Utility – MathsNET

Continuous Distributions

User Guide

Document Revision 1.0

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# Introduction

This asset will provide access to the MathNET Numerics Continuous Distributions functions. It is part of a series of assets that will offer complimentary mathematical functionality to what is currently possible with Blue Prism alone. For Probability Distributions, there are 3 assets.

* Continuous Distributions (This)
* Discrete Distributions (Late Summer - Autumn 2020)
* Multivariate Distributions (Late Summer - Autum 2020)

# Prerequisites

To use this asset, you require a licenced Blue Prism installation or trial. More information on Blue Prism can be found here. <https://www.blueprism.com>.

You will also require to download the *MathNET. Numerics dll* from NuGet. The library is found at <https://www.nuget.org/packages/MathNet.Numerics/>

This asset provides 17 probability definitions. Please see the table of contents for the extensive list. 2 have been omitted due to functional issues.

# Configuration

The asset is downloaded from the Digital Exchange (DX) It is installed in the usual manner using the import item from the file menu.

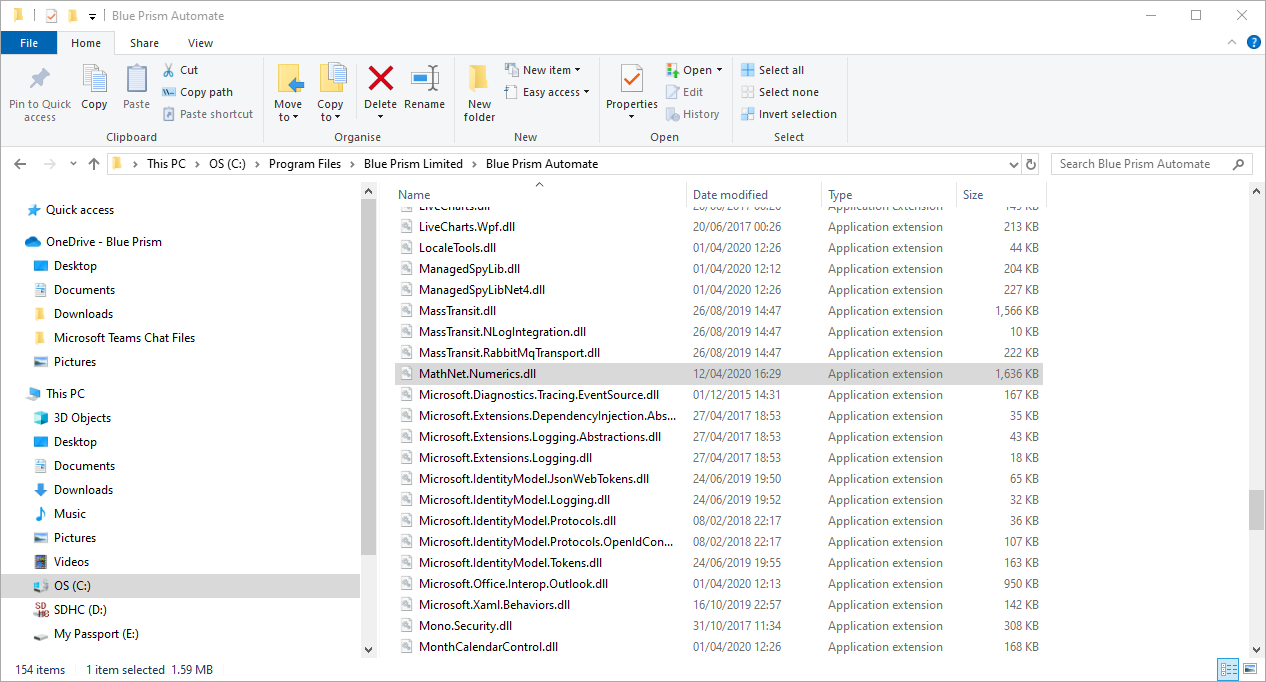
The bprelease file contains:

* Utility MathsNET –Continuous Distributions
* Process Example – MathsNet – Continuous Distributions

You will also be required to download the MathNET. Numerics dll from NuGet. It can be found at <https://www.nuget.org/packages/MathNet.Numerics/>

It needs to be installed in your Blue Prism directory, which will depend on your specific installation. If your Blue Prism is a default install, then the location for its deployment is

C:\program files\Blue Prism Limited\Blue Prism Automate



## Random Source Type

Some distributions can accept a random number generation source. These are shown below.

|  |  |
| --- | --- |
| **ID** | **Description** |
| 1 | Mersenne Twister |
| 2 | CryptoRandomSource |
| 3 | Palf |
| 4 | XorShift |
| 5 | Mcg31m1 |
| 6 | Mcg59 |
| 7 | WH1982 |
| 8 | WH2006 |
| 9 | Mrg32k3a |
| 10 | SystemRandomSource |

# Using the Asset

Probability distributions implement a common set of operations such as evaluating the density (PDF) at a given point, or to compute various statistical or other properties. Some properties are more numerically stable in the logarithmic domain, these exist with the ‘Ln’ suffix.

