UNIVERSITI SAINS MALAYSIA

Second Semester Examination
Academic Session 1998/99

February 1999

CPP302/CSE401 - Artificial Intelligence

Duration : [3 hours]

INSTRUCTION TO CANDIDATE:

- Please ensure that this examination paper contains **SIX** questions in **SEVEN** printed pages before you start the examination.
- Attempt **ALL** questions.
- **You are required to return back the question paper.**
- If you choose to answer the questions in English, at least one question must be answered in Bahasa Malaysia.

ENGLISH VERSION OF THE QUESTION PAPER

1. State whether the given statements are true or false:
(Note: Negative marking applies, i.e. -1 for each incorrect answer)

		TRUE	FALSE
(a)	In propositional calculus, we can access the individual components of a proposition.	______	______
(b)	An expression X logically follows from a set of predicate calculus expressions S if every interpretation that satisfies S also satisfies X.	______	______
(c)	The following two logical statements are equivalent: $\neg\exists\ X\ p(X) = \forall\ X\ p(X)$.	______	______
(d)	Binary resolution is applied to two clauses when both of them contain the same literal, leading to the generation of a Resolvent from the remaining literals.	______	______
(e)	We can attach procedural code to frames.	______	______
(f)	A frame-based system follows the associationist theory of representation.	______	______
(g)	In the state space representation of a problem, the nodes of the graph correspond to the possible solution states.	______	______
(h)	If two states have the same heuristic evaluation, it is preferred to examine the state that is furthest from the root node.	______	______
(i)	Data-driven search involves the generation of subgoals to move from the data to the goal.	______	______
(j)	A good heuristics can eliminate search entirely.	______	______
(k)	In parsing sentences, backtracking can be used for rule selections.	______	______
(l)	In natural language processing, the analysis of the intent of a dialogue is known as prosody.	______	______
(m)	In a goal-driven expert system, the expert system matches the rule's premises with the goal; selecting the rule and place its conclusion in the working memory.	______	______
(n)	The Dempster-Shafer theory makes a simple assumption that separates 'confidence for' from 'confidence against' a certain hypothesis.	______	______

...3/-

	TRUE	FALSE
(o) Case based reasoning systems are not capable of providing a good explanation of the solutions recommended by them.	______	______
(p) Cases can be represented as situation-action rules.	______	______
(q) The error produced by a neural network is independent of its connection weights.	______	______
(r) In a sigmoid function if the slope approaches infinity the function becomes a threshold function.	______	______
(s) Discrete features (say the colour with values red, yellow, blue) are best represented by employing a distributed representation scheme.	______	______
(t) In a Kohonen map, the winning unit will have its weight vector closest to the input vector.	______	______

(20 marks)

2. Give short answers (5 - 8 lines) for each question.

   (a) Logical problem-solving mechanisms rely on the unification algorithm. What do you understand about the unification algorithm and how does it work? Give an example of unification.

   (b) What are the respective advantages of breadth-first and depth-first search strategies and in what situations should each be used for optimum results?

   (c) In an expert system, what is the purpose of the explanation subsystem and what are the kind of explanations offered by it?

   (d) Give 5 preference heuristics that are typically used in a case-based reasoning system to help organise the storage and retrieval of cases?

   (e) What are the distinguishing characteristics of neural networks that make them different from traditional information systems?

   (f) Briefly describe the components of a generic neural network and how do they relate to a biological neural network.

   (g) What are the two types of parsing algorithms and what is their operational behaviour?

   (h) Explain the stages of language analysis. Give an example, if possible.

(20 marks)

3. (a) Attempt to unify the following pairs of expressions. Either show their most general unifiers or explain why they will not unify.

   (i) p(X,Y) and p(a,Z)

   (ii) p(X,X) and p(a,b)

   (iii) ancestor(X, father(X)) and ancestor(david, george)

   (iv) q(X) and ¬q(a)

(4 marks)

(b) Given the clauses below, use Resolution to prove whether *Marcus hates Caesar*, i.e. hate(marcus, caesar).

