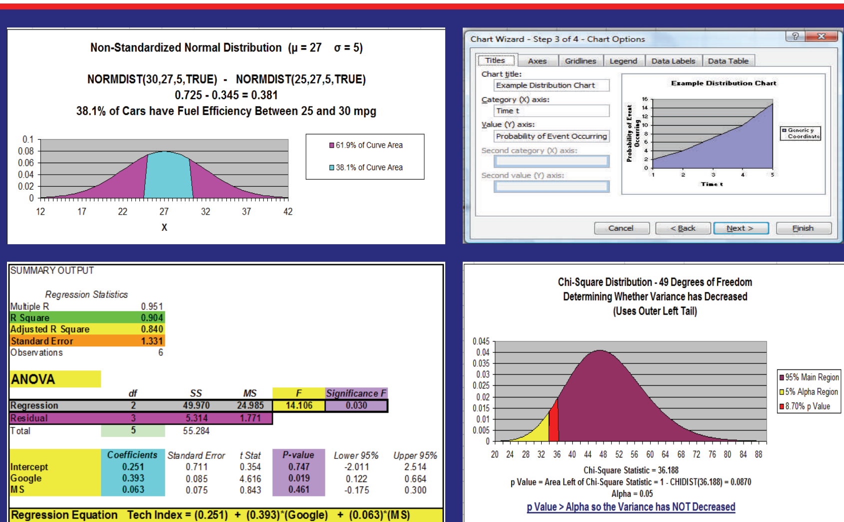
The Excel Statistical Master

How To Do MBA-Level Statistics in Excel

THE COMPLETE GUIDE

Manual 4 of 4—The GRAPHING Manual



Clear And Simple yet THOROUGH

Statistical Instruction for the MBA and Business Manager with LOTS of Worked-Out Problems and Screen Shots

MARK HARMON, MBA

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Chapter 15 - Other Useful Distributions

Contents

Multinomial Distribution

The Multinomial Distribution is a generalization of the well-known Binomial Distribution.

Like the Binomial Distribution, the Multinomial Distribution is a Discrete distribution, not a Continuous distribution. This means that the objects that form the distribution are whole, individual objects. This distribution curve is not smooth but moves abruptly from one level to the next in increments of whole units.

The Multinomial Distribution provides the probability of a combination of specified outputs for a given number of trials that are totally independent. The probability of each of the individual outputs of each of the trials must be known in order to utilize the Multinomial Distribution to calculate the probability of that unique combination of outputs occurring in the given trials.

Here is the formula for calculating the probability of a multinomial distribution:

$$P (X_1 = n_1, X_2 = n_2, \ldots, X_k = n_k) =$$

$$= [(n!) / (n1! * n2! * \ldots *nk!)] * [Pr(X1 = n1)]^{n1} * [Pr(X2 = n2)]^{n2} * \ldots * [Pr(Xk = nk)]^{nk}$$

An example makes the Multinomial Distribution easier to understand. An example follows on the next page:

Problem: A box contains 5 red marbles, 4 white marbles, and 3 blue marbles. A marble is selected at random, its color noted, and then the marble is replaced. 6 marbles are selected in this manner. Find the probability that out of those 6 marbles, 3 are red, 2 are white, and 1 is blue.

Total number of marbles = 12

n = total number of drawings = 6

X1 = Count of red marbles drawn = n1 = 3

X2 = Count of white marbles drawn = n2 = 2

X3 = Count of blue marbles drawn = n3 = 1

The probability of 3 red, 2 white, 1 blue = P(3 red, 2 white, 1 blue)

= P (X1 = n1, X2 = n2, …, Xk = nk)

= P (X1 = 3, X2 = 2, X3 = 3)

P ($X_1 = n_1, X_2 = n_2, \ldots, X_k = n_k$) =

= $[(n!) / (n1! * n2! * \ldots * nk!)] * [Pr(X1 = n1)]^{n1} * [Pr(X2 = n2)]^{n2} * \ldots * [Pr(Xk = nk)]^{nk}$

$= [(6!) / (3! * 2! * 1!)] * [5/12]^3 * [4/12]^2 * [3/12]^1$

= 625 / 5184 = 0.12056 = 12.06%

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Excel does not provide the Multinomial Distribution as one of its built-in functions.
The user must generate their own Excel formulas. In this case, it would be:

P(3 red, 2 white, 1 blue) = [(6!) / (3! * 2! * 1!)] * $[5/12]^3$ * $[4/12]^2$ * $[3/12]^1$

= (FACT(6) / (FACT(3) * FACT(2) * FACT(1))) * (((5/12)^3) * ((4/12)^2) * ((3/12)^1))

= 0.1206

= 12.06%

When k = 2, the Multinomial Distribution is the Binomial Distribution.

Hypergeometric Distribution

The Hypergeometric Distribution is almost the same as the Binomial Distribution, except that samples are NOT replaced back into the population. This is known as **Sampling Without Replacement**.

The **Binomial Distribution** calculates the probability of 1 of 2 possible outcomes occurring a certain number of times (x) in a certain number of independent trials (n). The probability of the outcome occurring in a single trial is known (p).

After each trial the samples ARE replaced back into the population when using the Binomial Distribution.

The **Hypergeometric Distribution** calculates the probability of 1 of 2 possible outcomes occurring a certain number of times (x) in a certain number of independent trials (n). The probability of the outcome occurring in a single trial is known (p).

After each trial the samples are NOT replaced back into the population when using the Hypergeometric Distribution.

Excel provides a built-in Hypergeometric Distribution function to calculate the probability of sampling events that are distributed hypergeometrically. This will calculate the probability of one of two possible outcomes occurring a certain number of times in a given number of trials - if the samples are not replaced. Excel's Hypergeometric formula is as follows:

= HYPGEOMDIST (k, n, k_Possible, N)

Exact number of successes = k

Number of trials = n

Initial possible number of success = k_Possible

Initial population size = N

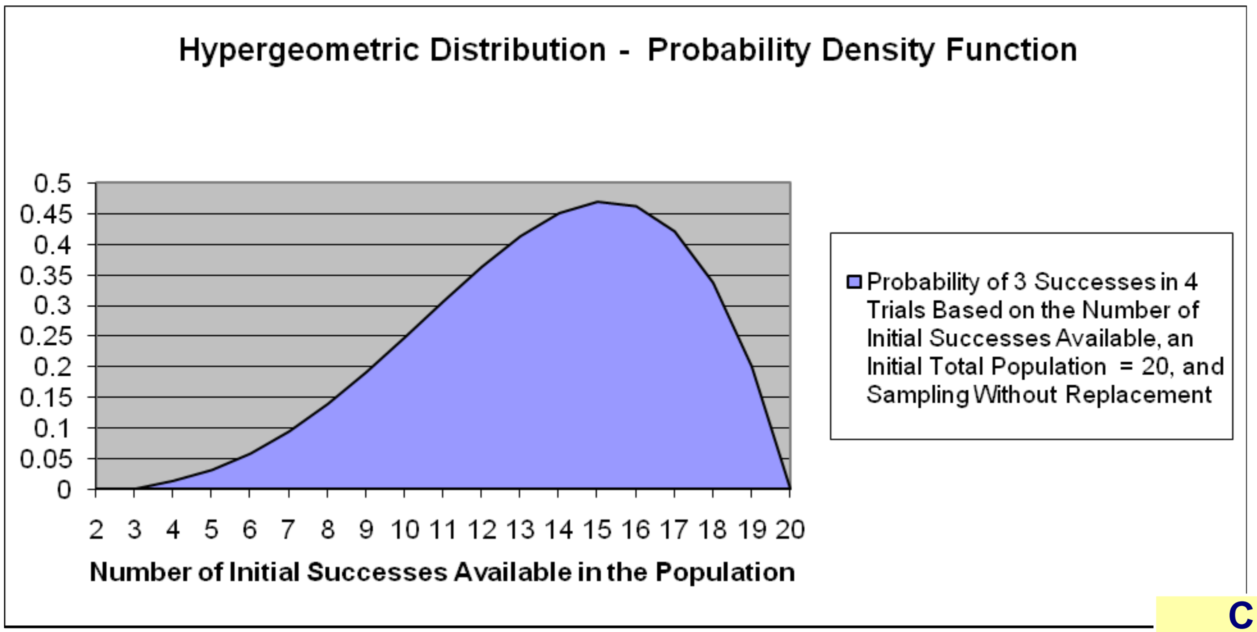
A graph of the Hypergeometric distribution below is based upon the Hypergeometric problem that follows in which:

Exact number of successes = k = 3

Number of trials = n = 4

Initial possible number of successes = k_Possible ---→ Figures in the Horizontal (x) Axis

Initial population size = N = 20



The problem below will illustrate the use of the Hypergeometric Distribution formula:

Problem: A 20-piece chocolate sample consists of 8 caramel samples and 12 nut samples. Calculate the probability that of 4 individual samples 3 taken will produce caramels. Each sample is eaten (not replaced) after it is taken. (If each sample were replaced before the next sample was taken, the Binomial distribution would be used)

Exact number of successes = k = 3

Number of trials = n = 4

Initial possible number of successes = k_Possible = 8

Initial population size = N = 20

= HYPGEOMDIST (k, n, k_Possible, N)

= HYPGEOMDIST (3, 4, 8, 20) = 0.1387 = 13.87%

This point on the graph corresponds to the point on the horizontal axis that equals 8. Note that the y-value of that graph point is 0.1387.

There is a 13.87% probability that 3 out of 4 samples taken without replacement will be caramel samples if the box initially had 20 pieces of candy that included 8 caramel samples.

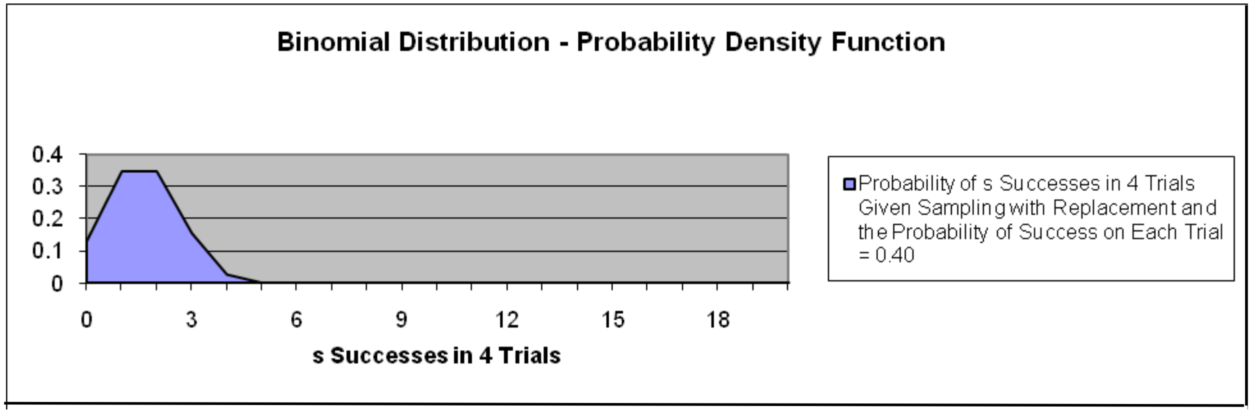
Sampling WITH Replacement – Using the Binomial Distribution

If this problem were the same except that you were sampling with replacement (putting each candy back instead of eating it before the next sample is taken), you would solve it with the Binomial Distribution as follows:

P (3 Caramels selected in 4 trials with replacement from a box having 20 pieces of candy including 8 caramels) = BINOMDIST (3, 4, 8/20, FALSE) = 0.1536 = 15.36%

(Use FALSE to indicate solving not for cumulative function (0 to 3) but solving for exactly 3 caramels chosen in 4 trials with replacement.

Note that the graph at point 3 on the Horizontal has a y value (probability) = 0.1536



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Poisson Distribution

The Poisson Distribution is a widely employed distribution that is used to describe the probability of events that are a result of a rate that occurs over time such as:

Product demand
Demand for services
Number of telephone calls that come over a switchboard
Number of accidents
Number of traffic arrivals
Number of defects

The Poisson Distribution is a Discrete distribution. This means that the events described by this function occur in whole units. The graph of the Poisson Distribution therefore moves from one level to the next in discrete increments, not smoothly.

The Poisson Distribution is used to calculate the probability of a certain number of specific events occurring over a given period of time - if it is known in advance that those events occur in frequency as predicted by the Poisson Distribution. Previous measurement must have been taken to determine: 1) that the events occur in frequency according to the Poisson Distribution, and 2) the average rate, which is the expected number of occurrences of that event over the given time period.

Excel's Poisson formula is given as follows:

POISSON (E(k), k, cumulative?)

= Probability of k or up to k occurrences in a certain time period if the expected number of occurrences in that time period is E(k).

A problem will better illustrate the use of the Poisson Distribution:

Problem: An average of 4.8 telephone calls per minute is made through the central switchboard according to the Poisson distribution. What is the probability that:

a) exactly 4 phone calls will be made in a given minute

Exact number of events = k = 4

Expected number of events = E(k)

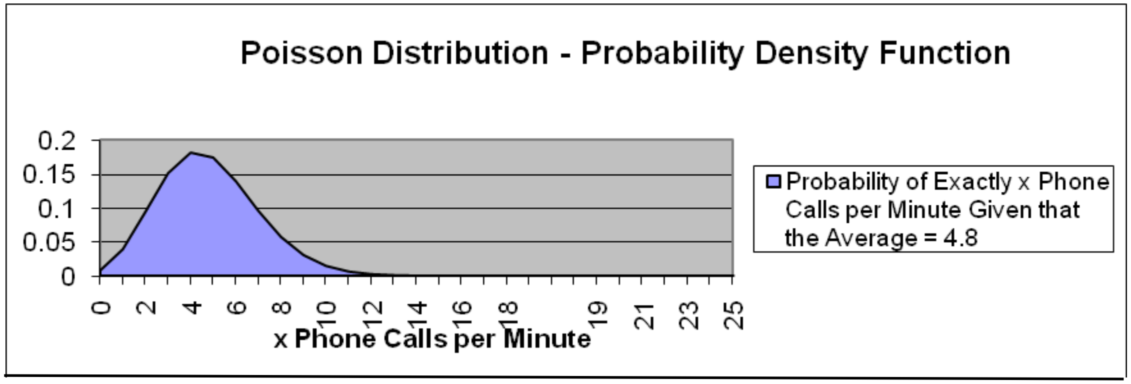
Cumulative Distribution Function? FALSE

We want to calculate the probability of EXACTLY 4 phone calls. This will be the Probability Density Function, not the Cumulative Distribution Function, which would measure the probability of up to 4 phone calls instead of exactly 4.

Pr (Exactly 4 Phone Calls) = Pr (k = 4) =

=POISSON (4, 4.8, FALSE) = 0.182 = 18.2%

Note that the point on the graph that has 4 as the value on the horizontal axis has a value of 0.182 on the vertical axis. The Poisson distribution is a discrete distribution and not a continuous distribution so the graph has corners at each point instead of being smooth.



b) up to 4 phone calls will be made in a given minute

Exact number of events = k = 4

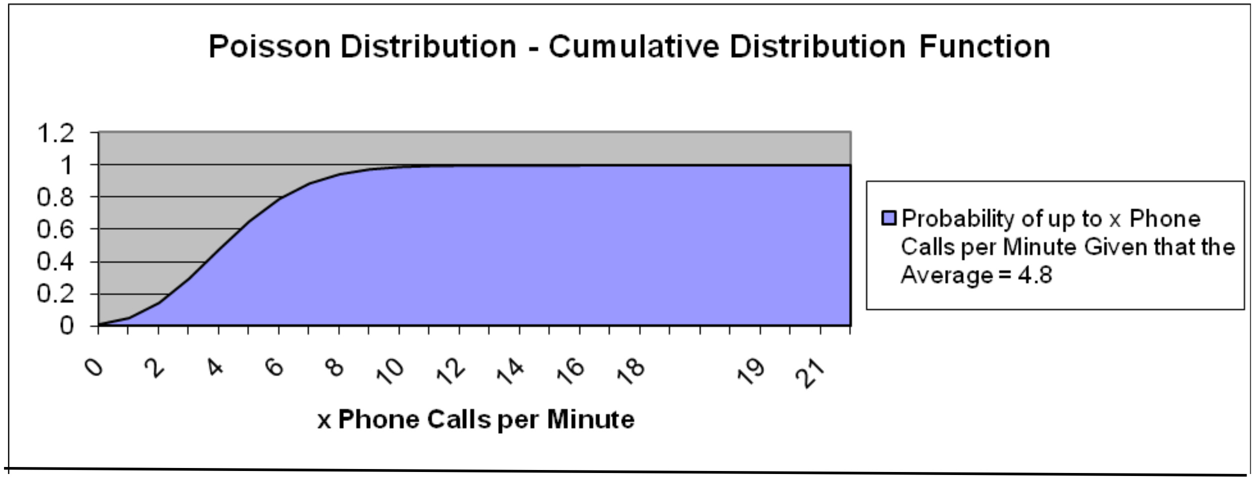
Expected number of events = E(k)

Cumulative Distribution Function? TRUE

We want to calculate the probability of UP TO 4 phone calls. This will be the Cumulative Distribution Function.

Pr (Up To 4 Phone Calls) = Pr (k ≤ 4) =

=POISSON (4, 4.8, TRUE) = 0.476 = 47.6%



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Uniform Distribution

A variable is uniformly distributed if all possible outcomes of that variable have an equal probability of occurring. For example, if a fair die has 6 possible outcomes when rolled once, each outcome has the same 1/6 chance of occurring.

The Uniform Distribution is a Discrete distribution. This means that its events described by this function occur in whole units.

There is no Excel built-in function for the Uniform Distribution. Instead the user must create the Excel calculations.
Here is an example:

Problem: A fair die is rolled once. What is the probability that either a 2 or a 5 will appear on top after the roll?

Number of total possible outcomes in 1 trial = 6

Number of times that 2 appears as a possible outcome = 1

Number of times that 5 appears as a possible outcome = 1

Probability of a 2 occurring in 1 roll = 1/6 = 0.1667

Probability of a 2 occurring in 1 roll = 1/6 = 0.1667

Pr (2 occurs) **OR** Pr (5 occurs) = Pr (2 occurs) **+** Pr (5 occurs)

= 0.1667 **+** 0.1667 = 0.333 = 33.33% probability

Exponential Distribution

The Exponential Distribution is used to calculate the probability of occurrence of an event that is the result of a continuous decaying or declining process. The lengths between arrival times in a Poisson process could be described with the Exponential Distribution. Examples of arrival times between Poisson events are as follows:

Time between telephone calls that come over a switchboard
Time between accidents
Time between traffic arrivals
Time between defects

An example of a decaying process that would be predicted by the Exponential Distribution would be:

Time until a radioactive particle decays

The Exponential Distribution is not appropriate for predicting failure rates of devices or lifetimes of organisms because a disproportionately high number of failures occur in the very young and the very old. In these cases, the distribution curve would not be a smooth exponential curve as described by the Exponential Distribution.

The Exponential Distribution predicts time between Poisson events as follows:

Probability of length of time t between Poisson events = $f(t) = ke^{-kt}$
k is sometimes called Lambda

Excel has a built-in Exponential Distribution function as follows:

= EXPONDIST (t, lambda, cumulative?)

Length of time period = t

Decay characteristic = lambda

Cumulative distribution = TRUE or FALSE

(if False, the probability of decay or failure at an exact moment is being calculated using the Probability Density Function)

(if True, the probability of decay or failure UP TO an exact moment is being calculated using the Cumulative Distribution Function)

A problem will illustrate the use of this function:

Problem: A production machine has a very low defect rate. Time between defects can be predicted by the following Exponential Distribution function:

Time between failures (t) = f(t) = 9 e^{-9t}

(t is measured in whole years)

Calculate the probability of a defect being produced within the next 1/10th year.

