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Problem 1)
P(JohnCalls | Alarm) = 0.90
P(¬MaryCalls | Alarm) = 1 - P(MaryCalls | Alarm) = 1 - 0.70 = 0.30
P(Alarm | Burglary, ¬Earthquake) = 0.94
P(¬Earthquake) = 1 - P(Earthquake) = 1 - 0.002 = 0.998
P(Burglary) = 0.001

The joint probability P(JohnCalls, ¬MaryCalls, Alarm, ¬Earthquake, Burglary) is approximately 0.00025329.

Problem 2)

a	P(a)
0	0.6
1	0.4

b	P(b)
0	0.592
1	0.408

c	P(c)
0	0.48
1	0.52

a	c	P(a,c)
0	0	0.24
0	1	0.36
1	0	0.24
1	1	0.16

b	c	P(b,c)
0	0	0.384
0	1	0.208
1	0	0.096
1	1	0.312

a	c	P(a|c) = P(a,c)/P(c)
0	0	0.5
0	1	0.692
1	0	0.5
1	1	0.308

b	c	P(b|c)=P(b,c)/P(c)
0	0	0.8
0	1	0.4
1	0	0.2
1	1	0.6

$P(a, b) = P(a)P(b)?$

a	b	P(a,b)
0	0	0.336
0	1	0.264
1	0	0.256
1	1	0.144

a	b	P(a)P(b)
0	0	0.3552
0	1	0.2448
1	0	0.2368
1	1	0.1632

We can see that P(a,b) ≠ P(a)P(b)

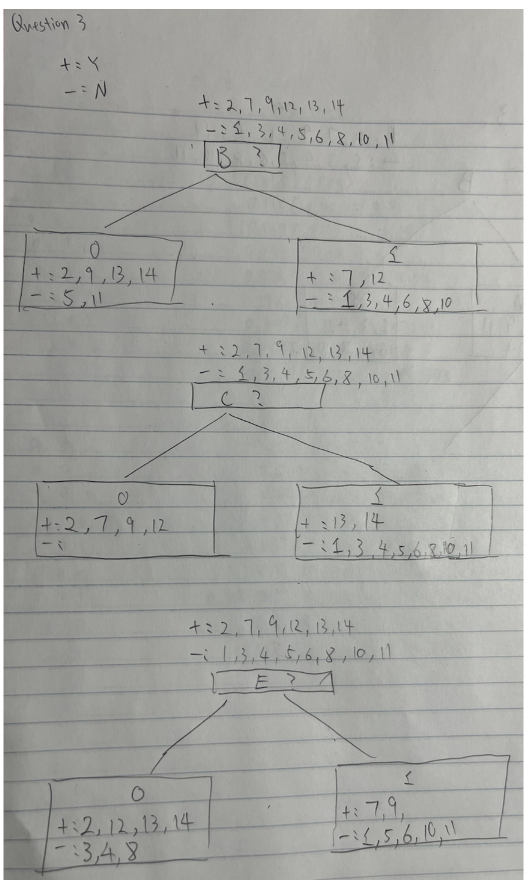
$P(a, b|c) = P(a|c)P(b|c)?$

a	b	c	P(a,b|c) = P(a,b,c)/p(c)
0	0	0	0.4
0	0	1	0.2796
0	1	0	0.1
0	1	1	0.4154
1	0	0	0.4
1	0	1	0.1231
1	1	0	0.1
1	1	1	0.1846

a	b	c	P(a|c)P(b|c)
0	0	0	0.4
0	0	1	0.2768
0	1	0	0.1
0	1	1	0.4152
1	0	0	0.4
1	0	1	0.1232
1	1	0	0.1
1	1	1	0.1848

We see that some of values for P(a, b|c) and P(a|c)P(b|c) are the same, or they have very close values. Therefore, P(a, b|c) = P(a|c)P(b|c)

Problem 3



Problem 4
Here is the formule

$$Entropy(E) = \sum_{i \in C} -P_i log_2(P_i)$$

$$Gain(E, A) = Entropy(E) - \sum_{v \in Values(A)} \frac{|E_v|}{|E|} Entropy(E_v)$$

