Arius®

Actual versus Expected Analysis

Milliman

IT TAKES VISION

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1. Arius Actual vs. Expected Analysis Introduction

Actual vs. Expected (AvE) diagnostics in Arius provide an easy approach for highlighting the impact of loss emergence and for assessing the effectiveness of various actuarial assumptions. These tools assist in answering the questions:

- How did losses emerge as compared to expectations?
- Do selected LDFs follow patterns in the data?
- How did my methods perform relative to each other?
- What is driving change to my ultimate loss estimates?

Arius offers two different Actual vs. Expected approaches to help your analysis, the Direct and the Indirect.

- **The Direct Approach**

  The Arius Direct approach to AvE calculates the expected amounts based on the prior development factors from a particular method and compares to actual current results, examining the assumptions of the particular method and how that method performed. There is a Direct Actual vs. Expected analysis corresponding to every standard development method within Arius.

- **The Indirect Approach**

  The Arius Indirect approach to AvE calculates the expected amounts using the prior indicated reserves, examining how the selected ultimate performed over the period. The Indirect approach is available for select methods from two perspectives.

  - Prior selections are used to calculate expected amounts.
  - Prior implied patterns of development are selected to calculate expected amounts.

  NOTE: To use implied patterns of development, you must make selections in the appropriate exhibit before appending a new diagonal. For example, you would make selections in the **Ratio of Cumulative Paid Loss to Ultimate Loss** exhibit in the case of the **Paid Loss Development** method. (You would use the similarly named corresponding exhibit for your chosen development method.)

Both the **Direct** and **Indirect** approaches can be used when comparing full periods or partial periods where interpolation is activated. Actual vs. Expected analysis can be particularly useful for early analysis mid-period when projecting end-of-period results, and for a quick rollforward at period-end when actual data becomes available and assumptions can be quickly verified. (See the section *The Direct Approach* for instructions on how to save SDFs from your mid-period analysis.)

Arius provides reports to calculate the $ and % change from expected, comparisons of Actual vs. Expected results based on method, and customizable graphing capabilities for each report.

These methods can be found in the respective development method collections in the **Collection Library**. If you have customized your development method collections, you may need to add these AvE tables to your collections from the **Object Library**; the system will not automatically add these to your customized collections. (See the section *Where to Find Actual vs. Expected Objects and Collections* below, or the *Collections* document on our *User Documentation* page.)

2. The Direct Approach

The **Direct** approach to Actual vs. Expected is more diagnostic in nature, focusing on testing the assumptions of each development method. This exhibit focuses on your last two diagonals of data and comparing each method's analysis and selections from the prior diagonal with the actual results reflected in the current diagonal.

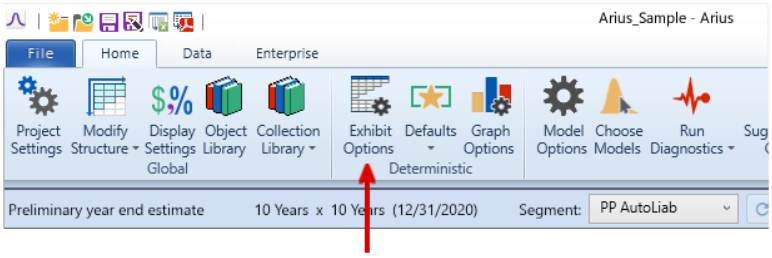
Using Paid Loss as an example, the Direct approach to AvE calculates expected paid loss for the current period by taking the last period's cumulative Paid Loss and applying an expected incremental development factor based on your prior period's selected Paid Loss Development factors. Expected Paid Loss is then compared to actual Paid Loss from the current period data, diagnostically answering the question:

