

# LAB 4 Local and Global variables. “Pass by value”, string and other library functions. 2D arrays. Pointer basics.

Due: Oct 21 (Fri) 11:00 pm

Total marks: 120 pts

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## Problem A0 Scope, Life time and Initialization of global variables, local variables and static global/local variables

Download the files `lab4A0.c` and `cal.c`. Read the code first. Observe that for functions that have no parameters, they are declared as `functionName(void)`, e.g., `modify(void)`. It will also work if we declare them as `functionName()`, but the former is the preferred way of declaring such functions. Also, if a function has no return value, it is declared as `void functionName` e.g., `void modify(void)`. Compile (how?) and run the main program.

**[Scope and initialization of global variables]** Observe that global variables `x` and `y`, which are defined in `cal.c`, can be accessed in other file `lab4A0.c` (`x` and `y` have global scope), and in order to access `x` and `y`, the other file needs to declare them using keyword **extern**. Moreover, the output `x:0 y:0` implies that global variables `x` and `y`, which were not initialized explicitly, all got initialized to 0 by the compiler. Also observe how the function `modify()`, which was defined in `cal.c`, was declared and used in the other file. In declaring a function, keyword **extern** is optional. Also observe how the values of `x` and `y` are changed in function `modify()` using compound operators, and how the second operation is evaluated following the operator precedence, giving `y` a new value 120, not 100 or 102.

**[Scope of local variables]** Next, uncomment the commented `printf` statement (middle of the main function), and compile the files again. Observe the error message. The problem here is that local variable `a`'s scope is the block/function in which it is defined. Here `a` is defined in the `if` block, so it is not accessible outside the `if` block, even in the `main` function. Modify by declaring `a` before the `if` clause, i.e., change to `int a; if (y != 0){ a = y;}` Now `a`'s defining block is the `main` function, so `a`'s scope is anywhere in `main` after its declaration, which makes it accessible after the `if` block. Compile and run the program again.

**[Lifetime of local variables]** Uncomment the commented block near the end of `main`. Observe that function `aFun` is called several times, and all produce the same value for `counter`. This is because local variable `counter` in the function has life time 'automatic' – comes to life (allocated in memory) when function `aFun` is called and vanishes (deallocated from memory) when function `aFun` returns. So each time the function is call, a brand-new variable called `counter` is created and initialized. Thus it always has value 100.

**[Initialization of local variables]** Observe the initial values of local variable `b` in `aFun`. In C and Java, if a local variable is not explicitly initialized, it is not initialized to 0 (or, more precisely, it is initialized with some garbage value). Run the program again and you might see different values.

**[Lifetime of static local variables]** Next, make `counter` a **static** local variable, compile and run again. Observe that the value of `counter` is different in each call and its value is maintained between the function calls, due to the fact that in C a static local variable has persistent lifetime over function calls, similar to global variable. (Note that, a static local variable's scope is still within the block where it is defined. So `counter` is still not accessible outside the function. Try to access `counter` in `main` and you will get compiling error.) Also observe that compound operator `+=` is used.

**[Initialization of static local variables]** Next, remove the initial value 100 for `counter`, compile and run again, and observe that in the first time call `counter` gets an initial value 0. As discussed in class, global variables and static local variables get initial value 0 if not initialized explicitly. ('Regular' non-static local variables such as `b`, as we observed above, are not initialized to 0, or, more precisely, are initialized with some garbage values).

**[Scope of static global variables]** Finally, make `y` in `cal.c` to be static and compile again. Observe that global variable `y` becomes inaccessible in `main`. (But it is still accessible later in file `cal.c`, where it is defined.)

[No submission for this question.](#)

## **Problem A1 variable scope, “Pass-by-value”, tracing a program with debugger (5pts)**

### **Specification**

To better understand variable scope and pass-by-value in C, in this exercise we trace a program using a software tool called debugger, rather than using print statements. A debugger allows us to examine the values of variables during program execution. With a debugger, you can do this by setting several “breakpoints” in the program. The program will pause execution at the breakpoints, and you can then view the current values of the variables.

You will use a GNU debugger call **`gdb`**. It is a command-line based debugger but also comes with a simple text-based gui (`tui`).

