Cardiff School of Computer Science and Informatics
Coursework Assessment Pro-forma

Module Code:	CMT304
Module Title:	Programming Paradigms
Lecturer:	Frank C. Langbein
Assessment Title:	Part 2: Functional Programming
Assessment Number:	2 of 4
Date Set:	14th December 2020
Submission date and Time:	24th May 2021 at 9:30am
Return Date:	14th June 2021

This assignment is worth 25% of the total marks available for this module. If coursework is submitted late (and where there are no extenuating circumstances):

1. If the assessment is submitted no later than 24 hours after the deadline, the mark for the assessment will be capped at the minimum pass mark;
2. If the assessment is submitted more than 24 hours after the deadline, a mark of 0 will be given for the assessment.

Your submission must include the official Coursework Submission Cover sheet, which can be found here:
`https://docs.cs.cf.ac.uk/downloads/coursework/Coversheet.pdf`

Submission Instructions

All submissions must be via Learning Central. Upload the following files in a **single zip file**, `[student number].zip`:

Description		Type	Name
Cover Sheet	**Compulsory**	One PDF (.pdf) file	`[student number].pdf`
Task 1	**Compulsory**	One source file	`sudoku.hs`
Task 2	**Compulsory**	One PDF (.pdf) file	`task2.pdf`

Any deviation from the submission instructions above (including the number and types of files submitted) will result in a mark of zero for the assessment or question part.

Staff reserve the right to invite students to a meeting to discuss coursework submissions.

Your submissions will be checked for plagiarism. Your work must be your own and you must independently solve the problem and submit your own solution. Any other material or sources of information you use must be referenced. Code and text you submit will be compared with other submissions and various other sources on and off the Internet. Any substantial similarities of your submission to unreferenced work or material not created by yourself will be subject to academic misconduct procedures. Marks will only be assigned for work you have done yourself (incl. finding and

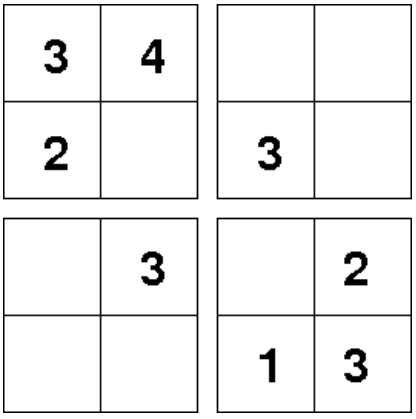
discussing material from references, but not the referenced work; there are no marks for code copied from elsewhere, but for either writing your own code or integrating and adapting code that you have not written).

Background

This is assignment **two** of a portfolio that will be composed of **four** assignments. Each of the four assignments is worth 25% , summing up to 100% of the total marks available for this module.

Assignment

Consider the problem of solving a 2×2 Sudoku puzzle. It is played on a grid consisting of 4×4 cells subdivided into four 2×2 squares as shown in the figure below. Some of the cells are empty, some of them are filled with digits from 1 through 4. The aim is to fill in the empty cells such that every row, every column, and every 2×2 square contains the digits 1, 2, 3, 4.



Task 1:

Write an efficient Haskell function that can solve this problem. Its input is a matrix, represented as a list of rows, where each row is a list of the numbers in the grid. The numbers are either 1, 2, 3, 4 if the field is filled or 0 if the field is empty. The output of the function should be *one* solution to the problem, in the same matrix format with the 0 values replaced by a number 1 to 4 (or an error message if the input has no valid solution). For example, for the above grid, the input is

```
input = [[3,4,0,0],
         [2,0,3,0],
         [0,3,0,2],
         [0,0,1,3]]
```

and one solution is

```
output = [[3,4,2,1],
          [2,1,3,4],
          [1,3,4,2],
          [4,2,1,3]].
```

Make sure you clearly document your approach and how to use your function in the comments. Note that you must write your own code to solve this problem and not just call a

library function to solve such problems. You may use the standard libraries listed in the Haskell 2010 language report, but not any other libraries.