(i)	man(marcus)
(ii)	pompeian(marcus)
(iii)	¬ pompeian(A) v roman(A)
(iv)	ruler(casear)
(v)	¬ persecute(E,F) v hate (F, E)
(vi)	¬ hate(G, H) v persecute(H, G)
(vii)	¬ roman(B) v loyalto(B, casear) v hate(B, casear)
(viii)	¬ man(C) v ¬ ruler(D) v ¬ tryassassinate(C, D) v loyalto(C, D)
(ix)	tryassassinate(marcus, casear)

(5 marks)

(c) Given below are a set of prolog facts describing concepts about birds and animals. Use the given facts to draw a semantic network describing birds and other animals.

There are two types of facts, their arguments hold the following information:

- Facts representing the hierarchical relationship (inheritance).
  isa(Type, Parent).

- Facts representing property relations.
  has_prop(Object, Property, Value).

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isa(canary, bird).
isa(ostrich, bird).
isa(robin, bird).
isa(penguin, bird).
isa(opus, bird).
isa(bird, animal).
isa(fish, animal).
isa(tweety, canary).
has_prop(tweety, color, white).
has_prop(robin, color, red).
has_prop(canary, color, yellow).
has_prop(penguin, color, brown).
has_prop(bird, travel, fly).
has_prop(fish, travel, swim).
has_prop(penguin, travel, walk).
has_prop(ostrich, travel, walk).
has_prop(robin, sound, sing).
has_prop(canary, sound, sing).
has_prop(bird, cover, feathers).
has_prop(animal, cover, skin).
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(6 marks)

4. (a) Use Dempster-Shafer theory to solve the following medical diagnosis problem. Suppose H represents the domain of focus, containing four hypothesis:

- The patient has cold (C).
- The patient has flu (F).
- The patient has allergy (A)
- The patient has pneumonia (P)

Suppose we get our first piece of evidence: *The patient has fever*, which means the belief

M1{ F, C, P } with support level (0.6)

Next, we get our second piece of evidence: *The patient has a runny nose*, which means the belief

M2{ A, F, C } with support level (0.8)

Task 1

Apply Dempster-Shafer rule to compute the combination of M1 and M2, which is defined as the belief M3.

Task 2

Suppose we now get some more evidence: *The patient has allergy,* which means the belief

M4 {A} with support level (0.9)

Combine the beliefs M3 and M4 to get the final combined belief M5.

(8 marks)

(b) Given the following rules in a backward-chaining expert system. Use the Stanford certainty factor algebra to determine E and its confidence.

Rules

$A \wedge B \Rightarrow C$ (0.9)
$C \vee D \Rightarrow E$ (0.75)
$F \Rightarrow A$ (0.6)
$G \Rightarrow$ (0.8)

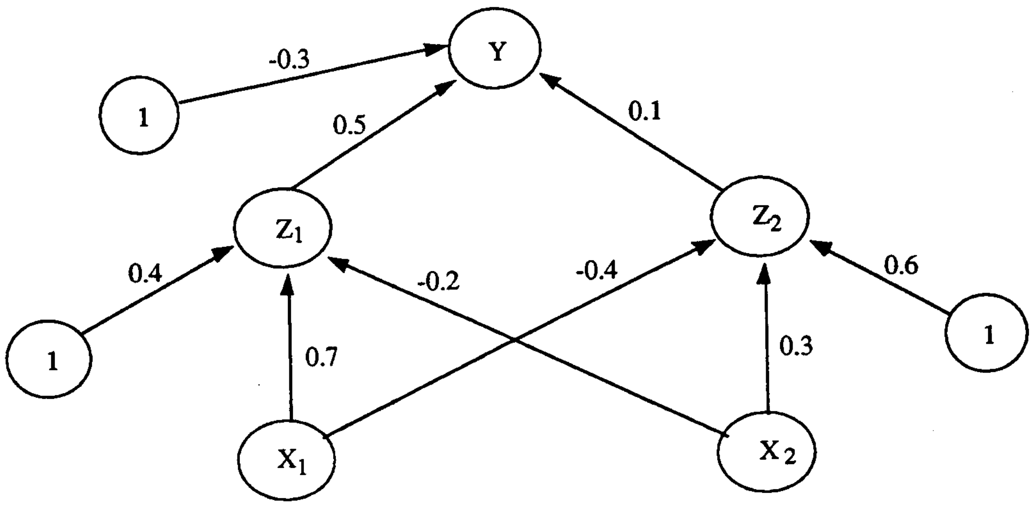
Concluded Facts (with confidences)

F(0.9)
B(-0.8)
G(0.7)

Use the following rules for combining the premises

CF(P1 OR P2) = MIN [CF(P1) , CF(P2)]
CF(P1 AND P2) = MAX [CF(P1) , CF(P2)]

5. (a) For the back propagation network given below, find the new weights when the input pattern (0, 1) is presented as input and the target pattern is (0.8). Use (a) the binary sigmoid activation function; (b) learning rate = 0.25; and activation function's slope parameter = 3.0.