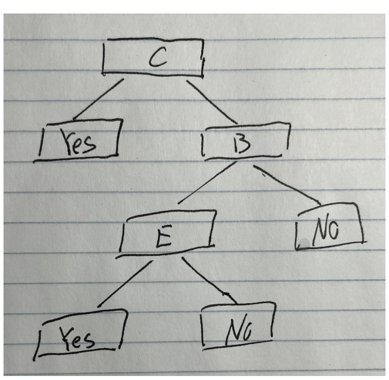
For attributes B:
Entropy(E_B) = -(6/14)log(6/14) - (8/14)log(8/14) = 0.985228
Entropy(E_B0) = -(4/6)log(4/6) - (2/6) log (2/6) = 0.918295
Entropy(E_B1) = -(2/8)log(2/8) - (6/8) log (6/8) = 0.811278
Gain for B = 0.985228 - (6/14)0.918295 - (8/14)0.811278 = 0.128

For attributes C:
Entropy(E_C) = -(6/14)log(6/14) - (8/14)log(8/14) = 0.985228
Entropy(E_C0) = -(4/4)log(4/4) - (0/4) log (0/4) = 0
Entropy(E_C1) = -(2/10)log(2/10) - (8/10) log (8/10) = 0.721928
Gain for C = 0.985228 - (4/14)0 - (10/14)0.721928= 0.469565

For attributes E:
Entropy(E_E) = -(6/14)log(6/14) - (8/14)log(8/14) = 0.985228
Entropy(E_E0) = -(4/7)log(4/7) - (3/7) log (3/7) = 0.985228
Entropy(E_E1) = -(2/7)log(2/7) - (5/7) log (5/7) = 0.86312
Gain for E = 0.985228 - (7/14)0.985228 - (7/14)0.86312 = 0.0611

Therefore, I will choose C to test first because the attributes C have biggest gain.

