Arius®

Deterministic Exhibit Statistics

Milliman

IT TAKES VISION

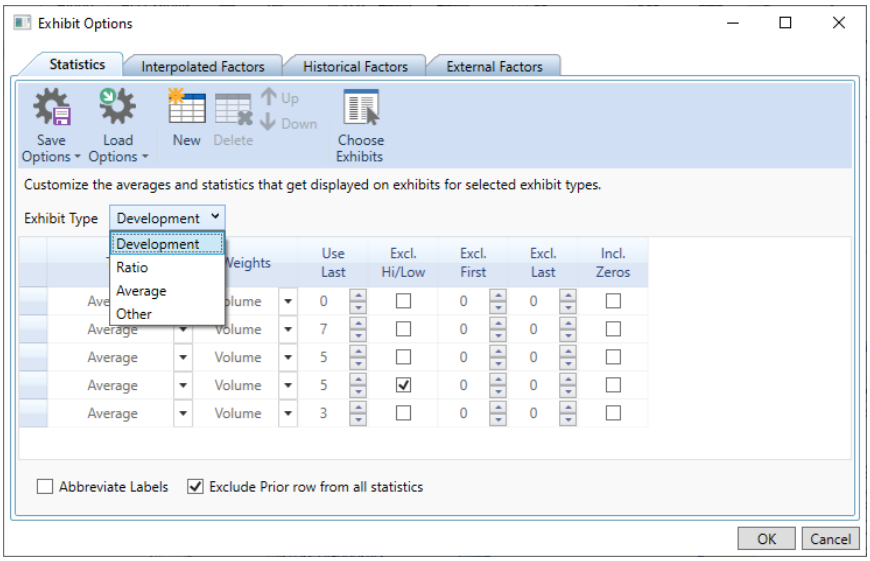
Milliman, Inc.
3424 Peachtree Road NE, Suite 1900
Atlanta GA 30326 USA

Tel +1 800 404 2276
Fax +1 404 237 6984

ActuarialSoftware.com

Deterministic Exhibit Statistics

Arius calculates a number of different types of statistics to help you analyze and understand your data. These calculations are associated directly with the Exhibit table types and fall into two categories: exhibit statistics and weighting methods. These are defined by clicking on the Exhibit Options icon on the main ribbon.



Arius recognizes that you may want to use different statistics (e.g., averages vs. linear trends) on different types of exhibits (e.g., development exhibits vs. ratio exhibits). Statistics can be appended to any of the four exhibit types (Development, Ratio, Average, Other). If you included a Prior row in your analysis, you can optionally set all statistics to ignore that row.

EXHIBIT TYPES

To define a new statistic for your exhibits, first identify the type of exhibit for which you are specifying statistics.

- **Development** - typical of chain-ladder or age-to-age methods, where each cumulative amount is divided by the preceding cumulative amount on the same row of the same triangle
- **Ratio** - Each cell of the triangle is divided by the corresponding cell of another triangle (other than average calculations noted below); for example, Cumulative Paid Loss to Cumulative Incurred Loss
- **Average** - Each cell of an amount ($, €, £, etc.) triangle is divided by the corresponding cell of a count type triangle (closed claims, earned exposure units, etc.); for example, Cumulative Paid Loss per Cumulative Closed Claims (average paid loss)
- **Other** - one triangle compared to corresponding cells of another that are not typically ratios or averages as defined above; examples include Cumulative Paid Loss to Ultimate Loss and Case Loss Reserves to Indicated Loss Reserves

TYPE OF STATISTIC ROW

Next, specify what type of statistic row you want to calculate and append to the exhibits:

- **Average** – calculated for each column giving all exposure periods equal weight, applying the following formula:

$$\sum_{i=1}^{n} X_i / n$$

  where **X** is the data element and **n** is the number of periods in each column

- **Linear Trend** – "line of best fit" is calculated down each column (from top to bottom) through a set of data points using a mathematical method that results in a straight line, applying the following least-squares formula:

$$Y = a + bX$$

  where **Y** is the data and **X** is the exposure period and

$$b = [n\sum XY - \sum X \sum Y] / [n\sum X^2 - (\sum X)^2]$$
$$a = (\sum Y - b\sum X) / n$$

