nn2233
Nelly Neha Reddy

MACHINE LEARNING FINAL EXAM

Question 1:

	MN	MLJ	JH	GHI	GCE	GCF	CDE	IK	KO	OPR	HSI	TS	USI	UJA	UWA	IAY	IZY	WAB
MN		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MLJ	1		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
JH	0	1		1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
GHI	0	0	1		1	1	0	0	0	0	2	0	1	1	0	1	1	0
GCE	0	0	0	1		2	2	0	0	0	0	0	0	0	0	0	0	0
GCF	0	0	0	1	2		1	0	0	0	0	0	0	0	0	0	0	0
CDE	0	0	0	0	2	1		0	0	0	0	0	0	0	0	0	0	0
IK	0	0	0	1	0	0	0		1	0	1	0	1	1	0	1	1	0
KO	0	0	0	0	0	0	0	1		1	0	0	0	0	0	0	0	0
OPR	0	0	0	0	0	0	0	0	1		0	0	0	0	0	0	0	0
HSI	0	0	1	2	0	0	0	1	0	0		1	2	1	0	1	1	0
TS	0	0	0	0	0	0	0	0	0	0	1		1	0	0	0	0	0
USI	0	0	0	1	0	0	0	1	0	0	2	2		1	1	1	1	0
UJA	0	0	0	1	0	0	0	0	0	0	1	0	1		1	2	1	1
UWA	0	0	0	0	0	0	0	0	0	0	0	0	1	2		1	0	1
IAY	0	0	0	1	0	0	1	1	0	0	1	0	0	2	1	1	1	1
IZY	0	0	0	1	0	0	0	1	0	0	1	0	0	1	0	1		0
WAB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	

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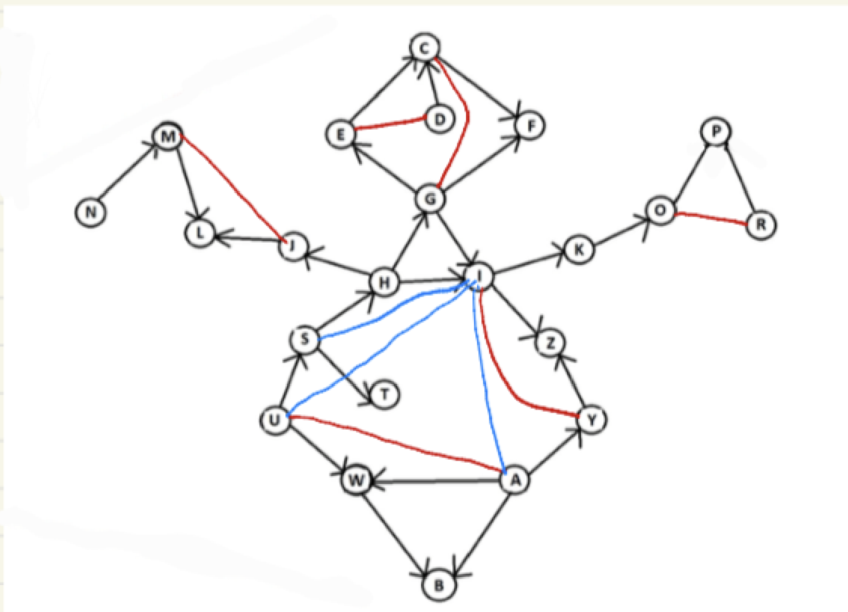
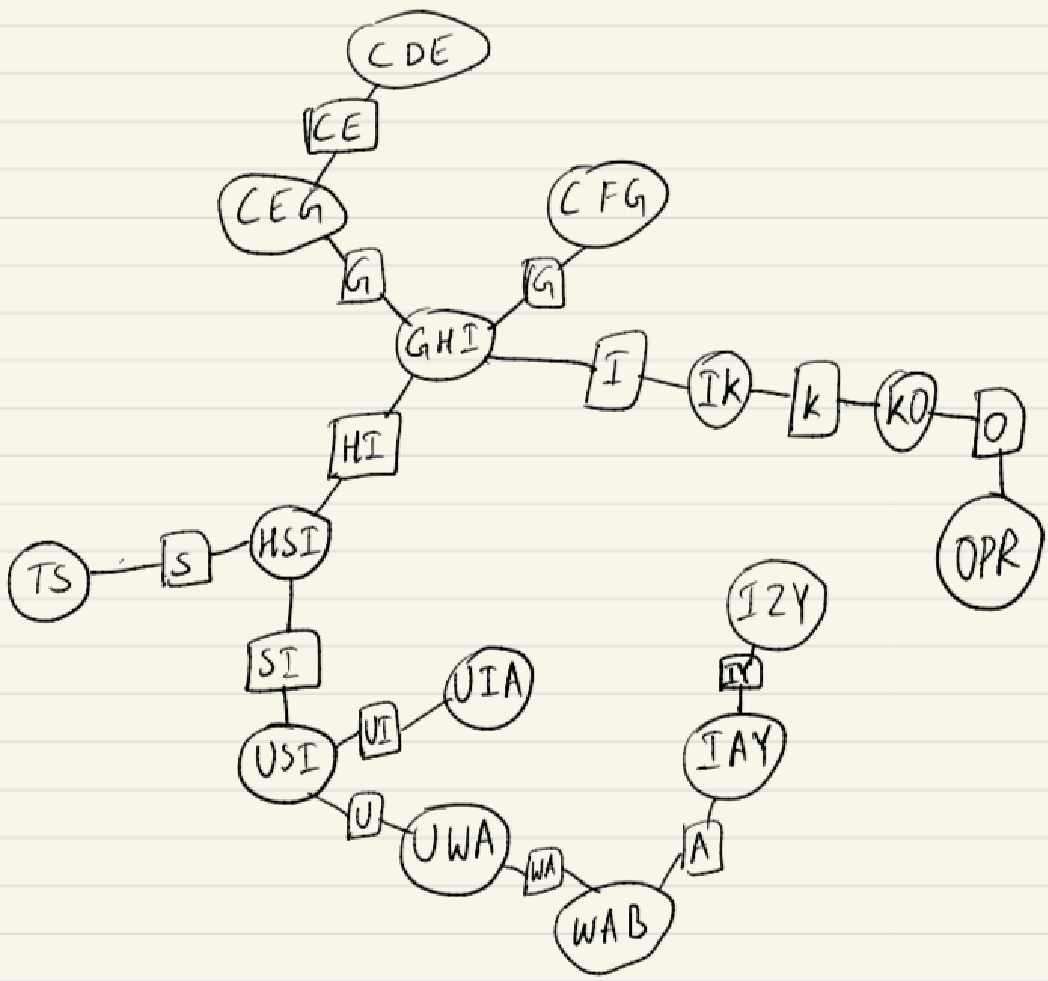
Problem 1:



