1(a). A group of students are designing a racing car game. The game will allow players to enter their name and then a choice of vehicle. They will then race against other vehicles that will be controlled by the program. Players will use the arrow keys to control their vehicle.

The students use abstraction during the design process.

i. State what is meant by abstraction **and** describe how it can be used to design the racing car game.

Definition

Use

---

[3]

ii. Explain why it is beneficial to use abstraction when designing a computer program such as a game.

---

[3]

(b).

i. The group of students use decomposition.

State what is meant by decomposition.

---**[1]**

ii. Describe **one** benefit of using decomposition when designing a computer program such as a game.

---**[2]**

2. A company runs a Virtual Learning Environment (VLE). Schools can register students to use the VLE. The students get their own account and the school can view and monitor their students who are registered. There are currently over 10 000 schools registered, each with up to 1000 students.

The students can watch videos, take quizzes and communicate using forums and online chat tools.

The company gathers a large amount of data and wants to use data mining to help them decide how to improve the VLE in the future.

Discuss how the company can use data mining to decide how to improve the VLE.

You should include the following in your answer:

- the characteristics of data mining
- the benefits of data mining in this scenario
- the drawbacks of data mining in this scenario.

---

[12]

3. A computer game has a building containing 7 rooms. There are secret passages between each room. **Fig. 3** shows the rooms and the passages between the rooms represented as a graph data structure.

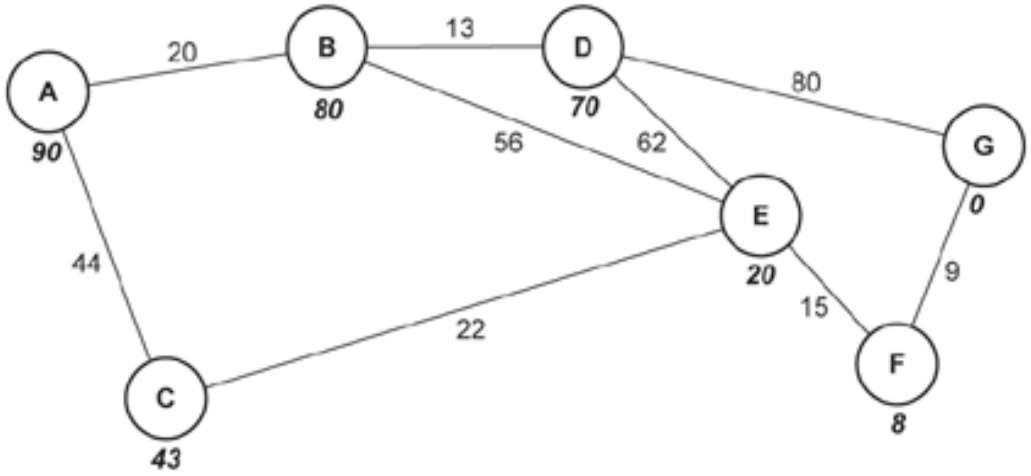


Fig. 3

The final game will involve multiple computer-controlled characters and interactive elements that make use of artificial intelligence to determine the moves they will make.

The artificial intelligence will use heuristics to determine where the computer-controlled characters will move in the game.

Discuss how heuristics can be used in algorithms.

You should include the following in your answer:

- the purpose of heuristics
- the benefits and drawbacks of heuristics
- the suitability of heuristics in algorithms within a computer game.

---

[9]

4. A company needs a new computer program that will create schedules for delivery drivers. It will need to identify a possible order that the drivers can deliver items and possible routes they could take.

Discuss how programmers could make use of problem recognition and problem decomposition when designing this system.

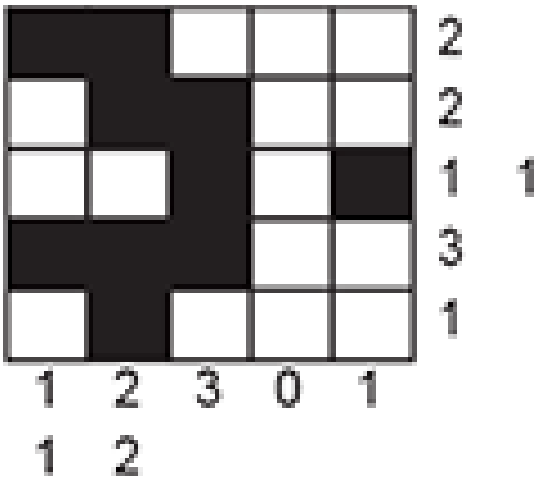
You should include the following in your answer:

- a description of both problem recognition and decomposition
- how each method can be used when designing the solution
- the benefits of using each method when designing the solution.

[9]

5(a). A Nonogram is a logic puzzle where a player needs to colour in boxes. The puzzle is laid out as a grid and each square needs to be either coloured black or left white.