## Normal

Normal distributions are important in [statistics](https://en.wikipedia.org/wiki/Statistics) and are often used in the [natural](https://en.wikipedia.org/wiki/Natural_science) and [social sciences](https://en.wikipedia.org/wiki/Social_science) to represent real-valued [random variables](https://en.wikipedia.org/wiki/Random_variable) whose distributions are not known.(source: <https://en.wikipedia.org/wiki/Normal_distribution> )

### Input:

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Data Type** |
| RandomSourceType | The type of random number generator used. Value range is 1-10. See Random Source Type.pg 7. | Number |
| Mean | The Mean value used by the distribution calculation. | Number |
| Precision | The precision value used by the distribution calculation | Number |
| Standard\_Dev | The standard deviation value used by the distribution calculation | Number |
| Variance | The variance value used by the distribution calculation. | Number |
| P | The probability point value | Number |
| X | The location X from which the distribution is calculated. | Number |

### Output:

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Data Type** |
| Normal\_CDF | Cumulative Distribution Function | Number |
| Normal\_InvCDF | Inverse Cumulative Distribution Function | Number |
| Normal\_PDF | Probability Distribution Function | Number |
| Normal\_PDFLn | Log Probability Function | Number |
| Normal\_Sample | Sample from the Normal Distribution using the Box-Muller algorithm. | Number |
| Normal\_WMP\_CumulativeDistribution | Computes the CDF of the distribution at x. | Number |
| Normal\_WMP\_Density | Computes the probability density of the distribution at x. | Number |
| Normal\_WMP\_DensityLn | Computes the log probability density of the distribution at x. | Number |
| Normal\_WMP\_InverseCumulativeDistribution | Computes the inverse of the cumulative distribution function for the distribution at a given probability. Also known at the quantile or percent point function. | Number |
| Normal\_WMSD\_CumulativeDistribution | Computes the CDF of the Distribution at x. | Number |
| Normal\_WMSD\_Density | Computes the probability density of the distribution at x. | Number |
| Normal\_WMSD\_DensityLn | Computes the log probability density of the distribution at x. | Number |
| Normal\_WMSD\_InverseCumulativeDistribution | Computes the inverse of the cumulative distribution function for the distribution at a given probability. Also known at the quantile or percent point function. | Number |
| Normal\_WMV\_CumulativeDistribution | Computes the CDF of the Distribution at x. | Number |
| Normal\_WMV\_Density | Computes the probability density of the distribution at x. | Number |
| Normal\_WMV\_DensityLn | Computes the log probability density of the distribution at x. | Number |
| Normal\_WMV\_InverseCumulativeDistribution | Computes the inverse of the cumulative distribution function for the distribution at a given probability. Also known at the quantile or percent point function. | Number |
| Normal\_Skewness | A measure of the asymmetry of the probability distribution of a real-valued random variable about its mean. | Number |
| Normal\_Entropy | Entropy measures the expected amount of information conveyed by identifying the outcome of a random trial. | Number |
| CalculationErrata | Error messages that have occurred during calculation. | Text |

## Continuous Uniform

In [probability theory](https://en.wikipedia.org/wiki/Probability_theory) and [statistics](https://en.wikipedia.org/wiki/Statistics), the **continuous uniform distribution** or **rectangular distribution** is a family of [symmetric](https://en.wikipedia.org/wiki/Symmetric_distribution) [probability distributions](https://en.wikipedia.org/wiki/Probability_distributions). The distribution describes an experiment where there is an arbitrary outcome that lies between certain bounds.(source <https://en.wikipedia.org/wiki/Uniform_distribution_%28continuous%29> )

### Input:

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Data Type** |
| RandomSourceType | The type of random number generator used. Value range is 1-10. See Random Source Type.pg 7. | Number |
| Lower | The lower range value. | Number |
| Upper | The upper range value. | Number |
| P | The probability point value | Number |
| X | The location X from which the distribution is calculated. | Number |

### Output:

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Data Type** |
| CDF | Cumulative Distribution Function | Number |
| InvCDF | Inverse Cumulative Distribution Function |  |
| PDF | Probability Distribution Function |  |
| PDFLn | Log Probability Function |  |
| Sample | Sample from the Normal Distribution using the Box-Muller algorithm. |  |
| CumulativeDistribution | Computes the CDF of the Distribution at x. |  |
| InverseCumulativeDistribution | Computes the inverse of the cumulative distribution function for the distribution at a given probability. Also known at the quantile or percent point function. |  |
| Density | Computes the probability density of the distribution at x. |  |
| DensityLn | Computes the log probability density of the distribution at x. |  |
| Entropy | Entropy measures the expected amount of information conveyed by identifying the outcome of a random trial. |  |
| Skewness | A measure of the asymmetry of the probability distribution of a real-valued random variable about its mean. |  |

## Log Normal

In [probability theory](https://en.wikipedia.org/wiki/Probability_theory), a **log-normal (or lognormal) distribution** is a continuous [probability distribution](https://en.wikipedia.org/wiki/Probability_distribution) of a [random variable](https://en.wikipedia.org/wiki/Random_variable) whose [logarithm](https://en.wikipedia.org/wiki/Logarithm) is [normally distributed](https://en.wikipedia.org/wiki/Normal_distribution). Thus, if the random variable *X* is log-normally distributed, then *Y* = ln(*X*) has a normal distribution. Source <https://en.wikipedia.org/wiki/Log-normal_distribution>

### Input:

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Data Type** |
| RandomSourceType | The type of random number generator used. Value range is 1-10. See Random Source Type.pg 7. | Number |
| Mean | The mean used by the distribution calculation. | Number |
| Standard\_Dev | The standard deviation value used by the distribution calculation | Number |
| P | The probability point value | Number |
| X | The location X from which the distribution is calculated. | Number |

### Output:

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Description** | **Data Type** | |
| CDF | Cumulative Distribution Function | Number | |
| InvCDF | Inverse Cumulative Distribution Function | Number | |
| PDF | Probability Distribution Function | Number | |
| PDFLn | Log Probability Function | Number | |
| Sample | Sample from the Normal Distribution using the Box-Muller algorithm. | Number | |
| CumulativeDistribution | Computes the CDF of the Distribution at x. | Number | |
| InverseCumulativeDistribution | Computes the inverse of the cumulative distribution function for the distribution at a given probability. Also known at the quantile or percent point function. | Number | |
| Density | Computes the probability density of the distribution at x. | Number | |
| DensityLn | Computes the log probability density of the distribution at x. | Number | |
| Entropy | Entropy measures the expected amount of information conveyed by identifying the outcome of a random trial. | Number | |
| Skewness | A measure of the asymmetry of the probability distribution of a real-valued random variable about its mean. | Number | |
| CalculationErrata | Any errors are detailed in this field. | | Text | |

