



# Basic Language Constructs for C++03 and C++11

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# 1. Overview

- These slides review basic C++ language constructs up to, but not including, **classes**.
- In the review, we discuss both C++03 and C++11
- In some cases, we compare and contrast the two versions
- The slides are accompanied by videos that further elucidate the concepts found here.



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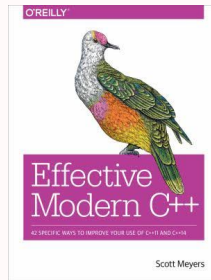
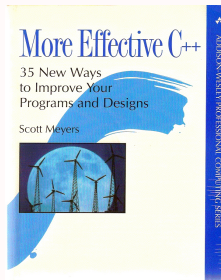
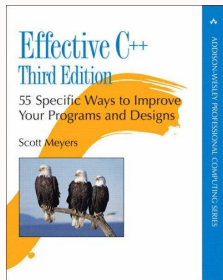
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## 2. References

- Any Intro C++ text
- <http://en.cppreference.com/w/cpp>
- The C++ ISO Standard



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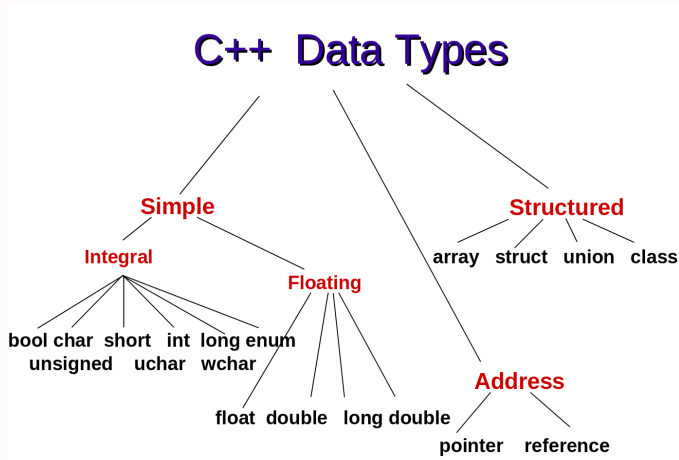
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## 3. Data and Expressions



`bool`  $\Rightarrow$  true or false

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## 3.1. Operators

- Expressions are composed of operators, variables, constants and parentheses
- Logical operators: `&&`, `||`, `!`
- Relational operators: `<`, `>`, `==`, `!=`, `<=`, `>=`
- However, an expression can be considered as a Boolean condition where 0 is false and all other values are true:  

```
int x = rand();  
if (x) ...
```
- Of course, the rules for mixed types still apply, so `2/4` evaluates to 0

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## 3.2. Operators

- unary, binary, and ternary describe the number of operands that an operator uses.
- For example,  $-7$  is **unary** minus; i.e., one operand
- $3 - 7$  is **binary** minus; i.e., two operands
- There is only one **ternary** operator and it's very useful; for example, the following expression evaluates to the larger of the two operands:  $(a > b) ? a : b$

## 3.3. Prefix and Postfix Operators

- Prefix operators are evaluated in place.
- Postfix operators are evaluated at the end of the statement

```
1 #include <iostream>
2 int main() {
3     int i = 0, j = 0;
4     std::cout << ++i << std::endl;    //output is 1
5     std::cout << j++ << std::endl;    //output is 0
6     std::cout << i << j << std::endl; //output is 11
7     return 0;
8 }
```



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## 3.4. Insertion/Extraction Operators

- They are binary, left associative operators that evaluate to the operator
- For example, the stream insertion operator, *operator*  $\ll$  evaluates to *operator*  $\ll$ , which is why the following expression works:

The expression:

```
cout << x << y << endl;
```

is actually:

```
((cout << x) << y) << endl;
```

where (cout << x) places the value of x into the output stream and evaluates to cout <<

so that the expression becomes:

```
((cout << y) << endl);
```

which places y into the output stream and evaluates to (cout << endl);

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## 3.5. constants and constant expressions

- **const**: named constants are preferable to **# define**, which is a C artifact

- `const char STAR = '*';`
  - `const unsigned MAX = 100;`

- **constexpr**: value known at compile time

```
constexpr int n1 = 10;
std::array<int, n1> a1; // fine
constexpr int n2 = 10;
int a2[n2];             // fine
int n3 = 10;
int a3[n3];             // warning
int n = 10;
std::array<int, n> a2;   // error
```

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## 3.6. NULL, 0, and nullptr

- NULL and 0 are integers
- nullptr is a pointer of all types
- prefer nullptr

```
void f(int i)    { std::cout << "int" << std::endl; }
void f(char* c) { std::cout << "pointer" << std::endl; }

int main() {
    f(NULL);      // error ambiguous call
    f(0);         // error ambiguous call
    f(nullptr);   // prints pointer
}
```



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## 3.7. Mixed Type Expressions

- Are promoted or truncated:
  1.  $5/2 \Rightarrow 2$
  2.  $\text{int}(2.3) \Rightarrow 2$
  3.  $\text{float}(2/4) \Rightarrow 0.0$
  4.  $4/8 \Rightarrow 0$
  5.  $\text{float}(4)/8 \Rightarrow 0.5$
  6.  $2.0/4 \Rightarrow 0.5$
- Prefer C++ cast  $\rightarrow$  easier to find in code  
`static_cast<float>(5/10)` evaluates to 0.0

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## 3.8. Structured Data Types

- Arrays, like C, are passed by reference
- **unions**: obviated by inheritance
- **structs**: same as classes except for default protection:
  - Default protection of class is **private**
  - Default protection of struct is **public**
  - structs are useful for storing global data:  
I prefer Singleton
- Classes are covered in slides about classes



