FIT5047 1st Semester 2018
Assignment 1 (100 marks = 20%)
Due Date: Week 7, Friday 5:00pm (20/04/18)

Problem Solving and Knowledge Representation

Submission: submit a PDF file with all of your answers through Moodle and Turnitin. If you have a Python .py or Java .java file from Question 1, then submit that as well. Also, submit them anywhere else as specified.

Note 1: Please recall the University and Faculty policies and regulations regarding Academic Integrity.

Note 2: You will be required to be prepared to present the work during lab/tutorial/studio time - to be determined by your lecturer and tutor. Be prepared for this to occur in week 8 or in week 9, to be determined by your lecturer and tutor. This is a compulsory part of this assessment.

Note 3: The assignment given below is currently incomplete but has sufficient exercises for you to be able to begin.

Question 1 (3 + 6 + (6+4) = 3 + 6 + 10 = **19 marks**)

Consider a variant of the 8-puzzle called the 15-puzzle, where `B' denotes the blank cell.

Goal state:
1 2 3 4
5 6 7 8
9 10 11 12
13 14 15 B

Initial state:

1 2 3 4
5 6 7 8
9 10 12 B
13 14 11 15

1a (3 marks)

Give three distinct admissible heuristics, none of which can be zero,

Call them h1, h2 and h3, s.t. h1 <= h2 <= h3

1b (6 marks)

Show how to solve this problem using Iterative Deepening (ID)

1c (6 + 4 = 10 marks)

Show how to solve this problem using A*, clearly stating which of your above heuristics you are using.

You will get a maximum of 6 marks if you do this correctly by hand without using a computer program.

You will get a maximum of 10 marks if you do this correctly by hand using a computer program written by you in Python (.py) or Java (.java).

Your program should take in any initial state, but you should test it with the given initial state. The input for your program should be represented as a string in the following format (String):

“1 2 3 4 5 6 7 8 9 10 12 B 13 14 11 15”

Where the above string represents the initial state as a single line.

Your answers should be in text and not handwritten. If you have written a computer program, then you will also need to submit your .py or .java program.

Question 2 (**19 marks**)

This question is based on a combination of the mice and cats (or missionaries and cannibals) problem (Amarel, 1968) and of the 15-puzzle exercise from Question 1.

There are three points, A, B and C in a body of water. We start with 1 mouse and 1 cat at each of A, B and C respectively. The boat is initially at A. There is a copy of the 15-puzzle located at B which is in the same initial state as the initial state from Question 1.

The boat can cross from A to B, or B to A, or B to C, or C to B, or A to C, or C to A.
There are two broad ways for the boat to proceed - either everything is taken from A to B (in however many steps), then everything is taken from B to C (in several steps), then everything is taken from C to A (in however many steps) or alternatively everything is taken from A to C (in however many steps), then everything is taken from C to B (in several steps), then everything is taken from B to A (in however many steps).

If our first step is to leave A in the direction of B, we can not move anything to C until everything has first been taken from A to B. We would then have to take everything from B to C (travelling back and forth between B and C however many times). We would then have to take everything from C to A (travelling back and forth between C and A however many times), whereupon we would have finished.

Alternatively, if our first step is to leave A in the direction of C, we can not move anything to B until everything has been taken from A to C (going back and forward between A and C however many times). We would then have to take everything from C to B (going back and forward however many times). We would then have to take everything from B to A (going back and forward however many times), whereupon we would have finished.

Whenever the boat crosses, there has to be at least 1 cat or at least 1 mouse on board.

The boat has seating capacity for at most 2. If we transport the 15-puzzle, then it will occupy 1 seat, leaving room for exactly 1 other passenger (a cat or a mouse).

The 15-puzzle is initially located at B. When we leave B to transport things away (either to A or to C, depending upon which way we are heading), we have two options.
In addition to taking the mouse and the cat which were initially at B, we can either take the 15-puzzle with us, or alternatively we can elect instead to have one extra mouse and one extra cat that we have to take with us when we leave B. In other words, depending upon which gives the best answer, either we transport 1 mouse, 1 cat and 1 8-puzzle from B (going back and forward however many times) or we transport 2 mice and 2 cats from B (going back and forward however many times).

If our initial move is from A to B, then we can assume that we arrived at B early enough for the 15-puzzle to have been solved for us and for us not to have to spend any moves on solving it. If our initial move is from A to C, then when we arrive at B we have to solve the 15-puzzle (with initial setting as in Question 1), and the number of steps to solve the 15-puzzle should be added to the number of water crossings.