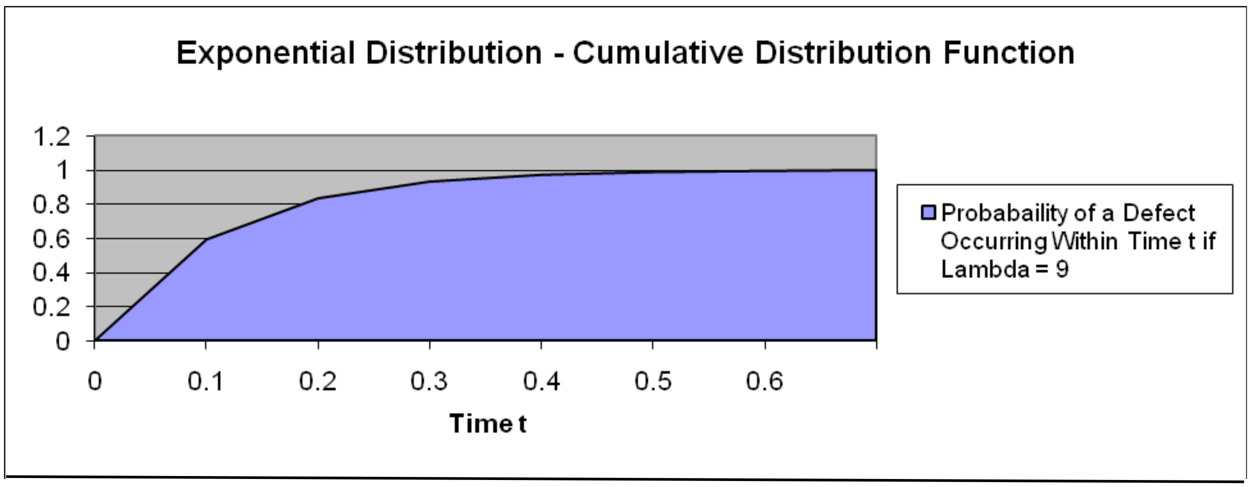
(Using "Within" indicates that the Cumulative Distribution function will be used)

t = 1/10 = 0.10 k = Lambda = 9 Calculate Cumulative = TRUE Distribution function?

Probability of defect occurring in 1/10 years

=EXPONDIST(0.1,9,TRUE) = 0.5934 = 59.34%

Note that the graph point at Time t = 0.1 has the probability of 0.5934.



Gamma Distribution

The Gamma Distribution represents the sum of n exponentially distributed random variables. Applications of the Gamma Distribution are often based on intervals between Poisson-distributed events. Examples of these would include queuing models, the flow of items through manufacturing and distribution processes, and the load on web servers and many forms of telecom.

Due to its moderately skewed profile, it can be used as a model in a range of disciplines, including climatology where it is a working model for rainfall, and financial services where it has been used for modeling insurance claims and the size of loan defaults. It has therefore been used in probability of ruin and value-at-risk equations.

The Gamma Distribution function is characterized by 2 variables, its shape parameter alpha (α) and its scale parameter theta (Φ). The Gamma Distribution function calculates the probability of wait time between Poisson distributed events to be time t, Excel has a built-in Gamma function as follows:

GAMMA (t Units of Time, α, Φ, Cumulative?)

= the probability that a Poisson-distributed event will occur at or within t Units of Time if the event can be characterized with a specific α and Φ.

Units of time = t

Alpha = α = shape parameter

Theta = Φ = Scale parameter

Cumulative? = if TRUE, calculating probability of event occurring within t units of time. If FALSE, calculating probability of event occurring at exactly t units of time.

Problem: Calculate the probability of the a Poisson-distributed event occurring before Time t = 10 if the Gamma Distribution function has alpha, α, = 2 and theta, Φ, = 4.

Units of waiting time until event occurs = t = 10

Alpha, α = 2

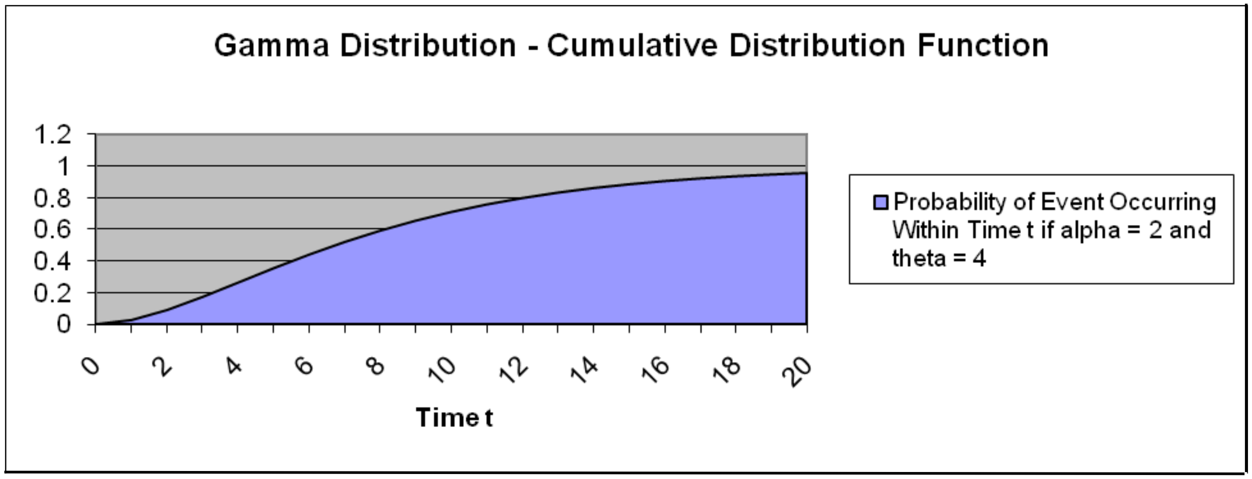
Theta, Φ = 4

Cumulative Distribution Function? = TRUE

Probability of this event occurring within
10 units of time (cumulative function)

= GAMMADIST (10, 2, 4, TRUE) = 0.7127 = 71.27%

Note that the graph point at Time t = 10 has a probability of 0.7127.



The Chi-Squared Distribution is a Gamma distribution in which the shape parameter, α, is set to the degrees of freedom divided by 2 and the scale parameter, Φ, is set to 2.

The Gamma Distribution with its shape parameter, α, set to 1 and its scale parameter, Φ, set to b, become the Exponential Distribution with k, lambda, set to b.

Beta Distribution

The Beta Distribution models events which are constrained to take place between a minimum and maximum time limit. For this reason, the Beta Distribution is often used for modeling project planning and control systems such as PERT (Project Evaluation and Review Technique) and CPM (Critical Path Method). The Beta Distribution is often used to calculate the probability that a project will be completed within a given period of time. Below is an example which illustrates its use:

Problem: Calculate the probability of completing the following project before Time t = 5 if the project is described by the following parameters:

Evaluation time period = t = 5

Alpha, α, = 8

Beta, β, = 10

Minimum completion time in units of time = 2

Maximum completion time in units of time = 7

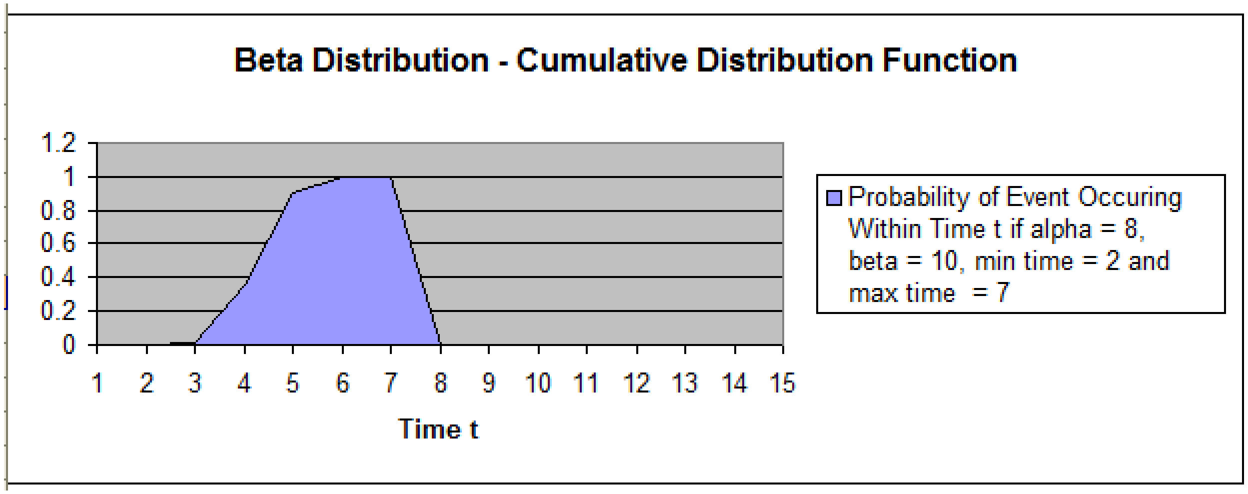
Probability of completing the task within time = 5 units of time (within = cumulative function)

= BETADIST (t, α, β, Min completion time, Max completion time)

= BETADIST (5, 8, 10, 2, 7) = 0.908

= 90.81%

Note that the graph point at Time t = 5 has a probability of 0.908.



Weibull Distribution

The Weibull Distribution is a special case of the Generalized Extreme Value distribution. The Weibull distribution has been used extensively as a model of time to failure for manufactured items and has become one of the principal tools of reliability engineering. The applications of the Weibull Distribution have expanded and include Finance and Climatology. There are three parameters of the Weibull distribution: time t, α - alpha (the shape parameter), and β (the scale parameter).

α > 1 --> Failure rate increases over time (suggests "wear out")
α = 1 --> Constant failure rate - Items fail from random events
α < 1 --> Failure rate decreases over time (suggest high "infant mortality")

Problem: Calculate the probability that a part will fail at time = 2 if the part's failure occurrence is Weibull-distributed and has α = 0.5 and β = 4.

t = Time = 2

α = Alpha = 0.5

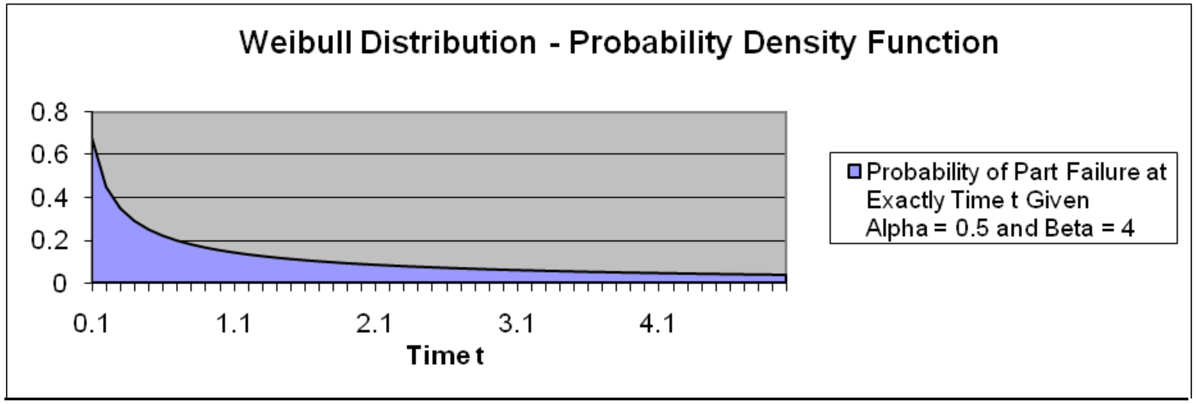
β = Beta = 4

We are determining the probability of part failure at exactly time t = 2 so we are using the Probability Density Function.

Probability of part failure occurring at exactly Time t = 2 given that time to part failure is Weibull-distributed with α = 0.5 and β = 4 is calculated is follows:

= WEIBULL(2,0.5,4,FALSE) = 0.087 --> 8.7% probability

Note that the graph point at Time t = 2.0 has a probability of 0.087.



Problem: Calculate the probability the a part will fail by time = 2 if the part's failure occurrence is Weibull distributed and has α = 0.5 and β = 4.

Time t = 2

α Alpha = 0.5

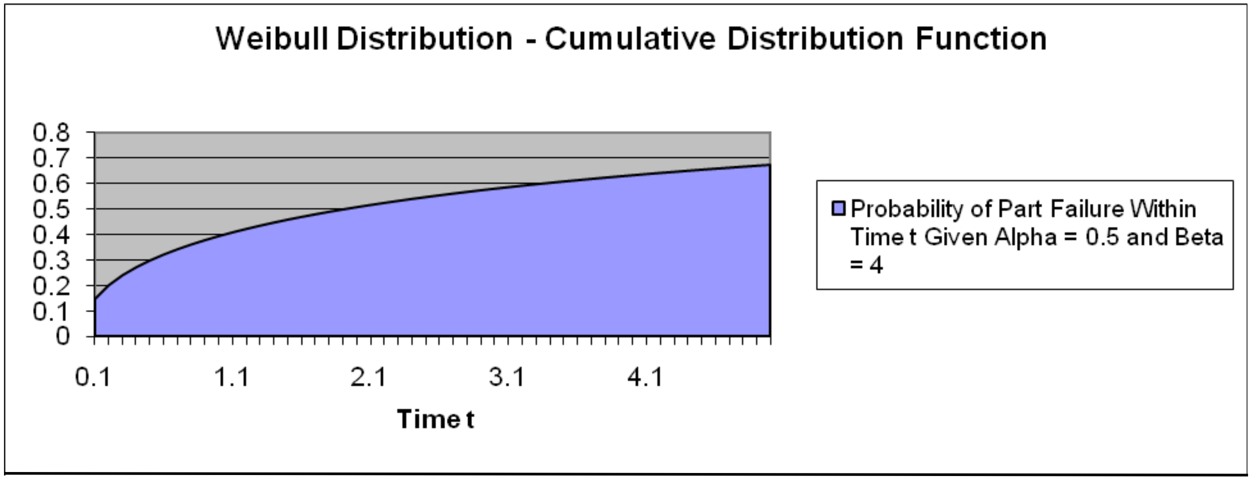
β = Beta = 4

We are determining the probability of part failure at exactly time t = 2 so we are using the Probability Density Function.

Probability of part failure occurring at exactly Time t = 2 given that time to part failure is Weibull-distributed with α = 0.5 and β = 4 is calculated is follows:

= WEIBULL(2,0.5,4,TRUE) = 0.506 --> 50.6% probability

Note that the graph point at Time t = 2 has a probability of 0.506.



F - Distribution

The F Distribution is used to determine whether two groups have different variances. The F Distribution is normally used to develop confidence intervals and hypothesis tests. It is rarely used for modeling applications.

The F Distribution has 4 parameters: X^2_1 (the calculated Chi-Square statistic for data group 1), X^2_2 (the calculated Chi-Square statistic for data group 2), v_1 (the degrees of freedom of group 1), and v_2 (the degrees of freedom of group 2). An example of how the Chi-Square statistic is calculated from a group of data can be found in the course module entitled "Chi-Square Independence Test."

The F Distribution is actually a family of distributions. Each different F Distribution has a unique combination of v_1 and v_2.

An individual F Distribution is actually the distribution of the F Statistic. The formula for the F Statistic is as follows:

F Statistic = $(X^2_1 / v_1) / (X^2_2 / v_2)$

As stated, the F Distribution is rarely used for modeling applications, but is often used for developing confidence intervals and hypothesis tests. Because of this, the most important use of a particular F Statistic is the calculation of its p Value. The p Value equals the percentage of total area under that unique F Distribution curve to the right of the given F statistic (and therefore the area in the outer curve tail to the right of the F Statistic). The Excel formula for the p Value for a particular F Statistic within its unique F Distribution is:

p Value = FDIST = (F Statistic, $v1$, $v2$)

The p Value is compared with α, the required Level of Significance. If the p Value is less than α, then the two data groups are assumed to have different variances. If the p Value is greater than α, the two data groups are assumed to have equal variances.

ANOVA (Analysis of Variance) tests calculate an F Statistic and its corresponding p Value for each pair of data sets that are being tested for independence. If the p Value pertaining to a a pair of data sets is less than the required α (which, for example, would equal 0.05 if a 95% Level of Certainty was required), it is assumed that the pair of data sets is not independent of each other. Refer to the ANOVA module of this course to see examples of this.

Calculating the F Statistic between two data sets involves a lot of work. A complete example of the calculation of the F Statistic and p Value between two data sets is shown at the end of the ANOVA module. Here, a hand-calculation of the F Statistic and p Value is performed to determine if there is a relationship between sales closing methods and sales results. The problem required a 95% Level of Certainty. The α (Level of Significance) was therefore equal to 0.05. The p Value between the two data sets was calculated to be 0.144. This p Value is less than α so sales are assumed to be related to the closing method used. Sales results and closing methods are assumed to not be independent of each other because different closing methods are shown to produce different sales results.

A summary of that problem is as follows:

The problem requires determination of whether closing methods used have an affect on sales. Three sales groups were each required to use a different closing method for the entire test. The total sales results from each group were recorded. ANOVA analysis was employed to determine with a 95% Level of Certainty whether the choice of closing method affected the level of sales.

The ANOVA process breaks the data down in two ways for analysis. One grouping of data is labeled the "Between Groups" data. The other grouping of the data is labeled the "Within Groups" data.

An F Statistic and its subsequent p Value were calculated based upon these two groups of data. The p Value (0.0144) was found to be less than α (0.05 --> based upon the 95% Level of Certainty). Therefore this implies that sales are not independent of closing method used.

A summary of the calculations is as follows:

"Between Groups" data grouping:

- X^2_1 = Chi-Square $\text{Statistic}_{\text{Group 1}}$ = 72
- v_1 = degrees of $\text{freedom}_{\text{Group 1}}$ = 2

"Within Groups" data grouping:

- X^2_2 = Chi-Square $\text{Statistic}_{\text{Group 2}}$ = 46
- v_2 = degrees of $\text{freedom}_{\text{Group 2}}$ = 9

F Statistic = $(X^2_1 / v_1) / (X^2_2 / v_2)$

= (72 / 2) / (46 / 9)

= 7.043478261

p Value = FDIST (F Statistic, v_1, v_2)

= FDIST (7.043478261, 2, 9)

= 0.0144

0.0144 is less than α (0.05) so it is assumed that the two groups are not independent. Sales are therefore related to the closing method used because the variances are different.

Chapter 16 - How To Graph Distributions

Contents

There are two steps to learning how to graph distribution functions:

1) Learning how to graph a generic set of x-y coordinates

2) Learning how to create the x coordinates and the y coordinates specific to the type of distribution being graphed.

- Normal Distribution
  - Probability Density Function
  - Cumulative Distribution Function

- Normal Distribution - Graphing Outer 2% Tails
  - Probability Density Function

- t Distribution
  - Probability Density Function

- Binomial Distribution
  - Probability Density Function
  - Cumulative Distribution Function

- Chi-Square Distribution
  - Probability Density Function

- Poisson Distribution
  - Probability Density Function
  - Cumulative Distribution Function

- Weibull Distribution
  - Probability Density Function
  - Cumulative Distribution Function

- Exponential Distribution
  - Probability Density Function
  - Cumulative Distribution Function

- Hypergeometric Distribution
  - Probability Density Function

- Beta Distribution
  - Cumulative Distribution Function

- Gamma Distribution
  - Probability Density Function
  - Cumulative Distribution Function

Graphing Overview

Overall, this course module will demonstrate how to create a chart from generic data. You have complete understanding of a creating chart from generic data before moving on to charting statistic distributions like the Normal or Chi-Square distributions.

The basic concepts of chart creation remain the same with all charts. The mean difference with creating charts of statistical distributions is the input data. All charts will be graphed in the same way except that different data sets will be plugged into each different chart. For this reason, it is very important to master graphing a chart with generic data before moving on to graph statistical distributions in the second half of this course module.

Incidentally, all graphs in this entire course using the instructions given below. With that, let's learn to graph a chart with generic data:

1) Learning how to graph a generic set of x - y coordinates.

