C++: Some Syntax

Assignments

- Read documents on webpage
- If you are using Windows or a Mac, 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

Create project

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

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

- So ALWAYS initialize your variables

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

Variables - Common Built in Types

- int 16-32 bits OS dependent!
- double 64 bit 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

Open Page

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
  - Put function declaration before place where called
    - Either just the declaration
    - Or entire function

- THIS IS FRUSTRATING FOR JAVA AND PYTHON PROGRAMMERS, ITS ALL THERE BUT DOES NOT WORK!

Go to 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>

Character Arrays – Correct

```
//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);
```

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

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

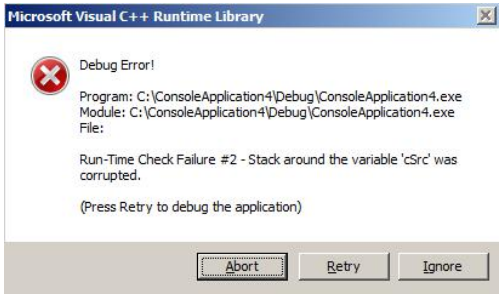
- Read 2_ readings
- Project 2 assigned

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
```

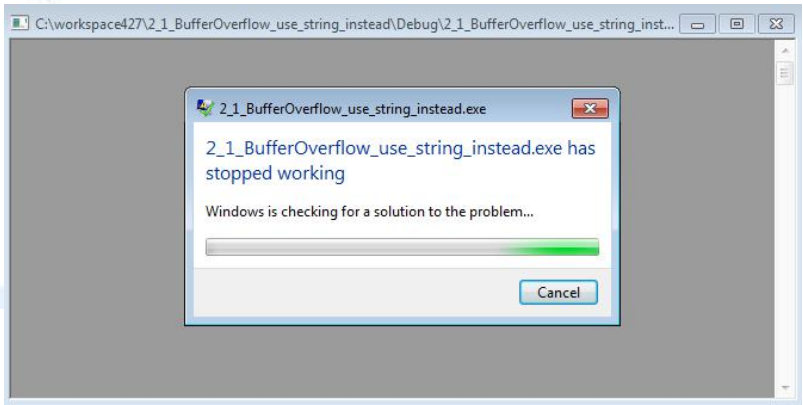
Buffer Overflow



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
- see http://www.cplusplus.com/reference/cstring

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;
}
```