

System Software

C programming manual: lab 1

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Bachelor Electronics/ICT

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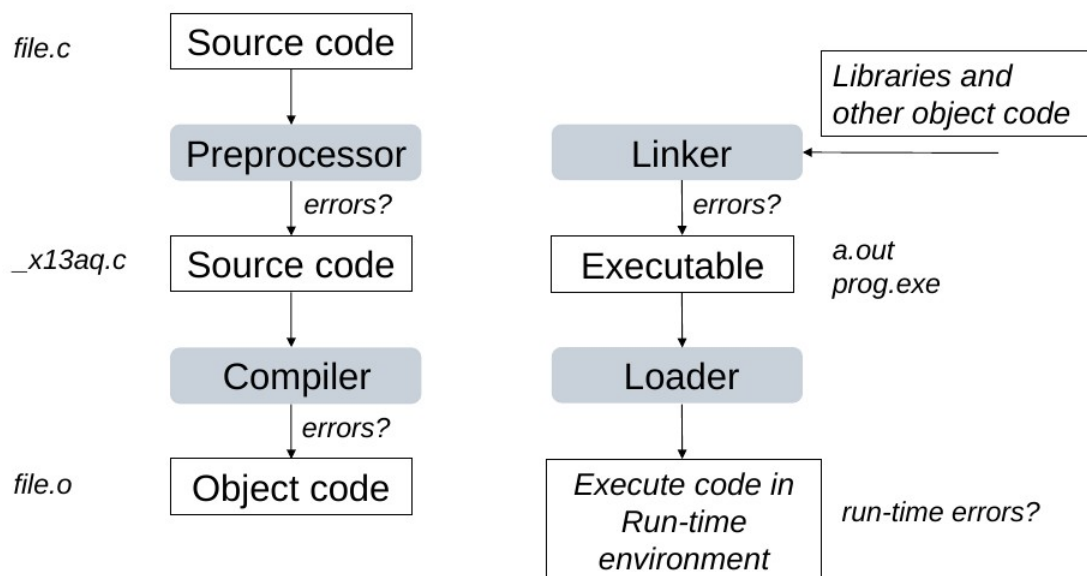
C programming

Lab targets: writing basic C programs, build them with gcc, run and test the programs.

Introduction to GCC

The GNU C compiler collection (GCC) is used for **all** programming exercises of this course. Gcc is one of the most used C/C++ compilers, not only on Linux where it comes pre-installed, but on many other platforms as well. GCC is more than only a set of compilers: it's really a collection of libraries and tools like gprof, gcov, gdb, etc. The entire GCC is open-source. Visit the GCC home page¹ for more information.

C program code must go through a number of processing stages before it can be loaded and run. First, C code must be preprocessed. Next, the compiler transforms the code to object code which then can be linked into an executable. The full processing chain is depicted below.



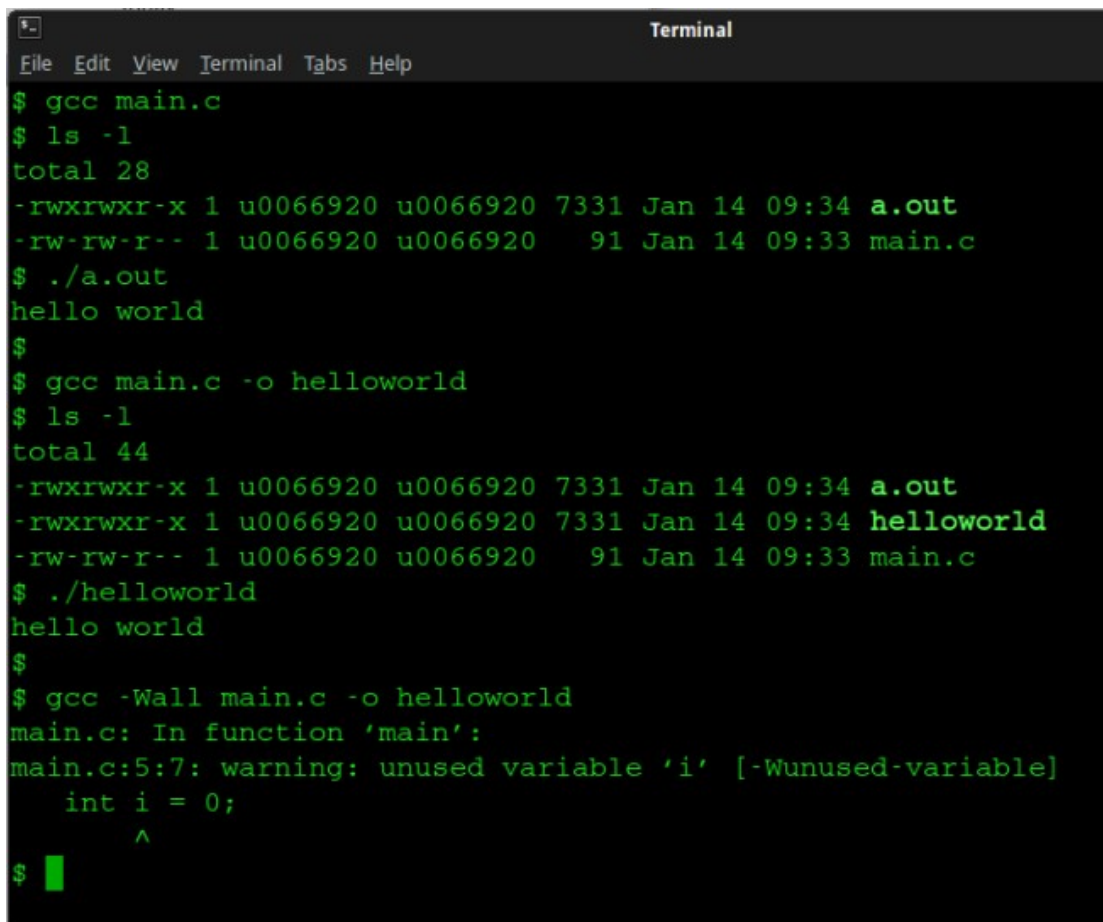
More details on the different processing steps will be given during this course. Hence, be patient. For now, it suffices to know that given a 'main.c' file, an executable can be obtained with the command 'gcc main.c'. After running this command, there are two possible results. The first - and probably the most likely - result is that an error occurs, typically because of compiler/linker errors. You must first solve all errors before you can retry. Hopefully, after some retries, the other possible result pops up on your screen: a successfully compiled program. In that case, you should find an executable file 'a.out' in the same directory. Check if this file has executable permission and if needed, modify the permissions of this file. Finally, you can execute the program with the command './a.out'. Notice that './' is just an indication that 'a.out' should be searched in the current directory.

