

1. A software company decides to release a duplicate file finder which it has named “De-Duplicator”. Duplicate files are files that are exactly the same (bit for bit identical). Space is often wasted on computers by having multiple versions of the same file. Duplicate file finders are programs that find and identify duplicate files on a hard drive so that they can be removed.

De-Duplicator creates a tree to represent directories and files on the system. It then traverses each directory and file represented in the tree. It does this using a depth-first traversal. State what order it will visit each of the files as shown in Fig.1 below.

[3]

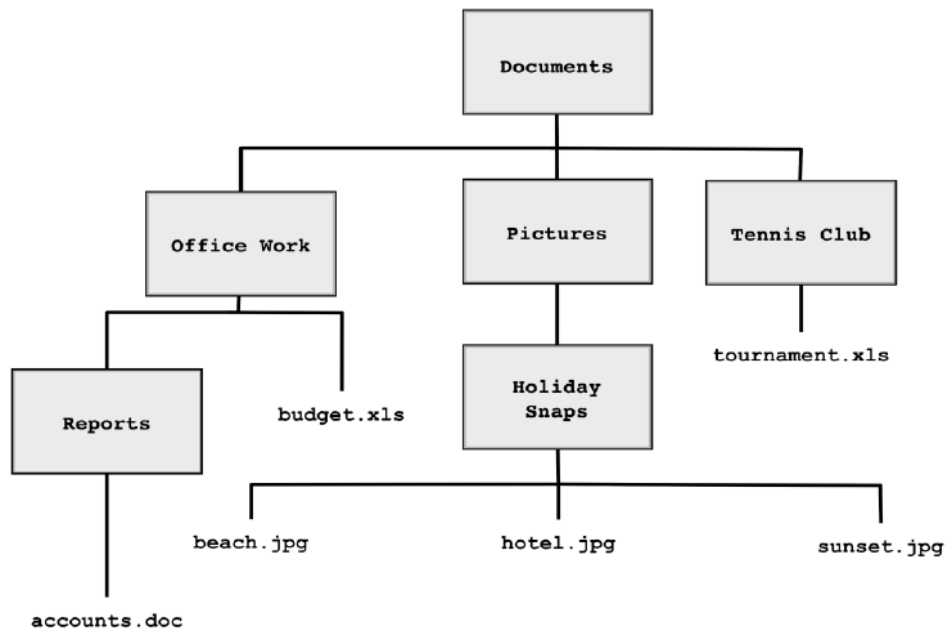
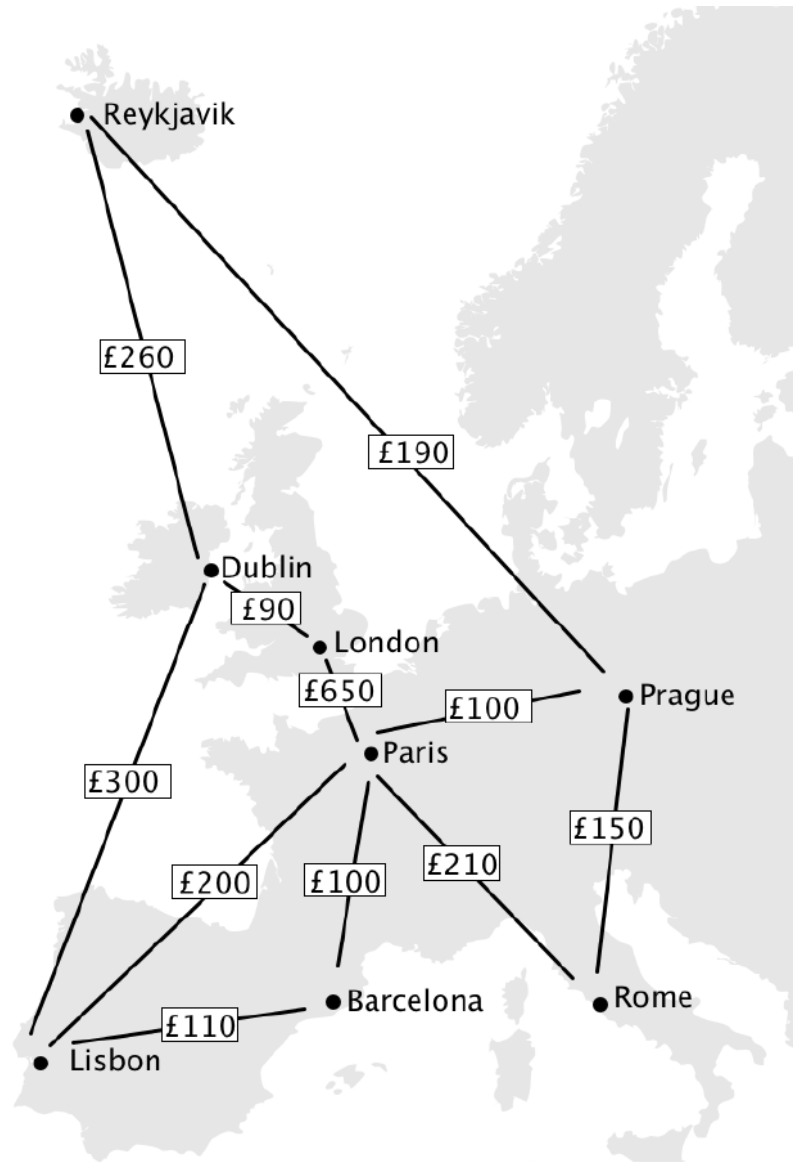


