# CONDITIONAL PROBABILITY

# what do you see in these images?

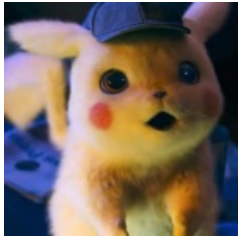
Images

Labels

Computer Generated

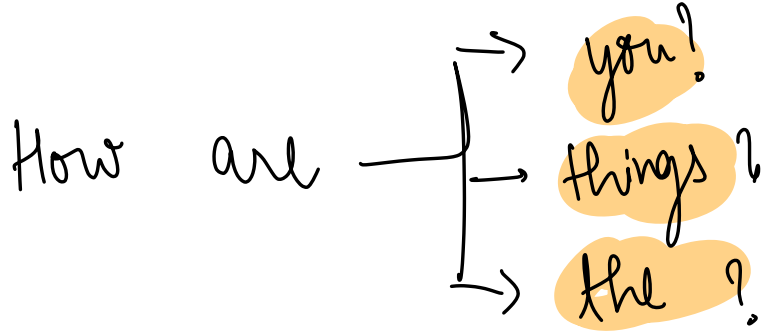
"Pink Golf Ball"

"Blue Elephant Rollerskating"



"Detective Pikachu"

Whatsapp




$X1 \rightarrow$ How
$X2 \rightarrow$ ARE
$X3 \rightarrow$ ?

Given that $X_1$ = "How" & $X_2$ = "are"
Compute probability of $X_3$ freq used in the dict.

lots of Computation behind Scene.

# Experiment: Sum of 2 Dice Throws

| $D_1+D_2$ | $D_2$: 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| $D_1$: 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 6 | 7 | 8 | 9 | 10 | 11 | 12 |

$$P[D_1 = 2] = \frac{6}{36} \qquad P[D_1 + D_2 \le 5] = \frac{10}{36}$$

$$P[D_1 = 2 \cap D_1 + D_2 \le 5] = \frac{3}{36}$$

$$P[D_1 = 2 \mid D_1 + D_2 \le 5] = \frac{3}{10}$$

"given"

$$P[D_1 = 2 \mid D_1 + D_2 \le 5] = \frac{P[D_1 = 2 \cap D_1 + D_2 \le 5]}{P[D_1 + D_2 \le 5]} = \frac{3/\cancel{36}}{10/\cancel{36}} = \frac{3}{10}$$

$$P[A \mid B] = \frac{P[A \cap B]}{P[B]}$$

Conditional Probabilities.

$$P[A \cap B] = P[A/B] \cdot P[B]$$

$$P[B \cap A] = P[B/A] \cdot P[A]$$

Multiplication Rule

$$P[A/B] \cdot P[B] = P[B/A] \cdot P[A] = P[A \cap B] = P[B \cap A]$$

$$P[A/B] \cdot P[B] = P[B/A] \cdot P[A]$$

$$P[B/A] = \frac{P[A/B].P[B]}{P[A]}$$

BAYES THOREM

"Images" → "labels" Easy $P[\text{labels}/\text{Images}]$

"labels" → "Images" Difficult $P[\text{Images}/\text{label}]$

$$P[\text{Images}/\text{labels}] = \frac{P[\text{labels}/\text{Images}] \times P[\text{Images}]}{P[\text{labels}]}$$

$$P[A/B] = \frac{P[B/A]\,P[A]}{P[B]}$$

**It is known that 60% people use Swiggy, 50% use Zomato. 20% people use both. Among those who use Zomato, what fraction also use Swiggy?**

## Quiz time!

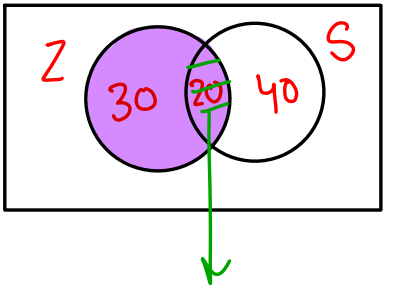
Quiz Ended!

1. It is known that 60% people use Swiggy, 50% use Zomato. 20% people use both.

Among those who use Zomato, what fraction also use Swiggy?

