

CSc 352

C - Syntax, Numbers, Math, I/O

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Inspired by Slides from Eric Anson

Announcements

- Readings - Did you get the book yet?
- PA 1 deadline

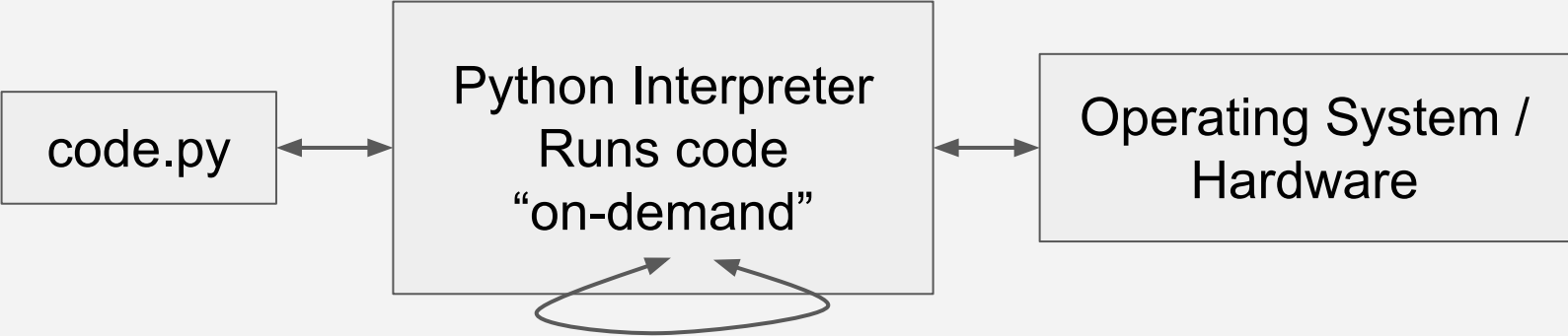
C Language

- Expectation: You already know Python and Java
- C syntax similar to Java, less so Python
 - Variables assignment, ifs, loops, curly-braces, etc

