CS_335 Foundations of Artificial Intelligence

(Attempt 2 questions out of 3)

Question 1

a) Shrdlu was an early natural language system. Describe some of its main features.
[**4 marks**]

b) Definite clause grammars (DCGs) allow Prolog code to be embedded in rules. Use a simple example to illustrate how this feature can be useful. [**3 marks**]

A subset of English is built up from the following:

```
animate nouns:     kitten, pup, man, boy, girl
inanimate nouns:   bone, book, prize, ball
determiners:       the, a
dative verbs:      gave, offered, presented, threw
```

Only the past tense third person singular and plural of verbs, as listed above, are to be used. The subject and dative case must be animate and the object case inanimate. Typical examples of sentences are:

a boy gave the pups the bones ; *the girls offered the kittens a ball*; *a man presented the girl a prize*; *a girl threw the cat a ball.*

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

A passive form of such sentences also exists. E.g., *the pups were given the bones by a boy*; *the kittens were offered a ball by the girls,* etc. Modify the grammar so that the passive form of the sentence is constructed in a parameter. So, for the goal

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

the variable `S` will be instantiated to the list

```
[the,dog,was,thrown,a,ball,by,the,boy].
```

(You can assume that a predicate `past_participle` is given producing the past participle of a verb , e.g. `past_participle(threw,thrown)`) [**8 marks**]
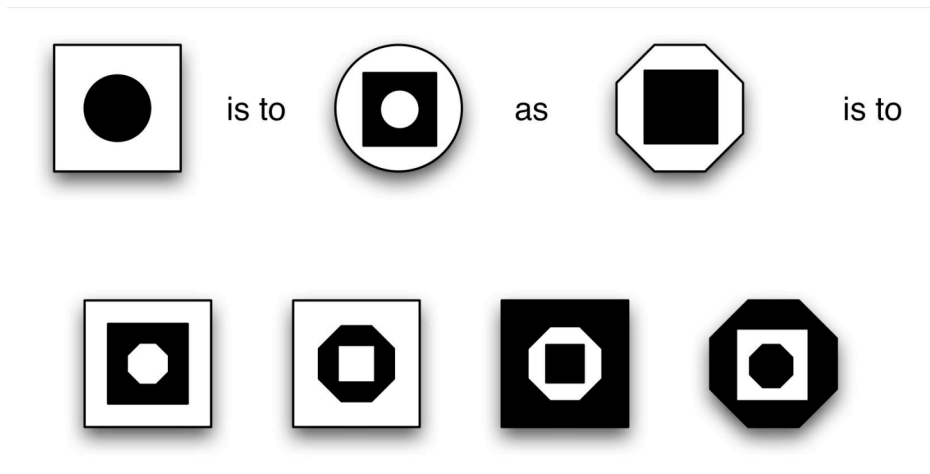
Question 2

a) Describe the mini-max algorithm for selecting a move in a two person game. Illustrate the method by applying it to the following game of connect-3. Black and Grey disks are dropped into the top of one of the columns and play alternates between Black and Grey, with Black making the first move. The winner is the first player to obtain three *adjacent* disks of their colour in a horizontal, vertical or diagonal line. Give a suitable heuristic function for this game, and extend the mini-max tree given below to depth 2, and hence determine Grey's move from the position at root. **[10 marks]**
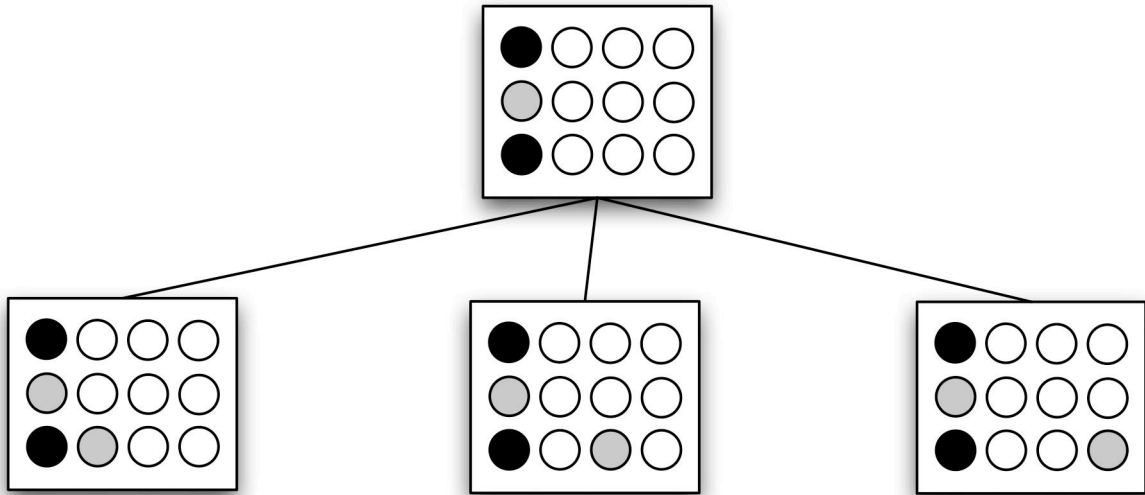
Indicate how the mini-max search space may be reduced using α–β pruning. In the tree for the connect-3 game you have constructed, show which leaves do not have to be evaluated if α–β pruning is applied. **[5 marks]**