44 users have participated

| | | |
|---|---|---|
| A | 0.20 | 25% |
| B | 0.50 | 5% |
| C ✓ | 0.40 | 52% |
| D | 0.33 | 18% |




$$P[S/Z] = \frac{P[S \cap Z]}{P[Z]}$$

$$= \frac{0.2}{0.5} = 0.4$$

$$P[Z/S] = \frac{0.2}{0.6} = 0.33$$

# Quiz time!

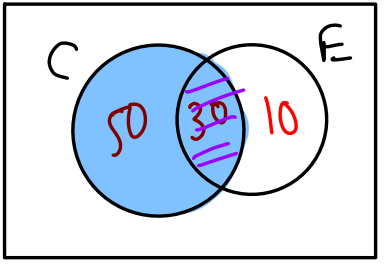
Quiz Ended!

2. It is known that 80% people like cappuccino, 40% people like espresso, and 30% like both.

**Among the people who like cappuccino, what fraction of people like espresso?**

53 users have participated

| | | | |
|---|---|---|---|
| | A | 0.3 | 8% |
| ✓ | B | 30/80 | 79% |
| | C | 30/40 | 9% |
| | D | 0.8 | 4% |




$$P[E/C] = \frac{P[E \cap C]}{P[C]}$$

$$= \frac{30}{80}$$

# Quiz time!

Quiz Ended!

**Which of these probabilities represent the following statement: Among the people who like cappuccino, what fraction of people like espresso?**


P [Espresso / Cappuccino]

# Quiz time!

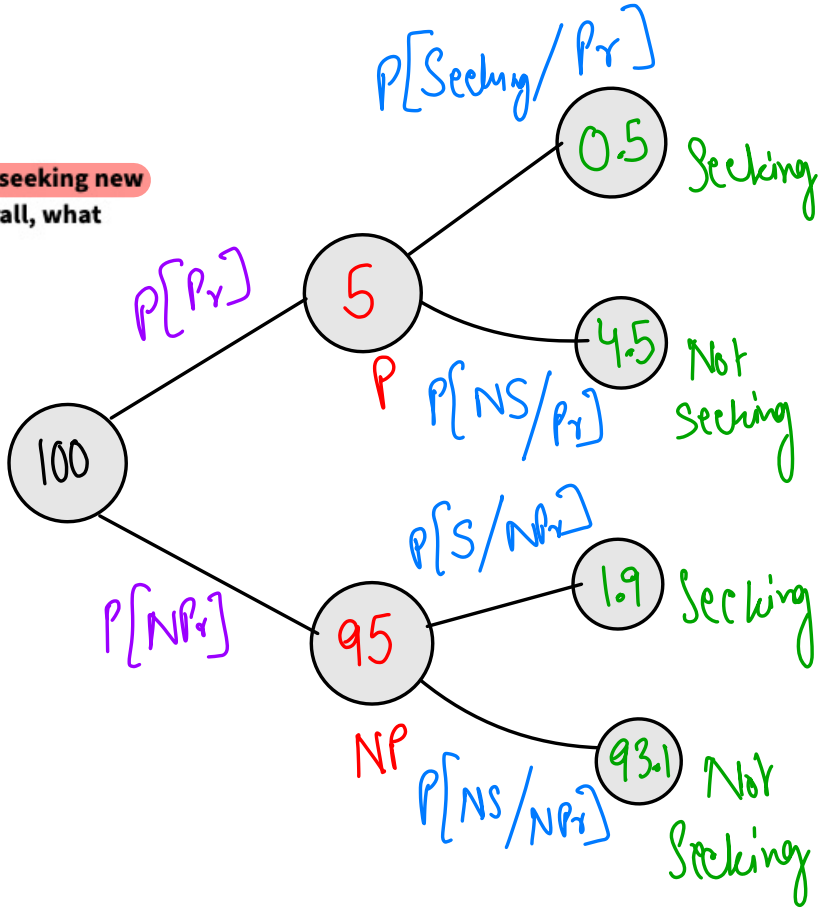
Quiz Ended!

**Q5) 5% of all LinkedIn users are premium users. 10% of premium users are seeking new job opportunities. Only 2% of non-premium users are seeking job. Overall, what percentage of people are seeking new job opportunities?**