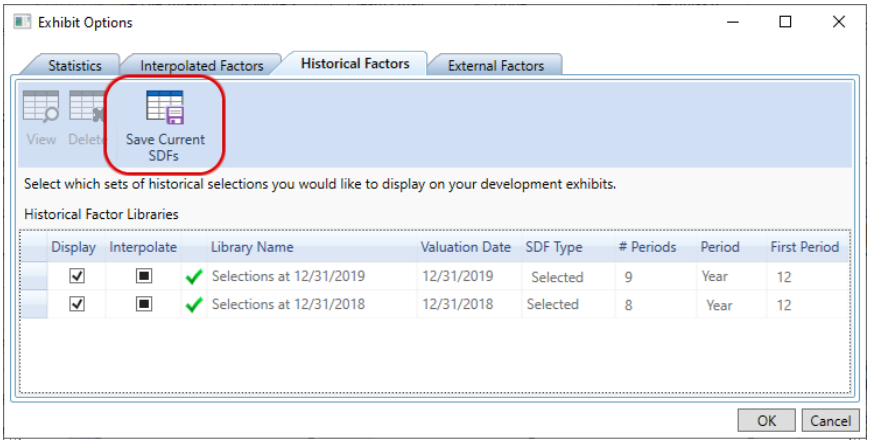
- How did my prior period selected Paid Loss development factors perform in predicting my current period Paid Loss?

For each development method this difference in AvE is stated as a percentage of Prior Ultimate Loss, providing a consistent benchmark across all the different development methods.

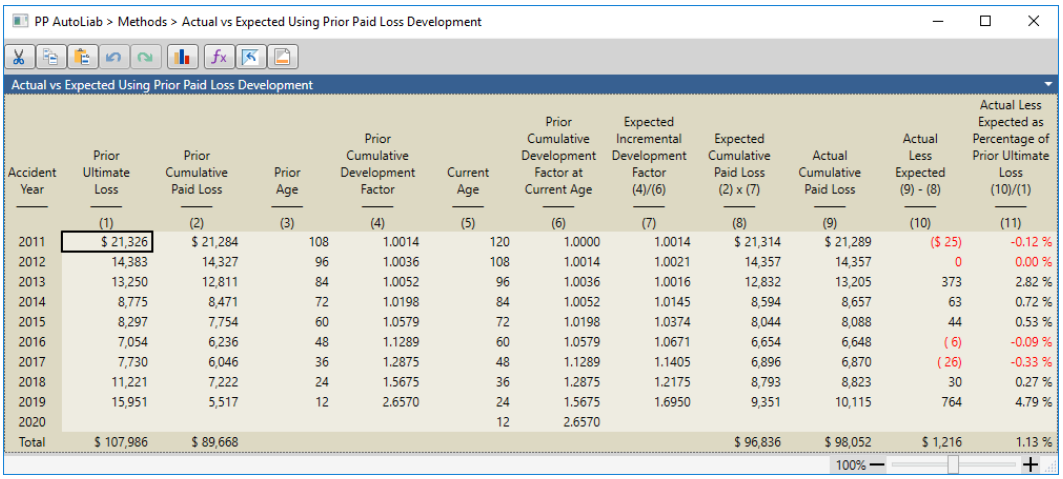
Your current selected factors are captured—i.e., become prior selections—when a new diagonal is appended to this project, and these factors are stored by Arius as prior period values. The Direct AvE methods and reports will populate when you have completed at least one prior period analysis, appended the next period's diagonal, and entered current period data in the new diagonal.

Note: For a mid-period analysis you must manually save your Selected Development Factors (SDFs) as *prior* through **Exhibit Options** (found on the **Home** ribbon). This is necessary because you will not add a new diagonal between mid-period and end-period analyses, and thus the factors are not otherwise automatically stored as prior data.





This is an example of the Direct approach.