## 4. Control Structures

- selection: **if**, **if/else**, **switch**
- repetition: **for**, **while**, **do/while**
- In general, I much prefer clarity and readability to obfuscated, hacked, terse code. Thus, I prefer the use of brackets because they promote readability. The first example below is preferable to the second:

```
int sum = 0;
for (unsigned i = 0; i < MAX; ++i) {
    sum += i;
}
```

```
int sum = 0;
for (unsigned i = 0; i < MAX; ++i) sum += i;
```

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## 4.1. switch

- If a **switch** value matches a **case** value, then it matches all cases until a **break** is encountered:

```
int count = 0;
int index = 1;
switch (index) {
    case 0: ++count;
    case 1: ++count;
    case 2: ++count;
    case 3: ++count;
    case 4: ++count;
    case 5: ++count;
    default: ++count;
}
cout << count << endl;  // prints 6
```

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## 4.2. switch/case/break is useful

- We may wish to match several values, so multiple case values w/out a break are like logical **or**. In the next example, we can match either upper or lower case letters:

```
int count = 0;
char ch = 'b';
switch (ch) {
    case 'A' : case 'a': ++count; break;
    case 'B' : case 'b': ++count; break;
    case 'C' : case 'c': ++count; break;
    default: cout << "Oops" << endl;;
}
```

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## 4.3. Short-circuit Evaluation

- If evaluation of the first operand obviates evaluation of the second, then the second operand is not evaluated.
- Short-circuit evaluation can be useful. If **number** happens to be zero, then we won't get a division by zero error in the following example:

```
float sum = 0.0;
int number = rand();
if ( number != 0 && sum/number > 90.0) {
    ...
}
```



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## 4.4. for

- The scope of the loop control variable (LCV) (in this case `i`) is the loop body:

```
for (int i = 0; i < MAX; ++i) {  
    cout << i;  
}  
i is out of scope here
```

- The following hack would be more readable if the programmer used **while** (`true`)

```
// Obfuscated code; great for job security!  
i = 0;  
for ( ; ; ) {  
    if (i > MAX) break;  
    cout << ++i;  
}
```

- **ranged for loops:** We will discuss later w/ vectors



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## 5. Functions

- Can be void or return a value.
- Each C++ program contains a function called `main`, which returns an integer.
- There are two acceptable forms of `main`:

```
*****
int main() {
    return 0;
}
*****
int main(int argc, char* argv[]) {
    return 0;
}
*****
and the return statement is optional
```



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## 5.1. Parameter Transmission Modes

- The C language has **one** mode
- C++ has four modes:
  1. **value**: default; makes local copy
  2. **reference**: use &; pass the address
  3. **const reference**: for large objects
  4. **rvalue reference**: later: ref v ptr

```
1 #include <iostream>
2 void f(int x) { ++x; }
3 void g(int& x) { ++x; }
4 int main() {
5     int i = 0, j = 0;
6     f(i);
7     g(j);
8     std::cout << i << j << std::endl; //output is 01
9 }
```



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## 5.2. Arrays are passed by reference

```
1 #include <iostream>
2 const int MAX = 3;
3 void f(int a[]) {
4     for (int i = 0; i < MAX; ++i) {
5         a[i] = i;
6     }
7 }
8 int main() {
9     int a[3];
10    f(a);
11    std::cout << a[2] << std::endl; //output is 2
12 }
```

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## 5.3. Static Function Variables

- Initialized upon first entry to the function
- Usually stored in global data segment

```
1 #include <iostream>
2 void f() {
3     static int count = 0;
4     int index = 0;
5     std::cout << ++count << ++index << std::endl;
6 }
7 int main() {
8     f();
9     f();
10 }
***** output *****
11
21
```

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## 5.4. Default Parameter Values

- If no value is passed to formal parameter, a default value is assigned, left to right.
- Thus, x, on line 2, is assigned the ascii code for 'A', which is 65, on line 7:

```
1 #include <iostream>
2 void f(int x = 0, char ch = 'Z') {
3     std::cout << x << ", " << ch << std::endl;
4 }
5 int main() {
6     f(17, 'B');
7     f('A');
8     f();
9 }
```

\*\*\*\*\* output \*\*\*\*\*

```
17, B
65, Z
0, Z
```

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## 5.5. Function Overload

- Two functions with same name but different parameter types
- The function return value cannot be used to resolve overload

```
#include <iostream>
void write(double x) {
    std::cout << "x is " << x << std::endl;
}
void write(int i) {
    std::cout << "i is " << i << std::endl;
}
int main() {
    double x = 2.5;
    write(7); // output: i is 7
    write(x); // output: x is 2.5
}
```

## 5.6. Command Line Parameters

- You can pass values into function `main`
- `argc` is number of parameters passed; `argv` is an array of C strings containing the values
- There's always at least one parameter passed: the name of the executable

```
1 #include <iostream>
2 int main(int argc, char* argv[]) {
3     for (int i = 0; i < argc; ++i) {
4         std::cout << argv[i] << '\t';
5     }
6     std::cout << std::endl;
7 }
```

\*\*\*\*\* invocation \*\*\*\*\*

```
$ ./a.out 2 4 cat
```

\*\*\*\*\* output \*\*\*\*\*

```
./a.out 2 4 cat
```

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## 6. Namespaces

- We can use the scope operator (colon  $\rightarrow$  ::) to access all three instances of **number**:

```
#include <iostream>
int number = 99;
namespace A {
    int number = 23;
}
int main() {
    int number = 0;
    std::cout << ::number << std::endl;
    std::cout << A::number << std::endl;
    std::cout << number << std::endl;
    return 0;
}
```

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