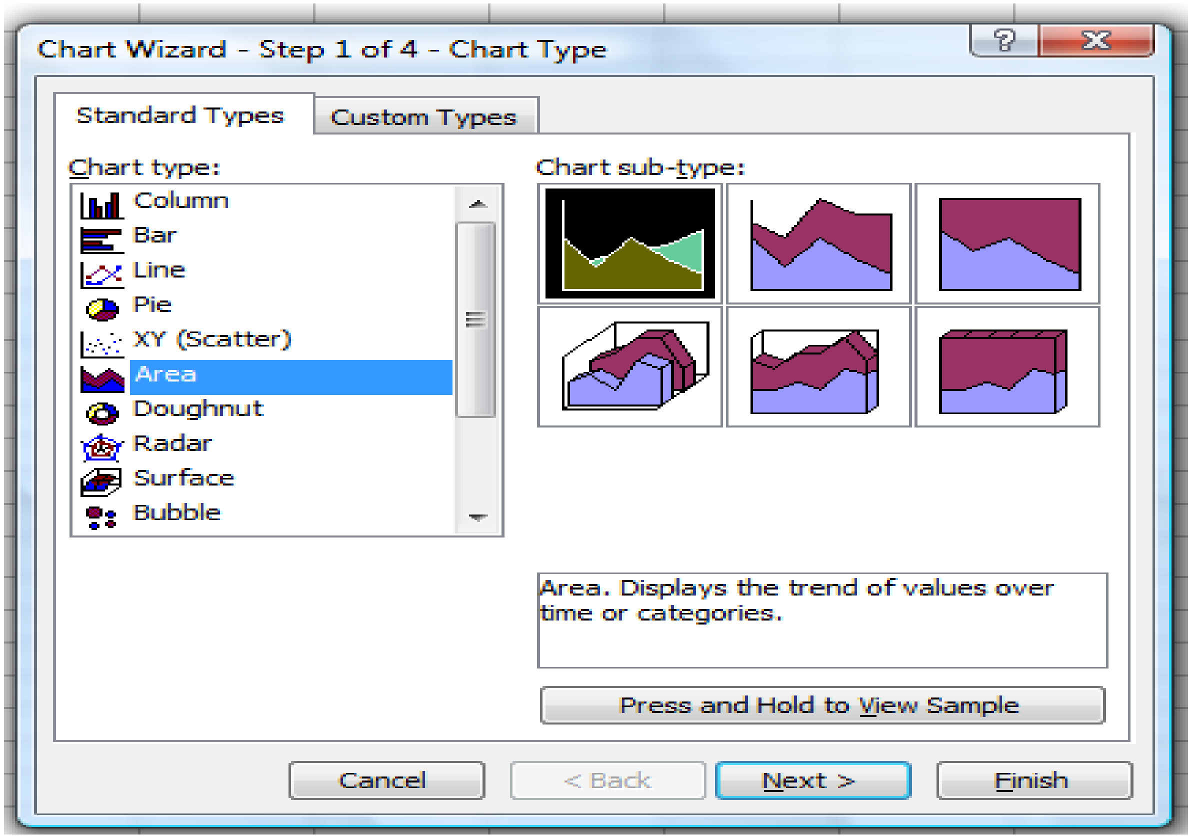
Here is a set of x - y coordinates that will be graphed:

x	y
1	2
2	4
3	7
4	10
5	15

To begin the process of creating a chart in Excel, go into Excel and do the following:

Insert / Chart

Then select the type of chart shown in the diagram below and click Next:



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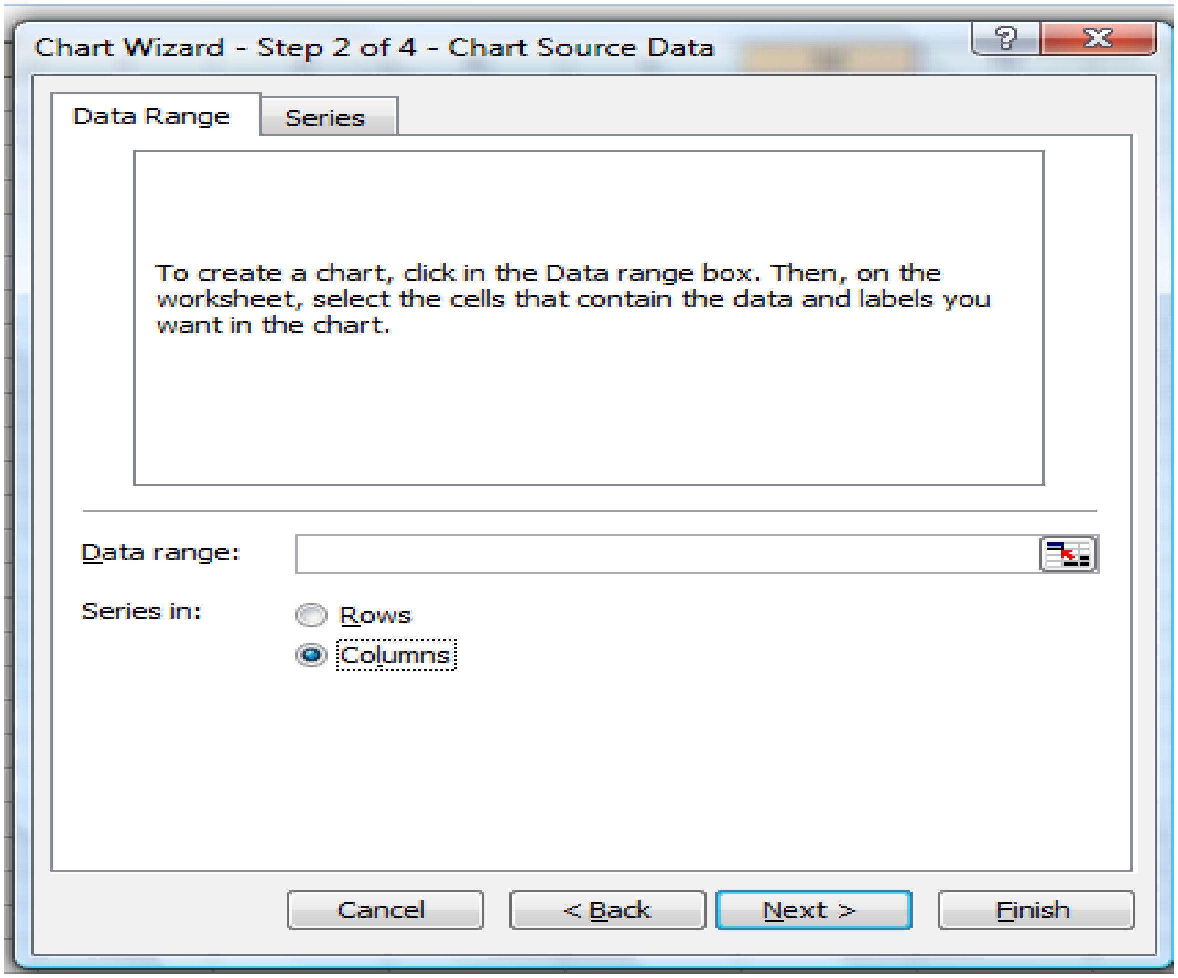
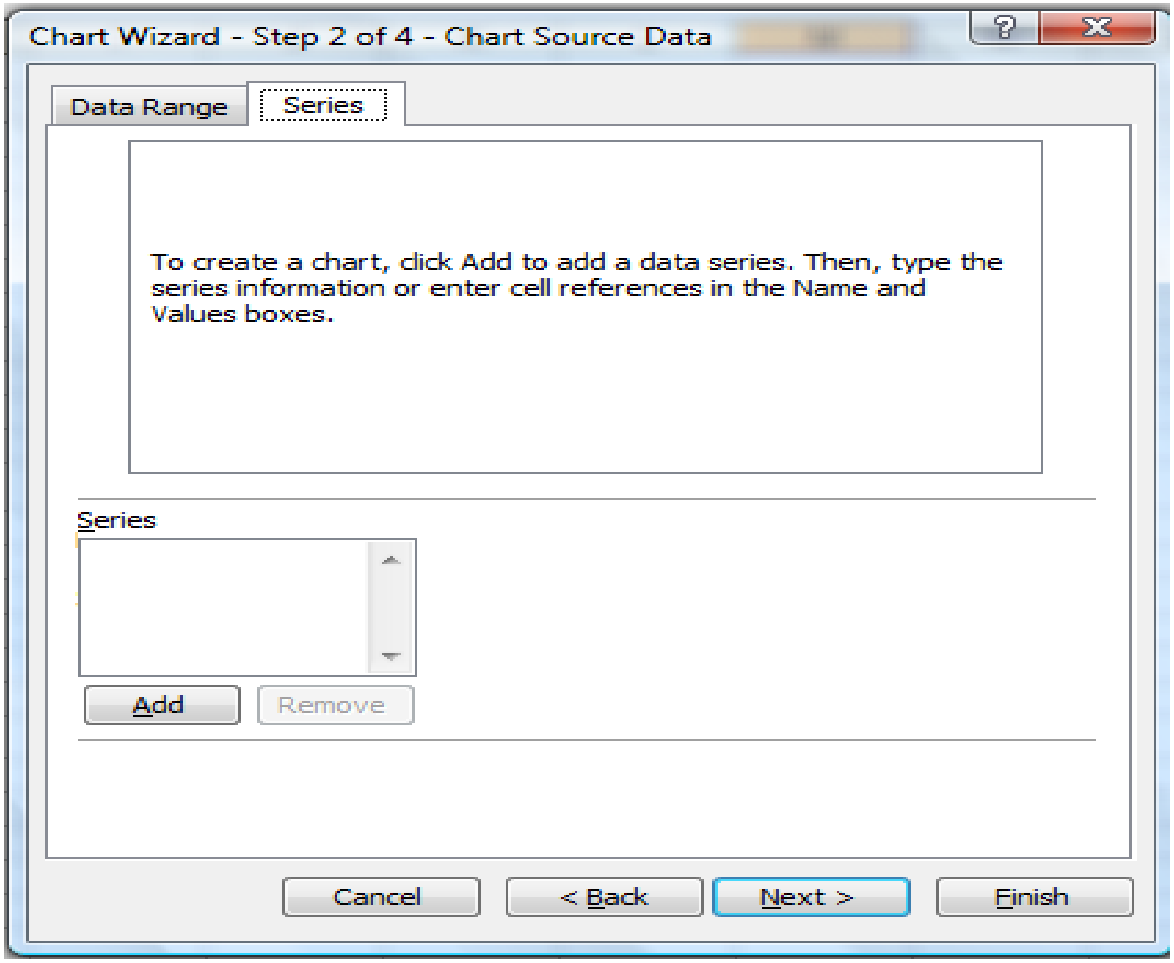
Click on Columns and then click the Series tab:



Click the Add Button to add a series of y-coordinate data



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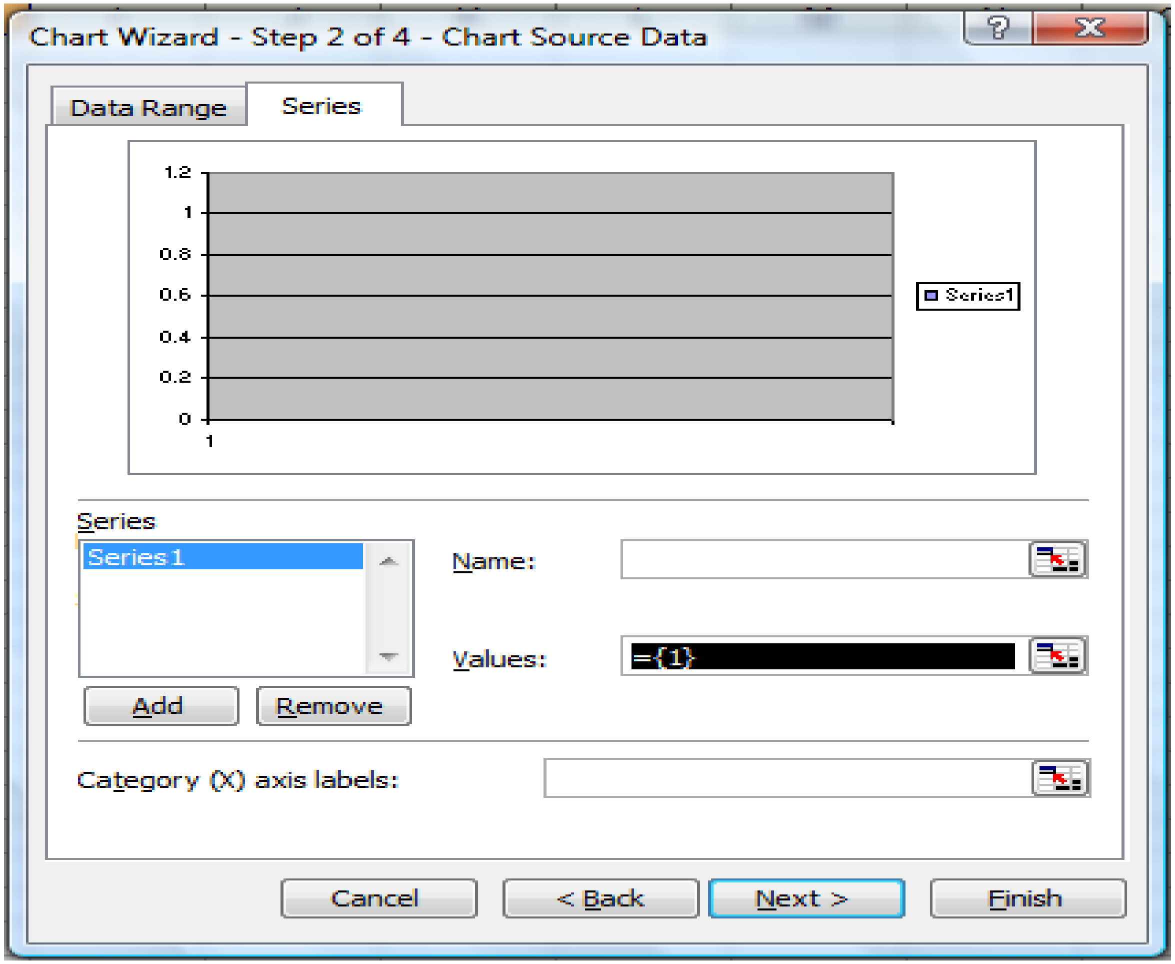
Highlight the default data in the Values input box. This is done below and everything in the Values input box is now highlighted dark black:

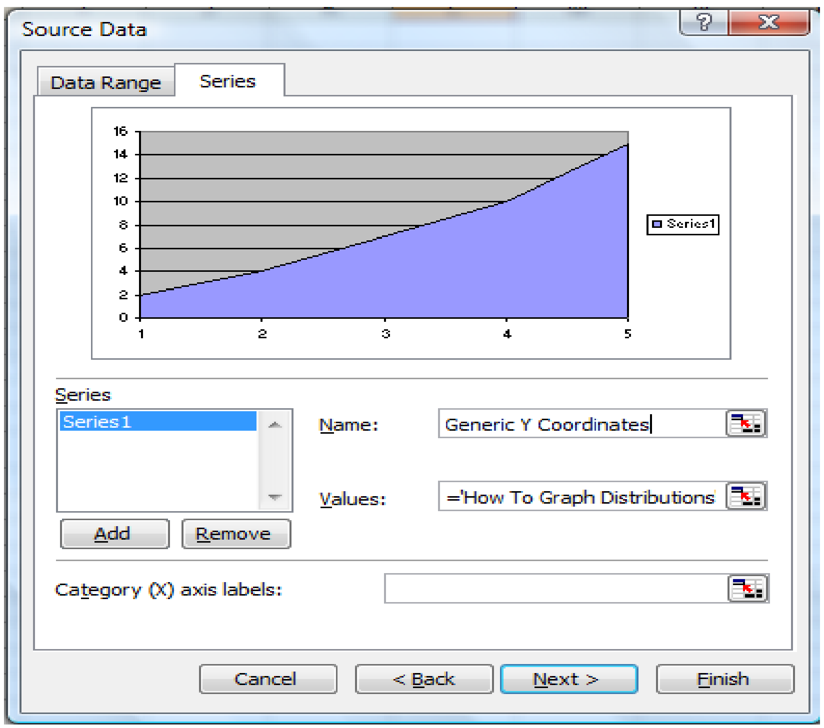


Highlight the y coordinates of what will be graphed as is highlighted in yellow here:

x	y
1	2
2	4
3	7
4	10
5	15

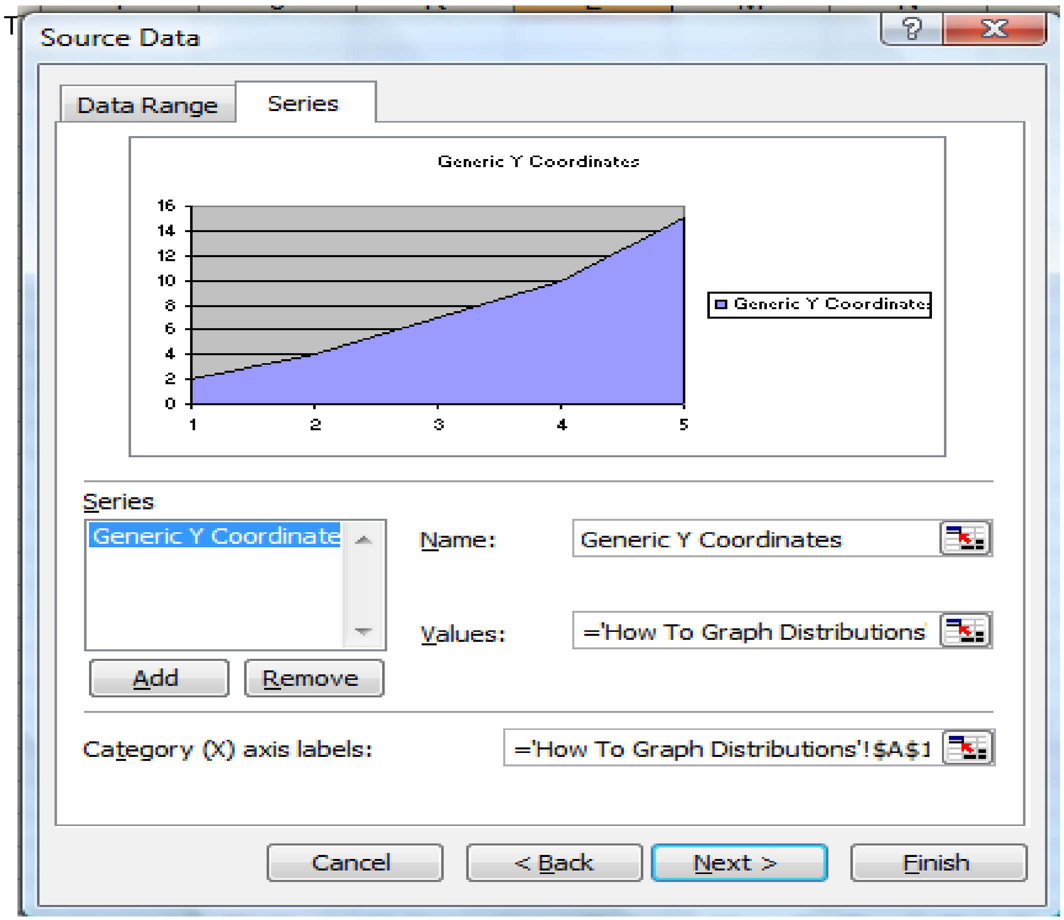
Highlighting the y-coordinates will cause their spreadsheet location to be recorded in the Values input box. In this case, the Y coordinates were labeled "Generic Y Coordinates." What you are seeing in the Values input box (="How to Graph Distributions) is part of the address of the data. This is name of the spreadsheet that held the data. The cell addresses follow the name of the spreadsheet and are part of that whole address.

A graph of the y data will be shown as well.