To debug a C program using **`gdb`**, you need to compile the program with `-g` flag of **`gcc`**.

### **Implementation**

**Note:** for this exercise suggest you connect to lab environment, as you may not have the same debugger on your system.

Download the program `swap.c`, and compile using **`gcc -g swap.c`**. Then invoke **`gdb`** by issuing **`gdb -tui a.out`**. A window with two panels will appear. The upper panel will display the source code and the lower panel allows you to enter commands. Now press enter key to load the source code in the upper panel and `gdb` prompt in the lower panel. Maximize the terminal and use arrow keys to scroll the upper panel so you can see the whole source code. First, we want to examine the values of variables `mainA` and `mainB` after initialization. So we set a breakpoint at the beginning of line 11 (before line 11 is executed) by issuing **`break 11`**. Observe that a “b+” or “B+” symbol appears on the left of line 11. We want to trace the values of variables `x` and `y` defined in function `swap`, both before and after swapping, so we set breakpoints at (the beginning of) line 18 and line 21. Finally, we set a breakpoint at line 12 so that we can trace the value of `mainA` and `mainB` after the function call. `c`

When the program pauses at a breakpoint, you can view the current values of variables with the `print` or `display` or even `printf` command.

### Sample input/output

```
red 64 % gcc -g swap.c
red 65 % gdb -tui a.out
```

....

Reading symbols from a.out...done.

(gdb) **break 11**

Breakpoint 1 at 0x400488: file swap.c, line 11.

(gdb) **break 18**

Breakpoint 2 at 0x4004a3: file swap.c, line 17.

(gdb) **break 21**

Breakpoint 3 at 0x4004b5: file swap.c, line 21.

(gdb) **break 12**

Breakpoint 4 at 0x400497: file swap.c, line 12.

(gdb) **run**  
Starting program: /eecs/home/huiwang/a.out

/\* run the program until the first breakpoint. Notice the > sign on the left of the upper panel \*/

Breakpoint 1, main () at swap.c:11

(gdb) **display mainA**

mainA = ?

(gdb) **display mainB**

mainB = ?

(gdb) **continue**

Continuing.

What do you get for mainA and mainB?

/\* continue execution to the next breakpoint. Notice the position of > sign \*/

Breakpoint 2, swap (x=1, y=20000) at swap.c:18

(gdb) **display x**

x = ?

(gdb) **display y**

y = ?

(gdb) **display mainA**

.....?

(gdb) **display mainB**

.....?

(gdb) **continue**

Continuing.

What do you get for x and y?

What do you get for mainA and mainB, and why?

Breakpoint 3, swap (x=20000, y=1) at swap.c:21

(gdb) **display x**

x = ?

(gdb) **display y**

y = ?

(gdb) **continue**

Continuing.

What do you get for x and y? Are they swapped?

Breakpoint 4, main () at swap.c:12

(gdb) **display mainA**

mainA = ?

(gdb) **display mainB**

mainB = ?

(gdb) **display x**

What do you get for mainA and mainB? Are they swapped?

```

.....?
(gdb) display y
.....?
(gdb) quit

```

What do you get here, and why?

**Submission** Write your answers into a text file, and submit it. Or submit a snapshot of your gdb session. (Anything that show your work is acceptable.)

**submit 2031B lab4 text\_file\_or\_pictures**

Any name is okay

## Problem A2 Variables (10 pts)

### Specification

Complete the ANSI-C program `runningAveLocal.c`, which should read integers from the standard input, and computes the running (current) average of the input integers. The program terminates when -1 is entered.

### Implementation

- Define a function `void run_avg(int sum, int count)` which, given the current sum `sum` and the total number of input `count`, computes and displays the running average in `double`. The current sum and input count are maintained in `main`.
- Complete `main` so that input is read and maintained.

### Sample Inputs/Outputs:

```
red 307 % gcc runningAveLocal.c
```

```
red 308 % a.out
```

```
Enter number (-1 to quit): 10
```

```
running average is 10 / 1 = 10.000
```

```
Enter number (-1 to quit): 20
```

```
running average is 30 / 2 = 15.000
```

```
Enter number (-1 to quit): 33
```

```
running average is 63 / 3 = 21.000
```

```
Enter number (-1 to quit): 47
```

```
running average is 110 / 4 = 27.500
```

```
Enter number (-1 to quit): 51
```

```
running average is 161 / 5 = 32.200
```

```
Enter number (-1 to quit): 63
```

```
running average is 224 / 6 = 37.333
```

```
Enter number (-1 to quit): -1
```

```
red 309 %
```

Assume all the inputs are valid.

