Table of Available Functions

This table lists the custom functions that are added to Excel by @RISK. When used, all functions are preceded by the entry **RISK**.

The example below shows how to enter a Discrete distribution formula into your spreadsheet.

Use the equals sign (=), followed by Risk, followed by the distribution name (Discrete), followed by the distribution's parameters ({X1,X2, ...,Xn}, {p1,p2,...,pn}).

It is important to begin with the equals sign (=) and to follow the order above.

The formula will look like the example below; however the parameters will be replaced with values.

Distribution Function	Returns
BETA(*alpha1*,*alpha2*)	beta distribution with shape parameters *alpha1* and *alpha2*
BETAGENERAL(*alpha1*,*alpha2*, *minimum*, *maximum*)	beta distribution with defined *minimum*, *maximum* and shape parameters *alpha1* and *alpha2*
BETASUBJ(*minimum*, *most likely*, *mean*, *maximum*)	beta distribution with defined *minimum*, *maximum*, *most likely* and *mean*
BINOMIAL(*n*,*p*)	binomial distribution with *n* draws and *p* probability of success on each draw
CHISQ(*v*)	Chi-Square distribution with *v* degrees of freedom
CUMUL(*minimum*,*maximum*, *{X1,X2,...,Xn}*,*{p1,p2,...,pn}*)	cumulative distribution with *n* points between *minimum* and *maximum* with cumulative probability *p* at each point
DISCRETE(*{X1,X2,...,Xn}*, *{p1,p2,...,pn}*)	discrete distribution with *n* possible outcomes with the value *X* and probability weight *p* for each outcome
DUNIFORM(*{X1,X2,...Xn}*)	discrete uniform distribution with n outcomes valued at *X1* through *Xn*
ERF(*h*)	error function distribution with variance parameter *h*
ERLANG(*m*,*beta*)	m-erlang distribution with integral shape parameter *m* and scale parameter *beta*
EXPON(*beta*)	exponential distribution with decay constant *beta*

=RiskDiscrete({X1,X2,...,Xn},{p1,p2,...,pn})

Distribution Function	Returns
EXTVALUE(*a*,*b*)	extreme value (or Gumbel) distribution with location parameter *a* and scale parameter *b*
GAMMA(*alpha*,*beta*)	gamma distribution with shape parameter *alpha* and scale parameter *beta*
GEOMETRIC(*p*)	geometric distribution with probability *p*
GENERAL(*minimum*,*maximum*,*{X1,X2,...,Xn}*,*{p1,p2,...,pn}*)	general density function for a probability distribution ranging between minimum and maximum with *n* (*x*,*p*) pairs with value *X* and probability weight *p* for each point
HISTOGRM(*minimum*,*maximum*,*{p1,p2,...,pn}*)	histogram distribution with *n* classes between *minimum* and *maximum* with probability weight *p* for each class
HYPERGEO(*n*,*D*,*M*)	hypergeometric distribution with sample size *n*, *D* number of items and *M* population size
INTUNIFORM(*minimum*,*maximum*)	uniform distribution which returns integer values only between *minimum* and *maximum*
INVGAUSS(*mu*,*lambda*)	inverse gaussian (or Wald) distribution with mean *mu* and shape parameter *lambda*
LOGISTIC(*alpha*,*beta*)	logistic distribution with location parameter *alpha* and scale parameter *beta*
LOGLOGISTIC(*gamma*,*beta*,*alpha*)	log-logistic distribution with location parameter *gamma*, scale parameter *beta* and shape parameter *alpha*
LOGNORM(*mean*,*standard deviation*)	lognormal distribution with specified *mean* and *standard deviation*
LOGNORM2(*mean*,*standard deviation*)	lognormal distribution generated from the "log" of a normal distribution with specified *mean* and *standard deviation*
NEGBIN(*s*,*p*)	negative binomial distribution with *s* successes and *p* probability of success on each trial
NORMAL(*mean*,*standard deviation*)	normal distribution with given *mean* and *standard deviation*

Distribution Function	Returns
PARETO(*theta,a*)	pareto distribution
PARETO2(*b,q*)	pareto distribution
PEARSON5(*alpha,beta*)	pearson type V (or inverse gamma) distribution with shape parameter *alpha* and scale parameter *beta*
PEARSON6(*beta,alpha1, alpha2*)	pearson type VI distribution with scale parameter *beta* and shape parameters *alpha1* and *alpha2*
PERT(*minimum,most likely, maximum*)	pert distribution with specified *minimum, most likely* and *maximum* values
POISSON(*lambda*)	poisson distribution
RAYLEIGH(*b*)	rayleigh distribution with scale parameter *b*
SIMTABLE(*{X1,X2,...Xn}*)	lists values to be used in each of a series of simulations
STUDENT(*nu*)	student's t distribution with *nu* degrees of freedom
TRIANG(*minimum,most likely, maximum*)	triangular distribution with defined *minimum, most likely* and *maximum* values
TRIGEN(*bottom,most likely,top, bottom perc.,top perc.*)	triangular distribution with three points representing value at *bottom percentile, most likely* value and value at *top percentile.*
UNIFORM(*minimum,maximum*)	uniform distribution between *minimum* and *maximum*
WEIBULL(*alpha,beta*)	weibull distribution with shape parameter *alpha* and scale parameter *beta*

Distribution Property Function	Specifies
COLLECT()	Causes samples to be collected during a simulation for the distribution in which the Collect function is included (when simulation settings specify Collect Samples for Distributions Marked with Collect only)
CORRMAT(*matrix cell range, position*,*instance*)	Identifies a *matrix* of rank correlation coefficients and a *position* in the matrix for the distribution in which the Corrmat function is included. *Instance* specifies the instance of the matrix at matrix cell range that will be used for correlating this distribution.
DEPC(*"ID"*,*coefficient*)	Identifies dependent variable in correlated sampling pair with rank correlation *coefficient* and *"ID"* identifier string
FIT(*ProjID*,*FitID*,*"selected fit result"*)	Links a data set identified by *ProjID* and *FitID* and its fit results to the input distribution so the input can be updated when data changes
INDEPC(*"ID"*)	Identifies independent distribution in rank correlated sampling pair — *"ID"* is identifier string
LOCK()	Blocks sampling of the distribution in which the Lock function is included
NAME(*"input name"*)	*Input name* for the distribution in which the Name function is included
SHIFT(*shift*)	Shifts the domain of the distribution in which the Shift function is included by *shift* value
TRUNCATE(*minimum, maximum*)	*Minimum-maximum* range allowable for samples drawn for the distribution in which the Truncate function is included
Output Function	**Specifies**
OUTPUT(*"name","output range name", position in range*)	Simulation output cell with *name, output range name* to which the output belongs, and the *position in range* (*Note: all arguments to this function are optional*)

