Introduction to Statistics and Probability

SDAIA
الهيئة السعودية للبيانات والذكاء الاصطناعي
Saudi Data & AI Authority

Probability and A/B Test

Let's start together…

Agenda

1. Introduction to Statistics
2. Data Science and Statistics
3. Type of Statistics
4. Descriptive Statistics
5. Inferential Statistics
6. Probability
7. A/B Testing
8. Recap

Probability

Probability

Probability is simply how likely something is to happen.

- Whenever we're unsure about the outcome of an event, we can talk about the probabilities of certain outcomes—how likely they are. The analysis of events governed by probability is called statistics.
- The best example for understanding probability is flipping a coin:
    - There are two possible outcomes—heads or tails.
    - What's the probability of the coin landing on Heads?
- The formula for probability is given by;

Probability

Terminology of Probability Theory

- **Experiment**: A trial or an operation conducted to produce an outcome is called an experiment.
- **Sample Space**: All the possible outcomes of an experiment together constitute a sample space.
- **Favorable Outcome**: An event that has produced the desired result or expected event is called a favorable outcome.
- **Trial**: A trial denotes doing a random experiment.
- **Random Experiment**: An experiment that has a well-defined set of outcomes is called a random experiment.
- **Event**: The total number of outcomes of a random experiment is called an event.

Probability

Events in Probability

In probability theory, an event is a set of outcomes of an experiment or a subset of the sample space. If P(E) represents the probability of an event E, then, we have:

- **P(E) = 0** if and only if E is an impossible event.
- **P(E) = 1** if and only if E is a certain event.
- **$0 \leq P(E) \leq 1$.**

Probability

Calculating Probability

In an experiment, the probability of an event is the possibility of that event occurring. The probability of any event is a value between (and including) "0" and "1".

Follow the steps below for calculating probability of an event A:

- **Step 1:** Find the sample space of the experiment and count the elements. Denote it by n(S).
- **Step 2:** Find the number of favorable outcomes and denote it by n(A).
- **Step 3:** To find probability, divide n(A) by n(S). i.e., P(A) = n(A)/n(S).

Probability

Probability Examples

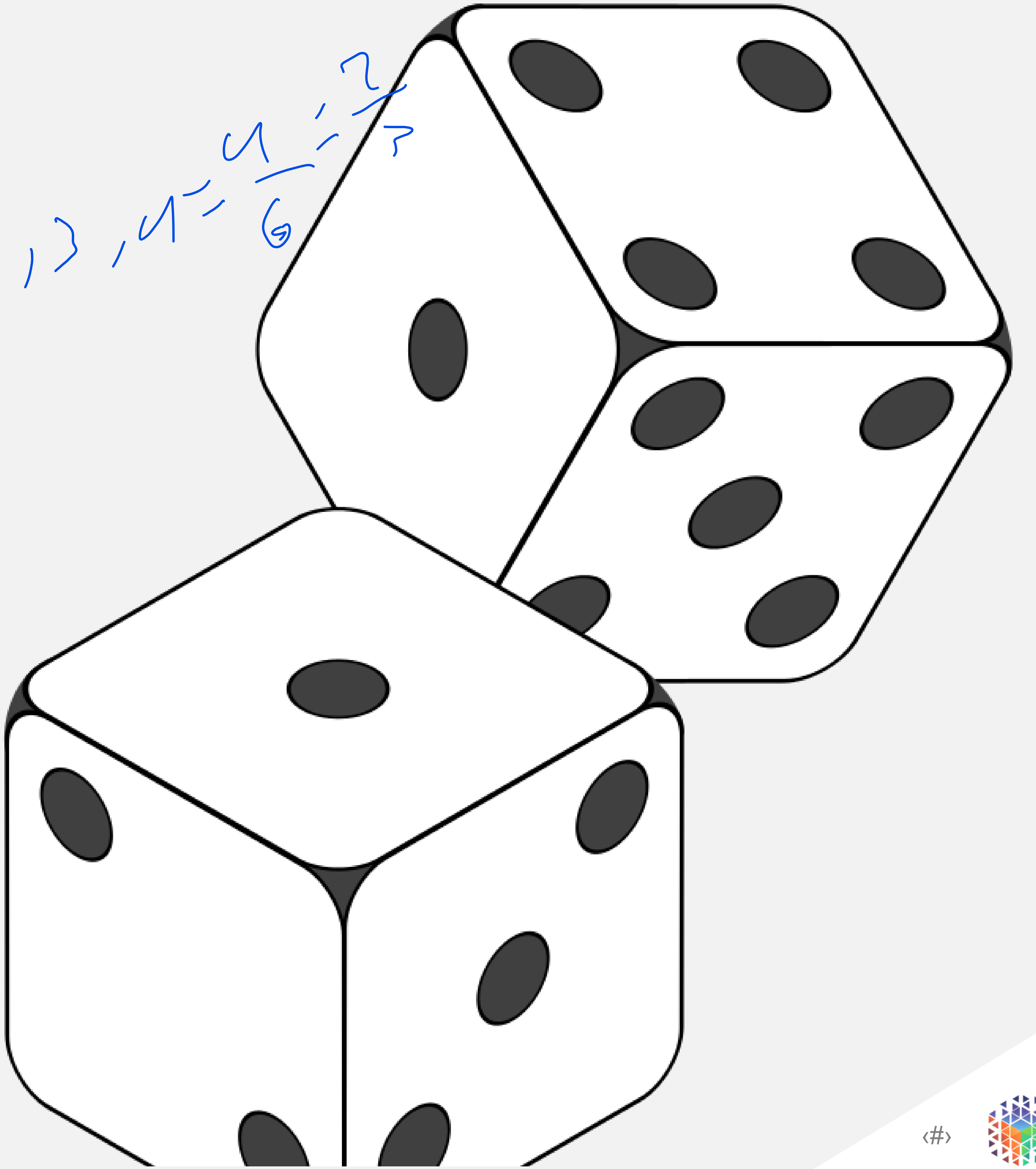
Example 1: Find the probability of getting a number less than 5 when a dice is rolled by using the probability formula.