Submit your program using **submit 2031B lab4 runningAveLocal.c**

## Problem A3 Variables (10 pts)

### Specification

Modify the above program, simplifying communications between functions.

## Implementation

- download program `runningAveLocal2.c`.
- define a function `void run_avg(int input)`, which, given the current input `input`, computes and displays the running average. Notice that unlike the function in A2, this function takes only one argument about current input and does not take current sum and input count as its arguments. In such an implementation, current sum and input count are not maintained in `main`. Instead, `main` just pass current input to `run_avg()`, assuming that `run_avg()` somehow maintains the current sum and input count info.
- **do not modify or add to the code in `main()`.**
- do not use any global variable. Without global variables, how can function `run_avg` maintain the current sum and input count info?

## Sample Inputs/Outputs:

Same as in problem A2.

Submit your program using `submit 2031B lab4 runningAveLocal2.c`

## Problem A4 Variables (10 pts)

### Specification

Modify the program above, further simplifying communications between functions by using global variables.

### Implementation

- download program `runningAveGlobal.c`. Complete the `main()` function.
- download program `function.c`. Complete function `void run_avg()`, which computes and displays the running average. Notice that this function takes no arguments.
- define all global variables in `function.c`

## Sample Inputs/Outputs:

Same as in problem A2.

Submit your program using

`submit 2031B lab4 runningAveGlobal.c function.c`

## Problem Pre-processing Macro

In the rest of this lab, you are going to practice using some C library functions. The simplified prototypes of the functions covered in this week's lecture are listed below:

### <stdio.h>

```
printf()
scanf()

getchar()
putchar()

sscanf()
sprintf()

fgets()
fputs()
```

### <string.h>

```
int strlen(s)
s strcpy(s,s)
s strcat(s,s)
int strcmp(s,s)
```

### <ctype.h>

```
int islower(int)
int isupper(int)
int isalpha(int)
int isdigit(int)
int isxdigit(int)

int tolower(int)
int toupper(int)
```

### <stdlib.h>

```
int atoi(s)
double atof(s)
long atol(s)
int rand(void)
int abs(int)
system(s)
exit(int)
```

### <math.h>

```
sin() cos()
double exp(x)
double log(x)
double pow(x,y)
double sqrt(x)
double ceil(x)
double floor(x)
```

For exact prototypes of these functions, you can either 1) issue `man 3 function_name` in the terminal. 2) look at Appendix B of the K&R textbook.

You are encouraged to use these functions when appropriate, especially string functions declared in `<string.h>` as well as string-related IO functions declared in `<stdio.h>`. **Don't forget to include the corresponding header files.** Moreover, if you use functions declared in `<math.h>`, then on the lab environment you need to link the library by using `-lm` flag of `gcc`. That is, `gcc file.c -lm` or `gcc -lm file.c`

## Problem B0 String manipulations, Library functions

Download file `lab4B0.c`. This short program first creates a character array and then uses string library function `strcpy` and `strcat` to change the content of the array. Observe that,

- we need to include `<string.h>` in order to use the string library functions.
- `char` array without initialization contains random values on some system (e.g., our lab). So don't assume it is initialized with all `\0` characters.
- `strcpy(s1, s2)` always copies whole source string `s2` (from the beginning to the first `\0` character -- inclusive) to the beginning of destination string `s1`.
  - `strncpy(s1, s2, n)` copies first `n` character of course string `s2` to the beginning of `s1`. If the first `n` character does not include the `\0` of the `s2`, (i.e.,  $n \leq \text{strlen}(s2)$ ), then no `\0` is copied to the destination string `s1`.
- `strcat(s1, s2)` always appends whole `s2` (from the beginning to the first `\0` character - inclusive) to the end of `s1`. `s1` may contain some characters so where is the end of `s1`? Starting from beginning of the array (the left end), the first `\0` in `s1` is considered the end of `s1`, thus the first character of `s2` replaces the first `\0` character in `s1`, gluing `s1` and `s2`.
  - `strncat(s1, s2, n)` appends the first `n` character of `s2` to the end of `s1`. It always adds a `\0` at the end of the `n` character (even if  $n \leq \text{strlen}(s2)$ ), terminating the destination string.
- `strlen(s)` and `printf("%s", s)` also treat the first `\0` of `s` as the end of the string.

