2.1 Elements of Computational Thinking: 30-minute Pack

Total Marks

OCR H446 · Calculators not allowed · about 30 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Callum is writing the control program for a vending machine. The machine should display a prompt unless a coin has been inserted AND the selection button has been pressed. His first version of the condition, using two Boolean variables hasCoin and buttonPressed, is:

```
IF NOT (hasCoin AND buttonPressed) THEN
  OUTPUT "Please insert a coin and press the button"
ENDIF
```

(a) Complete a truth table for the expression NOT (hasCoin AND buttonPressed) for all four combinations of hasCoin and buttonPressed. **(3)**

(b) Show that NOT (hasCoin AND buttonPressed) is logically equivalent to (NOT hasCoin) OR (NOT buttonPressed). **(3)**

(c) Rewrite the IF statement above so that it uses the simplified logical expression from part (b) instead, using OCR Exam Reference Language. **(3)**

(Total for Question 1 is 9 marks)

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2 Kelvin Grove Hospital models patient waiting times at its walk-in triage desk to test how changes might affect the department, without needing to trial them on real patients (performance modelling). One triage nurse (a single server) sees patients strictly in the order they arrive. Five patients arrive at times (in minutes after opening) of 0, 4, 5, 9 and 15, and require treatment (service) times of 6, 3, 5, 4 and 2 minutes respectively. The algorithm below simulates the queue:

```
arrival[1] <- 0
arrival[2] <- 4
arrival[3] <- 5
arrival[4] <- 9
arrival[5] <- 15
service[1] <- 6
service[2] <- 3
service[3] <- 5
service[4] <- 4
service[5] <- 2
finishPrev <- 0
totalWait <- 0
FOR i <- 1 TO 5
  IF arrival[i] > finishPrev THEN
    start[i] <- arrival[i]
  ELSE
    start[i] <- finishPrev
  ENDIF
  finish[i] <- start[i] + service[i]
  wait[i] <- start[i] - arrival[i]
  finishPrev <- finish[i]
  totalWait <- totalWait + wait[i]
NEXT i
```

(a) State what is meant by performance modelling as a computational thinking technique, and give one reason it is used instead of trialling changes on the real system. **(2)**

(b) Complete a trace table showing the values of start[i], finish[i] and wait[i] for i = 1 to 5, and the final value of totalWait, when the algorithm above is executed. **(6)**

(c) Calculate the mean waiting time per patient across this simulation, giving your answer to 1 decimal place. **(3)**

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(d) Explain why simulating a much larger number of patients would improve the reliability of this performance model's predictions, and suggest one limitation that would remain even with a much larger simulation. **(3)**

(Total for Question 2 is 14 marks)

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3 Freya analyses monthly visitor numbers for a council website: Jan 1200, Feb 1350, Mar 3100, Apr 1400, May 1450, Jun 1500.

(a) State two reasons why visualising this data (e.g. as a line graph) can make patterns easier to identify than examining the raw numbers alone. **(2)**

(b) Identify, from the data given, the month that is an outlier compared with the general trend, and suggest a possible real-world cause. **(2)**

(c) State one type of visualisation, other than a line graph, that would be more appropriate for showing the proportion of the total annual visitors contributed by each month, and justify your choice. **(2)**

(d) Explain one limitation of relying on visualisation alone, rather than combining it with other computational thinking techniques such as data mining, when analysing very large datasets. **(2)**

(Total for Question 3 is 8 marks)

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Mark scheme · 2.1 Elements of Computational Thinking: 30-minute Pack

Question 1

(a) correct hasCoin AND buttonPressed column for all 4 rows (T, F, F, F) **B1**

(a) correct NOT(...) column for all 4 rows (F, T, T, T) **B1**

(a) all four rows fully correct and consistently laid out **B1**

(a) Answer: hasCoin=T,buttonPressed=T: AND=T, NOT=F | T,F: AND=F, NOT=T | F,T: AND=F, NOT=T | F,F: AND=F, NOT=T

(b) states De Morgan's law: NOT (P AND Q) = (NOT P) OR (NOT Q) **M1**

(b) correctly substitutes P = hasCoin and Q = buttonPressed **M1**

(b) cso - concludes the two expressions are equivalent, consistent with the truth table in part (a) **A1**

(b) Answer: NOT (hasCoin AND buttonPressed) = (NOT hasCoin) OR (NOT buttonPressed), by De Morgan's law.

