HL Unit 5 – Abstract Data Structures

Quiz 2 – Linked Lists

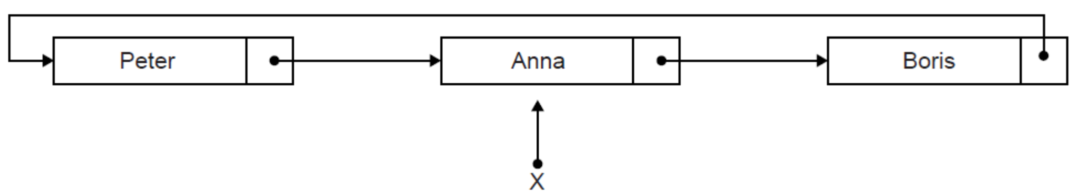
Question 1			
Objectives:	5.1.11	Exam Reference:	May-17 9

Identify the components of a node in a doubly linked list. [3]

Data;
A pointer/reference to the previous node;
A pointer/reference to the next node;

Question 2			
Objectives:	5.15.6, 5.1.11, 5.1.12, 5.1.13, 5.1.19	Exam Reference:	Nov-16 11

1. The diagram shows a list of names held in a circular linked list. The end of the list is pointed to by an external pointer, X.



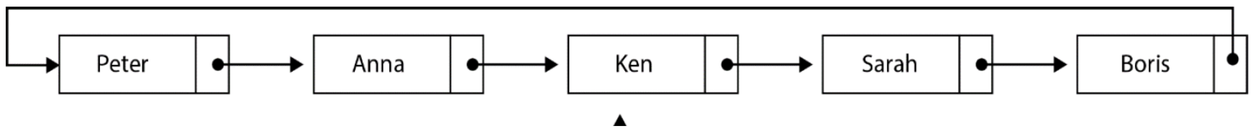
(a) State the first name in this circular list. [1]

Boris;

Two operations are performed on the list in the following order:
1. A node containing the name Sarah is inserted at the beginning of the list.
2. A node containing the name Ken is inserted at the end of the list.

(b) Sketch a diagram showing the resulting circular linked list. [3]

*Award up to **[3 max]**.*
For the diagram showing all nodes and links;
Ken inserted after Anna AND Sarah placed after Ken;
Node containing Ken is pointed to by X/Ken is currently at the end of the list;



(c) Describe how the number of names held in this list could be determined. [4]

Use a variable (counter) to keep track of/increment the number of nodes;
Use a temporary pointer;
Follow the pointers from the beginning of the list/from the node pointed to by pointer `X.next`;
Until the pointer to the end of the list (pointer X) is encountered;
Note: *Accept methods that start from the end of the list (X).*

(d) Explain how a stack could be used to output, in reverse order, all names held in the linked list. [4]

Traverse the list from beginning to end;
Pushing each data value from the list onto the stack;
While stack is not empty;
Popping an element from the stack and output the stack element;

(e) Compare the use of static and dynamic data structures. [3]

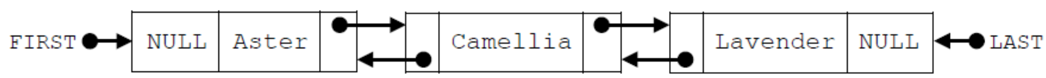
Static data structure has a predetermined number of elements but number of elements in dynamic data structure does not have to be defined in advance;
Static data structure has limited size, the amount of memory available is the only limit in size of dynamic data structure, size varies;
In static data structure elements can be directly accessed, in a dynamic data structure access is sequential (which is slower);

Question 3			
Objectives:	5.1.12, 5.1.13	Exam Reference:	Nov-17 13

(a) Describe the features of a dynamic data structure. [2]

*Award up to **[2 max]**.*
Each node contains data and also a link to other nodes;
Links between nodes are implemented by pointers (a pointer references a location in memory or holds a memory address);
List size is not fixed / predetermined;

Consider the following doubly linked list which holds the names of flowers in alphabetical order.



(b) Explain how "*Primrose*" could be inserted into this doubly linked list. You should draw a labelled diagram in your answer. [6]

*Award up to **[6 max]** as follows. (There are 7 marking points)*
[1] *create new node;*
[1] *instantiation of values and pointers in new node;*
[1] *state where the search starts from;*
[1] *how to detect position for insertion;*
[1] *update pointers in new node;*
[1] *update pointers from the node at the insertion point, to the new node;*
[1] *update external pointers;*
Remark*: Some answers may just use illustrations alone, or very minimal explanations: see note below;*

