Introduction to Linux Systems

GNU Make

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Fall 2023

Courtesy of XXX

Lab

- A Simple C Project Structure

https://hiltmon.com/blog/2013/07/03/a-simple-c-plus-plus-project-structure/

New folder for this lab

- 安裝相關套件
  ```
  $ sudo apt install gcc tree make
  ```
- 建立作業資料夾(Your local git repo不指定名稱)
  ```
  $ cd <Your local git repo>
  $ mkdir lab_5_<student_ID>
  $ cd lab_5_<student_ID>
  ```

Add .gitignore to prevent tracking object files

```
# Ignore the build and lib dirs
build
lib/*

# Ignore any executables
bin/*

# Ignore temporary files
*.swp
```

```
├── .gitignore
├── include/
│   └── strcpy.h
├── Makefile
└── src/
    ├── strcpy.c
    └── main.c
```

Split function into different file (Header)

```c
#pragma once

char *sstrcpy(char *dest, const char *src);
```

or

```c
#ifndef STRCPY_H
#define STRCPY_H

char *sstrcpy(char *dest, const char *src);

#endif /* STRCPY_H */
```

```
├── .gitignore
├── include/
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    └── main.c
```

Note: 🟦 include guard

https://en.wikipedia.org/wiki/Pragma_once
https://en.wikipedia.org/wiki/Include_guard

Split function into different file (Source)

```
#include "../include/strcpy.h"

char *sstrcpy(char *dest, const char *src)
{
        // FIXME
}
```

不能使用其他 library 提拱的 funciton

```
├── .gitignore
├── include/
│   └── strcpy.h
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└── src/
    ├── strcpy.c
    └── main.c
```

Program entry point

```
#include <stdio.h>
#include <stdlib.h>
#include "../include/strcpy.h"
int main() {
    const char *src = "f12345678";
    char *dest = malloc(10);
    dest = sstrcpy(dest, src);
    printf("%s\n", dest);
    return 0;
}
```

改成你的學號

```
├── .gitignore
├── include/
│   └── strcpy.h
├── Makefile
└── src/
    ├── strcpy.c
    └── main.c
```

Makefile

```
CC := gcc
SRCDIR := src
BUILDDIR := build
BINDIR := bin
INCDIR := include
TARGET := $(BINDIR)/runner

SRCEXT := c
SOURCES := $(shell find $(SRCDIR) -type f -name *.$(SRCEXT))
HEADERS := $(shell find $(INCDIR) -type f -name *.h)
OBJECTS := $(patsubst $(SRCDIR)/%,$(BUILDDIR)/%,$(SOURCES:.$(SRCEXT)=.o))
CFLAGS := -O2 -Wall

all: $(TARGET)

$(TARGET): $(OBJECTS)
		mkdir -p $(BINDIR)
		@echo "> Linking..."
		$(CC) $^ -o $(TARGET)


$(BUILDDIR)/%.o: $(SRCDIR)/%.$(SRCEXT)
		mkdir -p $(BUILDDIR)
		@echo "> Compiling..."
		$(CC) $(CFLAGS) -c -o $@ $<

clean:
		@echo "> Cleaning...";
		$(RM) -rf $(BUILDDIR) $(TARGET)
```

```
├── .gitignore
├── include/
│   └── strcpy.h
├── Makefile
└── src/
    ├── strcpy.c
    └── main.c
```

Variable and alias in Makefile

- `SOURCES := $(shell find $(SRCDIR) -type f -name *.$(SRCEXT))`
    - `src/strcpy.c src/main.c`
- `HEADERS := $(shell find $(INCDIR) -type f -name *.h)`
    - `include/strcpy.h`
- `OBJECTS := $(patsubst $(SRCDIR)/%,$(BUILDDIR)/%,$(SOURCES:.$(SRCEXT)=.o))`
    - `$(SOURCES:.$(SRCEXT)=.o) = src/strcpy.o src/main.o`
    - `build/strcpy.o build/main.o`
- `$(CC) $(CFLAGS) -c -o $@ $<`
    - `gcc -O2 -Wall -c -o build/strcpy.o src/strcpy.c`
    - `gcc -O2 -Wall -c -o build/main.o src/main.c`
- `main.o: main.c a.o`