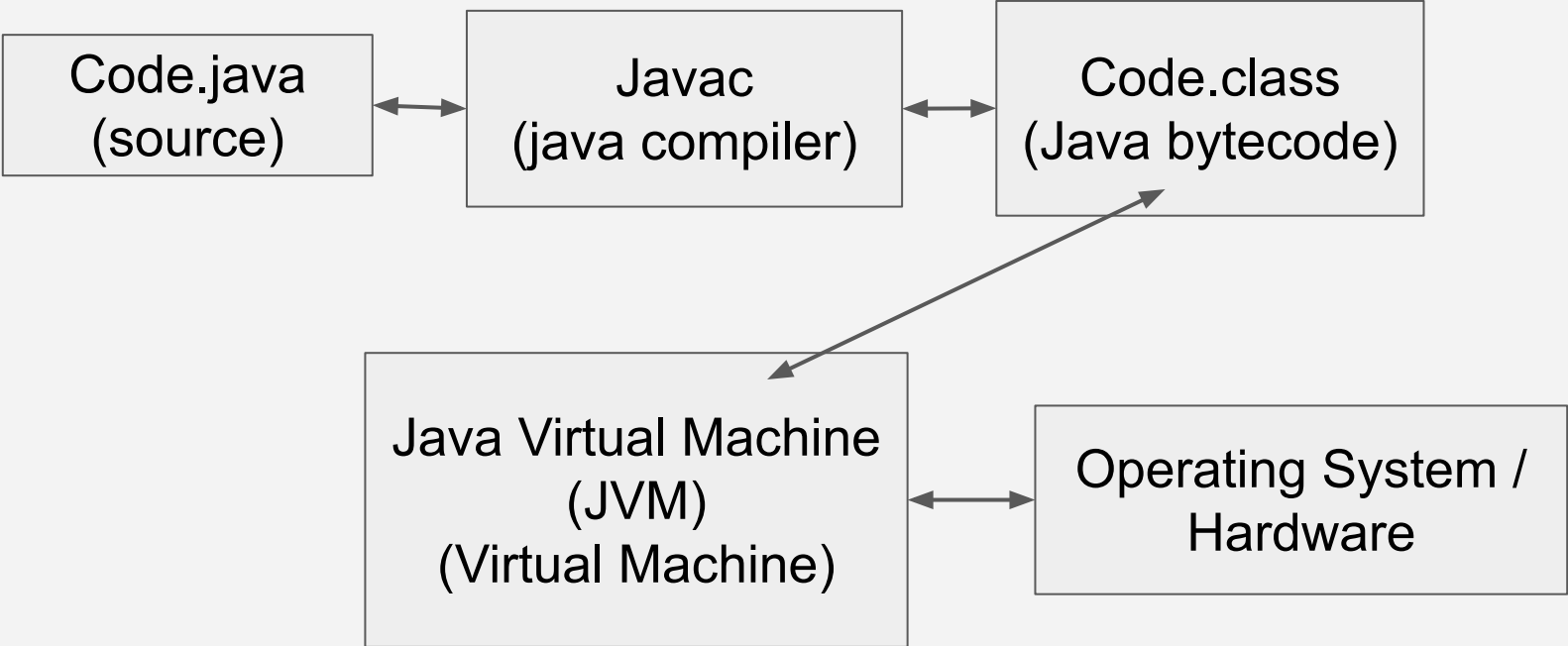
Differences between C and Java

- NOT object oriented (no classes, inheritance, methods, etc)
- Low-level (not run with interpreter / VM)
- Memory Management, Garbage Collection
- Pointers (similar to references)
- Less stuff is built-in, have to **#include** functionality
- No array boundary protection
- Less hand-holding :)