Now, click the cursor in the Category (X) axis labels and then highlight
the x coordinate data:

x	y
1	2
2	4
3	7
4	10
5	15



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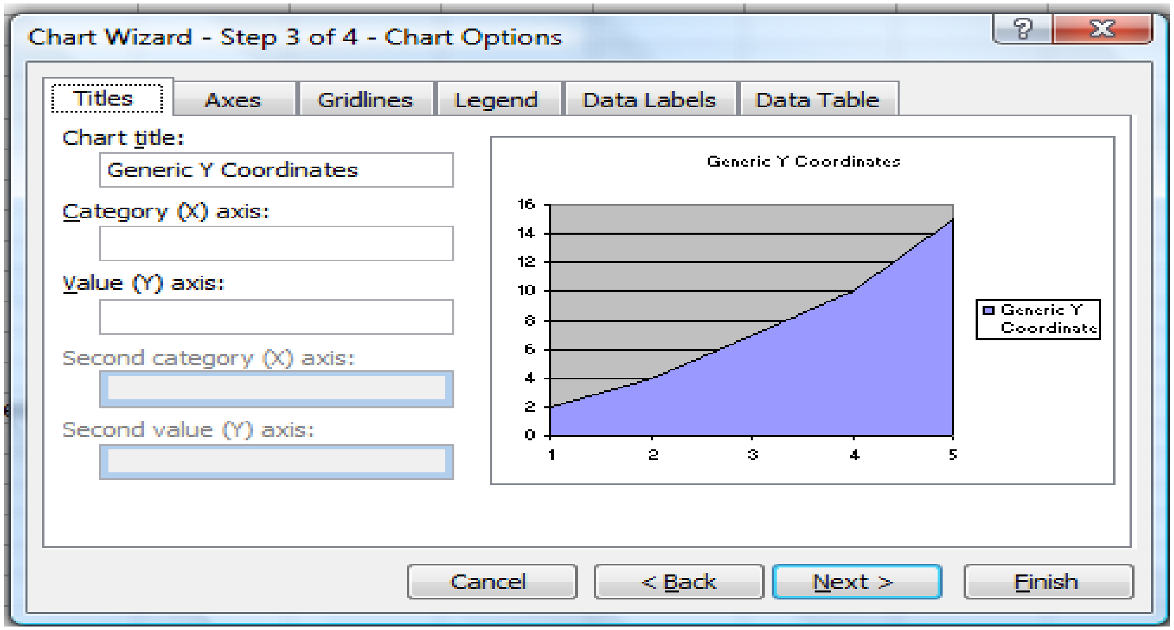
Select the Titles Tab:



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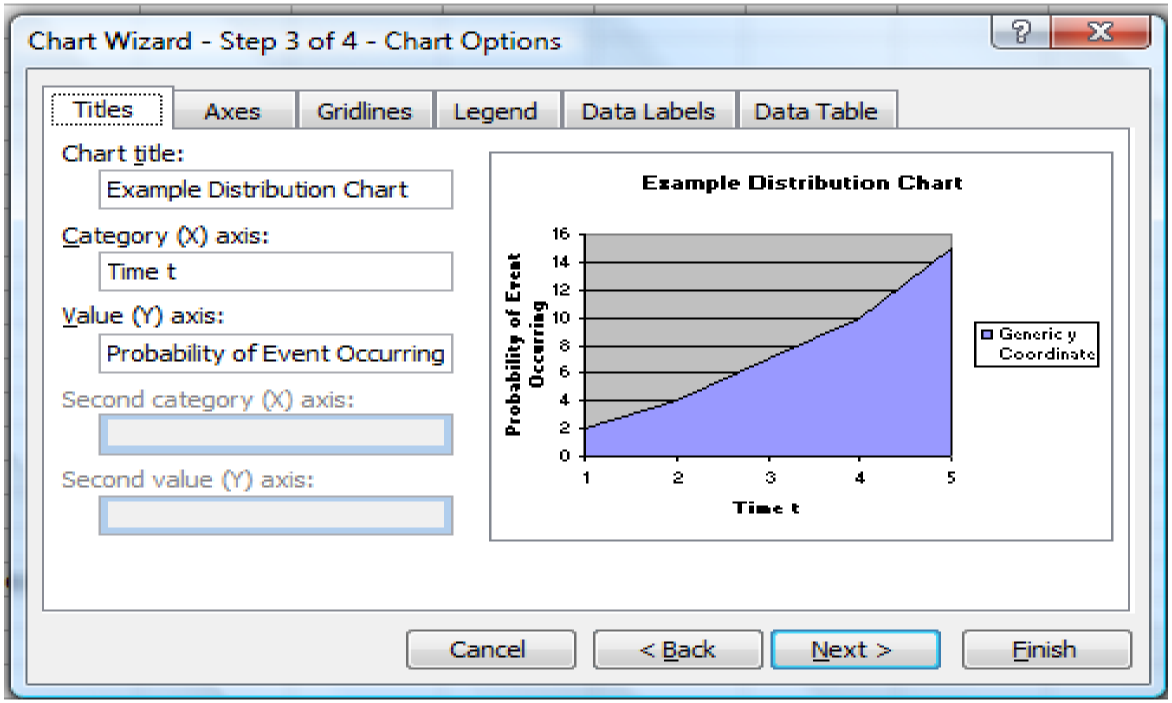
Type in a Chart Title, Category (X) axis, and Value (Y) axis and click Next:



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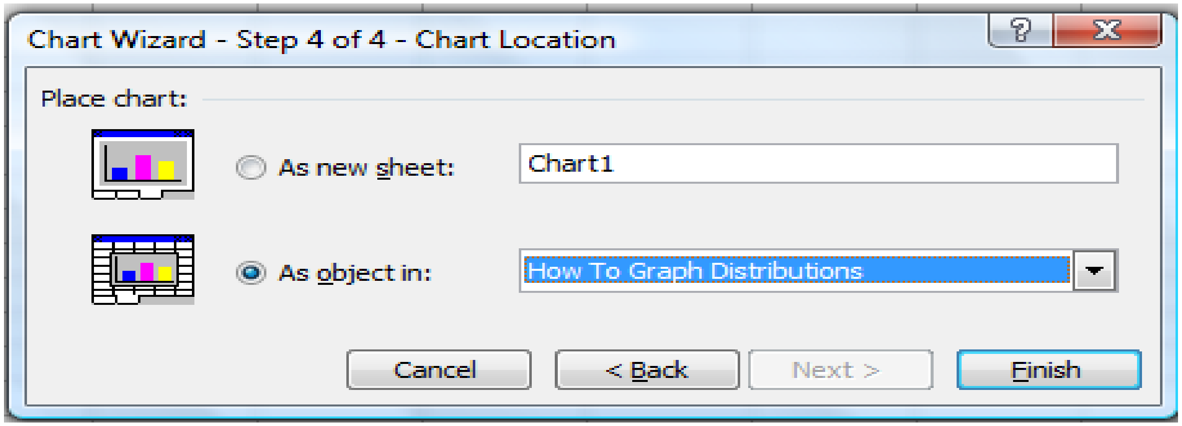
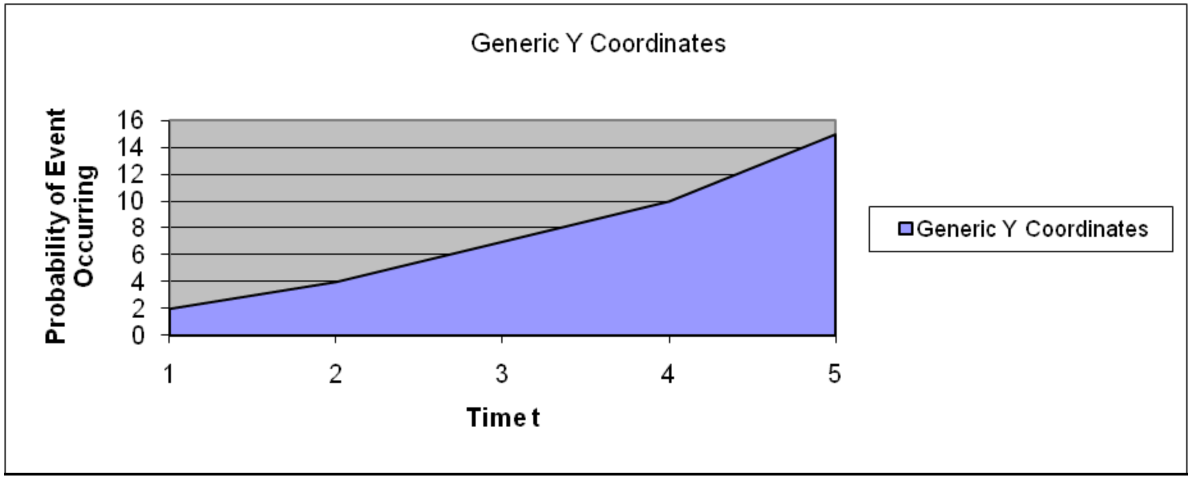
Click Finish



The resulting graph appears:



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2) Learning how to create the x coordinates and the y coordinates specific to the type of distribution being graphed.

Before you can begin to graph specific statistical functions, you must have mastered creating graphs of generic data. This was demonstrated in the first half of this course module. If you are not very familiar with the process of graphing generic data, please review the first half of this course module.

Creating the graphs of statistical functions is exactly the same as creating graphs using generic data. The main difference is that different sets of data are used for the Series 1 and for the (x) axis labels. Each of these sets of data is provided for each statistic function to be graphed.

Each statistical function graph shown below is a fully functioning graph copied directly from its Excel spreadsheet. The yellow cells are user inputs. Any changes made to the contents of any of these cells will be reflected in its appropriate graph immediately.

If you reconstruct the graphs in Excel exactly as displayed below, you should produce the same result – a fully functioning graph of that statistical function that changes its shape according to the user inputs typed into the yellow user input cells.

Each of the graphs has its own vertical and horizontal Excel address bars so that you will be able to replicate the formulas into the same corresponding cells in the Excel spreadsheet on your computer. For example, if a formula is typed into cell D4 in an example below, you should type the same formula into the cell D4 on the Excel spreadsheet on your computer.

The blue-colored cells below hold formulas that should be "copied down" the column. The exact formula to be copied into each specific blue cell will be displayed nearby in a tan-colored rectangular area. After you type the exact formula as it is shown into the indicated blue cell on your spreadsheet, you must then "copy the cell down." This is a process which copies the contents of the initial cell into each cell below. To "copy the cell down," mouse over the lower right corner of the initial cell. As you mouse of the lower right corner of this cell, you will notice that the cursor changes shape to a small cross. When that happens, right-click and "drag" the contents of the cell down the column while continuing to hold the mouse down (keeping the right-click button depressed).

Drag the formulas down the same number of cells as is done in the appropriate example below. When you release the mouse, you will notice that all of the cell that you "dragged" over now contain the formula and the correct result of the formula. The formulas below have been constructed so that you don't need to worry about relative and absolute addresses. If you are not familiar with those concepts, don't worry about it. Copying the formula from the top cell that you have typed it into down to the bottom of the column should produce the correct formula in each successive cell.

When you are constructing the graphs with Excel, you will need to know which sets of column data to specify as (x) axis labels and as Series 1 data. Each statistical function example below states over the top of the data columns whether it is to be used as Series 1 data. Only one example - Graphing the Outer Tails of the Normal Distribution – requires Series 2 Data. This is clearly labeled in the example.

The data column for each example that should be used as the (x) axis labels should be fairly apparent in each example. If it is not, simply look at the completed graph for each example and use the data column that is labeled with the same label as the x-axis on the completed graph.

When you have completed inputting the correct data columns into Excel and you are ready to view the output of the graph, you may designate that the output graph appears in exactly the same place on your spreadsheet as it appears in the example spreadsheet below.

You may find the process of graphing statistical functions a little confusing at first, but as soon as you complete your first one, you will probably be able to graph all of the other functions fairly easily. Just reconstruct everything exactly as it appears below -→ the same formulas in the same cells.

You'll notice that the t-Distribution and the Chi-Square distribution graphs had to be constructed from the actual formulas instead of using built-in Excel functions. This is the result of the built-in function producing an incorrect result (the t-Distribution) or no built-in function existing (the Chi-Square Distribution). For these distributions, you must take great care that you copy the formulas exactly as they appear in the examples and in exactly the same cells. Any mistake of a single character or cell address will cause the graphing function to produce an incorrect result. This is actually the case with all of the distributions, but the t-Distribution and Chi-Square Distribution are much more computationally intensive because we must deal with the formulas and not built-in Excel functions.

Most distributions have two major functions that can be graphed. These two functions are the Probability Density function and Cumulative Distribution function.

The **Probability Density function** provides the probability that the distributed variable will assume a certain value. For example, a Probability Density function might calculate the probability of an event occurring at exactly time = 5. The range of possible probabilities is listed on the vertical or y-axis.

The **Cumulative Distribution function** provides the probability that the distributed variable will assume any value up to a certain point. For example, a Cumulative Distribution function might calculate the probability of an event occurring at any time up until time = 5. The Cumulative Distribution function would equal the sum of the probabilities calculated by the Probability Density function at all points until time = 5. The Cumulative Distribution function values are shown on the vertical or y-axis and range in values from 0 to 1, which corresponds to 0% to 100%.

Below are displayed the x coordinate data, the y coordinate data, and the completed graph for the Probability Density function and / or the Cumulative Distribution function for most of the distributions mentioned in this course.

To build any of the graphs, substitute the x and y-coordinate data for the generic data and follow the same chart-building instructions.

Some of the distributions have built-in Excel functions which calculate the Probability Density function and / or the Cumulative Distribution function. Some do not. In some cases in which Excel did not provide a built-in function, a hand-calculation of the Probability Density function and / or the Cumulative Distribution function was used.

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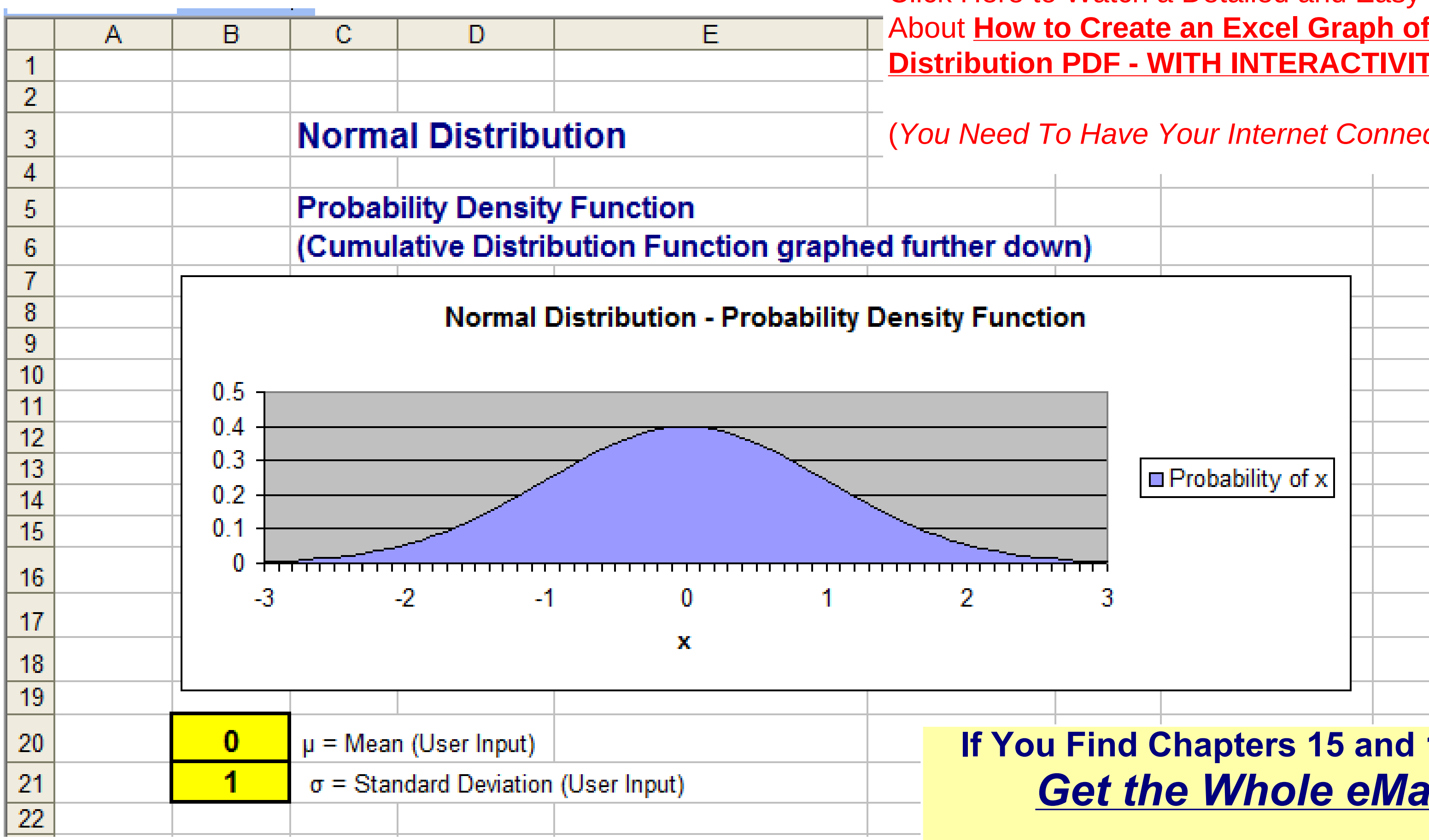

	A	B	C	D	E	F
19						
20		**0**	μ = Mean (User Input)			
21		**1**	σ = Standard Deviation (User Input)			
22						
23						

A specific Normal Curve can be completely constructed if only the mean and standard deviation are known. These are the two user inputs for this curve. Each formula to the right of a cell that is shown below is the formula within that cell. That formula is copied to end of each column of data. The generic chart-building process is applied to this data to construct the graph below the data.

To create the columns of data below which are the inputs for the graph and change when new data is typed into the user inputs above, copy the given formulas below into the designated cells, then copy the formula down the column by simply dragging the formula down the column:

C46 = B46*$B$21/10

D46 = C46+$B$20

E46 = NORMDIST(D46,$B$20,$B$21,FALSE)

	A	B	C	D	E	F
43					**Probability**	
44					**Density**	
45				**x Axis**	**Function**	
46		-30	-3	-3	0.004431848	
47		-29	-2.9	-2.9	0.005952532	
48		-28	-2.8	-2.8	0.007915452	
49		-27	-2.7	-2.7	0.010420935	

	A	B	C	D	E	F	G
43					Probability		
44					Density		
45				x Axis	Function		
46		-30	-3	-3	0.004431848		
47		-29	-2.9	-2.9	0.005952532		
48		-28	-2.8	-2.8	0.007915452		
49		-27	-2.7	-2.7	0.010420935		
50		-26	-2.6	-2.6	0.013582969		
51		-25	-2.5	-2.5	0.0175283		
52		-24	-2.4	-2.4	0.02239453		
53		-23	-2.3	-2.3	0.028327038		
54		-22	-2.2	-2.2	0.035474593		
55		-21	-2.1	-2.1	0.043983596		
56		-20	-2	-2	0.053990967		
57		-19	-1.9	-1.9	0.065615815		
58		-18	-1.8	-1.8	0.078950158		
59		-17	-1.7	-1.7	0.094049077		
60		-16	-1.6	-1.6	0.110920835		
61		-15	-1.5	-1.5	0.129517596		
62		-14	-1.4	-1.4	0.149727466		
63		-13	-1.3	-1.3	0.171368592		
64		-12	-1.2	-1.2	0.194186055		
65		-11	-1.1	-1.1	0.217852177		
66		-10	-1	-1	0.241970725		
67		-9	-0.9	-0.9	0.26608525		
68		-8	-0.8	-0.8	0.289691553		
69		-7	-0.7	-0.7	0.312253933		
70		-6	-0.6	-0.6	0.333224603		
71		-5	-0.5	-0.5	0.352065327		
72		-4	-0.4	-0.4	0.36827014		
73		-3	-0.3	-0.3	0.381387815		
74		-2	-0.2	-0.2	0.391042694		
75		-1	-0.1	-0.1	0.396952547		
76		0	0	0	0.39894228	The Mean	
77		1	0.1	0.1	0.396952547		
78		2	0.2	0.2	0.391042694		

	A	B	C	D	E	F
73		-3	-0.3	-0.3	0.381387815	
74		-2	-0.2	-0.2	0.391042694	
75		-1	-0.1	-0.1	0.396952547	
76		0	0	0	0.39894228	The Mean
77		1	0.1	0.1	0.396952547	
78		2	0.2	0.2	0.391042694	
79		3	0.3	0.3	0.381387815	
80		4	0.4	0.4	0.36827014	
81		5	0.5	0.5	0.352065327	
82		6	0.6	0.6	0.333224603	
83		7	0.7	0.7	0.312253933	
84		8	0.8	0.8	0.289691553	
85		9	0.9	0.9	0.26608525	
86		10	1	1	0.241970725	
87		11	1.1	1.1	0.217852177	
88		12	1.2	1.2	0.194186055	
89		13	1.3	1.3	0.171368592	
90		14	1.4	1.4	0.149727466	
91		15	1.5	1.5	0.129517596	
92		16	1.6	1.6	0.110920835	
93		17	1.7	1.7	0.094049077	
94		18	1.8	1.8	0.078950158	
95		19	1.9	1.9	0.065615815	
96		20	2	2	0.053990967	
97		21	2.1	2.1	0.043983596	
98		22	2.2	2.2	0.035474593	
99		23	2.3	2.3	0.028327038	
100		24	2.4	2.4	0.02239453	
101		25	2.5	2.5	0.0175283	
102		26	2.6	2.6	0.013582969	
103		27	2.7	2.7	0.010420935	
104		28	2.8	2.8	0.007915452	
105		29	2.9	2.9	0.005952532	
106		30	3	3	0.004431848	
107						

