

PRIFYSGOL CYMRU; UNIVERSITY OF WALES

DEGREE EXAMINATIONS MAY/JUNE 2003

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) Outline how certainty factors (CFs) are used in inexact reasoning. You should present the main formulas used in the calculation of CFs. **[4 marks]**
- b) A set of rules from a knowledge base, with associated certainty factors, is given below:

```
IF justin beats chris at chess
   OR mary is not at the dance
THEN chris is sad                                0.8

IF Liverpool wins the cup
THEN chris is sad                                0.8

IF mary has no dress to wear
   AND jenny not at the dance
THEN mary is not at the dance                    0.7

IF bob at the dance
THEN jenny is not at the dance                    0.6

IF justin is good chess player
THEN justin beats chris at chess                  0.8
```

The certainty factors for facts are given as:

```
CF(bob at the dance) = 1.0
CF(justin is good chess player) = 0.7
CF(Liverpool wins the cup) = 0.5
CF(mary has no dress to wear) = 0.6
```

Calculate the CF of the fact `chris is sad`. Indicate all your reasoning. **[8 marks]**

- c) What is a fuzzy set? Define how two fuzzy sets are *amalgamated*. Explain how a fuzzy expert system can be used for controlling devices. **[4 marks]**

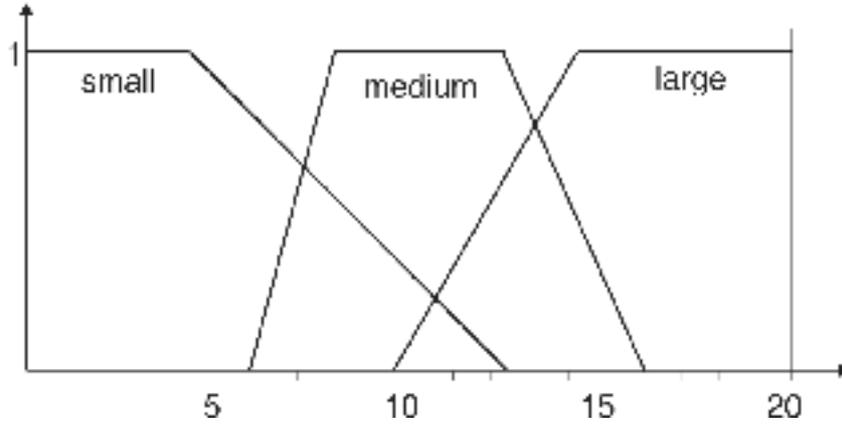
An autoclave (large oven) for curing metal components has a fuzzy controller for determining the speed of its fan and the temperature setting. The size of the metal components are described by the fuzzy concepts `small`, `medium` or `large`, the temperature by `moderate` or `hot` and finally the speed of the fan as `slow`, `average` or `fast`. The fuzzy rules used are:

```
IF component small THEN temperature moderate
IF component medium or large THEN temperature hot
```

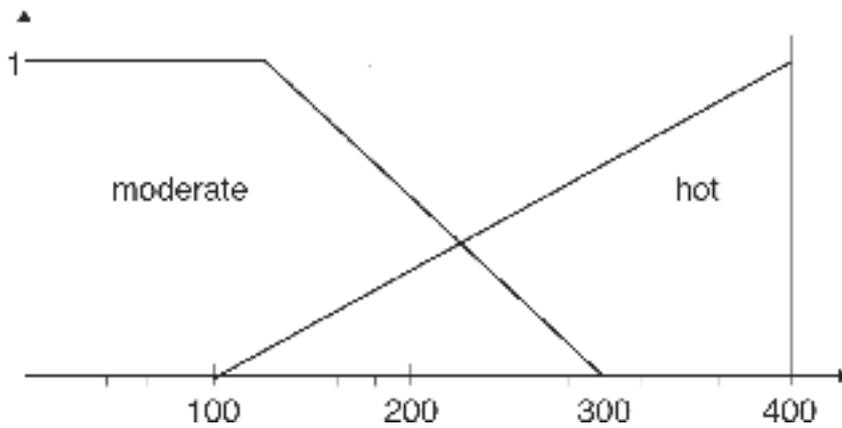
and for the speed of the fan

IF component small THEN speed slow
 IF component medium THEN speed average
 IF component large THEN speed fast

