CSCI 2270: Data Structures

Lecture 02: C++ Review

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C++: A quick review

Recommended C++ Resources

1. Bjarne Stroustrup, *The C++ Programming Language*, 4-th Edition.
   /* C++ Reference by the inventor of the lanaguage */
2. Scott Meyers, *Effective C++*
   /* C++ specific tips to improve programs and designs */
3. Scott Meyers, *Effective Modern C++*
   /* Similar tips extended to C++11 and C++14 versions */
4. Misfeldt, Bumgardner, and Gray, *The Elements of C++ Style*
   /* "Strunk and White" of writing human-readable C++ code */
5. Online Resources:
   - `http://www.cplusplus.com/doc/tutorial/`
   - `https://en.cppreference.com/`
   - `https://www.geeksforgeeks.org/c-plus-plus/`

Why C++?

- Popular and relevant (from last 20 years):
  - End-user applications (Word, Excel, Powerpoint, Photoshop, Acrobat, Doom 3, Web-browsers, and so on)

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  - Database software and large-scale web-applications (MySQL, Amazon, Google, Wikipedia, etc.)
  - Device drivers, numerical computations, and many more...

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  - Operating systems (Windows, OS X, Linux – some versions of C/C++)
  - Database software and large-scale web-applications (MySQL, Amazon, Google, Wikipedia, etc.)
  - Device drivers, numerical computations, and many more...
- Stable, compatible, and scalable.

C Vs C++?

- C++ is C incremented. /* C with classes */
- C++ is backward-compatible with C. /* some minor exceptions! */
- C++ is more expressive. /* fewer lines of code required! */
- C++ is just as permissive. /* can do anything that C can! */
- C++ is just as efficient. /* lets you manipulate bits directly! */
- C++ is more maintainable. /* Due to structure and elegance enabled by object-oriented features! */

Design Philosophy: by Bjarne Stroustrup

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Object-oriented C++ excels at both.

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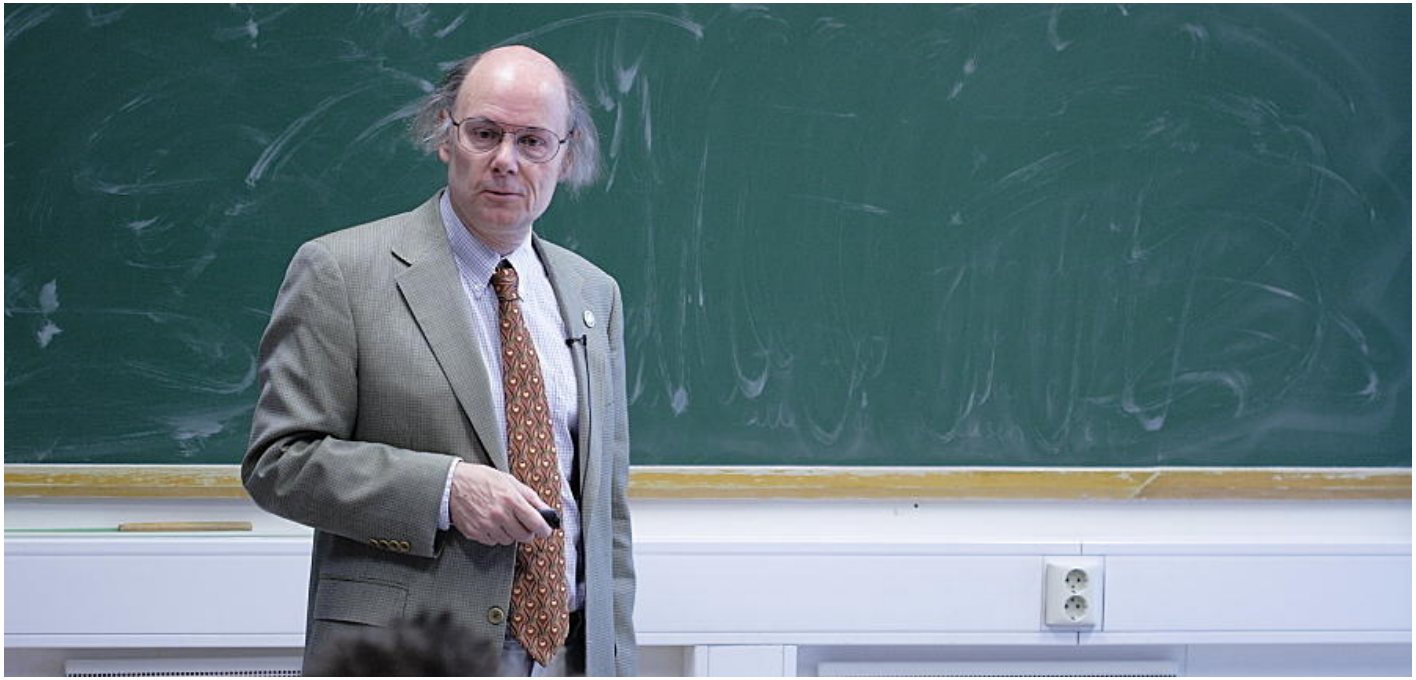
4. abstract: *separate interface form implementation (abstract classes)*
5. generic: *generic algorithms to manipulate arbitrary data-type (STL: containers, algorithms)*