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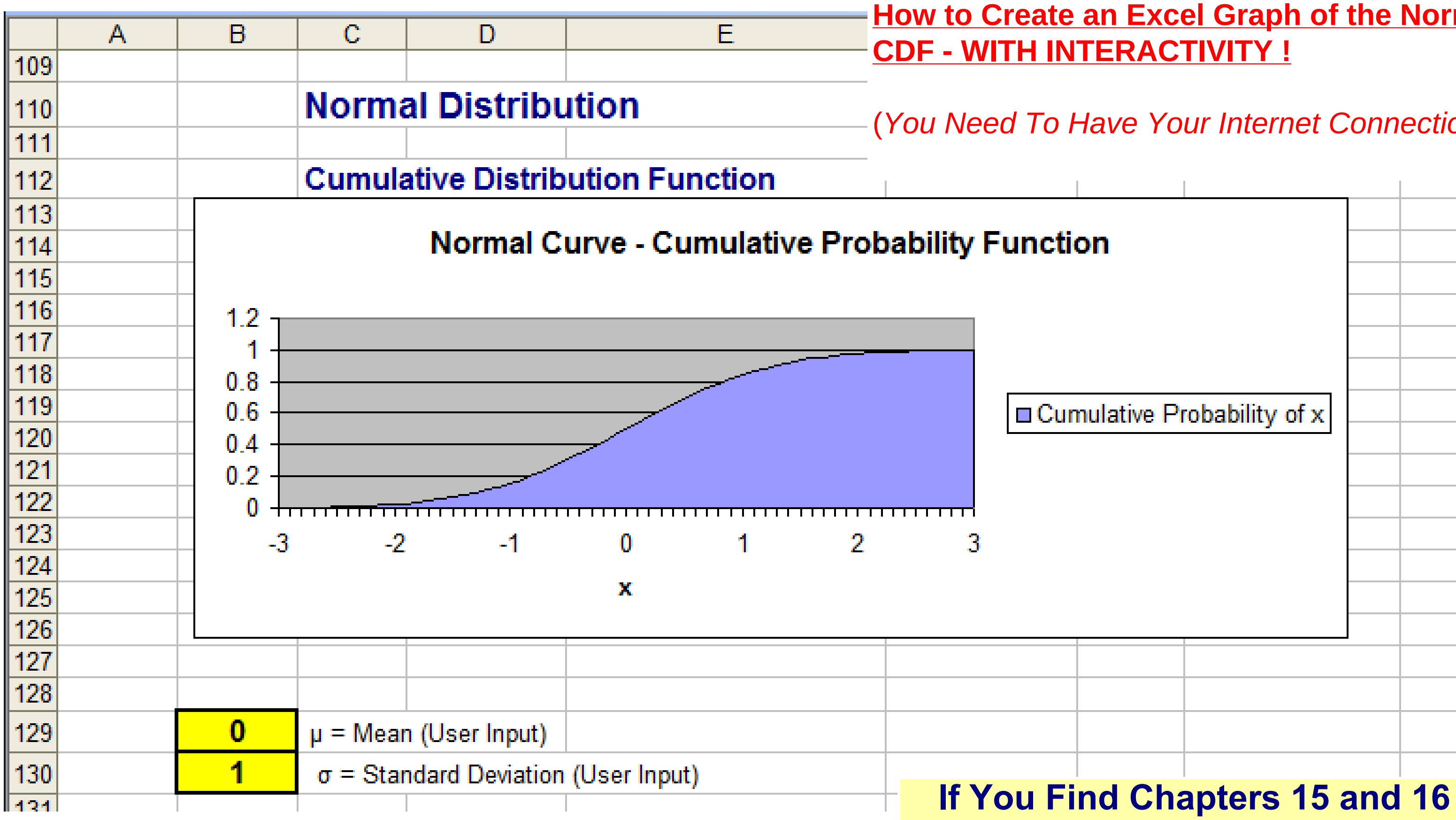

	A	B	C	D	E	F
129		**0**	μ = Mean (User Input)			
130		**1**	σ = Standard Deviation (User Input)			

A specific Normal Curve can be completely constructed if only the mean and standard deviation are known. These are the two user inputs for this curve. Each formula to the right of a cell that is shown below is the formula within that cell. That formula is copied to end of each column of data. The generic chart-building process is applied to this data to construct the graph below the data.

To create the columns of data below which are the inputs for the graph and change when new data is typed into the user inputs above, copy the given formulas below into the designated cells, then copy the formula down the column by simply dragging the formula down the column:

C154 = **=B154*$B$130/10**

D154 = **=C154+$B$129**

E154 = **=NORMDIST(D154,$B$129,$B$130,TRUE)**

	B	C	D	E
151				**Cumulative**
152				**Distribution**
153			**x Axis**	**Function**
154	-30	-3	-3	0.001349898
155	-29	-2.9	-2.9	0.001865813
156	-28	-2.8	-2.8	0.00255513

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	A	B	C	D	E	F
150						
151					Cumulative	
152					Distribution	
153				x Axis	Function	
154		-30	-3	-3	0.001349898	
155		-29	-2.9	-2.9	0.001865813	
156		-28	-2.8	-2.8	0.00255513	
157		-27	-2.7	-2.7	0.003466974	
158		-26	-2.6	-2.6	0.004661188	
159		-25	-2.5	-2.5	0.006209665	
160		-24	-2.4	-2.4	0.008197536	
161		-23	-2.3	-2.3	0.01072411	
162		-22	-2.2	-2.2	0.013903448	
163		-21	-2.1	-2.1	0.017864421	
164		-20	-2	-2	0.022750132	
165		-19	-1.9	-1.9	0.02871656	
166		-18	-1.8	-1.8	0.035930319	
167		-17	-1.7	-1.7	0.044565463	
168		-16	-1.6	-1.6	0.054799292	
169		-15	-1.5	-1.5	0.066807201	
170		-14	-1.4	-1.4	0.080756659	
171		-13	-1.3	-1.3	0.096800485	
172		-12	-1.2	-1.2	0.11506967	
173		-11	-1.1	-1.1	0.135666061	
174		-10	-1	-1	0.158655254	
175		-9	-0.9	-0.9	0.184060125	
176		-8	-0.8	-0.8	0.211855399	
177		-7	-0.7	-0.7	0.241963652	
178		-6	-0.6	-0.6	0.274253118	
179		-5	-0.5	-0.5	0.308537539	
180		-4	-0.4	-0.4	0.344578258	
181		-3	-0.3	-0.3	0.382088578	
182		-2	-0.2	-0.2	0.420740291	
183		-1	-0.1	-0.1	0.460172163	
184		0	0	0	0.5	The Mean
185		1	0.1	0.1	0.539827837	
186		2	0.2	0.2	0.579259709	

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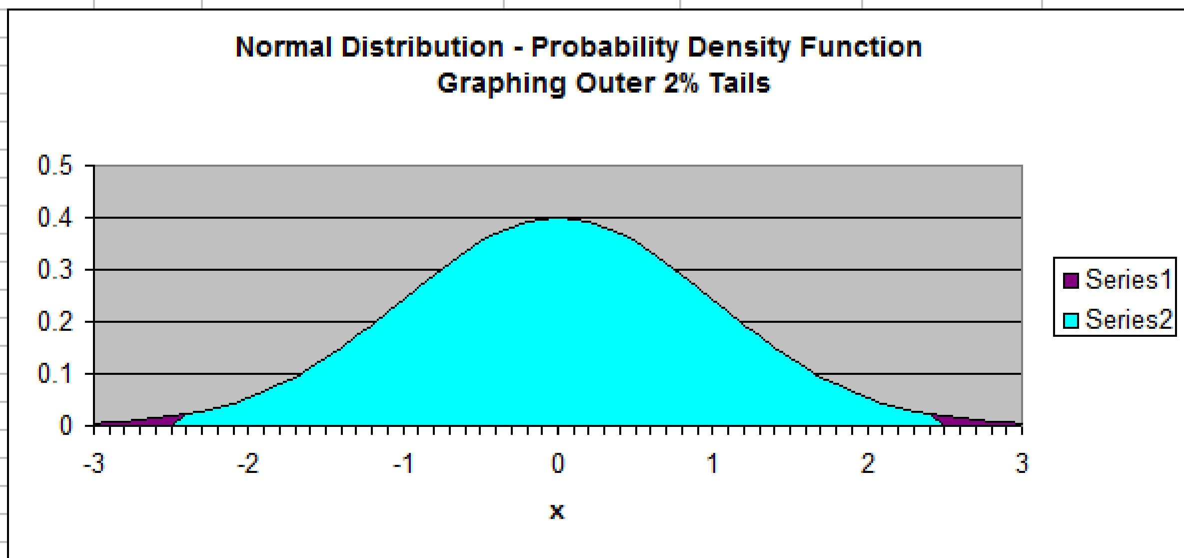
	A	B	C	D	E	F	G
183		-1	-0.1	-0.1	0.460172163		
184		0	0	0	0.5	The Mean	
185		1	0.1	0.1	0.539827837		
186		2	0.2	0.2	0.579259709		
187		3	0.3	0.3	0.617911422		
188		4	0.4	0.4	0.655421742		
189		5	0.5	0.5	0.691462461		
190		6	0.6	0.6	0.725746882		
191		7	0.7	0.7	0.758036348		
192		8	0.8	0.8	0.788144601		
193		9	0.9	0.9	0.815939875		
194		10	1	1	0.841344746		
195		11	1.1	1.1	0.864333939		
196		12	1.2	1.2	0.88493033		
197		13	1.3	1.3	0.903199515		
198		14	1.4	1.4	0.919243341		
199		15	1.5	1.5	0.933192799		
200		16	1.6	1.6	0.945200708		
201		17	1.7	1.7	0.955434537		
202		18	1.8	1.8	0.964069681		
203		19	1.9	1.9	0.97128344		
204		20	2	2	0.977249868		
205		21	2.1	2.1	0.982135579		
206		22	2.2	2.2	0.986096552		
207		23	2.3	2.3	0.98927589		
208		24	2.4	2.4	0.991802464		
209		25	2.5	2.5	0.993790335		
210		26	2.6	2.6	0.995338812		
211		27	2.7	2.7	0.996533026		
212		28	2.8	2.8	0.99744487		
213		29	2.9	2.9	0.998134187		
214		30	3	3	0.998650102		
215							
216							

Normal Distribution

Graphing the Outside Tails of the Probability Density Function



0	μ = Mean (User Input)
1	σ = Standard Deviation (User Input)

	B	C D
29	**0**	μ = Mean (User Input)
30	**1**	σ = Standard Deviation (User Input)

Graphing outer tails simply requires creating one more identical data series of Y data. One series will have everything zeroed out except the outer tail data. The other series will have the opposite data zeroed out. Both data series need to included the data points at the boundaries. To change the colors of each graph segment, Right-click on that segment and select "Format Data Series."

To create the columns of data below which are the inputs for the graph and change when new data is typed into the user inputs above, copy the given formulas below into the designated cells, then copy the formula down the column by simply dragging the formula down the column:

C56 = B56*$B$30/10

D56 = C56+$B$29

E56 = NORMDIST(D56,$B$29,$B$30,FALSE)

F62 = NORMDIST(D62,$B$29,$B$30,FALSE)

Row	B	C	D (x Axis)	E (Series 1: Probability y Axis)	F (Series 2: 2nd Identical Probability y Axis)
56	-30	-3	-3	0.004431848	0
57	-29	-2.9	-2.9	0.005952532	0
58	-28	-2.8	-2.8	0.007915452	0
59	-27	-2.7	-2.7	0.010420935	0
60	-26	-2.6	-2.6	0.013582969	0
61	-25	-2.5	-2.5	0.0175283	0
62	-24	-2.4	-2.4	0.02239453	0.02239453
63	-23	-2.3	-2.3	0	0.028327038
64	-22	-2.2	-2.2	0	0.035474593
65	-21	-2.1	-2.1	0	0.043983596

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	A	B	C	D	E	F	G
52							
53							
54					Series 1	Series 2	
55				x Axis	Probability y Axis	2nd Identical Probability y Axis	
56		-30	-3	-3	0.004431848	0	
57		-29	-2.9	-2.9	0.005952532	0	
58		-28	-2.8	-2.8	0.007915452	0	
59		-27	-2.7	-2.7	0.010420935	0	
60		-26	-2.6	-2.6	0.013582969	0	
61		-25	-2.5	-2.5	0.0175283	0	
62		-24	-2.4	-2.4	0.02239453	0.02239453	
63		-23	-2.3	-2.3	0	0.028327038	
64		-22	-2.2	-2.2	0	0.035474593	
65		-21	-2.1	-2.1	0	0.043983596	
66		-20	-2	-2	0	0.053990967	
67		-19	-1.9	-1.9	0	0.065615815	
68		-18	-1.8	-1.8	0	0.078950158	
69		-17	-1.7	-1.7	0	0.094049077	
70		-16	-1.6	-1.6	0	0.110920835	
71		-15	-1.5	-1.5	0	0.129517596	
72		-14	-1.4	-1.4	0	0.149727466	
73		-13	-1.3	-1.3	0	0.171368592	
74		-12	-1.2	-1.2	0	0.194186055	
75		-11	-1.1	-1.1	0	0.217852177	
76		-10	-1	-1	0	0.241970725	
77		-9	-0.9	-0.9	0	0.26608525	
78		-8	-0.8	-0.8	0	0.289691553	
79		-7	-0.7	-0.7	0	0.312253933	
80		-6	-0.6	-0.6	0	0.333224603	
81		-5	-0.5	-0.5	0	0.352065327	
82		-4	-0.4	-0.4	0	0.36827014	
83		-3	-0.3	-0.3	0	0.381387815	
84		-2	-0.2	-0.2	0	0.391042694	
85		-1	-0.1	-0.1	0	0.396952547	
86		0	0	0	0	0.39894228	The Mean
87		1	0.1	0.1	0	0.396952547	
88		2	0.2	0.2	0	0.391042694	
89		3	0.3	0.3	0	0.381387815	

	A	B	C	D	E	F	G	H
82		-4	-0.4	-0.4	0	0.36827014		
83		-3	-0.3	-0.3	0	0.381387815		
84		-2	-0.2	-0.2	0	0.391042694		
85		-1	-0.1	-0.1	0	0.396952547		
86		0	0	0	0	0.39894228	The Mean	
87		1	0.1	0.1	0	0.396952547		
88		2	0.2	0.2	0	0.391042694		
89		3	0.3	0.3	0	0.381387815		
90		4	0.4	0.4	0	0.36827014		
91		5	0.5	0.5	0	0.352065327		
92		6	0.6	0.6	0	0.333224603		
93		7	0.7	0.7	0	0.312253933		
94		8	0.8	0.8	0	0.289691553		
95		9	0.9	0.9	0	0.26608525		
96		10	1	1	0	0.241970725		
97		11	1.1	1.1	0	0.217852177		
98		12	1.2	1.2	0	0.194186055		
99		13	1.3	1.3	0	0.171368592		
100		14	1.4	1.4	0	0.149727466		
101		15	1.5	1.5	0	0.129517596		
102		16	1.6	1.6	0	0.110920835		
103		17	1.7	1.7	0	0.094049077		
104		18	1.8	1.8	0	0.078950158		
105		19	1.9	1.9	0	0.065615815		
106		20	2	2	0	0.053990967		
107		21	2.1	2.1	0	0.043983596		
108		22	2.2	2.2	0	0.035474593		
109		23	2.3	2.3	0	0.028327038		
110		24	2.4	2.4	0.02239453	0.02239453		
111		25	2.5	2.5	0.0175283	0		
112		26	2.6	2.6	0.013582969	0		
113		27	2.7	2.7	0.010420935	0		
114		28	2.8	2.8	0.007915452	0		
115		29	2.9	2.9	0.005952532	0		
116		30	3	3	0.004431848	0		
117								
118								

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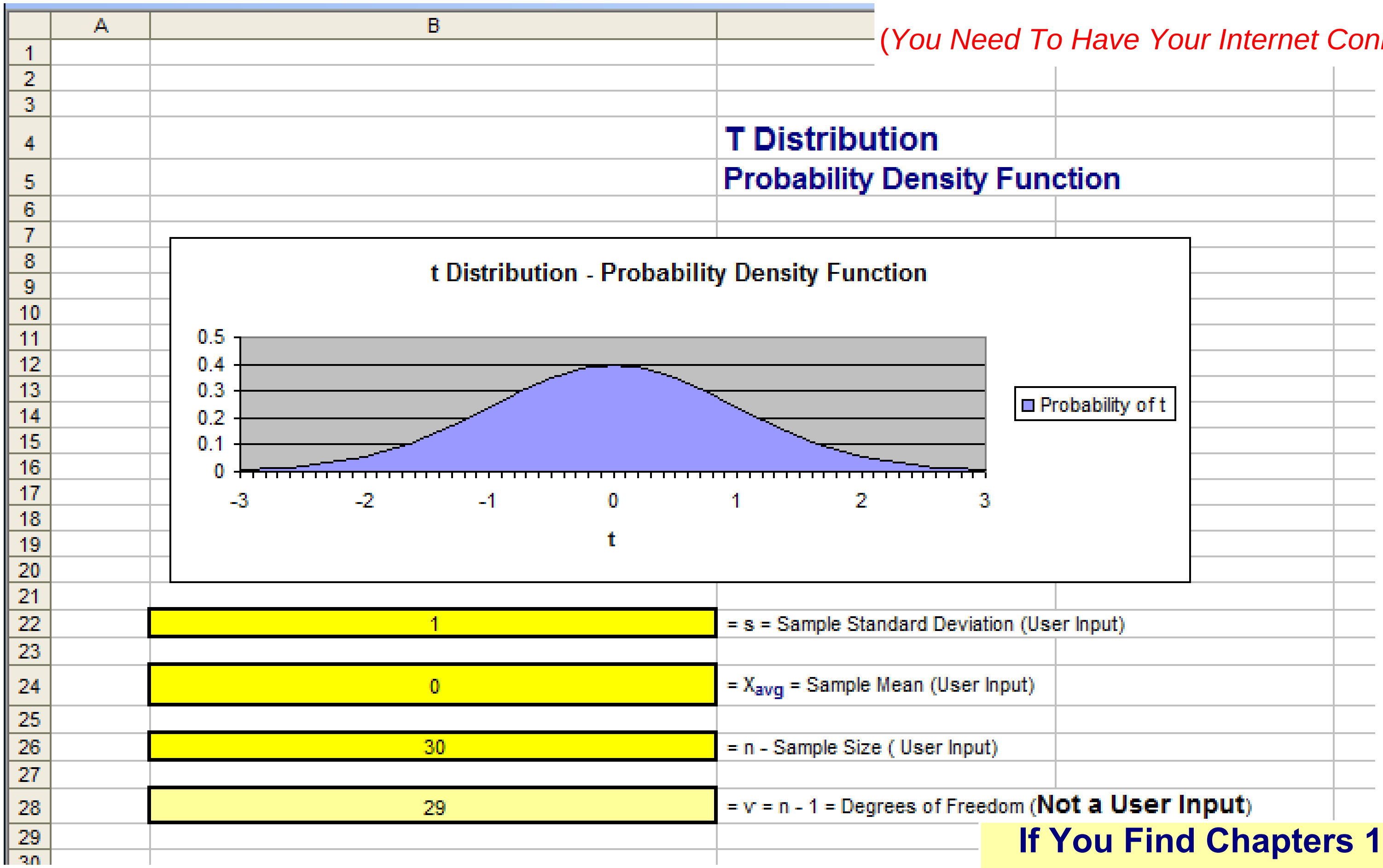

	A	B	C	D
21				
22		1	= s = Sample Standard Deviation (User Input)	
23				
24		0	= X_{avg} = Sample Mean (User Input)	
25				
26		30	= n - Sample Size (User Input)	
27				
28		29	= v = n - 1 = Degrees of Freedom (**Not a User Input**)	
29				
30				
31		In this case, we constructed the probability using the actual		
32		Probability Density function formula for the T Distribution.		
33		Built-in Excel functions were not used. This example illustrates		
34		how time-saving the Excel built-in functions are, as opposed		
35		to constructing the formulas by hand.		
36				
37		The reason that the actual formulas are used to graph		
38		the t distribution is that Excel's built-in function for the		
39		t Distribution Probability Density Function actually		
40		produces the wrong answer. The t Distribution reaches		
41		its highest value at approximately 0.4. The Excel TDIST		
42		function gives a value of approximately 1.0 as the highest		
43		value of the t-Distribution Probability Density function.		
44		This Excel function provides a completely incorrect		
45		answer and should not be used. Because of this,		
46		we are forced to used the actual formula to calculate		
47		the Probability Density function for the t Distribution.		
48				
49		The t Distribution is often used to analyze small samples. A		
50		t Distribution can be completely constructed if the following 3		
51		parameters are known: the sample mean (s), the sample standard		
52		deviation (σ), and the sample size (n). These are user inputs.		
53				
54		First, the t Distribution Probability Density Formula must be		
55		written in Excel. The formula of the Probability Density Function		
56		for the t Distribution is as follows:		
57				