Statistics Function	Returns
DATA(*cellref or output/input name, iteration#,Sim#*)	Data value of the simulated distribution for the entered *cellref* or *output/input name* in *iteration#* and *Sim#*
KURTOSIS(*cellref or output/input name, Sim#*)	Kurtosis of the simulated distribution for the entered *cellref* or *output/input name* in *Sim#*
MAX(*cellref or output/input name, Sim#*)	Maximum value of the simulated distribution for *cellref* or *output/input name* in *Sim#*
MEAN(*cellref or output/input name, Sim#*)	Mean of the simulated distribution for *cellref* or *output/input name* in *Sim#*
MIN(*cellref or output/input name, Sim#*)	Minimum value of the simulated distribution for *cellref* or *output/input name* in *Sim#*
MODE(*cellref or output/input name, Sim#*)	Mode of the simulated distribution for *cellref* or *output/input name* in *Sim#*
PERCENTILE(*cellref or output/input name, perc%, Sim#)*	Percentile *perc%* of the simulated distribution for *cellref* or *output/input name* in *Sim#*
RANGE(*cellref or output/input name, Sim#*)	Range of the simulated distribution for *cellref* or *output/input name* in *Sim#*
SKEWNESS(*cellref or output/input name, Sim#*)	Skewness of the simulated distribution for *cellref* or *output/input name* in *Sim#*
STDDEV(*cellref or output/input name, Sim#*)	Standard deviation of the simulated distribution for *cellref* or *output/input name* in *Sim#*
TARGET(*cellref or output/input name, target value, Sim#*)	Cumulative probability of *target value* in the simulated distribution for *cellref* or *output/input name* in *Sim#*
VARIANCE(*cellref or output/input name, Sim#*)	Variance of the simulated distribution for *cellref* or *output/input name* in *Sim#*

Supplemental Function	Returns
CURRENTITER()	returns the current iteration of the simulation
CURRENTSIM()	returns the current simulation number
Graphing Function	**Returns**
RESULTSGRAPH(*cellRef or output/input name ,graphType,xlFormat, leftdelimiter, rightdelimiter,xMin,xMax,xScale,Sim#*)	Graph of the simulated distribution for the entered *cellref* or *output/input name* in *Sim#*, displayed using *graphType in* metafile or *xlFormat*, with *leftdelimiter, rightdelimiter* locations for delimiters and*xMin,xMax*,xScale settings for X-axis.

Reference: @RISK Functions

Introduction

@RISK includes custom functions that can be included in Excel cells and formulas. These functions are used for:

1) **Defining probability distributions** (@RISK *distribution functions* and *distribution property* functions).
2) **Defining simulation outputs** (*RiskOutput* function)
3) **Returning simulation results to your spreadsheet** (@RISK *statistics* and *graphing* functions)

This reference chapter describes each of these types of @RISK functions and gives details about both the required and optional arguments for each function.

Distribution Functions

Probability distribution functions are used for adding uncertainty — in the form of probability distributions — to the cells and equations in your Excel worksheet. For example, you could enter RiskUniform(10,20) to a cell in your worksheet. This specifies that the values for the cell will be generated by a uniform distribution with a minimum of 10 and a maximum of 20. This range of values replaces the single "fixed" value required by Excel.

Distribution functions are used by @RISK during a simulation for sampling sets of possible values. Each iteration of a simulation uses a new set of values sampled from each distribution function in your worksheet. These values are then used in recalculating your worksheet and generating a new set of possible results.

As with Excel functions, distribution functions contain two elements, a function name and argument values which are enclosed in parentheses. A typical distribution function is:

RiskNormal(100,10)

A different distribution function is used for each type of probability distribution. The type of distribution which will be sampled is given by the name of the function. The parameters which specify the distribution are given by the arguments of the function.

The number and type of arguments required for a distribution function vary by function. In some cases, such as with:

RiskNormal(mean,standard deviation)

a fixed number of arguments are specified each time you use the function. For others, such as DISCRETE, you specify the number of arguments you desire, based on your situation. For example, a DISCRETE function may specify two possible outcomes, or three, or more as needed.

Like Excel functions, distribution functions may have arguments which are references to cells or expressions. For example:

RiskTriang(B1,B2*1.5,B3)

In this case the cell value would be specified by a triangular distribution with a minimum value taken from cell B1, a most likely value calculated by taking the value for cell B2 and multiplying it by 1.5 and a maximum value taken from cell B3.

Distribution functions also may be used in cell formulas, just as are Excel functions. For example, a cell formula could read:

B2: 100+RiskUniform(10,20)+(1.5*RiskNormal(A1,A2))

All standard Excel editing commands are available to you when entering distribution functions. However, you will need to have @RISK loaded for the distribution functions to be sampled by Excel. If it is not attached, Excel will return the expected value of the function when the worksheet is recalculated.

Entering Probability Distribution Functions

To enter probability distribution functions:

1) Examine your worksheet and identify those cells which you think have uncertain values

Look for those cells where the actual values which occur could vary from those shown in the worksheet. At first, identify those important variables whose cell values may have the largest variation in value. As your Risk Analysis gets more refined, you can further expand your use of distribution functions throughout the worksheet.

1) Select distribution functions for the cells you have identified. In Excel, use the Insert menu Function command to enter the selected functions into formulas.

You have over thirty types of distributions to choose from when selecting a distribution function. Unless you know specifically how uncertain values are distributed it is a good idea to start with some of the simpler distribution types — uniform, triangular, or normal. As a starting point, if possible, specify the current cell value as the mean or most likely value of the distribution function. The range of the function you are using then reflects the possible variation around the mean or most likely value.

The simple distribution functions can be very powerful as you can describe uncertainty with only a few values or arguments. For example:

- **RiskUniform*(Minimum, Maximum)*** uses only two values to describe the full range of the distribution and assign probabilities for all the values in the range.
- **RiskTriang*(Minimum, Most Likely, Maximum)*** uses three easily identifiable values to describe a complete distribution.

As your models become more complex, you probably will want to choose from more complex distribution types in order to meet your specific modeling needs. Use both the listings in this Reference section and the *Technical Appendices* to guide you in selecting and comparing distribution types.

Defining Distributions Graphically

A graph of the distribution is often helpful in selecting and specifying distribution functions. You can use @RISK **Define Distribution** window to display distribution graphs and add distribution functions to cell formulas. To do this, select the cell where you wish to add a distribution function and click the Define Distribution icon or the @RISK add-in menu Model Define Distribution command. The *Technical Appendices* also contains graphic depictions of different functions at selected argument values. For more information on the Define Distribution window, see the **Model Menu: Define Distribution Command** in the **@RISK Add-In Menu Commands** section in this manual.

It often helps to first use the Define Distribution window to enter your distribution functions to better understand how to assign values to function arguments. Then, once you better understand the syntax of distribution function arguments, you can enter the arguments yourself directly in Excel, bypassing the Define Distribution window.