(c) any correct logic: replaces the condition with (NOT hasCoin) OR (NOT buttonPressed) **M1**

(c) correct placement of NOT before each variable **M1**

(c) structure of IF...THEN...ENDIF and the OUTPUT statement preserved unchanged **A1**

(c) Answer:

```
IF (NOT hasCoin) OR (NOT buttonPressed) THEN
  OUTPUT "Please insert a coin and press the button"
ENDIF
```

Question 2

(a) identifies that performance modelling uses a simplified model/simulation to predict how a system will behave (oe) **B1**

(a) valid reason, e.g. cheaper/safer/faster than making changes to and testing a real system, or avoids risk to real patients (oe) **B1**

(a) Answer: Performance modelling uses a simplified model or simulation to predict how a system will behave under different conditions. It is used because trialling changes on the real hospital system could be slower, more expensive, or put real patients at risk.

(b) i=1: start=0, finish=6, wait=0 **B1**

(b) i=2: start=6, finish=9, wait=2 **B1**

(b) i=3: start=9, finish=14, wait=4 **B1**

(b) i=4: start=14, finish=18, wait=5 **B1**

(b) i=5: start=18, finish=20, wait=3 **B1**

(b) cao totalWait=14 **B1**

(b) Answer: i=1: start=0,finish=6,wait=0. i=2: start=6,finish=9,wait=2. i=3: start=9,finish=14,wait=4. i=4: start=14,finish=18,wait=5. i=5: start=18,finish=20,wait=3. totalWait=14.

(c) uses totalWait = 14 from part (b) **M1**

(c) divides by the number of patients, 5 **M1**

(c) cao 2.8 minutes **A1**

(c) Answer: 2.8 minutes

(d) explains that a larger sample smooths out random variation and is more representative of typical patient arrival/service patterns (oe) **B1**

(d) identifies a specific remaining limitation, e.g. the model assumes strict FIFO order and does not account for priority/emergency patients who would be seen out of turn in reality (oe) **B1**

(d) further valid development of the limitation or its consequence, e.g. this means the model may still underestimate waiting times for lower priority patients on a busy day (oe, ft) **B1**

(d) Answer: A larger simulation averages out random variation in arrival and service times, giving a more reliable, representative prediction. However, it would still assume strict first-come-first-served order and would not model priority/emergency patients being seen out of turn, so it could still underestimate waits for some patients in reality.

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Question 3

(a) identifies that people can recognise visual patterns/trends more quickly than by reading numeric tables (oe) **B1**

(a) identifies that anomalies or outliers stand out immediately in a chart (oe) **B1**

(a) Answer: A visual chart lets patterns and trends be spotted at a glance, more quickly than scanning a table of numbers; anomalies or outliers (unusually high or low points) stand out immediately.

(b) identifies March (3100) as the outlier **B1**

(b) plausible real-world cause, e.g. a one-off marketing campaign or local news event drove extra visits that month (oe) **B1**

(b) Answer: March (3100 visitors) is the outlier; a possible cause is a one-off marketing campaign or news story that temporarily increased visits.

(c) names an appropriate chart, e.g. a pie chart or a stacked bar chart **B1**

(c) valid justification, e.g. it clearly shows how each month's share compares to the whole/to the other months (part-to-whole relationship) (oe) **B1**

(c) Answer: A pie chart, because it clearly shows how each month's visitor total compares as a proportion of the whole year, rather than showing change over time.

(d) identifies that a chart with a very large number of data points can become cluttered/unreadable, or that the choice of scale can mislead the viewer (oe) **B1**

(d) identifies that data mining can uncover subtle patterns/relationships in the data that are not visible to the human eye in a chart (oe) **B1**

(d) Answer: With very large datasets, a chart can become too cluttered to read clearly, and misleading scales can distort the apparent pattern. Data mining can uncover subtle patterns or relationships in large datasets that would not be visible simply by looking at a chart.

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