

C++: Some Syntax

Assignments

- Read documents on webpage
- Please test your projects on linux before you submit.

Where we are

- C++ has lots of similarities to Java (more as we go)
- C++ faster than Java
- How to write a simple C++ “Hello World” program
- How to compile using command line
- How to compile using an IDE
- Basic IDE usage (debugging, variable view, breakpoints...)
- How to run a program
- **PRACTICE PLEASE**

Where we are going

Variables

Decisions and Loops(if,switch,for,while)

Functions

Arrays

Array Alternatives

Input (cin)

Variables

- Variables are defined
- But, no initialization guarantee (although some IDE's catch this)

```
int cnt;  
if(cnt < 5)  
{ cnt++;}
```

- So **ALWAYS** initialize your variables

```
int cnt = 0;  
if(cnt < 5)  
{ cnt++;}
```

Variables - Common Built in Types

- int size is 32 bits (4 bytes)
- double size is 64 bits (8 bytes), a real number
- bool true or false
- char 8-bit character, 'a' or '\0' to '\xFF' or -128 to 127, **note char is surrounded by single quotes**
- LOTS MORE (see readings on course webpage)
 - http://www.tutorialspoint.com/cplusplus/cpp_data_types.htm

Decisions - If

Syntax Same as Java

```
if (pad==0)
    conditionmet(pad);
else
    conditionNotMet(pad);
```

Decisions - If

But Python people may have a harder time

```
int pad=1;
if(pad==0)
    conditionmet(pad);
    pad=2;
cout<<"Pad is"<<pad<<endl; //What does this print?
```

Convey intent with {}

```
int pad=1;
if(pad==0){
    conditionmet(pad);
    pad=2;
}
cout<<"Pad is"<<pad<<endl; //What does this print?
```


Decisions - Switch

Syntax Same as Java

```
switch (x) {  
    case 1:  
        break;  
    case 2:  
        break;  
    default:  
}
```

```
switch (x) {  
    case 1:  
    case 2:  
    case 3:  
        cout << "x is 1, 2 or 3";  
        break;  
    default:  
        cout << "x is not 1, 2 nor 3";  
}
```

Const (Java equiv is final, no equiv in python)

const is a compiler enforced promise not to modify;

```
const int MYINT = 3;    //dandy
MYINT = 2;             //cannot modify
MYINT++;              //"  
const int MYINT2;      //must initialize when created  
MYINT2 = 5;           //cannot modify
```

Use const as often as possible

BTW Don't use magic numbers

- Magic number- don't know what it means

```
return 0;
```

What does 0
mean?

- Use self-documented const value

```
const int SUCCESS = 0;  
return SUCCESS;
```

indicates things
went well

Loops - For

Syntax Same as Java

```
for (int n=0; n<NUMBER_TIMES; n++) {  
    if(conditionmet(n))  
        break;  
}
```

Loops - While

Syntax Same as Java

```
while (myCount>0) {  
    if (myDangerousArray[myCount]==SOUGHT_AFTER_VALUE)  
        break;  
    --myCount; //loop control  
}
```

Functions – Mostly Same as in Java

- The Rule is: The compiler insists you declare everything before it is used.
- Must see the function declaration before you call the function
- How?
 - Put function declaration in header and include header at top of file (preferred because scales well)
 - Put function declaration before place where called (not as good, you have to put everything in 1 file)
 - Either just the declaration
 - Or entire function
- THIS IS FRUSTRATING FOR JAVA AND PYTHON PROGRAMMERS, ITS ALL THERE BUT DOES NOT WORK!

Go to 3_Functions and demo

Arrays – Similar to Java with a catch

- Groups a bunch of elements together
 - `T a[N]` //array of N elements of type T
- T can be any type or object
- Access `a[0]...a[N-1]`
- Problem is that they are not dynamically resizable

```
int iInts[20];  
char cBuff[10];
```

Character Arrays

- Tricky to deal with, easy to get wrong
- Run time checks now (on some compilers)
- char use single quotes ' '
- char array, use double quotes "

```
char aChar = 'a';  
char cSrc[30] = "I like lemon custard";
```

- Terminate strings with '\0' (note single quotes)
- Manipulate with strncpy, strcpy, strlen, sizeof, strcmp...

