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# StaTool

Statistic and Probability Tools  
for Windows

## User's Manual

Ref.: STAT

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## Introduction

StaTool is a Windows application for Statistic and Probability calculations.

**StaTool** performs 7 types of Statistic and Probability calculations:  
Hypothesis testing, Confidence interval estimation, Probability distributions,  
One variable statistic, Two variables statistic, Total Probability Law and Bayes' Theorem,  
Probability of A and B events

Please, read this manual carefully in order to learn all the capabilities of the application.

Note:

Design and specifications are subject to changes without notice.

## Formats for input values

The numeric values can be entered in the following formats:

- Standard numbers: 0.24; 15.23
- Percentage: 90%; 12%
- Fractions: 2/3; 5/8
- Scientific notation: 2E-4 (equal to  $2 \times 10^{-4} = 0.0002$ )

The decimal separator is a POINT.

Even, if you enter a COMMA, a POINT is entered instead.

## Types of calculations

**StaTool** performs 7 types of Statistic and Probability calculations:

- Hypothesis testing.
- Confidence interval estimation.
- Probability distributions.
- One variable statistic.
- Two variables statistic.
- Total Probability Law and Bayes' Theorem.
- Probability of A and B events.

We have to press the relevant label in the main window in order to access to each calculation type.

## Hypothesis testing

Allows us to test a population statistic using sample statistics.

Always, we have to enter the confidence level or the significance level.

Hypothesis testing can be two-sided, left side or right side.

StaTool has 9 types of Hypothesis testing:

### **One population:**

- 1) Mean of population (known population variance).
- 2) Mean of population (unknown population variance).
- 3) Variance of population.
- 4) Ratio of population.

### **Two populations:**

- 5) Mean difference of two populations (known population variances).
- 6) Mean difference of two populations (unknown and equal population variances).
- 7) Mean difference of two populations (unknown and different population variances).
- 8) Variance ratio of two populations.
- 9) Ratio difference of two populations.

## Confidence interval estimation

Allows us estimate the Confidence Interval of a population statistic using sample statistics.

Always, we have to enter the confidence level or the significance level.

StaTool has 9 types of Confidence Intervals:

### **One population:**

- 1) Mean of population (known population variance).
- 2) Mean of population (unknown population variance).
- 3) Variance of population.
- 4) Ratio of population.

### **Two populations:**

- 5) Mean difference of two populations (known population variances).
- 6) Mean difference of two populations (unknown and equal population variances).
- 7) Mean difference of two populations (unknown and different population variances).
- 8) Variance ratio of two populations.
- 9) Ratio difference of two populations.

## Probability distributions

For each probability distribution, we can calculate the percentage point or the probability (\*).

Probability can be left cumulative, right cumulative, interval, centered interval or point.

StaTool has 6 types of probability distribution:

- 1) Normal.
- 2) t-Student.
- 3) Chi-Square.
- 4) F-Snedecor.
- 5) Binomial.
- 6) Poisson.

### **Note:**

(\*) In the Binomial or Poisson distribution, we can calculate only the probability, not the percentage point.

## One variable statistic

Allows us to calculate statistical data for one numeric variable.

Data can be ungrouped or grouped (intervals or classes).

StaTool calculates the following statistical data:

- 1) Mean.
- 2) Median.
- 3) Mode.
- 4) Standard deviation.
- 5) Variance.
- 6) Coefficient of variation.
- 7) Skewness.
- 8) Kurtosis.
- 9) Moments (0th to 4th, about mean and origin).
- 10) Quartiles, deciles and percentiles and his inverses.
- 11) Graphic (bar and histogram chart) and printing.

- We can save and open data as a file (E1V extension).

- Also, we can print data and results.

## Two variable statistic

Allows us to calculate statistical data for two numeric variables X and Y.

We can calculate 5 types of functions for regression analysis using the least squared method:

- 1) Linear
- 2) Logarithmic
- 3) Exponential
- 4) Power
- 5) Quadratic

StaTool calculates the following statistical data:

- 1) Means of X and Y.
- 2) Standard deviations of X and Y.
- 3) Variances of X and Y.
- 4) Covariance.
- 5) Coefficient of correlation.
- 6) Formula of regression curve.
- 7) Estimation of X or Y.
- 8) Graphic (scatter plot and regression curve) and printing.

- We can save and open data as a file (E2V extension).

- Also, we can print data and results.

## Total Probability Law and Bayes' Theorem

We have a set of incompatible  $A_i$  events as a finite partition of the probability space. Also, we have the event  $B$  that is compatible with each  $A_i$ .

If we know the probabilities  $p(A_i)$  and  $p(B / A_i)$ , then StaTool calculates  $p(B)$  and  $p(A_i / B)$

## Probability of two events A and B

For  $A$  and  $B$  events, we can calculate some probability values when we know some other probability values:

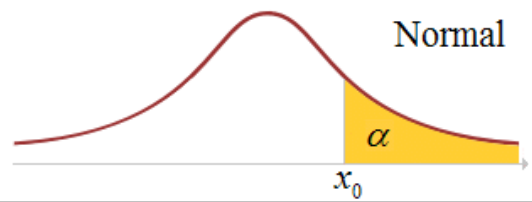
We have to know some of the following values of probability:

$p(A)$	$p(\bar{A})$
$p(B)$	$p(\bar{B})$
$p(A \cap B)$	$p(\overline{A \cap B})$
$p(A \cup B)$	$p(\overline{A \cup B})$
$p(\bar{A} \cap \bar{B})$	$p(\bar{A} \cup \bar{B})$
$p(A / B)$	$p(A - B)$
$p(B / A)$	$p(B - A)$

## Formulas of Probability distributions

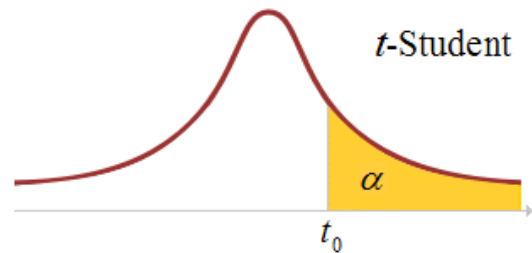
### Normal distribution (Gauss)

$$\alpha = p(x \geq x_0) = \int_{x_0}^{\infty} \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(x-\mu)^2}{2\sigma^2}} dx$$