PP AutoLiab > Methods > Actual vs Expected Using Prior Paid Loss Development

Actual vs Expected Using Prior Paid Loss Development

Accident Year	Prior Ultimate Loss	Prior Cumulative Paid Loss	Prior Age	Prior Cumulative Development Factor	Current Age	Prior Cumulative Development Factor at Current Age	Expected Incremental Development Factor (4)/(6)	Expected Cumulative Paid Loss (2) x (7)	Actual Cumulative Paid Loss	Actual Less Expected (9) - (8)	Actual Less Expected as Percentage of Prior Ultimate Loss (10)/(1)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
2011	$ 21,326	$ 21,284	108	1.0014	120	1.0000	1.0014	$ 21,314	$ 21,289	($ 25)	-0.12 %
2012	14,383	14,327	96	1.0036	108	1.0014	1.0021	14,357	14,357	0	0.00 %
2013	13,250	12,811	84	1.0052	96	1.0036	1.0016	12,832	13,205	373	2.82 %
2014	8,775	8,471	72	1.0198	84	1.0052	1.0145	8,594	8,657	63	0.72 %
2015	8,297	7,754	60	1.0579	72	1.0198	1.0374	8,044	8,088	44	0.53 %
2016	7,054	6,236	48	1.1289	60	1.0579	1.0671	6,654	6,648	(6)	-0.09 %
2017	7,730	6,046	36	1.2875	48	1.1289	1.1405	6,896	6,870	(26)	-0.33 %
2018	11,221	7,222	24	1.5675	36	1.2875	1.2175	8,793	8,823	30	0.27 %
2019	15,951	5,517	12	2.6570	24	1.5675	1.6950	9,351	10,115	764	4.79 %
2020					12	2.6570					
Total	$ 107,986	$ 89,668						$ 96,836	$ 98,052	$ 1,216	1.13 %

100%

3. The Indirect Approach

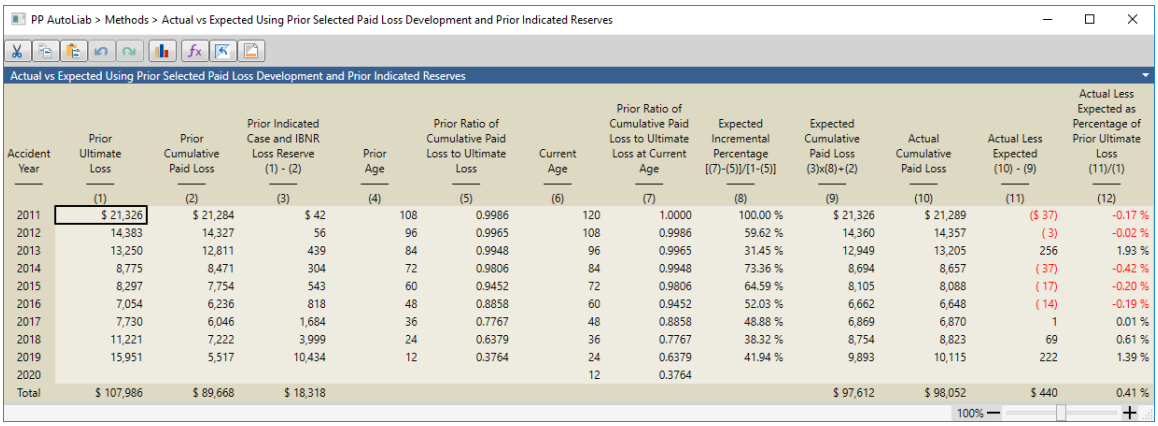
In the **Indirect** approach, expected values are calculated as a function of prior indicated reserves, thereby testing the development methods relatively, as opposed to the Direct approach which focuses on testing a specific development method's selections and assumptions independent of other development methods. The Indirect approach is offered based on two different strategies. One strategy relies on prior *selected* development factors whereas the other strategy relies on prior *implied* development factors.

The Indirect approach to AvE analysis answers two questions:

- How did my Selected Ultimates perform relative to Paid Loss and Incurred Loss emergence?
- How did each development method perform relative to all other development methods?

AvE RELYING ON PRIOR SELECTED DEVELOPMENT FACTORS

(Refer to *The Direct Approach* section above for details about how prior period values and factors are defined and captured.)


