THE UNIVERSITY OF ALABAMA AT BIRMINGHAM

CS330

C: Part II

Spring 2023

Lab 3

Compiled by John Bedingfield and Dylan Calvin

Today's Agenda

- char
- #define
- Typedef
- Struct
- More printf examples
- More on operands
- Switch
- While and Do-While
- Functions revisited
- User input via Scanf()
- GDB Basics

Odds and ends

- In Terminal: CTRL-C will terminate the program
- In C, 0 is False, anything non-zero evaluates to True
- In C, comments are the same as in Java
- **Note comments for Functions:**
  - Description
  - Describe inputs/arguments
  - Describe outputs/return
- No executable code outside Functions (like Java, unlike Python)
- Man (manual) pages are your friend
- Don't forget to 'exit' Vulcan
  - VSCode:
    - Click lower-left green connection status
    - From menu select: 'Close Remote Connection'

```
// single line comment

/*
block comment
*/

/*
description:  this function calculates the distance between two numbers
arguments:
  x1 represents the x1-location in pixels
  x2 represents the x2-location in pixels
returns: the euclidan distance between x1 and x2
*/
float calcDistance(int x1, int x2){
    // do stuff
}
```

ITEMS IN OUR C TOOLKIT

Variables

Do we need to store something for later use?
(or make our code easier to read [no magic numbers])?

Y

Do we need to store more than one item (same type)?

Y

N

What type? Declare variable

<type> <name>

LOOPs

Do we need to do something more than once?

Y

Do we know how many times we need to loop?

Y

for loop

N

Do we need to ensure the loop runs at least once?

Y

N

Control Flow

Do we need to make a decision, or determine what to do next?

Y

can we limit to:
(a) Evaluation using "=" only?
(b) Comparison of int or char only?

Y

N

If
else if
else

Other C Items

C Library Functions

printf() print

Errors? Contact Jan Bedingfield

THE UNIVERSITY OF ALABAMA AT BIRMINGHAM

C: Part II

The rest of the basics, and
Some things that may be different than Java (or Python)

Compiled by John Bedingfield and Dylan Calvin

char

- Represented via a single quote mark: ‘
  - E.g. char x = ‘a’;
  - Double quotes denote strings: char myString[] = “my string”;
- Also represented by decimal, ASCII

```
int main() {
    char x = 'a';
    printf("%c %d\n", x, x);

```

```
a 97
```

- Since C treats the characters as integers, we can use them in numerical expressions. For example:

```
char ch = 'c’;
ch++; /* ch becomes 'd' */
```

#define

- The `#define` directive is used to define a macro. In most cases, a macro is a name that represents a numerical value. To define such a macro, we write:

```
#define <macro_name> <value>
```

NOTE: there is no semicolon at the end

For example

```
#define NUM 100
```

```
#define TRUE 1
#define FALSE 0
```

```c
#include<stdio.h>

#define NUM 100

int main(){
    int a, b, c;
    a = 20 - NUM;
    b = 20 + NUM;
    c = 3 * NUM;
    printf("a is %d, b is %d, c is %d\n", a, b, c);

    return 0;
}
```

```
a is -80, b is 120, c is 300
```

typedef

- Typedef is similar to define, but used to map a new data type name to an existing type:

```
typedef <existing type> <new name>;
```

This has the added benefit of providing type checking

```
typedef int Length;

int main(){

    Length l = 10;
    printf("the length is %d\n", l);
```

```
the length is 10
```

You might see this with _t, e.g. size_t

```
typedef int size_t;
```

struct

- Struct (structure) is a collection of one or more variables (e.g. data structure)
- To declare:

struct [structure tag] {

<member type> <member name>;

...

