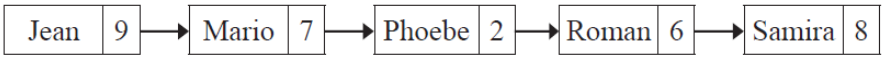
# HL Unit 5 – Abstract Data Structures

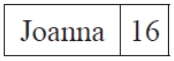
## Quiz 1 – Linked Lists

| Question 1 | | | |
|---|---|---|---|
| Objectives: | 5.1.12, 5.1.13 | Exam Reference: | May-14 6 |

Consider the following linked list which is maintained in alphabetical order.




With the aid of diagrams, explain how the node




would be inserted into the linked list. [3]

Initially compare with node pointed to by the head;
(If not correct place) move through list using pointers until correct alphabetical position is found;
Adjust pointers accordingly;

*(Drawings are acceptable, but award marks only if they clearly show how pointers are correctly rearranged, following the three guidelines above.)*

| Question 2 | | | |
|---|---|---|---|
| Objectives: | 5.1.11 | Exam Reference: | Nov-14 11 |

The temperature (in °C) of a lake was recorded every hour, every day, for one week. As each reading was taken, it was added sequentially to the collection *TEMPERATURES*, which is stored permanently.

At the end of the week this data was read into a two-dimensional array named *TEMPWEEK* as shown below.

| hours | indices | Monday [0] | Tuesday [1] | ... ... | Sunday [6] |
|---|---|---|---|---|---|
| 00:00 | [0] | 12.4 | 12.3 | | 12.6 |
| 01:00 | [1] | 12.3 | 12.3 | | 12.5 |
| ⋮ | ⋮ | | | | |
| 16:00 | [16] | 12.9 | 12.9 | | 12.9 |
| 17:00 | [17] | 13.0 | 13.0 | | 13.0 |
| 18:00 | [18] | 13.1 | 13.1 | | 13.1 |
| ⋮ | ⋮ | | | | |
| 22:00 | [22] | 12.3 | 12.3 | | 12.3 |
| 23:00 | [23] | 12.3 | 12.3 | | 12.3 |

(a) Construct the algorithm that will read the data from the collection into the array. You can use the collection functions *TEMPERATURES.getNext()* and *TEMPERATURES.isEmpty()*. [5]

*Award marks as follows up to **[5 marks max]**.*
*Award **[2 marks]** for correctly using `isEmpty()` and `getNext()` to retrieve all the items from the collection.*
*Award **[1 mark]** for looping through the 7 days.*
*Award **[1 mark]** for looping through the 24 hours.*
*Award **[1 mark]** for correctly filling the `TEMPWEEK` array.*

*Example pseudocode:*

```
DAYS = 0
HOURS = 0
loop while NOT TEMPERATURES.isEmpty ()
     TEMPWEEK[DAYS,HOURS] = TEMPERATURES.getNext()
     HOURS = HOURS + 1
     if HOURS = 24 then
          HOURS = 0
          DAYS = DAYS + 1
     end if
end loop
```

(b) Using the array *TEMPWEEK*, construct an algorithm to determine and output the minimum temperature for the week. [4]

*Award marks as follows up to **[4 marks max]**.*
*Award **[1 mark]** for looping through 7 days and the 24 hours.*
*Award **[1 mark]** for initializing the minimum value to something reasonable (an element of the array or a value less than absolute zero, –273.15 °C).*
*Award **[1 mark]** for correctly finding the minimum value.*
*Award **[1 mark]** for outputting the minimum value.*

*Example pseudocode:*

```
MINIMUM = TEMPWEEK[0, 0]
loop DAYS from 0 to 6
  loop HOURS from 0 to 23
    if TEMPWEEK[DAYS, HOURS] < MINIMUM then
      MINIMUM = TEMPWEEK[DAYS, HOURS]
    end if
  end loop
end loop

output MINIMUM
```

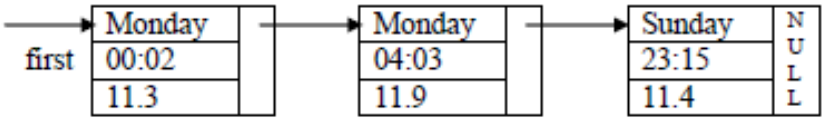
(c) If the temperature is less than 12.0°C then the day, time and temperature are also placed in a separate data structure.

(i) Describe a dynamic data structure that might be used to hold this data. You may use a labelled diagram. [3]

*However the answer is presented, descriptive text or graphically, award marks as follows up to **[3 marks max]**.*
*Award **[1 mark]** for indicating that each node contains a pointer to the next node.*
*Award **[1 mark]** for indicating that each node contains day, time, and temperature.*
*Award **[1 mark]** for stating/showing that the pointer in the last node is null.*

**Linked list**;
In which each node contains link/reference to the next node;
And data field that contains three data items;
Data items are day, time and temperature;
External pointer points to the first node in the list;
And the pointer field of the last node is null;

**OR**




(ii) Using this dynamic structure suggest how the number of days when the temperature of the lake was below 12.0°C can be found. [3]

*Award **[1 mark]** for each step identified up to **[3 marks max]**.*
Set counter to zero (0);
Start from the beginning of the list;
While the end of list is not reached;
Increase counter by 1;
Follow the pointers/links;

| Question 3 | | | |
|---|---|---|---|
| Objectives: | 5.1.12, 5.1.13 | Exam Reference: | May-15 11 |

In a small airport, the details of all flights due to arrive on a particular day are held in a collection, *FLIGHTS*. Each object in the collection contains the following information:

*ID*: unique flight number

*PLACE*: where the plane is coming from
*DUE*: the time it is scheduled to arrive
*EXPECTED*: the time it is expected to arrive (only if it is early or if it is delayed)
*ARRIVED*: the time of actual arrival.