Fig.1

2(a). Atlas Airlines runs flights across cities in Europe. It stores the prices of different flights in its computer system.



State a data structure that would be suited to represent the data above.

----- [1]

(b). A function `tripCost` has been written that takes in two cities and returns the price of a direct flight between them.

e.g. `tripCost("Dublin", "London")` returns 90.

A journey is represented by an array called `cities`. An example of a trip from Dublin to Rome is shown below:

Dublin
London
Paris
Rome

(i) Write a program in the language or pseudocode of your choice that uses the `cities` array to calculate and output the cost of a given journey as a monetary value. In the case above this would be £950.

[5]

(ii) Rather than storing cities in an array you could use a linked list.

Describe a difference between an array and a linked list.

[2]

(d). The tree is coded using object oriented programming.

Each dog breed is represented by an object of class Node.

The Node class has the methods:

getLeftNode () – returns the left hand child node or null if there is no left hand child.

getRightNode () – returns the right hand child node or null if there is no right hand child.

getBreed () – returns the name of the breed stored in that node.

The program allows for a breed name to be entered, and depending on whether the breed is in the tree or not, displays either:

`<breed name> is not in the tree.`

or

`<breed name> is in the tree.`

Complete the program below. Credit will be given for readability of code.

```
name=input("Enter the name of a breed")
breedNode=tree.root() //breedNode is an object of type Node
                        //representing the root of the tree
```


[6]

4(a). A coach company offers tours of the UK.

A linked list stores the names of cities on a coach tour in the order they are visited.



(i) Describe what is meant by the term 'linked list'.

[3]

(ii) The tour is amended. The new itinerary is: London, Oxford, Manchester then York. Explain how Birmingham is removed from the linked list and how York is added. You may use the diagram below to illustrate your answer.



5(a). A software development team is writing a word game.

The team is using Rapid Application Development.

Players are given 10 random letters and asked to find the largest word they can make from those letters. Each letter can only be used once. The length of the word determines the number of points awarded. e.g. a word with 6 letters would mean 6 points are awarded.

The function `validateAnswer` takes in the `randomLetters` as an array of letters and the player's `answer` as a string. It then checks if the word the player has entered only contains letters from the 10 random letters with each letter being used only once. (At this stage the program doesn't check if the answer provided is an actual word.) It then returns a score, out of 10, for a valid word or 0 for an invalid word.

Example

If the random letters are

`OPXCMURETN`

The word `COMPUTER` returns 8

Whereas

The word `POST` returns 0 (there is no S in the random letters).

And

The word `RETURN` returns 0 (there is only one R in the random letters).

Complete the function `validateAnswer`

```
function validateAnswer(answer, randomLetters[])
```

endFunction

[6]

(b). Code is to be added to check if the word is an actual English word. All English words are stored in a binary search tree.

Give **one** advantage of storing the words in a binary search tree over an array.