<member type> <member name>;

} [list of variables] ;

- Can combine typedef and struct
- Ordering members largest to smallest saves space
- See also Union

```c
#include<stdio.h>

struct Coordinate{
    int x;
    int y;
    int z;
};

int main(){
    struct Coordinate c;
    /* access structure elements using dot (.) notation */
    c.x = 1;
    c.y = 2;
    c.z = 3;

    printf("x is %d, y is %d, z is %d\n", c.x, c.y, c.z);

    /* if using pointers, the syntax is slightly different, using -> */
    struct Coordinate *c_ptr;
    c_ptr = &c;
    c_ptr->x = 10;
    printf("x is %d, y is %d, z is %d\n", c_ptr->x, c_ptr->y, c_ptr->z);

    return 0;
}
```

```
x is 1, y is 2, z is 3
x is 10, y is 2, z is 3
```

printf examples

```c
#include <stdio.h>
int main(void)
{
        int len;
        printf("%c\n", 'w');
        printf("%d\n", -100);
        printf("%f\n", 1.56);
        printf("%s\n", "some text"
        printf("%e\n", 100.25);
        printf("%g\n", 0.0000123);
        printf("%X\n", 15);
        printf("%o\n", 14);
        printf("test%n\n", &len);
        printf("%d%%\n", 100);
        return 0;
}
```

The program outputs:

w (the character constant must be enclosed in single quotes).
`-100`
`1.560000`
`some text` (the string literal must be enclosed in double quotes).
`1.002500e+002` (equivalent to $1.0025 \times 10^2 = 1.0025 \times 100 = 100.25$).
`1.23e-005` (because the exponent is less than `-4`, the number is displayed in scientific form).
`F` (the number `15` is equivalent to `F` in hex).
`16` (the number `14` is equivalent to `16` in octal).
`test` (since four characters have been printed before `%n` is met, the value `4` is stored into `len`.
`100%` (to display the `%` character, we must write it twice).

printf Precision

```c
#include <stdio.h>
int main(void)
{
        float a = 1.2365;
        printf("%f\n", a);
        printf("%.2f\n", a);
        printf("%.*f\n", 3, a);
        printf("%.f\n", a);
        return 0;
}
```

```
1.236500
1.24
1.237
1
```

++ and --

- **Similar to Java**

```
int a=25;
a++; /* is equal to a = a+1; */
a--; /* is equal to a = a-1; */
Can also use ++a, order matters:
```

```c
    int a = 5;
    int b;
    printf("a++ = %d\n", a++);  // prints 5, afterwards a evals to 6
    b = a++;  // a starts off 6, is assigned to b, then incremented to 7
    printf("1)  a = %d, b = %d\n", a, b);  // a is 7, b is 6
    a = 5;  // reset
    b = ++a;  // a starts of 5, is incremented to 6, then assigned to b
    printf("2)  a = %d, b = %d\n", a, b); // a is 6, b is 6
```

```
a++ = 5
1)  a = 7, b = 6
2)  a = 6, b = 6
```

Compound Assignment Operators

```
#include <stdio.h>
int main(void)
{
        int a = 4, b = 2;
        a += 6;
        a *= b+3;
        a -= b+8;
        a /= b;
        a %= b+1;
        printf("Num = %d\n", a);
        return 0;
}
```

switch statement

```c
#include <stdio.h>
int main(void)
{
        int a;
        printf("Enter number: ");
        scanf("%d", &a);
        switch(a)
        {
                case 1:
                        printf("One\n");
                break;
                case 2:
                        printf("Two\n");
                break;
                default:
                        printf("Other\n");
                break;
        }
        printf("End\n");
        return 0;
}
```

while loop

```
#include <stdio.h>
int main(void)
{
        int i = 10;
        while(i != 0)
        {
                printf("%d\n", i);
                i--;
        }
        return 0;
}
```

do-while loop

```
#include <stdio.h>
int main(void)
{
        int i = 1;
        do
        {
                printf("%d\n", i);
                i++;
        } while(i <= 10);
        return 0;
}
```

Difference between while and do-while ?
When to use for vs while ?

