Lecture 8

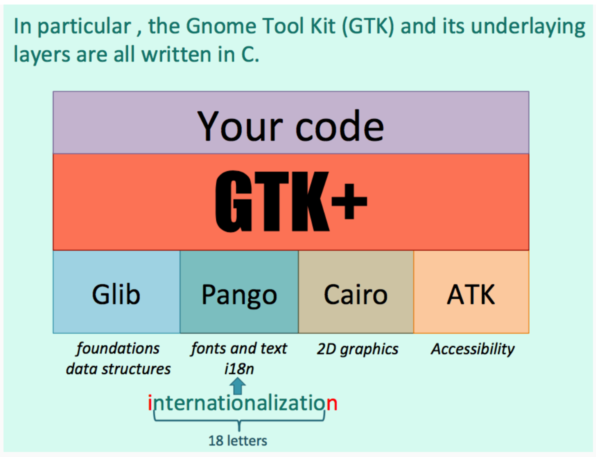
Static data and variables (typically list heads, tree roots and sometimes static arrays) are private to a file and invisible outside.

Using C in an Object-Oriented style

Few areas are more suited to Object-Oriented programming than **Graphical User Interfaces** and **Windows managers**.

Main Windows Managers

- GTK+
- Qt


In particular , the Gnome Tool Kit (GTK) and its underlaying layers are all written in C.
Your code
GTK+
Glib
Pango
Cairo
ATK
foundations data structures
fonts and text i18n
2D graphics
Accessibility
internationalization
18 letters

GTK+

GtkWidget is the "base class" of everything, containers and widgets such as labels, entry fields of buttons.

There is for everything a special "new" function that always returns a GtkWidget pointer.

When you need a specific behavior, you "cast" the GtkWidget pointer to a specific type.

```
#include <stdio.h>
#include <gtk/gtk.h>

int main( int argc, char *argv[]) {
  GtkWidget *window;
  GtkWidget *label;

  gtk_init(&argc, &argv);

  /*
  The GTK_WINDOW() macro turns the GtkWidget pointer
```

```
  returned by gtk_window_new() into a "true" window pointer.
  It implements inheritance of a sort.
  Inheritance can be achieved by organizing structures well.
  */

  window = gtk_window_new(GTK_WINDOW_TOPLEVEL);
  gtk_window_set_title(GTK_WINDOW(window), "CS205");
  gtk_window_set_default_size(
    GTK_WINDOW(window), 230, 150);

  /*
  The Window is cast to a "container" when adding something to it,
  and to a mere "object" when associating the funtion
  that quits GTK to its "close" button.
  */

  g_signal_connect_swapped(
    G_OBJECT(window), "destroy",
    G_CALLBACK(gtk_main_quit), NULL);

  gtk_main();

  return 0;
}
```

Source Control Systems

Repository

Changes are recorded, and can be rolled back.

- git

Finding Bugs

```
printf(" ...", ...);
fflush(stdout);
```

Static Analysis

- `gcc -Wall`
- oclint

Dynamic Analysis

- gdb
- ddd
- Visual C++
- eclipse
- Xcode

Valgrind works like a debugger, Electric-Fence is just a library (libefence) you link with. Your program will run far slower, but every memory access will be checked. More useful than traditional debuggers in my opinion.

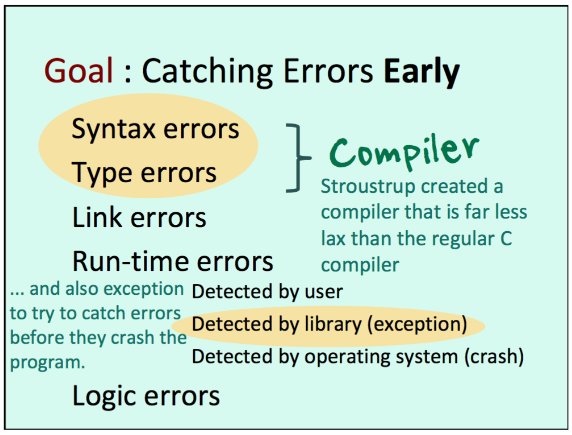
- Valgrind
- Electric-Fence

C++

Bjarne Stroustrup (1950 -)

"C with classes"

Goal : Catching Errors Early


Goal : Catching Errors **Early**

Syntax errors
Type errors
} Compiler
Stroustrup created a compiler that is far less lax than the regular C compiler

Link errors

Run-time errors
... and also exception to try to catch errors before they crash the program.
Detected by user
Detected by library (exception)
Detected by operating system (crash)

Logic errors

SIMULA

- Kristen Nygaard (1926-2002)
- Ole-Johan Dahl (1931-2002)

Stroustrup took many ideas from Simula, invented by two Norwegians who created all object-related concepts in the 1960s and became enormously influential.

