Nikhila K.

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Pp x Pp (Punnet Square)

	P	p
P	PP	Pp
p	Pp	pp

↑ T-S

5 babies and none are Tay-Sachs babies?

1 or more tay sachs = [not] {exactly 0 T-S babies}

exactly 0 = not T-S Baby 1 and not T-S baby 2 .... not T-S baby 5

WORKING WITH $\boxed{OR}$

$P(A \text{ or } B) = P(A) + P(B)$ — no overlap

SPECIAL CASE OF $\boxed{OR}$

↳ A/B don't overlap (are mutally exclusive)

$P(A \text{ or } B) = P(A) + P(B) - P(A \cap B)$

$\boxed{P(A \text{ and } B)}$ overlap

→ P(no T-S babies)

Exactly 0	Exactly 1	Exactly 2	Exactly 3	Exactly 4	Exactly 5

$\underbrace{\text{Exactly 0}}_{\text{NOT A}}$ $\underbrace{\text{Exactly 1 ... Exactly 5}}_{A}$

WORKING W/ $\boxed{AND}$

$$\begin{bmatrix} 1 \\ 2 \\ 9 \end{bmatrix} \xrightarrow{\text{random}} \begin{bmatrix} Y_1 \\ Y_2 \end{bmatrix} \; n=2$$

$P(Y_1 = 2 \text{ and } Y_2 = 2) = ?$

CASE 1: at random with replacement (Independent Identically distributed)

Making a punnet square.

	1	2	9
1	1,1	1,2	1,9
2	2,1	2,2	2,9
9	9,1	9,2	9,9

ordered pairs

$P(2 \text{ and } 2) = \frac{1}{9}$

$\boxed{Y_1 = 2}$

$P(Y_1) = \frac{1}{3} = \frac{3}{9}$ $\therefore$ $P(Y_1 = 2 \text{ and } Y_2 = 2) = P(Y_1 = 2) \times P(Y_2 = 2)$

$P(Y_2 = 2) = \frac{1}{3} = \frac{3}{9}$ - works for IID sampling
(IID)

CASE 2 : Simple Random Sampling (SRS) : At Random W/O sampling

$$\begin{bmatrix} 1 \\ 2 \\ 9 \end{bmatrix} \xrightarrow[SRS]{} \begin{bmatrix} Y_1 \\ Y_2 \end{bmatrix} \quad P(Y_1 = 2 \text{ and } Y_2 = 2) = 0$$

From previous punnet square

Q: Does EOM apply to 6 possibilities

	1	2	9
1	~~1,1~~	1,2	1,9
2	2,1	~~2,2~~	2,9
9	9,1	9,2	~~9,9~~

← not possible

First draw:
$P(Y_1 = 2) = \frac{1}{3} = \frac{2}{6}$

second draw:
$P(Y_2 = 2) = \frac{1}{3} = \frac{2}{6}$

But
$P_{SRS}(Y_1 = 2 \text{ and } Y_2 = 2) = 0$
$\therefore$ ~~out~~ Our theory doesn't work as far as SRS is concerned
SRS: 2^{nd} draw depends on first draw.

CONDITIONAL PROBABILITY ~~DEF~~.

P(B given A) [P(B|A)]

$$P(B \text{ GIVEN } A) = \frac{P(A \text{ and } B)}{P(A)}$$

↖ only if $P(A) > 0$ — ~~works for W/O sampling~~

$P(A \text{ and } B) = P(A) \cdot P(B|A) = P(B) \cdot P(B|A)$ ← General Product Rule for and

$$P(A|B) = \frac{P(A \text{ and } B)}{P(B)}$$

Special case

IID $P(A \text{ and } B) = P(A) \cdot P(B)$ as the events are independent of each other.

Def. 2 things A and B are independent if information about A does not change chances for B and vice versa.

☆ If A and B are independent,

$P(B|A) = P(B)$

Because A doesn't change B
and $P(A|B) = P(A)$

~~For~~ $P_{SRS}(Y_1 = 2 \text{ and } Y_2 = 2)$

$= P_{SRS}(Y_1=2) * P_{SRS}(Y_1=2 \mid Y_1=2)$

$= \frac{1}{3} \cdot 0 = 0$

Marijuana legalisation preferance studies

[MLP | G] n=106 $\xrightarrow{\text{sort}}$

Y	F
N	F
Y	M
N	M

→

	Y	N	
F	29	20	49
M	52	5	57
	81	25	106

2X2 contingency table

categorical data analysis (both variables qual.)

Q: Are gender and MLP independent?

A Imagine choosing a person @ random from 106 people.

$P(\text{Yes}) = \frac{81}{106}$ } By the equally likely model (as we chose total # of people for denominator)

$P(\text{Yes} \mid \text{Female}) = \frac{29}{49} = 59\%$ conditional probability: specialised data set.

$P(\text{Yes} \mid \text{Male}) = \frac{52}{57} \approx 91\%$

~~Are~~ In this study gender and MLP are dependent as gender has some change in ~~##~~ MLP %.
since 91% ≠ 59% ≠ 76%.

are strongly associated in data set
G and MLP
we can say this ~~###~~ because the % are so different.