b) Outline how the ANALOGY program for solving simple geometrical IQ type problems may be implemented in Prolog. Give a suitable representation of a rule which will allow the program to successfully solve the following problem (you will need to record whether the shape is black or white).
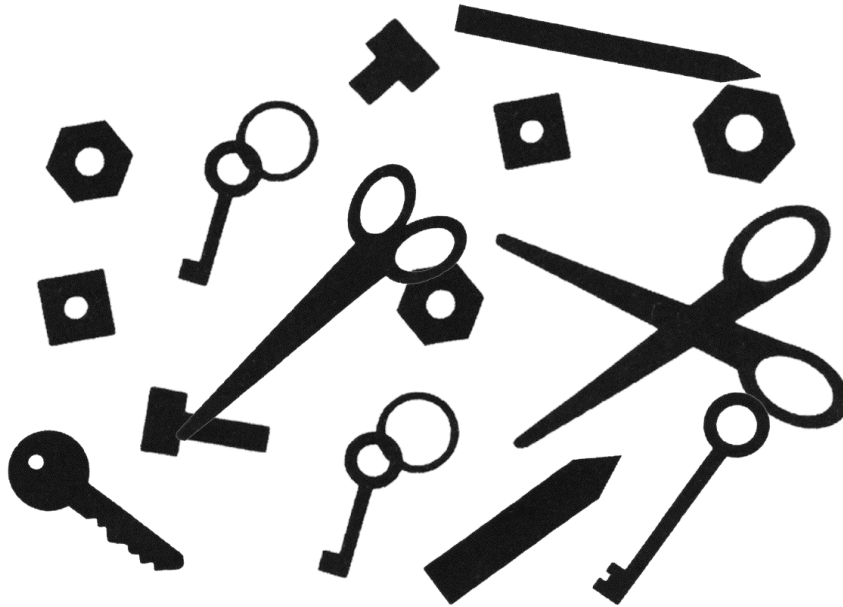
To what extent is the program somewhat unsatisfactory? **[10 marks]**

Question 3

a) The following picture contains silhouettes of objects from the classes: bolts, nuts, scissors, keys and pencils.

Explain how to describe the objects as Prolog terms using the attributes size, shape and holes, giving suitable values for these attributes. **[5 marks]**

Outline how a covering algorithm can be implemented to induce rules to describe these classes of objects. You should explain the format of the rules adopted and the type of heuristic used to select an attribute value pair, `Att=Val`, to appear in a conjunction in the body of a rule. **[8 marks]**

Give a possible rule describing the class of objects which are keys. **[2 marks]**

b) A *logic puzzle* can be specified by a set of clues together with a set of queries. Represent this in Prolog as `puzzle(Clues,Queries,Solution)` and write down and explain a general scheme `solve_puzzle(Puzz,Soln)` for solving such puzzles. **[5 marks]**

Three students won different prizes at a talent show. They live on different floors in the same house. They have different names and entered for different competitions. The following information is known:

Keith won a stereo and lives on the floor above the student who entered for singing.

Alan, the Welshman, won a camera and the student who lives on the floor below him is Scottish.

The student from Scotland entered the poetry competition.

The British student entered the dancing competition.

The following queries are asked:

Who won the TV?

What nationality is Peter?

Use a term `stdnt(Name, Prize, Contest, Nationality)` to denote each student and a list to indicate their position in the house. **Without** finding the solution, show how the clues and queries can be represented using this format so that the above predicate can be used to solve this puzzle. [**5 marks**]