For more information about the library functions, type `man` followed by the function name in your terminal (`man` is a Unix command that stands for 'manual'), e.g., `man strcat`

**No submission for problem B0.**

In the previous lab you have implemented your version of `strlen()`. In the next you implement two more common string library functions: `strcat()` and `strcmp()`.

## Problem B1 String manipulations, Library functions (10 pts)

### Specification

Implement your version of `strcat`, called `my_strcat`.

### Implementation

Download file `lab4strcat.c`. This program reads two words (strings with no spaces) from the user, stored them into arrays `a` and `b`. It then copies the inputs into another two arrays `c` and `d`, using library function `strcpy`. Then it calls `strcat` to concatenate `a` and `b`, and calls `my_strcat` to concatenate `c` and `d`. If implemented correctly, `a` and `c` should have the same content. The program terminates when user enters two `xxx`.

- Implement function `void my_strcat(char [])`. Obviously, function **should not call** library function `strcat`. **Also should not create extra temporary arrays in the function.**

- Complete the while loop so that it keeps on prompting the user for inputs, and terminates when both two input strings are `xxx`, as shown in the sample output. Use `strcmp` library function to check the termination condition.

**Sample input, output** (assume each input has less than 30 characters and contains no space.)

```
red 118 % a.out
hello
worlds
strcat:  helloworlds
mystrcat: helloworlds

good
ok
strcat:  goodok
mystrcat: goodok
hi
g
strcat:  hig
mystrcat: hig

goodluck
thanks
strcat:  goodluckthanks
mystrcat: goodluckthanks

xxx
good
strcat:  xxxgood
mystrcat: xxxgood

yy
xxx
strcat:  yyxxx
mystrcat: yyxxx

xxx
xxx
red 119 %
```

Submit your program using [submit 2031B lab4 lab4strcat.c](#)

Both `strcpy(s,t)`, `strcat(s,t)`, and `my_strcat(s,t)` modify the actual array pass to the function, by modifying `s`. Do you think that this is a bit odd, given that in C everything is pass by value? Recall that `void increment(int x)` or `void swap(int x, int y)` would never work, as `x` and `y` are just local copies of actual arguments. Isn't `s` just a local copy of the corresponding actual argument too? Think about this, we will talk about this soon.

## Problem B2 String manipulations, Library functions (15 pts)

### Introduction

Consider the string library function `strcmp(s,t)`. In Java there is a similar method `string.compareTo(s)`. This function determines if `s` lexicographically precedes `t` (i.e., if `s` appears earlier than `t` in dictionary). It does so by comparing the two strings character by

character. Issue `man strcmp` in the terminal , or search online resources to see how they work in C and Java

<http://www.cplusplus.com/reference/cstring/strcmp/>

<https://www.geeksforgeeks.org/strcmp-in-c-cpp/>

<https://www.programiz.com/c-programming/library-function/string.h/strcmp>

<https://overiq.com/c-programming-101/the-strcmp-function-in-c/>

<https://docs.oracle.com/javase/8/docs/api/java/lang/String.html#compareTo-java.lang.String>

## Specification

Implement your version of `strcmp`, called `my_strcmp`, which does the same comparison.

## Implementation

Download file `lab4strcmp.c`. This program reads two strings from the user, calls library function `strcmp` to compare their lexicographical ordering, and then calls function `my_strcmp` to compare the lexicographic ordering again.

The program terminates when user enters two `xxx`.

- Implement function `int my_strcmp(char [])`. **Obviously, the function should not call library function `strcmp`**. Note that your function doesn't have to return exactly the same value as `strcmp` -- it needs to return a value that has the same sign as those returned by `strcmp`.
- Complete the while loop so that it keeps on prompting user for inputs, and terminates when both two input strings are `xxx`, as shown in the sample output. Use function `strcmp` or `my_strcmp` to check.