Functions

- Need to define before use, can use a declaration statement
- Pass by Value vs Pass by Reference

Pass By Value

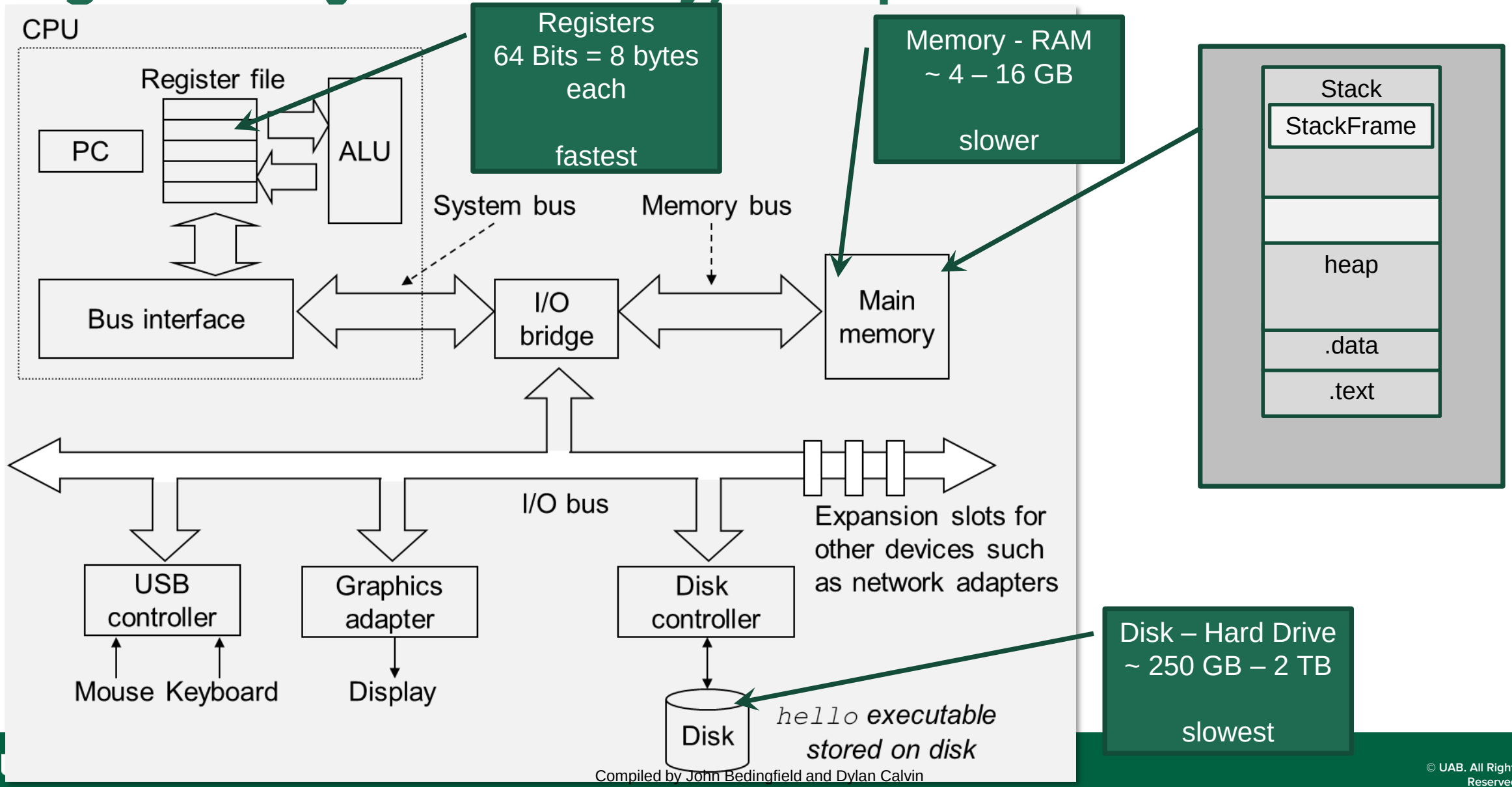
```c
#include <stdio.h>

void myFunc(int x){
    printf("inside myFunc x = %d (%p) \n", x, &x);
    x++;
    printf("inside myFunc x is now %d (%p)\n", x, &x);
    return;
}

int main(){
    int x = 5;
    printf("inside main, x is %d (%p)\n", x, &x);
    myFunc(x);
    printf("inside main, x is %d (%p)\n", x, &x);
    return 0;
}
```

```
inside main, x is 5 (0x7ffd49630c2c)
inside myFunc x = 5 (0x7ffd49630c0c)
inside myFunc x is now 6 (0x7ffd49630c0c)
inside main, x is 5 (0x7ffd49630c2c)
```