Fitting Data to Distributions

The @RISK Model window (Professional and Industrial versions only) allows you to fit probability distributions to your data. The distributions which result from a fit are then available to be assigned as input distributions and added to your spreadsheet model. By setting the **Source:** in the Define Distribution window to **Fit Results**, you can use the fit results from any Fit Tab for assigning distributions to model inputs. For more information on distribution fitting see the **Fitting Menu Commands** in the **@RISK Model Window Commands** section in this manual.

Distribution Property Functions

Optional arguments to distribution functions can be entered using **Distribution Property** functions. These optional arguments are used to name an input distribution for reporting and graphing, truncate the sampling of a distribution, correlate the sampling of a distribution with other distributions and keep a distribution from being sampled during a simulation. These arguments are not required, but can be added as needed.

Optional arguments specified using @RISK distribution property functions are embedded inside of a distribution function. Distribution Property functions are entered just as are standard Excel functions and can include cell references and mathematical expressions as arguments.

For example, the following function truncates the entered normal distribution to a range with a minimum value of 0 and a maximum value of 20:

=RiskNormal*(10,5,RiskTruncate(0,20))*

No samples will be drawn outside this minimum-maximum range.

Entering Arguments in @RISK Functions

The guidelines for entering Excel functions presented in the relevant User's Guide are also applicable to entering @RISK functions. However, some additional guidelines specific to @RISK functions are:

- Where integer arguments are required by a distribution function, any non-integer argument values will be truncated to integers.
- Integer arguments must be greater than or equal to -32,767 and less than or equal to 32,767. Values outside this range will cause the function to return #VALUE in Excel.
- Distribution functions with varying numbers of arguments (such as HISTOGRM, DISCRETE, and CUMUL) require that arguments of the same type be entered as arrays. Arrays in Excel are denoted by either enclosing the values of the array in {} brackets or using a reference to a contiguous range of cells — such as A1:C1. If a function takes a varying number of value / probability pairs, the values will be one array and the probabilities another. The first value in the value array is matched with the first probability in the probability array and so on.

Optional Arguments

Some @RISK functions have **optional** arguments, or arguments that may be used but are not required. The **RiskOutput** function, for example, has only optional arguments. You can use it with 0, 1 or 3 arguments, depending on what information you wish to define about the output cell where the function is used. You can:

1) Just identify the cell as an output, letting @RISK automatically generate a name for you (i.e., *=RiskOutput()*).
2) Give the output a name you select (i.e., *=RiskOutput("Profit 1999")*).
3) Give the output a name you select and identify it as part of an output range (i.e., *=RiskOutput("Profit 1999"," Profit By Year",1)*).

Any of these forms of the **RiskOutput** function are allowed because all of its arguments are optional.

When an @RISK function has optional arguments you can add the optional arguments you choose and ignore the rest. You must, however, include all required arguments. For example, for the **RiskNormal** function, two arguments, *mean* and *standard deviation*, are required. All of the arguments which can be added to the RiskNormal function via *distribution property functions* are optional and can be entered in any order you like.

Important Note on Excel Arrays

In Excel, you may not list cell references or names in arrays as you would list constants. For example, you could not use {A1,B1,C1} to represent the array containing the values in cells A1, B1, and C1. Instead, you must use the cell range reference A1:C1 or enter the values of those cells directly in the arrays as constants — for example, {10,20,30}.

- Distribution functions with fixed numbers of arguments will return an error value if an insufficient number of arguments is entered and will ignore extra arguments if too many are entered.
- Distribution functions will return an error value if arguments are of the wrong type (number, array or text).

More Information

This section briefly describes each probability distribution function available and the arguments required for each. In addition, the *Technical Appendices* describe the technical characteristics of each probability distribution function. The appendices include formulas for density, distribution, mean, mode, distribution parameters and graphs of the probability distributions generated using typical argument values.

Simulation Output Functions

Output cells are defined using *RISKOutput* functions. These functions allow the easy copying, pasting and moving of output cells. RISKOutput functions are automatically added when the standard @RISK Add Output icon is pressed. RISKOutput functions optionally allow you to name your simulation outputs and add individual output cells to output ranges. A typical RISKOutput function might be:

=RiskOutput("Profit")+NPV(.1,H1…H10)

where the cell, prior to its selection as a simulation output, simply contained the formula

= NPV(.1,H1…H10)

The added RiskOutput function selects the cell as a simulation output and gives the output the name "Profit".

Simulation Statistics Functions

@RISK statistics functions return a desired statistic on simulation results. For example, the function *RiskMean(A10)* returns the mean of the simulated distribution for the cell A10. These functions are updated real-time as a simulation is running.

@RISK statistics functions include all standard statistics plus percentiles, targets (for example, *=RiskPercentile(A10,.99)* returns the 99^{th} percentile of the simulated distribution). @RISK statistics functions can be used the way you would use any standard Excel function.

Statistics in Report Templates

Statistics functions may also reference a simulation output or input by name. This allows them to be included in templates which are used to generate pre-formatted reports in Excel on simulation results. For example, the function *=RiskMean("Profit")* would return the mean of the simulated distribution for the output cell named Profit defined in a model.

Note: A cell reference entered in a statistics function does not have to be a simulation output identified with a RiskOutput function.

Graphing Function

A special @RISK function *RiskResultsGraph* will automatically place a graph of simulation results wherever it is used in a spreadsheet. For example, *=RiskResultsGraph(A10)* would place a graph of the simulated distribution for A10 directly in your spreadsheet at the function's location at the end of a simulation. Additional optional arguments to *RiskResultsGraph* allow you to select the type of graph you want to create, its format, scaling and other options.

Supplemental Functions

Two additional functions — **CurrentIter** and **CurrentSim** — are provided for use in the development of macro-based applications using @RISK. These functions return the current iteration and current simulation, respectively, of an executing simulation.

Listing of Distribution Functions

Distribution functions are listed here with their required arguments. Optional arguments may be added to these required arguments using the **@RISK Distribution Property functions** listed in the next section.

BETA

BETA(*alpha1,alpha2*) specifies a beta distribution using the shape parameters *alpha1* and *alpha2*. These two arguments generate a beta distribution with a minimum value of 0 and a maximum value of 1.

Examples *RiskBeta(1,2) specifies a beta distribution using the shape parameters 1 and 2.*

RiskBeta(C12,C13) specifies a beta distribution using the shape parameter alpha1 *taken from cell C12 and a shape parameter* alpha2 *taken from cell C13.*

Guidelines *Both* alpha1 *and* alpha2 *must be greater than zero.*

BETAGENERAL

BETAGENERAL(*alpha1,alpha2,minimum,maximum*) specifies a beta distribution with the defined *minimum* and *maximum* using the shape parameters *alpha1* and *alpha2*.