## Beta

In [probability theory](https://en.wikipedia.org/wiki/Probability_theory) and [statistics](https://en.wikipedia.org/wiki/Statistics), the **beta distribution** is a family of continuous [probability distributions](https://en.wikipedia.org/wiki/Probability_distribution) defined on the interval [0, 1] [parametrized](https://en.wikipedia.org/wiki/Statistical_parameter) by two positive [shape parameters](https://en.wikipedia.org/wiki/Shape_parameter), denoted by *α* and *β*, that appear as exponents of the random variable and control the shape of the distribution. The generalization to multiple variables is called a [Dirichlet distribution](https://en.wikipedia.org/wiki/Dirichlet_distribution). (Source: <https://en.wikipedia.org/wiki/Beta_distribution> )

### Input:

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Data Type** |
| RandomSourceType | The type of random number generator used. Value range is 1-10. See Random Source Type.pg 7. | Number |
| a | The alpha value. | Number |
| b | The beta value. | Number |
| P | The probability point value | Number |
| X | The location X from which the distribution is calculated. | Number |

### Output:

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Data Type** |
| CDF | Cumulative Distribution Function | Number |
| InvCDF | Inverse Cumulative Distribution Function | Number |
| PDF | Probability Distribution Function | Number |
| PDFLn | Log Probability Function | Number |
| Sample | Sample from the Normal Distribution using the Box-Muller algorithm. | Number |
| CumulativeDistribution | Computes the CDF of the Distribution at x. | Number |
| InverseCumulativeDistribution | Computes the inverse of the cumulative distribution function for the distribution at a given probability. Also known at the quantile or percent point function. | Number |
| Density | Computes the probability density of the distribution at x. | Number |
| DensityLn | Computes the log probability density of the distribution at x. | Number |
| Entropy | Entropy measures the expected amount of information conveyed by identifying the outcome of a random trial. | Number |
| Skewness | A measure of the asymmetry of the probability distribution of a real-valued random variable about its mean. | Number |
| CalculationErrata | Error messages that have occurred during calculation. | Text |

## Cauchy

The **Cauchy distribution**, named after [Augustin Cauchy](https://en.wikipedia.org/wiki/Augustin_Cauchy), is a [continuous probability distribution](https://en.wikipedia.org/wiki/Continuous_probability_distribution). It is also known, especially among [physicists](https://en.wikipedia.org/wiki/Physicist), as the **Lorentz distribution** (after [Hendrik Lorentz](https://en.wikipedia.org/wiki/Hendrik_Lorentz)), **Cauchy–Lorentz distribution**, **Lorentz(ian) function**, or **Breit–Wigner distribution**. (source: https://en.wikipedia.org/wiki/Cauchy\_distribution)

### Input:

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Data Type** |
| RandomSourceType | The type of random number generator used. Value range is 1-10. See Random Source Type.pg 7. | Number |
| Location | The location value used by the distribution calculation | Number |
| Scale | The scale value used by the distribution calculation | Number |
| P | The probability point value | Number |
| X | The location X from which the distribution is calculated. | Number |

### Output:

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Data Type** |
| CDF | Cumulative Distribution Function | Number |
| InvCDF | Inverse Cumulative Distribution Function | Number |
| PDF | Probability Distribution Function | Number |
| PDFLn | Log Probability Function | Number |
| Sample | Sample from the Normal Distribution using the Box-Muller algorithm. | Number |
| CumulativeDistribution | Computes the CDF of the Distribution at x. | Number |
| InverseCumulativeDistribution | Computes the inverse of the cumulative distribution function for the distribution at a given probability. Also known at the quantile or percent point function. | Number |
| Density | Computes the probability density of the distribution at x. | Number |
| DensityLn | Computes the log probability density of the distribution at x. | Number |
| Entropy | Entropy measures the expected amount of information conveyed by identifying the outcome of a random trial. | Number |
| CalculationErrata | Error messages that have occurred during calculation. | Text |

## Chi

In [probability theory](https://en.wikipedia.org/wiki/Probability_theory) and [statistics](https://en.wikipedia.org/wiki/Statistics), the **chi distribution** is a continuous [probability distribution](https://en.wikipedia.org/wiki/Probability_distribution). It is the distribution of the positive square root of the sum of squares of a set of independent random variables each following a standard [normal distribution](https://en.wikipedia.org/wiki/Normal_distribution), or equivalently, the distribution of the [Euclidean distance](https://en.wikipedia.org/wiki/Euclidean_distance) of the random variables from the origin. It is thus related to the [chi-squared distribution](https://en.wikipedia.org/wiki/Chi-squared_distribution) by describing the distribution of the positive square roots of a variable obeying a chi-squared distribution.(source. <https://en.wikipedia.org/wiki/Chi_distribution>) (source: <https://en.wikipedia.org/wiki/Chi_distribution> )

### Input:

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Data Type** |
| RandomSourceType | The type of random number generator used. Value range is 1-10. See Random Source Type.pg 7. | Number |
| Freedom | The degree of freedom of the distribution. | Number |
| x | The location X from which the distribution is calculated. |  |