- **Exponential Curve** – "line of best fit" down the column (from top to bottom) through a set of data points using a mathematical method resulting in a curved line, applying the method of least-squares where the formula:

$$Y = ae^{bx}$$

  is replaced by the linear formula:

$$\ln(Y) = \ln(a) + bx$$

OTHER LINEAR TREND AND EXPONENTIAL CURVE PARAMETERS

- **Slope and Slope Percent** – For the linear projections, Arius displays the **b** value, which is the slope of the line. It represents the period-to-period change in absolute values. For exponential projections, Arius calculates the **b** value and displays the slope percentage that is the average percentage of change occurring in the numbers between exposure periods.
- **Intercept** – For both linear and exponential projections, Arius displays the **a** value that is the intercept of the fitted line or curve. The intercept corresponds to the Y-value on the fitted line or curve at x = 0 (the period preceding the first exposure period).
- **Projected** – For both the linear and exponential projections, Arius displays a projected value. The projected value corresponds to the Y-value on the fitted line or curve at x = n + 1 (the next exposure period at the stage of development).
- **R-squared** – Arius calculates the R-squared, or coefficient of determination, for each column of numbers on an exhibit. This statistic indicates how good the fit of the line or curve is to the data points. As a general rule, an R-squared of zero implies a poor fit of the line or curve to the data and an R-squared of one implies a perfect fit over time. Note, however, that since you can't always expect the numbers in a column to change systematically over time, a low R-squared (<

approximately .80) isn't necessarily bad and doesn't always indicate that your data is unreliable. Alternatively, a high R-squared may not be a reliable indicator of the trend.

Arius calculates R-squared as follows:

$$[na\sum Y + nb\sum XY - (\sum Y)^2] / [n\sum Y^2 - (\sum Y)^2]$$

For the exponential curve, *ln(Y)* is substituted for **Y** and *ln(a)* is substituted for **a**.

INCLUDE/EXCLUDE TYPES OF DATA

Sometimes, to make your statistics more meaningful, it may be necessary to exclude or include certain types of data. To support this need, you may select any of the following:

- **Use Last** – This selection identifies how many of the most recent diagonals to include in the calculation. The default includes all diagonals.
- **Exclude Hi/Low** – This selection excludes the highest and lowest values in each column from the calculations. The default includes all values.
- **Exclude First** – This selection identifies how many of the earliest diagonals to exclude from the calculation. Often data from a number of years ago is not a good predictor of future activity. The default includes all diagonals.
- **Exclude Last** – This selection identifies how many of the most recent diagonals to exclude from the calculation. The default includes all diagonals.
- **Include Zeros** – This selection includes zeros in the statistics calculation. Use this option if zeros in your exhibit are legitimate amounts and this should be considered in calculating the statistics. The default excludes zeros from calculations.

In addition to the selections above, you may also exclude individual development factors from the statistics. You can easily exclude a specific factor, a row of factors, or other subset of factors from the statistics by highlighting the factors directly on the triangle of the exhibit, right-clicking, and selecting **Exclude Factor(s) from Statistics**. As an example, if you exclude a factor that would otherwise be included in a three-year average, that average would now be calculated using the remaining two balances.

Note: The **Exclude Factor(s) from Statistics** command is executed *before* the **Exclude High/Low** command. So, for example, if you manually exclude the highest value in the column, any average that is set to exclude high/low will now exclude the second highest balance in the column.

TYPES OF WEIGHTING

Various weighting methods are available to allow you to give additional effect to different historical periods when calculating the above statistics. Weighting methods supported by Arius include:

- **None** – indicating no weighting method applied
- **Volume** – applies the greatest weight to the development factor in a column with the largest volume of data. Used with development exhibits only. The following formula is used:

$$\sum_{i=1}^{N} w_i X_i \Big/ \sum_{i=1}^{n} w_i$$

  where **X** is the development factor, **w** is the denominator used in the calculation of the development factor, and **n** is the number of periods in each column. This average is equivalent to producing a development factor by dividing the sum of one column of losses or claim counts by the sum of the corresponding elements in the previous column.