1, 2, 3, 4 = $\frac{4}{6} = \frac{2}{3}$

Example 2: What is the probability of getting a sum of 9 when two dice are thrown?

(6, 3) (4, 5)

( ) (5, 4)



Probability

Basic Probability Rules

1. Possible values for probabilities range from 0 to 1
   - 0 = impossible event
   - 1 = certain event
2. The sum of all the probabilities for all possible outcomes is equal to 1.
3. Addition Rule - the probability that one or both events occur
   - mutually exclusive events: $P(A \text{ or } B) = P(A) + P(B)$
   - not mutually exclusive events: $P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$
4. Multiplication Rule - the probability that both events occur together
   - independent events: $P(A \text{ and } B) = P(A) * P(B)$
   - $P(A \text{ and } B) = P(A) * P(B|A)$
5. Conditional Probability - the probability of an event happening given that another event has already happened
   - $P(A|B) = P(A \text{ and } B) / P(B)$

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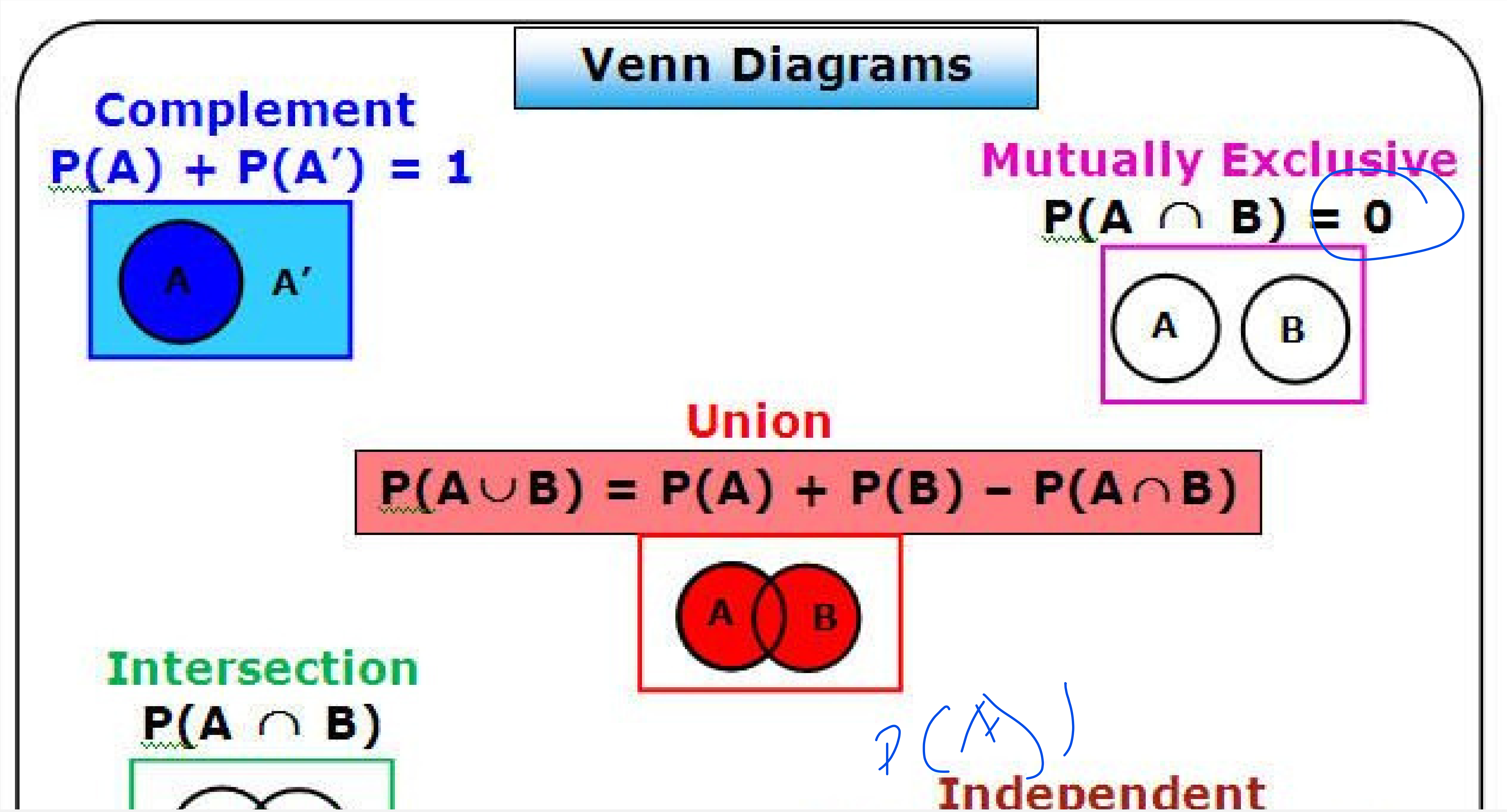
Probability

Basic Probability Rules



Probability

Probability Examples

Example : Organizing Data using Venn Diagrams to Find Probabilities.

A class contains 100 students; 70 of them like mathematics, 60 like physics, and 40 like both. If a student is chosen at random, using a Venn diagram, **find the probability that they like mathematics but not physics.**

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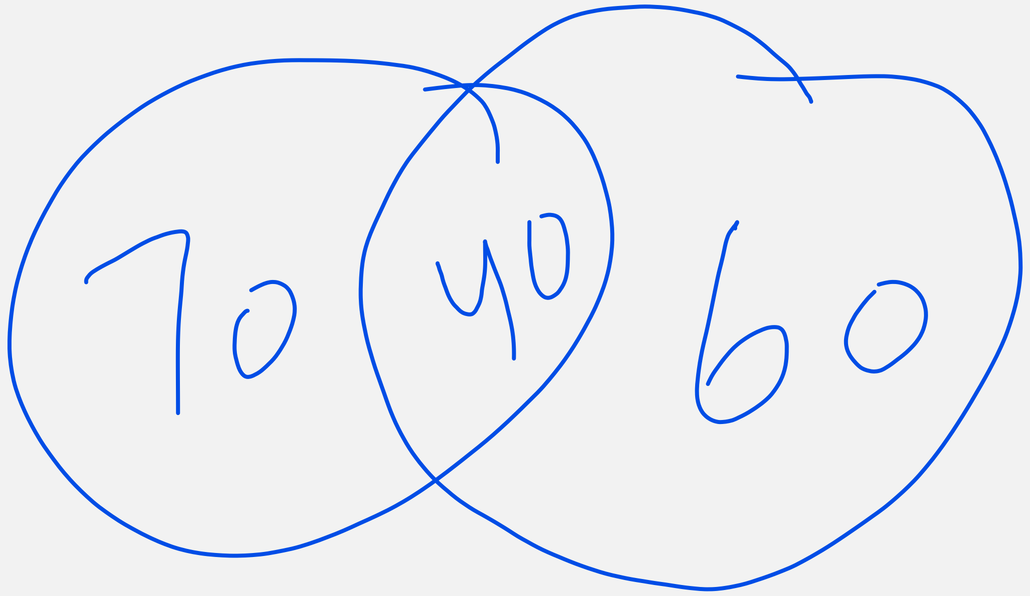