### Output:

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Data Type** |
| CDF | Cumulative Distribution Function | Number |
| Stddev | The standard deviation of the distribution. | Number |
| PDF | Probability Distribution Function | Number |
| PDFLn | Log Probability Function | Number |
| Sample | Sample from the Normal Distribution using the Box-Muller algorithm. | Number |
| CumulativeDistribution | Computes the CDF of the Distribution at x. | Number |
| Density | Computes the probability density of the distribution at x. | Number |
| DensityLn | Computes the log probability density of the distribution at x. | Number |
| Entropy | Entropy measures the expected amount of information conveyed by identifying the outcome of a random trial. | Number |
| Skewness | A measure of the asymmetry of the probability distribution of a real-valued random variable about its mean. | Number |

## Chi Squared

In [probability theory](https://en.wikipedia.org/wiki/Probability_theory) and [statistics](https://en.wikipedia.org/wiki/Statistics), the **chi-square distribution** (also **chi-squared** or ***χ*2-distribution**) with *k* [degrees of freedom](https://en.wikipedia.org/wiki/Degrees_of_freedom_(statistics)) is the distribution of a sum of the squares of *k* [independent](https://en.wikipedia.org/wiki/Independence_(probability_theory)) [standard normal](https://en.wikipedia.org/wiki/Standard_normal) random variables. The chi-square distribution is a special case of the [gamma distribution](https://en.wikipedia.org/wiki/Gamma_distribution) and is one of the most widely used [probability distributions](https://en.wikipedia.org/wiki/Probability_distribution) in [inferential statistics](https://en.wikipedia.org/wiki/Inferential_statistics), notably in [hypothesis testing](https://en.wikipedia.org/wiki/Hypothesis_testing) and in construction of [confidence intervals](https://en.wikipedia.org/wiki/Confidence_interval). (source. <https://en.wikipedia.org/wiki/Chi-square_distribution> )

### Input:

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Data Type** |
| RandomSourceType | The type of random number generator used. Value range is 1-10. See Random Source Type.pg 7. | Number |
| Freedom | The degree of freedom of the distribution. | Number |
| x | The location X from which the distribution is calculated. |  |

### Output:

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Data Type** |
| CDF | Cumulative Distribution Function | Number |
| CD | Cumulative Distribution at point x. | Number |
| PDF | Probability Distribution Function | Number |
| PDFLn | Log Probability Function | Number |
| Sample | Sample from the Normal Distribution using the Box-Muller algorithm. | Number |
| Stddev | The standard deviation of the distribution. | Number |
| Density | Computes the probability density of the distribution at x. | Number |
| DensityLn | Computes the log probability density of the distribution at x. | Number |
| Entropy | Entropy measures the expected amount of information conveyed by identifying the outcome of a random trial. | Number |
| Skewness | A measure of the asymmetry of the probability distribution of a real-valued random variable about its mean. | Number |

## Erlang

The **Erlang distribution** is a two-parameter family of continuous [probability distributions](https://en.wikipedia.org/wiki/Probability_distribution).The two parameters are:

* a positive integer k , the "shape", and
* a positive real number λ , the "rate". The "scale", μ the reciprocal of the rate, is sometimes used instead.

The Erlang distribution was developed by [A. K. Erlang](https://en.wikipedia.org/wiki/Agner_Krarup_Erlang) to examine the number of telephone calls which might be made at the same time to the operators of the switching stations. This work on telephone [traffic engineering](https://en.wikipedia.org/wiki/Teletraffic_engineering) has been expanded to consider waiting times in [queueing systems](https://en.wikipedia.org/wiki/Queueing_theory) in general. The distribution is also used in the field of [stochastic processes](https://en.wikipedia.org/wiki/Stochastic_process). (source: <https://en.wikipedia.org/wiki/Erlang_distribution> )

### Input:

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Data Type** |
| RandomSourceType | The type of random number generator used. Value range is 1-10. See Random Source Type.pg 7. | Number |
| Rate | The rate parameter. | Number |
| Shape | A positive value. The shape parameter. | Number |
| x | The location X from which the distribution is calculated. | Number |

### Output:

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Data Type** |
| CDF | Cumulative Distribution Function | Number |
| InvCDF | Inverse Cumulative Distribution Function | Number |
| PDF | Probability Distribution Function | Number |
| PDFLn | Log Probability Function | Number |
| Sample | Sample from the Normal Distribution using the Box-Muller algorithm. | Number |
| CD | Computes the Cumulative Distribution of the Distribution at x. | Number |
| Density | Computes the probability density of the distribution at x. | Number |
| DensityLn | Computes the log probability density of the distribution at x. | Number |
| Entropy | Entropy measures the expected amount of information conveyed by identifying the outcome of a random trial. | Number |
| Skewness | A measure of the asymmetry of the probability distribution of a real-valued random variable about its mean. | Number |

## Exponential

In [probability theory](https://en.wikipedia.org/wiki/Probability_theory) and [statistics](https://en.wikipedia.org/wiki/Statistics), the **exponential distribution** is the [probability distribution](https://en.wikipedia.org/wiki/Probability_distribution) of the time between events in a [Poisson point process](https://en.wikipedia.org/wiki/Poisson_point_process), i.e., a process in which events occur continuously and independently at a constant average rate. It is a particular case of the [gamma distribution](https://en.wikipedia.org/wiki/Gamma_distribution). It is the continuous analogue of the [geometric distribution](https://en.wikipedia.org/wiki/Geometric_distribution), and it has the key property of being [memoryless](https://en.wikipedia.org/wiki/Memoryless). In addition to being used for the analysis of Poisson point processes it is found in various other contexts.

