Assignment 1

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1 Problem

Question 2.1:
Bag I contains 3 red and 4 black balls and Bag II contains 4 red and 5 black balls. One ball is transferred from Bag I to Bag II and then a ball is drawn from Bag II. The ball so drawn is found to be red in colour. Find the probability that the transferred ball is black.

2 Solution

Let X $\in \{1, 2\}$ represent the bags and Y $\in \{0, 1\}$ where 1 denotes black and 0 denotes red.

$$Pr(Y = 1/X = 1) = \frac{4}{7} \tag{2.0.1}$$

$$Pr(Y = 0/X = 1) = \frac{3}{7} \tag{2.0.2}$$

Let E_1 denote the event of black ball being transferred from bag 1,
E_2 denote the event of red being transferred from bag 1 and
T be the event of red ball being drawn from bag 2 after transferring a ball from bag 1.
We can find the probability of E_1 and E_2 using 2.0.1 and 2.0.2

$$Pr(E_1) = Pr(Y = 1/X = 1) = \frac{4}{7} \tag{2.0.3}$$

$$Pr(E_2) = Pr(Y = 0/X = 1) = \frac{3}{7} \tag{2.0.4}$$

Probability that red ball is drawn from bag 2 and if red ball is transferred from bag 1 is

$$Pr(T/E_2) = \frac{5}{10} = \frac{1}{2} \tag{2.0.5}$$

Since red ball is being transferred, the number of red balls in bag 2 becomes 5 and total number of balls also increases by 1, i.e, 10.
And Probability that red ball is drawn from bag 2 and if black ball is transferred from bag 1 is

$$Pr(T/E_1) = \frac{4}{10} = \frac{2}{5} \tag{2.0.6}$$

Since black ball is being transferred, the number of red balls in bag 2 remains same and only total number of balls increases by 1, i.e, 10.

Now, we have to find probability of black ball being transferred from bag 1 to bag 2 if a red ball is being drawn from bag 2.
Using Baye's theorem,

$$Pr(E_1/T) = \frac{Pr(E_1 T)}{Pr(T)} \tag{2.0.7}$$

$$Pr(E_1/T) = \frac{Pr(E_1)Pr(T/E_1)}{Pr(E_1)Pr(T/E_1) + Pr(E_2)Pr(T/E_2)} \tag{2.0.8}$$

On substituting the values of Pr(E_1), Pr(E_2), Pr(T/E_1) and Pr(T/E_2) in equation 2.0.8, we get

$$Pr(E_1/T) = \frac{\frac{4}{7}\cdot\frac{2}{5}}{\frac{4}{7}\cdot\frac{2}{5} + \frac{3}{7}\cdot\frac{1}{2}}$$

$$\implies Pr(E_1/T) = \frac{\frac{8}{35}}{\frac{8}{35} + \frac{3}{14}}$$

$$\implies Pr(E_1/T) = \frac{16}{31} \tag{2.0.9}$$