PRIFYSGOL CYMRU; UNIVERSITY OF WALES

DEGREE EXAMINATIONS JANUARY 2003

SWANSEA

Computer Science

CS 335 Foundations of Artificial Intelligence

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_335 Foundations of Artificial Intelligence

(Attempt 2 questions out of 3)

Question 1

a) Explain, with reference to SimplerChild, how the basic ideas used in ELIZA are being employed in some front-ends to information retrieval systems on the Web. How successful do you consider this approach? [**4 marks**]

b) Definite clause grammars (DCGs) can allow parameters to appear in non-terminal symbols. Show, using a simple example, how this feature can be useful. [**4 marks**]

A subset of English is built up from the following:

```
animate nouns:    dog, cat, mouse, man, boy, girl, child
inanimate nouns:  bone, book, cheese, ball
dative verbs:     gives, offers, throws
determiners:      the, a
```

Only the present tense third person singular and plural are to be used. The subject and dative case must be animate nouns and the object case an inanimate noun. Typical examples of sentences are:

a boy gives the dog a bone ; *the girls offer the mice a cheese*; *a man gives the children the books*; *a girl throws the cat a ball*.

Construct a DCG to recognise such sentences. You can assume there is a predicate `add_s(X,Y)` which adds an 's' to the end of an identifier. [**10 marks**]

An alternative form of such sentences exist in which the order of the dative and object nouns is switched using the preposition *to*. E.g., *a boy gives a bone to the dog*; *the girls offer a cheese to the mice*. Modify the grammar so that the alternative form of the sentence is constructed in a parameter. So, for the goal

```
phrase(sentence(S),[the,boy,throws,the,dog,a,ball])
```

the variable `S` is instantiated to the list `[the,boy,throws,a,ball,to,the,dog]`. [**7 marks**]

Question 2

a) Discuss state of the art programs for playing two person games which are now available, making particular reference to DeepBlue. [**5 marks**]

b) *Briefly* describe the machine learning technique of explanation based generalisation (ebg), indicating how it might be implemented in Prolog. [**6 marks**]

You are provided with the following information:

Domain theory:

1. A traveller takes a drug if he is going to a country where malaria is present and the drug prevents malaria.
2. Malaria is present in a country, if the country is swampy, has mosquitoes and is in tropical Africa.
3. A country is in tropical Africa, if it is in Africa and near the equator.
4. A country is near the equator if its latitude is less than 5 degrees (North or South).
5. A drug prevents malaria if it is a prophylactic.

A training example consists of the following facts:
James is going to Rwanda; Rwanda is latitude3 degrees South; Rwanda is in Africa; Rwanda is swampy; there are mosquitoes in Rwanda and quinine is a prophylactic.

The training goal is `traveller_takes_drug('James',quinine)`.

Describe the domain theory as a set of suitable Prolog rules and the training example as a set of Prolog assertions using the predicate symbols `going_to/1`,`latitude/3`, `traveller_takes_drug/2`, `drug_prevents_malaria /1`, , `swampy/1`, `malaria_present_in/1`, `mosquitoes_in/1`, `tropical_africa/1`, `near_equator/1`, `in_africa/1`, `less_than_five/1`, `prophylatic/1`. (The third argument in `latitude`, indicates whether it is South or North). [**8 marks**].

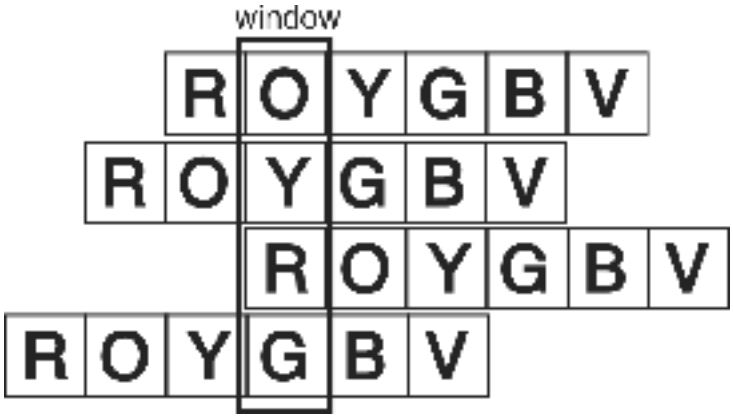
Determine the generalised rule, using ebg, when the operational criteria are [`in_africa`, `near_equator`, `swampy`, `mosquitoes_in`, `going_to`, `prophylatic`]. [**3 marks**]

Explain, using a diagram, how the general rule changes if the operational criteria are altered. What would the rule be if the operational criteria are [`tropical_africa`, `swampy`, `mosquitoes_in`, `going_to`, `drug_prevents_malaria`]? [**3 marks**]

Question 3

a) A game to discover a hidden code is played as follows:

The code consists of four ordered colours from the possible choices: red, orange, yellow, green, blue and violet (R,O,Y,G,B,V). The colours need not be distinct. A guess is made by sliding the four horizontal panels so that four colours appear in the window (e.g., the guess made in the figure is OYRG). The information provided to the player is: *i) the number of colours in the correct position and ii) the number of colours which are to the left of the correct colour.* So if the hidden code were YYGO, then the player would be told 1 correct and 2 colours to the left for the guess OYRG since the second Y is correct and O and R are to the left of Y and G respectively.



Outline how a generate and filter method may be used to play this game. You should give the main Prolog procedures for an implementation explaining clearly what the generator and filter are that you use. [**10 marks**]

Illustrate the execution of your algorithm by exhibiting the guesses made when the hidden code is YYGO. [**5 marks**]

b) Describe, using pseudo-code, the A* (best-first-search) algorithm using a heuristic function h. Prove if h is *admissible*, then A* will find an optimal solution if one exists? [**5 marks**]

Give the heuristic used by Korf for solving the Rubik cube and show that it is admissible and hence finds optimal solutions. Why is the usual 'human' approach to solving this puzzle far from optimal? [**5 marks**]