The exponential distribution is not the same as the class of [exponential families](https://en.wikipedia.org/wiki/Exponential_family) of distributions, which is a large class of probability distributions that includes the exponential distribution as one of its members, but also includes the [normal distribution](https://en.wikipedia.org/wiki/Normal_distribution), [binomial distribution](https://en.wikipedia.org/wiki/Binomial_distribution), [gamma distribution](https://en.wikipedia.org/wiki/Gamma_distribution), [Poisson](https://en.wikipedia.org/wiki/Poisson_distribution), and many others. (source: <https://en.wikipedia.org/wiki/Exponential_distribution> )

### Input:

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Data Type** |
| RandomSourceType | The type of random number generator used. Value range is 1-10. See Random Source Type.pg 7. | Number |
| Rate | The rate parameter. | Number |
| x | The location X from which the distribution is calculated. | Number |

### Output:

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Data Type** |
| CDF | Cumulative Distribution Function | Number |
| InvCDF | Inverse Cumulative Distribution Function | Number |
| PDF | Probability Distribution Function | Number |
| PDFLn | Log Probability Function | Number |
| Sample | Sample from the Normal Distribution using the Box-Muller algorithm. | Number |
| CumulativeDistribution | Computes the CDF of the Distribution at x. | Number |
| Density | Computes the probability density of the distribution at x. | Number |
| DensityLn | Computes the log probability density of the distribution at x. | Number |
| Entropy | Entropy measures the expected amount of information conveyed by identifying the outcome of a random trial. | Number |
| Skewness | A measure of the asymmetry of the probability distribution of a real-valued random variable about its mean. | Number |

## Fisher-Snedecor

In [probability theory](https://en.wikipedia.org/wiki/Probability_theory) and [statistics](https://en.wikipedia.org/wiki/Statistics), the ***F*-distribution**, also known as **Snedecor's *F* distribution** or the **Fisher–Snedecor distribution** (after [Ronald Fisher](https://en.wikipedia.org/wiki/Ronald_Fisher) and [George W. Snedecor](https://en.wikipedia.org/wiki/George_W._Snedecor)) is a [continuous probability distribution](https://en.wikipedia.org/wiki/Continuous_probability_distribution) that arises frequently as the [null distribution](https://en.wikipedia.org/wiki/Null_distribution) of a [test statistic](https://en.wikipedia.org/wiki/Test_statistic), most notably in the [analysis of variance](https://en.wikipedia.org/wiki/Analysis_of_variance) (ANOVA). (Source: <https://en.wikipedia.org/wiki/F-distribution> )

### Input:

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Data Type** |
| RandomSourceType | The type of random number generator used. Value range is 1-10. See Random Source Type.pg 7. | Number |
| d1 | The first degree of freedom. | Number |
| d2 | The second degree of freedom. |  |
| x | The location X from which the distribution is calculated. | Number |
| P | The given probability parameter. |  |

### Output:

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Data Type** |
| CD | Cumulative Distribution Function | Number |
| InvCDF | Inverse Cumulative Distribution Function | Number |
| Sample | Sample from the Normal Distribution using the Box-Muller algorithm. | Number |
| Density | Computes the probability density of the distribution at x. | Number |
| DensityLn | Computes the log probability density of the distribution at x. | Number |
| Dof1 | First degree of freedom of the distribution. | Number |
| Dof2 | Second degree of freedom of the distribution. | Number |

## Gamma

In [probability theory](https://en.wikipedia.org/wiki/Probability_theory) and [statistics](https://en.wikipedia.org/wiki/Statistics), the **gamma distribution** is a two-[parameter](https://en.wikipedia.org/wiki/Statistical_parameter) family of continuous [probability distributions](https://en.wikipedia.org/wiki/Probability_distribution). The [exponential distribution](https://en.wikipedia.org/wiki/Exponential_distribution), [Erlang distribution](https://en.wikipedia.org/wiki/Erlang_distribution), and [chi-squared distribution](https://en.wikipedia.org/wiki/Chi-squared_distribution) are special cases of the gamma distribution. There are three different [parametrizations](https://en.wikipedia.org/wiki/Statistical_parameter) in common use:

1. With a [shape parameter](https://en.wikipedia.org/wiki/Shape_parameter) *k* and a [scale parameter](https://en.wikipedia.org/wiki/Scale_parameter) *θ*.
2. With a shape parameter *α* = *k* and an inverse scale parameter *β* = 1/*θ*, called a [rate parameter](https://en.wikipedia.org/wiki/Rate_parameter).
3. With a shape parameter *k* and a mean parameter *μ* = *kθ* = *α*/*β*.

In each of these three forms, both parameters are positive real numbers.

The gamma distribution is the [maximum entropy probability distribution](https://en.wikipedia.org/wiki/Maximum_entropy_probability_distribution) (both with respect to a uniform base measure and with respect to a 1/*x* base measure) for a random variable *X* for which **E**[*X*] = *kθ* = *α*/*β* is fixed and greater than zero, and **E**[ln(*X*)] = *ψ*(*k*) + ln(*θ*) = *ψ*(*α*) − ln(*β*) is fixed (*ψ* is the [digamma function](https://en.wikipedia.org/wiki/Digamma_function)) (source: <https://en.wikipedia.org/wiki/Gamma_distribution> )

### Input:

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Data Type** |
| RandomSourceType | The type of random number generator used. Value range is 1-10. See Random Source Type.pg 7. | Number |
| Irate | The rate parameter. | Number |
| Ishape | The shape parameter | Number |
| x | The location X from which the distribution is calculated. | Number |
| P | The given probability parameter. |  |

### Output:

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Data Type** |
| Cd | Computes the CDF of the Distribution at x. | Number |
| Sample | Sample from the Normal Distribution using the Box-Muller algorithm. | Number |
| Entropy | Entropy measures the expected amount of information conveyed by identifying the outcome of a random trial. | Number |
| Skewness | A measure of the asymmetry of the probability distribution of a real-valued random variable about its mean. | Number |
| Stddev | Returns the Standard Deviation of the distribution. | Number |
| Density | Computes the probability density of the distribution at x. | Number |
| DensityLn | Computes the log probability density of the distribution at x. | Number |
| Rate | Returns the rate value. | Number |
| Shape | Returns the shape value. | Number |
| Invcd | Computes the inverse of the cumulative distribution function for the distribution at a given probability. Also known at the quantile or percent point function. | Number |
| Mean | Returns the mean of the distribution. | Number |
| Mode | The mode of the distribution. | Number |
| Variance | The variance of the distribution. | Number |