45 users have participated

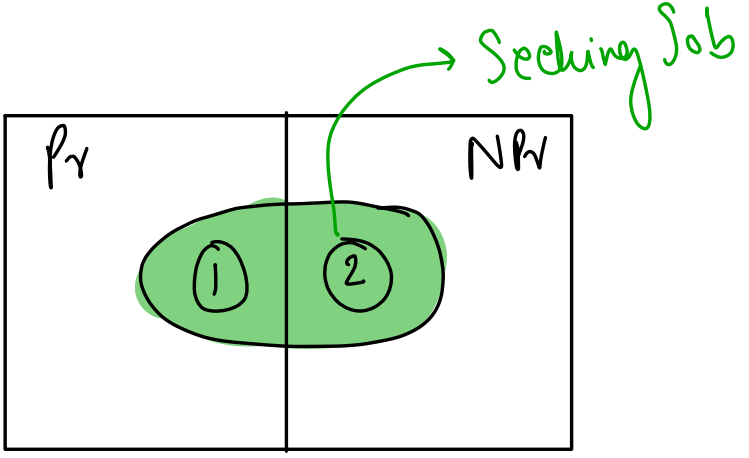
| | | | |
|---|---|---|---|
| A | 2% | 7% | |
| ✓ B | 2.4% | 69% | ✓ |
| C | 3.7% | 16% | |
| D | 5% | 9% | |

2.4%



$$P[S] = P[Pr] \cdot P[S/Pr] + P[NPr] \cdot P[S/NPr]$$

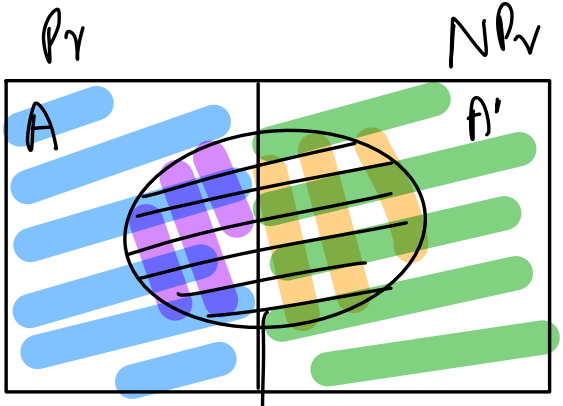
$$= P[Pr \cap S] + P[NPr \cap S]$$




$$P[S] = P[S \cap Pr] + P[S \cap NPr]$$

(1) (2)

$$= P[S/Pr]\,P[Pr] + P[S/NPr] \cdot P[NPr]$$



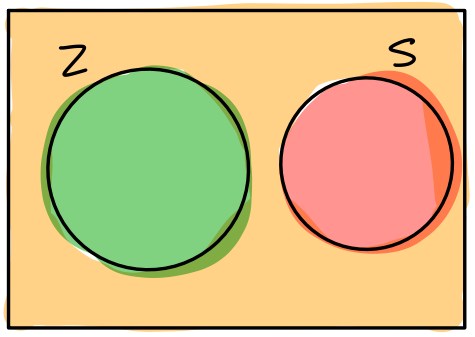

Seeking Jobs (C)

$$C = (A \cap C) \cup (A' \cap C)$$

$A \cap A' = \{\}$ "Mutually exclusive"

$A \cup A' = S/U$ "Mutually Exhaustive"

$$P[C] = P[A \cap C] + P[A' \cap C]$$




$Z \cup S \neq S$

$Z \cap S = \{\}$ "Mutually Exclusive"

NOT Mutually Exhaustive

# Quiz time!

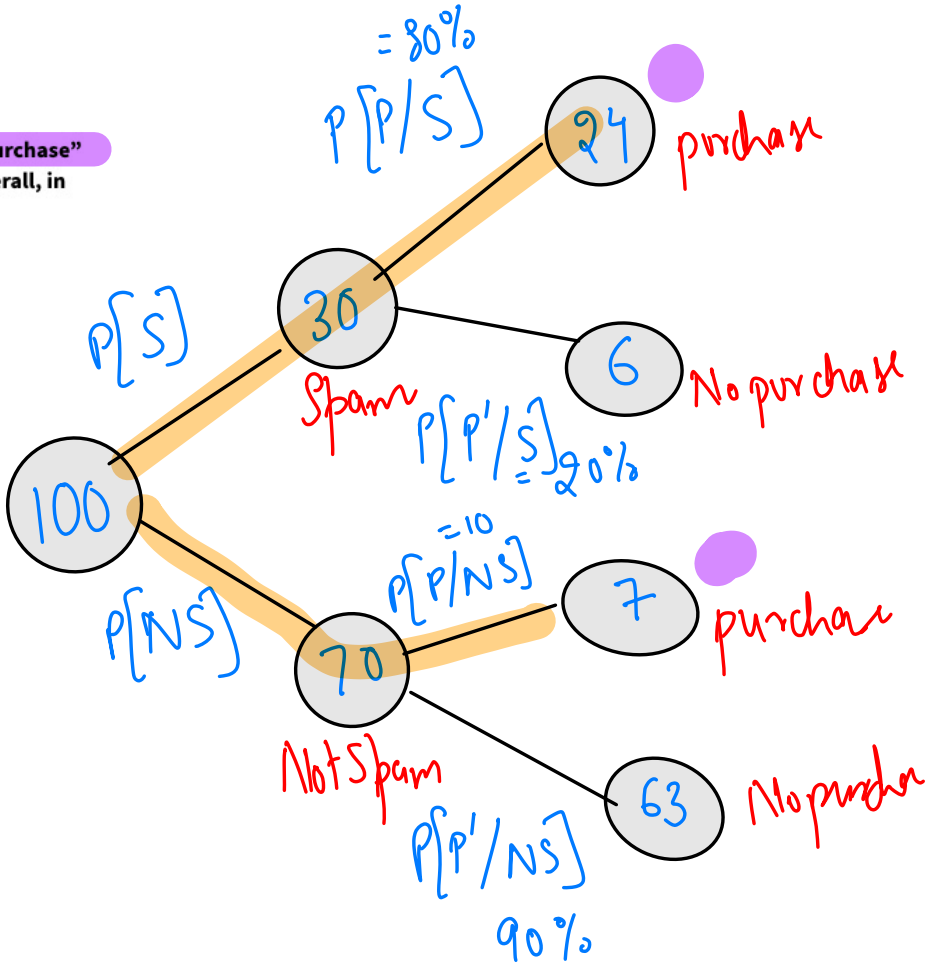
Quiz Ended!