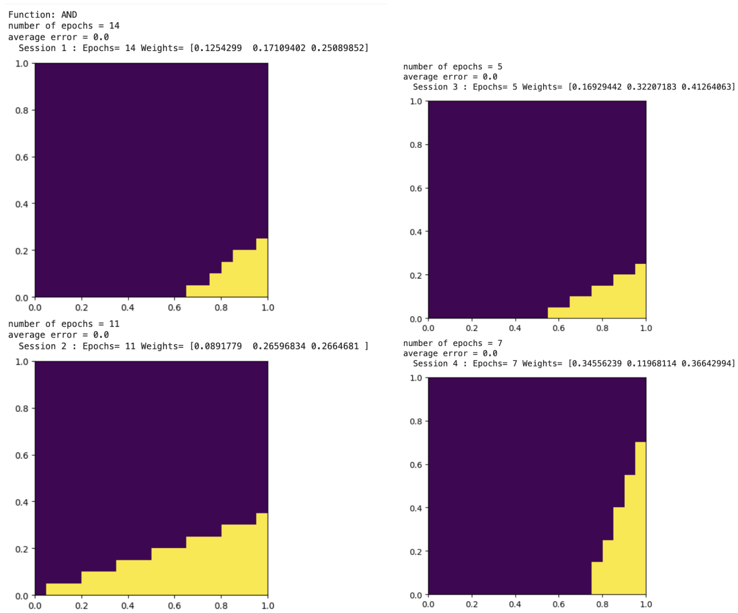
Problem 6



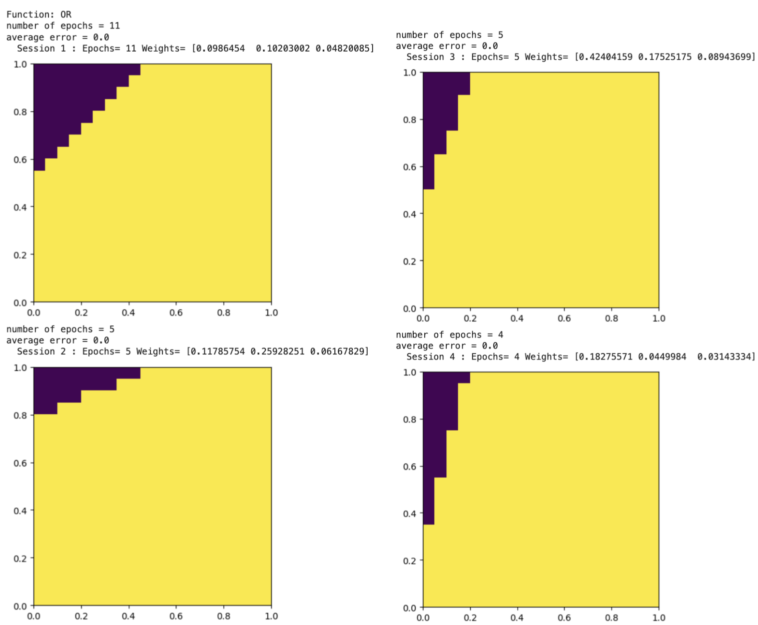
Problem 7

2) I run 4 training sessions.

For AND, different initial weight reported in the figure.

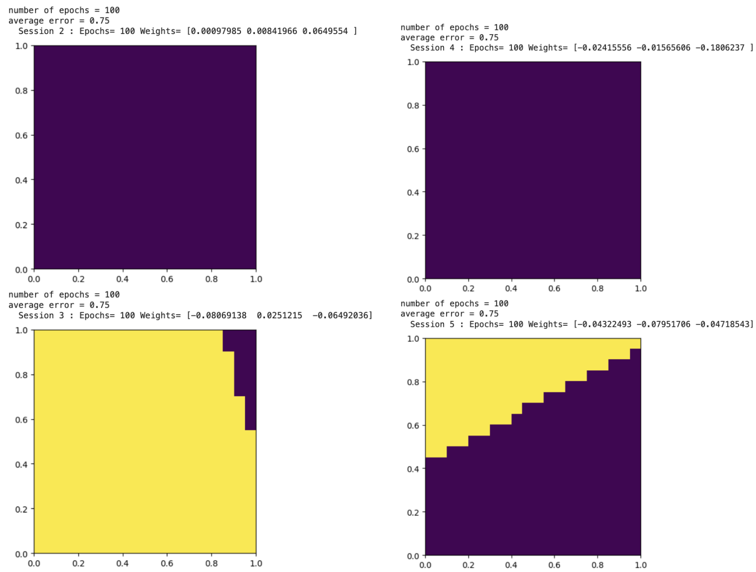


For OR, different initial weight reported in the figure.



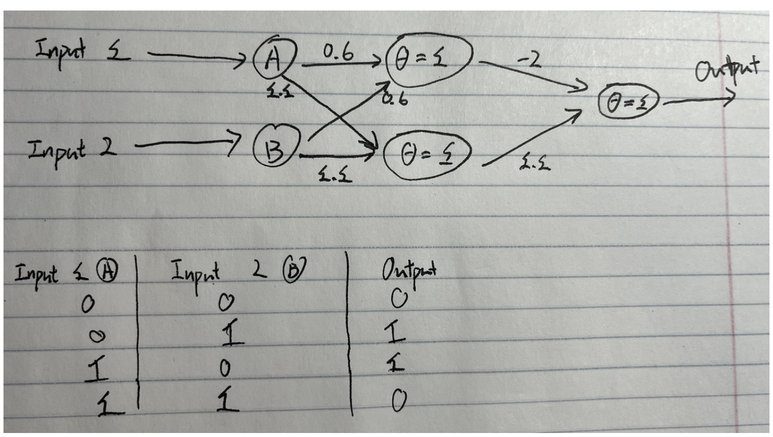
For XOR, different initial weight reported in the figure.

Test:



3) it's possible but the probability of this happening is low. If the random initialization of weights accidentally aligns the decision boundary correctly for the AND or OR operation, the perceptron would make zero errors. The perceptron's training process is crucial for adjusting the weights and aligning the decision boundary correctly to solve these problems. In most cases, without training, the perceptron's predictions will be far from accurate, as observed in the varied decision boundaries during different training sessions.

Problem 8



Problem 9

$$E(w) = \frac{1}{4}w(w+2)(w+1)(w-2),$$

dE/dw = w^3 + (¾)*w^2 - 2w - 1

$$\Delta w = -\alpha \frac{dE}{dw}$$,

α = 0.1, and w = 1.3

Δw = - 0.1 * (1.3^3 + ¾ *1.3^2 - 2*1.3 - 1) = 0.0135