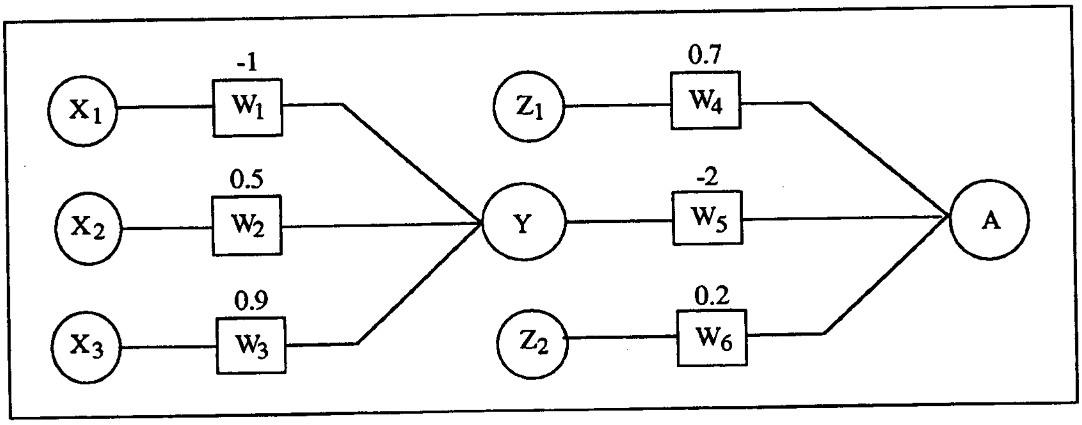


(10 marks)

(b) Show the trace of the operation of typical units in a Neural Network. Compute the total activation level of the unit A. The network structure is shown below. Use a bipolar sigmoid activation function for all the units.

The input values (i.e. activation levels) of the input units is:

$\mathbf{X_1 = 0.6 \quad X_2 = -1.0 \quad X_3 = 0.8 \quad Z_1 = -0.4 \quad Z_2 = 0.7}$



(5 marks)

6. (a) Map the following grammar into transition networks

sentence -> noun_phrase verb_phrase
sentence -> noun_phrase verb_phrase prep_phrase
noun_phrase -> noun
noun_phrase -> article noun
verb_phrase -> verb
verb_phrase -> verb noun_phrase
prep_phrase -> preposition noun_phrase
preposition -> with
preposition -> on
preposition -> to
article -> a
article -> the
noun -> lady
noun -> cat
noun -> ribbon
noun -> dog
verb -> likes
verb -> bites

Use the above transition networks to parse the following sentence:

The lady likes the cat with a ribbon.

(7 marks)

(b) Given below are a set of rules for giving investment advice. Draw the AND/OR graph for these rules and use it to suggest the proper investment for a particular individual, i.e. the goal is the predicate expression *investment(X)*. The case-specific data is as follows:

- The individual has two dependents.
- $20,000/- in savings
- Steady income of $30,000/-.

<u>Rules</u>:

(1) saving_account(inadequate) -> investment(savings)

(2) saving_account(adequate) AND income(adequate)-> investment(stocks)

(3) saving_account(adequate) AND income(inadequate)-> investment(combination)

(4) amount_saved(X) AND dependents(Y) AND greater(X, minsavings(Y)) > saving_account(adequate)

(5) amount_saved(X) AND dependents(Y) AND NOT greater(X, minsavings(Y)) > saving_account(inadequate)

(6) earning(X, steady) AND dependents(Y) AND greater(X, minincome(Y)) -> income(adequate)

(7) earning(X, steady) AND dependents(Y) AND NOT greater(X, minincome(Y)) -> income(inadequate)

(8) earning(X, unsteady) -> income(inadequate)
minincome(X) = 15,000 + (5000 * X)
minsavings(X) = 6000 * X

(8 marks)

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