Task 2: Write a short report on logic vs. functional programming related to the problem:

1. Provide, in up to 300 words, two arguments for and two arguments against using functional programming to solve the problem.
2. Discuss, in up to 300 words, whether the functional programming paradigm is suitable for this problem or whether another paradigm of your choice is more appropriate, based on your previous arguments.

The word limits are an upper limit, not a target length. Text longer than the word limit for each point will be ignored. Clearly mark each argument in your answer of the first point and indicate whether it is for or against. Only provide two arguments for and against; additional arguments will be ignored.

Learning Outcomes Assessed

- Evaluate and apply the functional programming paradigm to solve a given problem.
- Evaluate and apply a suitable programming paradigm and language from a selection of them to solve a given problem.
- Discuss and contrast the issues, features, design and concepts of a range of programming paradigms.

Criteria for assessment

Task 1: maximum 50 marks, assessed according to the following scale

Fail	0	No code has been submitted.
	$1-14$	Code does not run or does not produce valid output for any valid input; little to no relevant documentation.
	$15-24$	Code is valid without syntax errors and creates a valid output for every valid input (or produces a suitable error message for valid cases it cannot process). Even if the output is not a solution, a suitable attempt to solve the problem is visible. An attempt to document the code has been made.
Pass	$25-29$	Code is valid without syntax errors and creates a valid output for every valid input (or produces a suitable error message for valid cases it cannot process). A suitable attempt to solve the problem has been made, that will often find a solution (if there is at least one). The attempt has been reasonably documented, but no consideration has been given to optimise the program's performance.
Merit	$30-34$	Code is valid without syntax errors and creates a valid output for every valid input (or produces a suitable error message for valid cases it cannot process). A suitable attempt to solve the problem has been made, that will always find a solution (if there is any). The attempt has been well documented, stating the idea to solve the problem and how it has been implemented.

Distinction	$35-50$	Code is valid without syntax errors and creates a valid output for every valid input. A suitable attempt to solve the problem has been made, that will find a solution (if there is at least one) for all problems, with excellent performance. The attempt has been well documented clearly stating the idea to solve the problem and how it has been implemented. It clearly shows an effort to optimise the program's performance, e.g. by using efficient algorithms and data representations and also some heuristics.

Task 2: maximum 50 marks, assessed according to the following scale

Fail	0	No document has been submitted.
	$1-14$	An insufficient number of arguments has been submitted and/or they hardly apply to the functional programming paradigm. At most an incomplete attempt to discuss the suitability of the functional paradigm has been made.
	$15-24$	An insufficient number of arguments has been submitted, but they show some understanding of the functional programming paradigm. An attempt has been made to discuss the suitability of the functional paradigm, but it hardly relates to the paradigm.
Pass	$25-29$	The required number of valid arguments has been submitted. They are generally valid for the functional programming paradigm, but they repeat similar issues, do not consider the specific problem or contain mistakes in the details. A attempt has been made to discuss the suitability of the functional paradigm and some understanding of this paradigm is present.
Merit	$30-34$	The required number of valid arguments has been submitted. They show a clear understanding of the functional programming paradigm and it relates to the problem. The discussion of the suitability of the functional paradigm is well-developed, showing a clear understanding of the issues involved, and indicates the differences to the other chosen paradigm.
Distinction	$35-50$	The required number of valid arguments has been submitted. They show a clear understanding of the functional programming paradigm and the underlying theoretical concepts and/or realisations on programmable machines and how these relate to the problem. The discussion of the suitability of the functional paradigm is well-developed, showing a deep understanding of practical and theoretical issues involved, and clearly discusses concrete differences to the other chosen paradigm.

Feedback and suggestion for future learning

Feedback on your coursework will address the above criteria. Feedback and marks will be returned on 14th June 2021 via Learning Central. This will be supplemented with oral feedback on request.