	A	B	C
54		First, the t Distribution Probability Density Formula must be	
55		written in Excel. The formula of the Probability Density Function	
56		for the t Distribution is as follows:	
57			
58		$f(t,v) = c\ (1 + t^2/v)^{-((v+1)/2)}$	
59			
60		c = [Γ((v+1)/2)] / [SQRT(v * π) * Γ(v/2)]	
61			
62		= [Γ((v+1)/2)] / [SQRT(v * 3.14159265) * Γ(v/2)]	
63			
64			
65		GAMMALN (x) = LN (Γ(x))	
66			
67		therefore	
68			
69		$\Gamma(x) = e^{LN(\Gamma(x))} = e^{GAMMALN(x)}$ = EXP (GAMMALN(x))	
70			
71		To create the columns of data below which are the inputs for the graph	
72		and change when new data is typed into the user inputs above, copy the	
73		given formulas below into the designated cells, then copy the formula	
74		down the column by simply dragging the formula down the column, if	
75		applicable.	
76			
77		C92 = $B$28/2	
78			
79		C94 = GAMMALN(C92)	
80			
81		C98 = EXP(C94)	
82			
83		C102 = ($B$28+1)/2	
84			
85		C104 = GAMMALN(C102)	
86			
87		C108 = EXP(C104)	
88			
89		C114 = (C108)/(SQRT($B$28*3.14159265)*C98)	
90			
91			

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	A	B	C
76			
77		C92 = $B$28/2	
78			
79		C94 = GAMMALN(C92)	
80			
81		C98 = EXP(C94)	
82			
83		C102 = ($B$28+1)/2	
84			
85		C104 = GAMMALN(C102)	
86			
87		C108 = EXP(C104)	
88			
89		C114 = (C108)/(SQRT($B$28*3.14159265)*C98)	
90			
91			
92		v / 2 =	14.5
93			
94		GAMMALN (v / 2) =	23.86276584
95			
96		Γ (v / 2) = EXP (GAMMALN (v / 2)) =	
97			
98		EXP (GAMMALN (v / 2)) =	23092317917
99			
100			
101			
102		(v + 1) / 2 =	15
103			
104		GAMMALN ((v + 1) / 2) =	25.19122118
105			
106		Γ ((v + 1) / 2) = EXP (GAMMALN ((v + 1) / 2)) =	
107			
108		EXP (GAMMALN ((v + 1) / 2)) =	87178291181
109			
110			
111			
112		c = [Γ((v+1)/2)] / [SQRT(v * 3.14159265) * Γ(v/2)] =	
113			
114		=	0.395518579
115			
116		C128 = B128*$B$22/10	
117			
118		D128 = IF(C128<0,C128*(-1),C128)	
119			

	A	B	C	D	E	F
115						
116		C128 = B128*$B$22/10				
117						
118		D128 = IF(C128<0,C128*(-1),C128)				
119						
120		E128 = $C$114*(1+(D128^2)/$B$28)^((-1)*(($B$28+1)/2))				
121		$= c\,(1 + t^2/v)^{-((v+1)/2)}$				
122						
123		F128 =C128+$B$24				
124					Probability	
125					Density	
126					Function	
127				**t**	**f(t,v)**	**x Axis**
128		-30	-3	3	0.006860929	-3
129		-29	-2.9	2.9	0.008676034	-2.9
130		-28	-2.8	2.8	0.010923015	-2.8
131		-27	-2.7	2.7	0.013687759	-2.7
132		-26	-2.6	2.6	0.017067669	-2.6
133		-25	-2.5	2.5	0.021171422	-2.5
134		-24	-2.4	2.4	0.026118025	-2.4
135		-23	-2.3	2.3	0.032034989	-2.3
136		-22	-2.2	2.2	0.039055441	-2.2
137		-21	-2.1	2.1	0.047314006	-2.1
138		-20	-2	2	0.05694135	-2
139		-19	-1.9	1.9	0.068057325	-1.9
140		-18	-1.8	1.8	0.080762799	-1.8
141		-17	-1.7	1.7	0.095130344	-1.7
142		-16	-1.6	1.6	0.11119415	-1.6
143		-15	-1.5	1.5	0.128939663	-1.5
144		-14	-1.4	1.4	0.148293658	-1.4
145		-13	-1.3	1.3	0.169115546	-1.3
146		-12	-1.2	1.2	0.191190864	-1.2
147		-11	-1.1	1.1	0.214227874	-1.1
148		-10	-1	1	0.23785815	-1
149		-9	-0.9	0.9	0.261641853	-0.9
150		-8	-0.8	0.8	0.285078108	-0.8
151		-7	-0.7	0.7	0.307620497	-0.7
152		-6	-0.6	0.6	0.328697264	-0.6
153		-5	-0.5	0.5	0.347735317	-0.5
154		-4	-0.4	0.4	0.364186684	-0.4
155		-3	-0.3	0.3	0.377555707	-0.3
156		-2	-0.2	0.2	0.387425032	-0.2
157		-1	-0.1	0.1	0.393478426	-0.1
158		0	0	0	0.395518579	0

	A	B	C	D	E	F	G
154		-4	-0.4	0.4	0.364186684	-0.4	
155		-3	-0.3	0.3	0.377555707	-0.3	
156		-2	-0.2	0.2	0.387425032	-0.2	
157		-1	-0.1	0.1	0.393478426	-0.1	
158		0	0	0	0.395518579	0	Mean
159		1	0.1	0.1	0.393478426	0.1	
160		2	0.2	0.2	0.387425032	0.2	
161		3	0.3	0.3	0.377555707	0.3	
162		4	0.4	0.4	0.364186684	0.4	
163		5	0.5	0.5	0.347735317	0.5	
164		6	0.6	0.6	0.328697264	0.6	
165		7	0.7	0.7	0.307620497	0.7	
166		8	0.8	0.8	0.285078108	0.8	
167		9	0.9	0.9	0.261641853	0.9	
168		10	1	1	0.23785815	1	
169		11	1.1	1.1	0.214227874	1.1	
170		12	1.2	1.2	0.191190864	1.2	
171		13	1.3	1.3	0.169115546	1.3	
172		14	1.4	1.4	0.148293658	1.4	
173		15	1.5	1.5	0.128939663	1.5	
174		16	1.6	1.6	0.11119415	1.6	
175		17	1.7	1.7	0.095130344	1.7	
176		18	1.8	1.8	0.080762799	1.8	
177		19	1.9	1.9	0.068057325	1.9	
178		20	2	2	0.05694135	2	
179		21	2.1	2.1	0.047314006	2.1	
180		22	2.2	2.2	0.039055441	2.2	
181		23	2.3	2.3	0.032034989	2.3	
182		24	2.4	2.4	0.026118025	2.4	
183		25	2.5	2.5	0.021171422	2.5	
184		26	2.6	2.6	0.017067669	2.6	
185		27	2.7	2.7	0.013687759	2.7	
186		28	2.8	2.8	0.010923015	2.8	
187		29	2.9	2.9	0.008676034	2.9	
188		30	3	3	0.006860929	3	
189							
190							
191							

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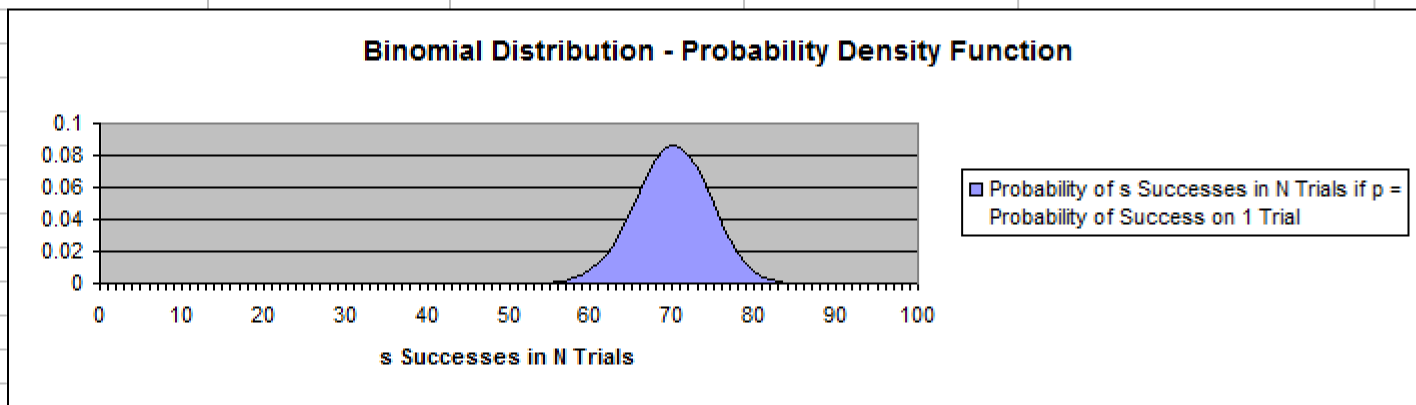
Binomial Distribution
Probability Density Function
(Cumulative Distribution Function graphed further down)



100	= N = Number of Trials
0.7	= p = Probability of Successful Outcome in 1 Trial

	A	B	C	D	E
20					
21		100	= N = Number of Trials		
22					
23		0.7	= p = Probability of Successful Outcome in 1 Trial		
24					
25					
26		Each Binomial Distribution can be completely constructed if only			
27		N and p are known. The number of Successes, s, will always be a			
28		number between 0 and N.			
29					
30		The Probability Density Function calculates the probability of exactly			
31		s successes.			
32					
33		To create the columns of data below which are the inputs for the graph			
34		and change when new data is typed into the user inputs above, copy the			
35		given formulas below into the designated cells, then copy the formula			
36		down the column by simply dragging the formula down the column:			
37					
38		**D41 = IF(B41>$B$21,0,BINOMDIST(B41,$B$21,$B$23,FALSE))**			
39					
40		**S = Number Successful Trials**	**Probability Density Function**		
41		0	5.15378E-53		
42		1	1.20255E-50		
43		2	1.38894E-48		
44		3	1.05868E-46		
45		4	5.99038E-45		
46		5	2.68369E-43		

	A	B	C	D	E
37					
38		D41 = IF(B41>$B$21,0,BINOMDIST(B41,$B$21,$B$23,FALSE))			
39					
40		**S = Number Successful Trials**	**Probability Density Function**		
41		0	5.15378E-53		
42		1	1.20255E-50		
43		2	1.38894E-48		
44		3	1.05868E-46		
45		4	5.99038E-45		
46		5	2.68369E-43		
47		6	9.91474E-42		
48		7	3.10662E-40		
49		8	8.42671E-39		
50		9	2.00993E-37		
51		10	4.26774E-36		
52		11	8.14751E-35		
53		12	1.40997E-33		
54		13	2.22703E-32		
55		14	3.2292E-31		
56		15	4.31995E-30		
57		16	5.35493E-29		
58		17	6.17392E-28		
59		18	6.64268E-27		
60		19	6.6893E-26		
61		20	6.32139E-25		
62		21	5.61901E-24		

	A	B	C	D
59		18	6.64268E-27	
60		19	6.6893E-26	
61		20	6.32139E-25	
62		21	5.61901E-24	
63		22	4.70805E-23	
64		23	3.7255E-22	
65		24	2.78895E-21	
66		25	1.9783E-20	
67		26	1.33155E-19	
68		27	8.51532E-19	
69		28	5.18015E-18	
70		29	3.00092E-17	
71		30	1.65717E-16	
72		31	8.73134E-16	
73		32	4.39295E-15	
74		33	2.11217E-14	
75		34	9.71183E-14	
76		35	4.2732E-13	
77		36	1.80029E-12	
78		37	7.26602E-12	
79		38	2.8108E-11	
80		39	1.04264E-10	
81		40	3.71006E-10	
82		41	1.26685E-09	
83		42	4.15245E-09	
84		43	1.30689E-08	
85		44	3.95039E-08	
86		45	1.14708E-07	
87		46	3.20017E-07	
88		47	8.57919E-07	
89		48	2.21033E-06	
90		49	5.4732E-06	
91		50	1.30262E-05	
92		51	2.97986E-05	
93		52	6.55186E-05	

	A	B	C
89		48	2.21033E-06
90		49	5.4732E-06
91		50	1.30262E-05
92		51	2.97986E-05
93		52	6.55186E-05
94		53	0.000138454
95		54	0.000281182
96		55	0.000548731
97		56	0.001028871
98		57	0.001853172
99		58	0.003205774
100		59	0.005324845
101		60	0.008490169
102		61	0.012990422
103		62	0.019066588
104		63	0.026834457
105		64	0.036198564
106		65	0.046779682
107		66	0.05788395
108		67	0.068539205
109		68	0.07761057
110		69	0.083984385
111		70	0.086783865
112		71	0.085561557
113		72	0.080412019
114		73	0.071966921
115		74	0.061269135
116		75	0.049559923
117		76	0.038039414
118		77	0.027665029
119		78	0.019034486
120		79	0.0123684
121		80	0.007575645
122		81	0.004364569
123		82	0.002359706
124		83	0.001194068
125		84	0.000563866

	A	B	C	D
116		75	0.049559923	
117		76	0.038039414	
118		77	0.027665029	
119		78	0.019034486	
120		79	0.0123684	
121		80	0.007575645	
122		81	0.004364569	
123		82	0.002359706	
124		83	0.001194068	
125		84	0.000563866	
126		85	0.000247659	
127		86	0.000100791	
128		87	3.7845E-05	
129		88	1.30451E-05	
130		89	4.10406E-06	
131		90	1.17042E-06	
132		91	3.00107E-07	
133		92	6.85027E-08	
134		93	1.37497E-08	
135		94	2.38912E-09	
136		95	3.52081E-10	
137		96	4.27877E-11	
138		97	4.11703E-12	
139		98	2.94073E-13	
140		99	1.3862E-14	
141		100	3.23448E-16	
142				

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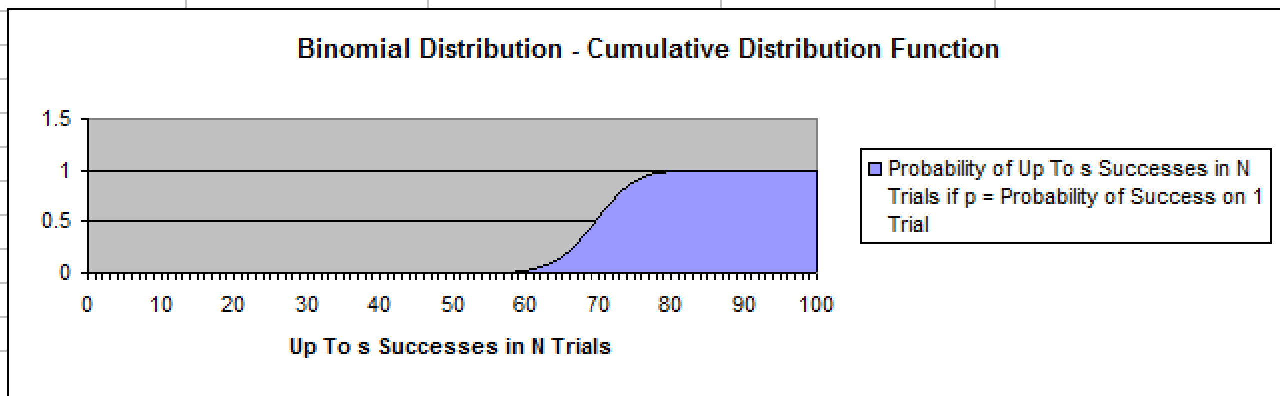
Binomial Distribution
Cumulative Distribution Function



100	= N = Number of Trials
0.7	= p = Probability of Successful Outcome in 1 Trial

	A	B	C	D	E
160					
161		100	= N = Number of Trials		
162					
163		0.7	= p = Probability of Successful Outcome		
164			in 1 Trial		
165					
166		Each Binomial Distribution can be completely constructed if only			
167		N and p are known. The number of Successes, s, will always be a			
168		number between 0 and N.			
169					
170		The Probability Density Function calculates the probability of exactly			
171		s successes.			
172					
173		To create the columns of data below which are the inputs for the graph			
174		and change when new data is typed into the user inputs above, copy the			
175		given formulas below into the designated cells, then copy the formula			
176		down the column by simply dragging the formula down the column:			
177					
178					
179		**C183 = IF(B183>$B$161,1,BINOMDIST(B183,$B$161,$B$163,TRUE))**			
180					
181					
182		**S = Number Successful Trials**	**Cumulative Distribution Function**		
183		0	5.15378E-53		
184		1	1.2077E-50		
185		2	1.40102E-48		
186		3	1.07269E-46		
187		4	6.09765E-45		

C183 = IF(B183>$B$161,1,BINOMDIST(B183,$B$161,$B$163,TRUE))

	A	B	C	D	E
182		S = Number Successful Trials	Cumulative Distribution Function		
183		0	5.15378E-53		
184		1	1.2077E-50		
185		2	1.40102E-48		
186		3	1.07269E-46		
187		4	6.09765E-45		
188		5	2.74467E-43		
189		6	1.01892E-41		
190		7	3.20851E-40		
191		8	8.74756E-39		
192		9	2.0974E-37		
193		10	4.47748E-36		
194		11	8.59526E-35		
195		12	1.49592E-33		
196		13	2.37662E-32		
197		14	3.46686E-31		
198		15	4.66663E-30		
199		16	5.8216E-29		
200		17	6.75608E-28		
201		18	7.31829E-27		
202		19	7.42113E-26		
203		20	7.0635E-25		
204		21	6.32536E-24		
205		22	5.34059E-23		
206		23	4.25956E-22		
207		24	3.21491E-21		
208		25	2.29979E-20		
209		26	1.56152E-19		
210		27	1.00768E-18		

	A	B	C	
209		26	1.56152E-19	
210		27	1.00768E-18	
211		28	6.18783E-18	
212		29	3.6197E-17	
213		30	2.01914E-16	
214		31	1.07505E-15	
215		32	5.468E-15	
216		33	2.65897E-14	
217		34	1.23708E-13	
218		35	5.51028E-13	
219		36	2.35131E-12	
220		37	9.61733E-12	
221		38	3.77253E-11	
222		39	1.41989E-10	
223		40	5.12995E-10	
224		41	1.77984E-09	
225		42	5.93229E-09	
226		43	1.90012E-08	
227		44	5.85051E-08	
228		45	1.73213E-07	
229		46	4.9323E-07	
230		47	1.35115E-06	
231		48	3.56148E-06	
232		49	9.03469E-06	
233		50	2.20609E-05	
234		51	5.18595E-05	
235		52	0.000117378	
236		53	0.000255833	
237		54	0.000537015	
238		55	0.001085746	
239		56	0.002114617	
240		57	0.003967789	
241		58	0.007173563	
242		59	0.012498407	
243		60	0.020988576	
244		61	0.033978998	
245		62	0.053045586	
246		63	0.079880042	

	A	B	C	D
246		63	0.079880042	
247		64	0.116078606	
248		65	0.162858288	
249		66	0.220742239	
250		67	0.289281444	
251		68	0.366892014	
252		69	0.450876399	
253		70	0.537660264	
254		71	0.623221821	
255		72	0.703633839	
256		73	0.77560076	
257		74	0.836869896	
258		75	0.886429818	
259		76	0.924469233	
260		77	0.952134261	
261		78	0.971168747	
262		79	0.983537147	
263		80	0.991112792	
264		81	0.995477361	
265		82	0.997837067	
266		83	0.999031135	
267		84	0.999595	
268		85	0.999842659	
269		86	0.99994345	
270		87	0.999981295	
271		88	0.99999434	
272		89	0.999998444	
273		90	0.999999615	
274		91	0.999999915	
275		92	0.999999983	
276		93	0.999999997	
277		94	1	
278		95	1	
279		96	1	
280		97	1	
281		98	1	
282		99	1	
283		100	1	

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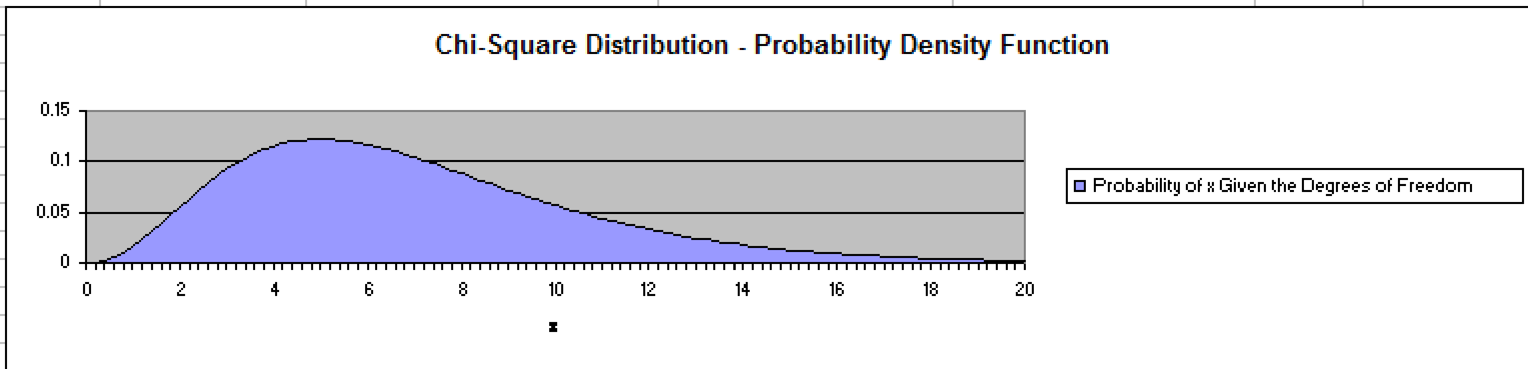
Chi-Square Distribution
Probability Density Function



7 = v = Degrees of Freedom (User Input)

A Chi-Squared Distribution can be completely constructed if the Degrees of Freedom are known. This parameter is a user input below.