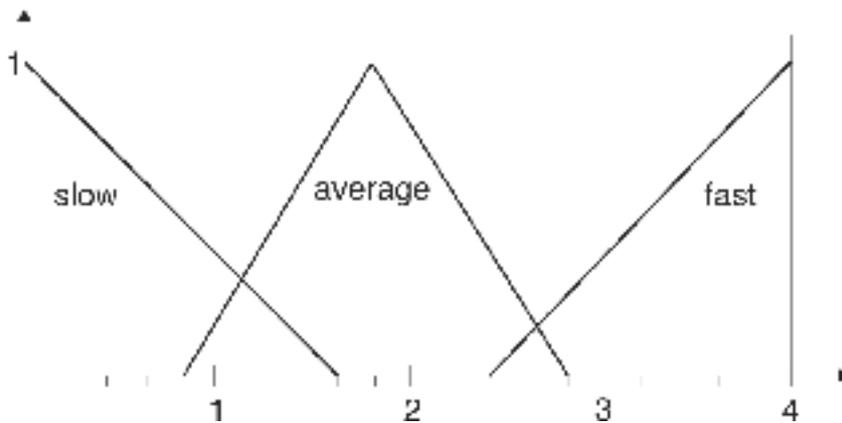
The graphs representing the fuzzy sets are given below:
 for size (cm)



for temperature (in Celcius)



and for speed (thousands of rev/min)



If the size of the component is 11cm, determine the settings for temperature and speed using the fuzzy system. Indicate all the steps in your working using diagrams where necessary. **[9 marks]**

- 2 a) Outline the inference method used in CLIPS. You should explain clearly what are: the fact agenda, the rule agenda and conflict resolution strategies. **[6 marks]**

A credit card company ExAm has four categories of cards: bronze, silver, gold and platinum. ExAm uses the following rules for allocating or renewing cards (note it is possible that lower ranking cards could be issued due to changes in circumstances):

If a person is employed and is not a payment defaulter then a bronze card can be issued.

If a person is employed with salary greater than £10,000, has a credit card at present and is not a payment defaulter then a silver card can be issued.

If a person is employed with salary greater than £20,000, has a credit card not bronze and is not a payment defaulter then a gold card can be issued.

If a person is employed with salary greater than £40,000, has a gold or platinum credit card and is not a payment defaulter then a platinum card can be issued.

Indicate the type of facts you should use to record the necessary information and give a CLIPS rule to gather these facts from the applicant. Write the above rules in CLIPS with appropriate salience declarations so that the highest ranking card is issued to the person. You should retract facts in the rules so that only one rule will fire and hence only one card will be issued.

Write a CLIPS function (using `switch`) which will return the credit rating determined as follows: bronze 10% of salary; silver 20% of salary; gold 30% of salary and platinum 50% of salary. Finally, give a rule which will print out the type of card allocated together with the credit rating. **[9 marks]**

- b) Describe the basic mechanisms behind DNA computing. Show how to solve the 3-colourability (3-COL) problem by using DNA computation. **[10 marks]**

- 3 a) Outline the main features of Genetic Programming (GP), mentioning the key concepts of terminal functions, primitive functions and the fitness function.

You are required to construct a program for controlling a simple robot. The robot's task is to follow the walls of a room from an initial start position to achieve a complete cycle of the room. Indicate possible choices for terminal and primitive function sets and give a suitable fitness function. Give an example of the type of LISP function which might be constructed by the GP. **[10 marks]**

- b) Default logic is an example of a non-monotonic logic, what does this mean? Give an example to illustrate your answer. **[4 marks]**

- c) Expert systems can often provide explanation facilities. Describe, with examples, how a system can answer both HOW and WHY queries. **[5 marks]**

- d) Show, by constructing a full and/or tree, how a backward chaining expert system would solve the goal `commits_crime(X)` given the set of rules and the one fact below. You should indicate when the user would be asked to provide answers.

Rules:

```
IF sells_to(X,Y,Z) AND weapon(Y) AND terrorist(Z)
THEN commits_crime(X)
```

```
IF sells_to(X,Y,Z) AND liquor(Y) AND under_age(Z)
THEN commits_crime(X)
```

```
IF gun(W) THEN weapon(W)
```

```
IF knife(W) AND has_long_blade(W) THEN weapon(W)
```

```
IF beer(L) OR whisky(L) THEN liquor(L)
```

```
IF age_of(M,A) AND A<18 THEN under_age(M)
```

Fact:

```
sells_to(joe,something,jack)
```

[6 marks]