## Inverse Gamma

In [probability theory](https://en.wikipedia.org/wiki/Probability_theory) and [statistics](https://en.wikipedia.org/wiki/Statistics), the **inverse gamma distribution** is a two-parameter family of continuous [probability distributions](https://en.wikipedia.org/wiki/Probability_distribution) on the positive [real line](https://en.wikipedia.org/wiki/Real_line), which is the distribution of the [reciprocal](https://en.wikipedia.org/wiki/Multiplicative_inverse) of a variable distributed according to the [gamma distribution](https://en.wikipedia.org/wiki/Gamma_distribution). Perhaps the chief use of the inverse gamma distribution is in [Bayesian statistics](https://en.wikipedia.org/wiki/Bayesian_statistics), where the distribution arises as the marginal posterior distribution for the unknown [variance](https://en.wikipedia.org/wiki/Variance) of a [normal distribution](https://en.wikipedia.org/wiki/Normal_distribution), if an [uninformative prior](https://en.wikipedia.org/wiki/Uninformative_prior) is used, and as an analytically tractable [conjugate prior](https://en.wikipedia.org/wiki/Conjugate_prior), if an informative prior is required.(Hoff, 2009:74) (source: <https://en.wikipedia.org/wiki/Inverse-gamma_distribution> )

### Input:

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Data Type** |
| iscale | The scale (beta) parameter. | Number |
| Ishape | Sets the shape (alpha) parameter. | Number |
| X | The x parameter. | Number |
| RandomSourceType | The type of random number generator used. Value range is 1-10. See Random Source Type.pg 7. | Number |

### Output:

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Data Type** |
| Cd | Computes the CDF of the Distribution at x. | Number |
| Sample | Sample from the Normal Distribution using the Box-Muller algorithm. | Number |
| Entropy | Entropy measures the expected amount of information conveyed by identifying the outcome of a random trial. | Number |
| Density | Computes the probability density of the distribution at x. | Number |
| DensityLn | Computes the log probability density of the distribution at x. | Number |
| Rate | Returns the rate value. | Number |
| Shape | Returns the shape value. | Number |
| Mode | The mode of the distribution. | Number |

## Laplace

In [probability theory](https://en.wikipedia.org/wiki/Probability_theory) and [statistics](https://en.wikipedia.org/wiki/Statistics), the **Laplace distribution** is a continuous [probability distribution](https://en.wikipedia.org/wiki/Probability_distribution) named after [Pierre-Simon Laplace](https://en.wikipedia.org/wiki/Pierre-Simon_Laplace). It is also sometimes called the **double exponential distribution**, because it can be thought of as two [exponential distributions](https://en.wikipedia.org/wiki/Exponential_distribution) (with an additional location parameter) spliced together back-to-back, although the term is also sometimes used to refer to the [Gumbel distribution](https://en.wikipedia.org/wiki/Gumbel_distribution). The difference between two [independent identically distributed](https://en.wikipedia.org/wiki/Independent_identically-distributed_random_variables) exponential random variables is governed by a Laplace distribution, as is a [Brownian motion](https://en.wikipedia.org/wiki/Brownian_motion) evaluated at an exponentially distributed random time. Increments of [Laplace motion](https://en.wikipedia.org/wiki/Laplace_motion) or a [variance gamma process](https://en.wikipedia.org/wiki/Variance_gamma_process) evaluated over the time scale also have a Laplace distribution.(source: <https://en.wikipedia.org/wiki/Laplace_distribution> )

### Input:

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Data Type** |
| iscale | The scale (beta) parameter. | Number |
| ilocation | Sets the location parameter. | Number |
| X | The x parameter. | Number |
| RandomSourceType | The type of random number generator used. Value range is 1-10. See Random Source Type.pg 7. | Number |

### Output:

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Data Type** |
| cd | Cumulative Distribution Function | Number |
| Sample | Sample from the Normal Distribution using the Box-Muller algorithm. | Number |
| Entropy | Entropy measures the expected amount of information conveyed by identifying the outcome of a random trial. | Number |
| Skewness | A measure of the asymmetry of the probability distribution of a real-valued random variable about its mean. | Number |
| Stddev | Returns the Standard Deviation of the distribution. | Number |
| Density | Computes the probability density of the distribution at x. | Number |
| DensityLn | Computes the log probability density of the distribution at x. | Number |
| Scale | Returns the scale value. | Number |
| Location | Gets the location (mu) of the laplace distribution. | Number |
| Mean | The mean of the distribution. | Number |
| Median | The median of the distribution. | Number |
| Mode | The mode of the distribution. | Number |
| Variance | The variance of the distribution. | Number |