  `$(CC) $(CFLAGS) -c -o $@ $<`

```
├── .gitignore
├── include/
│   └── strcpy.h
├── Makefile
└── src/
    ├── strcpy.c
    └── main.c
```

Current file architecture

```
$ tree .
```

```
.
├── include/
│   └── strcpy.h
├── Makefile
└── src/
    ├── strcpy.c
    └── main.c
```

Use Makefile and execute program

```
$ make
mkdir -p build
> Compiling...
gcc -O2 -Wall -I include -c -o build/strcpy.o src/strcpy.c
mkdir -p build
> Compiling...
gcc -O2 -Wall -I include -c -o build/main.o src/main.c
mkdir -p bin
> Linking...
gcc build/strcpy.o build/main.o -o bin/runner
```

這邊輸出可能會有 warning，如果程式正常執行可忽略

```
$ ./bin/runner
f12345678
```

File architecture after using make

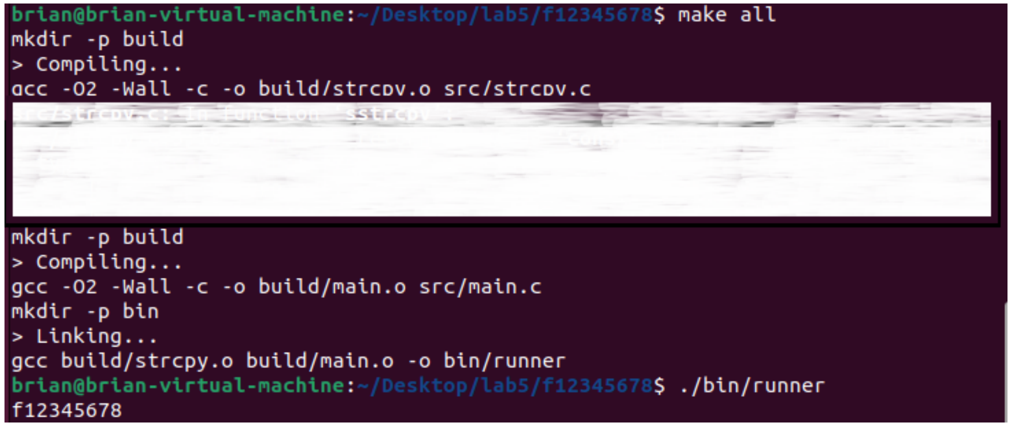
$ tree .

```
.
├── bin/
│   └── runner
├── build/
│   ├── strcpy.o
│   └── main.o
├── include/
│   └── strcpy.h
├── Makefile
└── src/
    ├── strcpy.c
    └── main.c
```

Demo

- 作業上傳:
  1. 將 lab_5_<student_ID> 資料夾上傳至 moodle (請同學使用 Linux 環境撰寫作業)
  2. 截圖上傳，須包含以下兩樣檢查項目。

- 截圖評分方式：
  - 編譯的 console 內容
  - runner 執行結果 (需輸出自己的學號)



```
brian@brian-virtual-machine:~/Desktop/lab5/f12345678$ make all
mkdir -p build
> Compiling...
gcc -O2 -Wall -c -o build/strcpy.o src/strcpy.c
[redacted]
mkdir -p build
> Compiling...
gcc -O2 -Wall -c -o build/main.o src/main.c
mkdir -p bin
> Linking...
gcc build/strcpy.o build/main.o -o bin/runner
brian@brian-virtual-machine:~/Desktop/lab5/f12345678$ ./bin/runner
f12345678
```

QUESTIONS