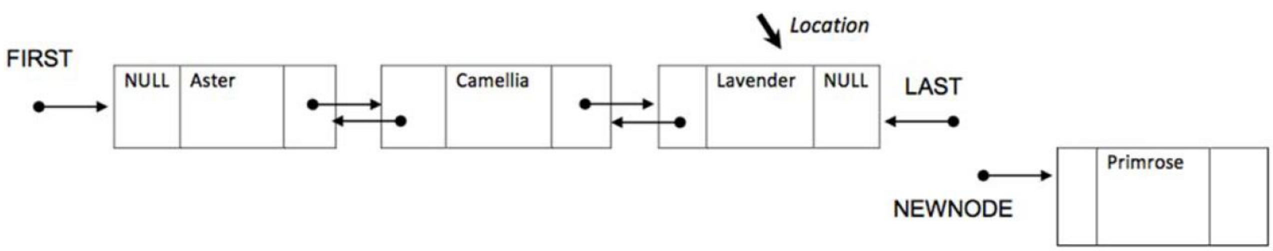
Create a new node (with pointer `NEWNODE`) with data field Primrose and two pointer fields (next and previous), to be inserted;

Perform a linear search, either from the beginning or end of the list (using pointers `FIRST` and `LAST`, on the alphabetically order list;

The location/position of insertion, is found by comparing nodes (Primrose to be inserted after Lavender, `LOCATION` points to Lavender) (***Accept*** *any description to that effect*);

(At the end of this phase, the situation looks as in ***Figure 1****)*

Figure 1



Then, continue by setting the “next” field/pointer in the newly created node to `NULL`;

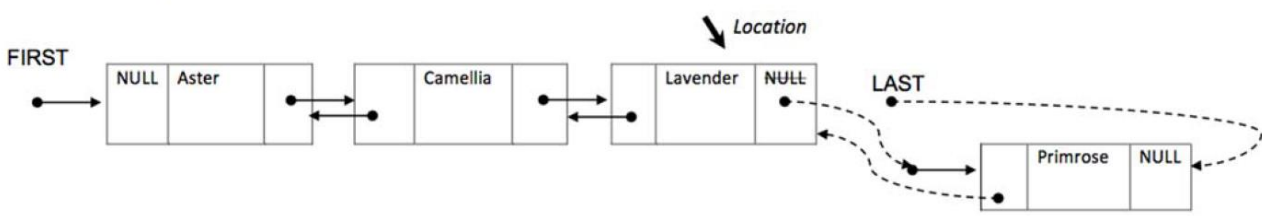
Set the “previous” pointer in the newly created node to the current `LAST` / to point to Lavender/ to point to the node detected by `LOCATION`;

Change/Set/Update the Lavender’s “next” pointer to point to the new node / to link with the `NEWNODE` pointer (delete `NULL` in the field and link to the existing `NEWNODE` pointer);

Update the `LAST` pointer to point to the newly created node;

Eventually the final doubly linked list looks like this (**Figure 2**);

Figure 2



Note: *Award **[4 max]** for responses that return one or more drawings without any explanation at all, for evidence of these features:*
[1] *Evidence of creation of an initial new node for Primrose out of the list;*
[1] *The order of nodes Aster/Camellia/Lavender/Primrose is eventually correct;*
[1] *The two unidirectional links between Lavender and Primrose are (eventually) correctly displayed, from-to the appropriate fields;*
[1] *LAST points correctly to the appropriate field in the new node Primrose, **and** NULL fills the last field of the new node;*

Consider the two stacks: *FLOWERS* and *FRUITS*.

FLOWERS
Aster
Broom
Camellia
Day Lily
Lavender
Primrose
Yarrow

FRUITS
Apple
Cherry
Orange
Pear

(c) Show the output produced by the following algorithm. [4]

```
loop while (NOT FRUITS.isEmpty()) AND (NOT FLOWERS.isEmpty())
  X = FRUITS.pop()
  Y = FLOWERS.pop()
  if X < Y then
    output X
  else
    output Y
  end if
end loop
```

*Award **[1]** for each one in the correct order.*
Apple;
Broom;
Camellia;
Day Lily;
Note: *Solution for the Spanish version (in this order):*
Aster; Camelia; Lavanda; Lirio;

A third stack, *FLOFRU*, is needed. It should contain all the data from *FLOWERS* and *FRUITS* and will store it as shown below

FLOFRU

Yarrow
Primrose
Lavender
Day Lily
Camellia
Broom
Aster
Pear
Orange
Cherry
Apple

(d) Describe how the *FLOFRU* stack could be created. [3]

Award marks as follows up to ***[3 max]****.*

Example answer 1
Create an empty stack (FLOFRU);
pop all elements from FRUITS and **push** them onto FLOFRU;
Then **pop** all elements from FLOWERS and **push** them onto FLOFRU;

Example answer 2
Create an empty stack (FLOFRU);
While FRUITS is not empty
  pop an element from FRUITS and **push** it onto FLOFRU;
While FLOWERS is not empty
  pop an element from FLOWERS and **push** it onto FLOFRU;

Note: *Award* ***[2 max]*** *for generic descriptions that do not use appropriate terminology on data structures and their operations.*