

## CSE 143

### Introduction to C++

[Appendix A]

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## C++ vs. C

- C++ is a superset of C
  - C++ has a huge number of new features
  - Often criticized as overly complex
- (Almost) any legal program in C is also a legal C++ program.
- The core of C++ works the same as in C
  - basic types, variables, expressions
  - declaring and using functions
  - statements (if, while, for, assignment, etc.)

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## C++ vs. C (cont.)

- Major changes in C++:
  - A "Better C"
  - Support for Data Abstraction (user-defined types)
  - Support for Object-Oriented Programming
- We'll introduce the latter two gradually
- Today we focus on some of the "better C" features

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## A "Better C"

- `cin` and `cout` for stream input and output (plus `cerr`)
- New comment style
- Relaxed placement of declarations
- Symbolic constants
- A real logical (Boolean) type: `bool`
- Better string library
- Enumerated types
- Structs as types
- Reference parameters

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## A Simple C++ Program

```
// A first C++ Program
// Print a greeting message
#include <iostream>
using namespace std;
int main( ) {
    cout << "Welcome to CSE143!" << endl;
    return 0;
}
```

- `//`-comments extend from `//` to end of line
- Operator `<<` writes the value of the right argument to the output stream on the left, here `cout` -- the screen.
- `endl` ends a line of output and ensures that it is displayed Right Now!.

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## A Second C++ Program

```
// Read two integers and print their sum.
#include <iostream>
using namespace std;
int main( ) {
    int i, j;
    cout << "Please enter a number: ";
    cin >> i;
    cout << "Please enter another number: ";
    cin >> j;
    cout << "The sum of " << i << " and " << j <<
        " is " << i + j << endl;
    return 0;
}
```

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## Second C++ Program (cont.)

- Operator `>>` reads a value from the stream that is its left argument (here `cin`, the keyboard) and stores it in the variable given as its right argument.
- The `>>` and `<<` operators can be strung together to read or write several items in a single statement.
- **Important:** Place your C++ functions in `.cpp` files (rather than `.c` files).
- The "using namespace `std`;" directive accesses the names defined in the header files

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## Two Styles of Comments

- Old C-style comments  
`/* This is a comment */`
- Double-slash comments (comment extends from the `//` to the end of the line)  
`int id; // student ID number`
- Which form is better?

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## Declarations Go Anywhere

- C++ declarations can appear anywhere a normal statement can:

```
void something (int x)
{
    if (x == 10)
        x = x / 2;
    int y; // Declaration can occur here
    ...
}
```

- Common usage: `for`-loop index variables

```
for (int k = 0; k < 100; k++) {
    // k is only defined inside this loop
}
```

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## Symbolic Constants

- Constant variables  
`const double PI = 3.14159;`
- `const` means that the value can't be changed
- From now on in CSE143, do not use `#define` ...  
`#define PI 3.14159`
- Why not?
  - Because `#define` is strictly textual substitution.
  - Explicit constants allow compile-time type checking and scope analysis using same rules obeyed by (non-const) variables.
- More about `const` another day

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## New `bool` type

- Direct implementation of the "Boolean" concept
- `bool` has two legal values: `true` and `false`
  - `bool`, `true` and `false` are reserved words

```
bool isBigNumber (double d) {
    if (d > 30e6) return true;
    else return false;
}
```

- Not supported in early C++ compilers (one reason you want to have a recent version)

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## `int` vs. `bool`

- `bool` and `int` values are usually interchangeable (for backward compatibility)
  - Review: in C, integer 0 is false, all other integer values are true.
- Use `bool` where Boolean values are natural  

```
int i; bool b;
b = (mass >= 10.8); //value is true or false
if (b) ... //OK
while (b && !(i < 15)) ... //OK
```
- Avoid:  

```
i = b; //marginally OK: value is 0 or 1
i = true; //OK, but bad style
b = i; //ill-advised (warning)
```
- `cout <<`
  - displays 0 or 1 for `bool` values

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## String Library

- C++ string type supports declaration, assignment, comparison, concatenation (+), etc.
- Underlying representation is still '\0'-terminated array of characters, but normally that can be ignored

```
#include <string>
using namespace std;

int demo() {
    string name = "Fred"
    string fullname;
    fullname = name + " Flintstone";
    if (fullname < "Ralph") ...
    ...
}
```

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## Enumerated Types

- User-defined type whose constants are meaningful identifiers, not just numbers
- Declare like other types; use like other integer values

```
enum Color { RED, GREEN, BLUE };

Color skyColor; ...
switch (skyColor) {
    case RED: ...
    case GREEN: ...
    case BLUE: ...
}
```

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## Structs as Types

- Old way:  

```
typedef struct {
    ...
} Student_record;
```
- New way:  

```
struct Student_record {
    ...
};
```
- Convention (e.g., as a matter of style): New type names are capitalized
- Preview: in C++ we often use *class* instead of *struct*  
Almost identical, but different connotations

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## Defining 'main'

- Usual signature for main (as in C, except void keyword not needed as a parameter):  

```
int main () { ... return x; ... }
```
- Sometimes seen in old code (but nonstandard!):  

```
void main () { .... /*no return*/ ... }
```
- A few others are possible, too. For you hackers:  

```
int main (int numArgs, char * argArray[ ]);
```

  - Allows OS to provide command line arguments to the program.

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## Parameters (Review)

- Puzzler: What does this print?

```
#include <iostream>
using namespace std;
...
// Double the value of k
void dbl(int k) { k = 2 * k; }

int main() {
    int n = 21;
    dbl(n);
    cout << n << endl;
}
```

- Output:

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## Value vs. Reference

- The default in C/C++ is call by **value**
    - a copy of the actual argument is made
    - exception: arrays
  - C technique for call by **reference**: use a pointer as the argument
    - Can still do this in C++
  - Reference parameters are **more efficient** for large objects (why?)
  - Reference parameters can be **less safe** than call by value (why?)
- C++ supports call by reference directly...

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## Reference Parameters

- Use `&` in parameter declaration to make the parameter an **alias** for the argument.

```
// Double the value of k
void dbl(int &k) { k = 2 * k; }

int main( ) {
    int n = 21;
    dbl(n);
    cout << n << endl;
}
```

- Output:

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## Reference as an Alias

- The parameter is an **alias** for actual argument
- Achieves same effect as pointer parameters, but
  - Use `&` in parameter declaration
  - No explicit `&` in argument
  - No explicit `*` when parameter used
- Assignments to parameter changes argument
  - Why? because one is an alias of the other

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