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CSCI 3202

Problem Set 3

**Problem 3.1**

(For b, c, d, and e, black nodes mean the variable is true, and red nodes mean the variable is false. Black leaf nodes mean that path matches the goal criteria, and red leaf nodes mean that path does not match the goal criteria. The variables are located on the right side of the graph.)

1. P(N, C, L) =0.7 \* 0.4 \* 0.2 = 0.056

P(~N, C, L) = 0.3 \* 0.4 \* 0.6 = 0.072

P(N, ~C, L) = 0.7 \* 0.6 \* 0.5 = 0.21

P(~N, ~C, L) = 0.3 \* 0.6 \* 0.8 = 0.144

P(L) = 0.056 + 0.072 + 0.21 + 0.144

= **0.482**

P(B) = P(B|L)P(L) + P(B|~L)P(~L)

= 0.9(0.482) + 0.2(0.518)

= **0.5374**

P(M) = P(M|L)P(L) + P(M|~L)P(~L)

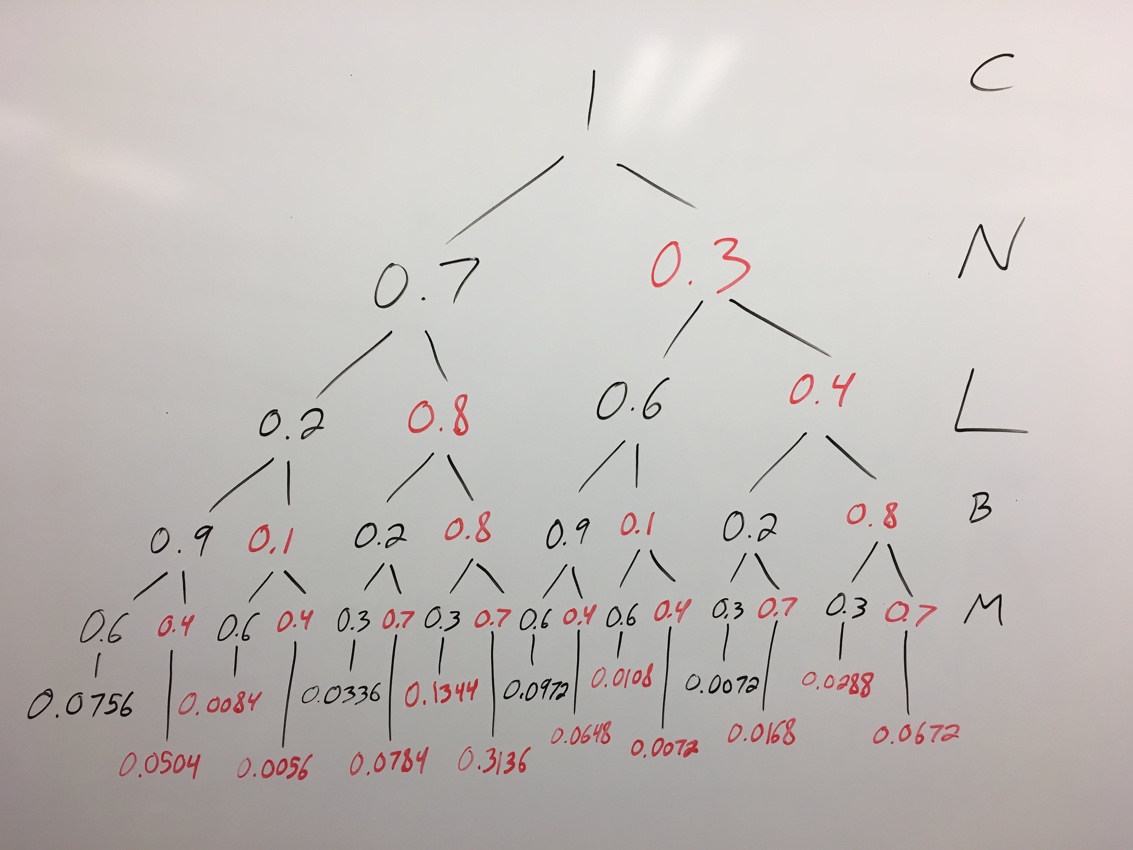
= 0.6(0.482) + 0.3(0.518)