4. It is known that 30% of emails are spam, and 70% are not spam. The word "purchase" occurs in 80% of spam emails. It also occurs in 10% of non-spam emails. Overall, in what percentage of emails would we see the word "purchase"?

40 users have participated

| | | |
|---|---|---|
| A | 45% | 3% |
| B | 10% | 5% |
| C ✓ | 31% | 85% |
| D | 71% | 7% |

24 + 7 = 31%



## Quiz time!

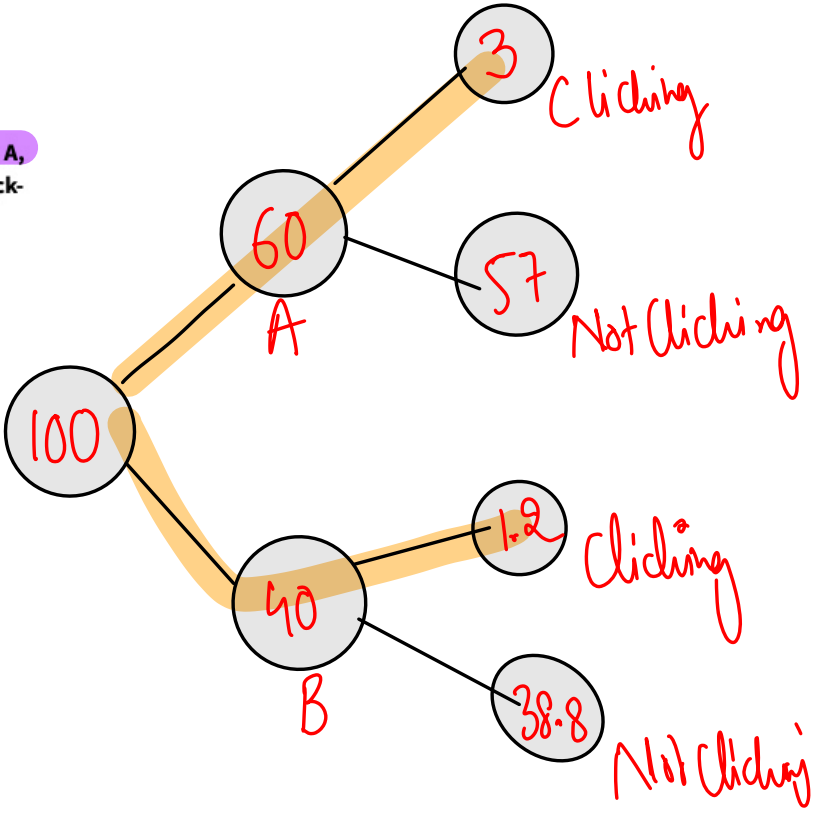
Quiz Ended!

