1. Module number	*SET09122/SET09822*
2. Module title	*Artificial Intelligence*
3. Module leader	*Ben Paechter*
4. Tutor with responsibility for this Assessment Student's first point of contact	*Ben Paechter*
5. Assessment	*Program **or** Report*
6. Weighting	*30% of overall module total:*
7. Size and/or time limits for assessment	*None*
8. Deadline of submission Your attention is drawn to the penalties for late submission	11.00pm 13 November 2020 – Hand in on Moodle
9. Arrangements for submission	Moodle

10. Assessment Regulations All assessments are subject to the University Regulations**.**	
11. The requirements for the assessment	*Please see document below*
12. Special instructions	*See document below*
13. Return of work	*within 3 weeks of submission.*
14. Assessment criteria	*See attached document* *Normal academic conventions for acknowledging sources should be followed.*

Artificial Intelligence

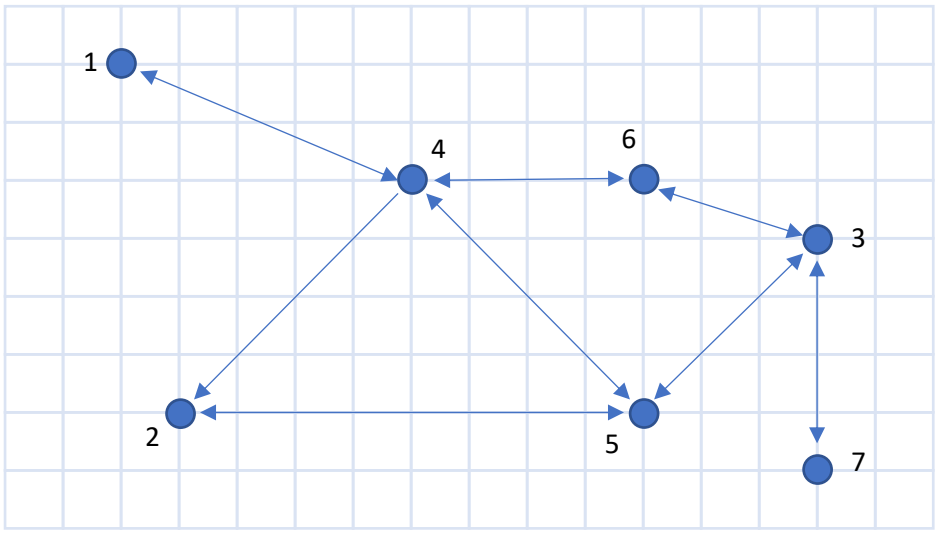
Coursework 1

There are two options, programming or essay. Each is about the same application described below. Please complete and submit for only ONE of the two options.

Caverns Routing Application

A robot has to navigate through a series of small underground caverns connected by straight tunnels. Some tunnels can only be navigated in one direction. The robot is given a map of the caverns and tunnels which is given as the coordinates of the centre of each cavern, plus a binary matrix showing which caverns can be reached from which other caverns.

For example, the following map:



is represented by the following coordinates for caverns:

(2,8) (3,2) (14,5) (7,6) (11,2) (11,6) (14,1)

and the following matrix to showing the connections:

To \ From	1	2	3	4	5	6	7
1	0	0	0	1	0	0	0
2	0	0	0	1	1	0	0
3	0	0	0	0	1	1	1
4	1	0	0	0	1	1	0
5	0	1	1	1	0	0	0
6	0	0	1	1	0	0	0
7	0	0	1	0	0	0	0

The connection matrix is given in the same order as the coordinates.

The task of the robot is always to navigate from the first cavern in the list to the last cavern in the list – or to identify that the route isn't possible

The distance between any two caverns is the Euclidean distance between the two coordinates:

$$\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

Cavern Map File format

Cavern maps are stored in .cav files which take the following format:

The file is a text file which contains a series of integers separated by commas.

The first integer gives the number of caverns - N.

The next N*2 integers give the coordinates of each of the caverns – each value is non-negative.

The final N*N integers give the connectivity of the tunnels. 1 means connected, 0 means not connected. Remember that some tunnel are one-way.

The order of the connectivity matrix is as follows:

Connectivity of Cavern 1 to Cavern 1

Connectivity of Cavern 2 to Cavern 1

Connectivity of Cavern 3 to Cavern 1

Connectivity of Cavern 4 to Cavern 1

Connectivity of Cavern 5 to Cavern 1

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Connectivity of Cavern 1 to Cavern 2

Connectivity of Cavern 2 to Cavern 2

Connectivity of Cavern 3 to Cavern 2

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.

.

So the file for the above example would be:

7,2,8,3,2,14,5,7,6,11,2,11,6,14,1,0,0,0,1,0,0,0,0,0,0,1,1,0,0,0,0,0,0,1,1,1,1,0,0,0,1,1,0,0,1,1,1,0,0,0,0,0,1,1,0,0,0,0,0,1,0,0,0,0

Solution File Format

Routes through caverns are stored in the output file by having a series of integers denoting the order of visiting the caverns. Caverns are numbered starting at 1 – as in the diagrams above. The integers should be separated by spaces.

For example, the output from the file above might be:

1 4 2 5 3 7

Because you must always start at the first cavern in the input file and end at the last cavern in the input file, where a route has been found, the first number will always be 1 and the last number will always be the number of the last cavern.