PP AutoLiab > Methods > Actual vs Expected Using Prior Selected Paid Loss Development and Prior Indicated Reserves

Actual vs Expected Using Prior Selected Paid Loss Development and Prior Indicated Reserves

Accident Year	Prior Ultimate Loss	Prior Cumulative Paid Loss	Prior Indicated Case and IBNR Loss Reserve (1) - (2)	Prior Age	Prior Ratio of Cumulative Paid Loss to Ultimate Loss	Current Age	Prior Ratio of Cumulative Paid Loss to Ultimate Loss at Current Age	Expected Incremental Percentage [(7)-(5)]/[1-(5)]	Expected Cumulative Paid Loss (3)x(8)+(2)	Actual Cumulative Paid Loss	Actual Less Expected (10) - (9)	Actual Less Expected as Percentage of Prior Ultimate Loss (11)/(1)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
2011	$ 21,326	$ 21,284	$ 42	108	0.9986	120	1.0000	100.00 %	$ 21,326	$ 21,289	($ 37)	-0.17 %
2012	14,383	14,327	56	96	0.9965	108	0.9986	59.62 %	14,360	14,357	(3)	-0.02 %
2013	13,250	12,811	439	84	0.9948	96	0.9965	31.45 %	12,949	13,205	256	1.93 %
2014	8,775	8,471	304	72	0.9806	84	0.9948	73.36 %	8,694	8,657	(37)	-0.42 %
2015	8,297	7,754	543	60	0.9452	72	0.9806	64.59 %	8,105	8,088	(17)	-0.20 %
2016	7,054	6,236	818	48	0.8858	60	0.9452	52.03 %	6,662	6,648	(14)	-0.19 %
2017	7,730	6,046	1,684	36	0.7767	48	0.8858	48.88 %	6,869	6,870	1	0.01 %
2018	11,221	7,222	3,999	24	0.6379	36	0.7767	38.32 %	8,754	8,823	69	0.61 %
2019	15,951	5,517	10,434	12	0.3764	24	0.6379	41.94 %	9,893	10,115	222	1.39 %
2020						12	0.3764					
Total	$ 107,986	$ 89,668	$ 18,318						$ 97,612	$ 98,052	$ 440	0.41 %

100%

Using Paid Loss as an example, this analysis uses the prior period selected Paid Loss Development factors to estimate the current period's cumulative Paid Loss, where calculation of expected current Paid Loss is a function of the prior period *selected* ultimate outstanding loss. This answers the additional question:

- How did my prior period selected development factors perform relative to all other development method selected development factors in the prior period?

(NOTE: Using Paid Loss as an example, if 100% weight had been given to the **Paid Loss Development** method in selecting the prior Ultimate Loss estimate, the results from this analysis will be identical to the Direct analysis of expected Paid Loss emergence.)

The **Expected Cumulative Paid Loss** column (9) can be referenced in the formula editor.

AvE RELYING ON PRIOR IMPLIED DEVELOPMENT FACTORS

PP AutoLiab > Methods > Actual vs Expected Using Prior Implied Paid Loss Development and Prior Indicated Reserves

Actual vs Expected Using Prior Implied Paid Loss Development and Prior Indicated Reserves

