

Hypothesis Testing

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Agenda

1. Null and Alternative hypothesis
2. Hypothesis testing steps
3. Hypothesis formulation
4. One-tailed and two-tailed tests
5. Type I and Type II errors
6. Hypothesis testing framework

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Pop Quiz

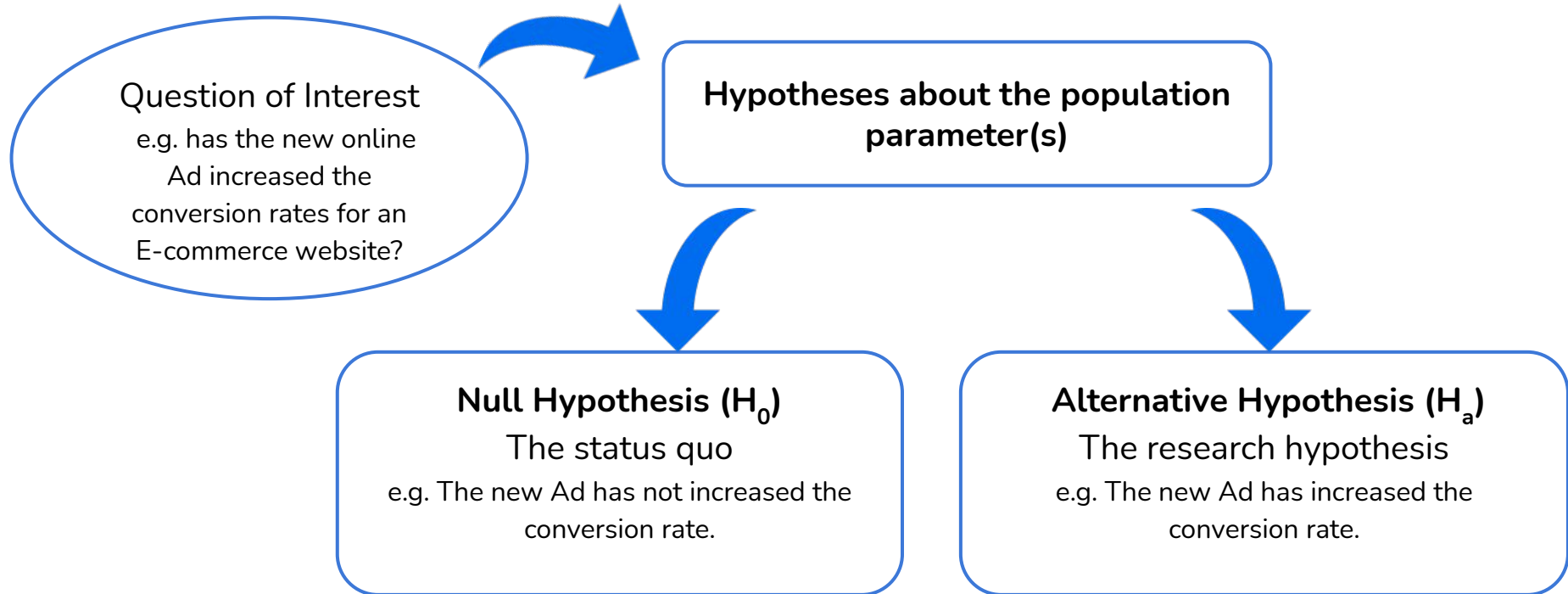
1. What is Null and Alternative hypothesis?
2. What are the steps to perform a hypothesis test?
3. What is the way to formulate a correct hypothesis?
4. What is the difference between one-tailed and two-tailed tests?
5. What are type I and type II errors?
6. How to choose the correct test for a given problem?

