Many language rules are checked by the compiler, and it is possible to bypass the rules using assembly language after compilation. Consider the following C program:

```c
//c.c
#include<stdio.h>

int x=3;

int main(void)
{
  int x=5;
  printf("x = %d\n", x);
}

```

1. Compile the program and generate its assembly code.

   在终端输入命令

```
gcc -S c.c
```

获得汇编代码c.s

```
  .file "c.c"
  .text
  .globl  _x
  .data
  .align 4
_x:
  .long 3
  .def  ___main;  .scl  2;  .type 32; .endef
  .section .rdata,"dr"
LC0:
  .ascii "x = %d\12\0"
  .text
  .globl  _main
  .def  _main;  .scl  2;  .type 32; .endef
_main:
LFB11:
  .cfi_startproc
  pushl %ebp
  .cfi_def_cfa_offset 8
  .cfi_offset 5, -8
  movl  %esp, %ebp
  .cfi_def_cfa_register 5
  andl  $-16, %esp
```

```
	subl	$32, %esp
	call	___main
	movl	$5, 28(%esp)
	movl	28(%esp), %eax
	movl	%eax, 4(%esp)
	movl	$LC0, (%esp)
	call	_printf
	movl	$0, %eax
	leave
	.cfi_restore 5
	.cfi_def_cfa 4, 4
	ret
	.cfi_endproc
LFE11:
	.ident	"GCC: (MinGW.org GCC-8.2.0-3) 8.2.0"
	.def	_printf;	.scl	2;	.type	32;	.endef

```

2. Understand the assembly code and modify it to let the program print the global variable `x` instead of the local variable `x`.

   `.globl _x`中_x代表一个地址，.globl表明_x会被链接器使用，需要在目标文件的符号表中标记为一个全局符号。

   `.cfi_startproc`和`.cfi_endproc`分别位于汇编函数的开头和结尾，标志函数的起止。

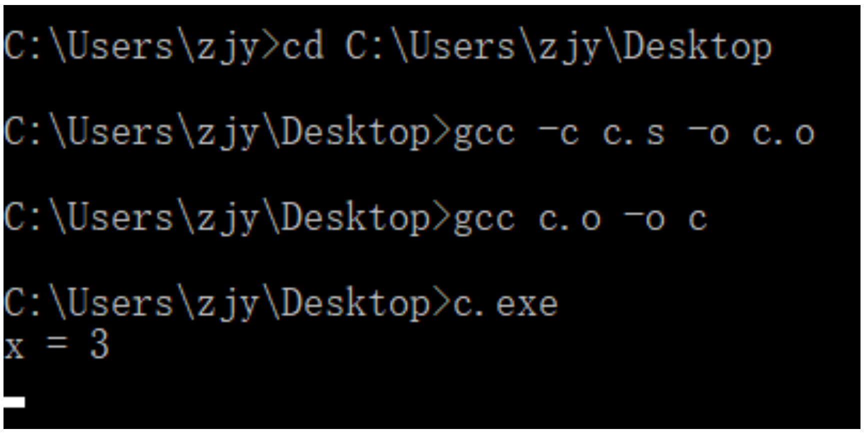
   `pushl %ebp`和`movl %esp, %ebp`两条指令是将栈顶指向ebp的地址。对寄存器esp做一系列运算之后，定位到x的栈地址，通过`movl $5, 28(%esp)`将5写入x。栈中存放的是局部变量，代表C语言中的int x=5;语句。`movl 28(%esp), %eax`将x的值放入基地址寄存器eax。`movl %eax, 4(%esp)`将eax中的值放入4(%esp)。LC0字段存放需要打印的信息。通过`movl $LC0, (%esp)`和`call _printf`

   调用打印出x = 5。

   因为_x代表全局变量，通过`movl _x, %eax`将全局变量放到eax中，打印出来的就是全局变量x。修改汇编指令如下：

```
	.file	"c.c"
	.text
	.globl	_x
	.data
	.align 4
_x:
	.long	3
	.def	___main;	.scl	2;	.type	32;	.endef
	.section .rdata,"dr"
LC0:
	.ascii "x = %d\12\0"
	.text
	.globl	_main
	.def	_main;	.scl	2;	.type	32;	.endef
_main:
LFB11:
	.cfi_startproc
	pushl	%ebp
	.cfi_def_cfa_offset 8
	.cfi_offset 5, -8
	movl	%esp, %ebp
	.cfi_def_cfa_register 5
	andl	$-16, %esp
	subl	$16, %esp
	call	___main
	movl	$5, 28(%esp)
	movl	_x, %eax
	movl	%eax, 4(%esp)
	movl	$LC0, (%esp)
	call	_printf
	movl	$0, %eax
	leave
	.cfi_restore 5
	.cfi_def_cfa 4, 4
	ret
	.cfi_endproc
LFE11:
	.ident	"GCC: (MinGW.org GCC-8.2.0-3) 8.2.0"
	.def	_printf;	.scl	2;	.type	32;	.endef
```

检验:



```
C:\Users\zjy>cd C:\Users\zjy\Desktop

C:\Users\zjy\Desktop>gcc -c c.s -o c.o

C:\Users\zjy\Desktop>gcc c.o -o c

C:\Users\zjy\Desktop>c.exe
x = 3
```