

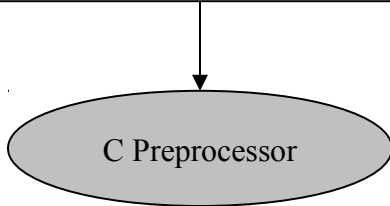
Princeton University  
COS 217: Introduction to Programming Systems  
Building C Programs

```
#include <stdio.h>

/* Write "hello, world\n" to stdout.
   Return 0. */

int main(void)
{
    printf("hello, world\n");
    return 0;
}
```

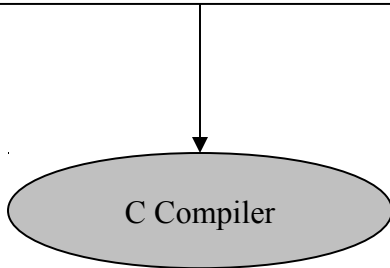
**hello.c**  
Source code  
C language  
Contains preprocessor directives



**Preprocess**  
gcc217 -E hello.c > hello.i

```
...
int printf(char *format, ...);
...
int main(void)
{
    printf("hello, world\n");
    return 0;
}
```

**hello.i**  
Source code  
C language  
Contains *declarations* of `printf()` and many other functions  
Missing *definition* of `printf()`

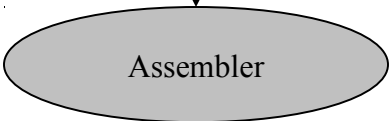


**Compile**  
gcc217 -S hello.i

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```
.section ".rodata"
cGreeting:
.string "hello, world\n"
.section ".text"
.globl main
.type main,@function
main:
movq $cGreeting, %rdi
movl $0, %eax
call printf
movl $0, %eax
ret
```

**hello.s**  
Source code  
Assembly language  
Missing definition of `printf()`



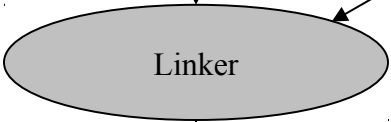
**Assemble**  
`gcc217 -c hello.s`

```
100101000110100100100...
```

**hello.o**  
Object code  
Machine language  
Missing definition of `printf()`

```
11110010000010100100110...
```

**libc.a**  
Library containing  
machine language definitions  
of `printf()` and many  
other functions



**Link**  
`gcc217 hello.o -o hello`

```
001010000101000000111110...
```

**hello**  
Executable code  
Machine language  
Contains definition of `printf()`

Shortcut:  
`gcc217 hello.c -o hello`

```
gcc217
is an abbreviation for
gcc -Wall -Wextra -Wno-unused-parameter
    -ansi -pedantic
```