ECS 171 : Midterm Review

Midterm Instructions

- This is a **closed book**, **in-person** midterm exam.
- Includes **20-30 questions**, including MCQs, True/False and around 5-7 numerical questions.
- The exam will test your knowledge on all topics covered so far, **except** ‘Probabilistic Graphical Models’.
- Discussions are also part of the material which you need to study for the exam.
- There is **NO partial credits** on T/F and Multiple Choice Questions. Select the best answer.
- Scratch papers will be provided to you to work on numerical questions. You need to return scratch papers with your name written.
- The exam duration is **50 minutes**.
- Make sure to show your **student ID/picture ID** when submitting your work
- A **cheat sheet** will be provided by the proctor during the exam. You may not use any other sources during the exam.
- You can use a **calculator**.
- Communicating with anyone else during the exam is considered “cheating”. You are not allowed to use earphone during the exam.
- Switch off your cell phone and let is stay in the off mode until the end of the exam.

Sample T/F Question

N-fold Cross validation is a method used to prevent overfitting.

A. True
B. False

Solution

True

In order to validate the training process of the model, n-fold (or k-fold) cross validation is used in order to generalize the training dataset.

Sample T/F Question

The following shows a simple linear regression model for a dataset with x1,…,xn attributes.

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n$$

A. True
B. False

Solution

False

It is multiple linear regression because it has multiple features. If the features are n-degree polynomial, then it is polynomial regression.

Sample T/F Question

Regularization is a method that penalizes model coefficients to reduce overfitting.

A. True
B. False

Solution

True

The cost function of a regularized model, C_{reg}, is given as :

$$C_{reg} = C_{original} + [\text{Regularization term}]$$

Sample MCQ Question

Which of the following is an example of a flag variable?

A. Gender: female/male
B. Weather: clear/rainy/cloudy
C. Temperature: [21, 80]
D. (A) and (B)

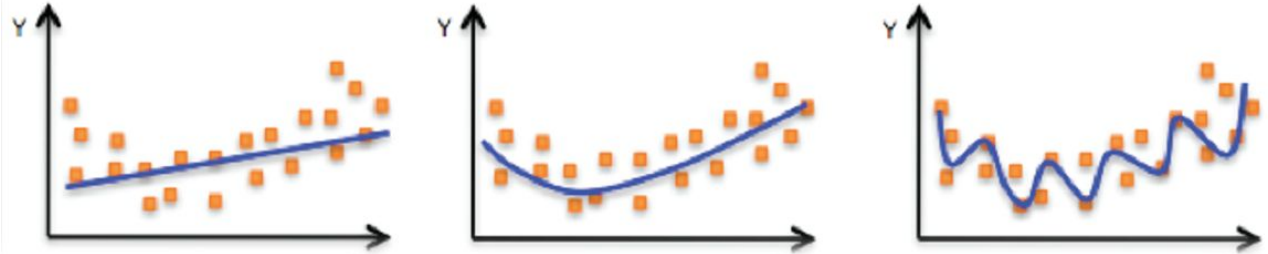
Solution

D. (A) and (B)

Flag variables, or categorical variables, are those variables which can be assigned with a string label

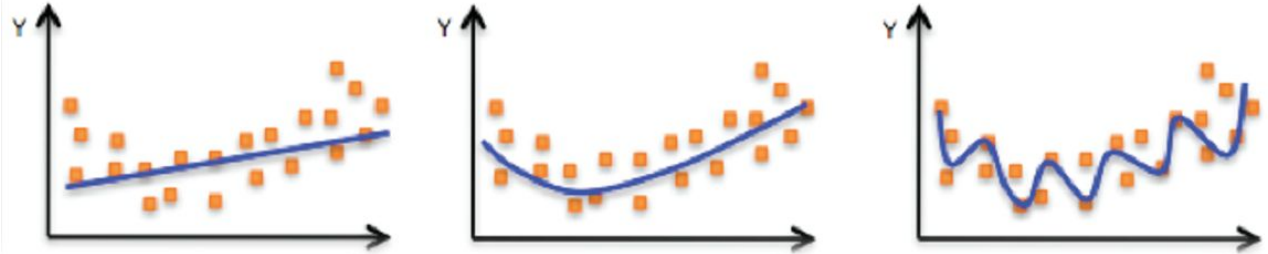
Sample MCQ Question

Indicate the model characteristics depicted in the following figure, from left to right.



A. Overfitting, under-fitting, balanced
B. Under-fitting, balanced, balanced
C. Under-fitting, balanced, overfitting
D. Overfitting, balanced, balanced

Solution



C. Under-fitting, balanced, overfitting

Sample MCQ Question

How many output neurons in ANN is needed to perform a binary classification?

