

CS 241: Systems Programming

Lecture 9. More C

Fall 2019

Prof. Stephen Checkoway

Announcement

No reading quiz for Wednesday (since you already did it for today)

Operators

The same as Java

- ▶ Arithmetic: +, -, *, /, %
- ▶ Logical: &&, ||, !
- ▶ Bitwise: &, |, ^, ~, <<, >>
- ▶ Pre/post increment, decrement: ++, --
- ▶ Relational: ==, !=, <, <=, >, >=
- ▶ Assignment: =, +=, -=, *=, /=, %=, &=, |=, ^=, <<=, >>=

There are some others we'll talk about later

- ▶ `sizeof`
- ▶ `.`
- ▶ `->`

C has pre- and post-increment (++) and -decrement (--) operators. What does this code print? (%d means print an integer)

```
int main(void) {  
    int x = 3;  
    int y = 5;  
    printf("%d %d\n", x--, ++y);  
    return 0;  
}
```

A. 2 5

B. 2 6

C. 3 5

D. 3 6

E. Undefined

C has pre- and post-increment (++) and -decrement (--) operators. What does this code print? (%d means print an integer)

```
int main(void) {  
    int x = 3;  
    printf("%d\n", x-- + --x);  
    return 0;  
}
```

A. 3

B. 4

C. 5

D. 6

E. Undefined

Huge difference from Java

C is **full** of **undefined behavior**, **implementation-defined behavior**, and **unspecified behavior**

Undefined behavior gives the compiler license to do whatever it wants, including nothing

Implementation-defined behavior means the compiler gets to choose (and document) its behavior

Unspecified behavior means the compiler gets to pick from among several choices

What does the code print?

A. foo

bar

1 2

B. bar

foo

1 2

C. 1 2

foo

bar

D. Undefined

behavior,

could print

anything

E. Unspecified

behavior,

either A or B.

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

```
int foo(void) {  
    printf("foo\n");  
    return 1;  
}
```

```
int bar(void) {  
    printf("bar\n");  
    return 2;  
}
```

```
int main(void) {  
    printf("%d %d\n", foo(), bar());  
    return 0;  
}
```

Control flow

if statements; for, while, do-while loops almost identical to Java

zero is **false**, nonzero is **true**

Examples

```
int signum(int x) {  
    if (x < 0)  
        return -1;  
    if (x > 0)  
        return 1;  
    return 0;  
}
```

```
int sum_of_squares(int n) {  
    int result = 0;  
    for (int i = 1; i < n; ++i)  
        result += i * i;  
    return result;  
}
```

Examples

```
bool get_reponse(void) {
    int response;
    do {
        printf("Enter y or n\n");
        response = getchar();
    } while (response != EOF
            && response != 'y'
            && response != 'n');
    return response == 'y';
}
```

Compiler options (gcc/clang)

- E preprocessor only
- S compile only (no assembly or linking)
- c compile/assemble (produce .o file)
- o `foo` specify output file as `foo`
- l`xxx` use library named `libxxx.so` or `libxxx.a`
- g emit debugging symbols (enables debugging)
- std=c11 use C11 standard
- pedantic be pedantic
- Wall turn on "all" warnings
- Wextra turn on extra warnings
- Werror make warnings into errors

Compiling code

```
$ <compiler> <options> <.c files> <libraries>
```

```
$ clang -Wall -o program -std=c11 *.c -lm
```

If you omit `-o output`, the default is `a.out`

If you omit `-std=c11`, `clang` and `gcc` have different defaults!

Formatting your code

It's important to be consistent more than anything else

Use tools!

```
$ clang-format foo.c # Writes formatted code to stdout
```

```
$ clang-format -i foo.c # Writes formatted code back to foo.c
```

In-class exercise

<https://checkoway.net/teaching/cs241/2019-fall/exercises/Lecture-09.html>

Grab a laptop and a partner and try to get as much of that done as you can!