

**PRIFYSGOL CYMRU; UNIVERSITY OF WALES**

**DEGREE EXAMINATIONS MAY/JUNE 2002**

**SWANSEA**

**Computer Science**

**CS 345 Artificial Intelligence Applications**

**Attempt 2 questions out of 3**

**Time allowed: 2 hours**

**Students are permitted to use the dictionaries provided by the University**

**Students are NOT permitted to use calculators**

**CS\_345**  
**Artificial Intelligence Applications**

*(Attempt 2 questions out of 3)*

- 1** a) How might a knowledge engineer convert rules expressed in English into rules with certainty factors (CFs)? Give examples to illustrate the approach. **[3 marks]**

Give the mathematical formulas for determining CFs as employed by MYCIN. What are the disadvantages of this uncertainty theory when used for deep reasoning? **[4 marks]**

The following rules are to be used to determine the certainty of the fact `john is happy`:

```
IF john wins at poker
  OR mary goes to party
THEN john is happy           0.8

IF England wins world cup
THEN john is happy           0.8

IF mary has dress to wear
  AND jane goes to party
THEN mary goes to party      0.7

IF bill doesn't go to party
THEN jane goes to party      0.6

IF john has good card hand
THEN john wins at poker      0.8
```

If the certainty of the facts are given as:

```
CF(bill doesn't go to party) = 0.9
CF(john has good card hand) = 0.7
CF(England wins world cup) = 0.5
CF(mary has a dress to wear) = 0.6
```

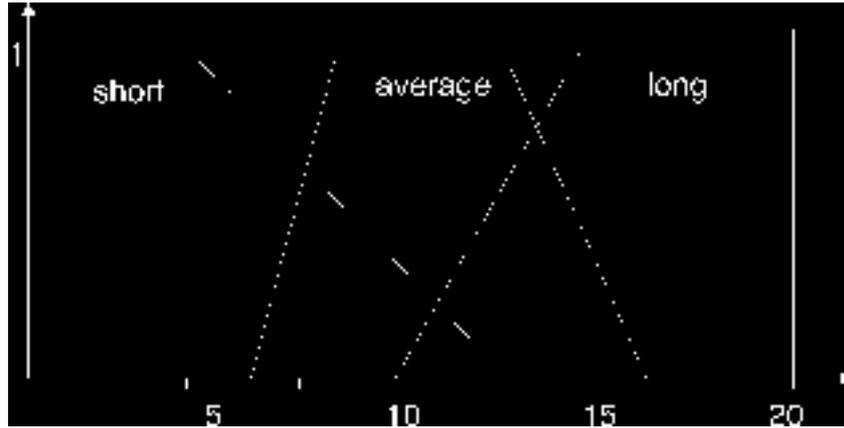
Calculate the CF of the fact `john is happy`. Indicate all your reasoning. **[6 marks]**

- b) Explain in detail, how a fuzzy expert system can be used for controlling devices. Describe two possible methods for implementing defuzzification (average point and centroid) and indicate why both are easy to evaluate/approximate if the fuzzy sets are represented by straight-line segment graphs. **[5 marks]**

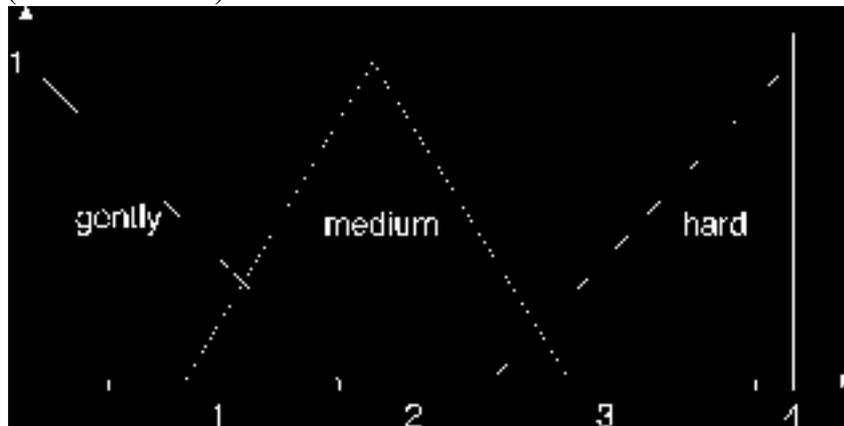
A fuzzy controller for a vacuum cleaner uses the following set of rules.

```
IF carpet short pile THEN suck gently
IF carpet average pile THEN suck medium
IF carpet long pile THEN suck hard
```