## Pareto

The **Pareto distribution**, named after the Italian [civil engineer](https://en.wikipedia.org/wiki/Civil_engineer), [economist](https://en.wikipedia.org/wiki/Economist), and sociologist [Vilfredo Pareto](https://en.wikipedia.org/wiki/Vilfredo_Pareto)[[1]](https://en.wikipedia.org/wiki/Pareto_distribution#cite_note-1), is a [power-law](https://en.wikipedia.org/wiki/Power-law) [probability distribution](https://en.wikipedia.org/wiki/Probability_distribution) that is used in description of [social](https://en.wikipedia.org/wiki/Social_sciences), [scientific](https://en.wikipedia.org/wiki/Scientific), [geophysical](https://en.wikipedia.org/wiki/Geophysical), [actuarial](https://en.wikipedia.org/wiki/Actuarial_science), and many other types of observable phenomena. Originally applied to describing the [distribution of wealth](https://en.wikipedia.org/wiki/Distribution_of_wealth) in a society, fitting the trend that a large portion of wealth is held by a small fraction of the population[[2]](https://en.wikipedia.org/wiki/Pareto_distribution#cite_note-2), the Pareto distribution has colloquially become known and referred to as the [Pareto principle](https://en.wikipedia.org/wiki/Pareto_principle), or "80-20 rule", and is sometimes called the "[Matthew principle](https://en.wikipedia.org/wiki/Matthew_principle)". This rule states that, for example, 80% of the wealth of a society is held by 20% of its population. However, one should not conflate the Pareto distribution with the Pareto Principle as the former only produces this result for a power value, α (*α* = log45 ≈ 1.16). While α } is variable, empirical observation has found the 80-20 distribution to fit a wide range of cases, including natural phenomena[[3]](https://en.wikipedia.org/wiki/Pareto_distribution#cite_note-3) and human activities. (source: <https://en.wikipedia.org/wiki/Pareto_distribution> )

### Input:

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Data Type** |
| iscale | The scale (beta) parameter. | Number |
| ishape | Sets the shape (alpha) parameter. | Number |
| X | The x parameter. | Number |
| RandomSourceType | The type of random number generator used. Value range is 1-10. See Random Source Type.pg 7. | Number |

### Output:

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Data Type** |
| cd | Cumulative Distribution Function | Number |
| Sample | Sample from the Normal Distribution using the Box-Muller algorithm. | Number |
| Entropy | Entropy measures the expected amount of information conveyed by identifying the outcome of a random trial. | Number |
| Density | Computes the probability density of the distribution at x. | Number |
| DensityLn | Computes the log probability density of the distribution at x. | Number |
| Scale | Returns the scale value. | Number |
| Shape | Gets the shape (alpha) of the Pareto distribution. | Number |
| Median | The median of the distribution. | Number |
| Mode | The mode of the distribution. | Number |

## Rayleigh

In [probability theory](https://en.wikipedia.org/wiki/Probability_theory) and [statistics](https://en.wikipedia.org/wiki/Statistics), the **Rayleigh distribution** is a [continuous probability distribution](https://en.wikipedia.org/wiki/Continuous_probability_distribution) for nonnegative-valued [random variables](https://en.wikipedia.org/wiki/Random_variable). It is essentially a [chi distribution](https://en.wikipedia.org/wiki/Chi_distribution) with two [degrees of freedom](https://en.wikipedia.org/wiki/Degrees_of_freedom).

A Rayleigh distribution is often observed when the overall magnitude of a vector is related to its directional [components](https://en.wikipedia.org/wiki/Euclidean_vector#Vector_components). One example where the Rayleigh distribution naturally arises is when [wind](https://en.wikipedia.org/wiki/Wind) velocity is analyzed in [two dimensions](https://en.wikipedia.org/wiki/Plane_(geometry)). Assuming that each component is [uncorrelated](https://en.wikipedia.org/wiki/Uncorrelated), [normally distributed](https://en.wikipedia.org/wiki/Normal_distribution) with equal [variance](https://en.wikipedia.org/wiki/Variance), and zero [mean](https://en.wikipedia.org/wiki/Mean), then the overall wind speed ([vector](https://en.wikipedia.org/wiki/Euclidean_vector) magnitude) will be characterized by a Rayleigh distribution. A second example of the distribution arises in the case of random complex numbers whose real and imaginary components are independently and identically distributed [Gaussian](https://en.wikipedia.org/wiki/Normal_distribution) with equal variance and zero mean. In that case, the absolute value of the complex number is Rayleigh-distributed.

The distribution is named after [Lord Rayleigh](https://en.wikipedia.org/wiki/John_Strutt,_3rd_Baron_Rayleigh) (source: <https://en.wikipedia.org/wiki/Rayleigh_distribution> )

### Input:

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Data Type** |
| iscale | The scale (beta) parameter. | Number |
| X | The x parameter. | Number |
| RandomSourceType | The type of random number generator used. Value range is 1-10. See Random Source Type.pg 7. | Number |
| P | The given probability parameter. |  |

### Output:

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Data Type** |
| cd | Cumulative Distribution Function | Number |
| Sample | Sample from the Normal Distribution using the Box-Muller algorithm. | Number |
| Entropy | Entropy measures the expected amount of information conveyed by identifying the outcome of a random trial. | Number |
| Skewness | A measure of the asymmetry of the probability distribution of a real-valued random variable about its mean. | Number |
| Stddev | Returns the Standard Deviation of the distribution. | Number |
| Density | Computes the probability density of the distribution at x. | Number |
| DensityLn | Computes the log probability density of the distribution at x. | Number |
| Scale | Returns the scale value. | Number |
| invcd | Computes the inverse of the cumulative distribution function for the distribution at a given probability. Also known at the quantile or percent point function. | Number |
| Mean | The mean of the distribution. | Number |
| Median | The median of the distribution. | Number |
| Mode | The mode of the distribution. | Number |
| Variance | The variance of the distribution. | Number |

## Student-T

In [probability](https://en.wikipedia.org/wiki/Probability) and [statistics](https://en.wikipedia.org/wiki/Statistics), **Student's *t*-distribution** (or simply the ***t*-distribution**) is any member of a family of continuous [probability distributions](https://en.wikipedia.org/wiki/Probability_distribution) that arises when estimating the [mean](https://en.wikipedia.org/wiki/Expected_value) of a [normally distributed](https://en.wikipedia.org/wiki/Normal_distribution) [population](https://en.wikipedia.org/wiki/Statistical_population) in situations where the [sample size](https://en.wikipedia.org/wiki/Sample_size) is small and the population [standard deviation](https://en.wikipedia.org/wiki/Standard_deviation) is unknown. It was developed by [William Sealy Gosset](https://en.wikipedia.org/wiki/William_Sealy_Gosset) under the pseudonym *Student*.