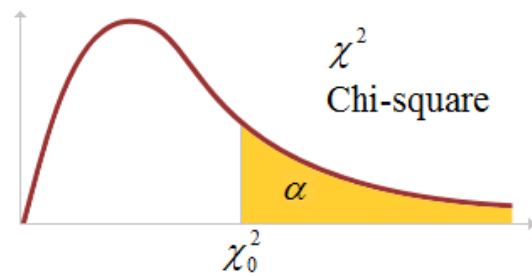
### t-Student distribution (Gosset)

$$\alpha = p(t \geq t_0) = \int_{t_0}^{\infty} \frac{\Gamma\left(\frac{n+1}{2}\right) \left(1 + \frac{t^2}{n}\right)^{-\frac{n+1}{2}}}{\Gamma\left(\frac{n}{2}\right) \sqrt{n} \pi} dt$$



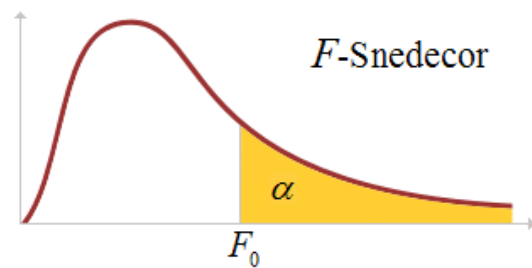
### Chi-square distribution (Pearson)

$$\alpha = p(\chi^2 \geq \chi_0^2) = \int_{\chi_0^2}^{\infty} \frac{e^{-x/2} x^{n/2-1}}{2^{n/2} \Gamma(n/2)} dx$$



### F distribution (Fisher-Snedecor)

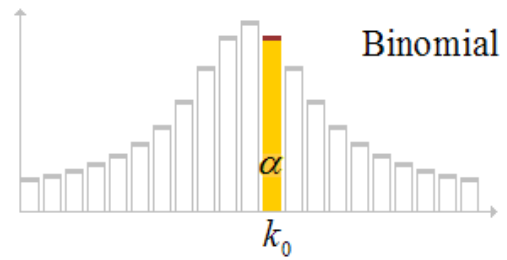
$$\alpha = p(F \geq F_0) = \int_{F_0}^{\infty} \frac{\Gamma\left(\frac{n_1+n_2}{2}\right) \left(\frac{n_1}{n_2}\right)^{\frac{n_1}{2}} F^{\frac{n_1}{2}-1}}{\Gamma\left(\frac{n_1}{2}\right) \Gamma\left(\frac{n_2}{2}\right) \left(1 + \frac{n_1}{n_2} F\right)^{\frac{n_1+n_2}{2}}} dF$$



**Binomial distribution**

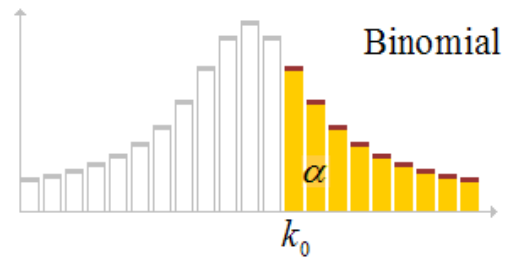
Probability at a point:

$$\alpha = p(x = k_0) = \binom{n}{k_0} p^{k_0} (1-p)^{n-k_0}$$



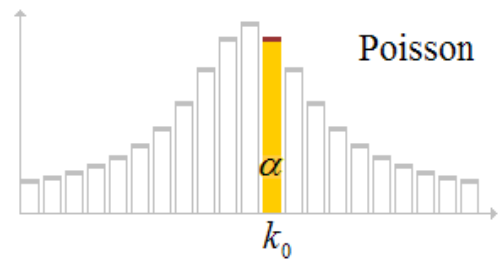
Upper cumulative probability:

$$\alpha = p(x \geq k_0) = \sum_{i=k_0}^n \binom{n}{i} p^i (1-p)^{n-i}$$

**Poisson distribution**

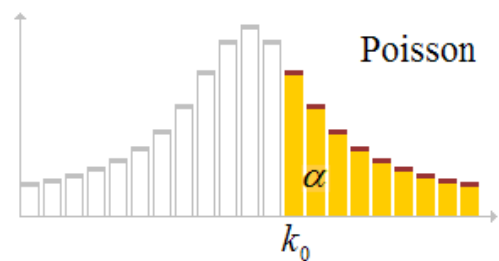
Probability at a point:

$$\alpha = p(x = k_0) = e^{-\lambda} \frac{\lambda^{k_0}}{k_0!}$$



Upper cumulative probability:

$$\alpha = p(x \geq k_0) = \sum_{n=k_0}^{\infty} e^{-\lambda} \frac{\lambda^n}{n!}$$



**Where:**

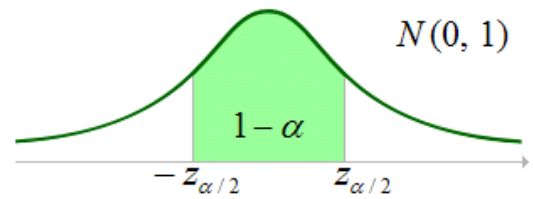
$\alpha$	Probability
$x$	Random variable of Normal distribution
$\mu$	Mean of Normal distribution
$\sigma$	Standard deviation of Normal distribution
$x_0$	Percentage point of Normal distribution
$t$	Random variable of $t$ -Student distribution
$n$	Degrees of freedom of $t$ -Student distribution
$t_0$	Percentage point of $t$ -Student distribution
$\chi^2$	Random variable of Chi-square distribution
$n$	Degrees of freedom of Chi-square distribution
$\chi_0^2$	Percentage point of Chi-square distribution
$F$	Random variable of $F$ -Snedecor distribution
$n_1$	Numerator degrees of freedom of $F$ -Snedecor distribution
$n_2$	Denominator degrees of freedom of $F$ -Snedecor distribution
$F_0$	Percentage point of $F$ -Snedecor distribution
$n$	Number of trials in Binomial distribution
$p$	Probability of success for each alone event in Binomial distribution
$x$	Random variable of Binomial distribution
$k_0$	Percentage point of Binomial distribution
$\lambda$	(Lambda): Mean and standard deviation of Poisson distribution
$x$	Random variable of Poisson distribution
$k_0$	Percentage point of Poisson distribution

## Formulas of Confidence interval estimation

### Mean of population

(known population variance)

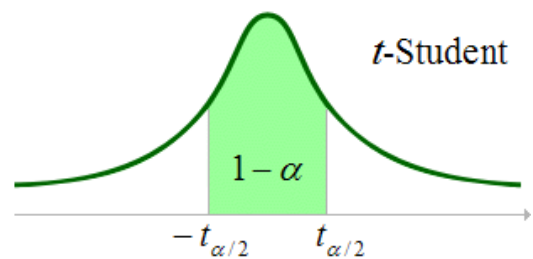
$$\mu \in \left( \bar{x} - z_{\frac{\alpha}{2}} \frac{\sigma}{\sqrt{n}}, \bar{x} + z_{\frac{\alpha}{2}} \frac{\sigma}{\sqrt{n}} \right)$$



