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## 1 Practice: C Programming Toolchain

- This directory contains practice material for the course.
  - This practice session deals with your C programming toolchain. Since we're working on Linux, you have many small, powerful UNIX commands available to you.
  - What you'll learn:
    - Finding out where you are on the computer
    - Climbing around the file system
    - Listing files
    - Downloading a file from the web
    - Compiling a simple C source file
    - Running an executable file
  - Whenever you see this symbol: \* [ ], you have something to do.
  - When you're in Emacs, put the cursor on the same line as the symbol and press `C-c C-c` then the symbol changes to \* [X]
- Let's try this! Press `C-c C-c` a few times.

## 2 Finding out where you are on the computer

- To find out where you are, enter `pwd` ("print working directory") after the terminal prompt `$`. In the example below, the answer is `/home/pi`, which is the home directory of the user `pi`.

```
~$ pwd
/home/pi
```

- The answer to the shell command `pwd` is stored in the variable `$PWD`. To check this, enter the command `echo $PWD` at the prompt.

```
~$ echo $PWD
/home/pi
```

- You can actually see this via the symbol `~` before the prompt, which stands for another variable, `$HOME`.

- ☐ Print the variable `$HOME`.

```
echo $HOME
```

- The shell, or `bash(1)`, is a program that is capable of scripting, or programming both interactively (on the console/terminal/command line), or via stored scripts.

## 3 Climbing around the file system

- The computer has a list of locations stored where it checks for available programs - like an index - called the `$PATH`.

- ☐ Print the `$PATH` on your computer

```
echo $PATH
```

- If it's not in the `PATH` list, the computer won't know it as a command. This includes executable files that you create yourself
- To change directory, use `cd`. E.g. `cd ~` or `cd $HOME` will get you to your home directory.

- Go to your home directory and print the working directory. You can execute both commands in one go whe putting a ; between them.

```
cd ~ ; pwd
```

```
/home/pi
```

- Make another directory and go there (you could put all of these commands on one line separating them with semi-colons).

```
mkdir -v test  
cd test  
pwd
```

(The `-v` flag means "verbose" - say what you just did).

- To go to any place, you can enter `cd` followed by the location (or explicit path), e.g. `/home/pi` or `/home/pi/test`, or by a relative path using `..`
- For example `cd ..` brings you back home from `test`, while `cd .` does nothing, and `cd ../..` gets you one directory up from `pi`.

- Follow this path using `cd`:

- Go back up one directory from `/test`
- Go back up one directory from `/pi`
- Go back up one directory from `~` (or `/home`)
- Go back down to `/test`

## 4 Listing files

- The command `ls` lists all files in the current directory
- `ls` also works with file paths, e.g. this listing of the directory `$HOME`:

```
ls /home/pi
```

- This command has many useful options: try them yourself

COMMAND	LISTING	WHAT?
<code>ls -l</code>	long listing	file owners, size, time, permissions
<code>ls -a</code>	with hidden files	includes configuration files
<code>ls -t</code>	time-ordered	files sort by time of modification

- The example output for `ls -l` shows one file called `README.org` with permissions for the owner (`pi`) and his group (also called `pi`) of size 6832 byte, last saved on May 14 at 18:38.

```
-rw-r--r-- 1 pi pi 6382 May 14 18:38 README.org
```

## 5 Getting a source file from the web

- The C source file `hello.c` is stored online at `pastebin.com`
- ☐ To download it to your `Downloads` directory, open a terminal and enter the following command:

```
wget pastebin.com/raw/N37Cp7ni -O hello.c -o log
```

- `wget` copies content from the web<sup>1</sup>
- `-O hello.c` writes the content into a file `hello.c`
- `-o log` writes messages into a file `log`<sup>2</sup>

- ☐ Check that you got the right content by entering `cat hello.c` at the command line. You should see this:

- The `cat` command views a file. To find out more about this or any other command, you can type `man cat` at the command line. This is the UNIX help system of manual pages.

- ☐ Take a look at `log`.

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<sup>1</sup>Notice that you did not need a browser to do this. `wget` is actually much smarter and faster than any browser download program. Its manual page (`man wget`) is highly readable.

<sup>2</sup>If we did not store the log in a file, it would simply be printed to the screen. An alternative is to redirect all messages to nowhere by replacing `-o log` with `&>/dev/null`.

```
pi@raspberrypi:~/Downloads $ cat hello.c
#include <stdio.h>

int main (void) {
    puts("Hello, world!\n");
    return 0;
}pi@raspberrypi:~/Downloads $
```

Figure 1: cat hello.c

## 6 Compiling a simple C source file

- You now have a fully formed C source file in your fingers.
- ☐ To compile the file, enter the following command on the command line - you shouldn't get any messages:

```
cc hello.c -o hello
```

This means "use `cc` to compile the file `hello.c` and put the result into `hello`".

- ☐ Now check the file listing with `ls -l`. You should see a new file, `hello`. Its name is highlighted, and you can see that it is 100 times larger and, most importantly, *executable*:

```
pi@raspberrypi:~/Downloads $ cc hello.c -o hello
pi@raspberrypi:~/Downloads $ ls -l
total 12
-rwxr-xr-x 1 pi pi 8072 May 18 10:42 hello
-rw-r--r-- 1 pi pi  87 May 18 10:20 hello.c
```

Figure 2: compile and list results

## 7 Running an executable file

- ☐ Run the executable file on the command line with the command `./hello`.

- To run the file, the computer needs a path to the file. Try entering the name of the file only.
- The path to the file can be explicit or implicit. Here is the explicit path solution:

```
pi@raspberrypi:~/Downloads $ ~/Downloads/hello
Hello, world!

pi@raspberrypi:~/Downloads $ █
```

Figure 3: run executable file (explicit path)

- The implicit path uses `./` to indicate the current directory:

```
pi@raspberrypi:~/Downloads $ ./hello
Hello, world!

pi@raspberrypi:~/Downloads $ █
```

Figure 4: run executable file (implicit path)

## 8 Summary

- To find out where you are, use `pwd`
- To move around use `cd` with explicit/implicit paths
- To list file information, use `ls`
- To get files from the web, use `wget`
- To compile a C source code file, use `cc`

## 9 Glossary

TERM	MEANING	WHAT?
UNIX	Operating system (OS)	Enables your computing
Linux <sup>3</sup>	Operating system (OS)	Enables your computing
\$PWD	Print working directory	Where you are in the file system
\$HOME	Hhome directory (~)	Where your files are
Shell	Connection to the OS	E.g. <code>bash</code> , scripting language
Prompt	Command line symbol	Enter shell commands after it
echo	Displays its arguments	E.g. <code>echo hello</code> prints <code>hello</code>
variable	Memory location	Can be declared/re/defined
PATH	Environment variable	Where computer looks for pgms
mkdir	Make a new directory	E.g. <code>mkdir -v test</code>
ls	List files	E.g. <code>ls -l</code> for a long listing
wget	Download web content	Needs URL only
man	UNIX manual pages	E.g. <code>man wget</code>
log	Message file	Log download process
cat	Viewing command	E.g. <code>cat hello.c</code>
cc	C compiler (GCC)	Includes flags like <code>-o</code>
compile	Make executable file	E.g. <code>cc hello.c</code>
executable	Binary (machine) file	Run e.g. with <code>./hello</code>

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<sup>3</sup>Linux comes in many shades and forms - because it is open source, everyone can take it and make it to what he wants it to be. On the Raspberry Pi, we use the Raspberry Pi OS, which is a Debian-style operating system (the package manager is `apt`).