COMPILE, LINK, EXECUTION

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About me

- 毫無回應，就只是個伊達
- Date Huang
- NCU CSIE

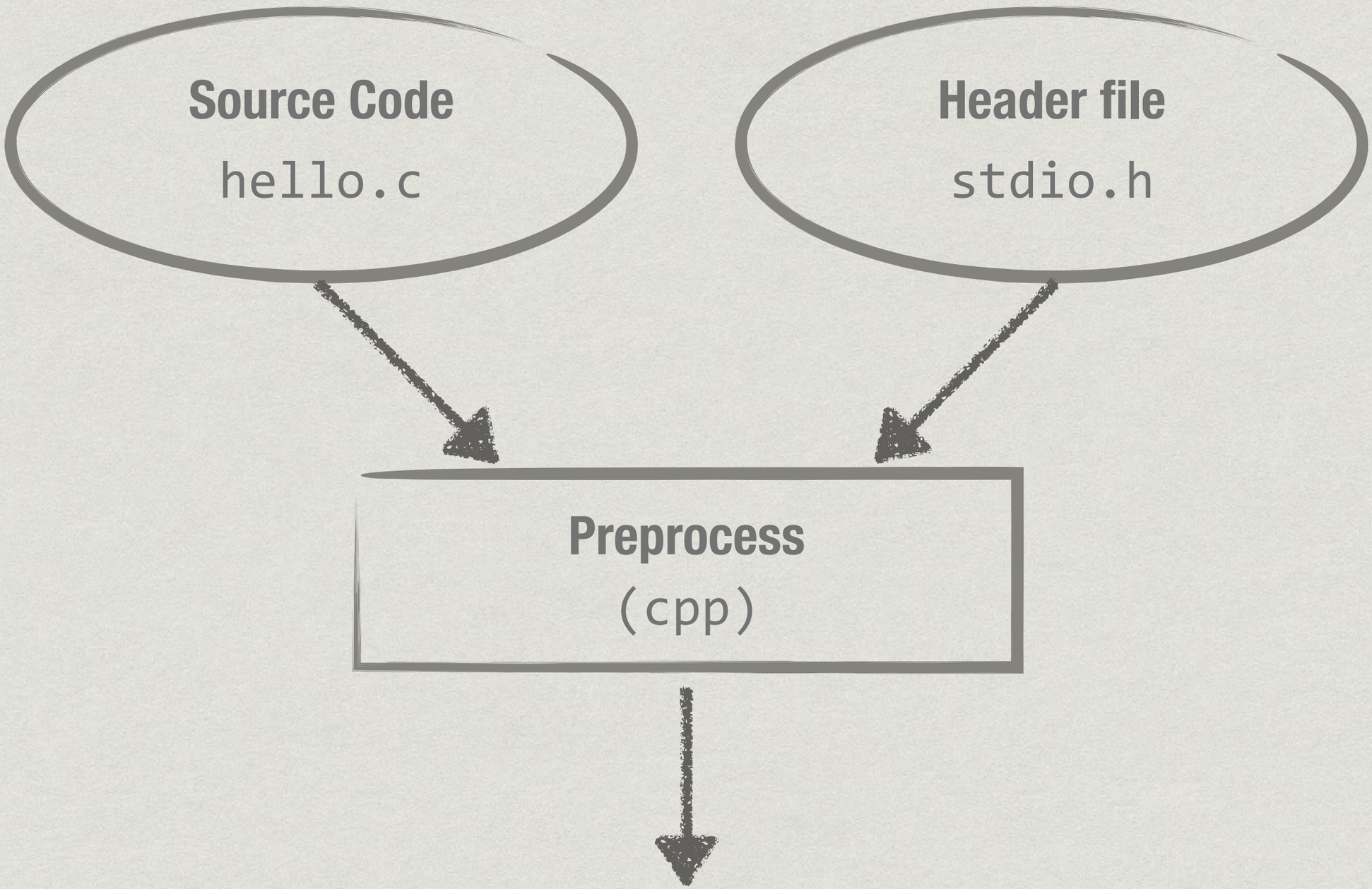
Demo Code

- https://github.com/tjjh89017/compile_link

Compilation Flow

- Preprocess
- Compilation
- Assembly
- Link

Compilation Flow



