AIML2026 ASSIGNMENT 03
(Due Date: April 1, 2026)

Instructions: Your answers can be in either Chinese or English. The following points should be noted.

- If you use a word processing software to edit your answer, please make sure that the file to be submitted is either in WORD or PDF format.

- You need to submit the answer file before the due date to the Gmail account `johnsum.nchu@gmail.com`.

- Email heading must be conformed to `AIML2026_Assignment03_studentID`.

- File name must be conformed to `AIML2026_Assignment03_studentID`.

- It is a bonus assignment. If you are too busy to complete the assignment, you can just skip it. There is no penalty.

The assessment of this course is solely depended on your work in the course project including your written report and your oral presentation. The scores obtained from the assignments are *bonus* marked up on your project score.

SECTION A: M-C Neuron

Question 1

Given the definition of a McCulloch-Pitts neuron as follows :

$$f(x_1, x_2) = h(x_1 + x_2),$$

where x_1, x_2 are the inputs, $f(\cdot, \cdot)$ the output and $h(s) = 1$ if $s > 0$ and otherwise 0.

(a) What is the value of $f(0,0)$?

(b) What is the value of $f(0,1)$?

(c) What is the value of $f(1,0)$?

(d) What is the value of $f(1,1)$?

Question 2

Given the definition of a McCulloch-Pitts neuron as follows :

$$f(x_1, x_2) = h(x_1 + x_2 - 2),$$

where x_1, x_2 are the inputs, $f(\cdot, \cdot)$ the output and $h(s) = 1$ if $s > 0$ and otherwise 0.

(a) What is the value of $f(0,0)$?

(b) What is the value of $f(0,1)$?

(c) What is the value of $f(1,0)$?

(d) What is the value of $f(1,1)$?

Question 3

Given the definition of a McCulloch-Pitts neuron as follows :

$$f(x_1, x_2) = h(x_1 + x_2 + 1),$$

where x_1, x_2 are the inputs, $f(\cdot, \cdot)$ the output and $h(s) = 1$ if $s > 0$ and otherwise 0.

(a) What is the value of $f(0,0)$?

(b) What is the value of $f(0,1)$?

(c) What is the value of $f(1,0)$?

(d) What is the value of $f(1,1)$?

SECTION B : Multiple M-C Neurons

Question 4

Figure 1 shows a network of three neurons. The definitions of the McCulloch-Pitts neurons $f(\cdot, \cdot)$, $g(\cdot \cdot)$ and $z(\cdot, \cdot)$ are given as follows :

$$\begin{aligned}
f(x_1, x_2) &= h(x_1 + x_2 - 0.1), \\
g(x_1, x_2) &= h(x_1 + x_2 - 1.1), \\
z(x_1, x_2) &= h(f(x_1, x_2) - g(x_1, x_2) + 0.5),
\end{aligned}$$

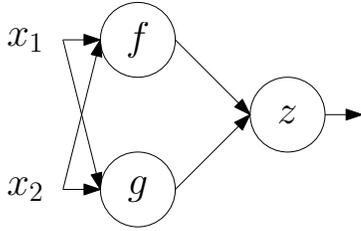| x_1	x_2	$f(x_1, x_2)$	$g(x_1, x_2)$	$z(x_1, x_2)$
0	0			
0	1			
1	0			
1	1			

Figure 1: A network (resp. computational model) consisting of three neurons (resp. computational units). All of them are 2-input-1-output neurons.

where x_1, x_2 are the inputs and $h(s) = 1$ if $s > 0$ and otherwise 0.

(a) What is the value of $z(0, 0)$?

(b) What is the value of $z(0, 1)$?

(c) What is the value of $z(1, 0)$?

(d) What is the value of $z(1, 1)$?

To answer this question, the following table might help.

x_1	x_2	$f(x_1, x_2)$	$g(x_1, x_2)$	$z(x_1, x_2)$
0	0			
0	1			
1	0			
1	1			

Question 5

Figure 1 shows a network of three neurons. The definitions of the McCulloch-Pitts neurons $f(\cdot, \cdot)$, $g(\cdot \cdot)$ and $z(\cdot, \cdot)$ are given as follows :

$$
\begin{aligned}
f(x_1, x_2) &= h(x_1 - x_2 + 0.1), \\
g(x_1, x_2) &= h(x_1 - x_2 + 1.1), \\
z(x_1, x_2) &= h(f(x_1, x_2) - g(x_1, x_2) + 0.5),
\end{aligned}
$$

where x_1, x_2 are the inputs and $h(s) = 1$ if $s > 0$ and otherwise 0.

