Ch16

Data Representation

CHAPTER ASSIGNMENT · 62 MARKS

Name _____ Class _____ No. _____ Date _____

Answer every question in the space given. Show your working. You may use the chapter page to help you.

Questions from *Computer Science for Cambridge International AS & A Level Coursebook*, 2nd edition, Sylvia Langfield and Dave Duddell (Cambridge University Press), for classroom use.

Tasks and questions from the chapter

DP **Discussion Point:** A record is a user-defined data type. It is also a component of a file. Can there be or should there be any relationship between these two concepts?

EQ16.01 **Extension Question 16.01:** Can you think of reasons why you might want to use binary files with variable-length records? How would you make sure a binary file with variable-length records would be read correctly?

Q16.01 Imagine the possible numeric values for a key field in a direct-access file are in the range of 1 to 30 but you want the file to have fewer than 30 file addresses.

You decide to test two examples of a modular division hashing algorithm. The first test uses 10 as the number for division, the second test uses 11.

(a) What are the two sets of addresses generated as remainders from the division for the key values 0 to 39 using 10 and 11?

(b) State one difference between the two sets of addresses.

(c) Is there any significant difference between the two sets of addresses?

(d) 11 is a prime number. Prime numbers are stated to give a better spread of use of the addresses in a file. Do you know when this is more likely to be true?

EQ16.02 **Extension Question 16.02:**

(a) Using the methods suggested in Chapter 1 (Section 1.01) can you confirm for yourself that the denary equivalents of the binary codes shown in Tables 16.02 and Table 16.03 are as indicated?

(b) Can you also confirm that conversion from positive to negative (or the conversion from negative to positive) for a fixed-format real value still follows the rules defined in Chapter 1 (Section 1.02) for two's complement representation?

EQ16.03 **Extension Question 16.03:** Look at the data in Table 16.03. Do you see any conflict with the above discussion? What is likely to be the approach in a typical floating-point system?

16.01 Convert the denary value –7.75 to a floating-point binary representation with ten bits for the mantissa and four bits for the exponent. Start by converting 7.75 to binary (make sure you add the sign bit!). Then convert to two's complement form. Finally, choose the correct value for the exponent to leave the implied position of the binary point after the sign bit. Convert back to denary to check the result.

RP **Reflection Point:** Whenever you are asked to create a binary representation from a denary value or vice-versa are you always checking your answer by converting it back to the original value?

Exam-style questions

1 A programmer may choose to use a user-defined data type when writing a program.

(a) Give an example of a non-composite user-defined data type and explain why its use by a programmer is different to the use of an in-built data type. [3]

(b) A program is to be written to handle data relating to the animals kept in a zoo. The programmer chooses to use a record user-defined data type.

(i) Explain what a record user-defined data type is. [2]

(ii) Explain the advantage of using a record user-defined data type. [2]

(iii) Write pseudocode for the definition of a record type which is to be used to store: animal name, animal age, number in zoo and location in the zoo. [5]

2

(a) A binary file is to be used to store data for a program.

(i) State the terms used to describe the components of such a file? [2]

(ii) Explain the difference between a binary file and a text file. [3]

(b) A binary file might be organised for serial, sequential or direct access.

(i) Explain the difference between the three types of file organisation. [4]

(ii) Give an example of file use for which a serial file organisation would be suitable. Justify your choice. [3]

(iii) Give an example of file use when direct access would be advantageous. Justify your choice. [3]

3 A file contains binary coding. The following are four successive bytes in the file:

10010101		00110011		11001000	00010001

(a) The four bytes represent two numbers in floating-point representation. The first byte in each case represents the mantissa. Each byte is stored in two's complement representation.

(i) Give the name for what the second byte represents in each case. [1]

(ii) State whether the representations are for two positive numbers or two negative numbers and explain why. [2]

(iii) One of the numbers is in a normalised representation. State which one it is and give the reason why. [2]

(iv) State where the implied binary point is in a normalised representation and explain why a normalised representation gives better precision for the value represented. [3]

(v) If two bytes were still to be used but the number of bits for each component was going to be changed by allocating more to the mantissa, state what effect this would have on the numbers that could be represented. Explain your answer. [2]

(b) Using the representation described in **part a**, give the representation of denary 12.43 as a floating-point binary number. [5]

4

(a) A particular programming language allows the programmer to define their own data types. `ThisDate` is an example of a user-defined structured data type.

```
TYPE ThisDate
    DECLARE ThisDay   : (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13,
                         14, 15, 16, 17, 18, 19, 20, 21, 22, 23,
                         24, 25, 26, 27, 28, 29, 30, 31)
    DECLARE ThisMonth : (Jan, Feb, Mar, Apr, May, Jun, Jul, Aug,
                         Sep, Oct, Nov, Dec)
    DECLARE ThisYear  : INTEGER
ENDTYPE
```

A variable of this new type is declared as follows:

```
DECLARE DateOfBirth : ThisDate
```

(i) Name the non-composite data type used in the `ThisDay` and `ThisMonth` declarations. [1]

(ii) Name the data type of `ThisDate`. [1]

(iii) The month value of `DateOfBirth` needs to be assigned to the variable `MyMonthOfBirth`.

Write the required statement. [1]

(b) Annual rainfall data from a number of locations are to be processed in a program.

The following data are to be stored:

- location name
- height above sea level (to the nearest metre)
- total rainfall for each month of the year (centimetres to 1 decimal place).

A user-defined, composite data type is needed. The programmer chooses `LocationRainfall` as the name of this data type.

A variable of this type can be used to store all the data for one particular location.

(i) Write the definition for the data type `LocationRainfall`. [5]

(ii) The programmer decides to store all the data in a file. Initially, data from 27 locations will be stored. More rainfall locations will be added over time and will never exceed 100.

The programmer has to choose between two types of file organisation. The two types are serial and sequential.

Give **two** reasons for choosing serial file organisation. [2]

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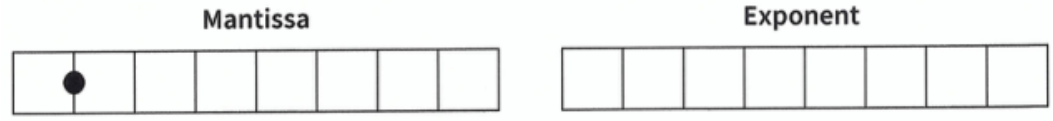
5 In a particular computer system, real numbers are stored using floating-point representation with:

- 8 bits for the mantissa
- 8 bits for the exponent
- two's complement form for both mantissa and exponent.

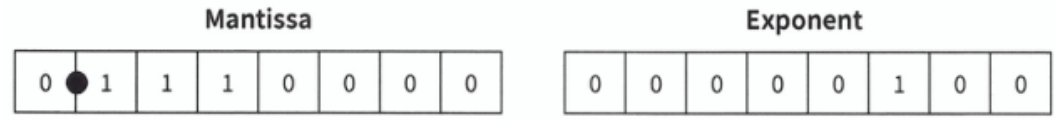
(a) Calculate the floating point representation of +3.5 in this system. Show your working. [3]



(b) Calculate the floating point representation of –3.5 in this system. Show your working. [3]



(c) Find the denary value for the following binary floating-point number. Show your working. [3]



(d) **(i)** State whether the floating-point number given in **part (c)** is normalised or not normalised. [1]

(ii) Justify your answer given in **part (d)(i)**. [1]

(e) Give the binary two's complement pattern for the negative number with the largest magnitude. [2]



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End of assignment · Check your answers against the chapter at gurujazzy.com/subjects/computer-science/as-a-level/data-representation/