Year 13 Computer Science Directed Study

Date Set: Thursday 10th February 2022 **Date Due:** Thursday 24th February 2022

Isaac Computer Science

Complete the following Isaac Computer Science gameboards – ensuring that you score 100% for each gameboard.

- **Models of Computation**

Subject Reading

The best Computer Scientists learn more about their discipline and expand their knowledge and skills through reading. After reading the text complete the reading log.

Researchers use tiny magnetic swirls to generate true random numbers
https://www.sciencedaily.com/releases/2022/02/220207124827.htm

Practice Questions

Complete the practice question packs provided. These should be green pen corrected. Please find the answers in the teams channel.

Revision Check

Please bring your revision books and documents for our first lesson back:
Tuesday 22nd February.

Maths for Regular Expressions

1. Read **pages 164 – 168**, **Chapter 21** of the AQA A-Level textbook by Bob Reeves.
   - Take bullet point notes or Cornell Notes (More information: https://lsc.cornell.edu/how-to-study/taking-notes/cornell-note-taking-system/)
   - These can be done digitally (typed) or on paper, then scanned and uploaded.
2. What is cardinality?
3. Use set comprehension to represent all real numbers greater than zero.
4. Use set comprehension to define all negative integers.
5. Use set comprehension to define the cube of all natural numbers.
6. Explain why the empty set is not the same as zero.
7. Use examples to explain the difference between union, intersection and difference when joining two or more sets together.
8. Define the Cartesian product that would result from A = {x, y, z} and B = {1, 2}.
9. What is the cardinality of a set resulting from the Cartesian product of A with 8 elements and B with 9 elements?
10. Use an example to explain a proper subset.

Regular Languages

1. Read **pages 156 – 159**, **Chapter 20** of the AQA A-Level textbook by Bob Reeves.
   - Take bullet point notes or Cornell Notes (More information: https://lsc.cornell.edu/how-to-study/taking-notes/cornell-note-taking-system/)
   - These can be done digitally (typed) or on paper, then scanned and uploaded.

2. Explain the difference between regular expressions and context-free languages.

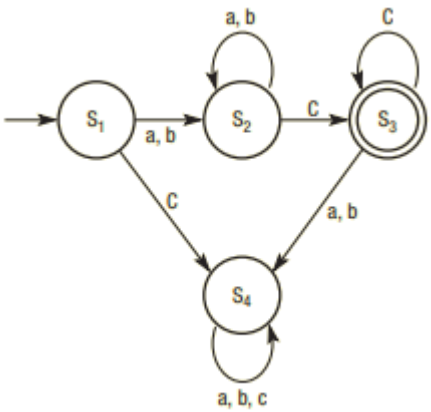
3. Identify two text strings that would be acceptable for the following regular expressions:
   a. a|b+c
   b. (a|b)c*
   c. a*b*c
4. Draw state transition diagrams for the three regular expressions in question 2.

5. Write a regular expression for each of the following descriptions that uses an alphabet of 0 and 1:
   a. Must start with a 1
   b. Any number of 0s followed by any number of 1s
   c. Any combination of 0s and 1s.

Unit 4 Practice Questions

1. A holiday tour business wants to create a new computer system. They offer 30 different tours every year, each of which can have up to 50 people on it. The tour company organises the travel and hotel arrangements and lays on a number of excursions. They need to organise tour guides to accompany their customers and manage all of the payments from customers and to suppliers.
   a) Explain how you could use abstraction by generalisation /categorisation to break this problem down.
   b) Produce a hierarchy chart to show how you could decompose this problem.
   c) List at least six items of data that the tour business will need to collect.
   d) Give two examples of how information hiding could be used in this scenario.

2. The finite state machine (FSM) shown processes a language with an alphabet of a, b and c.



   a. Which of these input strings would be accepted?
      i. aaabc
      ii. baabc
      iii. aaaab
      iv. abc
   b. Which of the states is the accepting state?
   c. Draw a transition table for this FSM.
   d. Write a regular expression that would recognise the same language as this FSM.

3. The common orders of time complexity are shown in the table.

Time complexity
$O(1)$
$O(n^2)$
$O(\log_2 n)$
$O(k^n)$
$O(n)$

a. Describe in words what O(1) means.

b. Which is the time complexity of an intractable problem?

c. What is meant by an intractable problem?

d. Which is the time complexity for a binary search?

e. Which is the time complexity for a linear search?

f. On average, would a binary search or a linear search be quickest on a list of just five items? Explain your answer

4. A Turing machine is represented by the following transition table.
   a. What is a Turing machine?

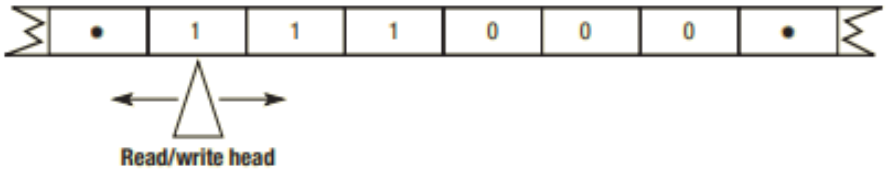
   b. What is a Universal Turing machine?

   c. Draw a state transition diagram for the instructions in the table.

State	Read	Write	Move	Next state
S0	1	0	R	S1
S0	0	1	R	S1
S0	B	0	R	SH
S1	1	1	R	S1
S1	0	0	R	S0
S1	B	1	R	SH

Write out the instructions in the format:
δ (Current State, Input Symbol) = (Next State, Output Symbol, Movement)

5. The Turing machine is carrying out a computation. Its starting state is S0 and the contents of the tape and location of the tape head are shown below. State SH is the halting state. Trace the computation, showing the contents of the tape, the current position of the read/write head and the current state as the input symbols are processed.



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A-Level Computer Science Reading Record

The best Computer Scientists learn more about their discipline and expand their knowledge and skills through reading. After reading the text you have been assigned, complete this sheet to reflect on what you have read.

Title	
Author	
Harvard Reference	

For more information about Harvard Referencing, visit
www.open.ac.uk/library/help-and-support/quick-guide-to-harvard-referencing-cite-them-right

Summarise the key points from the article. Use quotations, statistics and evidence from the text to support your point(s)

How can you use the knowledge you have gained from this article to improve your practice?