MN, MLJ, JH, GHI, GCE, GCF, CDE, IK, KO, OPR,
HSI, TS, USI, UIA, UWA, IAY, IZY, WAB


CDE
CE
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USI
UI
UIA
U
UWA
WA
WAB
A
IAY
IY
IZY

2:

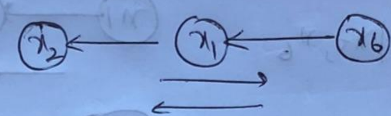
a-False
b-True
c-False
d-True
e-False
f-False
g-True
h-False
i-False
j-True

2. $P(x_1, x_2 \ldots x_7) = P(x_1|x_4,x_6)\, P(x_2|x_1)\, P(x_3|x_1,x_7)$

$P(x_4|x_5,x_6)\, P(x_5)\, P(x_6|x_7)\, P(x_7)$

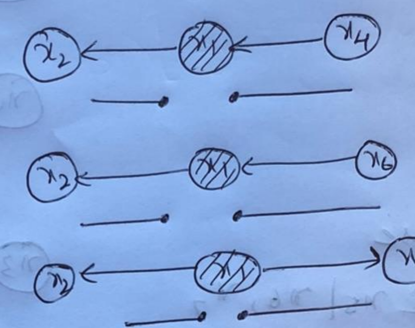
a) False

$x_2 \not\perp\!\!\!\perp x_6$



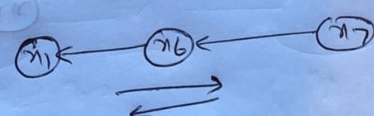
b) True

$x_2 \perp\!\!\!\perp x_6 | x_1, x_3, x_5$



c) False

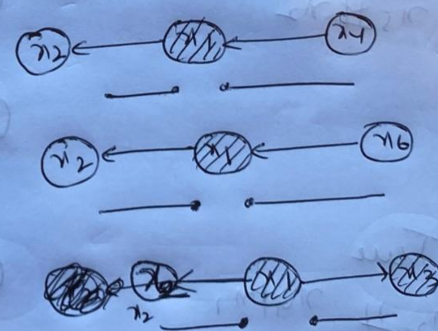
$x_1 \not\perp\!\!\!\perp x_7 | x_4$



d) True

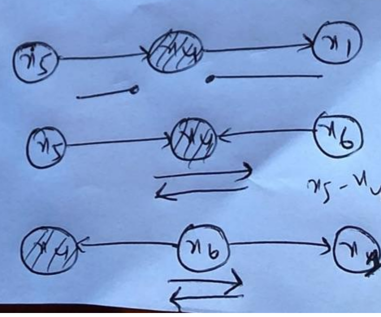
~~$x_5 \not\perp\!\!\!\perp$~~

$x_5 \perp\!\!\!\perp x_2 | x_1, x_3$



e) False

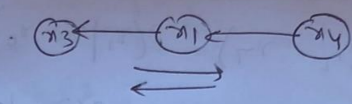
$x_5 \not\perp\!\!\!\perp x_1 | x_3, x_2, x_4$



$x_5 - x_4 - x_6 - x_1$

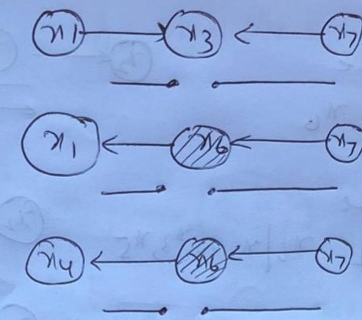
f) False

$x_4 \not\perp\!\!\!\perp x_3 | x_6$



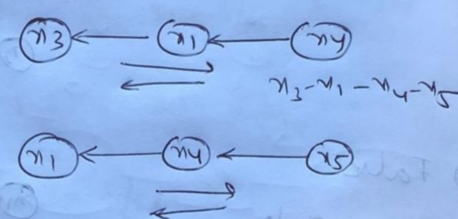
g) True

$x_2 \perp\!\!\!\perp x_7 | x_5, x_6$



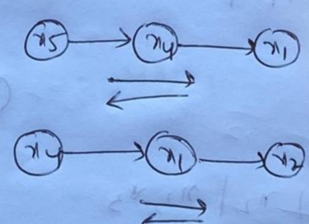
h) False

$x_3 \not\perp\!\!\!\perp x_5 | x_6, x_7$



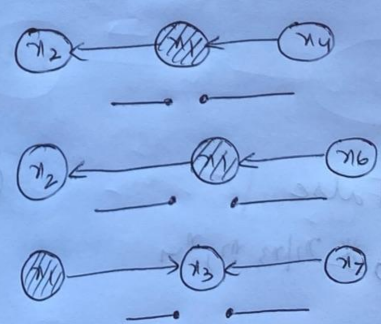
i) False

$x_5 \not\perp\!\!\!\perp x_2$



j) True

$x_2 \perp\!\!\!\perp x_4 | x_1$



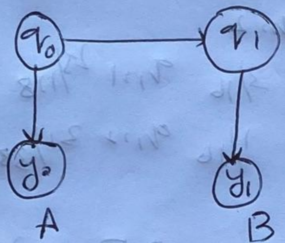
Question 3:

3.

$$\pi = P(q_0) = \begin{array}{cc} 1 & 2 \\ \end{array}\left[\begin{array}{cc} \frac{1}{3} & \frac{2}{3} \end{array}\right]$$

$$a^T = P(q_t \mid q_{t-1}) = \begin{array}{c|cc} & 1 & 2 \\ 1 & \frac{1}{8} & \frac{1}{2} \\ 2 & \frac{7}{8} & \frac{1}{2} \end{array}$$

$$\eta^T = P(y_t \mid q_t) = \begin{array}{c|cc} & 1 & 2 \\ A & \frac{1}{4} & 3/4 \\ B & \frac{3}{4} & 1/4 \end{array}$$

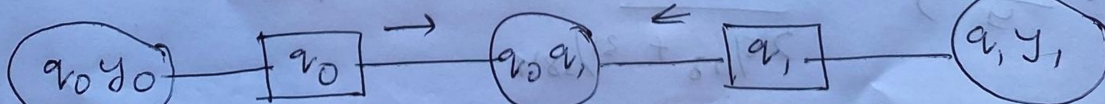


	A	B
$q_0=1$	$\frac{1}{12}$	$\frac{3}{12}$
$q_0=2$	$\frac{6}{12}$	$\frac{2}{12}$

	$q_0=1$	$q_0=2$
$q_0=1$, $q_0=1$	$\frac{1}{8}$	$\frac{1}{2}$
$q_0=2$, $q_0=2$	$\frac{7}{8}$	$\frac{1}{2}$