A. 1
B. 2
C. 3
D. 4

Solution

A. 1

A single output node giving high or low output is required for binary classification

Sample Numerical Question

In the following dataset with input attributes X = {x1,x2} and output variable y, calculate the total SSE for the following linear regression model:

$$f(X) = 0.5 + 0.8(x1) - 0.6(x2)$$

Note : SSE is calculated as $E(\mathbf{w}) = \frac{1}{2}\sum_{n=1}^{N}\{y(x_n, \mathbf{w}) - t_n\}^2$

Sample	x1	x2	y
1	3	4	0.7
2	2	5	-0.2
3	6	1	5

Solution

Sample	x1	x2	f(X)	y	$e = (y - f(X))^2$
1	3	4	0.5	0.7	0.04
2	2	5	-0.9	-0.2	0.49
3	6	1	4.7	5	0.09

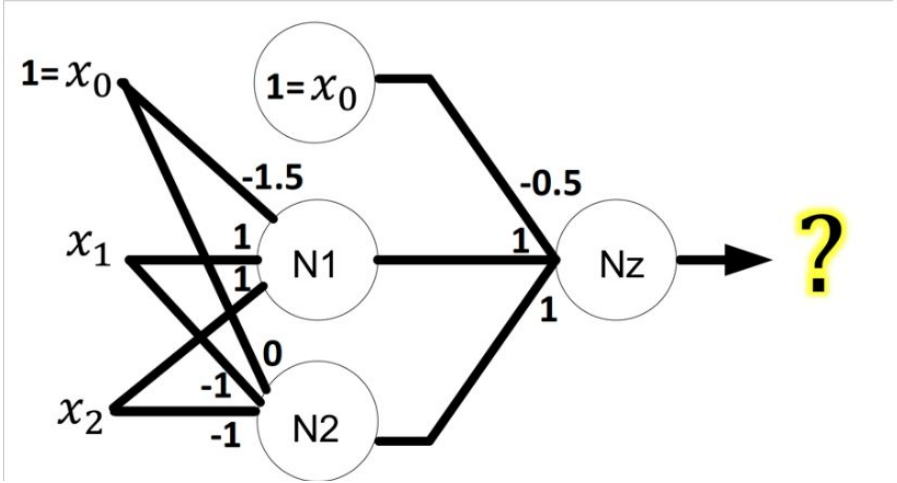
$$SSE = (e_1 + e_2 + e_3) / 2$$

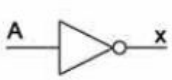
SSE = 0.31

Sample Numerical Question

Identify the logical gate for every neurons N1,N2,Nz respectively in the following figure if threshold is 0:

x_1	x_2	y: $g(x;w)$
0	0	?
0	1	?
1	0	?
1	1	?



Name	NOT	AND	NAND	OR	NOR	XOR	XNOR
Alg. Expr.	$\overline{A}$	AB	$\overline{AB}$	$A+B$	$\overline{A+B}$	$A \oplus B$	$\overline{A \oplus B}$
Symbol							

Truth Table

A	X
0	**1**
1	**0**

B	A	X
0	0	**0**
0	1	**0**
1	0	**0**
1	1	**1**

B	A	X
0	0	**1**
0	1	**1**
1	0	**1**
1	1	**0**

B	A	X
0	0	**0**
0	1	**1**
1	0	**1**
1	1	**1**

B	A	X
0	0	**1**
0	1	**0**
1	0	**0**
1	1	**0**

B	A	X
0	0	**0**
0	1	**1**
1	0	**1**
1	1	**0**

B	A	X
0	0	**1**
0	1	**0**
1	0	**0**
1	1	**1**

Solution

For any node : $z = w_0 + w_1x_1 + w_2x_2$

$y = 1$ if $z>=0$

$= 0$ if $z<0$

In N1 : Truth table similar to AND

x1	x2	Z = -1.5 + 1(x1) + 1(x2)	Y = (z>=0)
0	0	-1.5	0
0	1	-0.5	0
1	0	-0.5	0
1	1	0.5	1