Accident Year	Prior Ultimate Loss	Prior Cumulative Paid Loss	Prior Indicated Case and IBNR Loss Reserve (1) - (2)	Prior Age	Prior Ratio of Cumulative Paid Loss to Ultimate Loss	Current Age	Prior Ratio of Cumulative Paid Loss to Ultimate Loss at Current Age	Expected Incremental Percentage [(7)-(5)]/[1-(5)]	Expected Cumulative Paid Loss (3)x(8)+(2)	Actual Cumulative Paid Loss	Actual Less Expected (10) - (9)	Actual Less Expected as Percentage of Prior Ultimate Loss (11)/(1)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
2011	$ 21,326	$ 21,284	$ 42	108	0.9973	120	0.9981	26.52 %	$ 21,295	$ 21,289	($ 6)	-0.03 %
2012	14,383	14,327	56	96	0.9947	108	0.9973	50.04 %	14,355	14,357	2	0.02 %
2013	13,250	12,811	439	84	0.9847	96	0.9947	65.35 %	13,098	13,205	107	0.81 %
2014	8,775	8,471	304	72	0.9705	84	0.9847	48.17 %	8,617	8,657	40	0.45 %
2015	8,297	7,754	543	60	0.9341	72	0.9705	55.18 %	8,054	8,088	34	0.42 %
2016	7,054	6,236	818	48	0.8758	60	0.9341	46.91 %	6,620	6,648	28	0.40 %
2017	7,730	6,046	1,684	36	0.7727	48	0.8758	45.36 %	6,810	6,870	60	0.78 %
2018	11,221	7,222	3,999	24	0.6292	36	0.7727	38.71 %	8,770	8,823	53	0.47 %
2019	15,951	5,517	10,434	12	0.3603	24	0.6292	42.03 %	9,903	10,115	212	1.33 %
2020						12	0.3603					
Total	$ 107,986	$ 89,668	$ 18,318						$ 97,522	$ 98,052	$ 530	0.49 %

This analysis is identical to the Indirect approach to AvE which relies on prior selected development factors with the exception of columns 5 and 7 (**Prior Ratio of Paid Loss to Ultimate Loss**).

The *implied* ratios referenced in columns 5 and 7 of the Indirect approach are based on historical selections from the exhibit shown below which calculates ratios of cumulative paid loss to ultimate loss.

PP AutoLiab > Exhibits > Cumulative Paid Loss to Ultimate Loss

Ratio of Cumulative Paid Loss to Ultimate Loss

Accident Year	12	24	36	48	60	72	84	96	108	120
2011	0.3501	0.5883	0.7343	0.8594	0.9277	0.9668	0.9870	0.9882	0.9903	0.9905
2012	0.3648	0.6361	0.7638	0.8752	0.9323	0.9753	0.9830	0.9853	0.9873	
2013	0.3270	0.5878	0.7081	0.8436	0.9207	0.9432	0.9539	0.9833		
2014	0.3232	0.6223	0.7826	0.8933	0.9127	0.9515	0.9724			
2015	0.3056	0.6431	0.7601	0.8536	0.9211	0.9608				
2016	0.3760	0.5994	0.7510	0.8713	0.9288					
2017	0.3910	0.6290	0.7709	0.8760						
2018	0.3465	0.6343	0.7749							
2019	0.3640	0.6674								
2020	0.3994									
Average	0.3548	0.6231	0.7557	0.8675	0.9239	0.9595	0.9741	0.9856	0.9888	0.9905
7 Year Average	0.3579	0.6262	0.7588	0.8675	0.9239	0.9595	0.9741	0.9856	0.9888	0.9905
5 Year Average	0.3754	0.6347	0.7679	0.8676	0.9231	0.9595	0.9741	0.9856	0.9888	0.9905
3 Year Average	0.3700	0.6436	0.7656	0.8670	0.9209	0.9518	0.9698	0.9856	0.9888	0.9905
1 Year Average	0.3994	0.6674	0.7749	0.8760	0.9288	0.9608	0.9724	0.9833	0.9873	0.9905
Selections at 12/31/2019	0.3603	0.6292	0.7727	0.8758	0.9341	0.9705	0.9847	0.9947	0.9973	
Default	0.3994	0.6674	0.7749	0.8760	0.9288	0.9608	0.9724	0.9833	0.9873	0.9905
Manual Selected										
Selected	0.3994	0.6674	0.7749	0.8760	0.9288	0.9608	0.9724	0.9833	0.9873	0.9905

This variation of the Indirect approach using implied development factors can be more helpful where historical selections may not be reliable when viewed individually.