Examples *RiskBetaGeneral(1,2,0,100) specifies a beta distribution using the shape parameters 1 and 2 and a minimum value of 0 and a maximum value of 100.*

RiskBeta(C12,C13,D12,D13) specifies a beta distribution using the shape parameter alpha1 *taken from cell C12 and a shape parameter* alpha2 *taken from cell C13 and a minimum value from D12 and a maximum value of from D13.*

Guidelines *Both* alpha1 *and* alpha2 *must be greater than zero.*

BETASUBJ

BETASUBJ(minimum, most likely, mean, maximum) specifies a beta distribution with a *minimum* and *maximum* value as specified. The shape parameters are calculated from the defined *most likely* value and *mean*.

Examples ***RiskBetaSubj(0,1,2,10)*** *specifies a beta distribution with a minimum of 0, a maximum of 10, a most likely value of 1 and a mean of 2.*

RiskBetaSubj(A1,A2,A3,A4) *specifies a beta distribution with a minimum value taken from cell A1, a maximum value taken from cell A4, a most likely value taken from cell A2 and a mean value taken from cell A3.*

Guidelines Minimum *must be less than* maximum.

Most likely *must be greater than* minimum *and less than* maximum.

Mean *must be greater than* minimum *and less than* maximum.

If mean *is less than (*maximum + minimum*) / 2 then* most likely *must be less than* mean.

If mean *is greater than (*maximum + minimum*) / 2 then* most likely *must be greater than* mean.

If most likely *equals (*maximum + minimum*) / 2 then* mean *must equal* most likely.

BINOMIAL

BINOMIAL(*n, p*) specifies a binomial distribution with *n* number of trials and *p* probability of success on each trial. The number of trials is often referred to as the number of draws or samples made. The binomial distribution is a discrete distribution returning only integer values greater than or equal to zero.

Examples

RiskBinomial(5,.25) specifies a binomial distribution generated from 5 trials or "draws" with a 25% probability of success on each draw.

*RiskBinomial(C10*3,B10) specifies a binomial distribution generated from the trials or "draws" given by the value in cell C10 times 3. The probability of success on each draw is given in cell B10.*

Guidelines

The number of trials n *must be a positive integer greater than zero and less than or equal to 32,767.*

Probability p *must be greater than or equal to zero and less than or equal to 1.*

CHISQ

CHISQ(*v*) specifies a Chi-Square distribution with *v* degrees of freedom.

Examples

RiskChisq(5) generates a Chi-Square distribution with 5 degrees of freedom.

RiskChisq(A7) generates a Chi-Square distribution with the degrees of freedom parameter taken from cell A7.

Guidelines

Number of degrees of freedom v *must be a positive integer.*

CUMUL

CUMUL(*minimum,maximum,{X1,X2,..,Xn},{p1,p2,..,pn}*) specifies a cumulative distribution with *n* points. The range of the cumulative curve is set by the *minimum* and *maximum* arguments. Each point on the cumulative curve has a value *X* and a probability *p.* Points on the cumulative curve are specified with increasing value and increasing probability. Any number of points may be specified for the curve.

Examples

RiskCumul(0,10,{1,5,9},{.1,.7,.9}) specifies a cumulative curve with 3 data points and a range of 0 to 10. The first point on the curve is 1 with a cumulative probability of .1 (10% of the distribution values are less than or equal to 1, 90% are greater). The second point on the curve is 5 with a cumulative probability .7 (70% of the distribution values are less than or equal to 5, 30% are greater). The third point on the curve is 9 with a cumulative probability of .9 (90% of the distribution values are less than or equal to 9, 10% are greater).

RiskCumul(100,200,A1:C1,A2:C2) specifies a cumulative distribution with 3 data points and a range of 100 to 200. Row 1 of the worksheet — A1 through C1 — holds the values of each data point while row 2 — A2 through C2 — holds the cumulative probability at each of the 3 points in the distribution. In Excel braces are not required when cell ranges are used as entries to the function.

Guidelines

*The points on the curve must be specified in order of increasing value (*X1<X2<X3,...,<Xn*).*

The cumulative probabilities p *for points on the curve must be specified in order of increasing probability (*p1<=p2<=p3,...,<=pn*).*

The cumulative probabilities p *for points on the curve must be greater than or equal to 0 and less than or equal to 1.*

Minimum *must be less than* maximum. Minimum *must be less than* X1 *and* Maximum *must be greater than* Xn.

DISCRETE

DISCRETE(*{X1,X2,...,Xn},{p1,p2,...,pn}*) specifies a discrete distribution with a number of outcomes equaling *n*. Any number of outcomes may be entered. Each outcome has a value *X* and a weight *p* which specifies the outcome's probability of occurrence. As with the HISTOGRM function, weights may sum to any value — they are normalized to probabilities by @RISK.

Examples *RiskDiscrete({0,.5},{1,1}) specifies a discrete distribution with 2 outcomes valued 0 and .5. Each outcome has an equal probability of occurrence as the weight for each is 1. The probability of 0 occurring is 50% (1/2) and the probability of .5 occurring is 50% (1/2).*

RiskDiscrete(A1:C1,A2:C2) specifies a discrete distribution with three outcomes. The first row of the worksheet — A1 through C1 — holds the values of each outcome while row 2 — A2 through C2 — holds the probability "weight" of each occurring.

Guidelines *Weight values* p *must be greater than or equal to zero, and the sum of all weights must be greater than zero.*

DUNIFORM

DUNIFORM(*{X1,X2,...,Xn}*) specifies a discrete uniform distribution with *n* possible outcomes with an equal probability of each outcome occurring. The value for each possible outcome is given by the *X* value entered for the outcome. Each value is equally likely to occur. To generate a discrete uniform distribution where every integer in a range is a possible outcome, use the INTUNIFORM function.

Examples *RiskDuniform({1,2.1,4.45,99}) specifies a discrete uniform distribution with 4 possible outcomes. The possible outcomes have the values 1, 2.1, 4.45 and 99.*

RiskDuniform(A1:A5) specifies a discrete uniform distribution with 5 possible outcomes. The possible outcomes have the values taken from cells A1 through A5.

ERF

ERF(*h*) specifies an error function with a variance parameter *h*. The error function distribution is derived from a normal distribution.

Examples *RiskErf(5) generates an error function with a variance parameter 5.*

RiskErf(A7) generates an error function with a variance parameter taken from cell A7.

Guidelines *Variance parameter* h *must be greater than 0.*

ERLANG

ERLANG(*m*,*beta*) generates an m-erlang distribution with the specified *m* and *beta* values. *m* is an integer argument for a gamma distribution and *beta* is a scale parameter.

Examples *RiskErlang(5,10) specifies an m-erlang distribution with an* m *value of 5 and a scale parameter of 10.*

RiskErlang(A1,A2/6.76) specifies an m-erlang distribution with an m *value taken from cell A1 and a scale parameter equaling the value in cell A2 divided by 6.76.*

Guidelines m *must be a positive integer.*

beta *must be greater than zero.*

EXPON

EXPON(*beta*) specifies an exponential distribution with the entered *beta* value. The mean of the distribution equals *beta.*

Examples *RiskExpon(5) specifies an exponential distribution with a beta value of 5.*

RiskExpon(A1) specifies an exponential distribution with a beta value taken from cell A1.