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Introduction to Hypothesis Testing

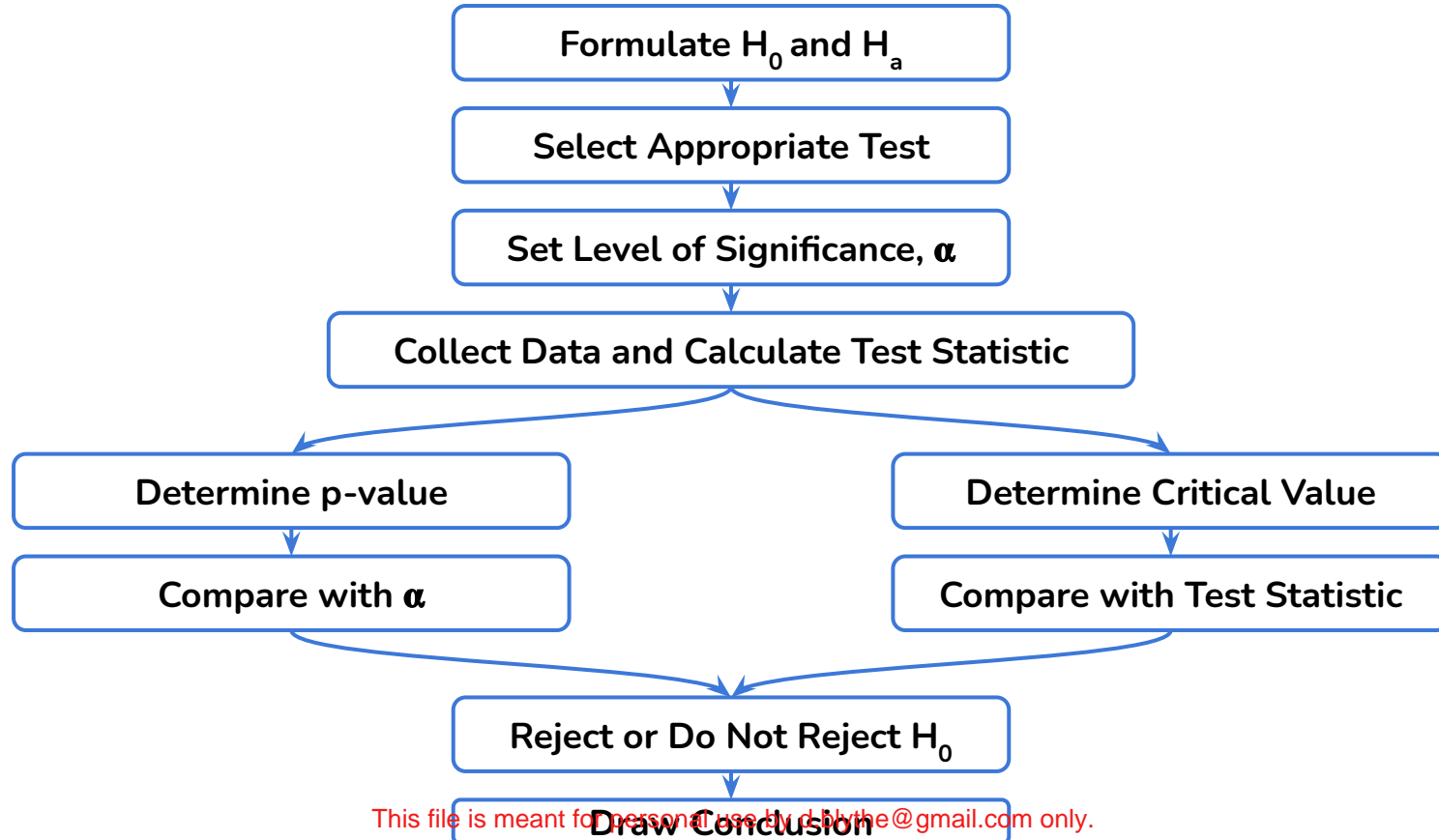


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Hypothesis Testing Steps



Hypothesis Formulation

Problem Statement 1:

The store manager believes that the average waiting time for the customers of the smart supermarkets at checkouts has become worse than 15 minutes. Formulate the hypothesis.

