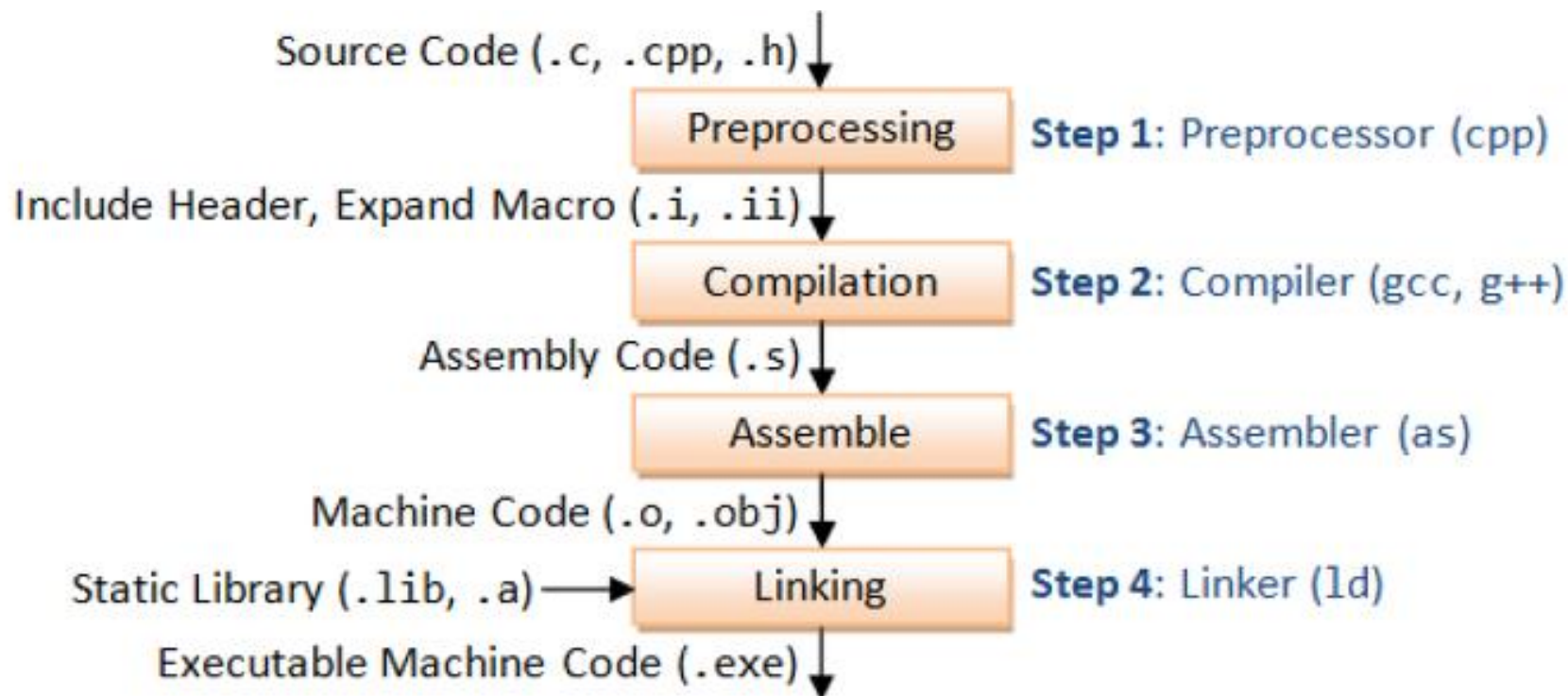


# Makefile

신광수

ksshin@sogang.ac.kr



# 1

## 컴파일과 컴파일러

### C Code

```
#include <stdio.h>

int main(void)
{
    printf("Hello, World!\n");
    return 0;
}
```

**gcc main.c**

### Assembly Code

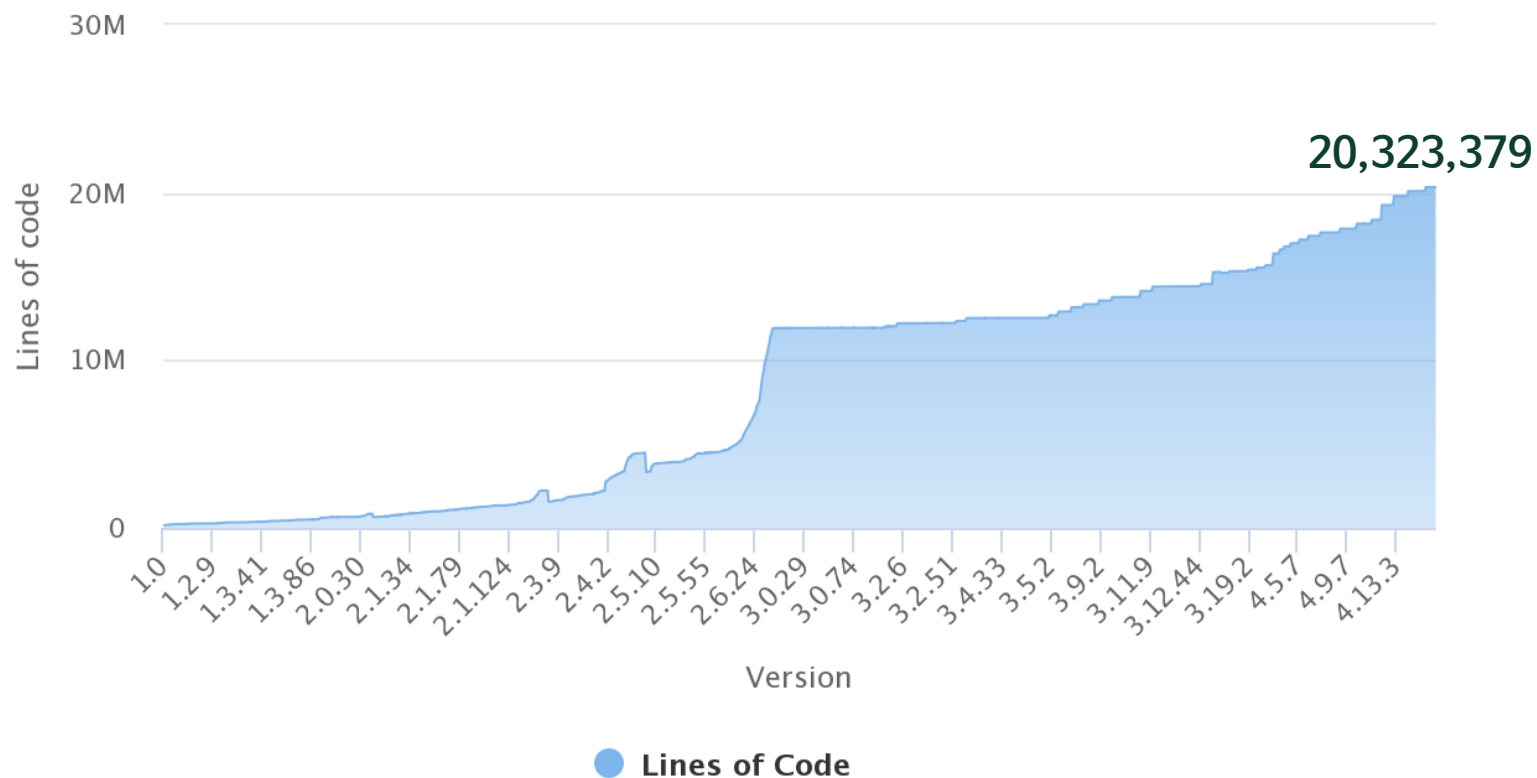
```
section .text
    global _start
_start:
    mov     edx,len
    mov     ecx,msg
    mov     ebx,1
    mov     eax,4
    int     0x80
    mov     eax,1
    int     0x80
section .data
msg db 'Hello, world!', 0xa
len equ $ - msg
```