Where the algorithm identifies that no route can be found, it should place a single 0 in the file.

You will find test input files, some with the best known solution, on Moodle

Option One – Programming

What to do:

Write a computer program to solve this problem which runs on the Windows command line. If you don't have access to a Windows computer, please contact Ben Paechter so that appropriate arrangements can be made.

The program should open a cavern map file with up to 5,000 caverns and find a path from the first cavern to the last cavern writing this to a solution file

The program should have one parameter which should be the name of the cave map file without the .cav extension. So, if the parameter is "banana" the cave map file read should be "banana.cav". The cave map file will be in the current folder.

The program should write the solution file to the current folder with the name being the parameter plus the extension .csn.

So, if the parameter is "banana" you program should open file banana.cav and write the solution to file banana.csn

You can choose any language that can produce an executable to be run from the command line as above. Note that some languages will produce code than runs faster than others.

The main aim of the program is to find the shortest route possible.

A secondary aim is to find the route as quickly as possible, by use of an efficient algorithm.

Your program must run in less than a minute, with the example files given, on a reasonably modern computer. If the program takes too long on one of the test files you will not receive a mark for that file.

Note that the time taken may vary depending out what else is happening of the machine and how much of the program is in memory. To get accurate results you should repeat the procedure and ensure that nothing resource intensive is running on the machine. On small files the time taken will not be measured accurately as it will be too short.

It is important that you adhere to the following instruction very carefully – marks will be deducted if your program does not fit with the exact specification:

- Your final program should not write any information to the screen (although you may wish to do this when developing the software).
- Your final program must not require any kind of keyboard or mouse input – it should simply run from the command line and open the cave map file from the current folder and write the solution file to the current folder.
- You must then adapt the Windows batch file provided on Moodle so that when caveroute <file> is typed on the command line your program executes - reading in <file>.cav and outputting <file>.csn and the time taken is displayed.

  So, for example, typing:

  caveroute banana

  should read the cave map file banana.cav (stored in the current folder) and write the solution to the solution file banana.csn (saved in the current folder)

Program Marking Scheme (Total Marks 30)

Your programs will each be tested on unseen problem instances of differing sizes. Each submission will be scored on each instance. If a program takes more than a minute to run on an instance it will be stopped and no mark will be awarded for that instance (instances will be chosen to make this a reasonable limit).

There will be 10 unseen problem instances and scores will be awarded as follows.

Best route found or *no-route-possible* correctly identified : 2.5 marks
Valid route found, but not the best route: 1.5 marks
No route found where there is one, invalid route found, program crashes, program doesn't finish in one minute: 0

Where a submission finds the shortest route on the most difficult problem instance, up to an additional 5 bonus marks are available. The award of these marks will depend on the speed of solving the most difficult problem instance. Programs that run faster will receive more of the 5 marks.

If, at the end of this process, your mark is less than 12 out of 30 – I will look at your source code to see if the mark can be brought up to 12.

What to hand in on Moodle (Option One):

- A zip file containing the caveroute.bat file and whatever else is needed to run the program from the command line (usually just the executable) . Please don't include anything else in the zip. Don't include source code or input files. **You must ensure that your program works from the command line or you will lose marks.** This should be set up so that if all the files are extracted to the same directory, typing the command line caveroute <file> in that directory will run your program on cavern map file <file>.cav
- A separate zip file containing your source code. This won't normally be marked but may be marked if your program does not run well, and will be part of the plagiarism check.
- **Deadline:** 11pm, 13 November 2020 on Moodle.

Plagiarism Check

Programs submitted will be checked for plagiarism. Anyone submitting a program which is the same as someone else's is liable to investigation for plagiarism. Be careful not to allow anyone else access to your program. Please submit your source code as detailed above. Those with similar program submissions, and a random sample of others, will undergo an interview with their source code to confirm authorship.

Option Two – Report

(a) Submit up to six pages describing how you would implement a solution to this problem in a programming language of your choice. You should start by naming and describing in detail the algorithm that you would use and **why** you chose that algorithm – i.e. why it is more suitable than other algorithms for solving this particular problem.

Marks will be given for diagrams which help understand the text, and particularly where the diagram is directly relevant to the problem being solved. You can use diagrams from the web, but these will not attract as many marks if they are not directly relevant to your text and the problem. They will receive no marks if not attributed.

You can include pseudo-code to enhance your answer, but should ensure that this is written to by relevant to the specific problem being solved (rather than generic pseudocode taken unaltered from the web).

If the problem were to change so that the cost of taking a particular tunnel in a particular direction is specified in the input caverns file – and is no-longer related to the distance travelled, explain how this might affect your choice of algorithm and identify any difficulties that might occur in this situation.

(20 Marks – Page limit 6)

(b) Research one other algorithm (not necessarily for the module material) which could be used for solving this problem, and briefly describe it, specifying the ways it differs from the algorithm used in (a). Comparatively evaluate the two algorithms from (a) and (b) for solving the specified caverns problem.

If the problem were to change so that the cost of taking a particular tunnel in a particular direction is given in the file – and is no-longer related to the distance travelled, explain how this might affect the comparative evaluation and why.

Submit a maximum of two pages

(10 Marks – Page limit 2)

What to hand in on Moodle (Option Two):

- A single pdf file containing your answers to questions (a) and (b).
- **Deadline:** 11pm, 13 November 2020 on Moodle.