Excel provides the Chi-Square function CHIDIST(x,v). Excel states that this function returns the one-tailed probability of the chi-squared distribution. The defined functionality of this built-in Excel function makes it appear to be the Probability Density function for the Chi-Square Distribution. This is not the case. This function actually calculates the percentage of area under the Chi-Square probability density function curve that is in the tail to the right of x.

The actual probability density function of the Chi-Square distribution is not a built-in Excel function. It must be constructed by hand. The formula is the following:

The actual probability density function of the Chi-Square distribution is not a built-in Excel function. It must be constructed by hand. The formula is the following:

Chi Square Probability Density Function =

$$= 1 / [\ (2^{v/2}) * \Gamma(v/2)\ ] * x^{(v/2-1)} * e^{-x/2}$$

To create the columns of data below which are the inputs for the graph and change when new data is typed into the user inputs above, copy the given formulas below into the designated cells, then copy the formula down the column by simply dragging the formula down the column:

C54 = CHIDIST(B54,$B$21)

D54 = (1)/((2^($B$21/2))*(EXP(GAMMALN($B$21/2))))*(B54^($B$21/2-1))*(EXP((-1)*(B54)/2))

$$= 1 / [\ (2^{v/2}) * \Gamma(v/2)\ ] * x^{(v/2-1)} * e^{-x/2}$$

x	CHIDIST(x,v) = % Curve Area Right of x	Probability Density Function
0.001	1	8.40624E-10
0.2	0.999974844	0.000430491
0.4	0.999736561	0.002203484
0.6	0.998991747	0.005494252
0.8	0.997443953	0.010205305
1	0.994828537	0.016131382
1.2	0.990926898	0.023024766
1.4	0.985571265	0.030628996

	A	B	C	D	E
52					
53		x	CHIDIST(x,v) = % Curve Area Right of x	Probability Density Function	
54		0.001	1	8.40624E-10	
55		0.2	0.999974844	0.000430491	
56		0.4	0.999736561	0.002203484	
57		0.6	0.998991747	0.005494252	
58		0.8	0.997443953	0.010205305	
59		1	0.994828537	0.016131382	
60		1.2	0.990926898	0.023024766	
61		1.4	0.985571265	0.030628996	
62		1.6	0.978644393	0.038697524	
63		1.8	0.970076448	0.047004024	
64		2	0.959840369	0.055347666	
65		2.2	0.947946513	0.063555272	
66		2.4	0.934437081	0.07148148	
67		2.6	0.919380643	0.079007687	
68		2.8	0.902866967	0.086040239	
69		3	0.885002234	0.092508198	
70		3.2	0.865904742	0.09836092	
71		3.4	0.845701103	0.103565589	
72		3.6	0.824522902	0.108104803	
73		3.8	0.802503859	0.111974281	
74		4	0.77977741	0.115180729	
75		4.2	0.756474733	0.117739889	
76		4.4	0.732723089	0.11967478	
77		4.6	0.70864454	0.121014129	
78		4.8	0.684354954	0.121790985	
79		5	0.659963234	0.122041521	
80		5.2	0.635570878	0.121803989	
81		5.4	0.611271555	0.121117837	
82		5.6	0.587151004	0.120022958	
83		5.8	0.563286964	0.118559073	
84		6	0.539749359	0.116765216	

	A	B	C	D	E
84		6	0.539749359	0.116765216	
85		6.2	0.516600352	0.114679327	
86		6.4	0.493894673	0.112337926	
87		6.6	0.47167991	0.109775862	
88		6.8	0.449996821	0.107026137	
89		7	0.428879838	0.104119775	
90		7.2	0.408357394	0.101085744	
91		7.4	0.388452264	0.097950921	
92		7.6	0.369182095	0.094740082	
93		7.8	0.350559786	0.09147593	
94		8	0.332593898	0.088179138	
95		8.2	0.315289058	0.084868409	
96		8.4	0.298646328	0.08156056	
97		8.6	0.282663629	0.0782706	
98		8.8	0.267336011	0.075011831	
99		9	0.252656039	0.071795944	
100		9.2	0.238614096	0.068633123	
101		9.4	0.225198667	0.065532144	
102		9.6	0.212396617	0.062500483	
103		9.8	0.200193434	0.059544415	
104		10	0.188573465	0.056669111	
105		10.2	0.177520127	0.053878734	
106		10.4	0.167016093	0.051176532	
107		10.6	0.157043473	0.048564924	
108		10.8	0.147583971	0.046045585	
109		11	0.13861902	0.043619519	
110		11.2	0.130129917	0.041287137	
111		11.4	0.122097927	0.039048323	
112		11.6	0.114504387	0.0369025	
113		11.8	0.10733079	0.034848684	
114		12	0.100558866	0.032885544	
115		12.2	0.094170637	0.031011448	
116		12.4	0.088148477	0.02922451	
117		12.6	0.082475162	0.02752263	
118		12.8	0.077133906	0.025903536	
119		13	0.07210839	0.024364811	
120		13.2	0.067382792	0.022903932	
121		13.4	0.062941802	0.021518291	

	A	B	C	D	E
120		13.2	0.067382792	0.022903932	
121		13.4	0.062941802	0.021518291	
122		13.6	0.058770638	0.020205221	
123		13.8	0.054855055	0.01896202	
124		14	0.051181353	0.017785969	
125		14.2	0.047736373	0.016674347	
126		14.4	0.044507499	0.015624451	
127		14.6	0.041482656	0.014633602	
128		14.8	0.038650298	0.01369916	
129		15	0.035999405	0.012818533	
130		15.2	0.033519467	0.011989186	
131		15.4	0.031200477	0.011208645	
132		15.6	0.029032916	0.010474501	
133		15.8	0.027007739	0.009784421	
134		16	0.025116361	0.009136143	
135		16.2	0.02335064	0.008527486	
136		16.4	0.021702865	0.007956346	
137		16.6	0.020165736	0.007420699	
138		16.8	0.018732349	0.006918602	
139		17	0.017396183	0.006448193	
140		17.2	0.016151078	0.006007688	
141		17.4	0.014991227	0.005595384	
142		17.6	0.013911153	0.005209656	
143		17.8	0.012905697	0.004848952	
144		18	0.011970002	0.004511799	
145		18.2	0.011099501	0.004196792	
146		18.4	0.010289898	0.003902601	
147		18.6	0.009537157	0.00362796	
148		18.8	0.008837491	0.003371672	
149		19	0.008187341	0.003132602	
150		19.2	0.007583373	0.002909677	
151		19.4	0.007022461	0.002701884	
152		19.6	0.006501675	0.002508263	
153		19.8	0.006018272	0.002327911	
154		20	0.005569683	0.002159976	
155					

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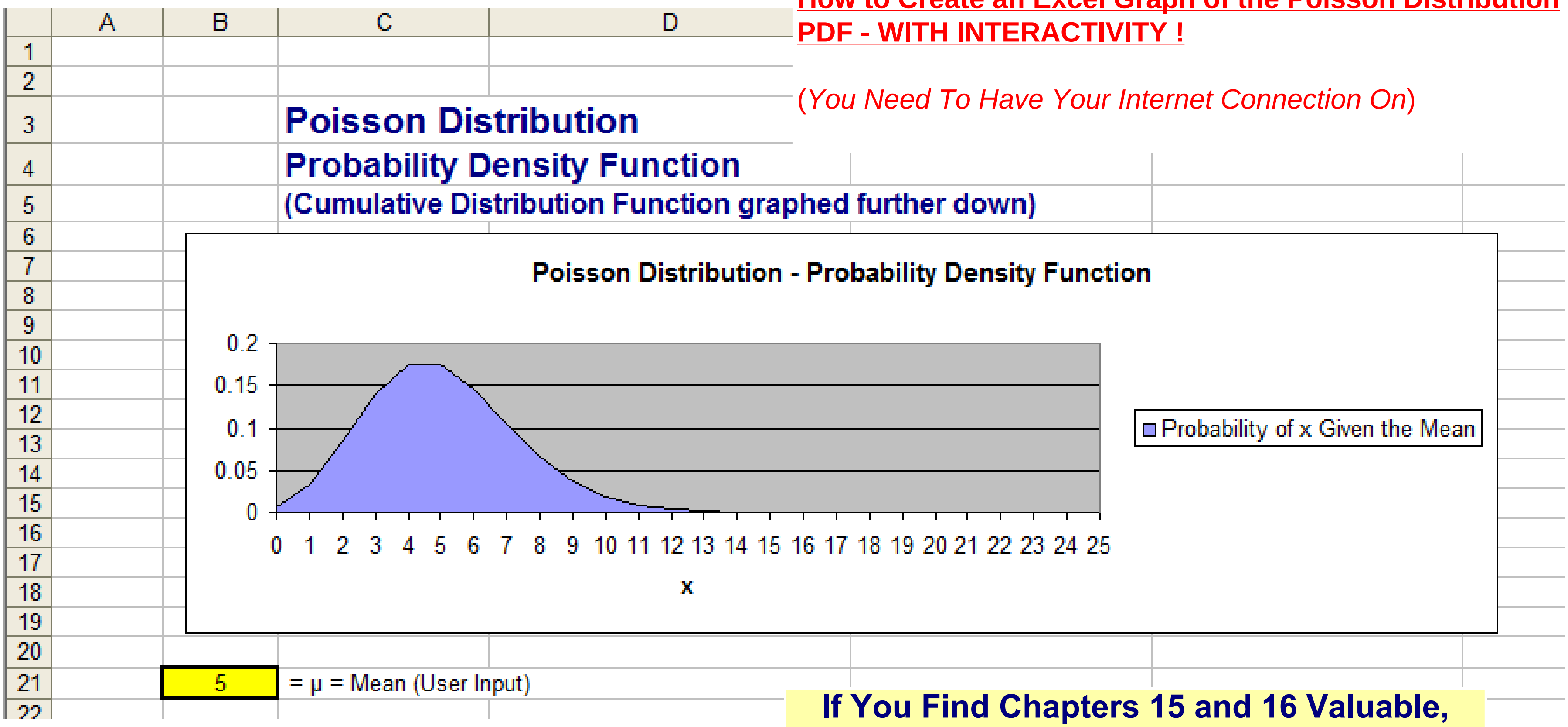

	A	B	C	D
20				
21		5	= μ = Mean (User Input)	
22				
23		The Poisson Distribution can be completely constructed		
24		if μ, the mean, is known. This is a user input.		
25				
26		The Poisson Distribution Is a discrete function so the graph		
27		has corners at each integer.		
28				
29		To create the columns of data below which are the inputs for the graph		
30		and change when new data is typed into the user inputs above, copy the		
31		given formulas below into the designated cells, then copy the formula		
32		down the column by simply dragging the formula down the column:		
33				
34		C37 = POISSON(B37,$B$21,FALSE)		
35				
36		x	f(x,μ)	
37		0	0.006737947	
38		1	0.033689735	
39		2	0.084224337	
40		3	0.140373896	
41		4	0.17546737	
42		5	0.17546737	
43		6	0.146222808	
44		7	0.104444863	

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	A	B	C	D
33				
34		C37 = POISSON(B37,$B$21,FALSE)		
35				
36		x	f(x,μ)	
37		0	0.006737947	
38		1	0.033689735	
39		2	0.084224337	
40		3	0.140373896	
41		4	0.17546737	
42		5	0.17546737	
43		6	0.146222808	
44		7	0.104444863	
45		8	0.065278039	
46		9	0.036265577	
47		10	0.018132789	
48		11	0.008242177	
49		12	0.00343424	
50		13	0.001320862	
51		14	0.000471736	
52		15	0.000157245	
53		16	4.91392E-05	
54		17	1.44527E-05	
55		18	4.01464E-06	
56		19	1.05648E-06	
57		20	2.64121E-07	
58		21	6.2886E-08	
59		22	1.42923E-08	
60		23	3.10701E-09	
61		24	6.47295E-10	
62		25	1.29459E-10	
63				

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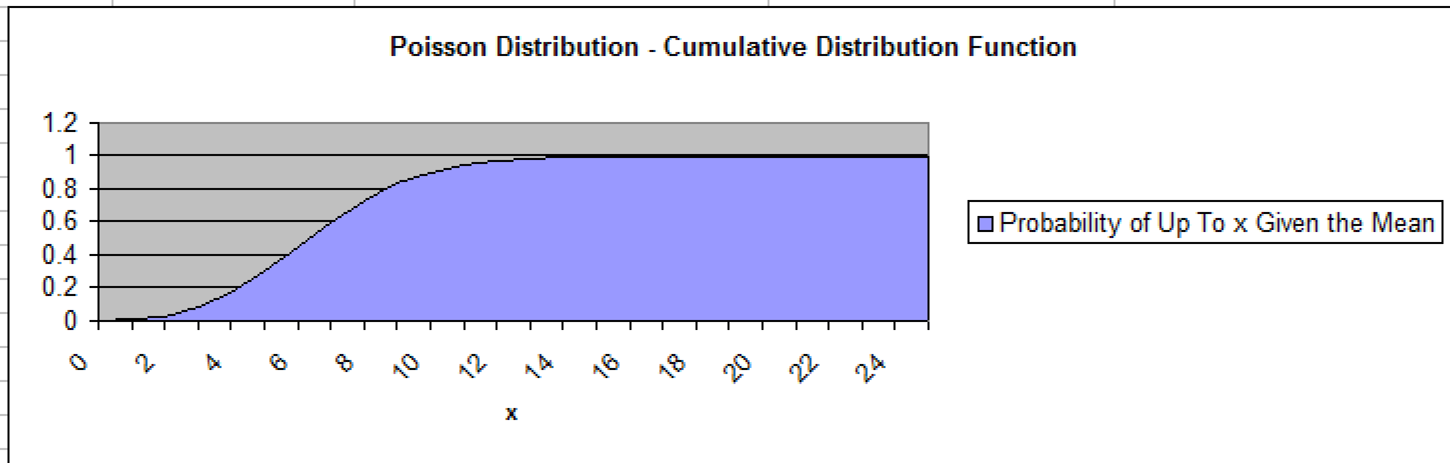
Poisson Distribution
Cumulative Distribution Function



7 = μ = Mean (User Input)

The Poisson Distribution can be completely constructed if μ, the mean, is known. This is a user input.

To create the columns of data below which are the inputs for the graph and change when new data is typed into the user inputs above, copy the given formulas below into the designated cells, then copy the formula down the column by simply dragging the formula down the column:

C101 = POISSON(B101,$B$88,TRUE)

x	f(x,μ)
0	0.000911882
1	0.007295056
2	0.029636164

	A	B	C	D
97				
98		C101 = POISSON(B101,$B$88,TRUE)		
99				
100		x	f(x,μ)	
101		0	0.000911882	
102		1	0.007295056	
103		2	0.029636164	
104		3	0.081765416	
105		4	0.172991608	
106		5	0.300708276	
107		6	0.449711056	
108		7	0.598713836	
109		8	0.729091268	
110		9	0.830495937	
111		10	0.901479206	
112		11	0.946650377	
113		12	0.973000227	
114		13	0.987188607	
115		14	0.994282798	
116		15	0.99759342	
117		16	0.999041817	
118		17	0.999638216	
119		18	0.999870149	
120		19	0.999955598	
121		20	0.999985505	
122		21	0.999995474	
123		22	0.999998646	
124		23	0.999999611	
125		24	0.999999893	
126		25	0.999999971	
127				
128				

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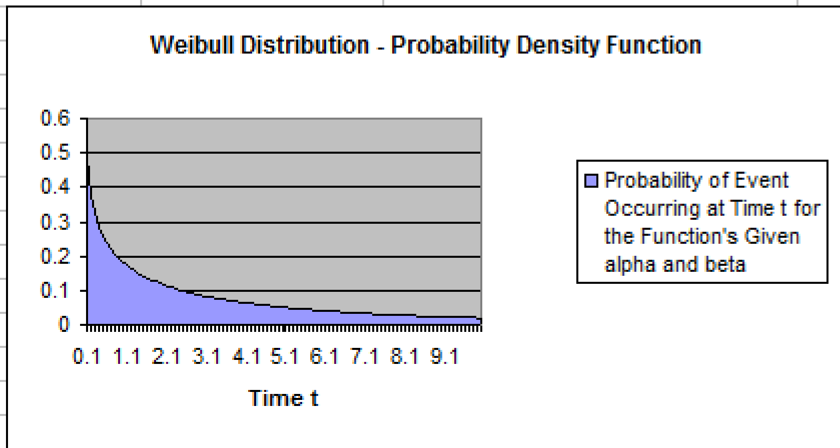
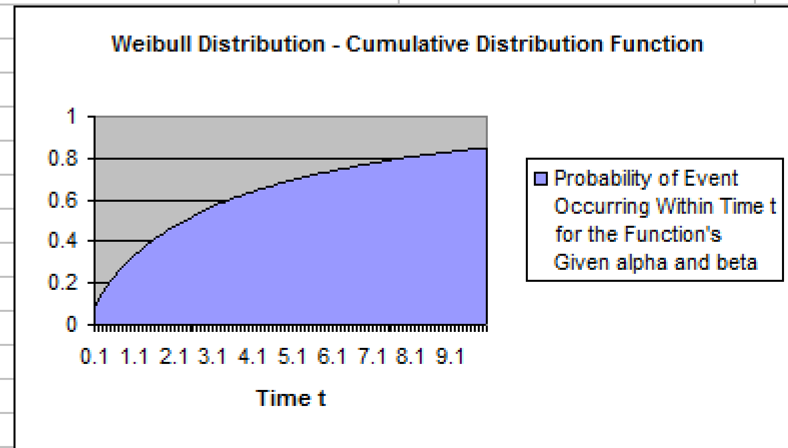
Weibull Distribution
Probability Density Function and Cumulative Distribution Function





0.7	= α = Shape Parameter (User Input)
4	= β = Scale parameter (User Input)

α > 1 --> Failure rate increases over time (suggests "wear out")
α = 1 --> Constant failure rate - Items fail from random events
α < 1 --> Failure rate decreases over time (suggest high "infant mortality")

To create the columns of data below which are the inputs for the graph and change when new data is typed into the user inputs above, copy the given formulas below into the designated cells, then copy the formula down the column by simply dragging the formula down the column:

C40 = WEIBULL(B41,$B$21,$B$23,TRUE)

D40 = WEIBULL(B41,$B$21,$B$23,FALSE)

	A	B	C	D
33				
34		C40 = WEIBULL(B41,$B$21,$B$23,TRUE)		
35				
36		D40 = WEIBULL(B41,$B$21,$B$23,FALSE)		
37				
38				
39		t	Cumulative Distribution Function	Probability Density Function
40		0.1	0.072818837	0.490705184
41		0.2	0.115579634	0.380194458
42		0.3	0.150522138	0.323349158
43		0.4	0.180881266	0.28601243
44		0.5	0.208050972	0.2586201
45		0.6	0.23280248	0.237201735
46		0.7	0.255622506	0.219745438
47		0.8	0.276844728	0.205097613
48		0.9	0.296711384	0.192538188
49		1	0.31540588	0.181588864
50		1.1	0.333071621	0.171916451
51		1.2	0.349823634	0.163279947
52		1.3	0.365756104	0.155499622
53		1.4	0.380947482	0.148438012
54		1.5	0.395464059	0.141987723
55		1.6	0.409362538	0.136063313
56		1.7	0.422691936	0.130595735
57		1.8	0.435495017	0.125528423
58		1.9	0.447809391	0.120814478
59		2	0.459668375	0.116414596
60		2.1	0.471101665	0.112295527
61		2.2	0.48213589	0.108428901
62		2.3	0.492795044	0.104790324
63		2.4	0.50310085	0.101358676
64		2.5	0.51307306	0.098115551
65		2.6	0.522729704	0.095044819
66		2.7	0.532087295	0.092132266