### Machine Code

```
7F454C46010101000000
000000000000002000300
0100000003540B3042C00
0000000000000000000000
3400200001000000000000
000000040B304B20CEB1C
620000006200000000500
000000100000048656C6C
6F20776F726C640AB94C
40B30493CD80EBFB
```

## Lines of code per Kernel version

Click and drag in the plot area to zoom in



Highcharts.com

torvalds Merge tag 'riscv-for-linux-4.20-rc4' of git://git.kernel.org/pub/scm/...		Latest commit 92b4192 9 hours ago
Documentation	Merge tag 'media/v4.20-3' of git://git.kernel.org/pub/scm/linux/kerne...	2 days ago
LICENSES	Merge tag 'docs-4.20' of git://git.lwn.net/linux	29 days ago
arch	Merge tag 'riscv-for-linux-4.20-rc4' of git://git.kernel.org/pub/scm/...	9 hours ago
block	SCSI: fix queue cleanup race before queue initialization is done	8 days ago
certs	export.h: remove VMLINUX_SYMBOL[] and VMLINUX_SYMBOL_STR[]	3 months ago
crypto	crypto: user - Zeroize whole structure given to user space	13 days ago
drivers	Merge tag 'media/v4.20-3' of git://git.kernel.org/pub/scm/linux/kerne...	2 days ago
firmware	kbuild: remove all dummy assignments to obj-	a year ago
fs	Merge git://git.kernel.org/pub/scm/linux/kernel/git/davem/net	2 days ago
include	Merge tag 'media/v4.20-3' of git://git.kernel.org/pub/scm/linux/kerne...	2 days ago
init	memblock: stop using implicit alignment to SMP_CACHE_BYTES	22 days ago
ipc	ipc: IPCMNI limit check for semmni	22 days ago
kernel	Merge branch 'akpm' (patches from Andrew)	3 days ago
lib	lib/ubsan.c: don't mark __ubsan_handle_builtin_unreachable as noreturn	3 days ago
mm	mm/memblock.c: fix a typo in __next_mem_pfn_range() comments	3 days ago
net	Merge git://git.kernel.org/pub/scm/linux/kernel/git/davem/net	2 days ago
samples	Merge tag 'vfio-v4.20-rc1.v2' of git://github.com/awilliam/linux-vfio	21 days ago
scripts	scripts/spdxcheck.py: make python3 compliant	3 days ago
security	Merge tag 'selinux-pr-20181115' of git://git.kernel.org/pub/scm/linux/...	6 days ago
sound	ALSA: hda - Fix incorrect clearance of thinkpad_acpi hooks	16 days ago
tools	Merge git://git.kernel.org/pub/scm/linux/kernel/git/davem/net	2 days ago
usr	initramfs: move gen_initramfs_list.sh from scripts/ to usr/	3 months ago
virt	Revert "mm, mmu_notifier: annotate mmu notifiers with blockable inval...	26 days ago
.clang-format	page cache: Convert find_get_pages_contig to XArray	a month ago
.coccinell	scripts: add Linux.coccinell for coccinell	2 years ago
.get_maintainer.ignore	Add hch to .get_maintainer.ignore	3 years ago
.gitattributes	.gitattributes: set git diff driver for C source code files	2 years ago
.gitignore	Merge tag 'kbuild-v4.17-2' of git://git.kernel.org/pub/scm/linux/kerne...	7 months ago
.mailmap	mailmap: Update email for Punit Agrawal	17 days ago
COPYING	COPYING: use the new text with points to the license files	8 months ago
CREDITS	MAINTAINERS: update OMAP MMC entry	3 days ago
Kbuild	Merge tag 'kbuild-v4.15' of git://git.kernel.org/pub/scm/linux/kernel/...	a year ago
Kconfig	kconfig: move the "Executable file formats" menu to fs/Kconfig.binfmt	4 months ago
MAINTAINERS	Merge git://git.kernel.org/pub/scm/linux/kernel/git/davem/net	2 days ago
Makefile	Linux 4.20-rc3	3 days ago
README	Drop all 00-INDEX files from Documentation/	2 months ago

