Parts 3-6 are EXAMPLES for cse634

FINAL TEST
CSE 352 ARTIFICIAL INTELLIGENCE
Fall 2008

- There are 6 pages in this exam. Please make sure you have all of them

INTRODUCTION – Philosophical AI Questions

Q1. Write some pro and contra arguments about TURING TEST as the test of artificial intelligence.

Q2. Describe some technological "science fiction" inventions in your favorite Science Fiction movie that are realistic as of today's state of technology, and some others that are not realistic.

PART ONE –Expert Systems

Q1. Write a simple (5-6 rules long) Expert System (in English) for a task (or tasks) chosen by you.

Q2. Conceptualize your system in PROPOSITIONAL LOGIC.

Q3. Pose some questions to your system in order to build a database of FACTS related to your task and use backward chaining to show if your task succeeds, or fails depending on the answers to the questions.

HINT: Look at Hmk1part1 solutions and our book.

PART TWO – Resolution and Predicate Logic

Q1. Write all resolvents of $\Delta = \{ \{a, \neg a, \neg b, c\}, \{a, b\}, \{\neg b, \neg c\}, \{b\} \}$

Q2. Apply all possible Resolution Strategies (state which are complete) to verify whether the set Δ below is satisfiable, or not.

$\Delta = \{ \{a, \neg b\}, \{\neg a, \neg b\}, \{b, c\}, \{a, \neg c\}, \{\neg a\}, \{a, b, \neg a\}, \{\neg b, a, c, b\}, \{b\}, \{c\}\}$

Q3. Use resolution deduction (and completeness of your resolution strategy) to decide the validity of the following argument.

From

A1: $(((a \rightarrow (\neg b \wedge c)) \rightarrow (b \rightarrow \neg a)) \vee ((a \rightarrow \neg c) \vee b))$ and

A2: $((a \rightarrow b) \rightarrow a)$,

we deduce that
B: (¬(a → (¬b ∧ c)) → (a ∧ (b ∧ ¬c)))

Q4. Prove the following Law of Quantifiers

$$(\forall x\, A(x) \bigcup \forall x\, B(x)) \Rightarrow \forall x (A(x) \bigcup B(x))$$

Give an example of a non empty domain X and formulas A(x), B(x),
For which the $\Leftarrow$ direction does not hold.

Q5. (a) Translate the following sentences into Predicate Logic and AI Logic under intended interpretation. Write down your choice of predicates.

A1: All flowers are blue and pretty.
A2: All blue flowers are pretty.
A3: All flowers are pretty.

(b) Decide whether the ARGUMENT: A1 /\ A2 => A3 is VALID, or NOT VALID. Show work.

Q6. (a) Translate the following sentences into Predicate Logic and AI Logic under intended interpretation. Write down your choice of predicates.

A1: All students are clever.
A2: Some clever students have blue eyes.
A3: There is a student with blue eyes.

(b) Decide whether the ARGUMENT: A1 /\ A2 => A3 is VALID, or NOT VALID. Show work.

PART THREE – Classification Rules

Definition 1

Given a classification dataset DB with a set A = $\{a_1, a_2, \ldots, a_n\}$ of attributes and a class attribute C with values $\{c_1, c_2, \ldots, c_k\}$ (k classes), any expression;

$a_1 = v_1 \Lambda \ \ldots \ \Lambda\, a_k = v_k$, where $a_i \in$ A and v_i are corresponding values of attributes,

is called attributes DESCRIPTION, for short a DESCRIPTION.

The expression C = c_k is called a class DESCRIPTION, for short a CLASS.

Definition 2

A CHARACTERISTIC FORMULA is any expression
$C = c_k \Rightarrow a_1 = v_1 \wedge \ldots \wedge a_k = v_k$, or shortly we write it as CLASS $\Rightarrow$ DESCRIPTION.

Definition 3

A DETERMINANT formula is any expression
$a_1 = v_1 \wedge \ldots \wedge a_k = v_k \Rightarrow C = c_k$, or shortly a formula
DESCIPTION $\Rightarrow$ CLASS.

Definition 4

A characteristic formula CLASS $\Rightarrow$ DESCRIPTION is called a CHARACTERISITIC RULE of a given dataset DB iff it is **TRUE** in DB, i.e. when the following condition holds

{o: DESCRIPTION} $\cap$ {o: CLASS } not= $\varnothing$,

Where {o: DESCRIPTION} is the set of all records of DB corresponding to the Attributes DESCRIPTION, {o: CLASS} is the set of all records of DB corresponding to the CLASS description.

Definition 5

A discriminant formula DESCRIPTION $\Rightarrow$ CLASS is called a DISCRIMINANT RULE for a given **DB** iff it is **TRUE in the DB,** i.e. the following holds
1. {o: DESCRIPTION} not= $\varnothing$
2. {o: DESCRIPTION} $\subseteq$ {o: CLASS}

Q1. Prove that for any data base DB, for any of its DISCRIMINANT rules DESCRIPTION $\Rightarrow$ CLASS, the formula
CLASS $\Rightarrow$ DESCRIPTION is a characteristic RULE for the DB, but not vice-versa.