## Sample input and output

```
red 118 % a.out
```

```
apple
```

```
beast
```

```
strcmp:  "apple" appears earlier in dictionary than "beast"
```

```
mystrcmp: "apple" appears earlier in dictionary than "beast"
```

```
ace
```

```
ave
```

```
strcmp:  "ace" appears earlier in dictionary than "ave"
```

```
mystrcmp: "ace" appears earlier in dictionary than "ave"
```

```
exit
```

```
exam
```

```
strcmp:  "exit" appears later in dictionary than "exam"
```

```
mystrcmp: "exit" appears later in dictionary than "exam"
```

```
exam
```

```
exam
```

```
"exam" and "exam" have same content
```

```
"exam" and "exam" have same content
```

```
exam
```

```
examine
```

```
strcmp:  "exam" appears earlier in dictionary than "examine"
```

```
mystrcmp: "exam" appears earlier in dictionary than "examine"
```



**examination**

**exam**

strcmp: "examination" appears later in dictionary than "exam"

mystrcmp: "examination" appears later in dictionary than "exam"

**xxx**

**hello**

strcmp: "xxx" appears later in dictionary than "hello"

mystrcmp: "xxx" appears later in dictionary than "hello"

**xxx**

**xxx**

red 119 %

Submit your program using [submit 2031B lab4 lab4strcmp.c](#)

## Problem C String manipulations, Library functions (10 pts)

### Specification

Develop an ANSI-C program that reads user information from the standard inputs, and outputs the modified version of the records.

### Implementation

Download file `lab4fgets.c` and start from there. Note that the program

- uses loop to read inputs (from standard in), one input per line, about the user information in the form of `name age rate`, where `name` is a word (with no space), `age` is an integer literal, and `rate` is a floating point literal. See sample input below.
- uses `fgets()` to read in a whole line at a time.  
As discussed earlier, since the input contains space, using `scanf("%s", inputArr)` does not work here, as `scanf` stops at the first blank (or new line character if no space). Consequently, if user enters `Joe 2 2.3`, only `Joe` is read in.  
As mentioned in this week's class, in order to read a whole line of input which may contain blanks, you can use `scanf("%[^\n]s", inputsArr)`, or, deprecated function `gets(inputsArr)`, but a much more common approach is to use function `fgets()`. Both these functions are declared in `stdio.h`.  
`fgets(inputsArr, n, stdin)` reads a maximum of `n` characters from `stdin` (Standard input) into array `inputsArr`.

The program should,

- after reading each line of inputs, if it is not "exit", output the original input using `printf` and `fputs`. Notice that since `fgets` reads in a '\n' at the end of input, `printf` does not need \n in the formatting string.
- then create a char array `resu` for the modified version of the input. In the modified version of input, the first letter of `name` is capitalized, `age` becomes `age + 10`, and `rate` has 100% increases with 3 digits after decimal point, followed by the floor and ceiling of the increase rate. The values are separated by dashes and brackets as shown below.
- then output the resulting string `resu`.
- continue reading input, until a line of `exit` is entered.

### Hints:

- When `fgets` reads in a line, it appends a new line character `\n` at the end (before `\0`). Be careful about this when checking if the input is `exit`.
- To create `resu`, you may want to tokenize the original input first, into several variables, then modify the variables, and then create `resu` from the modified variables. To tokenize a string and create a string from several variables, consider IO functions listed in page 6 of this pdf.
- If you use math library functions, be aware that the return type is `double`. Also if you run the program in our lab environment, need to compile the program using `-lm` flag of `gcc`.

### Sample Inputs/Outputs:

```
red 118 % a.out
Enter name, age and rate: sue 22 33.3
sue 22 33.3
sue 22 33.3
Sue-32-66.600-[66,67]
```

```
Enter name, age and rate: john 60 1.0
john 60 1.0
john 60 1.0
John-70-2.000-[2,2]
```

```
Enter name, age and rate: lisa 30 1.34
lisa 30 1.34
lisa 30 1.34
Lisa-40-2.680-[2,3]
```

```
Enter name, age and rate: judy 40 3.2
judy 40 3.2
judy 40 3.2
Judy-50-6.400-[6,7]
```

```
Enter name, age and rate: exit
red 119 %
```