**An e-commerce website shows two types of ads: A and B. 60% of the visitors see Type A, and 40% visitors see Type B. The click-through rate for Type A ads is 5%, while the click-through rate for Type B ads is 3%. What is the overall click through rate?**

47 users have participated

| | | | |
|---|---|---|---|
| A | 3 | 0% | |
| B | 4 | 6% | |
| C | 4.2 | 81% | ✓ |
| D | 8 | 13% | |

$3 + 1.2 = 4.2\%$

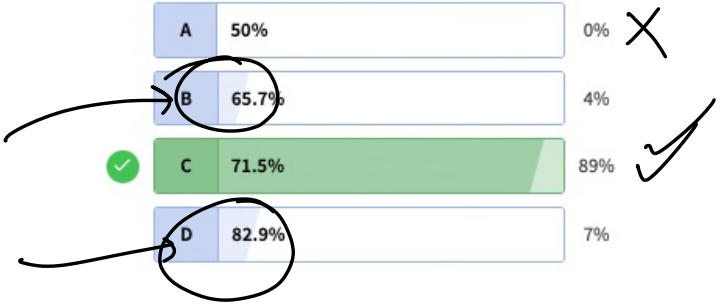


# Quiz time!

Quiz Ended!

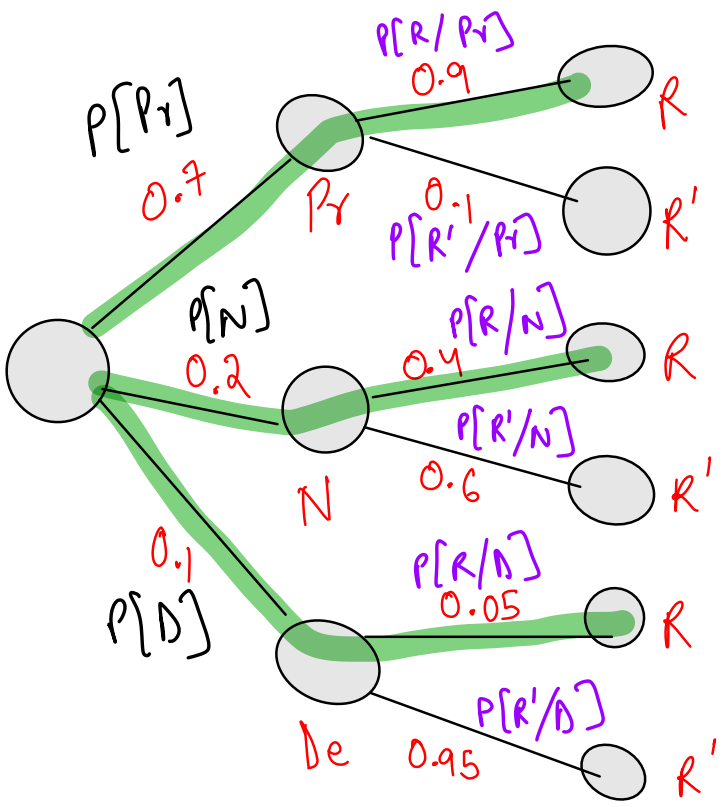
**In an NPS survey, it is seen that 70% are promoters, 20% are neutral, 10% are detractors. 90% of promoters, 40% of neutral, and 5% of detractors recommend the product to a friend. What is the overall percentalge of people who recommend the product?**

45 users have participated




| | Pr | N | D |
|---|---|---|---|
| R | 63 | 8 | 0.5 |
| NR | 7 | 12 | 9.5 |
| | 70 | 20 | 10 |

63 + 8 + 0.5 = 71.5%




$$P[R] = 0.7 \times 0.9 + 0.2 \times 0.4 + 0.1 \times 0.05$$

$$= 0.63 + 0.08 + 0.005$$

$$= 0.715$$

$$P[R] = P[R \cap Pr] + P[R \cap N] + P[R \cap D]$$

$$= P[R/Pr] \cdot P[Pr] + P[R/N] \cdot P[N] + P[R/D] \cdot P[D]$$

$$P[A/B] = \frac{P[A \cap B]}{P[B]}$$ Cond$^{n}$ Probability

$$P[A \cap B] = P[A/B] \cdot P[B] = P[B/A] \cdot P[A]$$ Multiplicate Rule

$$P[C] = P[C \cap A] + P[C \cap A']$$ Law of Total Prob.

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$P[\text{Raining} / H]$

$P[\text{Raining} / T]$

Independant Events

$$P[A/B] = P[A]$$
$$P[B/A] = P[B]$$

$\longrightarrow$

$$P[A/B] = \frac{P[A \cap B]}{P[B]}$$

$$P(A)$$

$$P[A \cap B] = P[A] \cdot P[B]$$