$$H_0: \mu = 15$$

$$H_a: \mu > 15$$

Problem Statement 2:

A pharmaceutical company has developed an improved drug. The company claims that it takes less than 12 minutes for the drug to enter in the patient's bloodstream. Formulate the hypothesis to convince the FDA to approve the claim.

$$H_0: \mu = 12$$

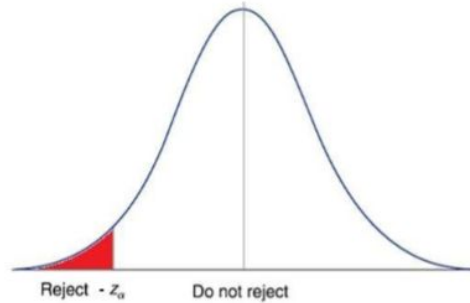
$$H_a: \mu < 12$$

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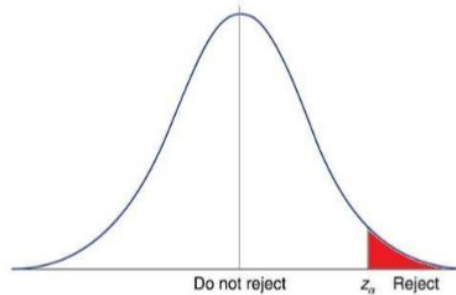
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One-tailed vs Two-tailed Test



