

From C to C++

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Enhancement of C++

- Some features of C++ that are not part of C
 - Reference types
 - Function/operator overloading
 - Function/class templates
 - Exception handling
 - Default function arguments
 - Object-oriented programming
 - ...
- C++ shares C's ability to deal efficiently with hardware at the level of bits, bytes, words, addresses, etc. → C++ has grown to be a **complex programming language**!

It takes years to be a savvy C/C++ programmer!

Our First Few C++ Programs

- First several examples of C++ programs of this course
 - <http://mirlab.org/jang/courses/dsa/example>
 - Let's check out some examples...
- More examples via Google
 - Google “c++ example vector unique”
- Choices of compilers
 - Unix/Linux: g++
 - Mac: g++
 - Windows
 - Window's bash (g++)
 - Dev C++ (g++.exe)
 - MS Visual Studio (cl.exe)

Examples are very important!

Pointers and Arrays

- Do you know pointers in C?
 - Very dangerous! (But convenient!)
- What could go wrong?
 - Confusing grammar
 - `int* x, y, z; ➔ int *x, y, z;`
 - Delete memory that has not been allocated
 - Double deletes are not allowed!
 - Check the availability of allocated memory
 - Memory leak (see next page)
 - Out-of-bound indexing for arrays (example)
 - For efficiency, C/C++ does not perform boundary checking!

Use STL vectors and `vec.at()` for safe (but inefficient) access.

Memory Leak

Quiz!

○ Definition of memory leak

- A memory leak occurs when you call “new” without calling a corresponding “delete” later.

Sometimes it's not so obvious!
(See “shallow copy”.)

○ How to avoid it?

- C++: “new” and “delete” must appear in pairs!
- C: “malloc” (or “calloc”, or “realloc”) and “free” must appear in pairs!

○ Example

```
int main() {
    // OK
    int * p = new int;
    delete p;

    // Memory leak
    int * q = new int;
    // no delete
}
```

```
void memLeak( )
{
    int *data = new int;
    *data = 15;
}
```

More examples!

How to Tackle Memory Leak?

- Good programming style

- New/delete pairs should appear in the same scope
 - Do not allocate memory in a function and free it outside.
- Avoid shallow copy
- ...

Google “avoid memory leak” ...

- Libraries

- STL vectors
- Smart pointers
- ...

- Tools for debugging

- Windows: Purify
- Unix/linux: Valgrind

Online Tutorials for C++

- There are quite a few good online tutorials on C++
 - C++ tutorial at www.cplusplus.com
 - C++ tutorial at www.cprogramming.com
- Do you think you know C/C++ already?
 - Deep C