### Mean of population

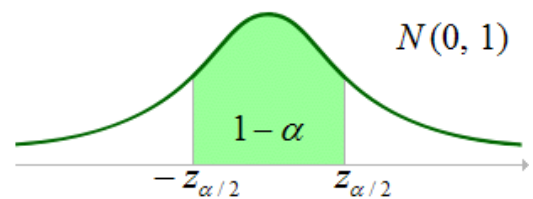
(unknown population variance)

$$\mu \in \left( \bar{x} - t_{\left(\frac{\alpha}{2}, n-1\right)} \frac{S}{\sqrt{n}}, \bar{x} + t_{\left(\frac{\alpha}{2}, n-1\right)} \frac{S}{\sqrt{n}} \right)$$



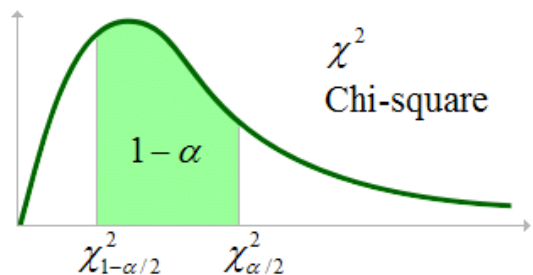
### Ratio of population

$$p \in \left( \hat{p} - z_{\frac{\alpha}{2}} \sqrt{\frac{\hat{p}(1-\hat{p})}{n}}, \hat{p} + z_{\frac{\alpha}{2}} \sqrt{\frac{\hat{p}(1-\hat{p})}{n}} \right)$$



### Variance of population

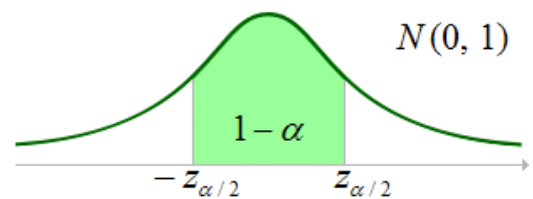
$$\sigma^2 \in \left( \frac{(n-1)S^2}{\chi^2_{\left(\frac{\alpha}{2}, n-1\right)}}, \frac{(n-1)S^2}{\chi^2_{\left(1-\frac{\alpha}{2}, n-1\right)}} \right)$$



### Mean difference of two populations

(known population variances)

$$\mu_1 - \mu_2 \in \left( \bar{x}_1 - \bar{x}_2 \pm z_{\frac{\alpha}{2}} \sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}} \right)$$



### Mean difference of two populations

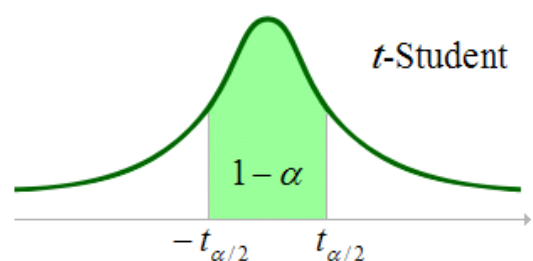
(unknown and equal population variances)

$$\mu_1 - \mu_2 \in \left( \bar{x}_1 - \bar{x}_2 \pm t_{\left(\frac{\alpha}{2}, n_1+n_2-2\right)} S_P \sqrt{\frac{1}{n_1} + \frac{1}{n_2}} \right)$$

Where:  $S_P^2 = \frac{(n_1-1)S_1^2 + (n_2-1)S_2^2}{n_1+n_2-2}$

(Pooled variance of the samples)

$$\sigma_1^2 = \sigma_2^2$$



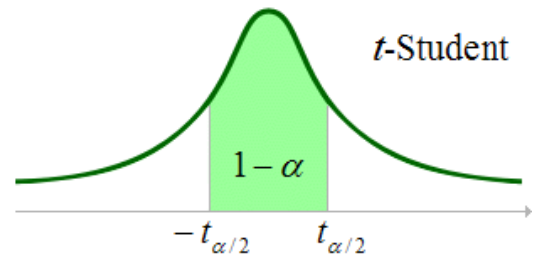
### Mean difference of two populations

(unknown and different population variances)

$$\mu_1 - \mu_2 \in \left( \bar{x}_1 - \bar{x}_2 \pm t_{\left(\frac{\alpha}{2}, \nu\right)} \sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}} \right)$$

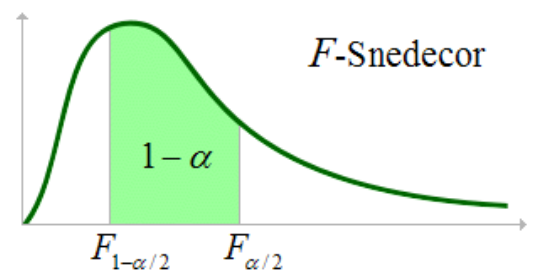
Where: 
$$\nu \approx \frac{(S_1^2/n_1 + S_2^2/n_2)^2}{\frac{(S_1^2/n_1)^2}{n_1-1} + \frac{(S_2^2/n_2)^2}{n_2-1}}, \quad \sigma_1^2 \neq \sigma_2^2$$

(Welch approximation)



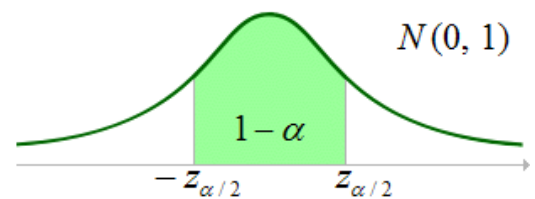
### Variance ratio of two populations

$$\frac{\sigma_1^2}{\sigma_2^2} \in \left( \frac{S_1^2}{S_2^2} F_{\left(1-\frac{\alpha}{2}, n_2-1, n_1-1\right)}, \frac{S_1^2}{S_2^2} F_{\left(\frac{\alpha}{2}, n_2-1, n_1-1\right)} \right)$$



### Ratio difference of two populations

$$p_1 - p_2 \in \left( \hat{p}_1 - \hat{p}_2 \pm z_{\frac{\alpha}{2}} \sqrt{\frac{\hat{p}_1(1-\hat{p}_1)}{n_1} + \frac{\hat{p}_2(1-\hat{p}_2)}{n_2}} \right)$$