*EXPECTED* and *ARRIVED* are blank at the beginning of the day and the collection is sorted in order of *DUE*.

A screen in the airport can display information on 20 planes at a time, which are held in a linked list.

(a) Describe the features of a linked list of 20 planes that have the above information. [3]

*Award **[1 mark]** for data, **[1 mark]** for pointers, **[1 mark]** for order.*
*Example:*
Each node would hold the data for one plane (ID, place, time due, time expected, landed);
Head pointer points to the first in the list;
Each subsequent pointer points to the next in the list and last node has null pointer;

All times are stored in the collection as the number of minutes since midnight. However, they are displayed on the screen in 24-hour format (for example, 10:58 is stored in the collection as 658).

(a) Construct an algorithm to convert the times held in the collection into hours and minutes needed for the 24-hour format displayed on the screen. [3]

*Award **[1 mark]** for calculating hours.*
*Award **[1 mark]** for calculating minutes.*
*Award **[1 mark]** for input and output/return.*

***Example 1:***

```
input CTIME // time held in the collection in minutes
     HOURS = CTIME div 60
     MINUTES = CTIME mod 60
output HOURS, MINUTES // time to be displayed on the screen
```

***Example 2:***

```
input CTIME // time held in the collection in minutes
HOURS = 0
MINUTES = CTIME
WHILE MINUTES>59
     MINUTES=MINUTES-60
     HOURS=HOURS+1
ENDWHILE
output HOURS, MINUTES // time to be displayed on the screen
```

***Example 3:***

```
Format24 (CTIME)
// method accepts time held in the collection in minutes
     HOURS = CTIME div 60
     MINUTES = CTIME mod 60
     return  HOURS + ":" + MINUTES
     // returns time to be displayed on the screen
end Format24
```

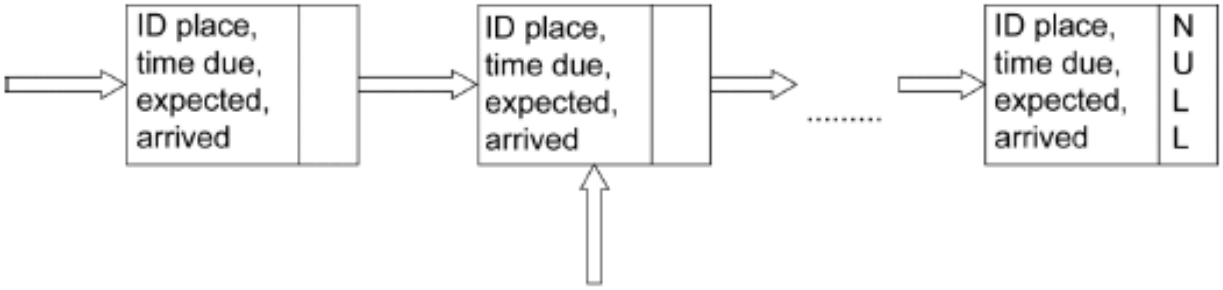
If a plane arrived more than 30 minutes ago it is removed from the linked list and the next one in the collection is added to the end of the list.

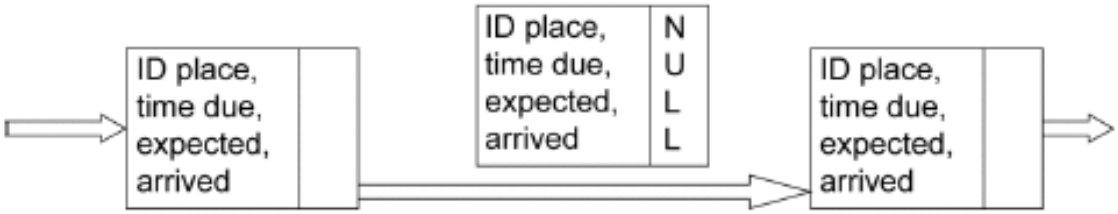
(b) With the aid of a diagram, explain how a plane which arrived more than 30 minutes ago could be removed from the linked list. [4]

*Award marks as follows, up to **[4 marks max]**.*
*Award **[1 mark]** for a diagram and explanation showing access to each plane via pointers;*
*Award **[1 mark]** for comparison of current time with time arrived;*
*Award **[1 mark]** for correct change of pointer from plane deleted;*
*Award **[1 mark]** for correct change of pointer to next plane;*

***Note:** The plane to be deleted could be at the beginning of the list **OR** at the end of the list **OR** in the middle of the list; award third and fourth mark (change of pointers) depending on the position of the node shown in the candidates' diagram/explanation.*

*For example:*
PLANES accessed sequentially via pointers;
PLANE.ARRIVED checked against current time;
if > 30 minutes;
if pointer is head pointer;
move head pointer to point to next PLANE;
else if plane is last in list previous pointer points to NULL;
else previous pointer changed to subsequent plane;
pointer of deleted plane null;




(c) For the application described above, compare the use of a linked list with the use of a queue of objects. [5]

*Award up to **[5 marks max]**.*
A queue would hold the elements in order of arrival;
And enqueue correctly to the end as required;

Dequeue would take planes from the top of the screen;
Which is not wanted as they arrive at different times;

Elements in a linked list could be removed from any position in the list;
Hence a linked list is better;

Searching for ID to amend will be equivalent;