C++ Philosophy

- Anchored in reality
  - Solve actual problems
  - Reasonably easy to implement
  - Work alongside prior languages (eg C)
- Performance
  - No overhead due to unused features
  - No language beneath C++ other than assembly
- Developer freedom
  - Programmers free to pick their style
  - Manual override
  - Allowing a useful feature is more important than preventing possible misuse

C++ not easier than C but makes code organization easier.

Extensions

- `.cpp`
- `.cc`

header files

- `.h` (C compatible)
- `.hpp` (usually contain class definitions)

A C program is a valid C++ program.

Obvious extensions to C

```
// iostream can replace stdio.h
// Note that there is no extension specified
#include <iostream>

// Without this you should refer to std::cout
using namespace std;

int main() {
  int val = 3;

  // endl: '\n' for dummies, but more portable
  cout << "val = " << val << endl;
  return 0;
}
```

Input/string type

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

int main() {
  string str1;
  string str2;
  str1 = "Hello";
  cout << "Your name ? ";
  cin >> str2;
  /*
  string grows as needed
  No need to specify a length.
  malloc() and realloc() behind the scene.
  */
  str1 += " " + str2;
  cout << str1 << endl;
  return 0;
}
```

Compile

`g++ -o myprog myprog.cpp`

`gcc -o myprog myprog.cpp -lc++`

(Standard C++ library)

Array

```
#include <iostream>

#define ARRAY_SZ 10
int main() {
  int *ip;

  ip = new int[ARRAY_SZ];
  for (int i = 0; i < ARRAY_SZ; i++) {
    ip[i] = i;
  }
  /*
  Square brackets if you free an array,
  not if you free a single object
  */
  delete[] ip;
  return 0;
}
```

Exceptions

```
try {
  ...
  throw exception
} catch (exception1){
  ...
} catch (exception2){
  ...
}
```

Functions

- Overloading
- Optional parameters with default values

`int my_func(string p1, int p2=0)`

- Automatic reference

```
#include <stdio.h>

int safe_scanf(int& value) {
  // Note that &value is still needed.
  return scanf("%d", &value);
}

int main() {
  int val;

  printf("Enter a value : ");
  /*
  Here the address of val (in the main) is
  passed to safe_scanf() that passes it again to scanf()
  */
  safe_scanf(val);
  printf("Value: %d\n", val);
  return 0;
}
```

CLASSES

In C++ you can have in a structure “member functions” (close to function pointers that are automatically initialized), also called “methods”

```
#ifndef MATRICES_HPP
#define MATRICES_HPP
struct matrix {
  short rows;
  short cols;
  double *cells;

  matrix *new_matrix(int r, int c);
  void free_matrix();
  matrix *matrix_add(matrix *m);
  matrix *matrix_scalar(double lambda);
  matrix *matrix_mult(matrix *m);
  matrix *matrix_inv();
  double matrix_det();
};
#endif
```

When actually writing the function (in another file) **you must prefix the function name by the struct name** (spoiler: same thing with classes) because you can imagine different structure containing functions with identical names (eg `length()`)

```
matrix *matrix::new_matrix(int r, int c) {
  ...
}
```

Turn a struct into a class

```
#ifndef MATRICES_HPP
#define MATRICES_HPP
class matrix {
  short rows;
  short cols;
  double *cells;

  public:
    matrix(int r, int c); // constructor
    ~matrix(); // destructor
    matrix *matrix_add(matrix *m);
    matrix *matrix_scalar(double lambda);
    matrix *matrix_mult(matrix *m);
    matrix *matrix_inv();
    double matrix_det();
};
#endif
```

Contrary to Java, the code of functions isn't usually supplied in the class definition (it can be, but this is usually only done for very simple functions that need only a few lines of code).

Code is given in other files, and each function name is given as `<class name>::<function name>` as we have seen with the struct example.

The class really is an **interface**, the specification of how you interact with the object. The source code may not be supplied in a legible form but only as a `.o` file.

Vectors

a built-in collection similar to a Java `ArrayList`

`#include <vector>`

`vector<any type> my_list;`

`my_list[i]`

`my_list.size()`

`my_list.push_back(e)` adds element at the end

`my_list.pop_back()` deletes last element

`my_list.insert(pos, e)`

No garbage collector in C++.

In Java, an object is always a reference (always created with `new`). Not in C++, where you can either declare an object or declare a pointer and allocate the object dynamically.

`ClassType object;`

`ClassType *object;`

Accessing attributes/methods

`.` With regular objects

`->` With object pointers

Mixing C and C++

Identifying the function

In C, you identify by the **name only** and check return type and parameter type.

In C++ you identify by **name and number and types of parameters**.

We must let the C++ compiler and linker know that a function is a C function, so that the generated computer code can be adapted.

`.h` file

```
#ifdef __cplusplus
extern "C" {
#endif
  extern int c_func1(char *arg);
  extern double c_func2(int arg1, int arg2);
#ifdef __cplusplus
}
#endif
```

…