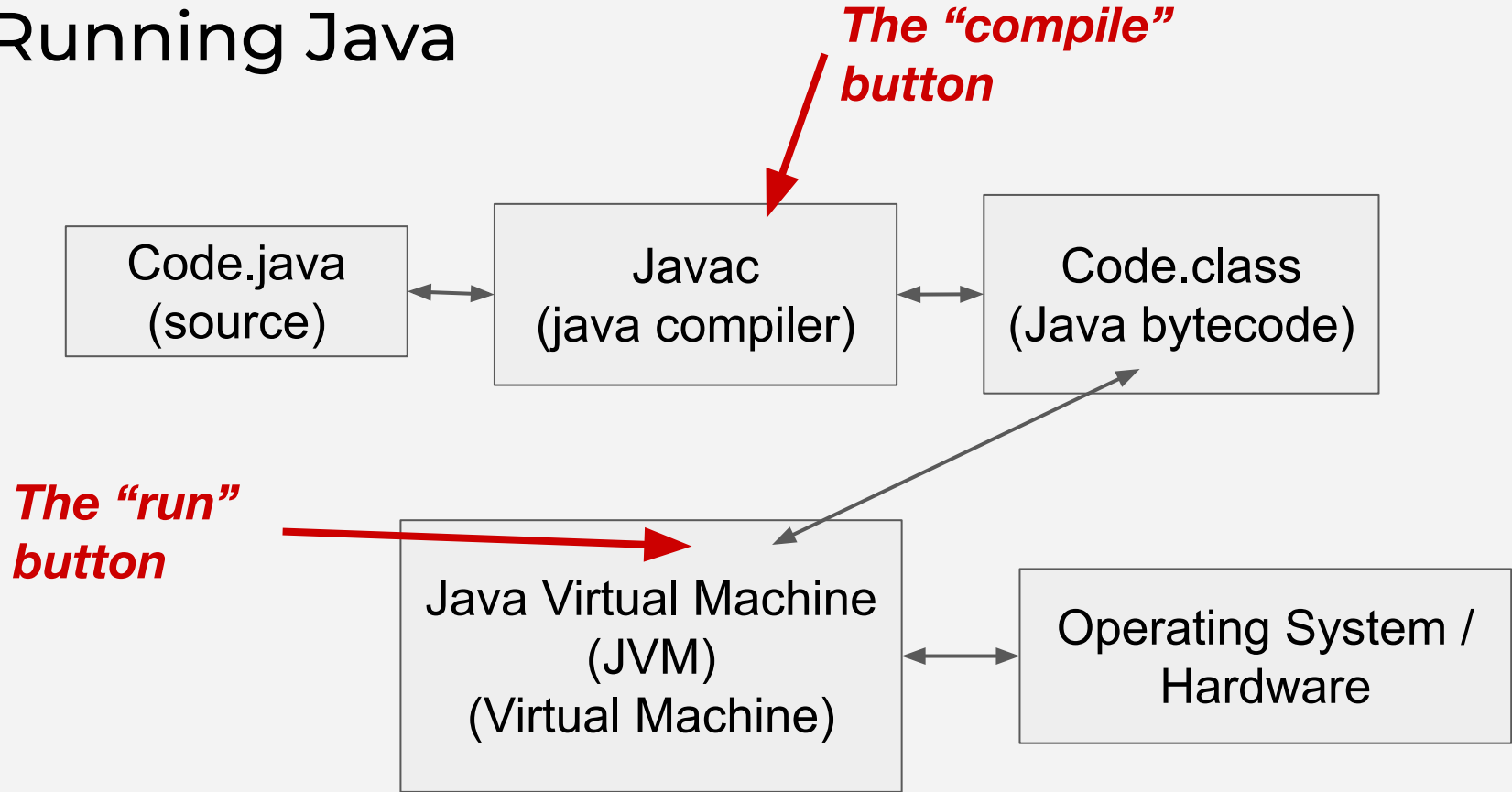
Running Python



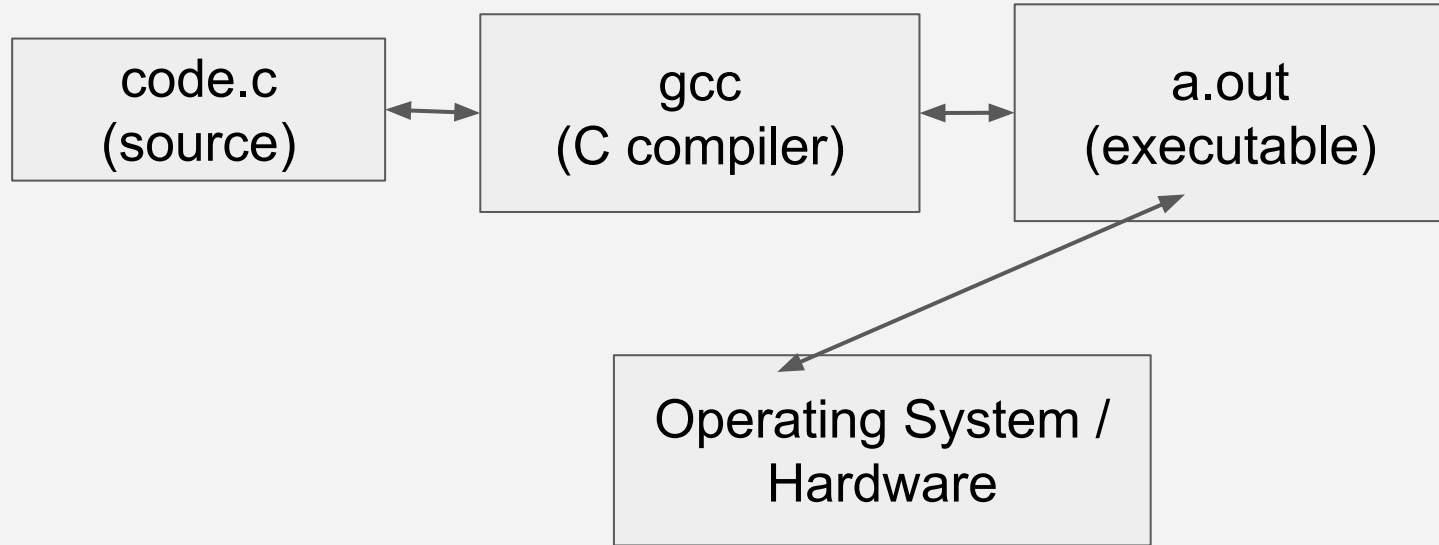
Running Java



Running Java