Solution

In N2 : Truth table similar to NOR

x1	x2	Z = 0 + (-1)(x1) + (-1)(x2)	Y = (z>=0)
0	0	0	1
0	1	-1	0
1	0	-1	0
1	1	-2	0

Solution

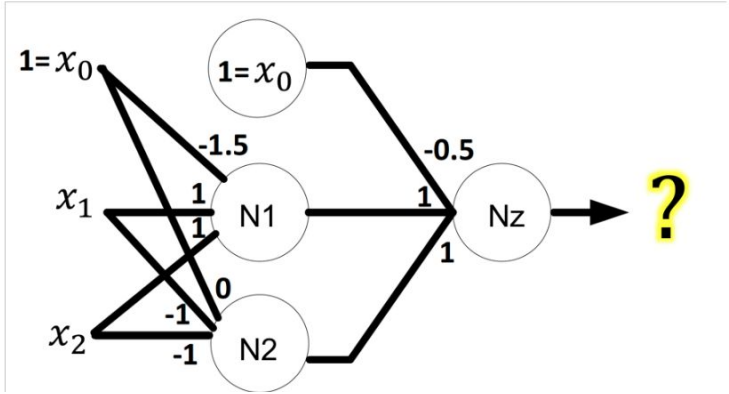
In N3 : Truth table similar to XNOR

x1	x2	x_n1	x_n2	Z = -0.5 + 1(x_n1) + 1(x_n2)	Y = (z>=0)
0	0	0	1	0.5	1
0	1	0	0	-0.5	0
1	0	0	0	-0.5	0
1	1	1	0	0.5	1

Note : Assume the same input for all nodes.

Solution

x_1	x_2	y: $g(x;w)$
0	0	?
0	1	?
1	0	?
1	1	?



N1 : AND

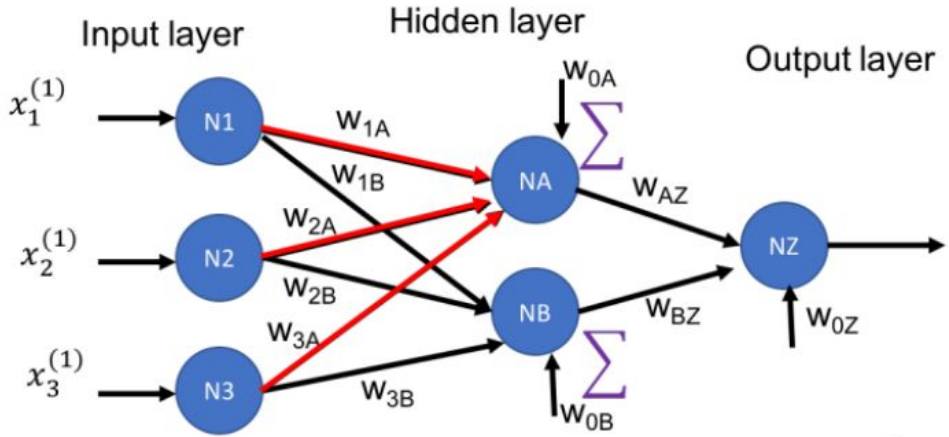
N2 : NOR

Nz : XNOR

Sample Numerical Question

Compute the output of the following neural network after 1 forward pass when sigmoid function is used as the activation function in all layers:

$$\begin{bmatrix} 1 & x_1^{(1)} & x_2^{(1)} & x_3^{(1)} \\ \vdots & & \ddots & \vdots \\ 1 & & \cdots & x_3^{(n)} \end{bmatrix} = \begin{bmatrix} 1 & 0.4 & 0.2 & 0.7 \\ \vdots & & \ddots & \vdots \\ 1 & & \cdots & x_3^{(n)} \end{bmatrix}$$



w_{0A} =0.5	w_{0B} =0.7	w_{0Z}=0.5
w_{1A} = 0.6	w_{1B} = 0.9	w_{AZ}=0.9
w_{2A}=0.8	w_{2B}=0.8	w_{BZ}=0.9
w_{3A}=0.6	w_{3B}=0.4	

$$net^{(i)}{}_j = \sum_k w_{kj} x_{kj}^{(i)}$$

$$net^{(1)}{}_A = \omega_{0j} + \omega_{1j} x_{1j}^{(1)} + \omega_{2j} x_{2j}^{(1)} + \omega_{3j} x_{3j}^{(1)} = 1.32$$

Solution

For any node : $z = w_0 + w_1x_1 + \ldots + w_nx_n$

$y = 1 / (1 + e^{-z})$

In NA : $z = 0.5 + 0.6(x1) + 0.8(x2) + 0.6(x3)$

$= 1.32$

$x_A = y = 1 / (1 + e^{-z})$

$= 0.7892$

Solution

In NB : $z = 0.7 + 0.9(x1) + 0.8(x2) + 0.4(x3)$

$= 1.5$

$x_B = y = 1 / (1 + e^{-z})$

$= 0.8176$

In NZ : $z = 0.5 + 0.9(x_A) + 0.9(x_B)$

$= 1.94612$

$y = 1 / (1 + e^{-z})$

$y = 0.8750$