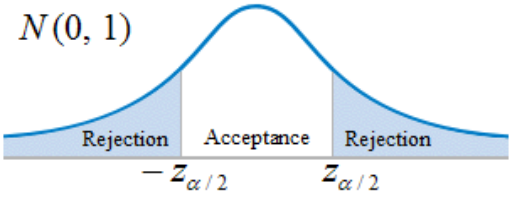
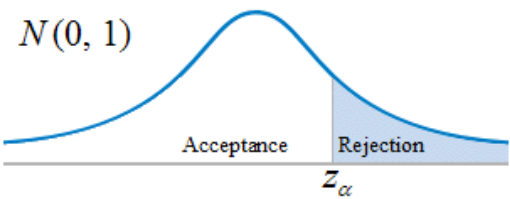
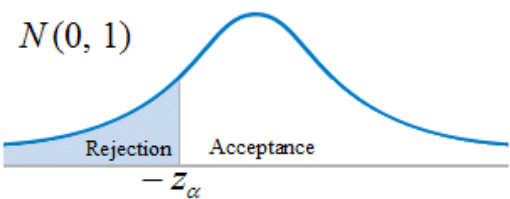


### Where:

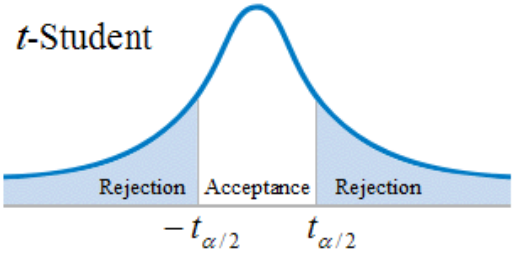
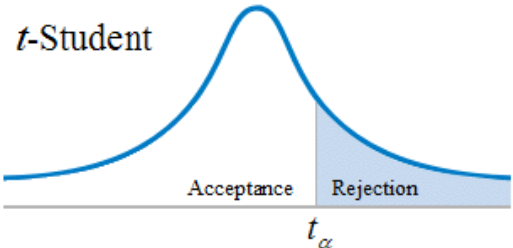
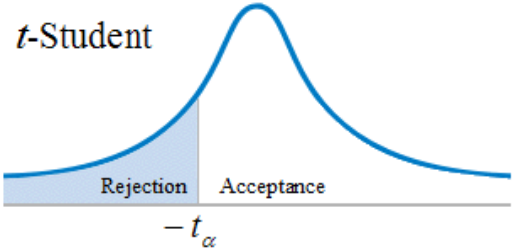
$\mu$	Mean of the population
$\bar{x}$	Mean of the sample
$\sigma$	Standard deviation of the population
$S$	Standard deviation of the sample
$p$	Ratio of the population
$\hat{p}$	Ratio of the sample
$n$	Sample size
$\alpha$	Significance level
$1-\alpha$	Confidence level
$z_{\frac{\alpha}{2}}$	Percentage point of the Normal distribution with an upper cumulative probability of $\frac{\alpha}{2}$
$t_{(\alpha, \nu)}$	Percentage point of the t-Student distribution with an upper cumulative probability $\alpha$ and $\nu$ degrees of freedom.
$\chi^2_{(\alpha, \nu)}$	Percentage point of the Chi-square distribution with an upper cumulative probability $\alpha$ and $\nu$ degrees of freedom.
$F_{(\alpha, \nu_1, \nu_2)}$	Percentage point of F-Snedecor distribution with an upper cumulative probability $\alpha$ and $\nu_1$ and $\nu_2$ degrees of freedom

## Formulas of Hypothesis testing

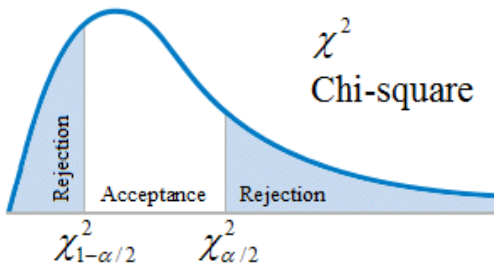
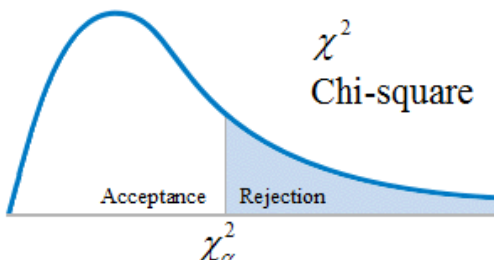
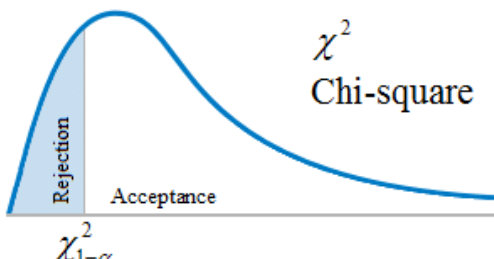
### Mean of population (known population variance)

<p><b>Two-sided:</b>  <math>H_0: \mu = \mu_0</math>  <math>H_1: \mu \neq \mu_0</math></p>	<p>Reject <math>H_0</math> if:  <math>z_0 \notin \left( -z_{\frac{\alpha}{2}}, z_{\frac{\alpha}{2}} \right)</math></p> <p>Where <math>z_0 = \frac{\bar{x} - \mu_0}{\sigma / \sqrt{n}}</math></p> <p>The statistic <math>z_0</math> follows a normal distribution <math>N(0, 1)</math>.</p>	
<p><b>Right side:</b>  <math>H_0: \mu \leq \mu_0</math>  <math>H_1: \mu &gt; \mu_0</math></p>	<p>Reject <math>H_0</math> if:  <math>z_0 &gt; z_{\alpha}</math></p>	
<p><b>Left side:</b>  <math>H_0: \mu \geq \mu_0</math>  <math>H_1: \mu &lt; \mu_0</math></p>	<p>Reject <math>H_0</math> if:  <math>z_0 &lt; -z_{\alpha}</math></p>	

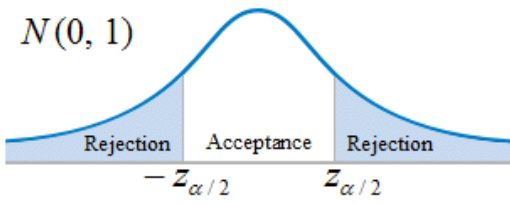
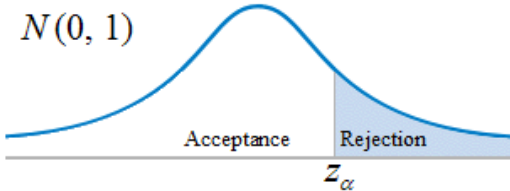
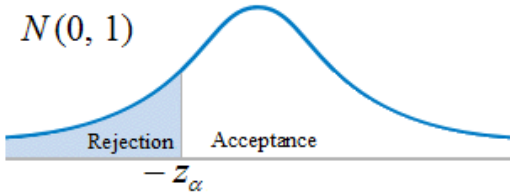
**Mean of population** (unknown population variance)