Guidelines Beta *must be greater than zero.*

EXTVALUE

EXTVALUE(*a*,*b*) specifies an extreme value distribution with location parameter *a* and shape parameter *b.*

Examples *RiskExtvalue(1,2) specifies an extreme value distribution with an* a *value of 1 and a* b *value of 2.*

RiskExtvalue(A1,B1) specifies an extreme value distribution with an a *value taken from cell A1 and a* b *value of taken from cell B1.*

Guidelines b *must be greater than zero.*

GAMMA

GAMMA(*alpha*,*beta*) specifies a gamma distribution using the shape parameter *alpha* and the scale parameter *beta*.

Examples *RiskGamma(1,1) specifies a gamma distribution where the shape parameter has a value of 1 and the scale parameter has a value of 1.*

RiskGamma(C12,C13) specifies a gamma distribution where the shape parameter has a value taken from cell C12 and the scale parameter has a value taken from cell C13.

Guidelines *Both* alpha *and* beta *must be greater than zero.*

GENERAL

GENERAL(*minimum*,*maximum*,*{X1,X2,...,Xn}*,*{p1,p2,...,pn}*) generates a generalized probability distribution based on a density curve created using the specified (*X*,*p*) pairs. Each pair has a value *X* and a probability weight *p* which specifies the relative height of the probability curve at that *X* value. The weights *p* are normalized by @RISK in determining the actual probabilities used in sampling.

Examples *RiskGeneral(0,10,{2,5,7,9},{1,2,3,1}) specifies a general probability distribution density function with four points. The distribution ranges from 0 to 10 with four points — 2,5,7,9 — specified on the curve. The height of the curve at 2 is 1, at 5 is 2, at 7 is 3 and at 9 is 1. The curve intersects the X-axis at 0 and 10.*

RiskGeneral(100,200,A1:C1,A2:C2) specifies a general probability distribution with three data points and a range of 100 to 200. The first row of the worksheet — A1 through C1 — holds the X *value of each data point while row 2 — A2 through C2 — holds the* p *value at each of the three points in the distribution. Note that braces are not required when cell ranges are used as array entries to the function.*

Guidelines *Probability weights* p *must be greater than or equal to zero. The sum of all weights must be greater than zero.*

X *values must be entered in increasing order and must fall within the minimum-maximum range of the distribution.*

Minimum *value must be less than* maximum.

GEOMET

GEOMET(*p*) generates a geometric distribution with the probability *p*. The value returned represents the number of failures prior to a success on a series of independent trials. There is a *p* probability of success on each trial. The geometric distribution is a discrete distribution returning only integer values greater than or equal to zero.

Examples *RiskGeomet(.25) specifies a geometric distribution with a 25% probability of success on each trial.*

RiskGeomet(A18) specifies a geometric distribution with a probability of success on each trial taken from cell A18.

Guidelines *Probability* p *must be greater than zero and less than or equal to one.*

HISTOGRM

HISTOGRM(*minimum,maximum,{p1,p2,...,pn}*) specifies a user-defined histogram distribution with a range defined by the specified *minimum* and *maximum* values. This range is divided into *n* classes. Each class has a weight *p* reflecting the probability of occurrence of a value within the class. These weights may be any values — the only important factor is the weight of one class relative to the others. This means that the sum of all the weights need not equal 100%. @RISK normalizes the class probabilities for you. Normalizing is done by summing all specified weights and dividing each weight by this sum.

Examples *RiskHistogrm(10,20,{1,2,3,2,1}) specifies a histogram with a* minimum *value of 10 and a* maximum *value of 20. This range is divided into 5 equal length classes as there are 5 probability values. The probability weights for the five classes are the arguments 1, 2, 3, 2 and 1. The actual probabilities which would correspond with these weights are 11.1% (1/9), 22.2% (2/9), 33.3% (3/9), 22.2% (2/9) and 11.1% (1/9). Division by 9 normalizes these values so that their sum now equals 100%.*

RiskHistogrm(A1,A2,B1:B3) specifies a histogram with a minimum *value taken from cell A1 and a* maximum *value taken from cell A2. This range is divided into 3 equal length classes as there are 3 probability values. The probability weights are taken from cells B1 through B3.*

Guidelines *Weight values* p *must be greater than or equal to zero, and the sum of all weights must be greater than zero.*

HYPERGEO

HYPERGEO(*n*,*D*,*M*) specifies a hypergeometric distribution with sample size *n*, number of items of a certain type equaling *D* and population size *M*. The hypergeometric distribution is a discrete distribution returning only non-negative integer values.

Examples *RiskHypergeo(50,10,1000) returns a hypergeometric distribution generated using a sample size of 50, 10 items of the relevant type and a population size of 1000.*

RiskHypergeo(A6,A7,A8) returns a hypergeometric distribution generated using a sample size taken from cell A6, a number of items taken from cell A7 and a population size taken from cell A8.

Guidelines *All arguments* — n, D and M — *must be positive integer values.*

The value for sample size n *must be less than or equal to the population size* M.

The value for number of items D *must be less than or equal to the population size* M.

INVGAUSS

INVGAUSS(*mu*,*lambda*) specifies an inverse gaussian distribution with mean *mu* and shape parameter *lambda*.

Examples *RiskInvgauss(5,2) returns an inverse gaussian distribution with a* mu *value of 5 and a* lambda *value of 2.*

RiskInvgauss(B5,B6) returns an inverse gaussian distribution with a mu *value taken from cell B5 and a* lambda *value taken from cell B6.*

Guidelines mu *must be greater than zero.*

lambda *must be greater than zero.*

INTUNIFORM

INTUNIFORM(*minimum*,*maximum*) specifies a uniform probability distribution with the entered *minimum* and *maximum* values. Only integer values across the range of the uniform distribution can occur and each has an equal likelihood of occurrence.

Examples *RiskIntUniform(10,20) specifies a uniform distribution with a* minimum *value of 10 and a* maximum *value of 20.*

RiskIntUniform(A1+90,B1) specifies a uniform distribution with a minimum *value equaling the value in cell A1 plus 90 and a* maximum *value taken from cell B1.*

Guidelines *The* minimum *value entered must be less than the* maximum *value.*

LOGISTIC

LOGISTIC(*alpha,beta*) specifies a logistic distribution with the entered *alpha* and *beta* values.

Examples *RiskLogistic(10,20) returns a logistic distribution generated using an* alpha *value of 10 and a* beta *value of 20.*

RiskLogistic(A6,A7) returns a logistic distribution generated using an alpha *value taken from cell A6 and a* beta *value taken from cell A7.*

Guidelines Beta *must be a positive value.*

LOGLOGISTIC

LOGLOGISTIC(*gamma,beta,alpha*) specifies a log-logistic distribution with location parameter *gamma* and shape parameter *alpha* and scale parameter *beta*.