Probability

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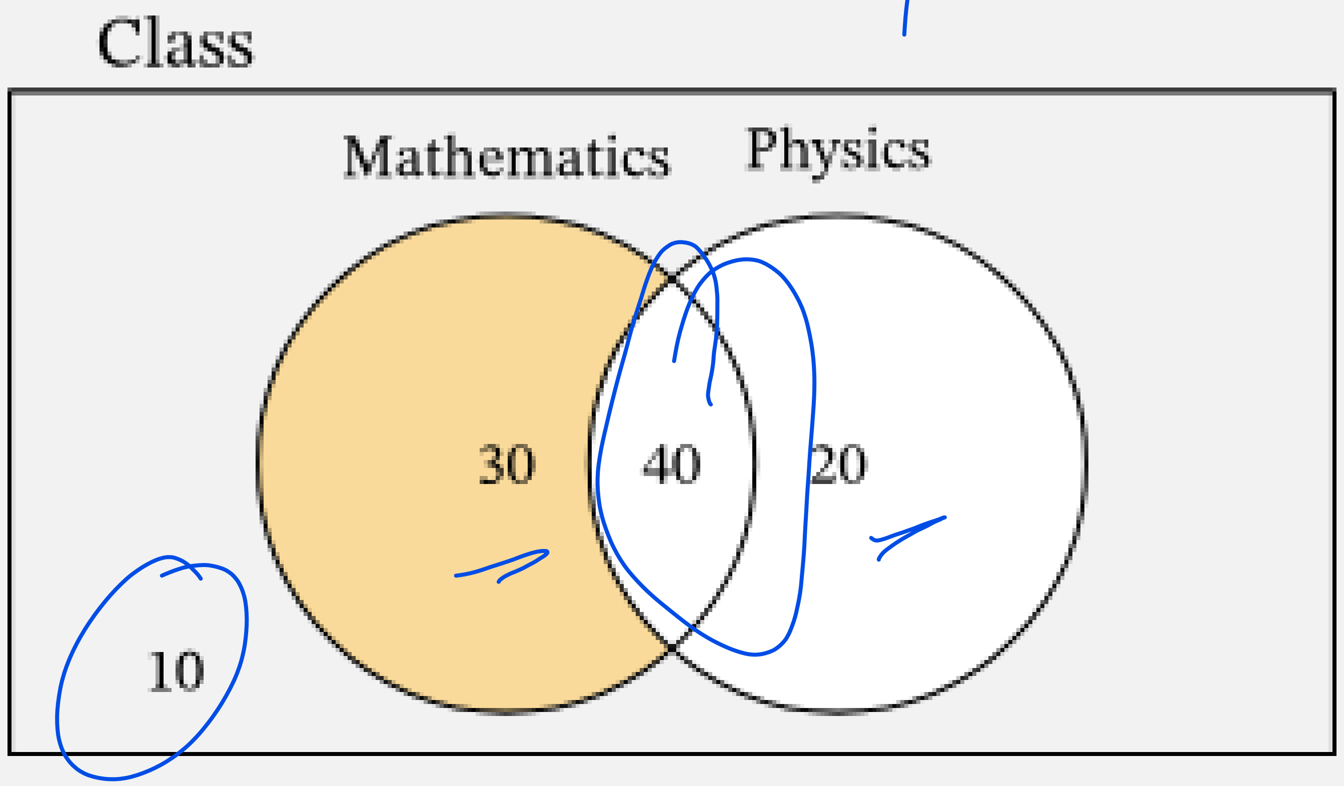

Probability

Bayes' Theorem on Conditional Probability

Bayes' theorem describes the probability of an event based on the condition of occurrence of other events. It is also called conditional probability. It helps in calculating the probability of happening of one event based on the condition of happening of another event.

For example, let us assume that there are three bags with each bag containing some blue, green, and yellow balls. What is the probability of picking a yellow ball from the third bag?