----- [1]

6. A software company is producing software that allows users with severe mobility issues to input data into a computer.

The software flashes up letters on the screen one at a time. The user sends a signal to the computer when the letter they want appears on the screen.

Rather than displaying the whole alphabet, once the first letter has been entered, the program only shows letters that could be possible according to words in its dictionary. All possible words are stored in a tree data structure.

The program is tested on a sample dictionary of four words, represented as a tree in Fig. 3:

BARON

BATHS

BELOW

BELTS

- (i) Annotate Fig. 3 to show how the word BELTS would be removed from the tree.

[2]

- (ii) Annotate Fig. 3 to show how the words BEACH and BONE would be added to the tree.

[2]

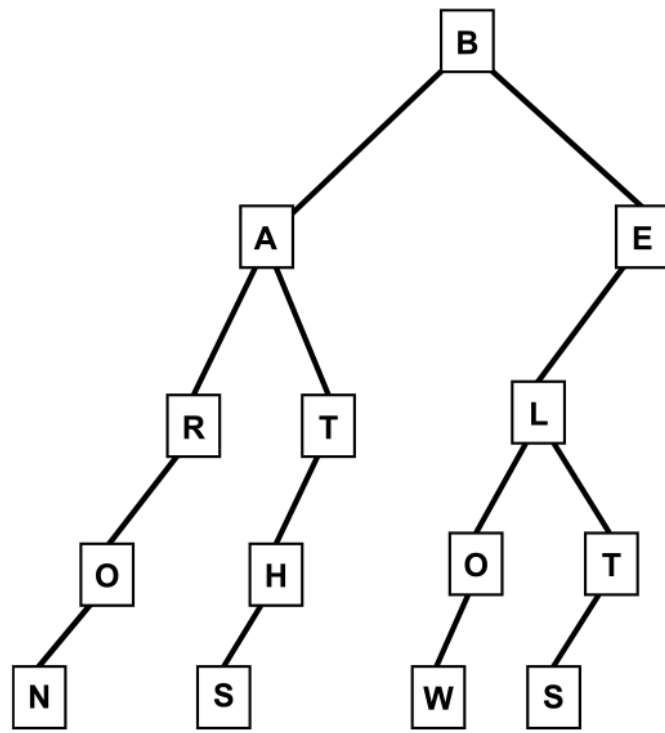


Fig. 3

END OF QUESTION PAPER

Question			Answer/Indicative content	Marks	Guidance
1			<ul style="list-style-type: none"> • Accounts.doc, budget.xls (1). • Followed by beach.jpg, sunset.jpg, hotel.jpg (in any order) (1). • Followed by tournament.xls (1). 	3	For 3 marks. If answer includes directory names ignore the directories and just mark order of files.
			Total	3	
2	a		<ul style="list-style-type: none"> • Graph (1). 	1	For 1 mark. Accept 2D array.
	b	i	<ul style="list-style-type: none"> • Creates a variable to represent total cost and initialises it to 0 (1). • Iterates up to the penultimate item of array (1). • Adds to the total cost ... (1). • ... Uses the correct arguments in the tripCost function (1). • Outputs the total cost formatted with a £ prefix (1). 	5	For 5 marks – 1 mark for each correct step in process. Any program that has the functionality specified in the question should receive full marks. Example: <pre>totalCost=0 for i=0 to cities.Length-2 totalCost=totalCost+ tripCost(cities[i],cities[i+1]) next i print ("£"+totalCost)</pre>
		ii	<ul style="list-style-type: none"> • A linked list is a dynamic data structure (1) whereas an array is static (1). • An array can have any element accessed directly (i.e. random access) (1) whereas a linked list needs to be traversed until the desired element is found (1). • Contents of an array are stored contiguously in memory (1) whereas the contents of a linked list may not be (1). 	2	Up to 2 marks for a valid description.

