CS-345
ARTIFICIAL INTELLIGENCE APPLICATIONS
(Attempt 2 questions out of 3)

Question 1

a. Outline the architecture of an expert system and carefully explain the function of each component. Indicate the different ways in which a user of the expert system and a developer/knowledge engineer might interface with the system. Discuss what forms of explanation a typical rule based expert system might be able to provide. **[8 marks]**

b. Briefly explain what you understand by the terms **monotonic reasoning**, **temporal reasoning** and **default reasoning**. Give examples of each. **[6 marks]**

c. The following rules are to be used in a backward chaining expert system to advise clients on financial investment:

```
IF     client personality cautious
       AND financial state conservative
THEN   advice is invest in savings

IF     client personality cautious
       AND financial state secure
THEN   advice is invest in (savings & stocks)

IF     client personality adventurous
       AND financial state conservative
THEN   advice is invest in (savings & stocks)

IF     client personality adventurous
       AND financial state secure
THEN   advice is invest in stocks

IF     client old
       OR  job not steady
THEN   client personality cautious

IF     client young
       AND job steady
       AND children
THEN   client personality cautious

IF     client young
       AND job steady
       AND no children
THEN   client personality adventurous

IF     assets less than liabilities
THEN   financial state conservative

IF     assets greater than or equal liabilities
THEN   financial state secure
```

By constructing the full and/or tree to determine the answer to the goal

```
                        advice is X
```

with respect to the above set of rules describe how a backward chaining expert system functions. Show what questions would be asked of the user and the answers given in a typical run. **[11 marks]**

Question 2

a. Explain how **Certainty Factors** (CFs) are used by Expert Systems such as MYCIN are used to handle the concept of inexact reasoning. Assuming that the range for a CF is −1 to +1 give the properties that are required for functions to combine CFs for rules with multiple premises and when several rules have the same conclusion. Suggest suitable functions. **[6 marks]**

b. The following rules to determine if a patient has malaria are given with their respective CFs:

```
IF    high_fever
      AND recently_in_jungle
      AND not_taken_pills
THEN patient_has_malaria         0.8

IF    patient_has_dysentry
THEN  patient_has_malaria        0.2

IF    recently_in_south_america
THEN  patient_has_dysentry       0.4

IF    recently_in_guatemala
THEN  recently_in_jungle         0.8

IF    recently_in_guatemala
THEN  recently_in_south_america 1.0

CF(recently_in_guatemala) =      1.0
CF(high_fever) =                 0.9
CF(not_taken_pills) =            0.5
```

Determine the CF of `patient_has_malaria` showing clearly the intermediate calculations. **[10 marks]**

c. Explain what is meant by a **Genetic Algorithm** (GA) and the steps involved in developing a GA to solve a particular problem. Your answer should include explanations of the terms **fitness function**, **mutation** and **crossover**.

[5 marks]

d. Compare and contrast **Genetic Programming** with the use of Genetic Algorithms. **[4 marks]**

Question 3

**a.** Explain what are meant by a **fuzzy set** and a **fuzzy rule**.

A fuzzy expert system consists of a number of fuzzy rules. Outline the mechanism for executing such a system. **[5 marks]**

b. A toaster is controlled by a fuzzy expert system with the following set of rules.

```
IF    bread is white
THEN  toast for short time

IF    bread is brown
THEN  toast for medium time

IF    bread is dark brown
THEN  toast for long time
```

The brownness of the bread, read by a sensor, is a fuzzy variable represented by a fuzzy set over a domain 0 to10 units. The concepts of white, brown and dark brown are represented in the figure below:
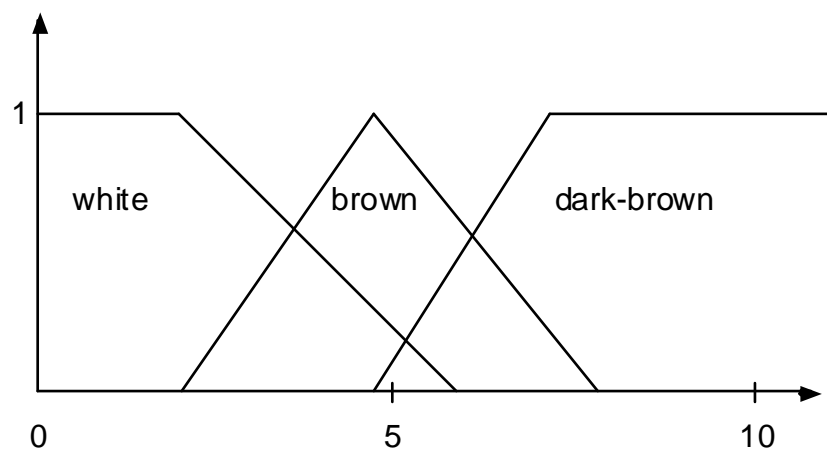
The length of toasting time ranges from 0 to 2 minutes and the fuzzy times short, medium and long are given below.
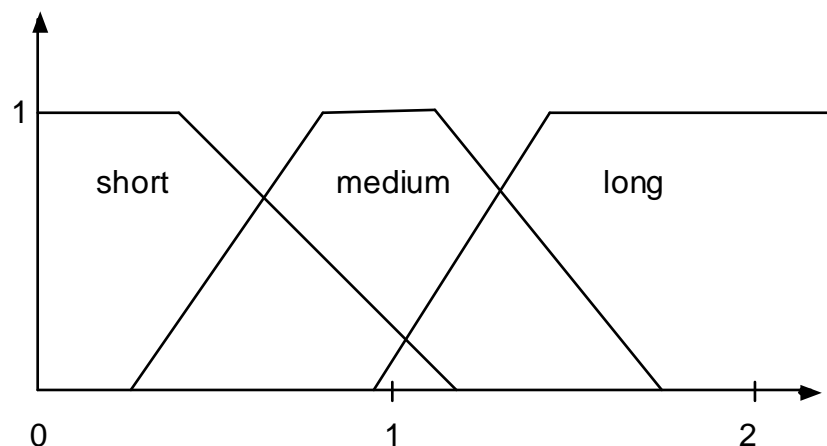
Show how to determine the toasting time, if the brownness of the bread determined by the sensor is 4 units. **[6 marks]**

c. What added complexity is needed if the thickness of the bread is also included as an extra variable for the controller. **[2 marks]**

d. Briefly explain how Adleman demonstrated that DNA molecules could be used to perform certain types of computation. Give examples of the types of computation that this approach can be used for and discuss its limitations.

[6 marks]

e. Describe the basis of the **Ant Colony Optimisation Algorithm**. Explain the difference between Global and Local updating and why they are used. Discuss the types of problem for which this approach may be useful and outline how a problem needs to be expressed in order for it to be amenable to solution using this approach. **[6 marks]**