A light sensor can detect the length of the carpet pile in mm. The fuzzy concepts `short`, `average` and `long pile` are represented by the graphs in the next figure (the values being measured in mm):



The fuzzy concepts for sucking power gently, medium and hard are represented as follows (in suitable units):



The cleaner's sensor records a length of pile of 11mm. Use the above set of rules to determine the value of the sucking power to which the cleaner will be set. Illustrate your working with the help of diagrams and *estimate* the average point for the defuzzification stage. [7 marks]

- 2 a) Explain how forward chaining operates in CLIPS, making reference to the fact agenda, rule agenda and conflict resolution strategies. [4 marks]

An expert system is to be constructed in CLIPS to determine the cost of house insurance. The details of the house to be recorded are: value; postal code (letters only); semi-detached, detached or bungalow; road adopted or unadopted. The details of the insured to be recorded are: name; sex; income and occupation. Define two suitable deftemplates to record these types of fact. [2 marks]

The basic insurance cost is 0.5% of the house value. Various discounts and surcharges are then determined in the following order.

- i) If postal code is SA then no surcharge; CF surcharge £50; M or L surcharge £75; all other codes a discount of £20.
- ii) If bungalow, then 1% surcharge on cost so far; detached 2% surcharge and semi no surcharge.
- iii) If road not adopted then surcharge of £50.
- iv) If occupation of insured is lecturer, discount of 2%; if teacher, discount of 1%; all others a surcharge of 1% on cost so far.
- v) If female, a discount of £50.

Write rules in CLIPS to express the above evaluation procedure, storing the current cost in a fact (`current cost ?c`). Ensure that the order of calculation is i) through v) by asserting appropriate facts. **[11 marks]**

b) Describe the Ant Colony Optimisation (ACO) algorithm as applied to solving the Travelling Salesman Problem (TSP). How does this algorithm compare with other biologically inspired algorithms for solving TSP? What other problems has this technique been applied to? **[8 marks]**

3 a) The values of a real valued function  $f(x, y)$  are given at points  $(x_i, y_j)$  for  $0 \leq i \leq N$ ,  $0 \leq j \leq M$ . It is known that the function is of the form

$$f(x, y) = p \cdot \sin(x+y) + q \cdot \cos(x \cdot y) + r \cdot y \cdot x^2$$

for some positive integer constants  $p$ ,  $q$  and  $r$ , which are all less than  $2^{16}$ . Explain how a genetic algorithm might be used to determine these constants. In the description, you should indicate two possible fitness functions which could be used, the possible encoding of the problem and a technique used for selecting elements from the population which is proportional to their fitness. **[10 marks]**

b) What is *default reasoning*? Explain by means of the following example why it is *non-monotonic*.

The default rule is:

All cats have tails

The exception rule:

All manx cats have no tail

We have the initial information that `kitty is a cat` and then we are later informed that `kitty is a manx cat`. **[4 marks]**

c) Describe backward chaining using a depth first search strategy as used in some expert system shells. **[5 marks]**

The following set of rules determine if a person is eligible for a loan:

```

IF has_good_assets(X)
THEN loan_offered_to(X)

IF has_good_savings(X)
THEN loan_offered_to(X)

IF partner(X,Y) AND owns_home(Y,H) AND
   value_greater_than(H,50000)
THEN has_good_assets(X)

IF owns_home(X,H) AND value_greater_than(H,50000)
THEN has_good_assets(X)

IF wife(X,W) THEN partner(X,W)
IF lives_with(X,W) THEN partner(X,W)

IF (bank_balance(X,B) OR building_soc_balance(X,B))
   AND greater_than(B,10000)
THEN has_good_savings(X)

```

Construct the full and/or tree of proofs for goal `loan_offered_to(X)`. Indicate when information must be provided by the user for primitive goals and give suitable answers.

**[6 marks]**