Submit your program using [submit 2031B lab4 lab4fgets.c](#)

## Problem D0. 2D array, Library functions.

Download file `lab4twoDarray.c`. This short program demonstrates how to create, initialize 2D arrays, and access array elements. Read and run the program, and observe

- the size of the 2D arrays.
- how to access 2D arrays at cell (element) level, using `[][]`.
- that, for char 2D array, each row is essentially a 1-d char array (i.e., a string if it is `\0` terminated). So each row can be feed into string library functions and `printf` directly, e.g., `strlen(b[1]) strcpy(b[2], "Hello") printf("%s", b[i])`. As a result, for example, we can print the char 2D array with one loop instead of two, whereas we need to use two loops for printing int 2D array.

[No submission for this part](#), but understanding this program gets you prepared for the next two exercises.

## Problem D1. 2D array, Library functions. (20 pts)

### Specification

Write an ANSI-C program that reads user information from the standard inputs, and outputs both the original and the modified version of the records.

### Implementation

A file `lab4table1.c` is for you to get started. The program should:

- use a table-like **2-D array** (i.e., an array of 'strings') to record the inputs.
- use loop and `scanf("%s %s %s")` to read inputs (from standard in), one input per line, about the user information in the form of `name age rate`, where `name` is a word (with no space), `age` is an integer literal, and `rate` is a floating point literal. See sample input below.
- store each input string into the current available 'row' of the 2D array, starting from row 0.
- create a modified string of the input, and store it in the next row of the 2D array. In the modified version of input, all letters in `name` are capitalized, `age` becomes `age + 10`, and `rate` has 50% increases and is formatted with 2 digits after decimal point.
- continue reading input, until a name `xxx` is entered, followed by any age and rate values.
- after reading all the inputs, output the 2-D array row by row, displaying each original input followed by the modified version of the input.
- display the current date and time and program name before generating the output, using predefined pre-processor macros such as `__FILE__`, `__TIME__` (implemented for you).

Note that as the partial implementation shows, each input line is read in as three 'strings' using `scanf("%s %s %s", ...)`. In the next question, you will practice reading in the whole line as a string, as in `lab4fgets` (and then tokenize the string). Each approach has its pros and cons.

**Note that you will lose all marks if, instead of a 2D-array, you use 3 parallel 1-D arrays -- one for all names, one for all ages, one for rates -- to store and display information.**

### Sample Inputs/Outputs:

```
red 307 % a.out
Enter name, age and rate: john 60 1.0
Enter name, age and rate: eric 30 1.3
Enter name, age and rate: lisa 22 2.2
Enter name, age and rate: Judy 40 3.2254
Enter name, age and rate: xxx 2 2
Records generated in file lab4table1.c on Oct 10 2022 13:32:48
row[0]: john 60 1.0
row[1]: JOHN 70 1.50
row[2]: eric 30 1.3
row[3]: ERIC 40 1.95
row[4]: lisa 22 2.2
row[5]: LISA 32 3.30
row[6]: Judy 40 3.2254
row[7]: JUDY 50 4.84
red 308 %
```

### Sample Inputs/Outputs: (download file `inputD.txt`)

```
red 309 % a.out < inputD.txt
```

```

Enter name, age and rate: Enter name, age and rate: Enter name, age
and rate: Enter name, age and rate: Enter name, age and rate: Enter
name, age and rate:
Records generated in file lab4table1.c on Oct 10 2022 13:42:03
row[0]: john 60 1.0
row[1]: JOHN 70 1.50
row[2]: Sue 30 1
row[3]: SUE 40 1.50
row[4]: Lisa 22 2.2
row[5]: LISA 32 3.30
row[6]: JuDy 40 3.22
row[7]: JUDY 50 4.83
row[8]: eric 30 1.3345
row[9]: ERIC 40 2.00
red 310

```

Submit your program using [submit 2031B lab4 lab4table1.c](#)

## Problem D2. 2D array, library functions. (20 pts)

### Specification

Same question as problem D1 but now you read each line of input as a whole line of string.

A file `lab4table2.c` is created for you to get started.

As the code shows, reading a whole line allows the input to be read into a table row directly. So you don't have to store the original input into the table manually. The disadvantage, however, is that you may need to tokenize the line in order to get the name, age and rate information.

