Digital Technologies, York College

A Level Computer Science

Summer Workbook

To prepare you for the start of A Level Computer Science in September, we'd like you to complete this workbook and submit it by 430pm on Sunday 3rd September via the email address below. We will be using this as a starting point for your work, and your answers will be discussed in class, so you'll need to be prepared.

On the following pages there are several activities that will start to get you thinking like a true computer scientist. You'll need to draw on logic and your understanding of maths and reasoning, you'll need to use your imagination and think creatively, and maybe do a little online research. Combining good research with sound, logical thinking gives a computer scientist a solid foundation to build upon. Adding imagination and creativity uses that foundation to find real solutions to difficult problems.

Good luck, and I look forward to welcoming you to the course in September.

Matthew Longman

M Longman

AS Computer Science Course Leader

Submitting completed work

When completed your work should be sent to the Computer Science team via the email address below.
Please submit your work by 430pm on Sunday 3rd September 2023

Email completed work to: **computerscienceyorkcollege@gmail.com**

Thinking Logically Sudoku

Sudoku is a popular logic puzzle commonly characterised by 9 grids of 3x3 squares.

The only rules are that each of the nine rows and columns and each of the 3x3 grids can contain the numbers between 1 and 9 only once. A simple example (using smaller grid sizes to make it easier):

	2	4	
1			3
4			2
	1	3	

How would you go about solving this problem? What steps would you take first?

Solving Sudoku is all about eliminating the impossible, but also about looking at the grid in different ways (whether row, column or 3x3 grid).

The first technique is called cross-hatching. We do this by taking one of the 3x3 grids (usually the one with the most numbers already filled in) and thinking about which numbers it is missing.

If we consider the top left, the numbers missing are 3 and 4. The 4 cannot go in the top left because of the 4 in the top row. That means that we have to put 4 in the bottom right.

That leaves us with the gap filling exercise, as the last spot must be a 3. You could use the same method to complete the rest of the grid.

3	2	4	
1	4		3
4			2
	1	3	

Now try solving this problem.

5	3			7				
6			1	9	5			
	9	8					6	
8				6				3
4			8		3			1
7				2				6
	6					2	8	
			4	1	9			5
				8			7	9

What are the steps you took to complete this Sudoku? Write some of them down below.

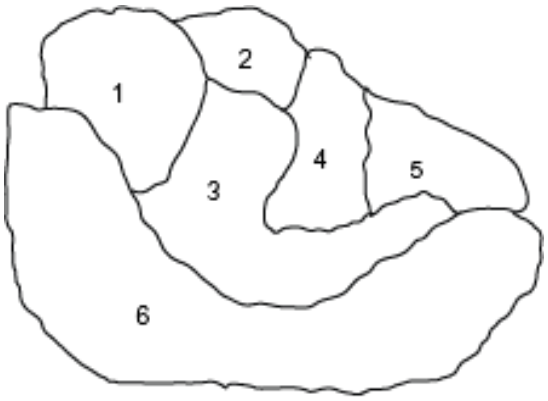
If you get stuck, there is a list of tactics at this page: http://www.paulspages.co.uk/sudoku/howtosolve/index.htm

How might you start to make a program to solve any Sudoku puzzle? What sort of data structures would you use? Would the computer be able to do everything that you did to solve the problem?

Many people have already implemented the code for this, although they may all take different approaches. One person is http://norvig.com/sudoku.html

Thinking Abstractly

Activity 1



Colour the map above, making sure that countries that share a border are not the same colour. You should also try and use as few colours as possible.

How many colours did you need?

How can you be sure?

Extension – adding rules ('constraints')

Countries 4 and 5 have now become one country. Does this change the graph and the colouring?

Country 3 does not exist anymore, and a new constraint has been introduced, that you must only have two colours. Is this possible?

Activity 2

8 kinds of animal, some eat others:

1 - Lion eats Baboon, Hyena, Zebra and Meerkat

2 - Baboon eats Meerkat

3 - Grasshopper

4 - Zebra

5 - Crocodile eats Grasshopper and Zebra

6 - Hyena eats Zebra, Baboon, Meerkat and Grasshopper

7 - Meerkat eats Grasshopper

8 - Cheetah eats Zebra

How would I work out a safe set of zoo allocations so no animal eats another?

Are there any problems that you can see with the model?

Extensions

Construct your own graph of a different food web. Fish or birds, for instance.

You could also draw your own 'country' like in activity 1 and draw a graph based on it.