<p><b>Two-sided:</b>  <math>H_0: \mu = \mu_0</math>  <math>H_1: \mu \neq \mu_0</math></p>	<p>Reject <math>H_0</math> if:  <math>t_0 \notin \left( -t_{\left(\frac{\alpha}{2}, n-1\right)}, t_{\left(\frac{\alpha}{2}, n-1\right)} \right)</math></p> <p>Where <math>t_0 = \frac{\bar{x} - \mu_0}{S/\sqrt{n}}</math></p> <p>The statistic <math>t_0</math> follows a <math>t</math>-Student distribution with <math>n-1</math> degrees of freedom.</p>	
<p><b>Right side:</b>  <math>H_0: \mu \leq \mu_0</math>  <math>H_1: \mu &gt; \mu_0</math></p>	<p>Reject <math>H_0</math> if:  <math>t_0 &gt; t_{(\alpha, n-1)}</math></p>	
<p><b>Left side:</b>  <math>H_0: \mu \geq \mu_0</math>  <math>H_1: \mu &lt; \mu_0</math></p>	<p>Reject <math>H_0</math> if:  <math>t_0 &lt; -t_{(\alpha, n-1)}</math></p>	

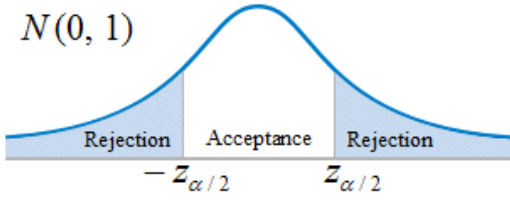
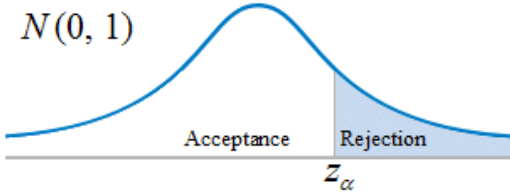
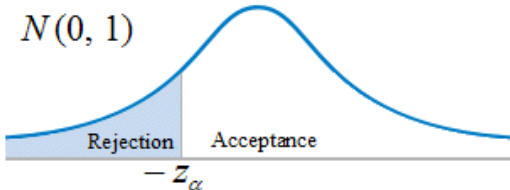
## Variance of population

<p><b>Two-sided:</b>  <math>H_0: \sigma^2 = \sigma_0^2</math>  <math>H_1: \sigma^2 \neq \sigma_0^2</math></p>	<p>Reject <math>H_0</math> if:  <math>\chi_0^2 \notin \left( \chi_{\left(1-\frac{\alpha}{2}, n-1\right)}^2, \chi_{\left(\frac{\alpha}{2}, n-1\right)}^2 \right)</math></p> <p>Where <math>\chi_0^2 = \frac{(n-1)S^2}{\sigma_0^2}</math></p> <p>The statistic <math>\chi_0^2</math> follows a Chi-square distribution with <math>n-1</math> degrees of freedom.</p>	 <p style="text-align: right;"><math>\chi^2</math> Chi-square</p>
<p><b>Right side:</b>  <math>H_0: \sigma^2 \leq \sigma_0^2</math>  <math>H_1: \sigma^2 &gt; \sigma_0^2</math></p>	<p>Reject <math>H_0</math> if:  <math>\chi_0^2 &gt; \chi_{(\alpha, n-1)}^2</math></p>	 <p style="text-align: right;"><math>\chi^2</math> Chi-square</p>
<p><b>Left side:</b>  <math>H_0: \sigma^2 \geq \sigma_0^2</math>  <math>H_1: \sigma^2 &lt; \sigma_0^2</math></p>	<p>Reject <math>H_0</math> if:  <math>\chi_0^2 &lt; \chi_{(1-\alpha, n-1)}^2</math></p>	 <p style="text-align: right;"><math>\chi^2</math> Chi-square</p>

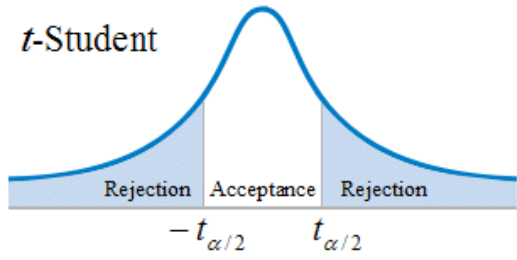
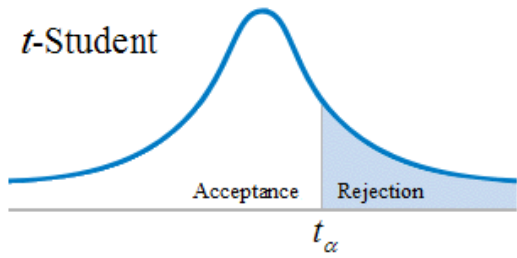
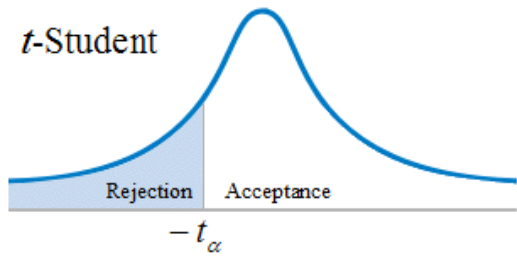
## Ratio of population

<p><b>Two-sided:</b>  <math>H_0: p = p_0</math>  <math>H_1: p \neq p_0</math></p>	<p>Reject <math>H_0</math> if:  <math>z_0 \notin \left( -z_{\frac{\alpha}{2}}, z_{\frac{\alpha}{2}} \right)</math></p> <p>Where <math>z_0 = \frac{n \hat{p} - n p_0}{\sqrt{n p_0 (1 - p_0)}}</math></p> <p>The statistic <math>z_0</math> follows a normal distribution <math>N(0, 1)</math>.</p>	
<p><b>Right side:</b>  <math>H_0: p \leq p_0</math>  <math>H_1: p &gt; p_0</math></p>	<p>Reject <math>H_0</math> if:  <math>z_0 &gt; z_\alpha</math></p>	
<p><b>Left side:</b>  <math>H_0: p \geq p_0</math>  <math>H_1: p &lt; p_0</math></p>	<p>Reject <math>H_0</math> if:  <math>z_0 &lt; -z_\alpha</math></p>	

