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Introduction to C

Oct 6 – 8, 2015
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```
int **b1, **b2;

/* Initialise metadata */
board_1->height = height;
board_1->width = width;
board_2->height = height;
board_2->width = width;

/* Allocate memory for grids */
board_1->space = malloc((height + 2) * sizeof(int *));
board_1->space[0] = malloc((height + 2) *
                           (width + 2) * sizeof(int));
for(i = 1; i < height + 2; i++) {
        board_1->space[i] = board_1->space[0] + i * (width + 2);
}
board_2->space = malloc((height + 2) * sizeof(int *));
board_2->space[0] = malloc((height + 2) *
                           (width + 2) * sizeof(int));
for(i = 1; i < height + 2; i++) {
        board_2->space[i] = board_2->space[0] + i * (width + 2);
}
```

Agenda

Tuesday

09:00-09:45	**Introduction**
09:45-10:00	Coffee break
10:00-10:45	**Getting started with C**
10:45-12:00	***Exercises***
12:00-13:00	Lunch break
13:00-14:00	**Control structures and loops**
14:00-14:30	***Exercises***
14:30-14:45	Coffee break
14:45-15:45	***Exercises***
15:45-16:00	Wrap-up day 1

Wednesday

09:00-10:00	**Pointers and dynamic memory management**
10:00-10:15	Coffee break
10:15-11:00	***Exercises***
11:00-11:30	**Strings, structures and datatypes**
11:30-12:00	***Exercises***
12:00-13:00	Lunch break
13:00-14:00	***Exercises***
14:00-14:30	**Dynamic arrays**
14:30-14:45	Coffee break
14:45-15:45	***Exercises***
15:45-16:00	Wrap-up day 2

Agenda

Thursday

09:00-09:45	**I/O**
09:45-10:00	Coffee break
10:00-11:15	***Exercises***
11:15-12:00	**Code structuring**
12:00-13:00	Lunch break
13:00-14:00	***Exercises***
14:00-14:15	Coffee break
14:15-15:00	**Programming practices and debugging**
15:00-15:45	***Exercises***
15:45-16:00	Course wrap-up

Introduction to C – exercises

1. Basics, compiling, datatypes and expressions

a) Write from a scratch a short program that prints out a sentence (e.g. “hello, world!”). Compile the code using GNU C compiler (gcc) and execute the program. See the lecture material for relevant code examples and compiler commands.

b) Perform simple expressions with different types of variables (integers, floats, doubles) and print out results with **`printf`** using correct format. File `ex1b_expressions.c` contains a skeleton code to start with.

c) Add some pointer variables to the previous exercise and perform some expressions via the pointers. Investigate both the original variable and the pointer variable after expressions. A skeleton code is provided in `ex1c_pointers.c`

2. Control structures

a) Write a control structure which checks whether an integer is negative, zero, or larger than 100 and performs corresponding **`printf`**. Investigate the behavior with different integer values. Skeleton code is given in file `ex2a_if_else.c`.

b) In the file `ex2b_my_pow_prog.c` you find a skeleton code for a program that calculates powers. Finish the code by adding a missing update loop.

c) Fibonacci numbers are a sequence of integers defined by the recurrence relation

$$F_n = F_{n-1} + F_{n-2}$$

with the initial values $F_0=0$, $F_1=1$. Print out Fibonacci numbers $F_n < 100$ using a **`while`** loop.

d) Write a function that determines if a given character is a vowel or a consonant. Use the switch-case structure. Skeleton code is given in file `ex2d_switch.c`.

3. Pointers and dynamic memory management

a) Implement a function that takes three arguments of type double. The function should return in the third argument the sum of the first two arguments. Template code is in file `ex3a_pointers.c`.

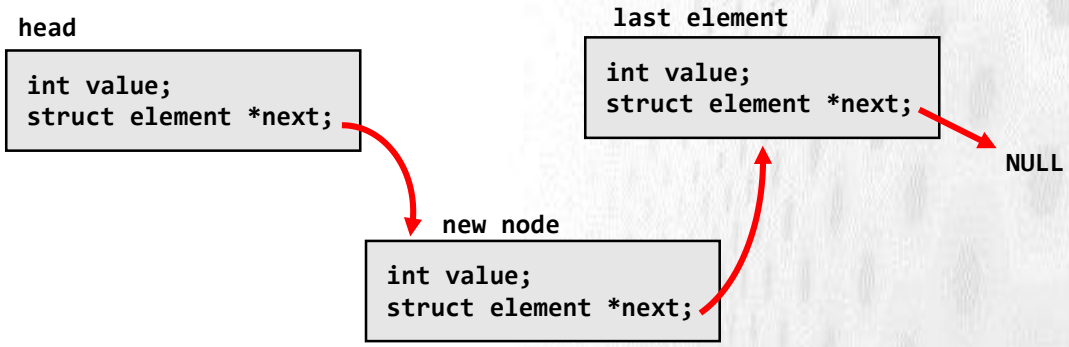
b) Modify the given template `ex3b_pointer_swap.c` and implement a function that swaps its pointer arguments **a** and **b** so that they point to **b** and **a** in reversed order. Can you make a version that can accept all pointer types? (Hint: remember the type **`void`**).

4. Strings, structures and datatypes

a) Implement a program that converts the strings given as command line arguments to upper case equivalents and prints them out on separate lines. Template can be found in ex4a_upcase.c. Use can use the routine **`toupper`** defined in the header file `ctype.h` to convert the string letter by letter. (Hint: **`man 3 toupper`**).

b) Modify the given template (`ex4a_structs.c`) so that you use a structure to pass the values to the output routine that prints the basic information of a book.

c) Implement the insertion routine for the linked list example program given in the template file `ex4b_linked_list.c`. Note that the list is implemented so that empty list has two nodes: **`head`** defined in the main routine holds the starting point and **`init_list`** routine allocates one place holder for the end point of the list. Implement the insert so that new value is added to the beginning of the list. After insertion the **`head->next`** should point to the new node.



5. Dynamic arrays

a) Write a function that allocates an integer array and sets the values in the array from 1 to the N where N is the size of the array given as an input argument. Print out the values in the calling main function. Skeleton is in file `ex5a_malloc.c`.
b) Extend the allocation function so that it allocates a two-dimensional array. Implement also a routine that frees the array. Skeleton file `ex5b_array.c` has some utility routines that print out the array for checking.

6. I/O

a) Implement a program that asks for user input and echoes back all numerical characters (0-9) and drops out all other input. If no numbers is given, program should report that no numbers were given. Skeleton code is in file `ex6a_echo.c`.
b) Extend the skeleton file ex6b_file_io.c file and implement a program that reads the input file "testdata.dat" line-by-line, converts the read text to upper case and prints the results to standard output.

7. Code structuring

a) Start from the provided single file version of a heat solver and move the function **`save_png`** to a separate file `pngwriter.c`. Create a header file `pngwriter.h` with needed declarations. Try to compile the new version and check that it works. Note that you will need two libraries, **`libpng`** and **`libm`** (use compiler flags **`-lpng`** and **`-lm`**).
b) Split the solver further so that the main routine is in a separate file `ex7_main.c` and the needed declarations in a header file `ex7_heat_solver.h`.

8. Debugging

Take a look at the demo code in folder demo, compile it using the provided `makefile` (issue the command **`make`**) and run the program. Find the reason for segmentation fault using **`gdb`**, fix the problem and check that the program works correctly after your corrections.