- **Time** – assigns the greatest weight to the most recent exposure period with the following formula:

$$\sum_{i=1}^{N} w_i X_i \Big/ \sum_{i=1}^{n} w_i$$

  where **X** is the data element, **w** is the weight assigned in ascending order corresponding to the number of each row, and **n** is the number of periods in each column.

- **User** – assigns different weights to the numbers in a column by applying the corresponding elements in the *Weights* input array. The average is then calculated with the following formula:

$$\sum_{i=1}^{N} w_i X_i \Big/ \sum_{i=1}^{n} w_i$$

  where **X** is the data element, **w** is the weight in the corresponding cell (as shown in an incremental view) and **n** is the number of periods in each column.

NOTE:

When entering weights into any array, remember that no development factor exists for the latest exposure period.

CHOOSE EXHIBITS WITH STATISTICS

By default, some of the system's exhibits display statistics and others do not. For example, all development exhibits do include statistics, though many ratio exhibits do not display them. You can override this default and control which exhibits include statistics.

To add statistics to an exhibit that does not currently have them, or to remove them from an exhibit, click the **Choose Exhibits** button. You will see two lists:

- Exhibits where statistics are not displayed, and
- Exhibits where statistics are displayed.

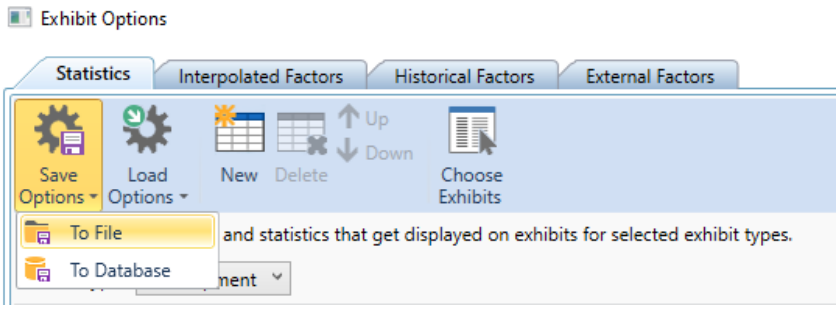
All of the system's exhibits are in one of these two lists. Use the **Show Statistics** and **Hide Statistics** buttons to move any exhibit from one list to the other. Choose **OK** when done.

Each exhibit in the right list will include the statistics calculations that are defined in the Exhibit Options dialog for that exhibit's type (development, ratio, etc.).

SAVING AND LOADING EXHIBIT OPTIONS

Once exhibit statistics are set, you have the ability to save these settings to an external file or to your Arius Enterprise Analysis database. This functionality is helpful if you want to apply similar settings across multiple Arius projects, which is done by simply loading the settings into another active project.

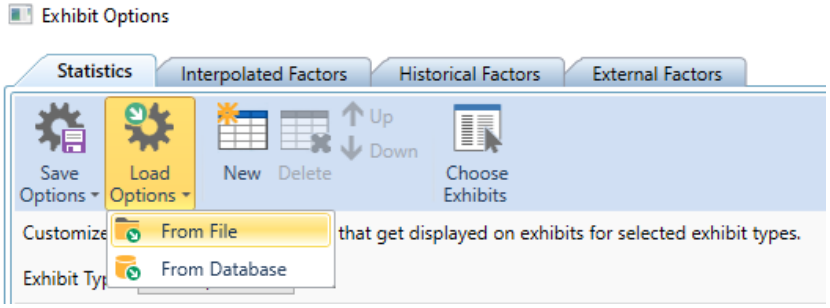
1. Select the **Save Options – To File** option from the EXHIBIT | STATISTICS window.



2. Provide a filename and location for this external file (*.exhopt) and click **OK.**

3. Open the Arius project file to which you want these same settings to apply.

4. Select **Load Options – From File** from the Exhibit Statistics window.



5. Browse to the file saved in step 2 and click **OK**. This step will replace the existing settings from both the Statistics and Interpolated Factors tab with the settings saved in the file being loaded.

   Note: Default settings are *positional*, meaning if defaults (green boxes) are displayed on the third statistic of an exhibit, changing the order or selections of the exhibit options may cause you to revisit your default selections.