C Basics

CSC100 Introduction to programming in C/C++

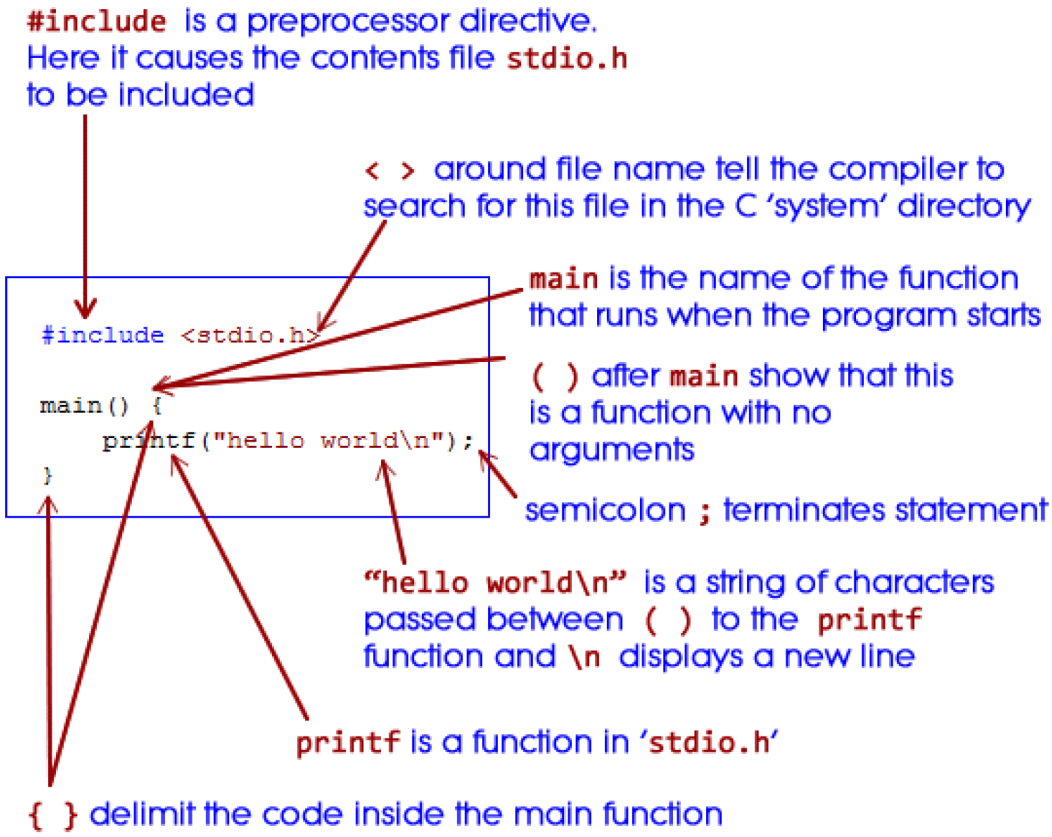
1 What are you going to learn?

This script summarizes and adds to the treatment by King (2008), chapter 2, C Fundamentals - see also slides (GDrive)

- Program structure
- Program: Printing a Pun
- Compiler workflow
- Shell execution
- Syntax highlighting
- Tangling code

---

2 Program structure



(Image source: Collingbourne, 2017)

3 Hello world program

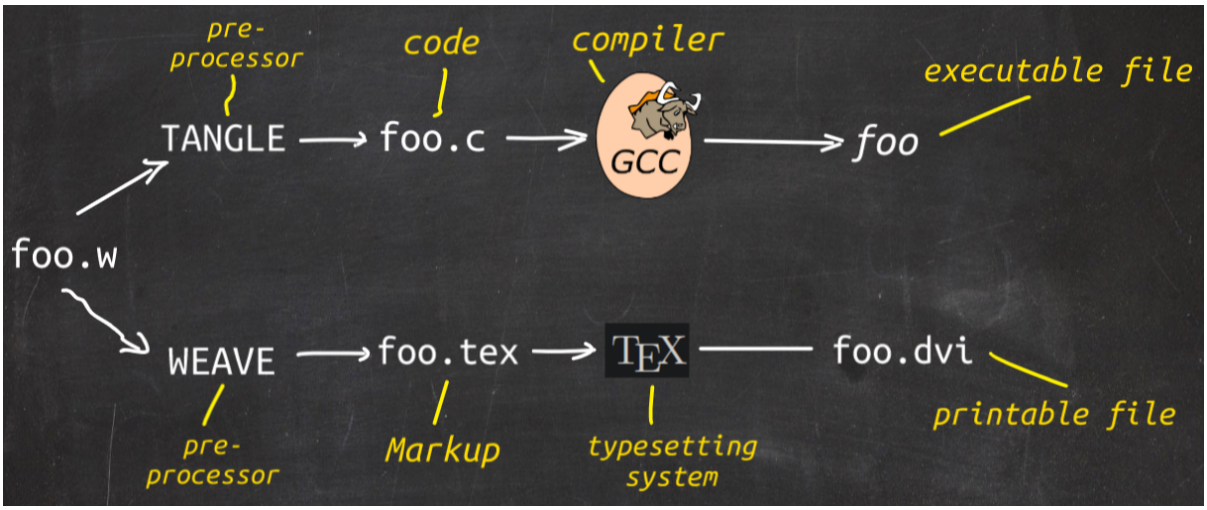
3.1 "What a Tangled Web We Weave…"