Preprocessed Code

`hello.i`

Compilation

`(cc1)`

Assembly Code

`hello.S`

Assembler

`(as)`

Static Library

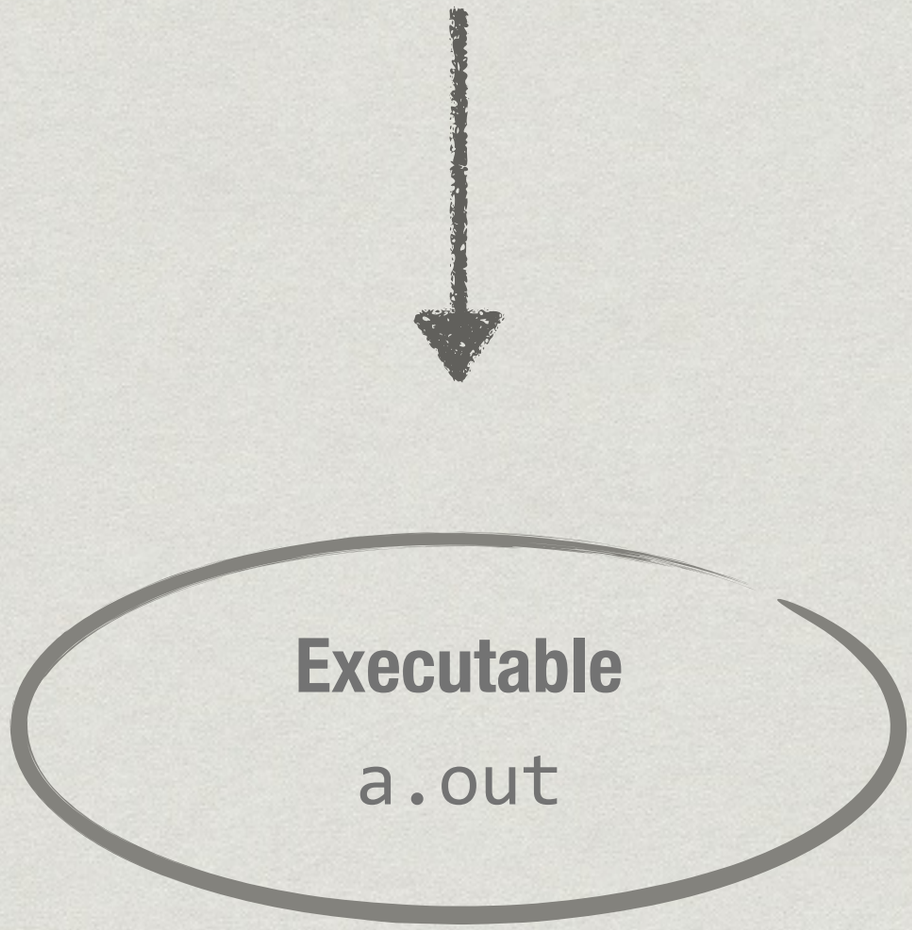
`libc.a`

Object file

`hello.o`

Linker

`(ld)`


Executable
a.out

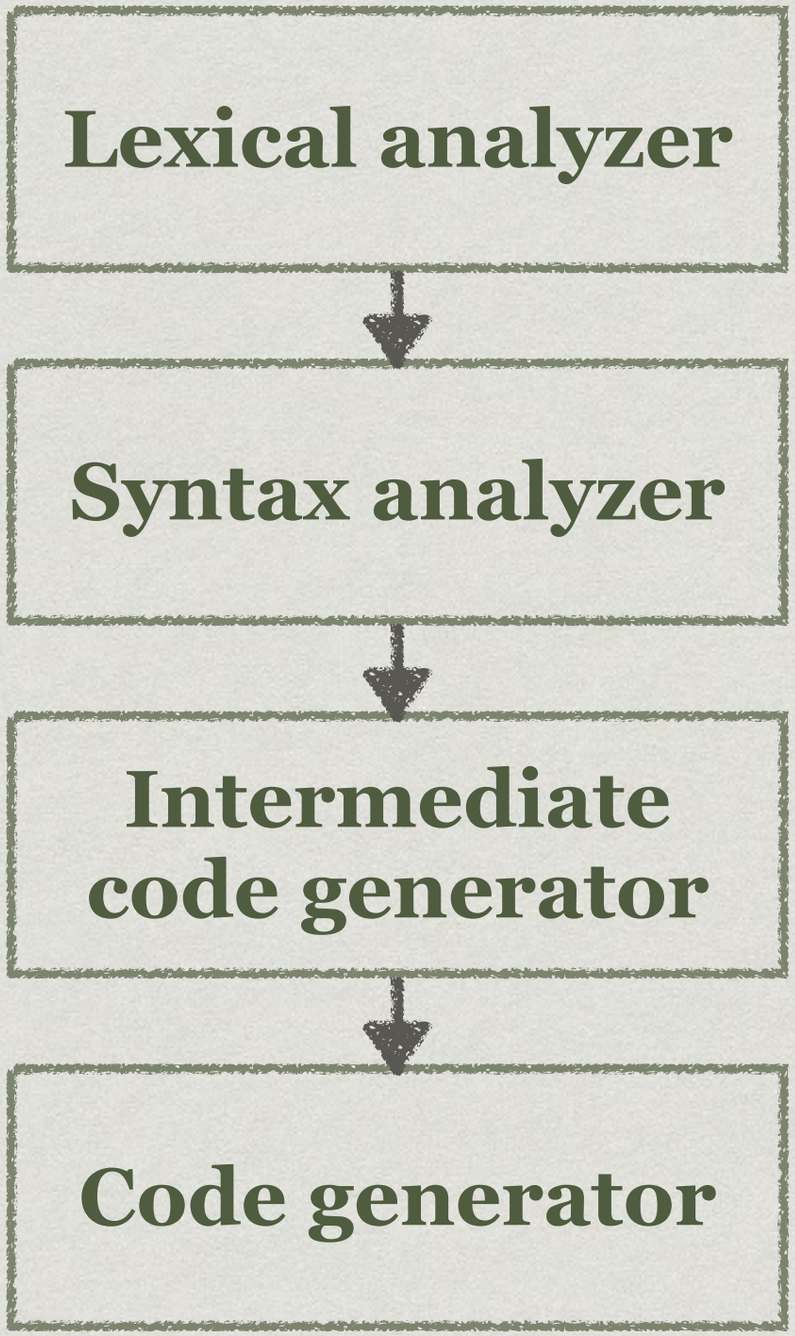
Preprocess

- Macro expansion
- Header files
- Conditional compilation
- Line control (Debug)
- Lines beginning ‘#’ as directives

```
#define PI 3.1459f

#include <stdio.h>

#if VERSION >= 2

#ifdef __LINUX__

etc.
```

Compilation

- Lexical analyzer
- Syntax analyzer
- Intermediate code generator
- Optimization (optional)
- Code generator