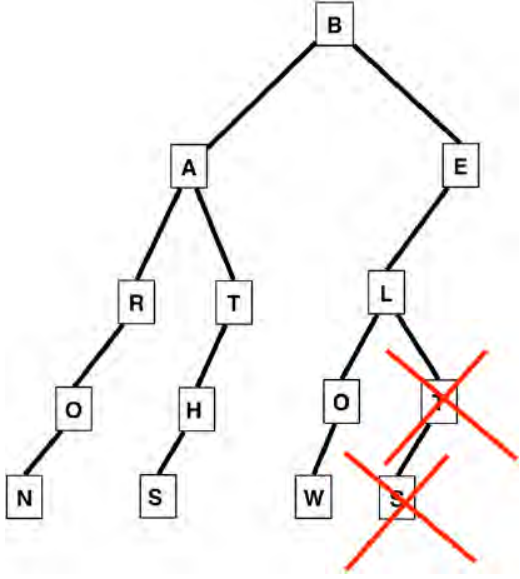
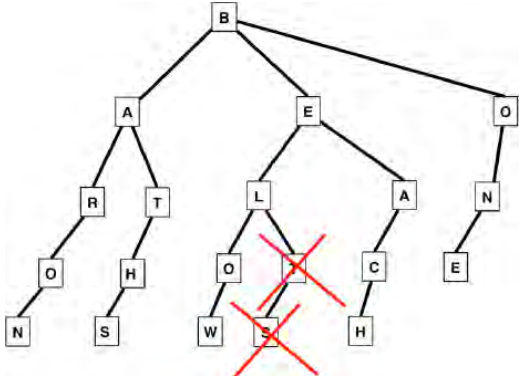
Question		Answer/Indicative content	Marks	Guidance
	c	<ul style="list-style-type: none"> • Takes in code of airport (1). • Iterates through the array (1). • Checks the value of the code column at each iteration (1). • To see if it is equal to code given (1). • When it is, it takes the airport name from the name column (1). • And prints it to the screen (1). 	6	<p>For 6 marks – 1 mark for each correct step in process.</p> <p>Any program that has the functionality specified in the question should receive full marks.</p> <p>Array could be 0 or 1 based.</p> <p>Examples include:</p> <pre>code=input("Please enter code") i=0 while airports[1,i]!=code i=i+1 endwhile print("The airport is: "+airports[2,i])</pre> <p>OR</p> <pre>code = input("Please enter code") name="" for i=0 to 7 if airports[1,i]==code then name=airports[2,i] endif next i print("The airport is: "+name)</pre>
		Total	14	

Question		Answer/Indicative content	Marks	Guidance
3	a	<pre> graph TD Harrier --> Greyhound Harrier --> Rottweiler Greyhound --> Chihuahua Chihuahua --> Doberman Doberman --> Dalmation Rottweiler --> Pug Rottweiler --> Whippet </pre> <p>Doberman in correct position (1) Dalmatian in correct position (1) (Allow FT if first mark is incorrect)</p>	2	<p>Allow one mark if added in wrong order.</p>
	b	<p>Pug > Harrier (go right) (1) Pug < Rottweiler (go left) (1) Found Pug (1)</p>	3	
	c	<p>Spaniel > Harrier (go right) (1) Spaniel > Rottweiler (go right) (1) Spaniel < Whippet, no child node so Spaniel is not in tree (1)</p>	3	
	d	<p>Calls getLeftNode() when name is less than the value of the current node (1) and calls getRightNode() when name is less than the value of the current node. (1) Declares a breed to be in the tree if and only if it exists.(1) Declares a breed not to be in the tree if and only if it doesn't exist (1) Presents output strings in correct format (1) Sensible use of variable names and correctly indented (1)</p>	6	<p>Points 4 and 5 can be awarded even if 1–3 aren't.</p> <pre> notThere = false while breedNode.getName() != name and notThere == false if name < breedNode.getName() then if breedNode.getLeftNode() != null then breedNode = getLeftNode() else notThere = true endif else // must be greater if breedNode.getRightNode() != null then breedNode = getRightNode() else notThere = true endif endif endif endwhile if notThere == true then print(name+ " is not in the tree.") else print(name+" is in the tree") endif </pre>
Total			14	