" Don't panic." Bjarne Stroustrup, Creator of C++.

“ The only way to learn a new programming language is by writing programs in it.”

Dennis Ritchie (1941-2011), Creator of C.

“Hello, World!” in C++ as a C program

```
1 // program1.cpp
2 #include<stdio.h>
3 int main()
4 {
5   printf("Hello, World!\n");
6   return 0;
7 }
```

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int main()
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}
```

```
#!/usr/local/bin/bash
# Shell script to compile and execute
g++ program1.cpp -o hello1
./hello1
```

“Hello, World!” in C++

```cpp
// program2.cpp
#include<iostream>
int main()
{
  std::cout << "Hello, World!" << std::endl;
  return 0;
}
```

“Hello, World!” in C++

```cpp
// program2.cpp
#include<iostream>
int main()
{
  std::cout << "Hello, World!" << std::endl;
  return 0;
}
```

```
#!/usr/local/bin/bash
# Shell script to compile and execute
g++ program2.cpp -o hello2
./hello2
```

“Hello, World!” in C++

```cpp
// program2.cpp
#include<iostream>
int main()
{
  std::cout << "Hello, World!" << std::endl;
  return 0;
}
```

```
#!/usr/local/bin/bash
# Shell script to compile and execute
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```

1. Like the cstdio header inherited from C’s stdio.h, iostream provides basic input and output services for C++ programs.

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```

1. Like the cstdio header inherited from C's stdio.h, iostream provides basic input and output services for C++ programs.
2. Namespaces allow one to reuse names across different libraries. The namespace `std` refers to standard namespace. You can obviate the need for using `std::` with standard streams cin and cout by declaring `using namespace std` in your program.

Command line arguments in C++

```cpp
// program3.cpp
#include<iostream>
int main(int argc, char* argv[])
{
  std::cout << "Hello,";
  for (int i=0; i < argc; i++) std::cout << " " << argv[i] ;
  std::cout << "!" << std::endl;
  return 0;
}
```

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#!/usr/local/bin/bash
# Shell script to compile and execute
g++ program3.cpp -o hello3
./hello3
./hello3 Ashutosh Maciej Shayon
```

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  return 0;
}
```

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# Shell script to compile and execute
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```

1. `argc` (argument count) is the number of argument to this program and `argv[]` (argument vector) is the array of character pointers (strings) that contain the arguments to the program.

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./hello3 Ashutosh Maciej Shayon
```

1. `argc` (argument count) is the number of argument to this program and `argv[]` (argument vector) is the array of character pointers (strings) that contain the arguments to the program.
2. What is unpleasant about this program, and how do you fix it?

Fundamental Types and their sizes

```cpp
// program4.cpp
#include<iostream>
int main(int argc, char* argv[])
{
  bool bo = true;
  char ch = 'a'; // signed and unsigned
  int in = 100; // signed and unsigned, short and long
  float fl = 1.2e10; // float, double, and long double
  std::cout << "Size of:" << std::endl;
  std::cout << "\t bool(" << sizeof(bo) << ")" << std::endl;
  std::cout << "\t char(" << sizeof(ch) <<")" << std::endl;
  std::cout << "\t int(" << sizeof(in) << ")" << std::endl;
  std::cout << "\t float(" << sizeof(fl) << ")\n";
  return 0;
}
```

Fundamental Types and their sizes

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  std::cout << "\t int(" << sizeof(in) << ")" << std::endl;
  std::cout << "\t float(" << sizeof(fl) << ")\n";
  return 0;
}
```

```
#!/usr/local/bin/bash
# Shell script to compile and execute
g++ program4.cpp -o sizes
./sizes
```