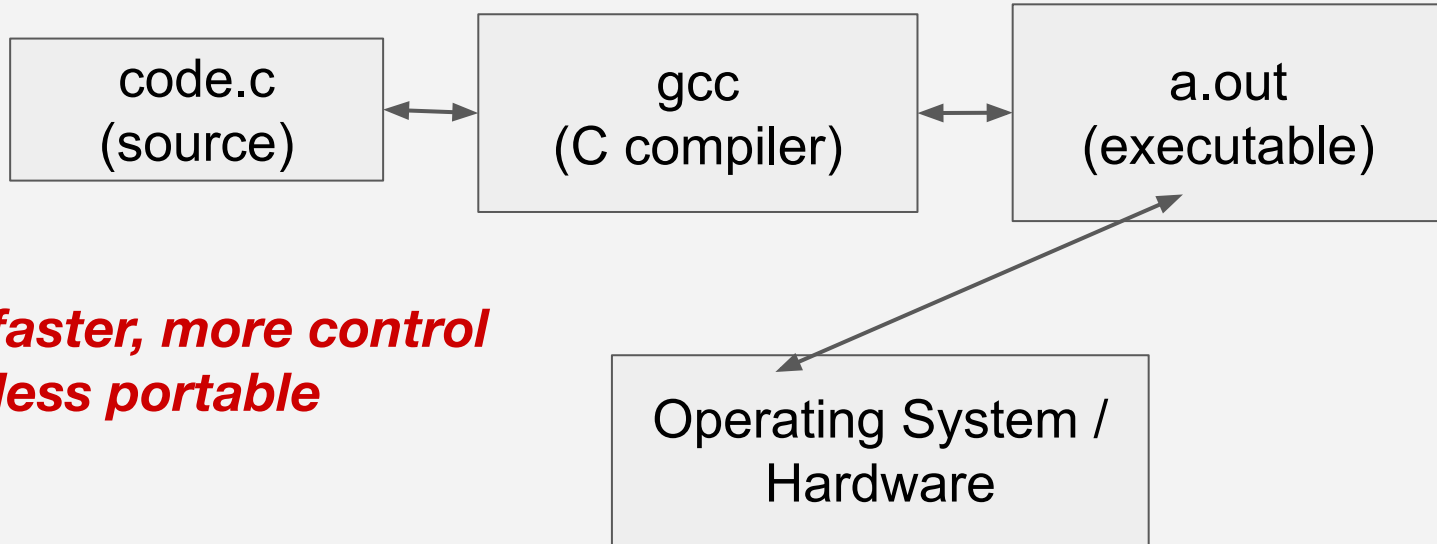


Running C



Running C

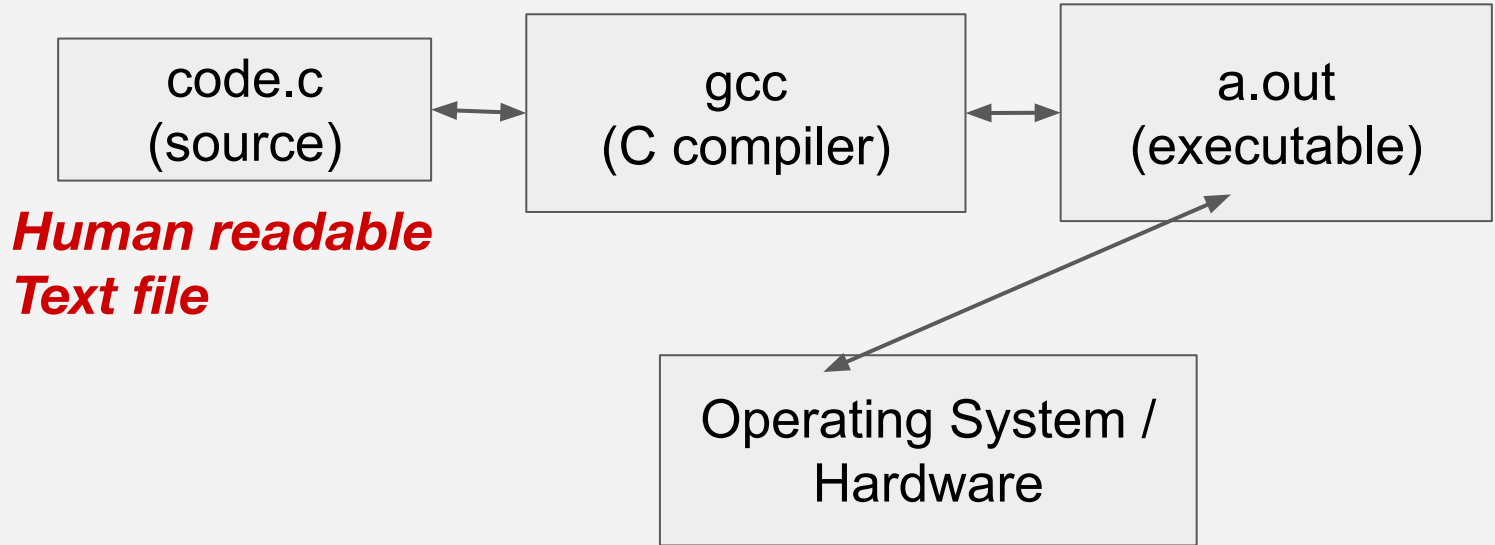
***Compiled and then run,
cuts out VM middle-man***