	A	B	C	D
66		2.7	0.532087295	0.092132266
67		2.8	0.541161009	0.089365307
68		2.9	0.549964835	0.086732746
69		3	0.558511704	0.084224582
70		3.1	0.566813598	0.081831847
71		3.2	0.574881651	0.079546468
72		3.3	0.582726227	0.077361156
73		3.4	0.590356997	0.075269306
74		3.5	0.597783003	0.073264915
75		3.6	0.605012712	0.071342515
76		3.7	0.612054071	0.069497107
77		3.8	0.618914547	0.067724115
78		3.9	0.625601168	0.066019336
79		4	0.632120559	0.064378902
80		4.1	0.638478974	0.062799249
81		4.2	0.644682325	0.061277081
82		4.3	0.650736205	0.059809349
83		4.4	0.656645914	0.058393225
84		4.5	0.662416482	0.057026081
85		4.6	0.668052682	0.055705472
86		4.7	0.673559052	0.054429121
87		4.8	0.67893991	0.0531949
88		4.9	0.68419937	0.052000823
89		5	0.689341351	0.050845028
90		5.1	0.694369593	0.049725774
91		5.2	0.699287669	0.048641424
92		5.3	0.70409899	0.047590441
93		5.4	0.708806821	0.046571381
94		5.5	0.713414285	0.045582882
95		5.6	0.717924373	0.044623661
96		5.7	0.722339953	0.043692509
97		5.8	0.726663772	0.042788281
98		5.9	0.73089847	0.041909898
99		6	0.735046579	0.041056337
100		6.1	0.739110533	0.040226629
101		6.2	0.74309267	0.039419856
102		6.3	0.74699524	0.038635147
103		6.4	[illegible]	[illegible]

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	A	B	C	D
102		6.3	0.74699524	0.038635147
103		6.4	0.750820407	0.037871676
104		6.5	0.754570256	0.037128656
105		6.6	0.758246795	0.036405341
106		6.7	0.761851958	0.03570102
107		6.8	0.76538761	0.035015015
108		6.9	0.76885555	0.034346682
109		7	0.772257515	0.033695406
110		7.1	0.77559518	0.033060599
111		7.2	0.778870165	0.032441703
112		7.3	0.782084033	0.031838181
113		7.4	0.785238296	0.031249521
114		7.5	0.788334416	0.030675236
115		7.6	0.791373807	0.030114857
116		7.7	0.794357836	0.029567935
117		7.8	0.797287828	0.029034041
118		7.9	0.800165065	0.028512765
119		8	0.802990789	0.028003711
120		8.1	0.805766202	0.027506501
121		8.2	0.808492471	0.027020771
122		8.3	0.811170727	0.026546174
123		8.4	0.813802066	0.026082374
124		8.5	0.816387551	0.025629049
125		8.6	0.818928215	0.02518589
126		8.7	0.821425058	0.024752598
127		8.8	0.823879054	0.024328888
128		8.9	0.826291146	0.023914483
129		9	0.828662252	0.023509119
130		9.1	0.830993262	0.023112538
131		9.2	0.833285044	0.022724496
132		9.3	0.835538438	0.022344754
133		9.4	0.837754264	0.021973082
134		9.5	0.839933316	0.021609261
135		9.6	0.84207637	0.021253076
136		9.7	0.844184179	0.020904322
137		9.8	0.846257476	0.020562799
138		9.9	0.848296974	0.020228316
139		10	0.850303367	0.019900687

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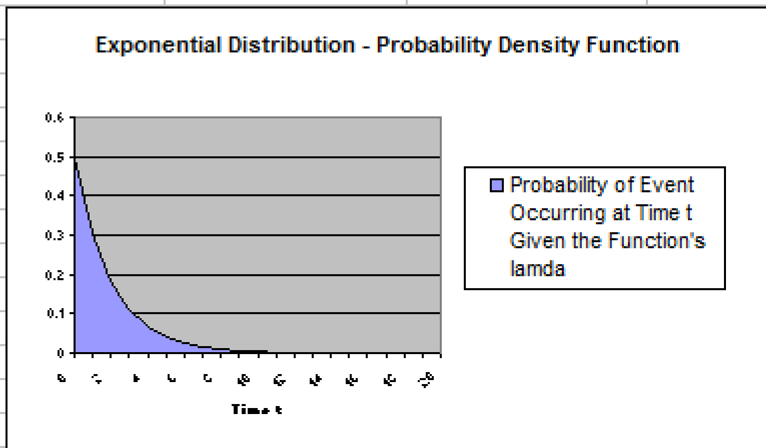
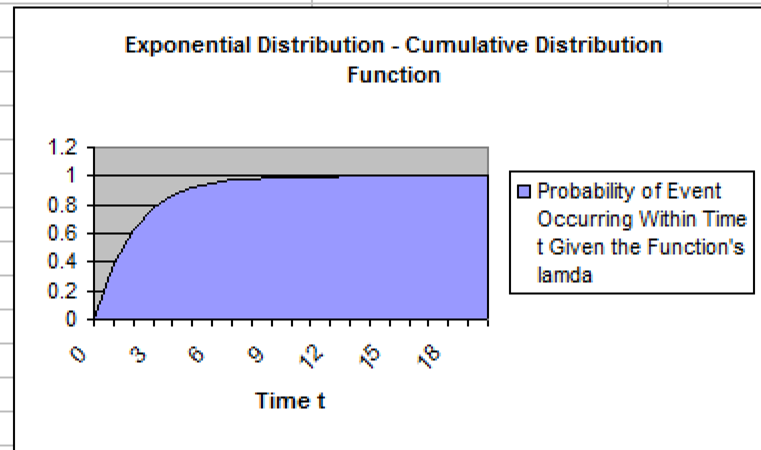
Exponential Distribution

Probability Density Function and Cumulative Distribution Function





0.5 = λ "lambda" (User Input)

To create the columns of data below which are the inputs for the graph and change when new data is typed into the user inputs above, copy the given formulas below into the designated cells, then copy the formula down the column by simply dragging the formula down the column:

C33 =EXPONDIST(B33,$B$20,TRUE)

D33 =EXPONDIST(B33,$B$20,FALSE)

t	Cumulative Distribution Function	Probability Density Function
0	0	0.5
1	0.39346934	0.30326533
2	0.632120559	0.183939721

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	A	B	C	D
26				
27		C33 =EXPONDIST(B33,$B$20,TRUE)		
28				
29		D33 =EXPONDIST(B33,$B$20,FALSE)		
30				
31				
32		t	Cumulative Distribution Function	Probability Density Function
33		0	0	0.5
34		1	0.39346934	0.30326533
35		2	0.632120559	0.183939721
36		3	0.77686984	0.11156508
37		4	0.864664717	0.067667642
38		5	0.917915001	0.041042499
39		6	0.950212932	0.024893534
40		7	0.969802617	0.015098692
41		8	0.981684361	0.009157819
42		9	0.988891003	0.005554498
43		10	0.993262053	0.003368973
44		11	0.995913229	0.002043386
45		12	0.997521248	0.001239376
46		13	0.998496561	0.00075172
47		14	0.999088118	0.000455941
48		15	0.999446916	0.000276542
49		16	0.999664537	0.000167731
50		17	0.999796532	0.000101734
51		18	0.99987659	6.17049E-05
52		19	0.999925148	3.74259E-05
53		20	0.9999546	2.27E-05
54				
55				

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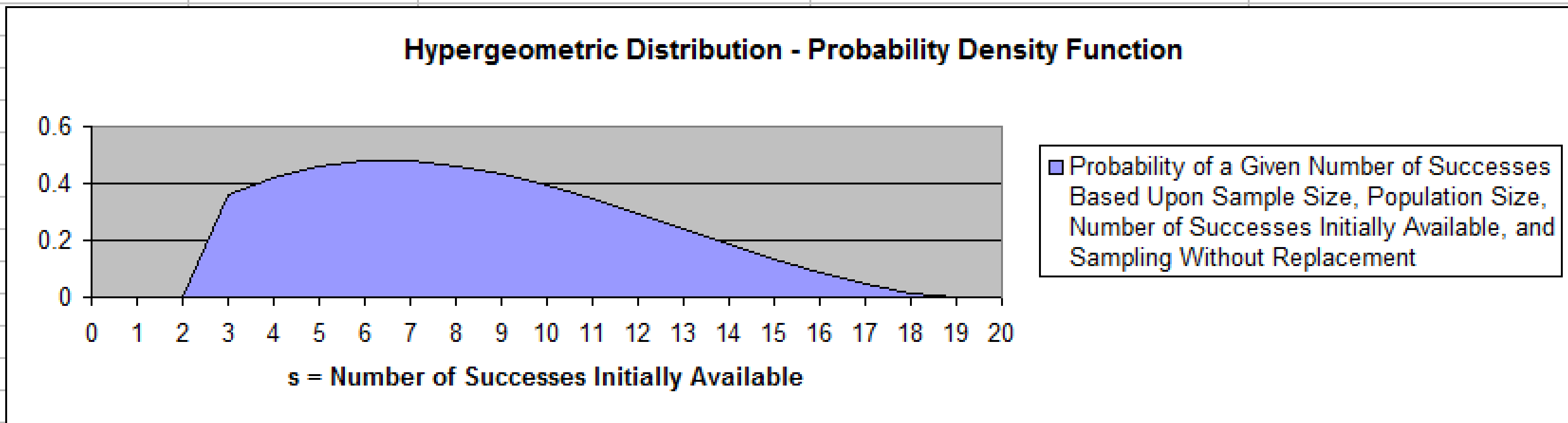
	A	B	C	D
1				
2				
3			**Hypergeometric Distribution**	
4			**Probability Density Function**	



	A	B	C
21		1	= Successes_Sample (User Input)
22			
23		3	= Sample Size (User Input)
24			
25		20	= Population Size (User Input)
26			

To create the columns of data below which are the inputs for the graph and change when new data is typed into the user inputs above, copy the given formulas below into the designated cells, then copy the formula down the column by simply dragging the formula down the column:

C36 =IF($B$23>B36,0,IF(B36>($B$25-$B$23+$B$21),0,HYPGEOMDIST($B$21,$B$23,B36,$B$25)))

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	A	B	C	D	E	F	G
20							
21		1	= Successes_Sample (User Input)				
22							
23		3	= Sample Size (User Input)				
24							
25		20	= Population Size (User Input)				
26							
27		To create the columns of data below which are the inputs for the graph					
28		and change when new data is typed into the user inputs above, copy the					
29		given formulas below into the designated cells, then copy the formula					
30		down the column by simply dragging the formula down the column:					
31							
32		C36 =IF($B$23>B36,0,IF(B36>($B$25-$B$23+$B$21),0,HYPGEOMDIST($B$21,$B$23,B36,$B$25)))					
33							
34							
35		s = Number of Successes Initially Available	Probability Density Function				
36		0	0				
37		1	0				
38		2	0				
39		3	0.357894737				
40		4	0.421052632				
41		5	0.460526316				
42		6	0.478947368				
43		7	0.478947368				
44		8	0.463157895				
45		9	0.434210526				
46		10	0.394736842				
47		11	0.347368421				
48		12	0.294736842				
49		13	0.239473684				
50		14	0.184210526				
51		15	0.131578947				
52		16	0.084210526				
53		17	0.044736842				

	A	B	C
34			
35		s = Number of Successes Initially Available	Probability Density Function
36		0	0
37		1	0
38		2	0
39		3	0.357894737
40		4	0.421052632
41		5	0.460526316
42		6	0.478947368
43		7	0.478947368
44		8	0.463157895
45		9	0.434210526
46		10	0.394736842
47		11	0.347368421
48		12	0.294736842
49		13	0.239473684
50		14	0.184210526
51		15	0.131578947
52		16	0.084210526
53		17	0.044736842
54		18	0.015789474
55		19	0
56		20	0
57			
58			
59			

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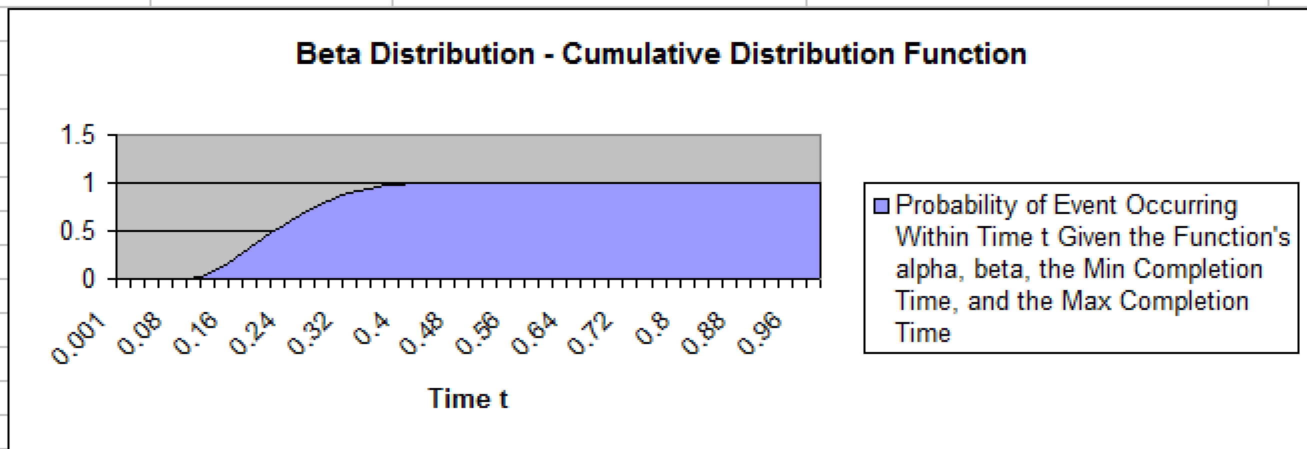
Beta Distribution
Cumulative Distribution Function



2	= α (User Input)
4	= β (User Input)
0.1	= Minimum Time of Occurrence (User Input)
0.5	= Maximum Time of Occurrence (User Input)

	A	B	C	D	E	F
21		2	= α (User Input)			
23		4	= β (User Input)			
25		0.1	= Minimum Time of Occurrence (User Input)			
27		0.5	= Maximum Time of Occurrence (User Input)			

Excel has a built-in function for the Cumulative Distribution function, but not for the Probability Density function for the Beta Distribution.

To create the columns of data below which are the inputs for the graph and change when new data is typed into the user inputs above, copy the given formulas below into the designated cells, then copy the formula down the column by simply dragging the formula down the column:

```
C40 =IF(B40<$B$25,0,IF(B40>$B$27,1,IF(B40=$B$27,1,BETADIST(B40,$B$21,$B$23,$B$25,$B$27))))
```

Row	Time t	Cumulative Distribution Function
40	0.001	0
41	0.02	0
42	0.04	0
43	0.06	0

	A	B	C	D	E	F	G
36							
37		C40 =IF(B40<$B$25,0,IF(B40>$B$27,1,IF(B40=$B$27,1,BETADIST(B40,$B$21,$B$23,$B$25,$B$27))))					
38							
39		**Time t**	**Cumulative Distribution Function**				
40		0.001	0				
41		0.02	0				
42		0.04	0				
43		0.06	0				
44		0.08	0				
45		0.1	0				
46		0.12	0.0225925				
47		0.14	0.08146				
48		0.16	0.16479				
49		0.18	0.26272				
50		0.2	0.3671875				
51		0.22	0.47178				
52		0.24	0.571585				
53		0.26	0.66304				
54		0.28	0.7437825				
55		0.3	0.8125				
56		0.32	0.86878				
57		0.34	0.91296				
58		0.36	0.9459775				
59		0.38	0.96922				

	A	B	C	
59		0.38	0.96922	
60		0.4	0.984375	
61		0.42	0.99328	
62		0.44	0.9977725	
63		0.46	0.99954	
64		0.48	0.99997	
65		0.5	1	
66		0.52	1	
67		0.54	1	
68		0.56	1	
69		0.58	1	
70		0.6	1	
71		0.62	1	
72		0.64	1	
73		0.66	1	
74		0.68	1	
75		0.7	1	
76		0.72	1	
77		0.74	1	
78		0.76	1	
79		0.78	1	
80		0.8	1	
81		0.82	1	
82		0.84	1	
83		0.86	1	
84		0.88	1	
85		0.9	1	
86		0.92	1	
87		0.94	1	
88		0.96	1	
89		0.98	1	
90		0.999	1	
91				

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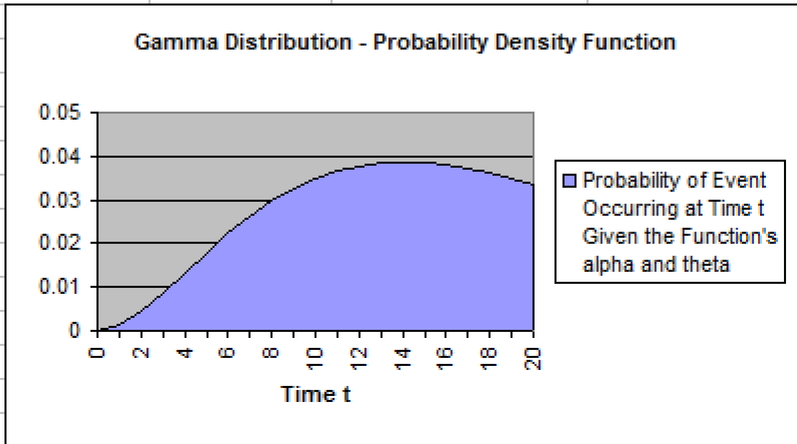
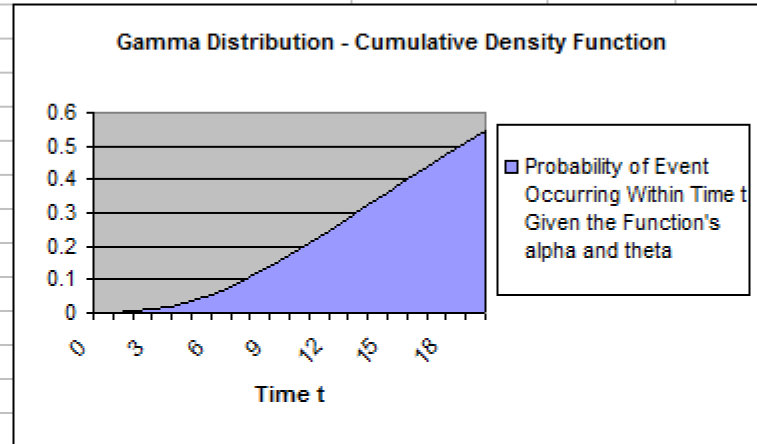
Gamma Distribution
Probability Density Function and Cumulative Distribution Function





3	= α "alpha" (User Input)
7	= Φ "theta" (User Input)

To create the columns of data below which are the inputs for the graph and change when new data is typed into the user inputs above, copy the given formulas below into the designated cells, then copy the formula down the column by simply dragging the formula down the column:

C34 =GAMMADIST(B34,$B$20,$B$22,TRUE)

D34 =GAMMADIST(B34,$B$20,$B$22,FALSE)

Time t	Cumulative Distribution Function	Probability Density Function
0	0	0

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	A	B	C	D	E
19					
20		3	= α "alpha" (User Input)		
21					
22		7	= Φ "theta" (User Input)		
23					
24		To create the columns of data below which are the inputs for the graph			
25		and change when new data is typed into the user inputs above, copy the			
26		given formulas below into the designated cells, then copy the formula			
27		down the column by simply dragging the formula down the column:			
28					
29		C34 =GAMMADIST(B34,$B$20,$B$22,TRUE)			
30					
31		D34 =GAMMADIST(B34,$B$20,$B$22,FALSE)			
32					
33		Time t	Cumulative Distribution Function	Probability Density Function	
34		0	0	0	
35		1	0.000436707	0.00126367	
36		2	0.003142366	0.004381792	
37		3	0.009546739	0.008546577	
38		4	0.020386931	0.013171268	
39		5	0.03590265	0.017840439	
40		6	0.055986935	0.022270295	
41		7	0.080301396	0.026277103	
42		8	0.108363299	0.029752215	
43		9	0.139610415	0.032642415	
44		10	0.173448462	0.034934553	
45		11	0.20928496	0.036643631	
46		12	0.246552567	0.037803634	
47		13	0.284724454	0.038460568	
48		14	0.32332358	0.038667224	
49		15	0.361927383	0.038479318	
50		16	0.400169336	0.037952706	
51		17	0.437737943	0.037141425	
52		18	0.474374296	0.03609638	
53		19	0.509868486	0.034864527	
54		20	0.544055318	0.033488408	
55					