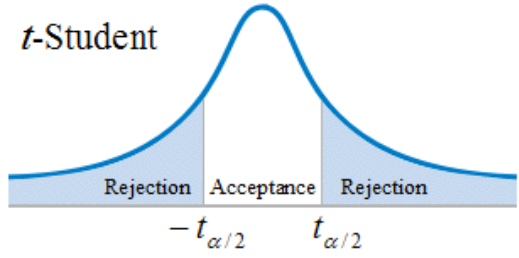
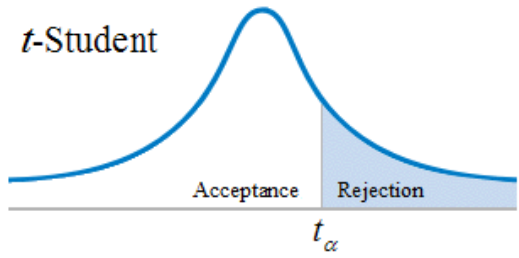
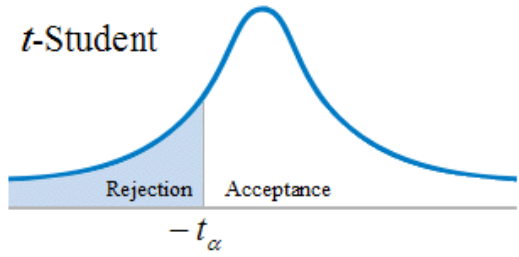
## Mean difference of two populations (known population variances)

<p><b>Two-sided:</b>  <math>H_0: \mu_1 - \mu_2 = \Delta_0</math>  <math>H_1: \mu_1 - \mu_2 \neq \Delta_0</math></p> <p><math>(\sigma_1^2 \neq \sigma_2^2)</math></p>	<p>Reject <math>H_0</math> if:  <math>z_0 \notin \left( -z_{\frac{\alpha}{2}}, z_{\frac{\alpha}{2}} \right)</math></p> <p>Where <math>z_0 = \frac{\bar{x}_1 - \bar{x}_2 - \Delta_0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}</math></p> <p>The statistic <math>z_0</math> follows a normal distribution <math>N(0, 1)</math>.</p>	
<p><b>Right side:</b>  <math>H_0: \mu_1 - \mu_2 \leq \Delta_0</math>  <math>H_1: \mu_1 - \mu_2 &gt; \Delta_0</math></p>	<p>Reject <math>H_0</math> if:  <math>z_0 &gt; z_\alpha</math></p>	
<p><b>Left side:</b>  <math>H_0: \mu_1 - \mu_2 \geq \Delta_0</math>  <math>H_1: \mu_1 - \mu_2 &lt; \Delta_0</math></p>	<p>Reject <math>H_0</math> if:  <math>z_0 &lt; -z_\alpha</math></p>	

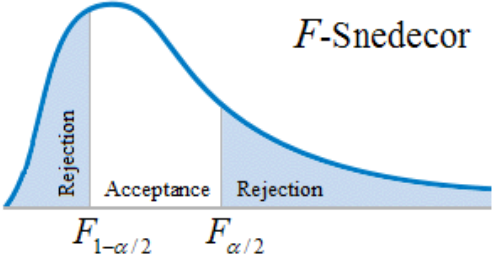
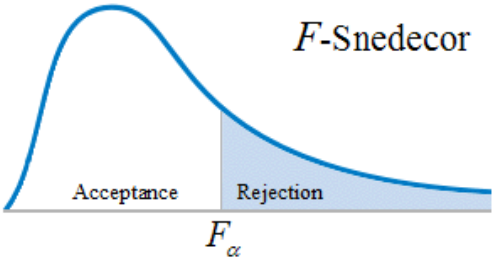
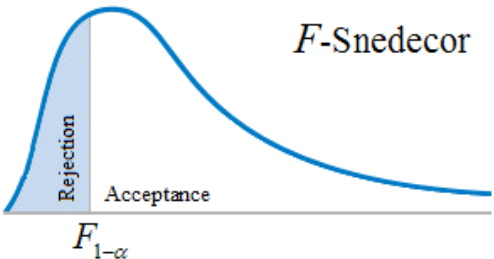
**Mean difference of two populations** (unknown and equal population variances)

<p><b>Two-sided:</b>  <math>H_0: \mu_1 - \mu_2 = \Delta_0</math>  <math>H_1: \mu_1 - \mu_2 \neq \Delta_0</math>  <math>(\sigma_1^2 = \sigma_2^2)</math></p>	<p>Reject <math>H_0</math> if:  <math display="block">t_0 \notin \left( -t_{\left(\frac{\alpha}{2}, n_1+n_2-2\right)}, t_{\left(\frac{\alpha}{2}, n_1+n_2-2\right)} \right)</math>           Where <math display="block">t_0 = \frac{\bar{x}_1 - \bar{x}_2 - \Delta_0}{S_p \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}</math> <math display="block">S_p^2 = \frac{(n_1-1)S_1^2 + (n_2-1)S_2^2}{n_1 + n_2 - 2}</math>           (Pooled variance of the samples)             The statistic <math>t_0</math> follows a <math>t</math>-Student distribution with <math>n_1 + n_2 - 2</math> degrees of freedom.</p>	<p><math>t</math>-Student</p> 
<p><b>Right side:</b>  <math>H_0: \mu_1 - \mu_2 \leq \Delta_0</math>  <math>H_1: \mu_1 - \mu_2 &gt; \Delta_0</math></p>	<p>Reject <math>H_0</math> if:  <math>t_0 &gt; t_{(\alpha, n_1+n_2-2)}</math></p>	<p><math>t</math>-Student</p> 
<p><b>Left side:</b>  <math>H_0: \mu_1 - \mu_2 \geq \Delta_0</math>  <math>H_1: \mu_1 - \mu_2 &lt; \Delta_0</math></p>	<p>Reject <math>H_0</math> if:  <math>t_0 &lt; -t_{(\alpha, n_1+n_2-2)}</math></p>	<p><math>t</math>-Student</p> 

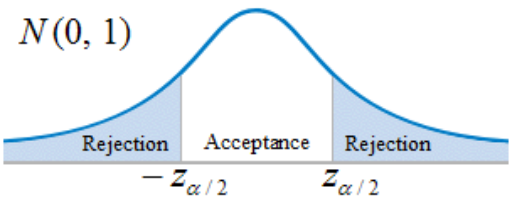
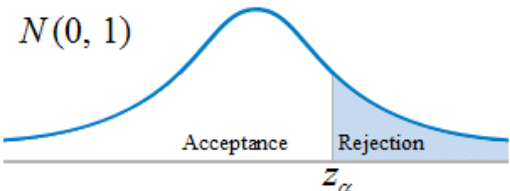
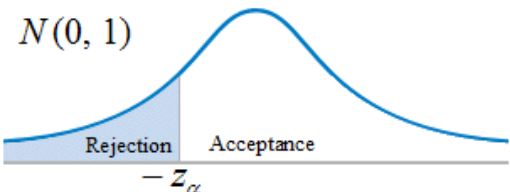
**Mean difference of two populations** (unknown and different population variances)

