 2017: Tock: **C++17**

C++11



C++ goes to eleven.

Range-based for loops

Above: range-based six loops

Range-based for loops

Range-based `for` loops are syntactic sugar for a common iterator idiom.

- In C++03:

```
const std::set<City> cities = . . . ;
for (std::set<City>::const_iterator i = cities.begin());
     i != cities.end();
     i++)
{
    const City &c = *i;
    . . .
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- In C++11:

```
const std::set<City> cities = . . . ;
for (const City &c : cities)
{
    . . .
}
```

Range-based for loops

- Range for with plain arrays, not just data structures with iterators. In C++11:

```
char name[] = "Stroustrup";
for (char letter : name)
    cout << letter << '\n';
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for (char &letter : name)
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```

- No access to the actual iterator!
  - If you need the index (0, 1, 2, ...), don't use range for.

Type inference with auto

But does it support type inference?

Type inference with auto

C++11 can in many instances infer types of variables automatically:

```
std::vector<Animal> pets = get_pets();
auto opal = pets[2];  // copy: Animal opal = pets[2];
auto &gus = pets[3];  // ref:  Animal &gus = pets[3];
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```

C++14 made auto return types work for most functions:

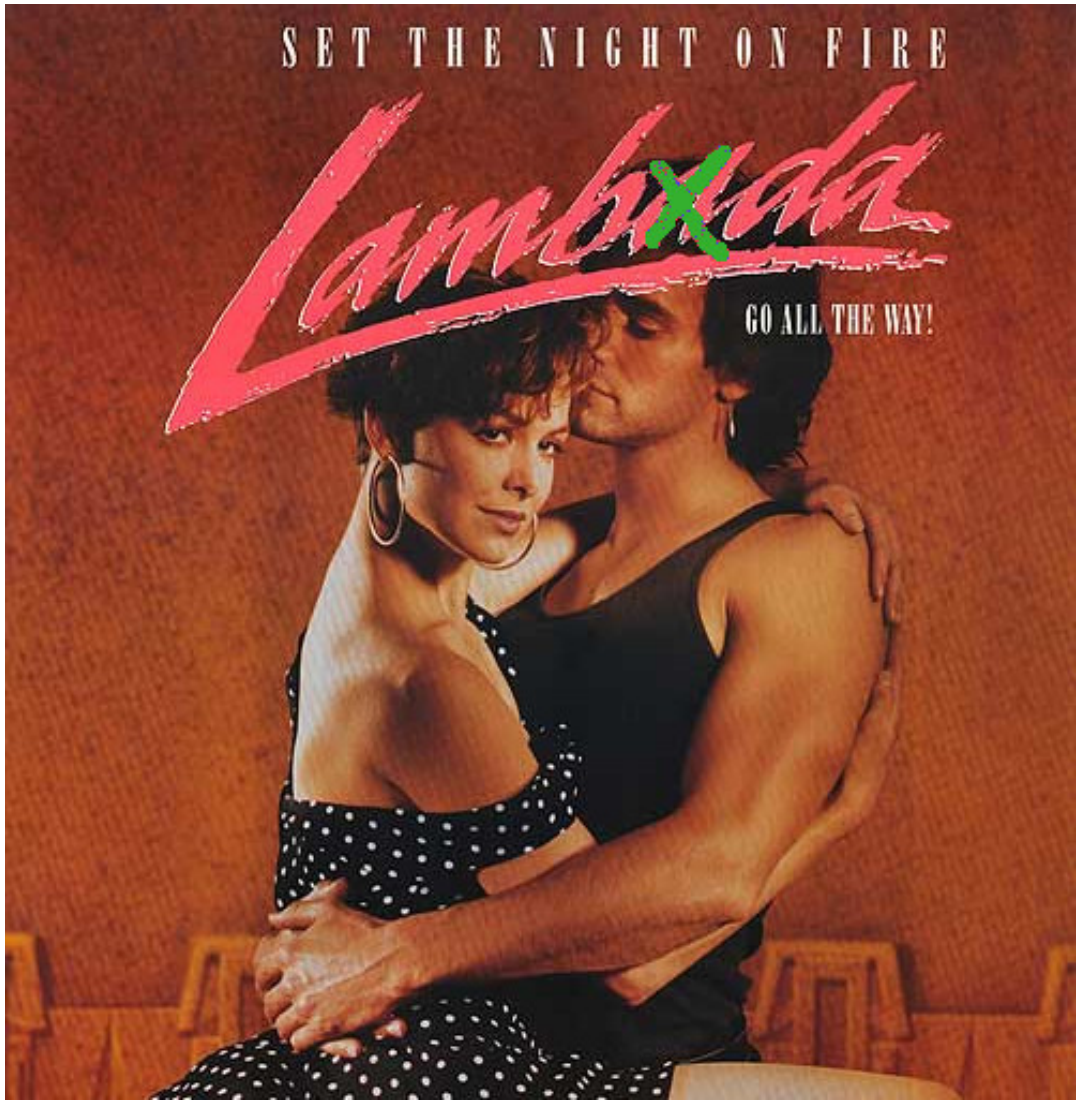
```
auto myfn(bool large)   // double myfn(bool large)
{
  if (large)
      return std::exp(20.0);
  else
      return 20.0;
}
```

Type inference with auto, cont'd

AAA style: "almost always auto":