### Sample Inputs/Outputs:

Same output as above, except that the generated file name is `lab4table2.c` now, and the time is different.

Submit your program using [submit 2031B lab4 lab4table2.c](#)

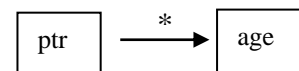
## Problem E Pointer 101 (10 pts)

### Specification

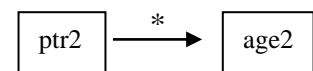
Write your first (short) program that uses pointers.

### Implementation

- define an integer `age` and initialize it to 10. Define another integer `age2`, which is initialized to 100;
- define an integer **pointer** variable `ptr`, and make it point to `age`
- display the value of `age`, both via `age` (direct access), and via pointer `ptr` (indirect access).
- use `ptr` to change the value of `age` to 14;
- confirm by displaying the value of `age`, both via `age` and via its pointer `ptr`

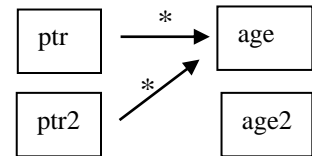


- define another pointer variable `ptr2`, and make it point to `age2`
- assign triple of `age`'s value to `age2` via pointer `ptr` and `ptr2` (i.e., without referring to `age` and `age2`). `age2` is 42 now.



- display the value of `age2`, both via `age2`, and via its pointer `ptr2`

- now let `ptr2` point to `age` (too) by getting the address of `age` from pointer variable `ptr` (i.e., without using `&age`)
- confirm by displaying the value of `ptr2`'s pointee via `ptr2`
- display value of `age`, both from `age`, and via `ptr` and `ptr2`.



- use `ptr2` to decrease the value of `age` by 1. `age` is 13 now.
- display value of `age`, both from `age`, and via `ptr` and `ptr2`.
- finally, display the address of `age`, using `printf("%p %p %p\n", &age, ptr, ptr2);`. Notice that here we print `ptr` and `ptr2` directly. This displays the content of the pointer variables, which is the address of `age` (in Hex).

### Sample Inputs/Outputs:

```

red 305 % a.out
age: 10 10
age: 14 14
age2: 42 42
ptr2's current pointee: 14
age: 14 14 14
age: 13 13 13
0x7ffd04a92bcc 0x7ffd04a92bcc 0x7ffd04a92bcc
red 306
  
```

You will get different numbers here but they should be identical to each other. This is the memory address of variable `age`, in Hex.

### Submission:

Name your program `lab4pointer.c` and submit using

`submit 2031B lab4 lab4pointer.c`

End of lab

In summary, in this lab you should submit the following:

**File\_for\_the\_debugger\_problem**  
**runningAveLocal.c** **runningAveLocal2.c**  
**runningAveGlobal.c** **function.c**  
**lab4strcat.c** **lab4strcmp.c**  
**lab4fgets.c**  
**lab4table1.c** **lab4table2.c**  
**lab4pointer.c**

Any name is okay

You may want to issue `submit -l 2031B lab4` to view the list of files that you have submitted.

Lower case L

## Common Notes

All submitted files should contain the following header:

```
/******  
* 22Fa - Lab4 *  
* Author: Last name, first name *  
* Email: Your email address *  
* EECS username: Your eeecs login username *  
* Yorku Student #: Your student number  
***** **/
```

## Other common notes:

- **Make sure your program compiles in the lab environment. The program that does not compile, or, crashes with “segmentation fault” in the lab will get 0.**
- **Note that labs are individual work. You can discuss with others but should not copy code from others, or from the web. Doing so is considered a violation of academic honesty.**
- **Note that if you have taken this course before, you should do the lab again. Submitting previous term’s file – even it is yours -- is considered self-plagiarism and thus will receive 0.**
- **All submissions need to be done from the lab, using command line.**
  - **Also note that you can submit the same file multiple times. Then the latest file will overwrite the old one.**
  - **If you submitted a wrong file, you cannot delete it. Ask the instructor to delete it for you.**

**Note that when compiling your program in the lab environment, you don’t have to turn on -Wall flag of gcc (you are welcome to do so), and don’t need to fix the warnings generated when using gcc -Wall file.c.**