<p><b>Two-sided:</b>  <math>H_0: \mu_1 - \mu_2 = \Delta_0</math>  <math>H_1: \mu_1 - \mu_2 \neq \Delta_0</math>  <math>(\sigma_1^2 \neq \sigma_2^2)</math></p>	<p>Reject <math>H_0</math> if:  <math>t_0 \notin \left( -t_{\left(\frac{\alpha}{2}, \nu\right)}, t_{\left(\frac{\alpha}{2}, \nu\right)} \right)</math></p> <p>Where <math>t_0 = \frac{\bar{x}_1 - \bar{x}_2 - \Delta_0}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}</math></p> $\nu = \frac{\left(\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}\right)^2}{\frac{\left(\frac{S_1^2}{n_1}\right)^2}{n_1 - 1} + \frac{\left(\frac{S_2^2}{n_2}\right)^2}{n_2 - 1}}$ <p>(Welch approximation)</p> <p>The statistic <math>t_0</math> follows a <math>t</math>-Student distribution with <math>\nu</math> degrees of freedom.</p>	<p><i>t</i>-Student</p> 
<p><b>Right side:</b>  <math>H_0: \mu_1 - \mu_2 \leq \Delta_0</math>  <math>H_1: \mu_1 - \mu_2 &gt; \Delta_0</math></p>	<p>Reject <math>H_0</math> if:  <math>t_0 &gt; t_{(\alpha, \nu)}</math></p>	<p><i>t</i>-Student</p> 
<p><b>Left side:</b>  <math>H_0: \mu_1 - \mu_2 \geq \Delta_0</math>  <math>H_1: \mu_1 - \mu_2 &lt; \Delta_0</math></p>	<p>Reject <math>H_0</math> if:  <math>t_0 &lt; -t_{(\alpha, \nu)}</math></p>	<p><i>t</i>-Student</p> 

### Variance ratio of two populations

<p><b>Two-sided:</b>  <math>H_0: \sigma_1^2 = \sigma_2^2</math>  <math>H_1: \sigma_1^2 \neq \sigma_2^2</math></p>	<p>Reject <math>H_0</math> if:  <math display="block">F_0 \notin \left( F_{\left(1-\frac{\alpha}{2}, n_1-1, n_2-1\right)}, F_{\left(\frac{\alpha}{2}, n_1-1, n_2-1\right)} \right)</math></p> <p>Where <math>F_0 = \frac{S_1^2}{S_2^2}</math></p> <p>The statistic <math>F_0</math> follows a <math>F</math>-Snedecor distribution with <math>n_1-1</math> and <math>n_2-1</math> degrees of freedom.</p>	 <p style="text-align: right;"><math>F</math>-Snedecor</p>
<p><b>Right side:</b>  <math>H_0: \sigma_1^2 \leq \sigma_2^2</math>  <math>H_1: \sigma_1^2 &gt; \sigma_2^2</math></p>	<p>Reject <math>H_0</math> if:  <math display="block">F_0 &gt; F_{(\alpha, n_1-1, n_2-1)}</math></p>	 <p style="text-align: right;"><math>F</math>-Snedecor</p>
<p><b>Left side:</b>  <math>H_0: \sigma^2 \geq \sigma_0^2</math>  <math>H_1: \sigma^2 &lt; \sigma_0^2</math></p>	<p>Reject <math>H_0</math> if:  <math display="block">F_0 &lt; F_{(1-\alpha, n_1-1, n_2-1)}</math></p>	 <p style="text-align: right;"><math>F</math>-Snedecor</p>

## Ratio difference of two populations

<p><b>Two-sided:</b>  <math>H_0: p_1 = p_2</math>  <math>H_1: p_1 \neq p_2</math></p>	<p>Reject <math>H_0</math> if:  <math>z_0 \notin \left( -z_{\frac{\alpha}{2}}, z_{\frac{\alpha}{2}} \right)</math></p> <p>Where <math>z_0 = \frac{\hat{p}_1 - \hat{p}_2}{\sqrt{\hat{p}(1-\hat{p})\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}</math></p> $\hat{p} = \frac{n_1 \hat{p}_1 + n_2 \hat{p}_2}{n_1 + n_2}$ <p>The statistic <math>z_0</math> follows a normal distribution <math>N(0, 1)</math>.</p>	 <p><math>N(0, 1)</math></p> <p>Rejection Acceptance Rejection</p> <p><math>-z_{\alpha/2}</math> <math>z_{\alpha/2}</math></p>
<p><b>Right side:</b>  <math>H_0: p_1 \leq p_2</math>  <math>H_1: p_1 &gt; p_2</math></p>	<p>Reject <math>H_0</math> if:  <math>z_0 &gt; z_{\alpha}</math></p>	 <p><math>N(0, 1)</math></p> <p>Acceptance Rejection</p> <p><math>z_{\alpha}</math></p>
<p><b>Left side:</b>  <math>H_0: p_1 \geq p_2</math>  <math>H_1: p_1 &lt; p_2</math></p>	<p>Reject <math>H_0</math> if:  <math>z_0 &lt; -z_{\alpha}</math></p>	 <p><math>N(0, 1)</math></p> <p>Rejection Acceptance</p> <p><math>-z_{\alpha}</math></p>

**Where:**

$1 - \alpha$	Confidence level
$\alpha$	Significance level
$H_0$	Null hypothesis
$H_1$	Alternative hypothesis
$\mu$	Mean of the population
$\bar{x}$	Mean of the sample
$\sigma$	Standard deviation of the population
$S$	Standard deviation of the sample
$p$	Ratio of the population
$\hat{p}$	Ratio of the sample
$n$	Sample size
$z_0$	Statistic that follows a normal distribution $N(0, 1)$
$t_0$	Statistic that follows a $t$ -Student distribution
$F_0$	Statistic that follows a $F$ -Snedecor distribution
$\chi_0^2$	Statistic that follows a Chi-square distribution
$z_\alpha$	Percentage point of the Normal distribution with an upper cumulative probability of $\alpha$
$t_{(\alpha, \nu)}$	Percentage point of the $t$ -Student distribution with an upper cumulative probability $\alpha$ and $\nu$ degrees of freedom.
$\chi_{(\alpha, \nu)}^2$	Percentage point of the Chi-square distribution with an upper cumulative probability $\alpha$ and $\nu$ degrees of freedom.
$F_{(\alpha, \nu_1, \nu_2)}$	Percentage point of $F$ -Snedecor distribution with an upper cumulative probability $\alpha$ and $\nu_1$ and $\nu_2$ degrees of freedom