The numbers at the side of each row and column tells the player how many of the boxes are coloured in consecutively. Where a row has two or more numbers, there must be a white square between the coloured squares.



In this example:

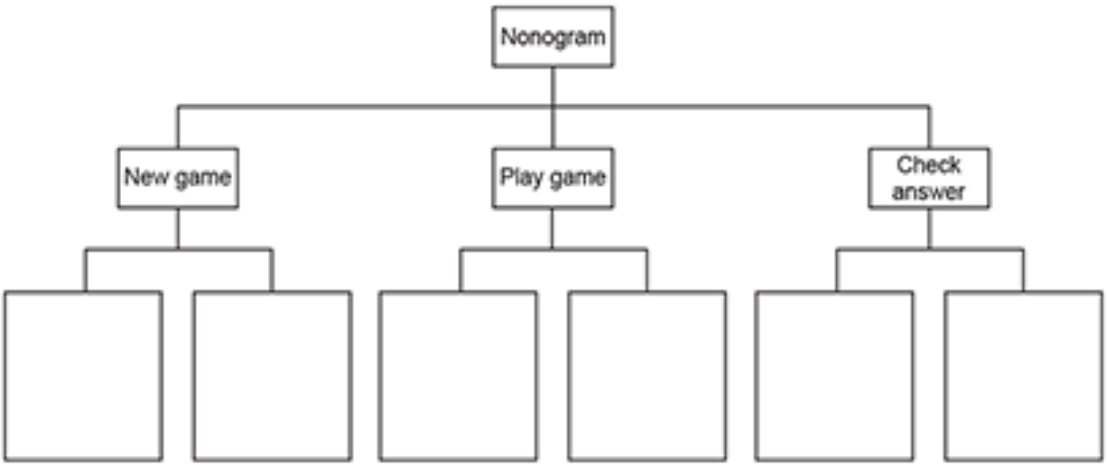
- the first column has 1 1, this means there must be two single coloured boxes in this column. There must be at least 1 white box between them.
- the first row has 2, this means there must be two consecutively coloured boxes in the row.

Juan is creating a program that will store a series of Nonograms for a user to play. The game will randomly select a puzzle and display the blank grid with the numbers for each row and column to the user.

The user plays the game by selecting a box to change its colour. If the box is white it will change to black and if it is black it will change to white. The user can choose to check the answer at any point, and the game will compare the grid to the answers and tell the user if they have got it correct or not.

Juan is creating a structure diagram to design the game.

i. Complete the structure diagram by adding another layer for New game, Play game and Check answer.



[3]

ii. A structure diagram is one method of showing the decomposition of a problem.

Explain why decomposing a problem can help a developer design a solution.

[2]

iii. Identify **one** input, **one** process and **one** output required for the game.

Input

Process

Output

[3]

(b). Juan uses the structure diagram to create a modular program with a number of subroutines.
The program will use two integer 2-dimensional arrays to store the puzzles:

- `puzzle(5,5)` stores the solution
- `answerGrid(5,5)` stores the user's current grid.

A `0` represents a white box and a `1` represents a black box.

i. Juan creates a function, `countRow()`, to count the number of coloured boxes in one row and return the number of consecutive coloured boxes in that row. If there is more than one set of coloured boxes in the row, these are joined together and the string is returned. For example, in the following grid `countRow` for row 0 will return "`2`" as a string, and `countRow` for row 2 will return "`1 1`" as a string. If there are no 1s in a row, then "`0`" is returned as a string.

1	1	0	0	0
0	1	1	0	0
0	0	1	0	1
1	1	1	0	0
0	1	0	0	0

Complete the pseudocode algorithm `countRow()`.

```
01    function countRow(puzzle:byref, rowNum:byval)
02    count = 0
03    output = " "
04    for i = 0 to ……
05      if puzzle[rowNum, i] == …… then
06         count = count + 1
07      elseif count >= 1 then
08         output = output + str(……) + " "
09         count = 0
10      endif
11    next i
12    if count>= 1 then
13         output=output+str(count)
14    elseif output == "" then
15         output = "……"
16    endif
17    return ……
18  endfunction
```

[5]

ii. Explain the purpose of line 03 in the function `countRow`.

[2]

iii. Describe the purpose of branching and iteration in the function `countRow`.

[3]

iv. The procedure `displayRowAnswer()` takes `puzzle` as a parameter and outputs the value in each box. Each box in a row is separated by a space. At the end of each row there are two spaces and (by calling the function `countRow` from **part (i)**) the clue values for that row.

For example the puzzle below:

1	1	0	0	0
0	1	1	0	0
0	0	1	0	1
1	1	1	0	0
0	1	0	0	0

Would output:

```
1  1  0  0  0     2
0  1  1  0  0     2
0  0  1  0  1     1  1
1  1  1  0  0     3
0  1  0  0  0     1
```

Write pseudocode or program code for the procedure `displayRowAnswer()`.

