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HW9

1. Find attribute w/ lowest entropy:

H(A)

=T	11	=F	12
x_1 - yes	(x 1)	x_5 - yes	(x 1)
x_2 - yes	(x 6)	x_6 - No	(x 6)
x_3 - No	(x 3)	x_7 - yes	(x 2)
x_4 - No	(x 1)	x_8 - No	(x 3)

$\therefore = -\left(\frac{7}{11}\log\frac{7}{11} + \frac{4}{11}\log\frac{4}{11}\right)$

$= -\frac{7}{11}\log\frac{7}{11} - \frac{4}{11}\log\frac{4}{11}$

$= 0.9456$

$= -\left(\frac{3}{12}\log\frac{3}{12} + \frac{9}{12}\log\frac{9}{12}\right)$

$= -\frac{1}{4}\log\frac{1}{4} - \frac{3}{4}\log\frac{3}{4}$

$= 0.8112$

compute weighted average:

$H(A) = 0.9456\left(\frac{11}{23}\right) + 0.8112\left(\frac{12}{23}\right) = \underline{0.8754}$

H(B)

=T	14	=F	9
x_1 - yes	(x 1)	x_3 - No	(x 3)
x_2 - yes	(x 6)	x_4 - No	(x 1)
x_5 - yes	(x 1)	x_7 - yes	(x 2)
x_6 - No	(x 6)	x_8 - No	(x 3)

$= -\left(\frac{8}{14}\log\frac{8}{14} + \frac{6}{14}\log\frac{6}{14}\right)$

$= 0.9852$

$= -\left(\frac{2}{9}\log\left(\frac{2}{9}\right) + \frac{7}{9}\log\left(\frac{7}{9}\right)\right)$

$= 0.7642$

$H(B) = 0.9852\left(\frac{14}{23}\right) + 0.7642\left(\frac{9}{23}\right) = \underline{0.8987}$

H(C)

=T	7	=F	16
x_1 - yes	(x 1)	x_2 - yes	(x 6)
x_3 - No	(x 3)	x_4 - No	(x 1)
x_5 - yes	(x 1)	x_6 - No	(x 6)
x_7 - yes	(x 2)	x_8 - No	(x 3)

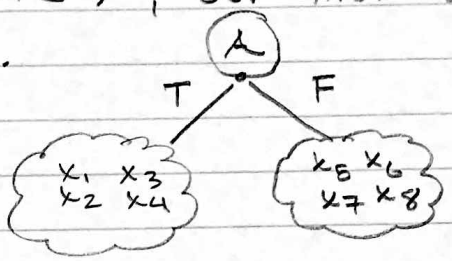
$= -\left(\frac{4}{7}\log\frac{4}{7} + \frac{3}{7}\log\frac{3}{7}\right) = 0.9852$

$= -\left(\frac{6}{16}\log\frac{6}{16} + \frac{10}{16}\log\frac{10}{16}\right)$

$= 0.9544$

$H(C) = 0.9852\left(\frac{7}{23}\right) + 0.9544\left(\frac{16}{23}\right) = \underline{0.9637}$

Since $H(A) < H(B) < H(C)$, our first split will be on attribute A.



Recalculate for next.

Left Branch

H(B)

=T | 7 | =F | 4

x_1 - yes (x1) | x_3 - No (x3)

x_2 - yes (x6) | x_4 - No (x1)

$= -\left(\frac{7}{7}\log\frac{7}{7} + \frac{0}{0}\log\frac{0}{0}\right)$ | $= -\left(\frac{0}{0}\log\frac{0}{0} + \frac{4}{4}\log\frac{4}{4}\right)$

$= -(1\log 0 + 0) = 0$ | $= 0$

$H(B) = 0\left(\frac{7}{11}\right) + 0\left(\frac{4}{11}\right) = \underline{0}$

Since $H(B) = 0$ = minimum entropy, we don't have to check $H(C)$. Choose B as next split.

Right Branch

H(C)

=T | 3 | =F | 9

x_5 - yes (x1) | x_6 - No (x6)

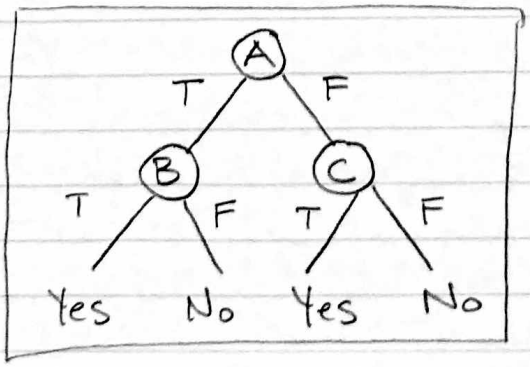
x_7 - yes (x2) | x_8 - No (x3)

$= -\left(\frac{3}{3}\log\frac{3}{3} + \frac{0}{0}\log\frac{0}{0}\right)$ | $= -\left(\frac{0}{0}\log\frac{0}{0} + \frac{9}{9}\log\frac{9}{9}\right)$

$= 0$ | $= 0$

$H(C) = 0\left(\frac{3}{12}\right) + 0\left(\frac{9}{12}\right) = 0$

Since $H(C) = 0$ = minimum entropy, choose C as split.