		$q_1=1$	$q_1=2$
$q_1=1$,	A	1/4	3/4
$q_1=2$,	B	3/4	1/4

We know the output sequence i.e $AB \Rightarrow y_0 = A, y_1 = B$



	A
$q_0=1$	1/12
$q_0=2$	6/12

$q_0=1$	1/12
$q_0=2$	6/12

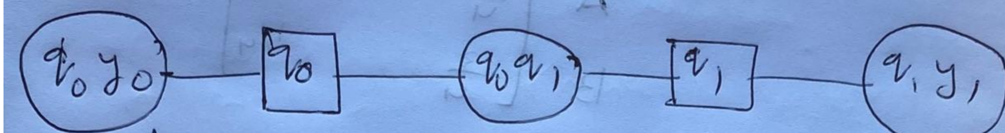
	$q_0=1$	$q_0=2$
$q_1=1$	1/8	1/2
$q_1=2$	7/8	1/2

$q_1=1$	3/4
$q_1=2$	1/4

	$q_1=1$	$q_1=2$
B	3/4	1/4

A

				$q_0=1$	$q_0=2$				
$q_0=1$ $1/12$		$q_0=1$ $1/12$	$q_1=1$	$1/128$	$3/16$	$q_1=1$ $3/4$		$q_1=1$	$q_1=2$
$q_0=2$ $6/12$		$q_0=2$ $6/12$	$q_1=2$	$7/384$	$1/16$	$q_1=2$ $1/4$	B	$3/4$	$1/4$



A

			$q_0=1$	$q_0=2$			
$q_0=1$ $1/12$	$q_0=1$ $5/192$	$q_1=1$	$1/128$	$3/16$	$q_1=1$ $25/128$	$q_1=1$	$q_1=2$
$q_0=2$ $6/12$	$q_0=2$ $1/4$	$q_1=2$	$7/384$	$1/16$	$q_1=2$ $31/384$	B $3/4$	$1/4$

Likelihood $P(y) = 5/192 + \frac{1}{4} = \frac{25}{128} + \frac{31}{384} = 53/192$

$$P\left(\frac{q_0=1}{y}\right) = \frac{5/192}{5/192 + 1/4} = 5/53$$

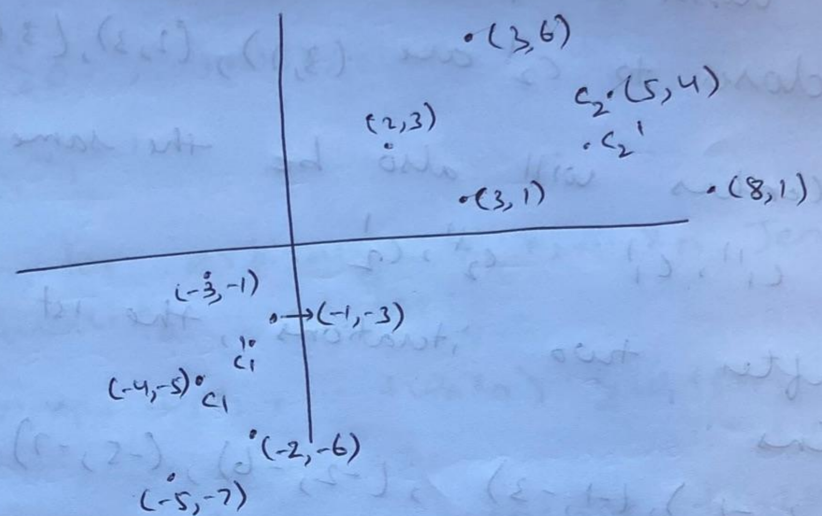
$$P\left(\frac{q_0=2}{y}\right) = \frac{1/4}{5/192 + 1/4} = 48/53$$

$$P\left(\frac{q_1=1}{y}\right) = \frac{25/128}{25/128 + 31/384} = 75/106$$

$$P\left(\frac{q_1=2}{y}\right) = \frac{31/384}{\frac{25}{128} + 31/384} = 31/106.$$

Question 4:

4. $c_1 = (-4,-5)$ $c_2 = (5,4)$



Points closer or nearer to c_1 are

$(-3,-1)$, $(-1,-3)$, $(-2,-6)$, $(-5,-7)$

Points closer or nearer to c_2 are

$(3,1)$, $(2,3)$, $(3,6)$, $(8,1)$

Iteration 1:-

centroid of first set of points

$$= \left(\frac{-3-1-2-5}{4}, \frac{-1-3-6-7}{4} \right)$$

$$= (-11/4, -17/4)$$

centroid of second set of points

$$= \left(\frac{3+2+3+8}{4}, \frac{1+3+6+1}{4} \right)$$

$$= (16/4, 11/4)$$

So the new centers are c_1', c_2'

$c_1' = \left(\frac{-11}{4}, \frac{-17}{4} \right)$ $c_2' = (16/4, 11/4)$

$= (-2.75, -4.25)$ $= (4, 2.75)$

Ituation 2:-

points closer to c_1' are $(-3,-1)$, $(-1,-3)$, $(-2,-6)$, $(-5,-7)$

Points closer to c_2' are $(3,1)$, $(2,3)$, $(3,6)$, $(8,1)$

New centers will also be the same

$c_1'' = c_1'$ $\quad$ $c_2'' = c_2'$

So after two iterations, the 1st cluster contains

$(-3,-1)$, $(-1,-3)$, $(-2,-6)$, $(-5,-7)$.

Second cluster contains

$(3,1)$, $(2,3)$, $(3,6)$, $(8,1)$.

Question 5:

5. Let $f(x)$ be a concave function and let $w_1, w_2, \dots w_n$ be weights with

$w_j \geq 0$, $j = 1, 2, \dots n$

$\sum_{j=1}^{n} w_j = 1$

Then, for arbitary $x_1, x_2 \dots x_n$ Jensen's inequality states:

$$f(w_1 x_1 + w_2 x_2 + \dots + w_n x_n) \geq w_1 f(x_1) + w_2 f(x_2) + \dots + w_n f(x_n)$$

$f(x) = \log x$ is a concave function

Let $w_j = 1/n$, $j = 1, 2, \dots n$

$$\log\left(\sum_j x_j/n\right) \geq \sum_j \frac{1}{n} \log x_j$$

$$\geq \sum_j \left(\log (x_j)^{1/n}\right)$$

$$\geq \log\left(\prod_j x_j^{1/n}\right)$$

Taking antilog

$$\sum_j x_j/n \geq \prod_j (x_j)^{1/n}$$

$$\frac{x_1 + x_2 + x_3 + \dots x_n}{n} \geq \sqrt[n]{x_1 \times x_2 \times \dots x_n}$$

Question 6:

x=302
y=154

6. Final layer size = $10 \times 12 \times 9$
Maxpoling with $3\times3, 2\times2$

$\frac{a_1-3}{2}+1=12$ $\qquad$ $\frac{b_1-3}{2}+1=9$

$\frac{a_1-3}{2}=11$ $\qquad$ $\frac{b_1-3}{2}=8$

$a_1-3=22$ $\qquad$ $b_1-3=16$

$a_1=25$ $\qquad$ $b_1=19$

$\Rightarrow$ Input size before maxpoling $=10\times25\times19$
ReLU does not change the size

convolution layer : $8\to10$, 2×2, 2×2

$\frac{a_8-2}{2}+1=25$ $\qquad$ $\frac{b-2}{2}+1=19$

$\frac{a_8-2}{2}=24$ $\qquad$ $\frac{b-2}{2}=18$

$a_8-2=48$ $\qquad$ $b-2=36$

$a_8=50$

$a=50$ $\qquad$ $b=38$

$\Rightarrow 8\times50\times38$

Maxpolling with $3\times3, 2\times2$

$\frac{a_0-3}{2}+1=50$ $\qquad$ $\frac{b_0-3}{2}+1=38$

$\frac{a_0-3}{2}=49$ $\qquad$ $\frac{b_0-3}{2}=37$

$a_0-3=98$ $\qquad$ $b_0-3=74$

$a_0=101$ $\qquad$ $b_0=77$

$\Rightarrow 8\times101\times77$

ReLU does not change size

Convolution layer: $1 \to 8$, 2×2, 3×2

$$\frac{x-2}{3}+1=101 \qquad \frac{y-2}{2}+1=77$$

$$\frac{x-2}{3}=100 \qquad \frac{y-2}{2}=76$$

$$x-2=300 \qquad y-2=152$$

$$x=302 \qquad y=154.$$

The size of the input is $1 \times 302 \times 154$

$x=302$, $y=154$.