= **0.4446**

P(S) = P(S|M)P(M) + P(S|~M)P(~M)

= 0.8(0.4446) + 0.1(0.5554)

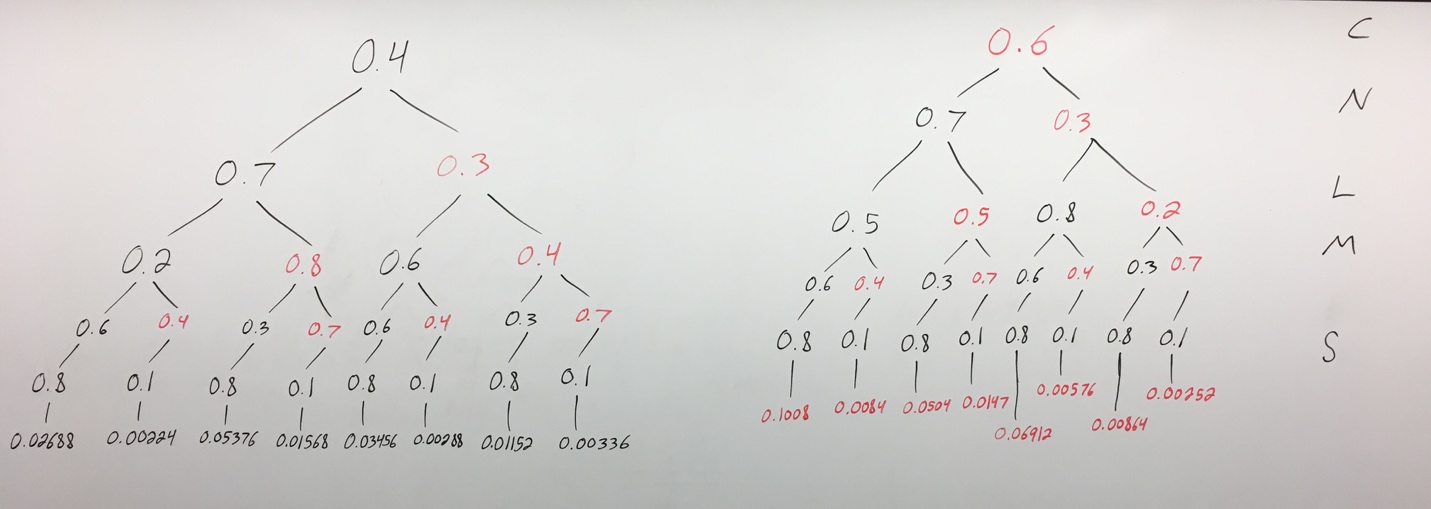
= **0.41122**



P(B, M|C) = summation of black leaf nodes / summation of all leaf nodes

= 0.2136 / 1

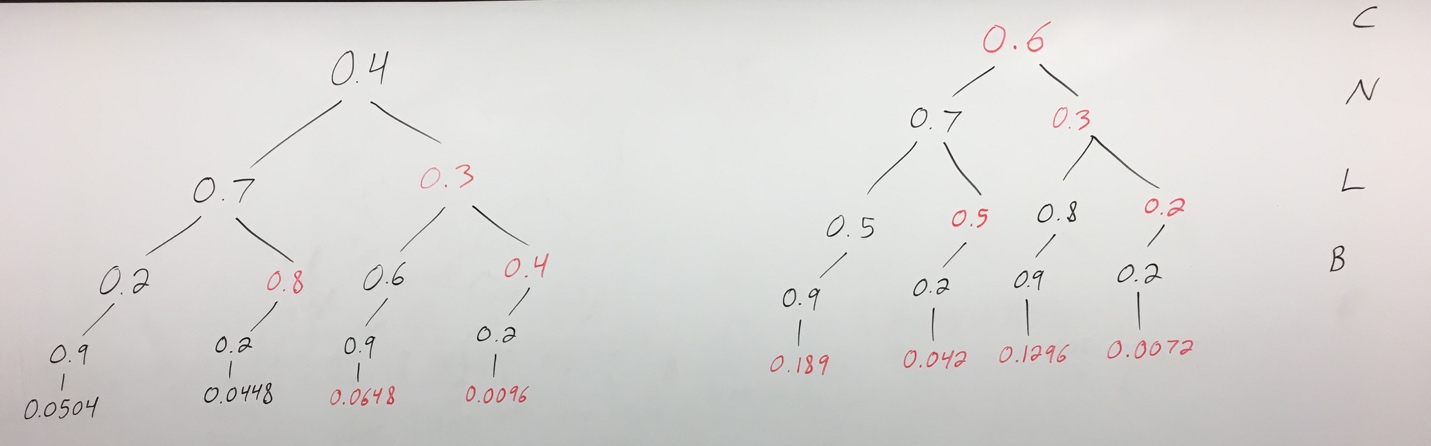
= **0.2136**



P(C|S) = summation of black leaf nodes / summation of all leaf nodes

= 0.15088 / 0.41122

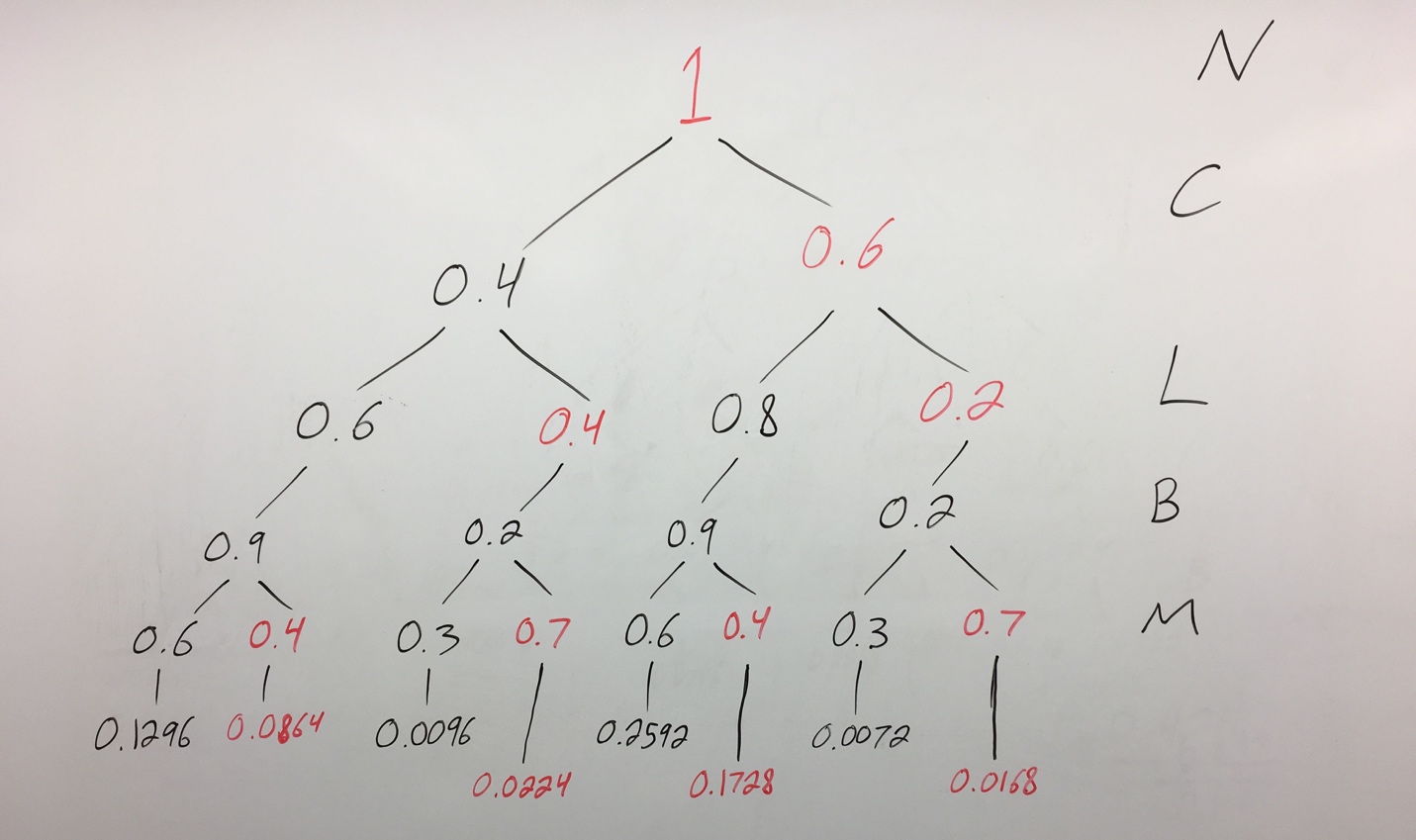
≈ **0.3669**



P(C, N|B) = summation of black leaf nodes / summation of all leaf nodes

= 0.0952 / 0.5374

≈ **0.17715**



P(M|B, ~N) = summation of black leaf nodes / summation of all leaf nodes

= 0.4056 / 0.704

≈ **0.5761**

**Problem 3.2**

1. Starting information =

=

= 1

Attribute A Set 1 =

= 0.6 \* (0.38998 + 0.52832)

= 0.6 \* (0.9183)

≈ 0.55098

Attribute A Set 2 =

= 0.4 \* (0.5 + 0.31128)

= 0.4 \* (0.811280

≈ 0.32451

Entropy(A) = 0.55098 + 0.324512

≈ 0.87549

Attribute B Set 1 =

