Intelligent Systems: Reasoning and Recognition

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ENSIMAG 2   Practice Exam

Conditions: You have the right to use any notes or written material. You may answer questions in English or in French. When appropriate, illustrate your answer with mathematics. Your written answers must be clear and legible. Illegible text will not be graded. Duration: 3 hours.

1) (4 points) What is an ROC curve? How is it computed? What does it tell you about a classifier? How can you use it to provide an objective comparison of two different classifiers?

2) (6 points) You are presented with a single neuron with two inputs (X_1, X_2) and a single output $h(X)$ computed using a sigmoid activation function ($F(z) = \sigma(z)$). Your network has been initialized with weights $W_1=-0.5$ and $W_2= +0.2$ and $b=0.5$. Assume a learning rate of $\eta=0.5$.
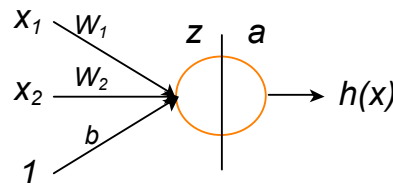
Your network should be trained to recognize the following training data:

m	x_1	x_2	y_m
1	1	0	0
2	0	1	0
3	0	0	1
4	1	1	1

a) Compute z, and a for $m=1$.
b) Compute $\delta_m^{(out)} = h(X_m) - y_m$ for $m=1$
c) Compute $\delta_m^{(1)}$ for $m=1$
d) Compute $\Delta W_1, \Delta W_2$, and Δb for $m=1$
e) Update W_1, W_2, and b for $m=1$.
f) Will your neuron converge for this training data?

3) (4 points) Assume the following temporal relations between intervals A, B, C and D.
        Interval A before Interval B: (A < B)
        Interval B during Interval D: (B d D)
        Interval A starts Interval C: (A s C)
        Interval D overlaps Interval C: (D o C)

a) What are the possible relations of A to D obtained by transitivity with B?
b) What are the possible relations of A to D obtained by transitivity with C?
c) What are the possible relations of A to D after constraint propagation?

4) (6 points) The goal of this question is to write CLIPS rules that will use the frequency of words and word pairs to predict the next word as a user types each word of a text.

Your system uses following templates for Words and Word-Pairs.

```
(deftemplate Word ; structure for counting words (1-Grams for words)
      (slot WORD1 (type STRING))
      (slot COUNT (type INTEGER) (default 0))  ; Number of instances of word
)

(deftemplate WordPair   ; structure for counting Word Pairs (2-Grams of words)
      (slot WORD1 (type STRING))
      (slot WORD2 (type STRING))
      (slot COUNT (type INTEGER) (default 0))   ; Number of instances of word
pair
)
```

As each word is typed by the user, your system will create a Fact of the form

(NewWord ?w)

where ?w is the most recent word. Your system will read words using a special function (read-word) that returns the most recent word as a string each time the user types a space. If the user types a carriage return, read-word returns as nil.

a) If there is no Fact of type NewWord, then the system should prompt the user to type a word. Write a rule named "ReadWord" that prints a question mark and then uses the function read-word to read the next word and create a fact of type NewWord.

b) For each new word, the system will generate a set of hypotheses, represented by a Fact of the form (NextWord ?w ?p), where ?w is a possible next word and ?p is the probability that this will be the next word based on the frequency of Words and WordPairs. Write a rule named NextWordHypothesis to create possible hypotheses and their probabilities.

c) Once all the hypotheses have been generated, the system should print out the most likely word. Write a rule named PredictWord that prints out the most likely next word. Make sure that this rule has lower priority than NextWordHypothesis so that it only executes after all hypotheses have been generated.

Look-up Table of Sigmoid function.

z	f(z)	z	f(z)	z	f(z)	z	f(z)	z	f(z)
0	0.500	1	0.731	2	0.881	3	0.953	4	0.982
0.1	0.525	1.1	0.750	2.1	0.891	3.1	0.957	4.1	0.984
0.2	0.550	1.2	0.769	2.2	0.900	3.2	0.961	4.2	0.985
0.3	0.574	1.3	0.786	2.3	0.909	3.3	0.964	4.3	0.987
0.4	0.599	1.4	0.802	2.4	0.917	3.4	0.968	4.4	0.988
0.5	0.622	1.5	0.818	2.5	0.924	3.5	0.971	4.5	0.989
0.6	0.646	1.6	0.832	2.6	0.931	3.6	0.973	4.6	0.990
0.7	0.668	1.7	0.846	2.7	0.937	3.7	0.976	4.7	0.991
0.8	0.690	1.8	0.858	2.8	0.943	3.8	0.978	4.8	0.992
0.9	0.711	1.9	0.870	2.9	0.948	3.9	0.980	4.9	0.993