

Probability

What – How to Calculate?

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| Probability

Given any experiment and any event A:

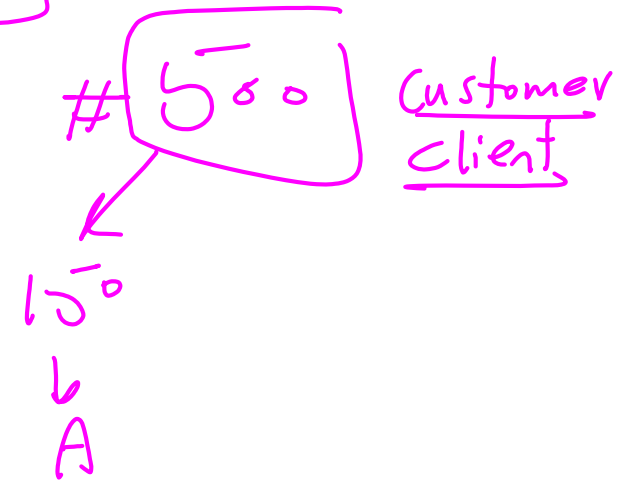
- The expression $P(A)$ denotes the **probability** that the event **A** occurs.
- $P(A)$ is the **proportion of times that event A would occur in the long run**, if the experiment were to be **repeated over and over again**.

| Probability – How to estimate?

- **Repeat** the experiment many times and determine the proportion of times that the event occurs
- Probabilities can be determined through **knowledge of the physical nature** of an experiment

$$P(A) = \frac{150}{500}$$

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| Axioms of Probability

- Let S be a sample space. Then $P(S) = 1$.

| Axioms of Probability

- For any event A, $0 \leq P(A) \leq 1$.

$$0 \leq P(A) \leq 1$$

| Axioms of Probability

- If A and B are mutually exclusive events, then $P(A \cup B) = P(A) + P(B)$.

- More generally, if $A_1, A_2, \dots$ are mutually exclusive events, then

$$P(A_1 \cup A_2 \cup \dots) = P(A_1) + P(A_2) + \dots$$

$A \cup B$

A or B

$$P(\text{too short}) = 0.02$$

$$P(\text{too long}) = 0.03$$

$$P(\text{too short} \overset{\cup}{\text{or}} \text{too long}) = P(\text{too short}) + P(\text{too long}) \\ = 0.02 + 0.03 = 0.05$$

| Note...

- For any event A,

$$P(A^c) = 1 - P(A)$$

- Let $\emptyset$ denote the **empty set**. Then $P(\emptyset) = 0$

$$p(\text{rain}) = 40\%$$

$$p(\text{Not rain}) = 60\%$$

$$p(\text{rain}) = 0.4$$

$\Downarrow$

$$p(\text{Not rain}) = 1 - 0.4 = 0.6$$

| Example

- You randomly draw a marble from a bag of marbles that contains 8 blue marbles, 5 green marbles, and 8 red marbles. What is P(draw a blue or red marble)?

$$\begin{array}{l} \# \quad 8 \\ \# \quad 5 \Rightarrow \boxed{21} \\ \# \quad 8 \end{array} \quad P(\text{blue or red}) = P(\underline{\text{blue} \cup \text{red}}) = \frac{16}{21}$$

$$\begin{aligned} P(\text{blue or red}) &= P(\text{blue}) + P(\text{red}) \\ &= \frac{8}{21} + \frac{8}{21} = 16/21 \end{aligned}$$

| Tips

- The probability of an event can only be between 0 and 1 and can also be written as a percentage.
- The probability of event A is often written as $P(A)$
- If $P(A) > P(B)$, then event A has a higher chance of occurring than event B.
- If $P(A) = P(B)$ then events A and B are equally likely to occur.



| References

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