See lecture notes for an example of a characteristic rule CLASS $\Rightarrow$ DESCRIPTION such that the corresponding formula DESCRIPTION $\Rightarrow$ CLASS is not a discriminant rule of DB and write your own example for the dataset below.

Given a dataset:

Record	a_1	a_2	a_3	a_4	**C**
o_1	+	1	1	0	+
o_2	+	1	2	0	+
o_3	-	0	0	0	-
o_4	-	0	2	1	-
o_5	+	1	1	0	+

C – class attribute

Q2. Use the data set given above to create an example of a characteristic rule CLASS $\Rightarrow$ DESCRIPTION such that the corresponding formula DESCRIPTION $\Rightarrow$ CLASS is not a discriminant rule.

Q3. For the data set given above find {o :DESCRIPTION} for the following descriptions

1) $a_1 = + \wedge a_2 = 1$
2) $a_3 = 1 \wedge a_4 = 0$
3) $a_2 = 0 \wedge a_1 = +$
4) $a_1 =$ {o : C= +}, {o : C = -}

Q4. For the following formulae determine whether they are / are not DISCRIMINANT / CHARACTERISTIC RULES of our dataset.

1) $a_1 = + \wedge a_2 = 1 \Rightarrow$ C = -
2) $C = + \Rightarrow a_1 =$ - $\wedge a_2 = 1 \wedge a_3 = 1$
3) $C =$ - $\Rightarrow a_1 = 1$
4) $C = + \Rightarrow a_1 = + \wedge a_4 = 0$
5) $a_1 = + \wedge a_2 = 1 \wedge a_3 = 1 \Rightarrow C = +$
6) $a_1 = + \wedge a_3 = 2 \Rightarrow C =$ -

PART FOUR – Classification by Decision Tree Induction I

Given a TRAINING and TEST classification data as follows:

TRAINING

Record	a_1	a_2	a_3	C
o_1	1	1	0	+
o_2	0	0	1	-
o_3	0	1	1	+
o_4	0	0	1	-
o_5	1	1	0	+
o_6	1	1	1	-
o_7	0	0	0	-
o_8	0	0	1	-

TEST

Record	a_1	a_2	a_3	C
o_1	1	1	0	+
o_2	1	0	1	-
o_3	0	0	1	+
o_4	0	0	0	-

Q1. Use attribute a_2 as the ROOT of the Decision Tree. Construct the tree (show steps) using your own choice of all node attributes.

Q2. Write down all the discriminant rules determined by your tree in two forms:
1. using the *att = v* expression and in a PREDICATE form using expressions
2. *att(x, v)* instead of *att = v*.
3. Are all of the rules determined by your tree TRUE in the TRAINING SET?

Q3. Use the TEST data to evaluate predictive accuracy of your set of rules generated by the given TRAINING data.

Q4. Re-write your TEST data using your choice of "real" values for attributes and values instead of our "abstract" attributes values.

Example a_1 = age, 1 = old, 0 = young
a_2 = color, 1 = blue, 0 = red

PART FIVE – ID3 Algorithm for DECISION TREE

Q1. For the data set given below, split it into TRAIN and TEST using not repeated Holdout (N- N/3 ; N/3).

Q2. Construct the Decision Tree using ID3 algorithm using your own choice of attributes as consecutive nodes.

Q3. Construct the Decision Tree using ID3 algorithm with the General Majority Voting (i.e. majority voting at any node of the tree) using your own choice of attributes as consecutive nodes.

Q4. Write down the set of discovered DISCRIMINANT RULES for Q2 and Q3. Evaluate accuracy of your rules.

Q5. Evaluate predictive accuracy for your both sets of rules from Q4 and your choice of the TEST data.

CLASSIFICATION DATA:

Age	Income	Student	Credit Rating	Buys Computer
<=30	high	yes	Fair	No
<=30	high	No	Excellent	No
31…40	high	No	Fair	Yes
>40	medium	yes	Fair	Yes
>40	Low	no	Fair	Yes
>40	low	Yes	Excellent	No
31…40	low	Yes	Excellent	No
<=30	medium	Yes	Fair	No
>40	high	Yes	Fair	No
>40	low	Yes	Fair	No
<=30	medium	Yes	Excellent	Yes
>40	medium	No	Excellent	Yes
31…40	high	Yes	Fair	No
>40	medium	No	Excellent	No

PART SIX – Neural Networks Classification

Given two records (Training Sample)

a_1	a_2	a_3	Class
0.5	0	0.2	1
0.1 -0.1 -0.2	0.3 0.2 0.1	0.2 -0.3, -0.1	1 0 0

1. Construct a Neural Network with one hidden layer (your own topology) and evaluate a passage of TWO EPOCHS.

Use Learning Rate ℓ = 0.7

REMEMBER: YOU HAVE TO SET YOUR INITIAL WEIGHTS AND BIASES RANDOMLY;

2. Write you're the terminating conditions for your network
3. Write a condition for success; i.e. how you decide that the record is well classified.