

Worksheet 6: Structs

Updated: 3rd April, 2020

The objectives of this practical are to understand how to:

- design and use structs; and
- implement a linked list using structs.

Pre-lab Exercises

1. Creating Structs

Declare (with typedef) suitable structs to hold the following information:

- (a) A date.
- (b) A set of coordinates in 3D space.
- (c) A postal address.
- (d) The details of a practical class at Curtin.
- (e) The details of *all* practicals for a unit.

2. Dynamic Allocation and Deallocation

Write C code to dynamically allocate and then deallocate the following:

- (a) The date struct from Question 1a.
- (b) An array of 25 coordinate structs from Question 1b.
- (c) A struct called Info that contains a char* field called name, intended to store names up to 99 characters.
- (d) An array of 25 Info structs.
- (e) The following struct, so that it keeps track of an array of 25 Info structs:

```
typedef struct {  
    int length; /* Number of items in the list. */  
    Info *list;  
} InfoList;
```

3. Expressions with Pointers, Arrays and Structs

The following expressions use a combination of pointers, arrays and structs. In each case, describe (i) what “var” is by itself and (ii) what the overall expression is accessing.

- (a) | var.b
- (b) | var->b

- (c) | `var[i].b`
- (d) | `var[i]->b`
- (e) | `var->b[i]`
- (f) | `var[i]->b[j]`
- (g) | `*(var[i]->b)`
- (h) | `var->b->c`
- (i) | `var.b[i][j].c`

4. Linked List Structs

Design a set of structs to hold a linked list, where:

- The values to be stored in the list are structs called `FruitBat`.
- The size of the list must be instantly accessible.
- The last element of the list must be instantly accessible.

How does the last point complicate the insertion of a new element?

5. Miscellaneous Questions

- (a) When inserting an element at the start of a linked list, you must (a) point the new node's "next" field to the existing first node, and (b) point "head" to the new node. Why does the *order* of these operations matter?
- (b) Can an element belong to more than one linked list simultaneously?
- (c) Can an element appear more than once in the same linked list?

Practical Exercises

1. Files and Structs

Write a C program to read a file and store the contents in a dynamically-allocated array of structs.

The file contains journal entries, each consisting of a date and a text string. Each entry occupies two lines. The first line of each entry contains the date (in "day/month/year" format) and the second contains the text. The text can be up to 100 characters long, not including the new-line character.

The very first line of the file contains a single integer, indicating the number of journal entries in the file.

The following is an example input file:

```
4
12/04/2010
Interview went well I think, though was told to wear shoes.
18/04/2010
Doc advised me to concentrate on something... I forget.
03/05/2010
Was asked today if I was an art exhibit.
19/05/2010
Apparently mudcakes not made of mud, or angry wasps.
```

You should declare a suitable struct (in a header file), allocate an array just large enough to hold all the entries, and then read each entry into the array.

Note: You will need to make use of *both* the `fscanf()` and `fgets()` functions.

Your program should take a single command-line parameter — an integer (converted from a string). This is a journal entry index, where the first entry is index zero, the second entry is index 1, etc. Your program should print out the entry at that index.

For example, given the above input file and an index of 2, your program should output:

```
[user@pc]$ 2010-05-03: Was asked today if I was an art exhibit.
```

Pay close attention to the date format — it differs from the input file!

Note: To have `printf()` use zeros instead of spaces as padding, place `0` between the `%` and the field width.

Finally, run `valgrind` on your program to test for memory errors, and fix any that you find.

2. Linked Lists

For this question please ensure that you download the `linkedlistTest.c` file from Blackboard and use that to test your Linked List

Write a set of C functions in a file called `'linkedlist.c'` to manipulate a generic linked list.

Note: The datatype of the data variable is `void*`

You will need to create appropriate structs, and write functions to:

- (a) Create an empty linked list.

```
LinkedList* createLinkedList();
```

Note: This is a simple function but not trivial, and it's vitally important. All of your other linked list functions will be useless if you don't know what you're doing here!

- (b) Insert an element at the start. This function should take (i) a pointer to an existing linked list, and (ii) a pointer to an existing journal entry struct, to be inserted at the start of the list.

```
void insertStart(LinkedList* list, void* entry);
```

- (c) Remove an element from the start. This function should take a pointer to an existing linked list, remove the first element from the list and return a pointer to it. (Return NULL instead if the list is empty.)

```
void* removeStart(LinkedList* list);
```

- (d) Insert an element at the end. This function should be similar to your insertStart function, however instead of working with the head of the list its now the tail.

```
void insertLast(LinkedList* list, void* entry)
```

- (e) Removing an element from the end. This function should be similar to your removeStart function, however instead of working with the head of the list its now the tail.

```
void* removeLast(LinkedList* list)
```

Note: The next 2 function require the use of other functions to properly work. To make this work they are needing to import both the list and a function pointer.

```
typedef void (*listFunc)(void* data)
```

- (f) Print out the contents of the list.

```
void printLinkedList(LinkedList* list, listFunc funcPtr);
```

- (g) Free the list.

```
void freeLinkedList(LinkedList* list, listFunc funcPtr);
```

Warning: You **really should** use valgrind to check for memory errors! We're getting into complex dynamic memory allocation, and mistakes are very easy.

3. Convert To Linked List

For this question you are to redo Question1 however with 2 differences/

- Remove the first line of the file that contains the number of entries
- Implement it using your LinkedList instead of an Array

Note: You can just copy your code rather than rewriting it all from scratch

End of Worksheet