+91- 8826-106-706
+91- 8826-254-020
www.ramanujanmathsclasses.com

Method-1

Question 12: A card from a pack of 52 cards is lost. From the remaining cards of the pack, two cards are drawn and are found to be both diamonds. Find the probability of the lost card being a diamond.

Solution Let E_1 and E_2 be the respective events of choosing a diamond(♦)card and a card which is not diamond.

Let A denote the lost card.

Out of 52 cards, 13 cards are diamond and 39 cards are not diamond

$\therefore$ $P(E_1) = 13/52 = 1/4$, $P(E_2) = 39/52 = 3/4$

When one diamond card is lost, there are 12 diamond cards out of 51 cards.

Two cards can be drawn out of 12 diamond cards in $^{12}C_2$ ways.

Similarly, 2 diamond cards can be drawn out of 51 cards in $^{51}C_2$ ways. The probability of getting two cards, when one diamond card is lost, is given by $P(A|E_1)$.

$$P(A|E_1) = \frac{^{12}C_2}{^{51}C_2} = \frac{12!}{2!\times 10!} \times \frac{2!\times 49!}{51!} = \frac{11\times 12}{50\times 51} = \frac{22}{425}$$

When the lost card is not a diamond, there are 13 diamond cards out of 51 cards.

Two cards can be drawn out of 13 diamond cards in $^{13}C_2$ ways whereas 2 cards can be drawn out of 51 cards in $^{51}C_2$ ways.

The probability of getting two cards, when one card is lost which is not diamond, is given by $P(A|E_2)$.

$$P(A|E_2) = \frac{^{13}C_2}{^{51}C_2} = \frac{13!}{2!\times 11!} \times \frac{2!\times 49!}{51!} = \frac{12\times 13}{50\times 51} = \frac{26}{425}$$

The probability that the lost card is diamond is given by $P(E_1|A)$.

By using Bayes' theorem, we obtain

$$P(E_1|A) = \frac{P(E_1)\cdot P(A|E_1)}{P(E_1)\cdot P(A|E_1) + P(E_2)\cdot P(A|E_2)}$$

$$= \frac{\frac{1}{4}\cdot\frac{22}{425}}{\frac{1}{4}\cdot\frac{22}{425} + \frac{3}{4}\cdot\frac{26}{425}}$$

$$= \frac{\frac{1}{425}\left(\frac{22}{4}\right)}{\frac{1}{425}\left(\frac{22}{4} + \frac{26\times 3}{4}\right)} \qquad = \frac{\frac{11}{2}}{25} \qquad = \frac{11}{50}$$

Method-2

Let H, S, C,D and A be the events as defined below :

H = Missing card is is a ♥ heart card, S = Missing card is is a ♠ spade card

C = Missing card is is a ♣club card, D = Missing card is is a ♦ Diamond card

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And A = Drawing two diamond cards from the remaining cards

Then P(H) = 13/52 = 1/4, P(S) = 13/52 = 1/4 P(C) = 13/52 = 1/4, P(D) = 13/52 = 1/4

Now, P(A/D) = Probability of drawing two diamond cards given that one diamond card is missing

$P(A/D) = {}^{12}C_2 / {}^{51}C_2$

P(A/H) = Probability of drawing two diamond cards given that one heart card is missing

$P(A/H) = {}^{13}C_2 / {}^{51}C_2$

Similarly $P(A/S) = {}^{13}C_2 / {}^{51}C_2$, $P(A/C) = {}^{13}C_2 / {}^{51}C_2$,

By Baye's Theorem, Require probability

$$P(D/A) = \frac{P(D)(A/D\ )}{P(D)(A/D\ )\,P(H)(P(A/H)P(S)(A/S\ )\,P(C)(P(A/C)}$$

$$= \frac{\frac{1}{4}12C2 / 51C2}{\frac{1}{4}12C2 / 51C2 + 1/4\ 13C2\ / 51C2 + 1/4\ 13C2\ / 51C2 + 1/4\,13C2\ / 51C2}$$

$$= \frac{12C2}{12C2 + 13C2 + 13C2 + 13C2}$$

$$= \frac{66}{66+78+78+78}$$

$$= \frac{66}{300}$$

$$= \frac{11}{50}$$

Method-3

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Thanks and Regards
Anil Ahuja
PGT Mathematics Teacher
More than 20 years Experience
14 years CBSE BOARD Class XII Mathematics Papers Evaluation Experience