ASTON UNIVERSITY

CS2320

Aston University

School of Engineering & Applied Science

CS2320: Introduction to Computational Intelligence

Summer Examinations 2013

Date:
Time: ??, 2 hours

Instructions to Candidates:

Answer ALL parts of ALL questions.

There are FOUR questions that do not necessarily have the same number of marks but the total is 100.

Materials Provided

Materials Allowed

1) Ideas from psychology have influenced many computational intelligence algorithms and approaches, especially about knowledge representation.

   a) Describe Aristotle and John Locke's ideas about **associationism** and how it explains the way people organise their knowledge of the world.

   (3 marks)

   b) **Semantic nets** are a theory of knowledge representation that came from psychology and have been used to implement **Intelligent Knowledge-Based Systems**.

      i) Suppose a semantic net represents information about students, modules, and degrees at universities. Explain the process of **inheritance** and illustrate it by drawing a suitable portion of the university semantic net.

      (5 marks)

      ii) How did psychologists such as Quillian and Collins provide evidence that people organize knowledge using inheritance? Describe the experimental design they used and how it provided evidence for the process.

      (5 marks)

2) Freemind is an open-source program for creating **mind maps** that was used during the laboratory classes for this module. Two example knowledge domains, **mental health** (in the GRiST project) and **logistics** (in the ADVANCE project), were described where mind maps were used as part of developing a decision support system.

   a) Draw a mind map that is a suitable representation of knowledge about a person's social life (friends, going out, etc) and living circumstances, which might be important for assessing their mental health. Your mind map should have AT LEAST FIVE concepts coming from the central node and a depth of THREE nodes (i.e. the path from the center node to the leaf node includes four nodes).

   (7 marks)

   b) Explain how the properties of Freemind and mind mapping in general were used in the GRiST or ADVANCE projects to elicit knowledge from human experts and incorporate it into an intelligent knowledge-based system.

   (7 marks)

   c) Explain the difference between **crisp sets** and **fuzzy sets** and the role of **membership grades**.

   (4 marks)

   d) List TWO advantages and TWO disadvantages of cognitive modeling when creating intelligent knowledge-based systems.

   (4 marks)

3) A **production-rule system** has the following rules:

Rule 1: IF A THEN E
Rule 2: IF B THEN D
Rule 3: IF H THEN A
Rule 4: IF E AND G THEN C
Rule 5: IF E AND K THEN B
Rule 6: IF D AND E AND K THEN C
Rule 7: IF G AND K AND F THEN A

Suppose the **starting state** of initial known facts in **working memory** consists of H and K and the **goal** to be proved is D.

a) Show the steps by which **forward chaining** will prove the goal fact, D, (i.e. add D to the known facts). For EACH STEP of your proof, you should state the rules that are triggered, the rule that is fired, the new working memory, and the **conflict resolution** strategy used for firing the rule, when appropriate. Make sure you give TWO different strategies (i.e. not the same one each time).

(7 marks)

b) Show the steps by which **backward chaining** will prove the goal fact, D. If a choice of rules is required, explain why one is chosen rather than the other.

(8 marks)

c) Write down a suitable Lisp **association list** structure for representing RULE 5. *This rule structure will be used for your answers to the remaining parts of this question*.

(5 marks)

d) Write the Lisp code for a function called `get-conditions` that takes a rule with the list structure you defined in (c) and returns the conditions.

(4 marks)

e) Write the Lisp code for a function called `get-conclusion` that takes a rule and returns the conclusion.

(4 marks)

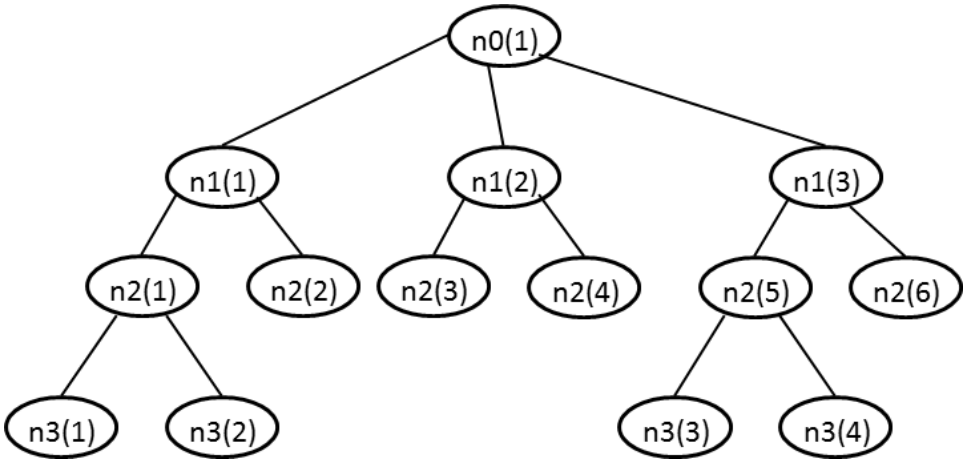
f) Define a Lisp function called `trigger-rule` that takes a rule and the current known facts as arguments and returns the rule conclusion if the conditions are `TRUE` or `NIL` otherwise.

(6 marks)

g) Write the Lisp code for a function called `fire-rule` that takes a list of facts and rules and returns a new list of facts after firing a rule or `NIL` if no rule was fired.

(6 marks)

4) Consider the tree shown in the figure below. The labels such as n0(1) for each node in the search tree represent the level of the node (n0, n1, etc) and, within the brackets, the position of the node in the level starting from the leftmost node. So n2(2) is the second node from the left at level 2. Suppose the **goal node** is **n2(3).**



a) Explain how this tree notation can represent a problem space that needs to be searched to find a solution. Your answer should define the terms **node, state, path,** and **goal.** It should also refer to a real-world example problem to illustrate how these terms relate to searching for a solution to the problem (in other words, use an example problem to illustrate your definitions).

(6 marks)

b) List the order of nodes searched by the **breadth-first uninformed search** method that leads to the goal node and, for each node, show the state of the **open** and **closed** node queues.

(7 marks)

c) List the order of nodes searched by the **depth-first uninformed search** method that leads to the goal node and, for each node, show the state of the open and closed node queues.

(7 marks)

d) Describe the general approach of **depth-first search with iterative deepening** and explain why it is optimal compared to **uninformed** depth-first search. List the nodes that would NOT BE SEARCHED compared to ordinary depth-first uninformed search if the level of iterative deepening was set to level 2, where the levels are numbered from 0 to 3 as the question explained at the beginning.

(5 marks)

END OF EXAMINATION PAPER