See <http://www.cplusplus.com/reference/cstring>

Include <string.h>

Note: These are C (not C++) string manipulation functions

Character Arrays – Correct using C functions

```
//source string and intended destination
char cSrc[30] = "I like lemon custard";
char cDst[30];

int iLen1,iLen2=0;
iLen1 = strlen(cSrc); //size of string
iLen2 = sizeof(cSrc); //size of buffer

strcpy(cDst,cSrc); //copy the src to the dest,
strncpy(cDst,cSrc, sizeof(cDst)); //copy all 30 chars

//=0 same
//<0 cDst <cSrc
//>0 cDst >cSrc
int iRes = strcmp(cDst, cSrc);
```

Correct

Go to 2_BufferOverflow and demo

Character Arrays – Crash Program

- Easy to get wrong, crashes now. In the past it did not.

```
//source string and intended destination
char cSrc[] = "I like lemon custard, and this string is lengthy";
char cDst[10];
```

```
//uhoh cDst is not terminated, no worries
//cDst[10] = '\0'; //this will throw exception since
//strings are 0 indexed
cDst[sizeof(cDst)-1] = '\0';
```

```
//here comes the bufferoverflow, copy more than 10 chars in
//because cSrc is much larger than cDst
strcpy(cDst,cSrc); //boom! crashes
```

```
strncpy(cDst,cSrc,sizeof(cDst)); //copy only amount
//that fits
```



Buffer
Overflow

BTW a crash is
the best case
scenario. It
could keep going

Go to 2_BufferOverflow and demo

Strings – Special Characters

- strings enclosed in double quotes`""`
- chars enclosed in single quotes`'`
- Characters with special meaning
 - `'\n'` newline equiv to `std::endl`
 - `'\"'` treat `"` as part of string not end of it
 - `'\''` same as above
 - `'\\'` include a `\` in the string
 - `'\0'` null

Arrays – An easier safer alternative

- Standard Library
- Use `std::string` if you need a string
- Use `std::vector` if you need array like functionality (more on this later)
 - Both - Dynamically Resizable
 - Both – Speed ranges from almost as fast to much faster as array based code
 - Easy to get right

```
char longbuff[] = "what if this is more than 10 chars?";  
std::string shortbuff = longbuff;
```

Input using std::string

```
// ask for a person's name, and greet the person
#include <iostream>
#include <string>

int main()
{
    // ask for the person's name
    std::cout << "Please enter your first name: ";

    // read the name
    std::string name;      // define 'name'
    std::cin >> name;      // read into 'name'

    // write a greeting
    std::cout << "Hello, " << name << "!" << std::endl;
    return 0;
}
```

Typedef – used a lot

- typedef - just a redefinition

```
typedef type newname;
```

```
typedef int feet;    //feet is another name for int  
feet length;
```

- Why? Simplifies syntax. Hides scary innards.

```
string outputfilename;
```

is really

```
typedef basic_string<char> string;
```

Enum – used a lot

- Defines a range of allowable values

```
enum enum-name { list of names } var-list;
```

- Why? Defensive programming, can only be one of defined values. NOTHING ELSE

```
//var of type color can only be one of 3 values  
enum color{ RED=1, GREEN, BLUE };  
  
color myEnumColor;  
myEnumColor = BLUE;
```

- myEnumColor can be RED, GREEN, or BLUE not 1,2, or 3!
- enum values also tend to be descriptive

Go to 'Enum Constants Demo' project

Operators

- For this class mostly same as Java and Python

Assignment (=)

Arithmetic operators (+, -, *, /, %)

Compound assignment (+=, ...)

Increase and decrease (++ , --)

Relational and equality operators (==, !=, >, <, >=, <=)

Logical operators (!, &&, ||)

Operators

- **Conditional operator (?) – same as Java**

```
c = (a > b) ? a : b;
```

- **Bitwise Operators (&, |, ^, ~, <<, >>)**
 - useful for combining flags

Bitwise Operators (something new)

```
enum MyOptions {
    OpAutoRedraw    = 0x01,    // 0x01 == 1 == "00000001"
    OpAntiAlias     = 0x02,    // 0x02 == 2 == "00000010"
    OpPixelShader   = 0x04,    // 0x04 == 4 == "00000100"
    OpVertexShader  = 0x08,    // 0x08 == 8 == "00001000"
    OpFullscreen    = 0x10,    // 0x10 == 16 == "00010000"
    OpDaylight      = 0x20,    // 0x20 == 32 == "00100000"
    OpGlow          = 0x40,    // 0x40 == 64 == "01000000"
                        // 0x80 == 128 == "10000000" do not need to use all bits
};

int main() {
    //note this is a hex representation
    //always positive all bits are info, no sign bit
    unsigned char options = 0x00;

    //lets say you want to set (0x01) and fullscreen(0x10)
    options=options|OpAutoRedraw| OpFullscreen;

    //now options = 00010010

    //should succeed
    if (options & OpAutoRedraw)
        cout<<"OpAutoRedraw is set";

    //should fail
    if (options & OpAntiAlias)
        cout<<"OpAntiAlias is set";
}
```

See <http://www.cplusplus.com/forum/general/>

Structs (like a class with public only members)

- User defined data type
- Set of data elements grouped under one name

```
struct product {  
    int weight;  
    float price;  
} ;  
  
product apple;  
product banana, melon;
```