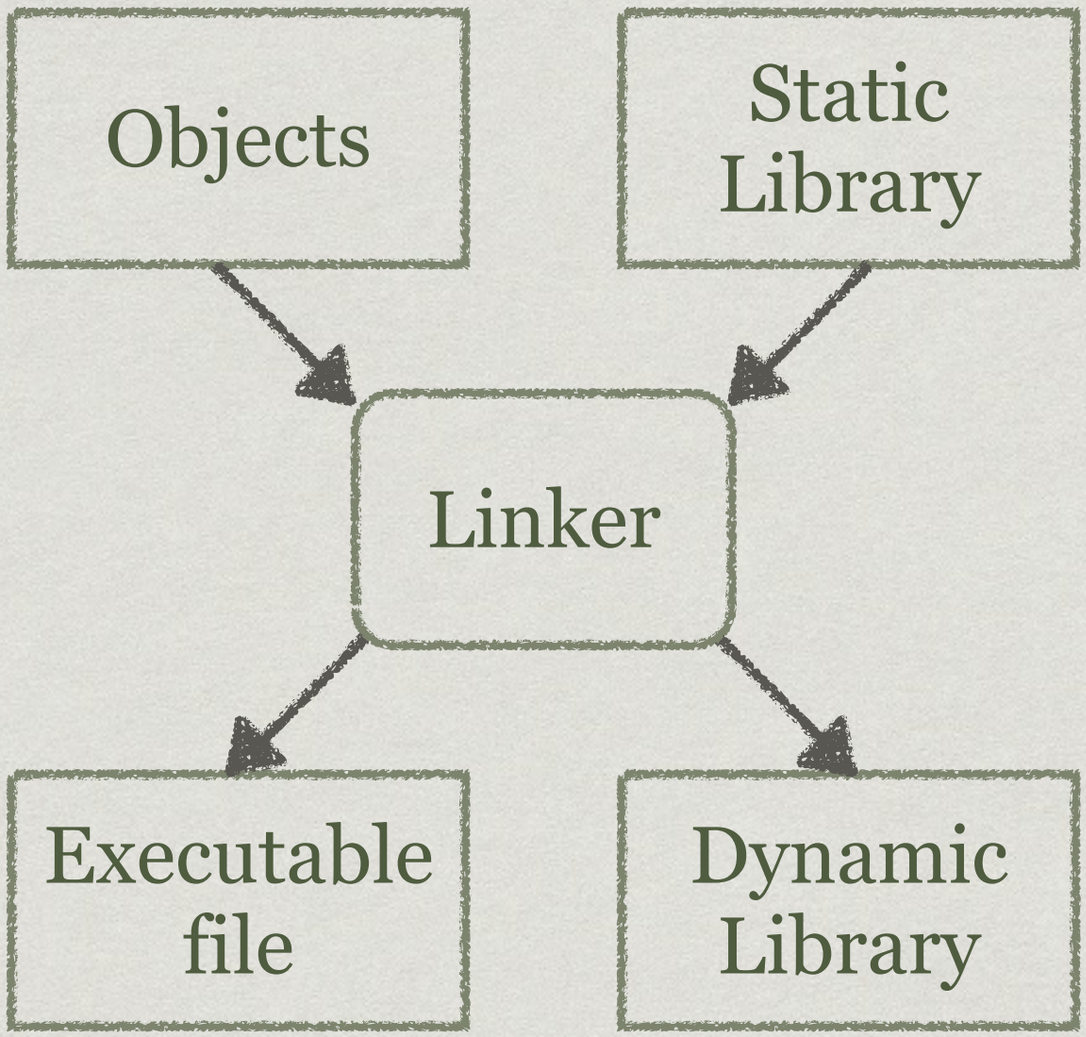
Assembly

- Turn Assembly Code into Machine Code

```
MOV AL, 61h

↓

B0 61
```

Link

- Combine objects and static libraries.
- Replace symbols with “address” or “offset”.



Section

- Text Section
  - Code!!!
- Data Section
  - Global variable with initial value
- BSS Section
  - Global variable without initial value

```
int a = 0;                          // .data
int b;                              // .bss
const double PI = 3.14159f;         // .rodata

int main(){

    int c = 321;                    // stack
    char *d = malloc(16);           // heap

    return 0;
}
```

Static Linking

- Combine the library you need into program.
- Filename Extension
  - In Unix-like: `.a`
  - In Windows: `.lib`

Dynamic Linking

- All program share one library.
- Filename Extension
  - In Unix-like: `.so`
  - In Windows: `.dll`

Static Linking

- Advantage
  - Faster than dynamic linking
  - Portable (Machine)
- Disadvantage
  - Makes program bigger
  - Modifying Library needs rebuild program

Dynamic Linking

- Advantage
  - Modifying Library doesn’t need rebuild program
  - Portable (Library Version)
- Disadvantage
  - Need additional library
  - Slower than static linking

Override Dynamic Library

- **Use environment variable** `LD_PRELOAD` **to load custom library**
- `LD_PRELOAD=./libtest.so ./main`

Reference

- How A Compiler Works: GNU Toolchain
  - http://www.slideshare.net/jserv/how-a-compiler-works-gnu-toolchain
- The Internals of "Hello World" Program
  - http://www.slideshare.net/jserv/helloworld-internals
- Internal and External Linkage in C
  - https://github.com/u1240976/mess_note/blob/master/talk/internal_and_external_linkage_in_C.rst