= 0.875 \* (0.4613 + 0.5239)

= 0.875 \* (0.9852)

≈ 0.8621

Attribute B Set 2 =

= 0.125 \* (0+ 0)

= 0.125 \* (0)

= 0

Entropy(B) = 0.8621 + 0

≈ 0.8621

**Attribute B resulted in the most decrease in entropy, so B is the more informative attribute.**

1. Starting information =

=

= 1

Attribute A Set 1 =

= 0.5 \* (0.2575 + 0.4644)

= 0.5 \* (0.7219)

≈ 0.36095

Attribute A Set 2 =

= 0.5 \* (0.4644 + 0.2575)

= 0.5 \* (0.7219)

≈ 0.36095

Entropy(A) = 0.36095 + 0.36095

≈ 0.7219

**The largest value of X such that Attribute B is more informative than Attribute A (0.7219) is 27 with an entropy value of ≈0.7197.**

I got this answer by trying different values of x in the following code:

from math import log2  
  
 x = 27  
  
 set1\_yes = x  
 set1\_no = 50  
  
 set2\_yes = x  
 set2\_no = 50  
  
 set3\_yes = (100 - 2 \* x)  
 set3\_no = 0  
  
 set1\_total = set1\_yes + set1\_no  
 set2\_total = set2\_yes + set2\_no  
 set3\_total = set3\_yes + set3\_no  
  
 set1\_weight = set1\_total / (set1\_total + set2\_total + set3\_total)  
 set2\_weight = set2\_total / (set1\_total + set2\_total + set3\_total)  
 set3\_weight = set3\_total / (set1\_total + set2\_total + set3\_total)  
  
 pa = set1\_yes / set1\_total *# P(set 1 yes)* pb = set1\_no / set1\_total *# P(set 1 no)* pc = set2\_yes / set2\_total *# P(set 2 yes* pd = set2\_no / set2\_total *# P(set 2 no)* pe = set3\_yes / set3\_total *# P(set 3 yes)* pf = set3\_yes / set3\_total *# P(set 3 no)* set1\_entropy = set1\_weight \* ((-pa \* log2(pa)) + (-pb \* log2(pb)))  
 set2\_entropy = set2\_weight \* ((-pc \* log2(pc)) + (-pd \* log2(pd)))  
 set3\_entropy = set3\_weight \* ((-pe \* log2(pe)) + (-pf \* log2(pf)))  
  
 entropy = set1\_entropy + set2\_entropy + set3\_entropy  
 print(entropy)

**Problem 3.3**

Use city example