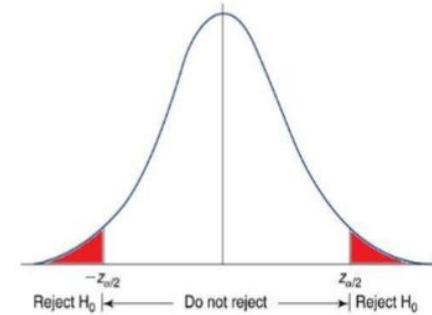
- Lower tail test.
- $H_1: \mu < \dots$

Reject H_0 if the value of test statistic is too small



- Upper tail test.
- $H_1: \mu > \dots$

Reject H_0 if the value of test statistic is too large



- Two tail test.
- $H_1: \mu \neq \dots$

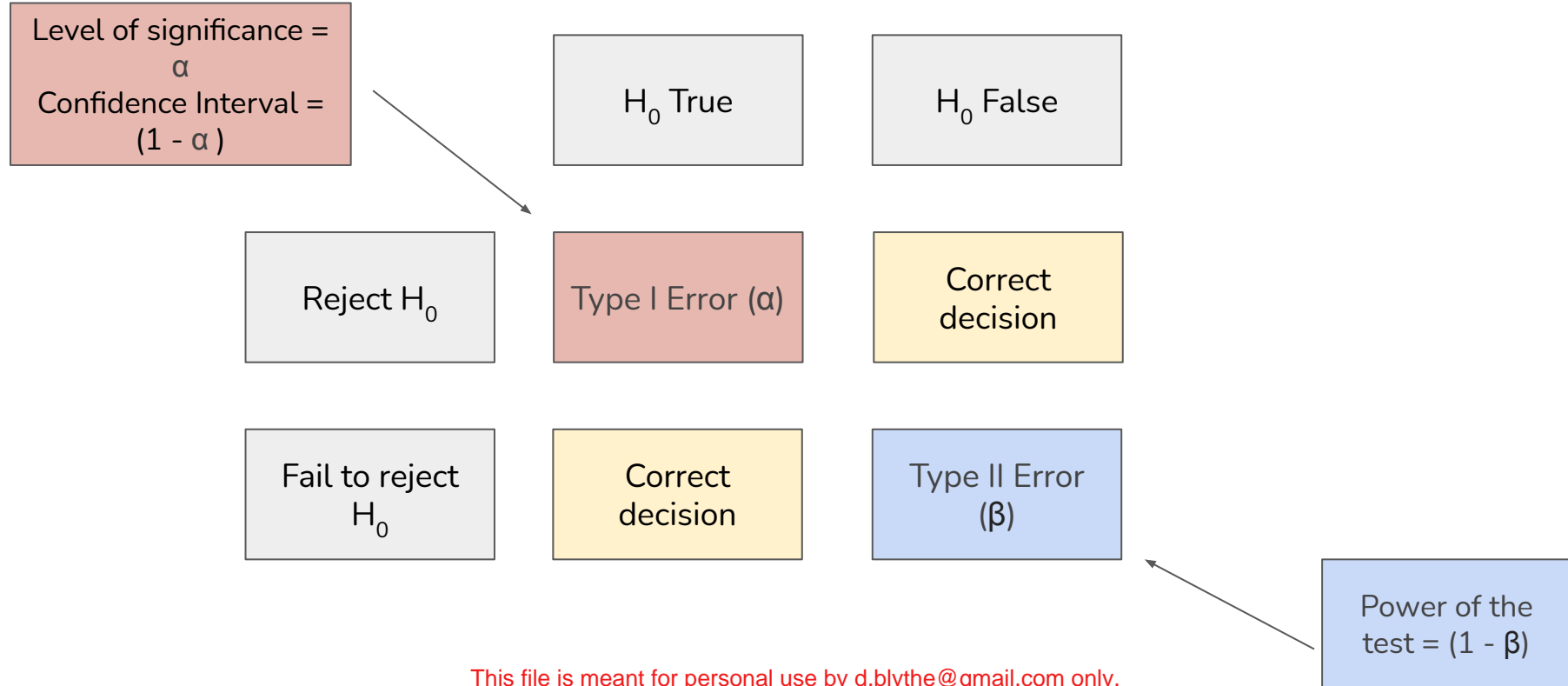
Reject H_0 if the value of test statistic is either too small or too large

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Type I and Type II errors



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Example

Problem Statement: The store manager believes that the average waiting time for the customers of the smart supermarkets at checkouts has become worse than 15 minutes. Formulate the hypothesis.

Null Hypothesis (H_0): The average waiting time at checkouts is less than equal to 15 minutes.

Alternate Hypothesis (H_a): The average waiting time at checkouts is more than 15 minutes.

Type I error (false positive): Reject Null hypothesis when it is indeed true. “The fact is that the average waiting time at checkout is less than equal to 15 minutes but the store manager has identified that it is more than 15 minutes”.

Type II error (false negative): Fail to reject Null hypothesis when it is indeed false. “The fact is that the average waiting time at checkout is more than 15 minutes but the store manager has identified that it is less than equal to 15 minutes”.

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Hypothesis Testing Frameworks

Choice of test depends on test statistic and data availability

Means

Compare the sample mean to the population mean when std dev is known

1-sample z-test

Compare the sample mean to the population mean when std dev is unknown

1-sample t-test

Compare the sample means from 2 independent populations when std devs are known

2-sample ind. z-test

Compare the sample means from 2 independent populations when std devs are unknown