¹ gcc.gnu.org

There are two more options worth knowing before you start programming. First, the '-o' options allows you to give a more meaningful name to the executable file. For example, 'gcc main.c -o helloworld' creates an executable file called 'helloworld', assuming there were no errors during compilation.

Second, the '-Wall' option turns on many warning flags used by gcc to check for potential mistakes. Do **not** neglect warnings because in many cases warnings are forerunners to some future problems. Therefore, some programmers and companies treat warnings at the same level as errors. We also insist that you **always** compile with '-Wall' and that you only consider the program succesfully compiled when **no** more warning messages show up. The 'all' in '-Wall' suggests that all warnings will be captured, but that's **not** true. In the man pages of 'gcc' it is explained which warning flags are set and which aren't set with the '-Wall' option.

The above described commands are illustrated in the screenshot given below.

A terminal window titled "Terminal" with a menu bar (File, Edit, View, Terminal, Tabs, Help). The terminal shows the following commands and output:

```
$ gcc main.c
$ ls -l
total 28
-rwxrwxr-x 1 u0066920 u0066920 7331 Jan 14 09:34 a.out
-rw-rw-r-- 1 u0066920 u0066920 91 Jan 14 09:33 main.c
$ ./a.out
hello world
$
$ gcc main.c -o helloworld
$ ls -l
total 44
-rwxrwxr-x 1 u0066920 u0066920 7331 Jan 14 09:34 a.out
-rwxrwxr-x 1 u0066920 u0066920 7331 Jan 14 09:34 helloworld
-rw-rw-r-- 1 u0066920 u0066920 91 Jan 14 09:33 main.c
$ ./helloworld
hello world
$
$ gcc -Wall main.c -o helloworld
main.c: In function 'main':
main.c:5:7: warning: unused variable 'i' [-Wunused-variable]
    int i = 0;
        ^
$
```

General hint: As mentioned in the course slides, there exists very nice references to the C standard library with example code for many library calls. One such reference is <http://www.java2s.com/Code/C/CatalogC.htm>.

Exercise: *system() library call, Linux console commands*

Open a Linux console terminal, go to your home directory and execute the following command sequence:

```
clear
ls -l > files.txt
sort files.txt | more
```

Implement a C program that executes this sequence of commands from within the main-function using the system() library call of stdlib.h. You can start from example code available on <http://www.java2s.com/Code/C/CatalogC.htm>!

Exercise: *datatype size, type qualifiers*

- The memory size of the built-in data types int, float, etc. is system dependent. Write a program that prints the memory size of int, float, double, void, and pointer using the sizeof() library function.
- What happens to the memory sizes when you use the type qualifiers short and long?
- Find out if a char is an unsigned or signed data type on the system you use.

You can start from example code available on <http://www.java2s.com/Code/C/CatalogC.htm>!

Exercise: *strings*

There is no built-in data type 'string' in C. As a matter of fact, strings in C are defined as null-terminated arrays of char. For example:

```
char name[4] = "luc";
```

The array 'name' defines a null-terminated string which means that name[0] = 'l', name[1]='u', name[2]='c' and name[3]='\0'. The termination '\0' is very important as all string manipulation functions will use this character to detect the end of the string. Also notice the difference between single and double quotes: 'c' indicates the constant char c, but "c" defines a constant string containing only one character being c. But if you store the string "c" you need a char array of length at least 2 because also the '\0' char must be stored to terminate the string.

Fortunately, to ease the pain of not having a built-in data type string, the C standard library provides a entire set of string manipulation functions. The target of this exercise is to explore a number of these functions.

Write a program that declares the string variables 'first', 'second', 'name' and 'str' both of some maximum length MAX.

- Use 'scanf' to read out your first and second name in 'first' and 'second', respectively.
- Convert your second name to all upper case chars and store the result in 'str'.
- Apply 'strcmp' on 'second' and 'str' and make sure you understand the result. Is there another compare function ignoring the case of chars?

- Concatenate your first and second name into 'name'; be aware that there is an unsafe and a safe string copy and concatenation function. Print the result.
- Read your birth year in some int 'year'.
- Concatenate 'first', 'second' and 'year' into 'name'. This time, use 'snprintf' to do the concatenation. Notice that there is also an 'unsafe' version of 'snprint' being 'sprintf'.
- Finally, use 'sscanf' to read from 'name' the 'first', 'second' and 'year' values again. Print the result on screen to check the result.

Once more, you can start from example code available on <http://www.java2s.com/Code/C/CatalogC.htm>!