

# Hypothesis Testing Cheat Sheet

## Key Concepts

- ◇ Hypothesis testing uses statistical tests to determine if a hypothesis is true.
- ◇ **The null hypothesis,  $H_0$** , is the statement that there **IS NO** statistically significant difference or relationship between variables.
- ◇ Any differences that are observed are due to chance. It is a statement of “no effect” or “no difference.” It is the hypothesis which a researcher tries to disprove, reject or nullify.
- ◇ **The alternative hypothesis,  $H_1$  or  $H_a$** , is the statement created by researchers when they speculate upon the outcome of a research or experiment.
- ◇ The alternative hypothesis states that there **IS** a statistically significant difference or relationship between variables.
- ◇ The alternative hypothesis is what the researcher really thinks is the cause of a difference. For example, they may be testing the effects of a new drug.

## How Does Hypothesis Testing Improve Products & Processes?

Hypothesis testing can be used in business operations as well. Tests can 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.

## Three Hypothesis Testing Methods

1. **Classical:** Compare a test statistic to a critical value.
2. **p value:** Probability of a test statistic being contrary to the null hypothesis.
3. **Confidence Interval:** Is the test statistic between or outside of the confidence interval.

## Type I and Type II Errors

Type I error - Reject a null hypothesis that is true (Producer’s Risk)

Type II error - Not reject a null hypothesis that is false (Consumer’s Risk)

## How to Conduct a Hypothesis Test

### Steps to Follow

1. Define the null and alternative hypothesis.
2. Conduct the test.
3. Using data from the test:
  - Calculate the test statistic (i.e. F) and the critical value (i.e. F crit).
  - Calculate a p value and compare it to a significance level ( $\alpha$ ) or confidence level (1- $\alpha$ ). For example, if the significance level = 5%, then the confidence level = 95%.
4. Interpret the results to accept or reject the null hypothesis.

### Interpreting the 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

### Translating Stat Speak to English

Null Hypothesis: means or variances are **not significantly different**.

#### Reject the Null Hypothesis

$$p \text{ value} < \alpha$$

Means are not the same or  
Variances are not the same

Means are different  
Variances are different

#### Cannot Reject the Null Hypothesis

$$p \text{ value} > \alpha$$

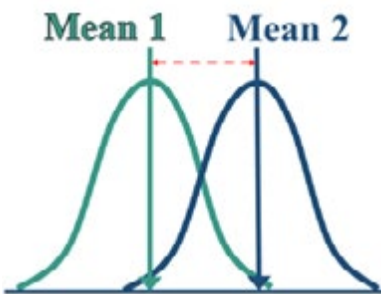
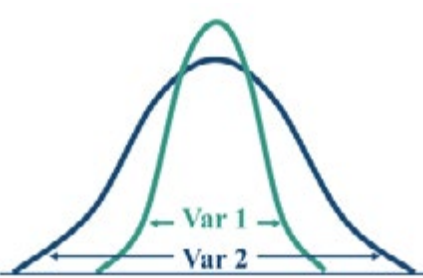

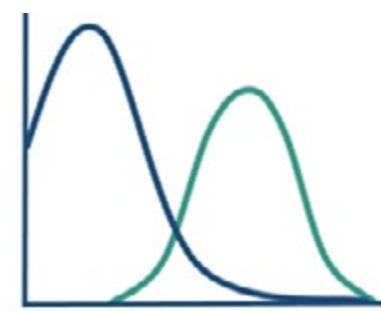
Means are not significantly different  
Variances are not significantly different

Means are the same or  
Variances are the same



# Hypothesis Testing Cheat Sheet

## Examples of Statistical Tests included in QI Macros for Excel

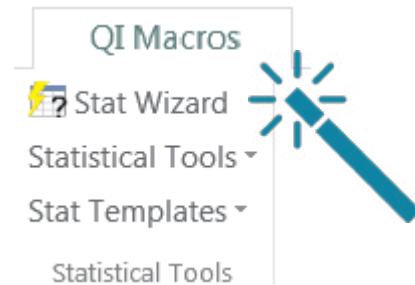
Test of Means	Test of Variances	Test of Relationships	And More
			
ANOVA t tests z test	f test Levenes test	Chi-square Descriptive Statistics Multiple Regression Analysis	AQL Sampling Tables Normality Test Sample Size Calculator

### Advantages of Using QI Macros

- Just select your data and then the test you want from QI Macros menu.
- Performs all of the calculations and interprets the results for you. (i.e. Reject null hypothesis because  $p < \alpha$ , means are different)
- Draws a box plot or other chart to better explain the results.
- Compatible with PC and Mac. Excel 2010-2019 and Office 365.
- Reduce risk of manual calculations or your own Excel formulas.
- Save Time!

### Not Sure Which Statistical Test to Run?

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



### Example of QI Macros Results

Groups	Count	Sum	Average	Variance
5%	6	60	10	8
10%	6	94	15.6667	7.86667
15%	6	102	17	3.2
20%	6	127	21.1667	6.96667

Post Hoc	5%	10%	15%
10%	5.86667		
15%	7	1.33333	
20%	11.1667	5.5	4.16667

Colored cells have significant mean differences

Source of Variation	SS	df	MS	F	P-Value	F crit
Between Groups	382.792	3	127.597	19.6052	0.000	3.09839
Within Groups	130.167	20	6.50833			
Total	512.958	23				

ANOVA **Reject Null Hypothesis because  $p < 0.05$  (Means are Different)**