

# Hypothesis Testing

## Hypothesis Testing Asks the Question:

Are two or more sets of data the same, different or related statistically?  
Specifically, do they have the same or different means and variances?  
Or is there a relationship between the data?

## How Does Hypothesis Testing Improve Products & Processes?

Hypothesis tests help identify differences between machines, formulas, raw materials, medications, etc. Without such testing, employees may change the product or process causing more variation. Hypothesis tests enable data driven decisions.

## Steps to Perform a Hypothesis Test

1. Define the null (H0) and an alternate (Ha) hypothesis. The null hypothesis assumes that differences are due to chance - that the means or variation are statistically the same. The goal is to prove that they are NOT statistically the same at some level of confidence (usually 95%, 99%).
2. Using data from the test, calculate the test statistic (t test, f test, ANOVA, etc.).
3. The test statistic is often converted to a p value (probability), but not always.
4. Use one of these methods to determine if you can reject or cannot reject the null hypothesis.
  - **Classical** - compare a test statistic to a critical value
  - **p value** - probability of a test statistic being contrary to the null hypothesis
  - **Confidence Interval** - is the test statistic between or outside of the confidence interval

## Interpreting the Test Results

Test Method	Compare	Result
Classical	test statistic > critical value (i.e. $F > F_{crit}$ )	Reject the null hypothesis
Classical	test statistic < critical value (i.e. $F < F_{crit}$ )	Cannot Reject the null hypothesis
p value	p value < $\alpha$	Reject the null hypothesis
p value	p value > $\alpha$	Cannot Reject the null hypothesis

## Advantages of Using the QI Macros for Statistical Tests

The QI Macros can do F-tests, t-tests, ANOVA and much more.

1. Just select your data and the test you want from the QI Macros menu.
2. The QI Macros will prompt you for your confidence level and perform all of the calculations for you.

Anova: Single Factor		$\alpha$	0.05			
SUMMARY						
Groups	Count	Sum	Average	Variance		
Data1	7	6005%	858%	20.80988		
Data2	7	9410%	1344%	41.17286		
Data3	7	10215%	1459%	43.22702		
Data4	7	12720%	1817%	68.60571		
ANOVA						
Cannot Reject Null Hypothesis because $p > 0.05$ (Means are the same)						
Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	329.6018	3	109.8673	2.528365	0.081	3.008787
Within Groups	1042.893	24	43.45387			
Total	1372.495	27				

3. **The QI Macros output will even interpret the results for you:**
  - Reject Null Hypothesis vs Cannot Reject Null Hypothesis
  - because:  $p > \alpha$  or  $p < \alpha$
  - therefore : Means/Variances are the Same or Different
4. The interactive output worksheet also lets you change the confidence level ( $\alpha$ ) to determine the impact on the results.

## Not Sure Which Test to Run?

Just select your data and the QI Macros Stat Wizard will analyze it and run the correct statistical tests for you.

The wizard will also tell you:

- Data Is or Is Not Normal
- Means are the Same or Different
- Variances are the Same or Different

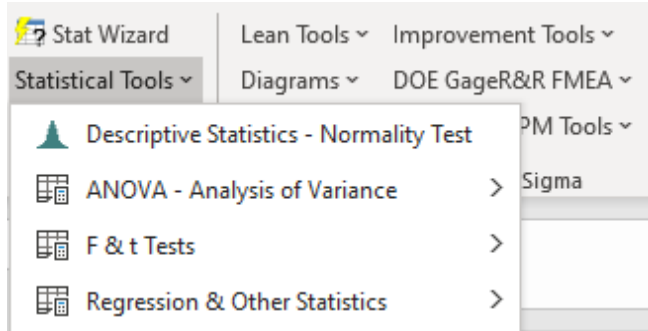
	A	B	C	D	E	F
	Hardwood Concentration	5%	10%	15%	20%	
1	%					
2	Obs1	7	12	14	19	
3	Obs2	8	17	18	25	
4	Obs3	15	13	19	22	
5	Obs4	11	18	17	23	
6	Obs5	9	19	16	18	
7	Obs6	10	15	18	20	

Learn more at: [www.qimacros.com/hypothesis-testing/](http://www.qimacros.com/hypothesis-testing/)

## Using the Stat Wizard

The **QI Macros Statistical Wizard** will analyze your data and run the correct statistical tests for you.

1. Just click and drag over your data to select it.
2. Then click on the QI Macros Menu and Stat Wizard.
3. If you know the test you want to run, select it on the Statistical Tools menu:



## Types of Hypothesis Tests

Variable Data	1 Sample	2 Samples	2 + Samples
<b>Test of Variances</b>		F-test: normal data Levenes test: non-normal data	Levenes test
<b>Test of Means</b>			
One Factor (e.g. time)	t-test - 1-sample	t-test - 2-sample	One Way ANOVA
Two Factor (e.g. time + temp)			Two Way ANOVA Two Way ANOVA with Replication
Attribute Data	1 Sample	2 Samples	2 + Samples
One-Factor	One-Sample Proportion Test	Two-Sample Proportion Test	Chi-Square Test
Two-Factors			Chi-Square Test
Non-Parametric	1 Sample	2 Samples	3 Samples
<b>Continuous Data</b>			
Independent		Wilcoxon Mann-Whitney	Kurskal-Wallis
Dependent		Spearman	
Goodness of Fit	Kolmogorov-Smirnov	Tukey	
<b>Ordinal Data</b>			
Independent	1-Sample Sign Test	Sign Test	
Dependent		Spearman	

## Other Statistical Tools in the QI Macros

### Regression Analysis

Calculates Goodness of fit, p-value and  $y = F(x)$  for predication and estimation.

### Sample Size Calculator

For both attribute and variable data.