> "Oh, what a tangled web we weave, when first we practice to deceive!" (Sir Walter Scott, 1808)

In this section, we're once again running code blocks from within Org-mode - with a few new literate programming features:

- To distinguish (and reference) code blocks, we will name them (`#+NAME:`). The name can can then be referenced anywhere
- To turn the code block into a source code C file (`.c`), we will add a `:tangle FILENAME` statement to the header
- To create the tangled (source code) file from a block, use the keys `C-c C-v t` (`org-babel-tangle`)
- To create the tangled (source code) from a file (all blocks), use the keys `C-c C-v f` (`org-babel-tangle-file`)
- Since source code files should have comments, we add the header argument `:comments both`: now, the most recent org block is used as a comment

- The workflow of "tangling" and "weaving"[1] looks like this:



Learn more about extracting source code from Org files.

3.2 Hello World Version 1

- What happens here:
  - A header file (`stdio.h`) is included for input/output
  - A function (`main`) without arguments (`void`) is defined
  - The function returns integer data (`int`)
  - A string (`"..."`) is printed out
  - A new-line is added at the end (`\n`)
  - If successful, the program returns the value `0`

```
#include <stdio.h>
int main(void)
{
  printf("Hello world\n");
  return 0;
}
```

```
Hello world
```

3.3 Hello World Version 2

The program could also have been written much simpler:

- This function `main` is missing the `void` argument, and the `int` (indicating the type of variable returned - an integer).
- Alas, in Org-mode, this program will not compile, though outside of Org-mode, it will (with a warning). Try it!

```
#include <stdio.h>
main()
{
  printf("Hello world\n");
}
```

3.4 Hello World Version 3

The program could also have been written more complicated:

- `int argc` is an integer, or single number - the number of arguments that were passed to `main`
- `char **argv` (or `char *argv[]`) is a pointer that refers to an array of characters - a more complicated data structure.

```
#include <stdio.h>

int main(int argc, char **argv)
{
  printf("hello world\n");
  return 0;
}
```

```
hello world
```

4 Compiler workflow

The machine cannot process `pun.c` without help. It must

Preprocess	**The preprocessor acts on lines beginning with #**
Compile	The compiler translates instructions into object code

Preprocess	The preprocessor acts on lines beginning with #
Link	The linker combines object code and functions like `printf()`
Run	The final `*.exe` program is a binary (machine) program
Debug	The debugger controls rule violations along the way

I compiled the `hello.c` program on a Linux box - the executable is called `hello.out`. Compare the two executables - what do you notice?

```
-rwxrwxrwx 1 marcus marcus 48432 Dec 29 08:38 hello.exe
-rwxrwxrwx 1 marcus marcus 16696 Dec 29 12:28 hello.out
```

Challenge: are these executables portable?[2]

5 Shell execution

- You can also save the code in a program `pun.c`
- Compile it on the Windows command line or in the Emacs shell:

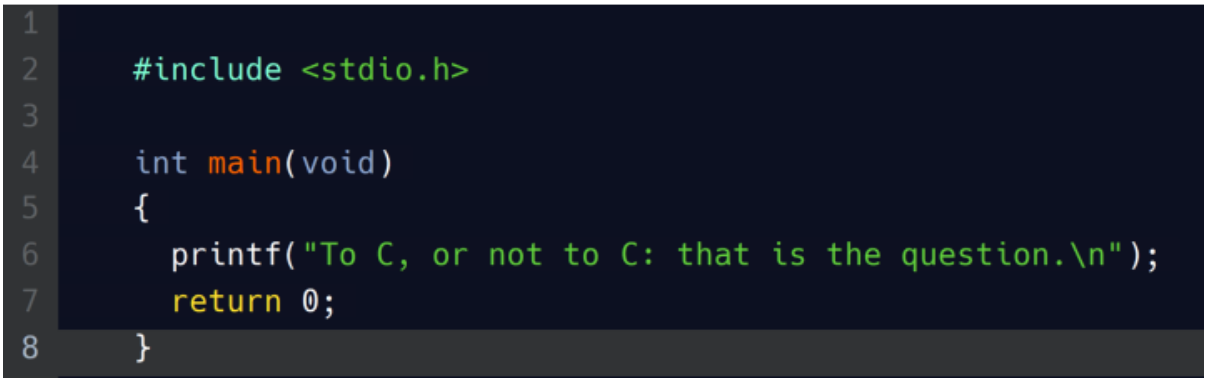
COMMAND	ACTION
C-x C-f pun.c	Create C file `pun.c`
	Copy block or write code anew in `pun.c`
C-x C-s	Save `pun.c`
M-x eshell	start a command line shell in an Emacs buffer
`gcc -o pun pun.c`	compile program and create executable
`ls`	list files - you should see `pun.exe`
`pun`	execute program

  - The shell is an Emacs Lisp simulation of a Linux shell (`bash`)
  - Windows `PowerShell` would also work (run with `./pun[.exe]`)

6 Syntax highlighting

- Notice the slight syntax highlighting difference to `repl.it`

- There is no highlighting standard - you should experiment with different themes[3]
- Display line numbers with `display-line-numbers-mode`, and highlight lines with `hl-line-mode`[4]:



7 Comments

Forgetting to terminate a comment may cause the compiler to ignore part of your program - but both syntax highlighting and auto-indent in the editor will tip you off:

```
printf("My "); /* forgot to close this comment ...
                  printf("cat ");
                  printf("has ");  /* so it ends here */
printf("fleas");
```

Let's fix this:

```
printf("My "); /* forgot to close this comment */
printf("cat ");
printf("has ");  /* so it ends here */
printf("fleas");
```

8 Concept summary

- C programs must be compiled and linked
- Programs consist of directives, functions, and statements
- C directives begin with a hash mark (#)
- C statements end with a semicolon (;)
- C functions begin and end with parentheses { and }

9 Code summary

CODE	EXPLANATION
`#include`	directive to include other programs
`stdio.h`	standard input/output header file (more)
`main(void)`	main function without argument
`main(int argc, char **argv)`	main function with two arguments
`return`	statement (successful completion)
`void`	empty argument - no value
`printf`	printing function
`\n`	escape character (new-line)
`/* ... */` `//...`	comments

10 Jargon

CONCEPT	EXPLANATION
Compiler	translates source code to object code
Linker	translates object code to machine code
Syntax	language rules
Debugger	checks syntax
Directive	starts with #, one line only, no delimiter
Preprocessor	processes directives
Statement	command to be executed, e.g. `return`
Delimiter	ends a statement (in C: semicolon - ;)
Function	a rule to compute something with arguments

11 What's next

12 References

- Collingbourne (2019). The Little Book of C (Rev. 1.2). Dark Neon.

- King (2008). C Programming - A Modern Approach. Norton. Online: knking.com.
- tutorialspoint.com (n.d.). C Library - <stdio.h> [website]. URL: tutorialspoint.com.

Footnotes:

[1] In our case, instead of weaving TeX files (`.tex`) to print, we weave Markdown files (`.md`), or WORD (`*.odt`) files, or we dispense with the weaving altogether because Org-mode files (equivalent of the `*.w` or "web" files) look fine on GitHub. GitHub.

[2] Executables are the result of compilation for a specific computer architecture and OS. The `.exe` program was compiled for Windows, the `.out` program was compiled for Linux. They will only run on these OS.

[3] You can find themes for GNU Emacs here, and install them using `M-x package-list-packages`.

[4] If you always want to have line numbers and highlight the line under the cursor, put these lines in your `.emacs` file: and restart Emacs:

```
;; always display line numbers
(global-display-line-numbers-mode)
;; enable global highlighting
(global-hl-line-mode 1)
```

Author: Marcus Birkenkrahe
Created: 2022-02-07 Mon 13:12
Validate