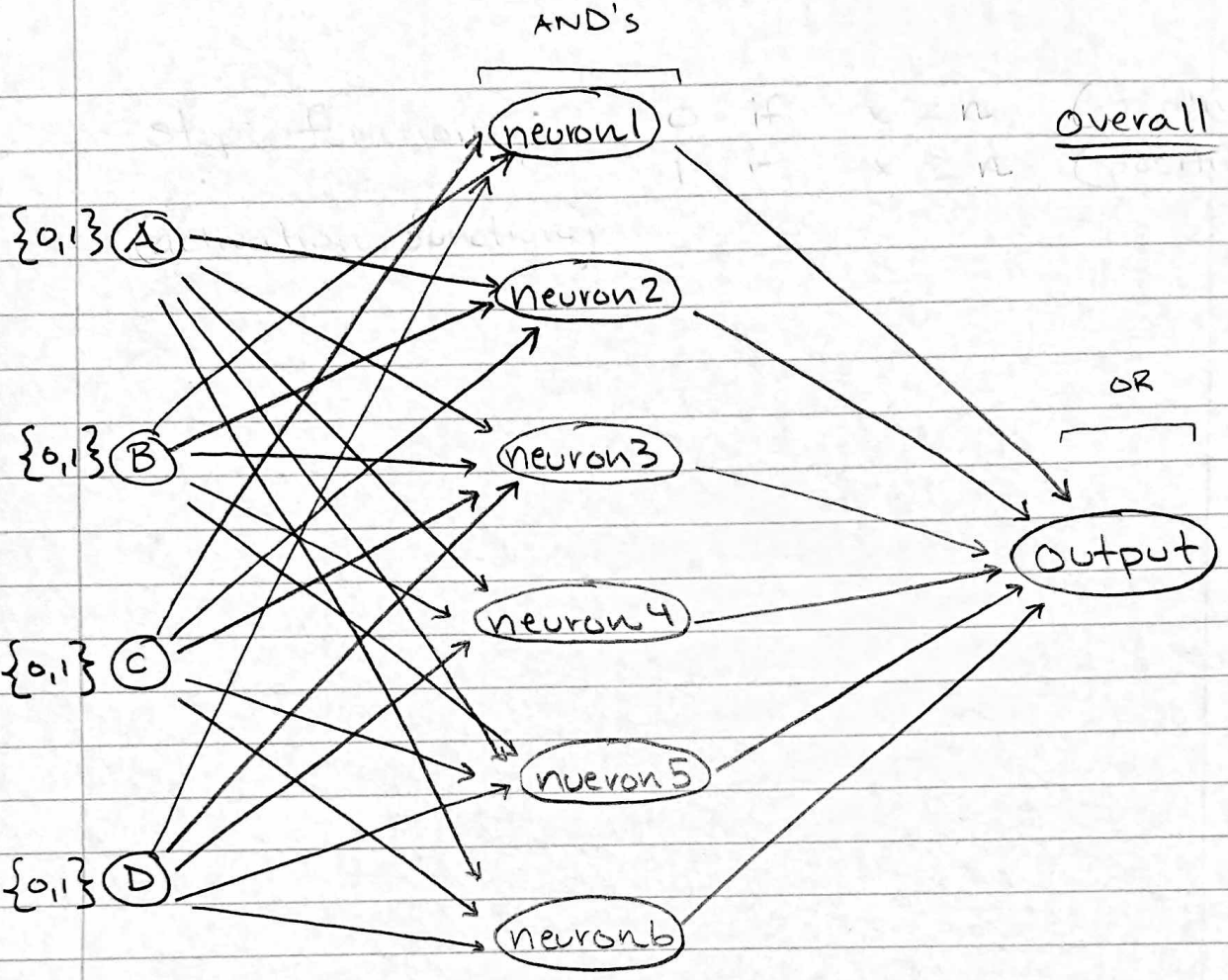


2. create $(A \vee \neg B) \oplus (\neg C \vee D)$

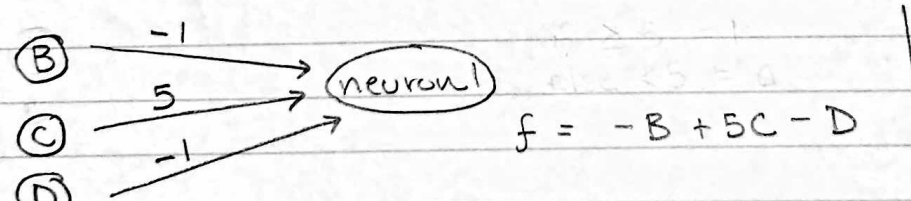
A	B	C	D	$A \vee \neg B$	$\neg C \vee D$	output
0	0	0	0	1	1	0
0	0	0	1	1	1	0
0	0	1	0	1	0	1
0	0	1	1	1	1	0
0	1	0	0	0	1	1
0	1	0	1	0	1	1
0	1	1	0	0	0	0
0	1	1	1	0	1	1
1	0	0	0	1	1	0
1	0	0	1	1	1	0
1	0	1	0	1	0	1
1	0	1	1	1	1	0
1	1	0	0	1	1	0
1	1	0	1	1	1	0
1	1	1	0	1	0	1
1	1	1	1	1	1	0