Examples *RiskLoglogistic(-5,2,3) returns a log-logistic distribution generated using a* gamma *value of -5, a* beta *value of 2, and an* alpha *value of 3.*

RiskLoglogistic(A1,A2,A3) returns a log-logistic distribution generated using a gamma *value taken from cell A1, a* beta *value taken from cell A2, and an* alpha *value taken from cell A3.*

Guidelines Alpha *must be greater than zero.*

Beta *must be greater than zero.*

LOGNORM

LOGNORM(*mean,standard deviation*) specifies a lognormal distribution with the entered *mean* and *standard deviation*. The arguments for this form of the lognormal distribution specify the actual *mean* and *standard deviation* of the generated lognormal probability distribution.

Examples *RiskLognorm(10,20) specifies a lognormal distribution with a* mean *of 10 and a* standard deviation *of 20.*

*RiskLognorm(C10*3.14,B10) specifies a lognormal distribution with a* mean *equaling the value in cell C10 times 3.14 and a* standard deviation *equaling the value in cell B10.*

Guidelines *The* mean *and* standard deviation *must be greater than 0.*

LOGNORM2

LOGNORM2(*mean of corresponding normal dist.,std. dev. of normal*) specifies a lognormal distribution where the entered mean and standard deviation equal the mean and standard deviation of the corresponding normal distribution. The arguments entered are the mean and standard deviation of the normal distribution for which an exponential of the values in the distribution was taken to generate the desired lognormal.

Examples

RiskLognorm2(10,20) specifies a lognormal distribution generated by taking the exponential of the values from a normal distribution with a mean *of 10 and a* standard deviation *of 20.*

*RiskLognorm2(C10*3.14,B10) specifies a lognormal distribution generated by taking the exponential of the values from a normal distribution with a* mean *equaling the value in cell C10 times 3.14 and a* standard deviation *equaling the value in cell B10.*

Guidelines

The standard deviation *must be greater than 0.*

NEGBIN

NEGBIN(*s,p*) specifies a negative binomial distribution with *s* number of successes and *p* probability of success on each trial. The negative binomial distribution is a discrete distribution returning only integer values greater than or equal to zero.

Examples

RiskNegbin(5,.25) specifies a negative binomial distribution with 5 successes with a 25% probability of success on each trial.

RiskNegbin(A6,A7) specifies a negative binomial distribution with the number of successes taken from cell A6 and a probability of success taken from cell A7.

Guidelines

Number of successes s *must be a positive integer less than or equal to 32,767.*

Probability p *must be greater than zero and less than or equal to one.*

NORMAL

NORMAL(*mean*,*standard deviation*) specifies a normal distribution with the entered *mean* and *standard deviation*. This is the traditional "bell shaped" curve applicable to distributions of outcomes in many data sets.

Examples *RiskNormal(10,2) specifies a normal distribution with a* mean *of 10 and a* standard deviation *of 2.*

RiskNormal(SQRT(C101),B10) specifies a normal distribution with a mean *equaling the square root of the value in cell C101 and a* standard deviation *taken from cell B10.*

Guidelines *The* standard deviation *must be greater than 0.*

PARETO

PARETO(*theta*,*a*) specifies a pareto distribution with the entered *theta* and *a* values.

Examples *RiskPareto(5,5) specifies a pareto distribution with a* theta *value of 5 and an* a *value of 5.*

RiskPareto(A10,A11+A12) specifies a pareto distribution with a theta *value taken from cell A10 and an* a *value given by the result of the expression A11+A12.*

Guidelines Theta *must be greater than 1.*

The a *argument must be greater than 0.*

PARETO2

PARETO2(*b*,*q*) specifies a pareto distribution with the entered *b* and q values.

Examples *RiskPareto2(5,5) specifies a pareto distribution with a* b *value of 5 and a* q *value of 5.*

RiskPareto2(A10,A11+A12) specifies a pareto distribution with a b *value taken from cell A10 and a* q *value given by the result of the expression A11+A12.*

Guidelines b *must be greater than 0.*

q must be greater than 0.

PEARSON5

PEARSON5(*alpha*,*beta*) specifies a pearson type V distribution with shape parameter *alpha* and scale parameter *beta*.

Examples *RiskPearson5(1,1) specifies a pearson type V distribution where the shape parameter has a value of 1 and the scale parameter has a value of 1.*

RiskPearson5(C12,C13) specifies a pearson type V distribution where the shape parameter has a value taken from cell C12 and the scale parameter has a value taken from cell C13.

Guidelines Alpha *must be greater than zero*

Beta *must be greater than zero.*

PEARSON6

PEARSON6(*beta*,*alpha1*,*alpha2*) specifies a pearson type VI distribution with scale parameter *beta* and shape parameters *alpha1* and *alpha2*.

Examples *RiskPearson6(2,1,5) specifies a pearson type VI distribution where* beta *has a value of 2,* alpha1 *has a value of 1 and beta2 has a value of 5.*

RiskPearson6(D3,E3,F3) specifies a pearson type VI distribution where beta *has a value taken from cell D3, alpha1 has a value taken from cell E3, and* beta2 *has a value taken from cell F3.*

Guidelines Alpha1 *must be greater than zero.*

Alpha2 *must be greater than zero.*

Beta *must be greater than zero.*

PERT

PERT(minimum, most likely, maximum) specifies a PERT distribution (as special form of the beta distribution) with a *minimum* and *maximum* value as specified. The shape parameter is calculated from the defined *most likely* value.

Examples ***PERT(0,2,10)*** *specifies a beta distribution with a minimum of 0, a maximum of 10, and a most likely value of 2.*

PERT(A1,A2,A3) *specifies a PERT distribution with a minimum value taken from cell A1, a maximum value taken from cell A3, and a most likely value taken from cell A2.*

Guidelines Minimum *must be less than* maximum.

Most likely *must be greater than* minimum *and less than* maximum.

POISSON

POISSON(*lambda*) specifies a poisson distribution with the specified *lambda* value. The argument *lambda* is also the same as the mean of the poisson distribution. The poisson distribution is a discrete distribution returning only integer values greater than or equal to zero.

Examples *RiskPoisson(5) specifies a poisson distribution with a* lambda *of 5.*

RiskPoisson(A6) specifies a poisson distribution with a lambda *value taken from cell A6.*

Guidelines Lambda *must be greater than zero.*

RAYLEIGH

RAYLEIGH(*b*) specifies a rayleigh distribution with mode *b*.

Examples *RiskRayleigh(3) specified a rayleigh distribution with a mode of 3.*

RiskRayleigh(C7) specifies a rayleigh distribution with a mode taken from the value in cell C7.