(a) What is the value of $z(0, 0)$?

(b) What is the value of $z(0, 1)$?

(c) What is the value of $z(1, 0)$?

(d) What is the value of $z(1, 1)$?

To answer this question, the following table might help.

SECTION C : Logic Operations

Question 6

Below is the truth table for a logical OR gate.

x_1	x_2	$z(x_1, x_2)$
0	0	0
0	1	1
1	0	1
1	1	1

It is known that a logical OR gate can be implemented by one McCulloch-Piits neuron.

$$z(x_1, x_2) = h(x_1 + x_2 - 0.5).$$

Now, you need to design a network of three neurons as shown Figure 1 to implement a logical OR gate. What should be the parameters in the neurons $f(\cdot, \cdot)$, $g(\cdot, \cdot)$ and $z(\cdot, \cdot)$?

Question 7

Below is the truth table for a logical AND gate.

x_1	x_2	$z(x_1, x_2)$
0	0	0
0	1	0
1	0	0
1	1	1

It is known that a logical OR gate can be implemented by one McCulloch-Piits neuron.

$$z(x_1, x_2) = h(x_1 + x_2 - 1.5).$$

Now, you need to design a network of three neurons as shown Figure 1 to implement a logical OR gate. What should be the parameters in the neurons $f(\cdot, \cdot)$, $g(\cdot, \cdot)$ and $z(\cdot, \cdot)$?

Question 8

Below is the truth table for a logical NAND gate.

x_1	x_2	$z(x_1, x_2)$
0	0	1
0	1	1
1	0	1
1	1	0

It is known that a logical OR gate can be implemented by one McCulloch-Piits neuron.

$$z(x_1, x_2) = h(-x_1 - x_2 + 1.5).$$

Now, you need to design a network of three neurons as shown Figure 1 to implement a logical OR gate. What should be the parameters in the neurons $f(\cdot, \cdot)$, $g(\cdot, \cdot)$ and $z(\cdot, \cdot)$?

SECTION D : LLM & Others

Question 9

Large language models, like Deep Seek, Google Gemini, Open AI GhatGPT and Xai Grok, are now widely applied.

(a) If Professor John Sum applies Gemini to justify the quality of your assignment, is it fair and ethical? Please comment!

(b) If Professor John Sum applies Gemini to justify the quality of your report, is it fair and ethical? Please comment!

Question 10

Large language models, like Deep Seek, Google Gemini, Open AI GhatGPT and Xai Grok, are now widely applied.

(a) If Professor John Sum applies Gemini to give comments on your report, is it ethical? Besides, will you accept the comments? Please comment!

(b) If you applies Gemini to create some contents for your report, is it ethical? Besides, should Professor John Sum accept them? Please comment!

Question 11

Self-Driving technology has recently been advanced.

(a) In a car accidence, a self-driving car has crashed another car. Who should take the legal responsibility?

(b) In a car accidence, a self-driving car has hit a person. That person is eventually dead. Who should take the legal responsibility?

(c) In a car accidence, two self-driving cars crash. Who should take the legal responsibility?

(d) An officer in a financial institute applied an agentic AI to analyze the trend of a stock and then invested on behalf of the client on the stock. After a week, the client found that the investment decision was wrong. The client had to settle millions of USD for the lost. Who should take the responsibility for this instance?

Question 12

Autonomous systems always apply AI in them.

(a) Give two exemplar autonomous systems in which AI has been applied and explain why AI has to be applied.

(b) If the AI system in an autonomous system gives wrong decision, who should take the responsibility?

Question 13

(a) Is the McCulloch-Pitts neuron model the only neuron model? If not, state the names of any other five mathematical models for a neuron.

(b) Can a digital computer be made solely by McCulloch-Pitts neurons?

(c) Which scholar(s) had applied the McCulloch-Pitts neuron model in the design of a neuronal network system?

(d) What is the problem regarding the training of a multi-layered neural network with McCulloch-Pitts neuron model?

(e) G. Hinton *et al* proposed the sigmoidal neuronal model in the 1980s for building a multi-layered neural network. State the reason why this neuron model can leverage the problem of the McCulloch-Pitts neuron model in training a multi-layered network.

(f) State a reason why forgetting learning is a must for training a multi-layered network with sigmoidal neurons.