	A	B	C	D
neuron 1:	X	0	1	0
neuron 2:	0	1	0	X
neuron 3:	0	1	0	1
neuron 4:	0	1	X	1
neuron 5:	1	0	1	0
neuron 6:	1	X	1	0

have a hidden neuron for each case.

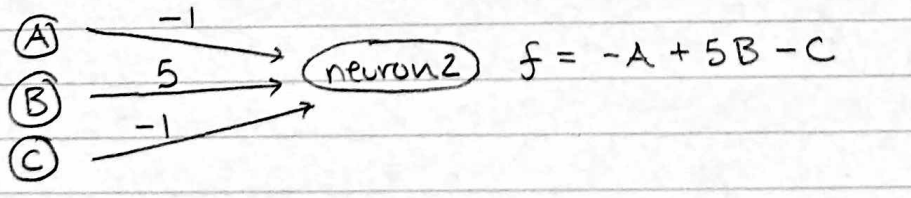


(broken down:)



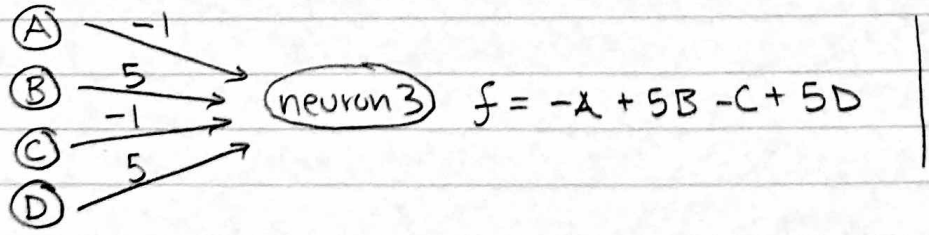
$f = -B + 5C - D$

$f \geq 5 = 1$
$f < 5 = 0$



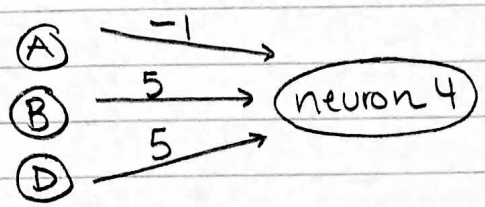
$f = -A + 5B - C$

$f \geq 5 = 1$
$f < 5 = 0$



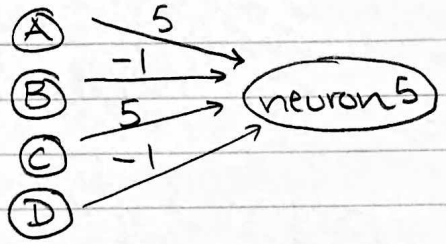
$f = -A + 5B - C + 5D$

$f \geq 10 = 1$
$f < 10 = 0$



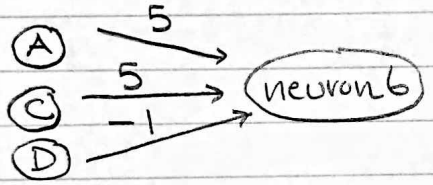
$f = -A + 5B + 5D$

$f \geq 10 = 1$
$f < 10 = 0$



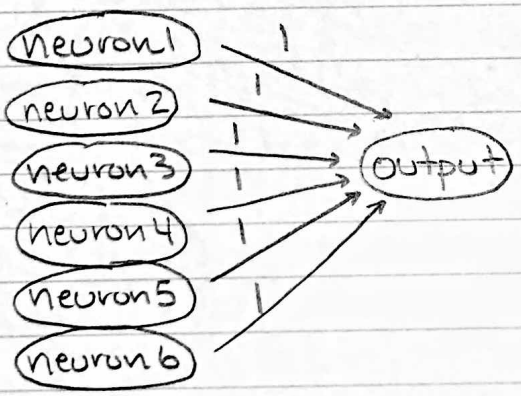
$f = 5A - B + 5C - D$

$f \geq 10 = 1$
$f < 10 = 0$



$f = 5A + 5C - D$

$f \geq 10 = 1$
$f < 10 = 0$



$f =$ neuron 1 + neuron 2 + neuron 3 + neuron 4 + neuron 5 + neuron 6

$f \geq 1 = 1$
$f < 1 = 0$