Guidelines b *must be greater than zero.*

SIMTABLE

SIMTABLE(*{val1,val2,...,valn}*) specifies a list of values which will be used sequentially in individual simulations executed during a Sensitivity Simulation. In a Sensitivity Simulation the number of simulations, set using the Iterations Simulations command, is greater than one. In a single simulation or a normal recalculation SIMTABLE returns the first value in the list. Any number of SIMTABLE functions may be included in a single worksheet. As with other functions, the arguments of SIMTABLE may include distribution functions.

Examples *RiskSimtable({10,20,30,40}) specifies four values to be used in each of four simulations. In Simulation #1 the SIMTABLE function will return 10, Simulation #2 the value 20 and so on.*

RiskSimtable(A1:A3) specifies a list of three values for three simulations. In Simulation #1 the value from cell A1 will be returned. In Simulation #2 the value from cell A2 will be returned. In Simulation #3 the value from cell A3 will be returned.

Guidelines *Any number of arguments may be entered.*

The number of simulations executed must be less than or equal to the number of arguments. If the number of arguments is less than the number of an executing simulation, ERR will be returned by the function for that simulation.

STUDENT

STUDENT(*nu*) specified a student's t distribution with *nu* degrees of freedom.

Examples *RiskStudent(10) specifies a student's t distribution with 10 degrees of freedom.*

RiskStudent(J2) specifies a student's t distribution with the degrees of freedom taken from the value in cell J2.

Guidelines Nu *must be a positive integer.*

TRIANG

TRIANG(*minimum,most likely,maximum*) specifies a triangular distribution with three points — a *minimum, most likely* and *maximum*. The direction of the "skew" of the triangular distribution is set by the size of the *most likely* value relative to the *minimum* and the *maximum*.

Examples *RiskTriang(100,200,300) specifies a triangular distribution with a* minimum *value of 100, a* most likely *value of 200 and a* maximum *value of 300.*

RiskTriang(A10/90,B10,500) specifies a triangular distribution with a minimum *value equaling the value in cell A10 divided by 90, a* most likely *value taken from cell B10 and a* maximum *value of 500.*

Guidelines *The* minimum *value must be less than or equal to the* most likely *value.*

The most likely *value must be less than or equal to the* maximum *value.*

The minimum *value must be less than the* maximum *value.*

TRIGEN

TRIGEN(*bottom value,most likely value,top value, bottom perc., top perc.*) specifies a triangular distribution with three points — one at the most likely value and two at the specified bottom and top percentiles. The bottom percentile and top percentile are values between 0 and 100. Each percentile value gives the percentage of the total area under the triangle that falls to the left of the entered point. Use of the TRIGEN function avoids the problem of the minimum and maximum values not actually being possible occurrences in the standard TRIANG function. This is because in the TRIANG function these are the points where the distribution intersects the X-axis, or points of zero probability.

Examples *RiskTrigen(100,200,300,10,90) specifies a triangular distribution with a* 10th percentile value *of 100, a* most likely *value of 200 and a* 90th percentile value *of 300.*

RiskTrigen(A10/90,B10,500,30,70) specifies a triangular distribution with a 30th percentile value *equaling the value in cell A10 divided by 90, a* most likely *value taken from cell B10 and a* 70th percentile value *of 500.*

Guidelines *The* bottom percentile value *must be less than or equal to the most likely value.*

The most likely value *must be less than or equal to the* top percentile value.

The bottom percentile value *must be less than the* top percentile value.

UNIFORM

UNIFORM(*minimum,maximum*) specifies a uniform probability distribution with the entered *minimum* and *maximum* values. Every value across the range of the uniform distribution has an equal likelihood of occurrence.

Examples *RiskUniform(10,20) specifies a uniform distribution with a* minimum *value of 10 and a* maximum *value of 20.*

RiskUniform(A1+90,B1) specifies a uniform distribution with a minimum *value equaling the value in cell A1 plus 90 and a* maximum *value taken from cell B1.*

Guidelines *The* minimum *value entered must be less than the* maximum *value.*

WEIBULL

WEIBULL(*alpha*,*beta*) generates a weibull distribution with the shape parameter *alpha* and a scale parameter *beta*. The weibull distribution is a continuous distribution whose shape and scale vary greatly depending on the argument values entered.

Examples *RiskWeibull(10,20) generates a weibull distribution with a shape parameter 10 and a scale parameter 20.*

RiskWeibull(D1,D2) generates a weibull distribution with a shape parameter taken from cell D1 and a scale parameter taken from cell D2.

Guidelines *Both shape parameter* alpha *and scale parameter* beta *must be greater than zero.*

Listing of Distribution Property Functions

The following functions are used to add optional arguments to distribution functions. The arguments added by these functions are not required, but can be added as needed.

Optional arguments are specified using @RISK distribution property functions that are embedded inside of a distribution function. These functions include:

COLLECT

COLLECT() identifies specific distribution functions whose samples are collected during a simulation and whose:

- *statistics are displayed*
- *data points are available*
- *sensitivities and scenario values are calculated*

When COLLECT is used and **Inputs Marked With Collect** is selected for **Collect Distribution Samples** in the Simulation Settings dialog, only functions identified by COLLECT are displayed in the Results window Explorer list.

Earlier versions of @RISK had the COLLECT function entered by placing it in the cell formula immediately preceding the distribution function for which samples will be collected, e.g.:

=RiskCollect()+RiskNormal(10,10)

COLLECT is typically used when a large number of distribution functions are present in a simulated worksheet, but sensitivities and scenario analyses are desired on only a pre-identified subset of important distributions. It can also be used to bypass Windows memory constraints that keep sensitivities and scenario analyses from being performed on all functions in a large simulation.

Example ***RiskNormal***(10,2,RiskCollect()) *collects samples from the probability distribution* ***RiskNormal***(10,2).

Note: The "Inputs Marked WithCollect" box in Simulation Settings must be selected for COLLECT functions to take effect.

CORRMAT

CORRMAT (*matrix cell range,position,instance*) identifies a distribution function belonging to a set of correlated distribution functions. The function is used to specify multivariate correlation. CORRMAT identifies 1) a matrix of rank correlation coefficients and 2) the location in the matrix of the coefficients used in correlating the distribution function which follows the CORRMAT function.

Correlated distribution functions typically are defined using the @RISK Model Window Model menu Correlate Distributions command; however, the same type of correlation may be directly entered in your spreadsheet using the CORRMAT function.

The matrix identified by the *matrix cell range* is a matrix of rank correlation coefficients. Each element (or cell) in the matrix contains a correlation coefficient. The number of distribution functions correlated by the matrix equals the number of rows or columns in the matrix. The argument *position* specifies the column (or row) in the matrix to use in correlating the distribution function which follows the CORRMAT function. The coefficients located in the column (or row) identified by *position* are used in correlating the identified distribution function with each of the other correlated distribution functions represented by the matrix. The value in any given cell in the matrix gives the correlation coefficient between 1) the distribution function whose CORRMAT *position* equals the column coordinate of the cell and 2) the distribution function whose CORRMAT *position* equals the row coordinate of the cell. *Positions* (and coordinates) range from 1 to N, where N is the number of columns or rows in the matrix.