Question			Answer/Indicative content	Marks	Guidance
4	a	i	<p>A dynamic / data structure (1) Each node / item consists of data and pointer (1) Pointer gives location of next node. (1)</p>	<p>3 (AO1.2)</p>	<p>Accept 'element' instead of 'node / item'</p> <p>Examiner's Comments Surprisingly few candidates achieved full marks on this question. Many received some marks but in general responses lacked detail. Centres should advise candidates that the number of marks awarded for questions gives an indication of the number of different points required in the response.</p>
		ii	<p>Description can be written:</p> <ul style="list-style-type: none"> - Oxford pointer changed to bypass Birmingham and point to Manchester. (1) - A node is created holding the data York / York is placed in next free space / node / item (1) - Manchester remains in original position and pointer changed to point to the York node. (1) - The York node points to null (or terminator). (1) <p>OR via diagram eg.:</p> <pre> graph LR London[London] --> Oxford[Oxford] Oxford --> Manchester[Manchester] Birmingham[Birmingham] --> Manchester Manchester --> York[York] York --> null </pre>	<p>4 (AO2.1)</p>	<p>On diagram don't penalise if the pointer from Birmingham is left intact. It should be clear in both diagram and text that Oxford no longer points to Birmingham.</p> <p>In diagram solution, London, Oxford and Manchester must remain in the same positions.</p> <p>Examiner's Comments Those candidates who scored well in 2ai) went on to achieve at least some of the marks here. Many candidates found it challenging to clearly explain how the linked list was manipulated. If the question states that 'you may use the diagram to illustrate your answer', centres should encourage candidates to do so.</p>

Question		Answer/Indicative content	Marks	Guidance
	b	<p>A linked list requires every node to be checked (until the desired record is found). (1)</p> <p>A linked list will take longer to search (as more nodes are added). (1)</p> <p>A hash table enables direct access to the location of the record. (1)</p> <p>A hash table will take the same time to search (as more nodes are added)/It takes no longer as more records are added. (1)</p>	<p>4</p> <p>(AO1.2 – 2 marks</p> <p>AO2.2 – 2 marks)</p>	<p>Some candidates may talk about time complexity: linked lists being linear / $O(n)$ and hash table being constant / $O(1)$</p> <p>Accept these as points 1 & 2 and 3 & 4 conjoined i.e. full marks.</p> <p>Examiner's Comments</p> <p>Most candidates gained some credit on this question by explaining why hash tables are better suited than linked lists for searching. Those who did not gain credit described in some detail how hash tables were structured, but did not apply their response to the scenario.</p>
		Total	11	

Question		Answer/Indicative content	Marks	Guidance
5	a	<ul style="list-style-type: none"> – Function traverses every letter of answer (1) – Function traverses every randomLetters (1) – Correctly checks each letter of answer against each of randomLetters (1) – Returns 0 if answer contains a letter that doesn't occur in randomLetters (1) – Returns 0 if letter occurs more times in answer than randomLetters (1) – Returns answer length for a valid word.(1) 	6 (AO3.2)	<pre> i=0 while i<answer.length j=0 letter=answer.substring(i,1) while j<10 and randomLetters[j]!=letter j=j+1 endwhile if j<10 then randomLetters[j]="!" else return 0 endif i=i+1 endwhile return answer.length </pre> <p>Examiner's Comments Many candidates achieved some of the available marks on this question for attempting to traverse each letter in the word and each letter in the random word - a loop with a nested loop. Some achieved more marks for comparing the current letters and outputting the length of the valid word. Fewer candidates achieved the final marks for checking if the letter was in the word or duplicated.</p>
	b	BS Tree can be searched quicker than an array.	1 (AO1.2)	<p>Accept $O(\log n)$ search time rather than $O(n)$</p> <p>Examiner's Comments Very few candidates did not achieve this mark, most correctly stating the advantage '<i>faster to search</i>'.</p>
		Total	7	

Question			Answer/Indicative content	Marks	Guidance
6		i	<ul style="list-style-type: none"> - T and S removed /T removed/Link between L and T removed... - ...No further nodes removed <p>(1 Mark per -, Max 2)</p>	2 (AO2.1)	
		ii	<ul style="list-style-type: none"> - BEACH added - BONE added <p>(1 Mark per -, Max 2)</p>	2 (AO2.1)	 <p>Whether branches point left or right or order of branches is irrelevant. As long as branches form the words without unnecessary repetition of nodes, award the marks.</p> <p>Examiner's Comments</p> <p>Invariably, all candidates fared well on both parts of this question.</p>
Total				4	