[6]

v. The function `checkWon()` takes `answerGrid` and `puzzle` as parameters and compares each element in the grids. If they are identical, it returns `true`, otherwise returns `false`.

```
01  function checkWon(puzzle)
02    for row = 0 to 4
03      for column = 0 to 4
04        if puzzle[row, column] == answerGrid[row, column] then
05          return false
06        endif
07      next column
08    next column
09    return true
10  endfunction
```

There are **three** logic errors in the function `checkWon`

State the line number of each error and give the corrected line.

Error 1 line number _____

Error 1 correction _____

Error 2 line number _____

Error 2 correction _____

Error 3 line number _____

Error 3 correction _____

[3]

(c). * Juan passed the two arrays as parameters, but he did consider making them globally accessible.

Compare the use of global and local variables and data structures in this program. Include the use of parameters and program efficiency in your answer.

_____

_____

_____

_____

_____

[9]

(d). Juan wants to create a program that will generate new Nonograms with different grid sizes. For example a Nonogram with a 10 × 10 grid or a 5 × 20 grid.

Describe how the program could be written to automatically generate a new Nonogram.

[4]

6(a). Amy's processor makes use of pipelining during the fetch-decode-execute cycle.

The processor's pipeline consists of the following stages:

- Fetching the instruction from memory
- Decoding the instruction
- Executing the instruction.

Instructions A, B, C and D need to be processed.

Identify the stage(s) and instruction(s) run during each pipeline below.

Pipeline 1

Pipeline 2

Pipeline 3

Pipeline 4

---

[4]

(b). Explain why pipelining can improve the performance of the processor.

---**[2]**

7. Lucas writes a program that makes use of a circular queue. The queue stores the data entered into the program. An array is used to represent the queue.

The program needs two pointers to access and manipulate the data in the queue.

State the purpose of the two pointers and give an appropriate identifier for each.

Pointer 1 purpose

Pointer 1 identifier

Pointer 2 purpose

Pointer 2 identifier

---

[4]

8. Explain why a quicksort is known as a divide and conquer algorithm.

---**[2]**

9(a). * The game will have thousands of users. Taylor will store data about the users and their actions while playing the game in a large database.

Evaluate how Taylor can use data mining to inform future changes to improve his circus game.

[9]

(b). Taylor is creating an online multiplayer game where users can create accounts and build their own circus. Each circus will contain characters such as clowns, animals, magicians and dancers.

Users can set up a new circus in the online world, purchase new characters and visit other users' circuses.

Taylor uses computational methods to analyse the problem including abstraction.

Describe how Taylor could use abstraction in the design of his online circus game.

[3]

10. OCR-Tickets wants to sell tickets for their concerts, plays and other events online. A customer should be able to create an account and then be able to log into their account. Once logged in, customers should be able to carry out actions such as setting their preferences and purchasing tickets.

OCR-Tickets have hired a software development company to create the system for them.

The system requirements have a number of features that mean they are solvable by computational methods, such as decomposition.

Explain why decomposition can help the development of the program.

[4]

11. Sally is a classroom teacher. She would like a program to be able to organise where students will sit in her classroom.

A plan of her classroom is shown **in Fig. 1**.

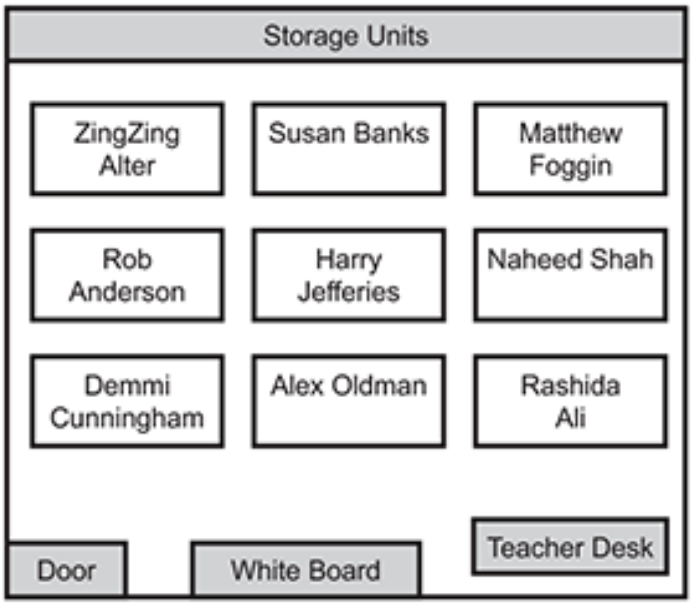


Fig. 1

i. State **three** ways that Sally has made use of abstraction in Fig. 1.

1 _____

_____

2 _____

_____

3 _____

_____

[3]

ii. Explain **two** benefits to Sally of using abstraction before creating the programming code.

1 _____

_____

_____

_____

2 _____

_____

_____

_____

[4]

END OF QUESTION PAPER