The *instance* argument is optional and is used when multiple groups of correlated inputs use the same matrix of correlation coefficients. *Instance* is an integer or string argument and all inputs in a correlated group of inputs share the same instance value or string. String arguments used to specify *instance* need to be in quotes.

The CORRMAT function generates correlated sets of random numbers to be used in sampling each of the correlated distribution functions. The sample matrix of rank correlation coefficients calculated on the correlated set of random numbers approximates as closely as possible the target correlation coefficient matrix which was entered in the worksheet.

Correlated sets of random numbers specified by the CORRMAT function are generated when the first CORRMAT function is called during a simulation. This is usually during the first iteration of the simulation. This may cause a delay while values are sorted and correlated. The length of the delay is proportional to the number of iterations and the number of correlated variables.

Correlation coefficients must be less than or equal to 1 and greater than or equal to -1. Coefficients on the diagonal of the matrix must equal 1.

DEPC

DEPC(*"ID",coefficient*) designates a dependent variable in a correlated sampling pair. The *ID* in quotes is the string used to identify the independent variable being correlated with. The string must be in quotes. This is the same *ID* used in the INDEPC function for the independent variable. The coefficient entered is the rank-order correlation coefficient which describes the relationship of the values sampled for the distributions identified by the DEPC and INDEPC. The DEPC function is used with the distribution function which specifies the possible values for the dependent variable

Understanding Rank-Order Correlation Coefficient Values

The rank-order correlation coefficient was developed by C. Spearman in the early 1900's. It is calculated using rankings of values, not actual values themselves (as is the linear correlation coefficient). A value's "rank" is determined by its position within the min-max range of possible values for the variable.

The coefficient is a value between -1 and 1 which represents the desired degree of correlation between the two variables during sampling. Positive coefficient values indicate a positive relationship between the two variables — when the value sampled for one is high, the value sampled for the second will also tend to be high. Negative coefficient values indicate an inverse relationship between the two variables — when the value sampled for one is high, the value sampled for the second will tend to be low.

@RISK generates rank-correlated pairs of sampled values in a two step process. First, a set of randomly distributed "rank scores" are generated for each variable. If 100 iterations are to be run, for example, 100 scores are generated for each variable. (Rank scores are simply values of varying magnitude between a minimum and maximum. @RISK uses van der Waerden scores based on the inverse function of the normal distribution). These rank scores are then rearranged to give pairs of scores which generate the desired rank correlation coefficient. For each iteration there is a pair of scores, with one score for each variable.

In the second step, a set of random numbers (between 0 and 1) to be used in sampling is generated for each variable. Again, if 100 iterations are to be run, 100 random numbers are generated for each variable. These random numbers are then ranked smallest to largest. For each variable, the smallest random number is then used in the iteration with the smallest rank score, the second smallest random number is used in the iteration with the second smallest rank score and so on. This ordering based on ranking continues for all random numbers, up to the point where the largest random number is used in the iteration with the largest rank score.

In @RISK this process of rearranging random numbers happens prior to simulation. It results in a set of pairs of random numbers that can be used in sampling values from the correlated distributions in each iteration of the simulation.

This method of correlation is known as a "distribution-free" approach because any types of distributions may be correlated. Although the samples drawn for the two distributions are correlated, the integrity of the original distributions are maintained. The resulting samples for each distribution reflect the input distribution function from which they were drawn.

Earlier versions of @RISK had the DEPC function entered by placing it in the cell formula immediately preceding the distribution function which will be correlated, e.g.:

=RiskDepC(”Price 1”,.9)+RiskNormal(10,10)

This form of function entry is still supported. However, these functions will be moved inside the distribution function they are correlating whenever the formula or correlated distribution is edited in the @RISK Model window.

The correlation coefficient generated by using DEPC and INDEPC is approximate. The generated coefficient will more closely approximate the desired coefficient as increasing numbers of iterations are executed. There may be a delay at the start of a simulation when distributions are correlated when DEPC and INDEPC are used. The length of the delay is proportional to the number of DEPC functions in the worksheet and the number of iterations to be performed. See the **@RISK Modeling Techniques** chapter for a detailed example of dependency relationships.

Examples *RiskNormal(100,10, RiskDepC("Price",.5)) specifies that the sampling of the distribution NORMAL(100,10) will be correlated with the sampling of the distribution identified with the function INDEPC("Price"). The sampling of NORMAL(100,10) will be positively correlated with the sampling of the distribution identified with the function INDEPC("Price") as the* coefficient *is greater than 0.*

Guidelines Coefficient *must be a value greater than or equal to -1 and less than or equal to 1.*

"ID" *must be the same string of characters used to identify the independent variable in the INDEPC function.* "ID" *may be a reference to cell that contains an identifier string.*

FIT

FIT(*ProjID,FitID,"selected fit result"*) links a data set and its fit results to the input distribution the FIT function is used in. The *ProjID* and *FitID* are internal @RISK IDs that identify the fit from which the distribution was selected and should not be changed. The *selected fit result* in quotes is a string used to identify the type of fit result to select. The FIT function is used to link an input to the fit results for a data set so that when the data is changed the input distribution selected from the fit can be updated.

The *selected fit result* can be any of the following entries:

- **Best Chi-Sq**, indicating the best fitting distribution from the Chi-sq test should be used
- **Best A-D**, indicating the best fitting distribution from the Anderson-Darling test should be used
- **Best K-S**, indicating the best fitting distribution from the Kolmogorov-Smirnov test should be used.
- **Best RMS Err,** indicating the best fitting distribution from the RMS Error test should be used
- A **distribution name**, such as *"Normal"*, indicating that the best-fitting distribution of the entered type should be used.

What Happens When Data Changes When RiskFit is Used

The RiskFit function "hot-links" a distribution function to a data set and the fit of that data set. The data used in a fit can be either in Excel or on a fit tab in the @RISK – Model window. When the fitted data changes in either one of these locations, the following actions take place:

3) @RISK re-runs the fit using the current settings on the fit tab where the fit was originally run

4) The distribution function that includes the RiskFit function that references the fit is changed to reflect the new fit results. The changed function replaces the original one in Excel. If, for example, the distribution function's RiskFit argument specified "Best Chi-sq" for *selected fit result*, the new best-fitting distribution based on the Chi-Sq test would replace the original one. This new function would also include the same RiskFit function as the original one.

@RISK can perform the above actions either 1) immediately when the data and fit have changed or 2) when a simulation starts or the list of Outputs and Inputs is generated. The Update method used is specified using the @RISK Model window **Fitting menu Update Linked @RISK Functions command**.