- To access data members use .

```
apple.weight  
apple.price
```

- Convenient way to store chunks of related data

[See](http://www.cplusplus.com/doc/tutorial/struct)

<http://www.cplusplus.com/doc/tutorial/struct>

So Far

- Decisions and Loops
- Some Built in types
- Special chars
- Variables
- How to handle input (`cin>>...`)
and output (`cout<<...`)
- Do not use arrays
 - Use `std::string` for strings
 - Use vector as array substitute (**later**)
- Const, typedef, enum
- structs

What we can build

- Data processing app
- Standard I/O (no files)
- Bit manipulation
- Custom data types using structs

C++: Some Odds and Ends

What have we learned

- `const`
- `typedef`
- `enum`
- Bitwise operators
- `structs`

Assignments

- Read 2_ readings
- Project 2 assigned

Character Arrays – Worse than crash program

- Corrupt data

```
//source string and intended destination
char cSrc[] = "I like lemon custard, and this string is lengthy";
char cDst[10];
```

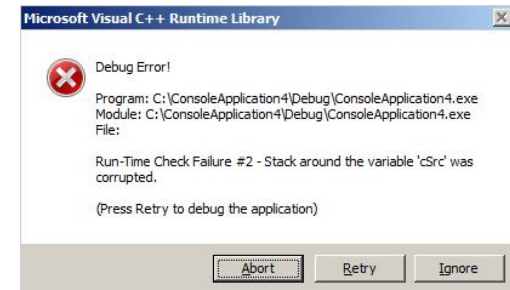
```
int iLen1,iLen2=0;
iLen1 = strlen(cSrc);    //size of string
iLen2 = sizeof(cSrc);    //size of buffer
```

```
//here comes the bufferoverflow, copy more than 10 chars in
//because cSrc is much larger than cDst
strcpy(cDst,cSrc);        //boom! crashes
//strncpy(cDst,cSrc, sizeof(cDst)); //boom! crashes
```

```
strncpy(cDst,cSrc, strlen(cDst));    //copy only the
                                     //amount that will fit
```



Buffer
Overflow



Character Arrays - Getting burned

```
// Name      : 2_1_BufferOverflow_use_string_instead.cpp[]

#include <iostream>
#include <string>

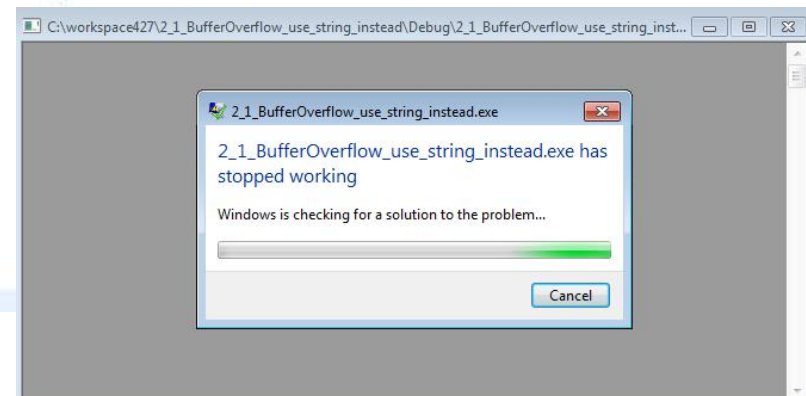
int main() {

    char shortbuff[10];
    memset(shortbuff,0, sizeof(shortbuff));
    char longbuff[] = "what if this is more than 10 chars?";

    //buffer overflow happens next statement because longbuff is longer than shortbuff
    //could try catch it and go on
    //could ensure that only 10 chars are wriotten in
    //nah..stick with easiest stuff to start, always use std::string
    //it expands and contracts as needed, no worries
    strcpy(shortbuff, longbuff);

    return 0;
}
```

http://www.tutorialspoint.com/cplusplus/cpp_strings.htm



Character Arrays – Getting burned

- `<string.h>` functions
- Prefer `strncpy()` to `strcpy(..)` (only a little better)
- Both still a huge source of errors

<http://www.cplusplus.com/reference/cstring>

- see

Strings 2 – Input, Simple UI Tricks

```
// ask for a person's name, and generate a framed greeting
#include <iostream>
#include <string>

int main()
{
    std::cout << "Please enter your first name: ";
    std::string name;
    std::cin >> name;

    // build the message that we intend to write
    const std::string greeting = "Hello, " + name + "!";

    // build the second and fourth lines of the output
    const std::string spaces(greeting.size(), ' ');
    const std::string second = "* " + spaces + " *";

    // build the first and fifth lines of the output
    const std::string first(second.size(), '*');

    // write it all
    std::cout << std::endl;
    std::cout << first << std::endl;
    std::cout << second << std::endl;
    std::cout << " * " << greeting << " * " << std::endl;
    std::cout << second << std::endl;
    std::cout << first << std::endl;

    return 0;
}
```