# Homework Assignment N°1

AML3
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# 1 Exercise 1

## 1.1 Part a

From the topology of the graph, we deduce that:

$$P(S) = \sum_c P(D|C = c) \sum_d P(I|D = d) \sum_i P(S|I = i) \sum_g P(G = g|D = d, I = i)$$

Because $P(G|D = d, I = i)$ is a probabitlity distribution, $\sum_g P(G|D = d, I = i) = 1$. Our final formula is the following:

$$P(S) = \sum_c P(D|C = c) \sum_d P(I|D = d) \sum_i P(S|I = i)$$

$$P(S) = [s_0, s_1] = [0.516, 0.484]$$

## 1.2 Part b

From the graph we know that

$$P(G, I = i_0) = \sum_c P(D|C = c) \sum_d P(I|D = d)P(G|D = d, I = i0) \sum_s P(S|I = i_0)$$

Once again, $P(S|I = i_0)$ is a probability distribution, then

$$P(G, I = i_0) = \sum_c P(D|C = c) \sum_d P(I|D = d)P(G|D = d, I = i0)$$

$$P(G, I = i_0) = [p(g_0|i_0), p(g_1|i_0), p(g_2|i_0)] = [0.1384, 0.2272, 0.2024]$$

Because it is not a probability distribution, its sum is not 1. From Bayes rule we know that by dividing by $P(I = i_0)$ we would obtain $P(G|I = i_0)$ which is a distribution.

$$P(G|I = i_0) = \frac{P(G, I = i_0)}{P(I = i_0)} = \frac{P(G, I = i_0)}{\sum_g P(G, I = i_0)} = \frac{P(G, I = i_0)}{0.568}$$

$$P(G|I = i_0) = [0.244, 0.4, 0.356]$$

Which adds up to 1 accordingly.

## 1.3 Part c

Same process as before:

$$P(S, G = g_0) = \sum_c P(D|C = c) \sum_d P(I|D = d) \sum_i P(G = g_0|D = d, I = i)P(S|I = i)$$

$$P(S, G = g_0) = [p(s_0|g_0), p(s_1|g_0)] = [0.245, 0.148]$$

Because it is not a probability distribution, its sum is not 1. From Bayes rule we know that by dividing by $P(G = g_0)$ we would obtain $P(S|G = g_0)$ which is a distribution.

$$P(S|G = g_0) = \frac{P(S, G = g_0)}{P(G = g_0)} = \frac{P(S, G = g_0)}{\sum_s P(S, G = g_0)} = \frac{P(S, G = g_0)}{0.393}$$

$$P(S|G = g_0) = [0.624, 0.376]$$

Which adds up to 1 accordingly.