Alternative wording:

Let us say the above again in different words. In the initial state, A has 1 mouse and 1 cat; B has 1 mouse, 1 cat and 1 15-puzzle (whose initial state is as in Question 1); C has 1 mouse and 1 cat.
We start at A and decide to head in the direction A,B,C,A or the direction A,C,B,A.
When crossing from a first location X to a second location Y, we take everything that is at X with us until we get it to Y.
Whichever direction we go in, when we leave B, we either take 1 extra mouse, 1 extra cat and the 15-puzzle with us or we take 2 extra mice and 2 extra cats with us. If we go from C to B, the number of steps required to solve the 15-puzzle is added to the total number of river crossings. If we go from A to B, then we do not have to solve the 15-puzzle. The 15-puzzle occupies a seat. Any crossing must have at least one cat or at least one mouse, and at most two seats can be full. This finishes the alternative wording of the problem.

Solve this in as few steps as possible.

Explain your search procedure, explaining why you believe your solution to be in as few steps as possible.

Your answer should be in electronic form (e.g., .doc, .docx, .tex, .pdf) and not handwritten.

Question 3 (16 + 15 = **31 marks**)

This question is inspired by the James Webb telescope, some information about which is given at http://www.abc.net.au/radionational/programs/scienceshow/james-webb-space-telescope-to-peer-back-even-closer-to-the-big/9478822

The fictional matters in this question concern neither James Webb nor (music composer) Jimmy Webb. We will refer to our fictional telescope as FictionalWichitaOrbit telescope, or FWO.

For FWO to be built, funding must first be obtained, and it would be wise to make a plan.
The FWO will have two arms, mirrors in the arms, a LASER (Light Amplification by the Stimulated Emission of Radiation) beam and supporting material.
Material has to be assembled on Earth pre-launch, then launched into space, then assembled.
Two arms have to built, both of which have to be built on Earth and then folded pre-launch.
The mirrors have to be built on Earth, as also does a laser.
Protection, which protects against both solar radiation and flare, has to be put on the mirrors.
A solar panel battery charger (for the laser) must be taken into orbit.
There will only be a software verifier available in orbit if it is packed on Earth pre-launch.
The only resources required in orbit not present and inside at launch will be human labour or an artificial general intelligence (AGI) - if this is human labour then it will be transported from a nearby space station, but if this is an AGI then it can be obtained by first sending a signal back to Earth with a request to ask the space station to program the AGI and then send it to FWO.
The AGI can not be used unless a software verifier is run on it at the FWO site.
After assembling FWO in orbit, any human labour which came from the space station has to be returned to the space station.
The task will be deemed complete when corrected polished mirrors are placed in the unfolded arms, the laser is switched on and the human labour (if any was used) is returned to the space station.
Before turning on the laser, to avoid a possible short circuit, solar radiation must be checked.
The arms must be unpacked before unfolding. If mirrors are placed in arms or corrected, it can damage the polish.

It can be assumed that funding is initially obtained.

3a (16 marks)

Write this in the language of the STanford Research Institute Planner (STRIPS) with operators, actions, preconditions and effects.

3b (15 marks)

Showing steps, partial plans and all relevant other reasoning, show a plan for achieving the building of FWO.
Make any necessary assumptions explicit.
If it is impossible to build the FWO according to the current requirements, then show why that is and then make the smallest change possible so that there is a plan for building the FWO.

Try to minimise the number of steps required, and outline why you think you have achieved a plan which reaches a goal state in a minimum number of steps.

Your answer should be in text and not handwritten.

Question 4 (**16 marks**)

Consider the following premises:
All humans are mortal unless they have had their mind uploaded into a computer program.
All dogs are mortal unless they have had their mind uploaded into a computer program.
Mind upload of a life form into a computer program can not occur unless either (Star Trek) teleportation can occur or all of the following have occurred: driverless cars are safe, and N. Chmait has won the Kurzweil Prize, and the technological singularity has occurred.

The technological singularity has not occurred.

N. Chmait won the Kurzweil Prize in 2017.

Socrates lives in a household whose only residents are humans and dogs.

Humans and dogs are both life forms.

Teleportation requires quantum mechanical tunnelling and the creation of two strong plasma fields.

When quantum mechanical tunnelling occurs, it is possible to have at most one strong plasma field.

If the above premises are all true, then prove that Socrates is mortal.

Approximately half the available marks for this question will be for representing the relevant statements in a suitable logical form.

Where possible, give names of the logical steps.

Your answer should be in text and not handwritten.

Ass't 1 Qu 5 (15 marks) will come later.

Students should submit a file called FIT5047_*StudentId*_1stSem2018_Asst1.pdf to the relevant place on Moodle.
Students using a .py program or a .java program in Question 1 should also submit a second file, FIT5047_*StudentId*_1stSem2018_Asst1.py or FIT5047_*StudentId*_1stSem2018_Asst1.java .

Please note that *StudentId* refers to your Student Id number. So, as an example, if your StudentId is 12345678 and you submit a Python file, then you should submit two files, respectively called FIT5047_12345678_1stSem2018_Asst1.pdf and FIT5047_12345678_1stSem2018_Asst1.py .

Recall notes on page 1 about Academic Integrity and about the requirement for your attending an interview as a compulsory part of your assessment.