2-sample ind. t-test

Compare the sample means from 2 related populations when std devs are unknown

Paired t-test

Compare the sample means from 2 or more independent populations

ANOVA Test

Proportions

Compare the sample proportion to the population proportion

1-sample z-test

Compare the sample proportions from two populations

2-sample z-test

Variances

Compare the sample variance to the population variance

Chi-Square test

Compare the sample variances from two populations

F-test

Frequencies

Check whether the categorical variables from a population are independent

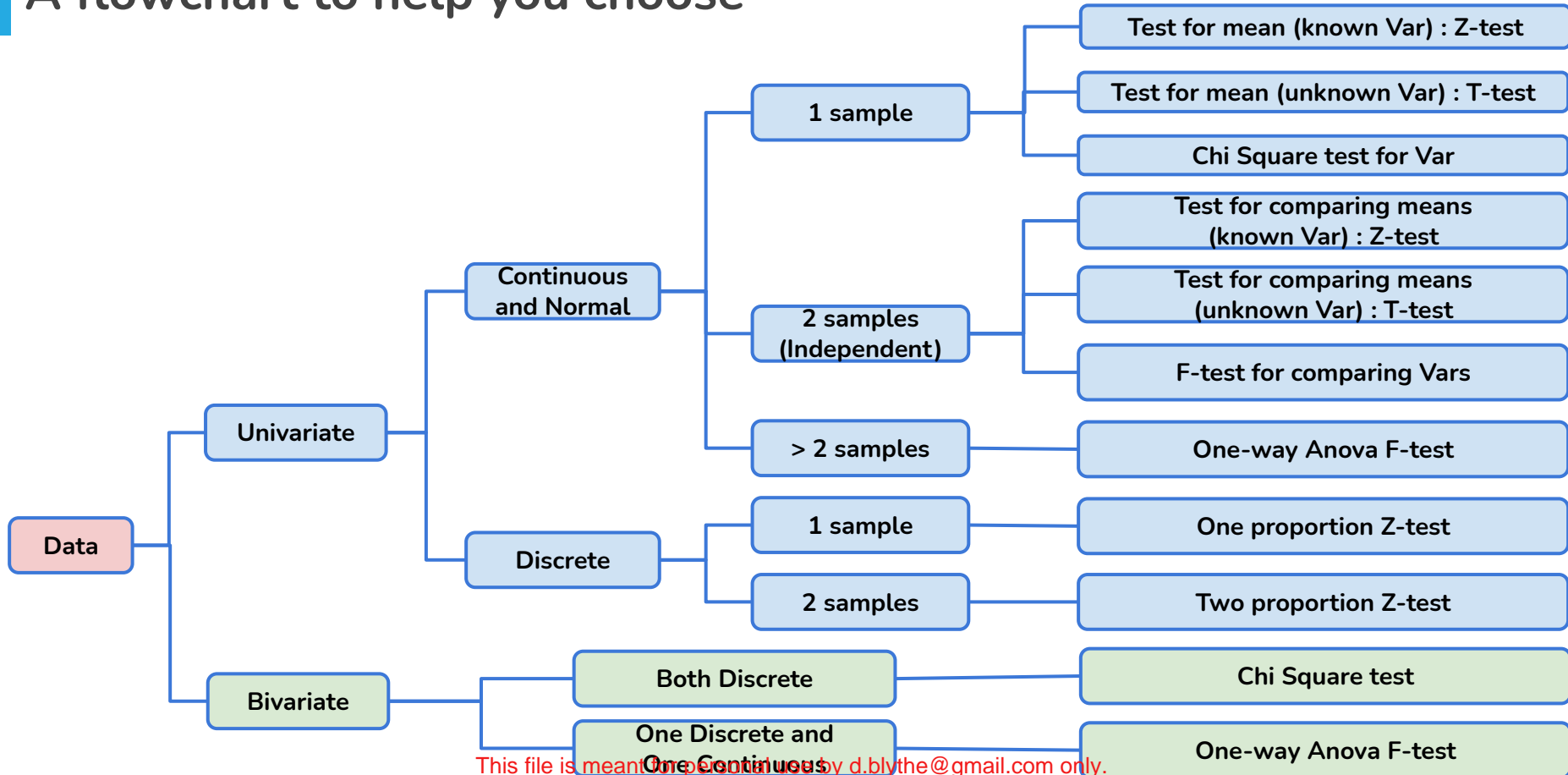
Chi-Square Test of Independence

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A flowchart to help you choose



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Let's discuss some of the tests

Now, we will discuss some of the important hypothesis tests in the below case studies.

Case Study	Tests covered
Mobile Internet Case Study	One sample t-test
Titan Insurance Case Study	Paired t-test
Diet Case Study	ANOVA test

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