The *t*-distribution plays a role in a number of widely used statistical analyses, including [Student's *t*-test](https://en.wikipedia.org/wiki/Student%27s_t-test) for assessing the [statistical significance](https://en.wikipedia.org/wiki/Statistical_significance) of the difference between two sample [means](https://en.wikipedia.org/wiki/Mean), the construction of [confidence intervals](https://en.wikipedia.org/wiki/Confidence_interval) for the difference between two population means, and in linear [regression analysis](https://en.wikipedia.org/wiki/Regression_analysis). The Student's *t*-distribution also arises in the [Bayesian analysis](https://en.wikipedia.org/wiki/Bayesian_analysis) of data from a normal family.

If we take a sample of n observations from a [normal distribution](https://en.wikipedia.org/wiki/Normal_distribution), then the *t*-distribution with ν = n − 1 [degrees of freedom](https://en.wikipedia.org/wiki/Degrees_of_freedom_(statistics)) can be defined as the distribution of the location of the sample mean relative to the true mean, divided by the sample standard deviation, after multiplying by the standardizing term n In this way, the *t*-distribution can be used to construct a [confidence interval](https://en.wikipedia.org/wiki/Confidence_interval) for the true mean.

The *t*-distribution is symmetric and bell-shaped, like the [normal distribution](https://en.wikipedia.org/wiki/Normal_distribution), but has heavier tails, meaning that it is more prone to producing values that fall far from its mean. This makes it useful for understanding the statistical behavior of certain types of ratios of random quantities, in which variation in the denominator is amplified and may produce outlying values when the denominator of the ratio falls close to zero. The Student's *t*-distribution is a special case of the [generalised hyperbolic distribution](https://en.wikipedia.org/wiki/Generalised_hyperbolic_distribution). (source: <https://en.wikipedia.org/wiki/Student%27s_t-distribution> )

### Input:

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Data Type** |
| iscale | The scale parameter. | Number |
| Ilocation | Sets the location parameter. | Number |
| Ifreedom | The degree of freedom of the distribution. | Number |
| x | The x parameter. | Number |
| p | The given probability parameter. | Number |
| RandomSourceType | The type of random number generator used. Value range is 1-10. See Random Source Type.pg 7. | Number |

### Output:

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Data Type** |
| cd | Cumulative Distribution Function | Number |
| Sample | Sample from the Normal Distribution using the Box-Muller algorithm. | Number |
| Density | Computes the probability density of the distribution at x. | Number |
| DensityLn | Computes the log probability density of the distribution at x. | Number |
| Location | Gets the location (mu) of the student distribution. | Number |
| Median | The median of the distribution. | Number |
| Mode | The mode of the distribution. | Number |
| Invcd | Computes the inverse of the cumulative distribution function for the distribution at a given probability. Also known at the quantile or percent point function. | Number |
| Dof | Degree of freedom. | Number |
| Scale | Returns the scale value. |  |

## Weibull

In [probability theory](https://en.wikipedia.org/wiki/Probability_theory) and [statistics](https://en.wikipedia.org/wiki/Statistics), the **Weibull distribution** [/ˈveɪbʊl/](https://en.wikipedia.org/wiki/Help:IPA/English) is a continuous [probability distribution](https://en.wikipedia.org/wiki/Probability_distribution). It is named after Swedish mathematician [Waloddi Weibull](https://en.wikipedia.org/wiki/Waloddi_Weibull), who described it in detail in 1951, although it was first identified by [Fréchet (1927)](https://en.wikipedia.org/wiki/Weibull_distribution#CITEREFFréchet1927) and first applied by [Rosin & Rammler (1933)](https://en.wikipedia.org/wiki/Weibull_distribution#CITEREFRosinRammler1933) to describe a [particle size distribution](https://en.wikipedia.org/wiki/Particle-size_distribution). (source: <https://en.wikipedia.org/wiki/Weibull_distribution> )

Input:

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Data Type** |
| iscale | The scale parameter. | Number |
| ishape | Sets the shape parameter. | Number |
| x | The x parameter. | Number |
| p | The given probability parameter. | Number |
| RandomSourceType | The type of random number generator used. Value range is 1-10. See Random Source Type.pg 7. | Number |

### Output:

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Data Type** |
| cd | Cumulative Distribution Function | Number |
| Sample | Sample from the Normal Distribution using the Box-Muller algorithm. | Number |
| Entropy | Entropy measures the expected amount of information conveyed by identifying the outcome of a random trial. | Number |
| Skewness | A measure of the asymmetry of the probability distribution of a real-valued random variable about its mean. | Number |
| Stddev | Returns the Standard Deviation of the distribution. | Number |
| Density | Computes the probability density of the distribution at x. | Number |
| DensityLn | Computes the log probability density of the distribution at x. | Number |
| Mean | The mean of the distribution. | Number |
| Median | The median of the distribution. | Number |
| Mode | The mode of the distribution. | Number |
| Variance | The variance of the distribution. | Number |
| Shape | The shape value (returns original parameter value) | Number |
| Scale | Returns the scale value. | Number |

# Support

This asset is provided free-of-charge by Blue Prism. Blue Prism does not provide formal support of this asset. Please direct any questions you have, related to this asset, to the Digital Exchange Community page:

<https://community.blueprism.com/communities/community-home?CommunityKey=1e516cfe-4d1f-4de9-a9eb-58d15bf38c81>

Please note that 2 distributions, Stable and Triangular have been omitted due to issues with their functionality. Should the library be revised at a future date, we will endeavour to incorporate them.