IMPORTANT NOTE: To use the Indirect approach to AvE using Implied Development Factors, selections must be made in the appropriate exhibit before appending a new diagonal. For example, you would make selections in the **Ratio of Cumulative Paid Loss to Ultimate Loss** exhibit (shown above) in the case of the **Paid Loss Development** method. You will make selections from the similarly named corresponding exhibit for your chosen development method.

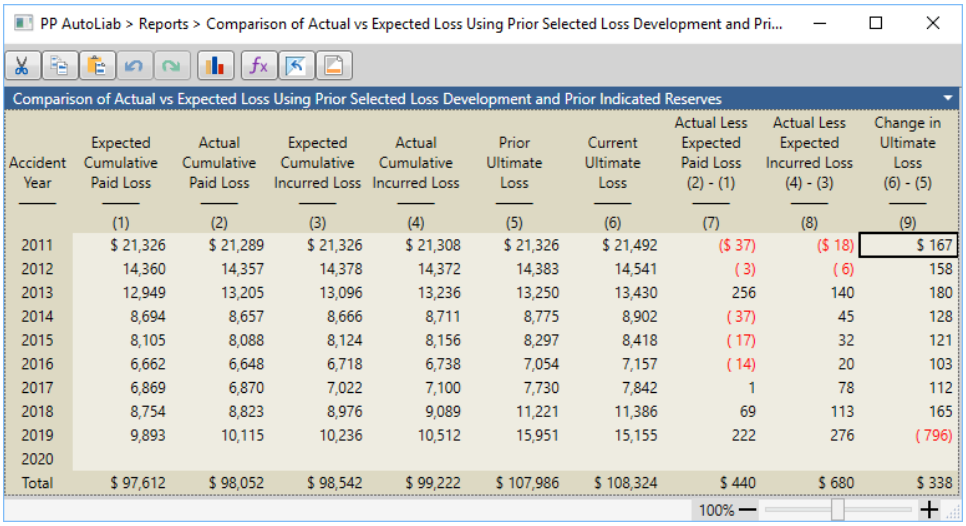
- These selections must be made for the current period before appending the next period diagonal to establish prior selections for this exhibit for future analysis. This should be included as a standard step in your analysis each development period.

To determine the source of a ratio column, click in the column and choose the **Source Data** icon  from the **Exhibit** ribbon (or right-click in the column and select **Source Data** from the list).

4. Reports

Comparison of AvE Using Prior Selected Development and Prior Indicated Reserves

These reports, available for several data elements, compare results of AvE Using Prior *Selected* Development and Prior Indicated Reserves, resulting in a final column Change in Ultimate. For example, the following report compares paid and incurred loss results.


PP AutoLiab > Reports > Comparison of Actual vs Expected Loss Using Prior Selected Loss Development and Pri...

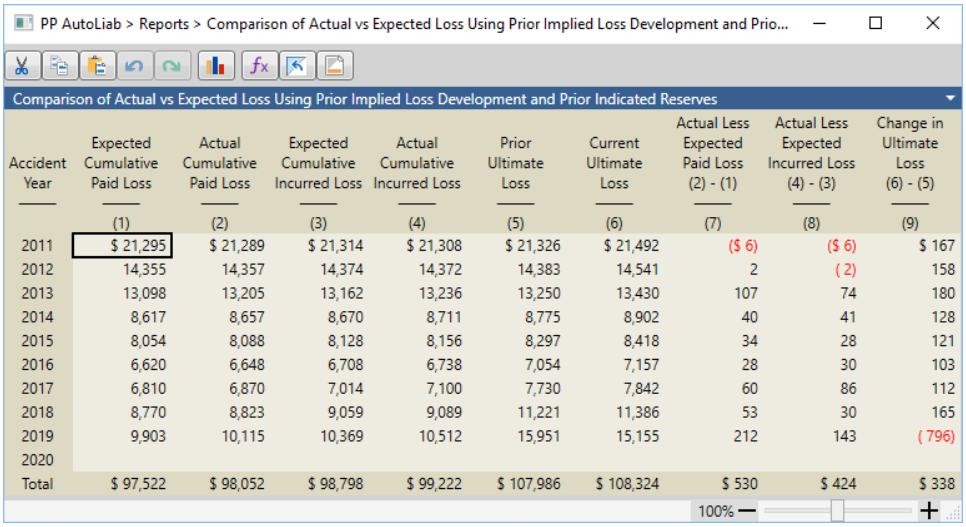
Comparison of Actual vs Expected Loss Using Prior Selected Loss Development and Prior Indicated Reserves

