Computing Lab Assignment - In class task

Source: https://www.geeksforgeeks.org/dsa/rotate-a-linked-list/

August 22, 2025

1. Given a singly linked list, find the middle node of the linked list. One possibility is to traverse the entire linked list once to count the total number of nodes. After determining the total count, traverse the list again and stop at the (count/2)th node to return its value. Alternatively, use the Tortoise and Hare algorithm to find the middle of the linked list. Initialize both slow and fast pointers at the head. Move slow by one step and fast by two steps each iteration. When fast reaches the end (or null), slow will be at the middle. For even nodes, slow automatically ends at the second middle.

2. Given a Linked List of M nodes and a number N, find the value at the N^{th} node from the end of the Linked List. If there is no N^{th} node from the end, print -1.

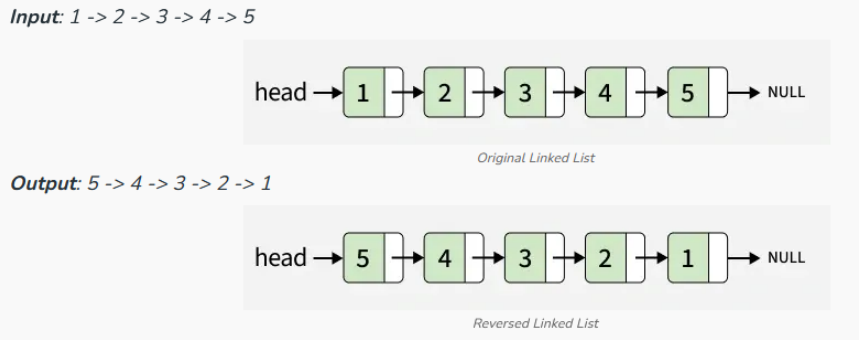
   The idea is to maintain two pointers, say main_ptr and ref_ptr point to the head of Linked List and move ref_ptr to the Nth node from the head to ensure that the distance between main_ptr and ref_ptr is (N - 1). Now, move both the pointers simultaneously until ref_ptr reaches the last node. Since the distance between main_ptr and ref_ptr is (N - 1), so when ref_ptr will reach the last node, main_ptr will reach Nth node from the end of Linked List. Return the value of node pointed by main_ptr.

3. Given a singly linked list, reverse the linked list by changing the links between nodes.

   The idea is to reverse the links of all nodes using three pointers:

   - prev: pointer to keep track of the previous node
   - curr: pointer to keep track of the current node
   - next: pointer to keep track of the next node

   Starting from the first node, initialize curr with the head of linked list and next with the next node of curr. Update the next pointer of curr with prev. Finally, move the three pointer by updating prev with curr and curr with next.



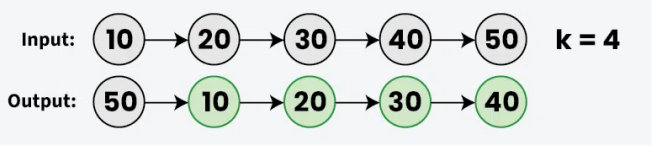
4. Given a singly linked list $L_0 \to L_1 \to \dots L_{n-1} \to L_n$, rearrange the nodes in the list so that the newly formed list is: $L_0 \to L_n \to L_1 \to L_{n-1} \to L_2 \to L_{n-2} \to \dots$. You are required to do this in place without altering the node values.

   - Find the middle of the linked list using the fast and slow pointer method. This involves moving one pointer twice as fast as the other so that when the faster pointer reaches the end, the slower pointer will be at the middle.
   - Reverse the second half of the list starting just after the middle node and split them in two parts.
   - Merge the two halves together by alternating nodes from the first half with nodes from the reversed second half.

5. Given a singly linked list and an integer k, rotate the linked list to the left by k places.

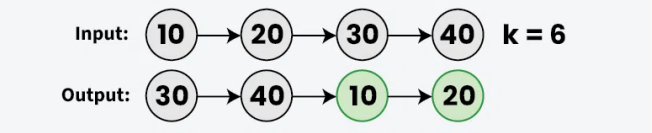
   The idea is to first convert the linked list to circular linked list by updating the next pointer of last node to the head of linked list. Then, traverse to the kth node and update the head of the linked list to the (k+1)th node. Finally, break the loop by updating the next pointer of kth node to NULL..

Input: *linked list = 10 -> 20 -> 30 -> 40 -> 50, k = 4*
Output: *50 -> 10 -> 20 -> 30 -> 40*



Explanation: *After rotating the linked list to the left by 4 places, the **5th** node, i.e node **50** becomes the head of the linked list and next pointer of node **50** points to node **10**.*

Input: *linked list = 10 -> 20 -> 30 -> 40, k = 6*
Output: *30 -> 40 -> 10 -> 20*



Explanation: *After rotating the linked list to the left by 6 places (same as rotating by 2 places as (k % len) = (6 % 4 = 2)) , the **3rd** node, i.e node **30** becomes the head of the linked list and next pointer of node **40** points to node **10**.*

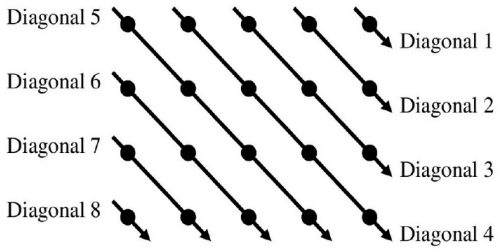
6. Given a singly linked list, check if the given linked list is palindromic.