Enumeration Type and its size

```
1  // program5.cpp
2  #include<iostream>
3  int main(int argc, char* argv[])
4  {
5    // Enums: user-defined types
6    enum exams {MIDTERM1, MIDTERM2, FINAL, PROJECT};
7    exams ex = MIDTERM1;
8    std::cout << "Size of exams (" << sizeof(ex);
9    std::cout << ")" << std::endl;
10   std::cout << "Size of exams (" << sizeof(exams);
11   std::cout << ")" << std::endl;
12   return 0;
13 }
```

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int main(int argc, char* argv[])
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  std::cout << "Size of exams (" << sizeof(ex);
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  std::cout << "Size of exams (" << sizeof(exams);
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```

1. An *enumeration* is a use-defined type that can hold a set of values specified by the user.

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  exams ex = MIDTERM1;
  std::cout << "Size of exams (" << sizeof(ex);
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  std::cout << "Size of exams (" << sizeof(exams);
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```

1. An *enumeration* is a use-defined type that can hold a set of values specified by the user.
2. Once defined, it works like an integer type.

Enumeration Types and Switch Statement

```
1  // program6.cpp
2  #include<iostream>
3  int main(int argc, char* argv[])
4  {
5    enum exams {MIDTERM1, MIDTERM2, FINAL, PROJECT};
6    exams ex1 = (exams) atoi(argv[1]);
7    switch (ex1) {
8    case MIDTERM1:
9    case MIDTERM2:
10     std::cout << "Can improve the grades with finals!";
11     break;
12   case FINAL:
13   case PROJECT:
14     std::cout << "Sorry! You cannot improve!";
15     break;
16   }
17   return 0;
18 }
```

Pointer Variables

```
1  // program7.cpp
2  #include<iostream>
3  int main(int argc, char* argv[])
4  {
5    char ch= 'a';
6    char *cp; // cp is a pointer variable
7    cp = &ch; // cp points to the address of the ch
8    std::cout << "Size of a pointer to char: ";
9    std::cout << sizeof(char *) << std::endl;
10   std::cout << "Address of ch is = " << (void *) cp;
11   return 0;
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1. What are the sizes of pointers to different types of objects?

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2. Repeat the above exercise for other types.

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   - 3.1 `T* p`
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3. A pointer to variable of type T is:
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   - 3.2 `T *p`
4. A pointer variable equal to 0 means it does not refer to an object. Use of **NULL** discouraged!

Arrays (Statically Declared Arrays)

```
1  // program8.cpp
2  #include<iostream>
3  int main(int argc, char* argv[])
4  {
5    int ia[3]; //An array of three integers with garbage
       values
6    std::cout << ia[1] << std::endl;
7    float fa[] = {1, 2, 3}; //An array of three floats
       initialzed: size automatically computed
8    std::cout << fa[1] << std::endl;
9    return 0;
10 }
```

1. Static Array storage is contiguous.
2. Array bound must be a constant expression. If you need variable bounds, use a `vector`.
3. What happens when initialization and array size mismatch?
4. Multi-dimensional arrays (contiguous in row-order fashion!).

Arrays (Dynamically Declared Arrays)

```
1  // program9.cpp
2  #include<iostream>
3  int main(int argc, char* argv[])
4  {
5    int* pa = 0; // pa is a pointer to integers
6    int n;
7    std::cout <<  "Enter dynamically allocated array size:";
8    std::cin >> n;
9    pa = new int[n];
10   for (int i = 0; i < n; i++) {
11     pa[i] = i;
12   }
13   // Use a as a normal array
14   delete[] pa; // When done, free memory pointed to by a.
15   pa = 0; //// Clear a to prevent using invalid memory
         reference.
16   return 0;
17 }
```

References (A Rose by another name!)

```cpp
// program10.cpp
#include<iostream>
int main(int argc, char* argv[])
{
  int i = 1;
  int &r = i; // r and i refer to same int
  // int &s;  // Error: must be initialized unless "extern"
  int x = r;  // x = 1
  r = 2;      // x = 2
  return 0;
}
```

Structures (Our first data-structure!)

```
1  // program11.cpp
2  #include<iostream>
3  int main(int argc, char* argv[])  {
4    struct address {
5      std::string name;
6      long int number;
7      std::string street;
8      std::string town;
9      std::string state;
10     int zip;
11   };
12   address myadress = {"Ashutosh Trivedi", 4141, "Spruce
         Street", "Philadelphia", "PA", 19104};
13   std::cout << myadress.name << " lives in " << myadress.
         town << std::endl;
14   return 0;
15 }
```