Developing logical thinking

Now for a bit of fun. Much of computational problem solving requires logical thinking and one way to develop good logical thinking skills is to practice on logic problems. Here are several puzzles for you to have a go at. It would be possible to create computer algorithms to solve these but for now let's see how the human brain does.

Word ladder

Convert the word LISP into the word JAVA in 5 steps or less. You must only change one letter of the word on each step. On every step you should have created a word in the English dictionary.

L I S P

- - - -

- - - -

- - - -

- - - -

J A V A

What strategies did you adopt (if any) for solving this? Write your answer below:

Bit ladder

Convert the binary word 000 into the binary word 100 in 7 steps or less. You must only change one bit of the word on each step. You may only use 1s and 0s.

0 0 0

- - -

- - -

- - -

- - -

- - -

- - -

1 0 0

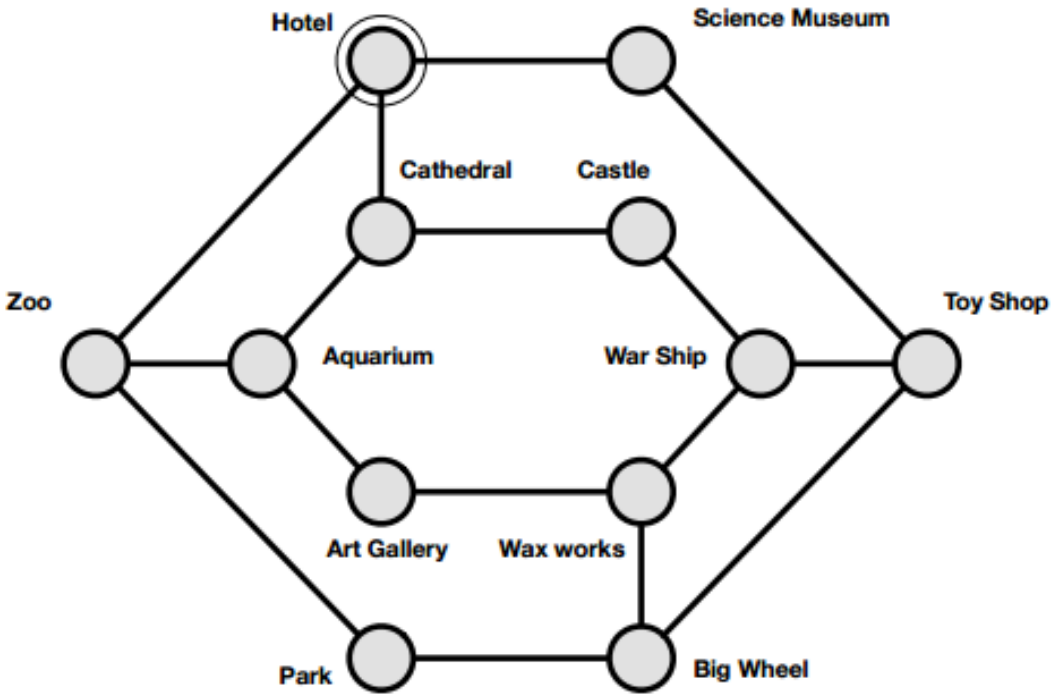
Again, think about any strategy you adopted and describe it below:

A bit of computational thinking wisdom

Bit ladders that end up back where they started, cycling through all of a sequence of 'words' by changing one symbol at a time, are also known as Gray codes. They are important as a different way to represent numbers in binary, giving a way of 'counting' through all the numbers by changing one bit at a time. This matters in devices that have mechanical switches like the early telegraph. The mechanism that flips bits won't change different ones at exactly the same time, so you could falsely register the wrong number mid-change if more than one needs to change at once. Gray codes avoid the problem.

The tour guide

You are a hotel tour guide. Tourists staying in your hotel expect to be taken on a tour visiting all the city's attractions. You have been given an underground map that shows all the locations of the attractions and how you can get from one to another using the underground network. You must work out a route that starts from the hotel and takes your tour group to every tourist site. The tourists will be unhappy if they pass through the same place twice. They also want to end up back at their hotel that evening.



Again, think about any strategies you adopted to solve this and describe them below.

A bit of computational thinking wisdom

A good representation for problems involving 'places' and ways to get between them is to draw circles (or nodes) for the places and lines (called edges) between them to show the links. This is called a graph by computer scientists.

The last few puzzles have been taken from the excellent cs4fn website published by the University of London. If you enjoyed tackling these puzzles you can find many more at:

https://cs4fndownloads.files.wordpress.com/2016/02/cs4fnpuzzlebook11.pdf

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