```
auto num_users  = 5;
auto name_array = "hello world";
auto name_str   = std::string{"hello world"};
auto name_str2  = "hello world"s; // Same, since C++14
```

Lambdas



Can you believe there were *two* movies in 1990 about the lambada dance?
Both were box-office flops.

Lambdas

Lambdas are unnamed functions that can *capture* variables in the surrounding scope:

```
int min_value = flag ? 3 : 5;
auto it = std::find_if(vec.begin(), vec.end(),
                       [min_value](int num) -> bool {
                           return num >= min_value
                       });
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- `[captures] (arguments) -> ret_type { body }`
- Square brackets: variables to capture
  - `&var` to capture by reference
  - `=` for all variables used
  - `&` for all variables used, by reference.
- Parentheses: function parameters
- `->`: return type

constexpr

Apologies to Allie Brosh of Hyperbole and a Half.

`constexpr`

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```
// OK in C++11, but a loop or if would only work in C++14:
constexpr long long factorial(int n)
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  return n <= 0 ? 1
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int x = . . .;
auto x_fact = factorial(x); // Computed at run-time
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// Computed at compile-time:
constexpr auto thirteen_fact = factorial(13);

int x = . . .;
auto x_fact = factorial(x); // Computed at run-time

constexpr auto x_fact_2 = factorial(x); // ERROR
```

Move semantics

Imagine this truck is full of semantics.

Move semantics

One of the most significant changes in C++11 was the addition of *move constructors*, *move assignment operators*, and *rvalue references*.

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  - The data is lost from the original location.
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  - "Valid but unspecified state".
- Most of the standard data structures support move semantics.

Move semantics, cont'd

To add move semantics to your own data structures, add a move constructor and a move assignment operator with an *rvalue reference* parameter (&&):

```
class my_string {
  char *data;
  std::size_t length;
public:
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class my_string {
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public:

  my_string(my_string &&other)
      : data(other.data), length(other.length)
  { other.data = nullptr; other.length = 0; }
```

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  my_string &operator =(my_string &&other)
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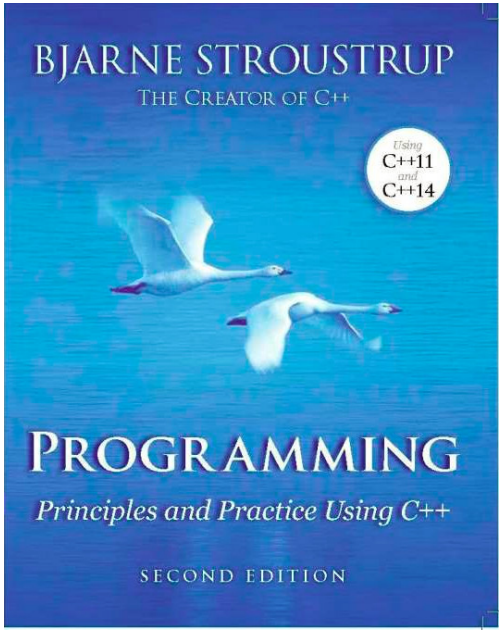
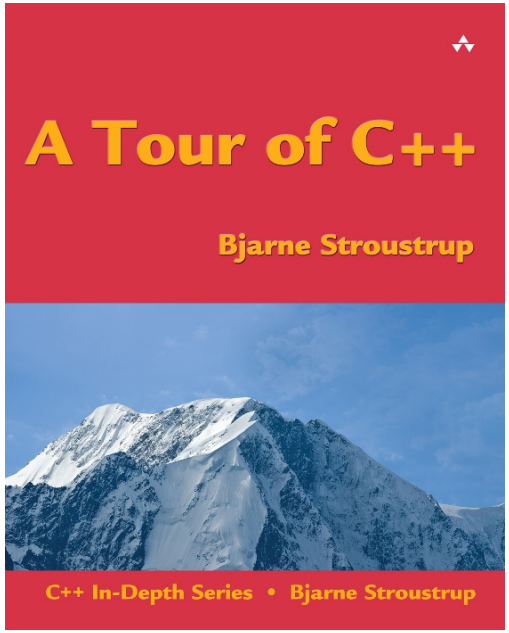
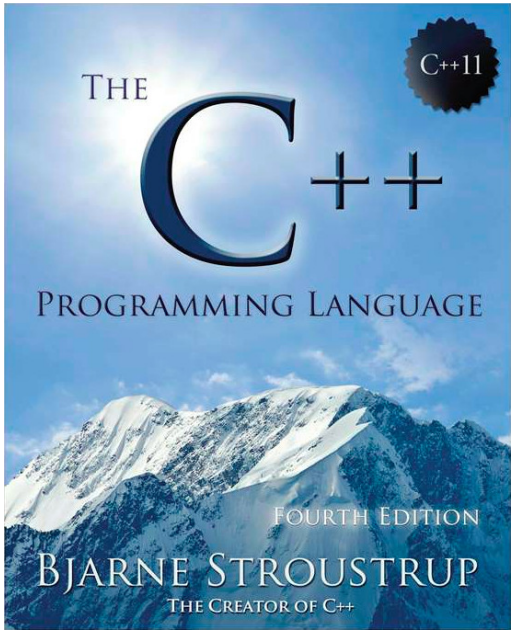
  my_string &operator =(my_string &&other)
  { std::swap(data, other.data);
    std::swap(length, other.length);
  }

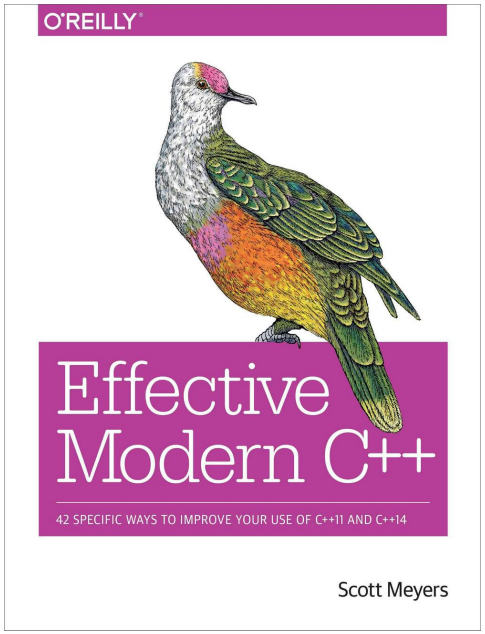
  // Probably also need a copy constructor and assignment operator
  // (const my_string &other)
}
```

Further reading









Books

- Stroustrup, *Programming: Principles and Practice Using C++*, 2nd ed. 2014.
  - Introductory programming textbook using modern C++.
- Stroustrup, *A Tour of C++*. 2013.
  - Overview of modern C++ for people who know old-fashioned C++.
  - 2nd ed. will cover C++20, but that's a few years off.
- Stroustrup, *The C++ Programming Language*, 4th ed. 2013.
  - The complete reference manual for C++. Covers up to C++11.
- Scott Meyers, *Effective Modern C++*
  - Using new features of C++11 and C++14 to maximum effect.

Free online material

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