   Follow the steps below to solve the problem: Use two pointers say, fast and slow to find the middle of the list. fast will move two steps ahead and slow will move one step ahead at a time. If list is odd, when fast $\rightarrow$ next is NULL , slow will point to the middle node. If list is even, when fast->next->next is NULL slow will point to the middle node. Reverse the second half of the list starting from the middle. Check if the first half and the reversed second half are identical by comparing the node values. Restore the original list by reversing the second half again and attaching it back to the first half.

7. Given a linked list and a value x, partition it such that all nodes less than x come first, then all nodes with a value equal to x, and finally nodes with a value greater than x. The original relative order of the nodes in each of the three partitions should be preserved. [Related: Given a linked list of 0s, 1s and 2s, The task is to sort the list in non-decreasing order.]

   The idea is to use three dummy nodes to create three separate partitions: less, equal, and greater. As the list is traversed, each node is added to its corresponding partition. Once all nodes are processed, the partitions are connected to form the final list.

8. Define a two-dimensional array A in the main() function of a C program. In the main() function, the user supplies the number r of rows and the number c of columns in A. The user then calls an initialize function to initialize the array with user inputs. Each row is allocated memory to store exactly c int variables.



Write a function to print the diagonals of A. A diagonal of A starts from the left or the top boundary, proceeds toward south-east, and ends at the right or the bottom boundary. Let us number the diagonals in the south-west direction starting from top right. As an example, the adjacent figure shows a 4×5 matrix. The elements are represented by black dots. Note that not all the diagonals contain the same number of elements.

9. HopSearch is an algorithm for searching in sorted arrays. Although slower than binary search, HopSearch is much faster than linear search. HopSearch uses a doubly nested loop, and employs a Hop strategy at exponentially increasing indices. Like binary search, Hop search maintains a search interval I = [L, R]. To start with, the interval I encompasses the entire array. Each iteration of the outer loop reduces the interval I to a strictly smaller sub-interval I' = [L', R'] determined as follows. It keeps on looking at the indices 1, 2, 4, 8, 16, … relative to L until an index is found, at which the array element is greater than or equal to the key, or the array size is exceeded. These comparisons help to choose the sub-interval I' to the correct one from [L, L], [L+1, L+1], [L+2, L+3], [L+4, L+7], [L+8, L+15], . . . , [L+2^t, R]. In the next iterations, the same search mechanism is continued, on gradually shrinking intervals. The loop stops when the interval length reduces to one. A final comparison of the key is made with the element at the only index of the interval, and depending on the outcome of this comparison, L (key found) or –1 (key not found) is returned. Code up HopSearch() as a single function. Write an application to call HopSearch with an array and get it sorted. Put the search routine and application in separate files. Assume that a sorted array is passed as input along with an element to search from the command line (you do not know the size of the array in advance).

10. Consider an array of n positive integers A. We plan to sort A in place, using an algorithm called *magicSort*. This algorithm repeatedly sorts the array A, based on a digit position starting from the least and going to the most significant ends of the numbers. As an example, take A = {415, 73, 516, 923, 890, 318}. In the first iteration, the array gets sorted based on the rightmost / least-significant digits, and changes to {89$\underline{0}$, 7$\underline{3}$, 92$\underline{3}$, 41$\underline{5}$, 51$\underline{6}$, 31$\underline{8}$}. The second iteration sorts A using the second / middle digits, changing A to {41$\underline{5}$, 51$\underline{6}$, 31$\underline{8}$, 92$\underline{3}$, 7$\underline{3}$, 89$\underline{0}$}. The third / last iteration

looks at the the leftmost / most-significant digits, and changes A to {07$\underline{3}$, 31$\underline{8}$, 41$\underline{5}$, 51$\underline{6}$, 89$\underline{0}$, 92$\underline{3}$}. Not all elements of A are required to have the same number of digits (see the element 73 in the above example). In order to address this issue, we first compute the maximum in A, and the number of digits in that maximum element. All elements of A can now be considered to consist of these many digits. Each digit-based sorting iteration uses a two-dimensional array B with 10 rows, one for each of the digits 0, 1, 2, . . . , 9. One by one, the corresponding digit d of A[i] is extracted, and A[i] is appended to the d-th row of B. A count array C of size 10 keeps track of how many elements of A are sent to the different rows of B. After all A[i] are copied to their correct rows, the rows of B are copied sequentially, back to A. Code up magicSort. Follow the same convention as in the problem above (separate functions / files / command line input).