***PRO: faster, more control
CON: less portable***

Running C

Machine code
Not (easily) human readable
Binary file



C Compilers

- A program that takes C source code (text) as input, and produces an executable file (binary) that can run directly on an operating system, as output
- Two popular: **gcc** and **clang**
- For this course: **gcc**

`$ man gcc` # so many options, what should we use?

gcc Options

-Wall

C compilers differentiate warnings from errors by default

Warnings can be turned on / off

This option enables **all** warnings

-Werror

Treat all warnings as errors

Won't compile unless there are *no* warnings / errors)

-std=c11

Multiple C standard / versions

For this class: C11 (as opposed to C89, C99, C17)

Compiling with gcc

```
$ ls
```

```
some_code.c
```

```
$ gcc -Wall -Werror -std=c11 some_code.c
```

```
$ ls
```

```
a.out      some_code.c
```

```
$
```

Compiling with gcc

```
$ ls
```

```
some_code.c
```

```
$ gcc -Wall -Werror -std=c11 some_code.c
```

```
$ ls
```

```
a.out      some_code.c
```

```
$
```

So what goes in a .c file?

Compile and run a C Program

```
int main() {  
    printf("hi\n");  
}
```

- Log on to lectura (or local)
- Create file named some_code.c
- Put this in it, then run:

```
$ gcc some_code.c  
$ ./a.out
```

Compile and run a C Program

```
int main() {  
    printf("hi\n");  
}
```

Now try:

```
$ rm a.out
```

```
$ gcc -Wall -Werror -std=c11 some_code.c
```

```
$ ./a.out
```

Also try with c89

A Simple C Program

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

```
int main() {  
    printf("hi\n");  
    return 0;  
}
```

A Simple C Program

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

```
int main() {  
    printf("hi\n");  
    return 0;  
}
```

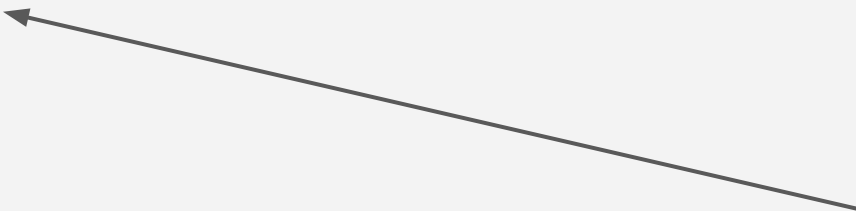
return type, function name, param
sequence (like Java)



Function calls, arguments,
params, etc works similar to Java
(more on that in future)



Curly-braces for functions
Also used for ifs, loops, scope
(like Java)



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

```
int age = 45;
```

```
int height = 104;
```

```
int main() {
```

```
    int weight = 180;
```

```
    printf("age: %d\n", age);
```

```
    printf("height: %d, weight: %d\n", height, weight);
```

```
    return 0;
```

```
}
```

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

```
int age = 45;  
int height = 104;
```

Global variables of type int
C uses static types, like Java



```
int main() {  
    int weight = 180;
```

Local integer variable




```
    printf("age: %d\n", age);  
    printf("height: %d, weight: %d\n", height, weight);
```

```
    return 0;
```

```
}
```

Print formatting
See: man 3 printf



printf format strings

The first argument is a string that can contain regular characters, escape characters (starting with \) and conversion specifiers (starting with %)

```
printf("word %d another %f another, %x \n", a, b, c);
```

Number of conversion specifiers must match values following

Each conversion specifier can have multiple options

D for dec int, **x** for hex int, **f** for float number, etc

See man page

<https://flaviocopes.com/c-conversion-specifiers/>

Style requirements

Style Guide - <https://benjdd.com/courses/cs352/spring-2023/style/>

Man pages

Different types of man pages:

1. User commands
2. System Calls (OS / kernel functions)
3. Library calls (program libraries)
4. Special files (usually from /dev)
5. File formats and conventions
6. Games
7. Miscellaneous
8. System admin commands
9. Nonstandard Kernel Routines

When we see something like **CAT(1)** this tells us it is from category 1

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

```
int main() {
```

```
    int height = 0;
```

```
    int weight = 0;
```

```
    printf("Enter height: ");
```

```
    scanf("%d", &height);
```

```
    printf("Enter weight: ");
```

```
    scanf("%d", &weight);
```

```
    printf("\nYour height and weight is: ");
```

```
    printf("    height: %d, weight: %d\n", height, weight);
```

```
    return 0;
```

```
}
```



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

The scanf function comes from the stdio component of the C standard library as well

```
int main() {
```

```
    int height = 0;
```

```
    int weight = 0;
```

Call scanf, specify expected type in the format string

```
    printf("Enter height: ");
```

```
    scanf("%d", &height);
```

```
    printf("Enter weight: ");
```

```
    scanf("%d", &weight);
```

Why the "&" ?

For now, just know that you need to put it there, will address further later

```
    printf("\nYour height and weight is: ");
```

```
    printf("  height: %d, weight: %d\n", height, weight);
```

Print the results

```
    return 0;
```

```
}
```

Averaging Numbers

Write a C program that:

- Asks the user for three integer numbers
- Computes the average
- Prints the result

Math in C

Most of the standard / simple math operators work as-expected

+ - / * % ++ --

Some of the more “advanced” operations in the `<math.h>` module

`.... exp(base, exponent) sqrt(number) fabs(a, b)`

Look at some man pages

(What are these “floats” and “doubles”?) (-lm)

Primitive Types in C

Integer representation
Floating-point representation

char short int long long long float double long double

- **Integers** can be preceded by **signed** or **unsigned** (signed default)
- Why so many types? Sizes.
 - Some use different amount of bytes
 - Less bytes = less memory, but less range
- Keep in mind: behind the scenes, **all** of these types are just binary sequences of 1s and 0s

Primitive Types in C

<code>char</code>	min = 8 bits	-128 to 127
<code>short</code>	min = 16 bits	-32,768 to 32,767
<code>int</code>	min = 16 bits	-32,768 to 32,767
<code>long</code>	min = 32 bits	-2,147,483,647 to 2,147,483,647
<code>Long long</code>	min = 64 bits	-9,223,372,036,854,775,808 to 9,223,372,036,854,775,807
<code>float</code>	typically 32 bits	
<code>double</code>	typically 64 bits	
<code>long double</code>	typically 128 bits	

- Specifics varies from machine to machine
- Use `sizeof()` and `limits.h`

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

```
int main() {
```

```
    int      a = 100;
```

```
    long long b = 10000;
```

```
    float     c = 1.76891401;
```

```
    double    d = 12875.1002713;
```

```
    printf("Int: %d\n", a);
```

```
    printf("Long long: %lld\n", b);
```

```
    printf("Float: %f\n", c);
```

```
    printf("Double: %lf\n", d);
```

```
    printf("Double with four dec: %.4f\n", d);
```

```
    return 0;
```

```
}
```

What will it print?

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

```
int main() {  
    signed char x = 0;  
    printf("%ld\n", sizeof(x)); // prints out 1 (1 bytes = 8 bits)  
    printf("%d\n", x);  
    long i = 0;  
    while (i < 257) {  
        x = x + 1;  
        i += 1;  
    }  
    printf("%d\n", x);  
    return 0;  
}
```

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

void bin(char n) {
    unsigned int i;
    for (i = 1 << 7; i > 0; i = i / 2) {
        (n & i) ? printf("1") : printf("0");
    }
    printf("\n");
}

int main() {
    char x = 127;
    for (int i = 0; i < 3; i += 1) {
        printf("%d\n", x);
        bin(x);
        x += 1;
    }
    return 0;
}
```


What will be in output.txt?

```
$ gcc -Wall -Werror -std=c11 -o add add.c  
$ echo "addition is: " >> output.txt  
$ cat input.txt | ./add > output.txt
```

```
20  
30
```

input.txt

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

add.c

```
int main() {  
    int x1 = 0, x2 = 0;  
    scanf("%d", &x1);  
    scanf("%d", &x2);  
    printf("result: %d\n", (x1 + x2));  
    return 0;  
}
```