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

Bags(X)	n(Y=0)	n(Y=1)
0	4	3
1	5	4

$$Pr(Y = 0, X = 0) = \frac{4}{7} \qquad (2.0.1)$$

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

There are 2 states, S={0,1}
S=0 after transferring black ball.
S=1 after transferring red ball.

1) **Transferring a black ball**.

   Probability of transferring a black ball from bag 1 to bag 2 is:

$$Pr(Y = 0, X = 0) = Pr(S = 0) = \frac{4}{7} \qquad (2.0.3)$$

Let T be the event of drawing a red ball from bag 2 after transferring a random ball from bag 1 to bag 2.
Now, after transferring black ball to bag 2, the probability of picking a red ball from bag 2 is:

$$Pr(T|S = 0) = \frac{4}{10} = \frac{2}{5} \qquad (2.0.4)$$

2) **Transferring a red ball.**

Probability of transferring a red ball from bag 1 to bag 2 is

$$Pr(Y = 1, X = 0) = Pr(S = 1) = \frac{3}{7} \qquad (2.0.5)$$

Now, after transferring red ball to bag 2, the probability of picking a red ball from bag 2 is:

$$Pr(T|S = 1) = \frac{5}{10} = \frac{1}{2} \qquad (2.0.6)$$

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,

$$Pr(S = 0|T) = \frac{Pr(S = 0, T)}{Pr(T)} \qquad (2.0.7)$$

$$Pr(S = 0|T) = \frac{Pr(S = 0)Pr(T|S = 0)}{Pr(S = 0)Pr(T|S = 0) + Pr(S = 1)Pr(T|S = 1)}$$

On substituting the values, we get

$$Pr(S = 0|T) = \frac{\frac{4}{7} \cdot \frac{2}{5}}{\frac{4}{7} \cdot \frac{2}{5} + \frac{3}{7} \cdot \frac{1}{2}}$$

$$\implies Pr(S = 0|T) = \frac{\frac{8}{35}}{\frac{8}{35} + \frac{3}{14}}$$

$$\implies Pr(S = 0|T) = \frac{16}{31}$$