Digital Design and Verification

IFYP Program

Pointers & Linked List

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Revision History

Revision Number	Revision Date	Revision By	Nature of Revision	Approved By
1.0	15/08/2024	S. M. Sarmad	First Draft	
1.1	03/03/2025	Hira Sohail	Revision	

Task # 01:

Develop a simple task management system using a singly linked list. Each task has a description, a priority level, and a due date. The system should allow users to add, remove, and display tasks, as well as prioritize them based on their due dates.

Define a Task structure with the following fields:

- description: A string describing the task.
- priority: An integer representing the task's priority (e.g., 1 for high, 2 for medium, 3 for low).
- due_date: A string representing the due date (e.g., "2024-08-15").
- next: A pointer to the next task in the list

- **Add Task**: Implement a function to add a new task to the list.

The new task should be inserted based on its due date, with the earliest due date appearing first

- **Remove Task**: Implement a function to remove a task from the list. The function should remove the first occurrence of a task with a given description.

- **Display Tasks**: Implement a function to display all tasks in the list in order, showing their description, priority, and due date.

- **Update Task**: Implement a function to update the priority or due date of an existing task based on its description.

Task # 02:

In this lab, you will work directly with C pointers and structs to manipulate linked lists. The focus of this exercise is to deepen your understanding of pointers, list traversal, and recursive functions by completing and extending an existing C program. You will not use the Scheme-like functions (car, cdr, cons) from the previous lab, but instead, you will rely solely on pointer manipulation to achieve the desired outcomes.

You are provided with a program (namelist.c) that maintains a list of names through a menu-driven interface. This program includes basic functionality to insert, delete, and print names, as well as several unimplemented stubs for additional features. Your task is to complete these stubs and enhance the program by adding new functionality.

- **Initial Exploration:**
  Copy the provided namelist.c file to your account, compile it, and run it several times to understand its current functionality.
  Identify how names are inserted, deleted, and printed from the list.
- **Count the Items in the List:**
  Implement the function countList(const node_t *first) that traverses the list and prints the total number of items.
  The function should iterate through the list node-by-node, counting each item.
- **Print the Last Item in the List:**
  Implement the function printLast(const node_t *first) that prints the data of the last item in the list.
  If the list is empty, the function should print an appropriate message.
- **Pointer Manipulation Review:**
  Before proceeding further, carefully review the provided code. Notice the different types of parameters (node_t * and node_t **) used in various functions like print, printLast, countList, addName, and deleteName.
  Write a brief explanation on why these different types are used and how they impact the functions' behaviors.
- **Move an Item to the Front:**

Implement the function putFirst(node_t **firstPtr) that moves a specified item from anywhere in the list to the front.

This function should:

Search the list for the specified item.

Reassign the necessary pointers to move this item to the front of the list without creating or destroying any nodes.

Handle edge cases, such as when the list is empty or the item is not found.

- **Recursive List Printing:**

  Implement the function printRec(const node_t *first) to print all the elements of the list using recursion instead of iteration.

- **Print the Last Item Recursively:**

  Implement the function printLastRec(const node_t *first) to recursively print the last item in the list.

- **Print the List in Reverse Order**:

  Implement the function printReverse(const node_t *first) to print the names in reverse order, from the last node to the first.

Testing:

Test your program thoroughly with various cases, including:

- An empty list (null).
- A list with one item.
- A list with multiple items, ensuring that all functions behave correctly.

Task # 03:

Your task is to write a C program that takes user input to create two unsorted linked lists of integers. The program should then merge these two linked lists into a single linked list and sort the resulting linked list in ascending order.

- You are provided with two linked lists. The user will enter the number of elements in each list and also enter their values.
- The linked lists are initialized and provided in the form of nodes, where each node contains an integer value and a pointer to the next node in the list.
- Your program should merge the two linked lists into a single linked list and then sort the merged list in ascending order.
- Implement the solution using linked lists. Do not use arrays or other data structures to hold the elements during the merge and sort process.
- Write a function Node* merge_and_sort_lists(Node* list1, Node* list2) that takes the heads of the two linked lists as input and returns the head of the merged and sorted linked list.

Given the following two linked lists:

- List 1: 7 -> 3 -> 5
- List 2: 2 -> 4 -> 1

Your function should return to a merged and sorted list:

- Merged and Sorted List: 1 -> 2 -> 3 -> 4 -> 5 -> 7

Submission:

- The completed namelist.c file with your implementations for task 3.
- A brief written explanation of what you learnt along with test cases and outputs in a report. Flow chart in each task is required.