High Level (just for today) Computer Architecture



Input/Output: Terminal Input via scanf()

Syntax:

```
int scanf(const char *restrict format, ...);
int scanf(<conversion spec string>, <pointer arg>);
```

- The scanf() function is used to read data from stdin (*st*andar*d in*put stream) and store that data in program variables.
- The scanf() function accepts a variable list of parameters. The first is a format string similar to that of printf(), followed by the memory addresses of the variables in which the input data will be stored.
- Typically, the format string contains only conversion specifiers. The conversion characters used in scanf() are the same as those used in printf().

Input/Output: Terminal Input via scanf() Example

Syntax:

int scanf(const char *restrict format, ...);

int scanf(<conversion spec>, <pointer arg>);

```
48    /* take as terminal input */
49    int n;
50    printf("Please enter an integer:\n");
51    //scanf("%d", &n)
52    int returnCode;
53    if ( (returnCode = scanf("%d", &n)) < 0){
54        printf("there was an error on input\n");
55    }
```

Using gdb to better understand your program

gdb is an extremely powerful tool for debugging programs, helping you identify any runtime or logical errors (e.g. segmentation faults, core dumps, array out-of-bounds exceptions).
To debug your programs using gdb, you will need to compile with the **-g** option. This will instruct the compiler to generate the executable with source level debug info.

```
gcc -g name.c -o name
```

Now you can enter the gdb debugger with one of the following commands:

```
gdb name        gdb -tui name
```

The TUI version is recommended for new users and shows the source code and gdb command line in one window

You should see something similar to the picture, with -tui

The program here shows you how to take two numbers from user input and compute their sum!

Cmder

add.c

```
3       int main(){
4
5               int a, b, c;
6               printf("Enter an integer: ");
7               scanf("%d" , &a);
8               printf("Enter a second integer: ");
9               scanf("%d" , &b);
10
11              c = a + b;
12
13              printf("Sum of %d and %d is %d \n" , a, b, c);
14
15              return 0;
16      }
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
```

```
exec No process In:                                    Line: ??    PC: ??
GNU gdb (GDB) Red Hat Enterprise Linux 7.6.1-110.el7
Copyright (C) 2013 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.  Type "show copying"
and "show warranty" for details.
This GDB was configured as "x86_64-redhat-linux-gnu".
For bug reporting instructions, please see:
<http://www.gnu.org/software/gdb/bugs/>...
Reading symbols from /home/UAB/cobrian/Lab4_files/add...done.
(gdb)
```

GDB Basics

- To set a breakpoint:
  - (b)reak <line number>
  - or to break at the start of a function: (b)reak <name of function>
  - To remove a breakpoint: clear <line number>
- run
- Inspect variables
  - To display once: (p)rint <variable name>
  - To display at each step: display <variable name>
- Step through the code
  - (n)ext (don't dive into functions, step-over)
  - (s)tep (dive into functions, step-into)
  - (c)ontinue (continue running until the end or next breakpoint)
- RETURN (or ENTER) will repeat the last command entered
- (q)uit

Resources:

Beej's Quick Guide: https://beej.us/guide/bggdb/
https://www.gnu.org/software/gdb/documentation/
Manual: http://sourceware.org/gdb/current/onlinedocs/gdb.pdf

THE UNIVERSITY OF ALABAMA AT BIRMINGHAM

Back-ups

Input/Output

- User Terminal Input: scanf()
- File I/O
- fopen()
- fscanf()
- fprintf()
- fgets()?
- fputs()?