Intelligent Systems: Reasoning and Recognition

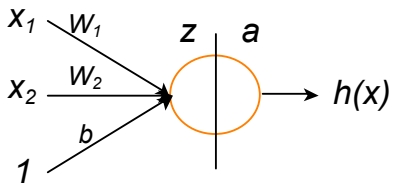
James L. Crowley

MoSIG M1 Final Exam - May 2018

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) (5 points) Provide a general definition for knowledge. For each of the following types of knowledge, provide a definition, explain how the form of knowledge can be represented, describe tasks for which the form may be used, and explain how the form of knowledge can be acquired: Conceptual knowledge, Declarative knowledge, Procedural knowledge, and Situational knowledge.

2) (6 points) You are presented with a single neuron with two inputs (x_1, x_2) and a single output, $h(\vec{X}) = a$ computed using a sigmoid, $\sigma(z)$. Your network has been initialized with weights w_1=+0.1 and w_2= –0.1 and b=0. Assume a learning rate of η=0.1.



Your network should be trained to recognize the following training data:

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

a) Compute z, and $h(\vec{X}_m)$ for m=1.
b) Compute $\delta_m^{(2)} = h(\vec{X}_m) - y_m$ for m=1
c) Compute $\delta_m^{(1)}$ for m=1
d) Compute Δw_1, Δw_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) (3 points) Given the following deftemplates in CLIPS:

```
(deftemplate product (slot NAME)(slot CATEGORY)(slot PRICE))
```

Write a rule in CLIPS that will select and print the NAME and PRICE of the least expensive product for each CATEGORY of product.

4) (6 points) You have been hired as a political analyst to work on the political campaign for a referendum. Your job is to identify the sectors of the population for which you can design targeted publicity. For this you prepare a personality quiz for use with Facebook. Each question has a small number of possible responses. You receive *M* responses before Facebook forces you to remove question 5. Facebook then allows you to publish the quiz with only questions 1 to 4.
The questions are as follows

1) What is your gender? A) Male, B) Female.
2) What is your favorite spectator sport? A) Football B) Rugby C) Tennis D) Basketball E) Other F) I do not watch sports.
3) What is your favorite music? A) Rock B) Jazz C) Hip Hop D) Classic E) Blues F) Other.
4) What is your age? A) 18-29, B) 30-39, C) 40-49, D) 50-59, E) 60 or older
5) How will you vote in the referendum? A) Yes B) No C) Undecided D) I will not vote.

a) (1 points) For the group who have responded A or B in Question 5, explain how to use a ratio of histograms to predict the most likely vote for each age (question 4). How many persons should be polled?

b) (1 point) Explain how to estimate and use a ratio of histograms to predict the response to question 5 as a function of the answers to questions 1 to 4.

c) (1 point) Explain how to estimate and use a multivariate Gaussian Density to predict the response to question 5 as a function of the answers to questions 1 to 4. How many people must be polled? How can you determine the probability of error?

d) (1 point) Explain how to use a Kernel Density Estimator to predict the response to question 5 as a function of the answers to questions 1 to 4.

e) (1 points) Explain how to use the EM algorithm to discover categories of voters who are undecided given their responses to questions 1 to 4. How would you initialize the algorithm? How would you determine the number of categories?

f) (1 point) After Facebook has forced you to remove question 5, how receive new data with responses to only questions 1 to 4. How can you use assign this new data to the categories discovered with EM in question e?

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