# 2

## 모듈화

```
#include "addition.h"
#include "subtraction.h"
```

```
int main(void) {
    int a = 5;
    int b = 3;

    printf("add: %d\n", add(a, b));
    printf("sub: %d\n", sub(a, b));

    return 0;
}
```

**main.c**

```
#ifndef _ADD_H_
#define _ADD_H_

#include <stdio.h>

int add(int a, int b);

#endif
```

**addition.h**

```
#include "addition.h"

int add(int a, int b) {
    int c = a + b;
    printf("%d + %d = %d\n", a, b, c);

    return c;
}
```

**addition.c**

**subtraction.h**

```
#ifndef _SUB_H_
#define _SUB_H_

#include <stdio.h>

int sub(int a, int b);

#endif
```

**subtraction.c**

```
#include "subtraction.h"

int sub(int a, int b) {
    int c = a - b;
    printf("%d - %d = %d\n", a, b, c);

    return c;
}
```

# 2

## 모듈화

Compile을 해 봅시다.

```
gcc main.c
```

오류가 발생합니다.

```
/tmp/ccuXC3rT.o: In function `main':  
main.c:(.text+0x21): undefined reference to `add'  
main.c:(.text+0x41): undefined reference to `sub'  
collect2: error: ld returned 1 exit status
```



# 2

## 모듈화

모듈화 하면 컴파일 하는 과정이 살짝 복잡해집니다.  
각 소스코드 별로 object 파일을 생성합니다.

```
gcc -c -o addition.o addition.c  
gcc -c -o subtraction.o subtraction.c  
gcc -c -o main.o main.c
```

그 이후, 생생한 object 코드를 합쳐 컴파일을 진행해야 합니다.

```
gcc -o main addition.o subtraction.o main.o
```

히히히히히히히히히?



# 3

## make

리눅스 계열 운영체제에서는 이러한 불편함을 줄이기 위해 make라는 명령어를 지원합니다.

```
make
```

다만 이러한 명령어를 사용하기 위해서는 해당 폴더에 Makefile이 필요하며, 이 Makefile에 컴파일에 필요한 다양한 명령어 및 내용을 담아 저장합니다.

```
vi Makefile
```





# 4

## Makefile

기초적인 Makefile을 만들어봅시다.

```
main : addition.o subtraction.o main.o
    gcc -o main addition.o subtraction.o main.o

addition.o : addtition.c
    gcc -c -o addition.o addition.c

subtraction.o : subtraction.c
    gcc -c -o subtraction.o subtraction.c

main.o : main.c
    gcc -c -o main.o main.o
```

(타겟) : (의존)  
(명령어)

# 4

## Makefile

효율적인 Makefile을 만들어봅시다.

```
CC = gcc
CFLAGS = -W -Wall
TARGET = main
OBJECTS = addition.o subtraction.o main.o

all : $(TARGET)

$(TARGET) : $(OBJECTS)
    $(CC) $(CFLAGS) -o $@ $^
```

(타겟) : (의존)  
(명령어)

## 5

## clean

컴파일 한 이후에는 .o 파일이 쌓인다. 이를 정리할 수 있는 코드를 추가하자.

```
CC = gcc
CFLAGS = -W -Wall
TARGET = main
OBJECTS = addition.o subtraction.o main.o

all : $(TARGET)

$(TARGET) : $(OBJECTS)
    $(CC) $(CFLAGS) -o $@ $^

clean :
    rm $(OBJECTS) $(TARGET)
```

(타겟) : (의존)  
(명령어)

# 6

## Practice

---

앞의 예시에서 multiplication(\*), division(/), modular(%) 연산을 진행할 소스코드를 추가하고, 이에 대한 Makefile을 구성해본다.

추가 할 헤더: multiplication.h, division.h, modular.h

추가 할 코드: multiplication.c, division.c, modular.c

실습에 사용된 Makefile 및 소스 코드를 “Makefile\_학번.zip”로 압축하여 제출