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$$\boxed{P(A|B) = \frac{P(B|A)\,P(A)}{P(B)}}$$

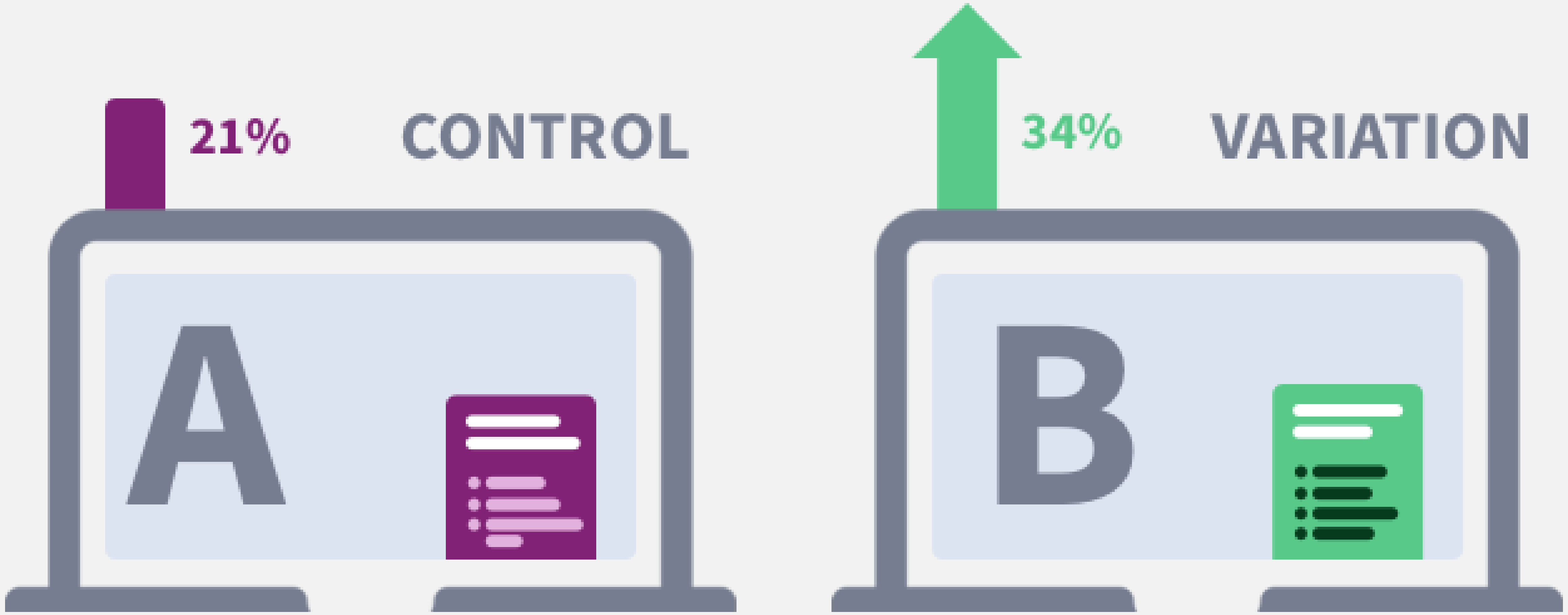
A/B Testing

A/B Testing

What is A/B Testing?

A/B testing is a marketing strategy that pits two different versions of a website, advert, email, popup, or landing page against each other to see which is most effective.

For example, you might test two different popups (to see which drives more webinar sign-ups) or two different Google Ads (to see which drives more purchases). This provides key insights on where and how to invest your marketing budget and gives you the courage to take potentially risky moves.



A/B Testing

How Does A/B Testing work?

A/B testing works by randomly showing two versions of the same asset (ad, website, pop-up, offer, etc.) to different users. The random part is important because this provides more accurate information without skewing the results.

- One version is the "control" group, or the version already in use. The second version changes a single element.
- You can change multiple elements, but it does make it harder to tell what change made the difference. This is called multivariate testing (more on this later).

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For example, you might show half of your website visitors a blue "buy now" button and the other half a red "buy now" button. After a certain period of time (generally at least two weeks), you'd compare conversion rates to see which color button resulted in more purchases.

A/B Testing

Why A/B Testing is important?

Accurate A/B tests can make a huge difference in your return on investment. By using controlled tests and gathering empirical data, you can figure out exactly which marketing strategies work best for your company and your product.

1. **Understand target audience**.
2. **Higher conversion rates**.
3. **Stay on top of changing trends**.
4. **Reduce bounce rates**.

Thank You

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