## Formulas of One variable statistic

<b>Mean</b>	$\bar{x} = \frac{\sum x_i n_i}{N}$
<b>Variance (<math>s^2</math>) and standard deviation (<math>s</math>)</b>	$s^2 = \frac{\sum x_i^2 n_i}{N} - \bar{x}^2; \quad s = \sqrt{\frac{\sum x_i^2 n_i}{N} - \bar{x}^2}$
<b>Coefficient of variation</b>	$CV = \frac{s}{\bar{x}}$
<b>Percentiles</b>	$P_k = L + a \frac{\frac{k \cdot N}{100} - N_{i-1}}{n_i}$
<b>Deciles</b>	$D_k = L + a \frac{\frac{k \cdot N}{10} - N_{i-1}}{n_i}$
<b>Quartiles</b>	$Q_k = L + a \frac{\frac{k \cdot N}{4} - N_{i-1}}{n_i}$
<b>Median</b>	$Me = L + a \frac{\frac{N}{2} - N_{i-1}}{n_i}, \quad Me = P_{50} = D_5 = Q_2$
<b>Mode</b>	$Mo = L + a \frac{\Delta_1}{\Delta_1 + \Delta_2} \quad \Delta_1 = n_i - n_{i-1}, \quad \Delta_2 = n_i - n_{i+1}$ <p>If intervals aren't the same width, density of frequency is used instead frequency.</p>
<b>Moments</b>	<p>About the mean: <math display="block">m_k = \frac{\sum (x_i - \bar{x})^k n_i}{N}</math></p> <p>About the origin: <math display="block">a_k = \frac{\sum x_i^k n_i}{N}</math></p>
<b>Skewness</b>	$g_1 = \frac{m_3}{s^3}$
<b>Kurtosis</b>	$g_2 = \frac{m_4}{s^4} - 3$

**Where:**

$N$	Number of items (size of the sample)
$L$	Left endpoint of the relevant interval
$a$	Width of the relevant interval
$N_{i-1}$	Cumulative frequency of the previous interval
$n_i$	Frequency of the relevant interval
$n_{i-1}$	Frequency of the previous interval
$n_{i+1}$	Frequency of the next interval

## Formulas of Two variables statistic

<b>Means</b>	$\bar{x} = \frac{\sum x_i n_i}{N}; \quad \bar{y} = \frac{\sum y_i n_i}{N}$
<b>Variations</b>	$s_x^2 = \frac{\sum x_i^2 n_i}{N} - \bar{x}^2; \quad s_y^2 = \frac{\sum y_i^2 n_i}{N} - \bar{y}^2$
<b>Covariance</b>	$s_{xy}^2 = \frac{\sum x_i y_i n_i}{N} - \bar{x} \bar{y}$
<b>Pearson coefficient of correlation</b>	$r = \frac{s_{xy}}{s_x s_y}$
<b>LINEAR regression</b>	$y - \bar{y} = \frac{s_{xy}}{s_x^2} (x - \bar{x}) \quad \rightarrow \quad y = a + b x$
<b>LOGARITHMIC regression</b>	$y - \bar{y} = \frac{s_{\ln x y}}{s_{\ln x}^2} (\ln x - \overline{\ln x}) \quad \rightarrow \quad y = a + b \ln x$
<b>EXPONENTIAL regression</b>	$\ln y - \overline{\ln y} = \frac{s_{x \ln y}}{s_x^2} (x - \bar{x}) \quad \rightarrow \quad y = a \cdot b^x$
<b>POWER regression</b>	$\ln y - \overline{\ln y} = \frac{s_{\ln x \ln y}}{s_{\ln x}^2} (\ln x - \overline{\ln x}) \quad \rightarrow \quad y = a \cdot x^b$
<b>QUADRATIC regression</b>	$\rightarrow y = a x^2 + b x + c$

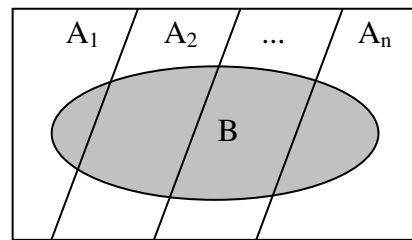
## Formulas of Total Probability Law and Bayes' Theorem

### Total Probability Law

$$P(B) = P(A_1) \cdot P(B / A_1) + P(A_2) \cdot P(B / A_2) + \dots + P(A_n) \cdot P(B / A_n)$$

### Bayes' Theorem

$$P(A_i / B) = \frac{P(A_i) \cdot P(B / A_i)}{P(B)}$$



## Formulas of probability of two events A and B

$$P(E)=1$$

$$P(\emptyset)=0$$

$$P(\bar{A})=1-P(A)$$

$$P(\bar{B})=1-P(B)$$

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

$$P(A \cap B) = P(A) \cdot P(B/A)$$

$$P(A \cap B) = P(B) \cdot P(A/B)$$

$$P(A - B) = P(A) - P(A \cap B)$$

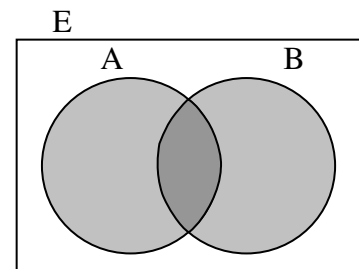
$$P(B - A) = P(B) - P(A \cap B)$$

$$P(\overline{A \cup B}) = P(\bar{A} \cap \bar{B})$$

$$P(\overline{A \cap B}) = P(\bar{A} \cup \bar{B})$$

$$P(A/B) = \frac{P(A \cap B)}{P(B)}$$

$$P(B/A) = \frac{P(A \cap B)}{P(A)}$$



## Specifications

<b>Description</b>	StaTool. Application for Windows with capabilities of statistic and probability calculations.
<b>Output precision</b>	From 8 to 10 digits
<b>Internal precision</b>	16 digits.
<b>Types of calculations:</b>	<b>7 types:</b> <ul style="list-style-type: none"><li>- Hypothesis testing</li><li>- Confidence interval estimation</li><li>- Probability distributions</li><li>- One variable statistic</li><li>- Two variables statistic</li><li>- Total Probability Law and Bayes' Theorem</li><li>- Probability of A and B events</li></ul>
<b>Size</b>	Width = 1024 pixels, height = 732 pixels.

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