

give different real life examples of the situations with the test appliance
 The hypothesis test must match the situation:
 Means → t-test
 proportions → z-test
 Variances → chi-square test
 Distributions → KS-test

Below are **different real-life scenarios**, each mapped to the **correct hypothesis test** based on what is being measured (mean, proportion, variance, distribution).

For each case:

- I give **the situation**,
- **Null/alternative hypothesis**,
- **Correct test**,
- **Why that test fits**,
- **Real-world ML/Data-Science connection (optional)**.

1. MEAN COMPARISONS → t-TEST

One Sample t-Test

In the population, the average IQ is 100. A team of scientists wants medication to see if it has either a positive or negative effect on intelligence at all. A sample of 30 participants who have taken the medication had a mean IQ of 102 with a standard deviation of 20. Did the medication affect intelligence?

3. Calculate Degrees of Freedom

$$n - 1 = 30 - 1 = 29$$

OVERVIEW OF T-TESTS

T-test

Used to compare two samples to determine if they came from the same population.



Are both of them humans?

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Example 1: Does a new training program increase average employee productivity?

- ChatGPT 5.2
- $H_1: \mu_{\text{after}} > \mu_{\text{before}}$
 - **Test: Paired t-test**
 - **Why:** Same individuals measured twice → comparing means of paired samples.

ML Connection: Evaluating if a new preprocessing method increases model accuracy on average across datasets.

Example 2: Are boys' average heights different from girls' average heights in a school?

- $H_0: \mu_{\text{boys}} = \mu_{\text{girls}}$
- $H_1: \mu_{\text{boys}} \neq \mu_{\text{girls}}$
- **Test:** Independent two-sample t-test
- **Why:** Comparing means of two unrelated groups.

ML Connection: Does model A give significantly higher mean accuracy than model B?

Example 3: Is the average delivery time of Zomato shorter than its competitor?

- $H_0: \mu_{\text{Zomato}} = \mu_{\text{competitor}}$
- $H_1: \mu_{\text{Zomato}} < \mu_{\text{competitor}}$
- **Test:** Two-sample t-test

ML Connection: Testing if a new optimization reduces mean inference time.



2. PROPORTIONS → z-TEST FOR PROPORTIONS



Example 1: Is the Covid-19 vaccine success rate above 95%?

- **Situation:** Proportion of people who develop immunity.
- $H_0: p = 0.95$
- $H_1: p > 0.95$
- **Test:** One-proportion z-test

- **Why:** Large sample, categorical outcome (immune / not immune).

Example 2: Do more than 60% of customers prefer Diet Coke over regular Coke?

- $H_0: p = 0.60$
- $H_1: p > 0.60$
- Test: One-proportion z-test

Example 3: Is the click-through rate (CTR) different for Ad A vs Ad B?

- $H_0: p_A = p_B$
- $H_1: p_A \neq p_B$
- Test: Two-proportion z-test

ML Connection: A/B testing models, features, UI, or increasing conversion rate.

✓ 3. VARIANCES → CHI-SQUARE TEST FOR VARIANCE

Observed Value			Chi-Sq Stats = $\sum[(\text{Observed} - \text{Expected})^2] / \text{Expected}$		
High income	Med income		Low income		
25	15	60	B.Tech	0.0476	0.1481
20	5	40	M.Tech	0.0714	0.2222
45	20	100			1.125
Expected Value			Chi-Square Statistics = 2.3643 Degree of freedom = 2 P-Value = 0.3066		
income	Low income				
27	12				
18	8				
Category 5		53	50		
Category 6					
Category 7					
Category 8					
CALCULATE			a single variance		

in machine production lower after maintenance?
is consistent (low-variance) output.

Example 2: Does a new traffic-signal algorithm reduce variation in waiting time?

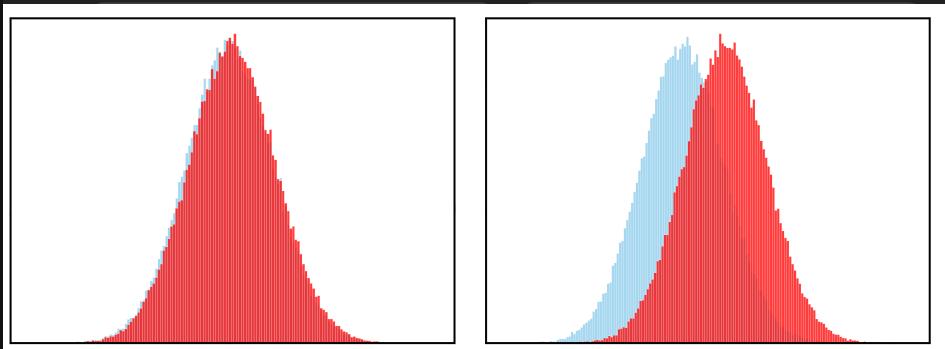
- $H_0: \sigma^2_{\text{new}} = \sigma^2_{\text{old}}$
- $H_1: \sigma^2_{\text{new}} < \sigma^2_{\text{old}}$
- Test: Chi-square test

ML Connection: Testing if new ML model predictions have smaller variance → more stable.

Example 3: Does a manufacturing line produce parts with variance within acceptable limits?

- $H_0: \sigma^2 = \sigma^2_{\text{target}}$
 - $H_1: \sigma^2 \neq \sigma^2_{\text{target}}$
 - Test: Chi-square goodness-of-fit for variance
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4. DISTRIBUTIONS → KS-TEST (Kolmogorov–Smirnov Test)



Example 1: Does customer purchase amount follow a normal distribution?

- Situation: Analyst wants to check if revenue $\sim \text{Normal}(\mu, \sigma)$.
- H_0 : Distribution = $\text{Normal}(\mu, \sigma)$
- H_1 : Distribution \neq Normal
- Test: One-sample KS Test
- Why: Compares empirical distribution vs theoretical CDF.

ML Connection: Checking if residuals follow normal distribution for linear regression assumptions.

Example 2: Are the distributions of transaction amounts before and after a fraud event identical?

- $H_0: F_{\text{before}}(x) = F_{\text{after}}(x)$
- $H_1: F_{\text{before}}(x) \neq F_{\text{after}}(x)$
- Test: Two-sample KS test

Used in fraud detection → sudden distribution change.

Example 3: Do two different sensors produce statistically identical readings?

- $H_0: F_{\text{sensor1}}(x) = F_{\text{sensor2}}(x)$
- $H_1: F_{\text{sensor1}}(x) \neq F_{\text{sensor2}}(x)$
- Test: Two-sample KS test

ML Connection: Comparing data drift vs training dataset distribution.

🎯 QUICK MATCHING TABLE

Scenario	What is measured?	Correct Test
Comparing average marks of two classes	Mean	t-test
Checking if >40% voters support a candidate	Proportion	z-test for proportions
Checking if variance of machine output changed	Variance	Chi-square test
Checking if data follows normal distribution	Distribution	KS-test
Checking if two apps have same response-time distribution	Distribution	Two-sample KS-test
A/B test CTR difference	Proportion	z-test
Stability of new ML model predictions	Variance	Chi-square
Pre-/post training productivity	Mean	Paired t-test

Want next?

I can give:

- 20 more scenarios for each test
- Numerical examples
- How to choose the test automatically using a flowchart
- Derivation of each test statistic and p-value

Just say "next".

