1. This question explores the general ideas behind artificial intelligence and its historical development.

   a) Draw a **mind map** describing FOUR different ways of representing knowledge that artificial intelligence researchers have used. Each approach will be a separate **node** coming from the central node of the mind map and you should have a depth of at least THREE nodes (i.e. the path from the center node to each leaf node includes four nodes). This should give the mind map about the right level of detail for each knowledge representation approach.
   (10 marks)

   b) Explain how the history of psychology and philosophy relates to and has informed the knowledge representation approaches in your mind map.
   (7 marks)

   c) Explain why the representation of a problem is so important to being able to solve it. Illustrate your answer with one or more example problems that demonstrate how different representations affect the ability to find a solution.
   (8 marks)

2. The following set of rules, Rule 1 to Rule 4, is a simple **expert system** that defines relationships between the following facts: web-spinner, photographer, spiderman, six-arms, dr-octopus, spider-bite, and radioactive:

```
Rule 1: If web-spinner AND photographer THEN spiderman
Rule 2: If six-arms THEN dr-octopus
Rule 3: If eight-legs THEN web-spinner
Rule 4: If spider-bite AND radioactive THEN web-spinner
```

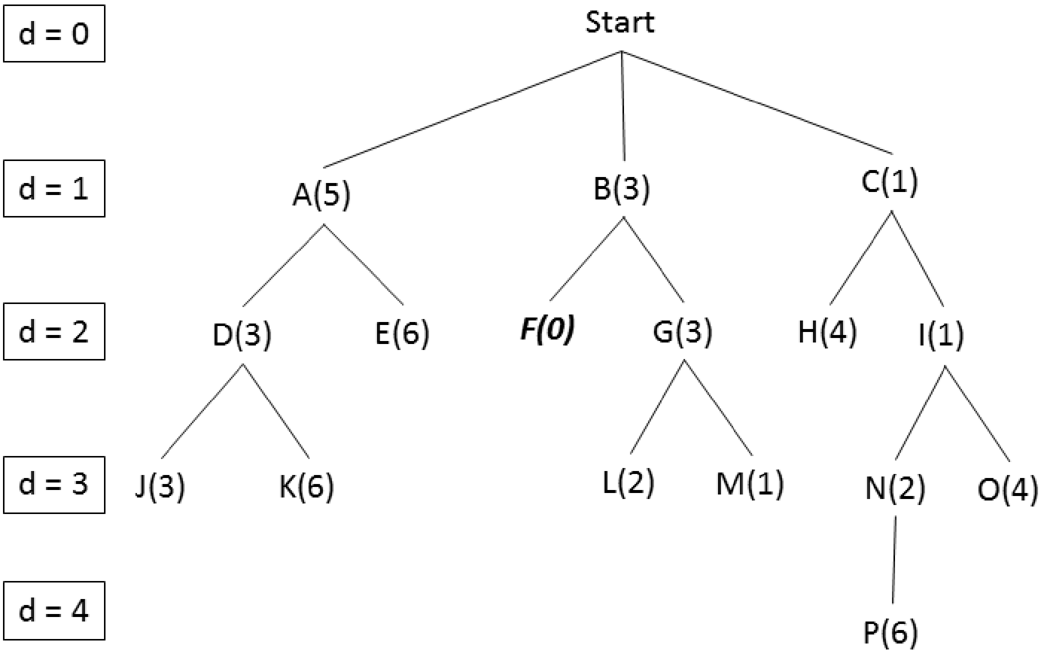
   The starting facts that are already known about the system (i.e. the **working memory**) are: photographer, spider-bite, and radioactive.

   A human user of the expert system wants to know whether the fact spiderman is TRUE. In other words, spiderman is a **goal**.

   a) Explain how a **forward-chaining** reasoning process would use the rules and starting facts to determine whether the goal, spiderman, is TRUE. Your answer should show the sequence of rules leading to the goal, the consequent changes to the known facts, and explain the following terms: **trigger**, **fire**, and **conflict resolution**.
   (8 marks)

   b) Explain how a **backward-chaining** reasoning process would use the rules and facts to find out whether the goal, spiderman, is true. Your answer should show the sequence of rules used to prove the goal, the proof list, and explain what happens at each step of the reasoning process. Make sure your reasoning process handles two rules having the same conclusion.
   (7 marks)

3. The following diagram shows a search tree with five **depth** levels, from depth d = 0 to 4. The nodes are labelled alphabetically from A to P. The number in brackets is the output of an evaluation function rating the cost for choosing that node: LOWER costs mean nodes are a BETTER choice for visiting next. The goal state is F, which has zero cost.



a) List the nodes visited by **breadth-first** search, including the **open** and **closed** queues at each step.
(5 marks)

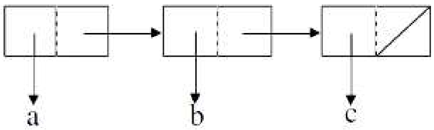
b) List the nodes visited by **depth-first** search, including the **open** and **closed** queues at each step.
(5 marks)

c) List the nodes visited by **best-first** search, including the **open** and **closed** queues at each step.
(5 marks)

d) List the nodes visited by **A*** search, including the **open** and **closed** queues at each step. Use the depth, d, as the measure of distance of a node from the start.
(5 marks)

e) Explain why **A*** search will ALWAYS produce an optimal (i.e. the most efficient) path and why this is not true for **best-first** search.
(5 marks)

4. List processing in Lisp can be usefully represented by the box-and-pointer notation where each list member has two pointers, one to its value and the other to the rest of the list, as shown by the diagram below:



The following code is a Lisp list representing a single bedroom in a house:

```
(bedroom1 ((width 10)(length 20)))
```

a) Represent the list using the box-and-pointer notation. (5 marks)

b) Draw a hierarchical tree structure that is equivalent to the list. (5 marks)

c) Write the Lisp code for a function called `count-bedrooms` that takes a list of all bedrooms in the house and returns the total number. (4 marks)

d) Write the Lisp code for a function called `get-area` that takes the list representing a bedroom and returns the area of that bedroom (the area is the width multiplied by the length). (6 marks)

e) In your lab classes, you were asked to create an intelligent knowledge-based system for choosing accommodation. Suppose you want a function called `rate-house` that creates a score between ZERO and TEN depending on how well the house matches a person's desired number of bedrooms and the average bedroom area. For example, a person might want 4 bedrooms with an average area of 150. The Lisp interpreter would execute the function and return a rating depending on how well the bedrooms match the person's requirements as follows:

```
(rate-house bedrooms 4 150)
8
```

i) Specify in English the steps your `rate-house` function would need to take to process the bedrooms and generate a rating. It is your choice how you calculate the rating but you will gain marks for a sensible approach. (7 marks)

ii) Write Lisp code that would implement the English steps you have specified for the `rate-house` function. (8 marks)

END OF EXAMINATION PAPER