Accident Year	Expected Cumulative Paid Loss	Actual Cumulative Paid Loss	Expected Cumulative Incurred Loss	Actual Cumulative Incurred Loss	Prior Ultimate Loss	Current Ultimate Loss	Actual Less Expected Paid Loss (2) - (1)	Actual Less Expected Incurred Loss (4) - (3)	Change in Ultimate Loss (6) - (5)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
2011	$ 21,326	$ 21,289	$ 21,326	$ 21,308	$ 21,326	$ 21,492	($ 37)	($ 18)	$ 167
2012	14,360	14,357	14,378	14,372	14,383	14,541	(3)	(6)	158
2013	12,949	13,205	13,096	13,236	13,250	13,430	256	140	180
2014	8,694	8,657	8,666	8,711	8,775	8,902	(37)	45	128
2015	8,105	8,088	8,124	8,156	8,297	8,418	(17)	32	121
2016	6,662	6,648	6,718	6,738	7,054	7,157	(14)	20	103
2017	6,869	6,870	7,022	7,100	7,730	7,842	1	78	112
2018	8,754	8,823	8,976	9,089	11,221	11,386	69	113	165
2019	9,893	10,115	10,236	10,512	15,951	15,155	222	276	(796)
2020									
Total	$ 97,612	$ 98,052	$ 98,542	$ 99,222	$ 107,986	$ 108,324	$ 440	$ 680	$ 338

100%

Comparison of AvE Using Prior Implied Development and Prior Indicated Reserves

These reports, available for several data elements, compare results of AvE Using Prior *Implied* Development and Prior Indicated Reserves, resulting in a final column Change in Ultimate. For example, the following report compares paid and incurred loss results.


PP AutoLiab > Reports > Comparison of Actual vs Expected Loss Using Prior Implied Loss Development and Prio...

Comparison of Actual vs Expected Loss Using Prior Implied Loss Development and Prior Indicated Reserves

Accident Year	Expected Cumulative Paid Loss	Actual Cumulative Paid Loss	Expected Cumulative Incurred Loss	Actual Cumulative Incurred Loss	Prior Ultimate Loss	Current Ultimate Loss	Actual Less Expected Paid Loss (2) - (1)	Actual Less Expected Incurred Loss (4) - (3)	Change in Ultimate Loss (6) - (5)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
2011	$ 21,295	$ 21,289	$ 21,314	$ 21,308	$ 21,326	$ 21,492	($ 6)	($ 6)	$ 167
2012	14,355	14,357	14,374	14,372	14,383	14,541	2	(2)	158
2013	13,098	13,205	13,162	13,236	13,250	13,430	107	74	180
2014	8,617	8,657	8,670	8,711	8,775	8,902	40	41	128
2015	8,054	8,088	8,128	8,156	8,297	8,418	34	28	121
2016	6,620	6,648	6,708	6,738	7,054	7,157	28	30	103
2017	6,810	6,870	7,014	7,100	7,730	7,842	60	86	112
2018	8,770	8,823	9,059	9,089	11,221	11,386	53	30	165
2019	9,903	10,115	10,369	10,512	15,951	15,155	212	143	(796)
2020									
Total	$ 97,522	$ 98,052	$ 98,798	$ 99,222	$ 107,986	$ 108,324	$ 530	$ 424	$ 338

100%

5. Where to Find Actual vs. Expected Objects and Collections

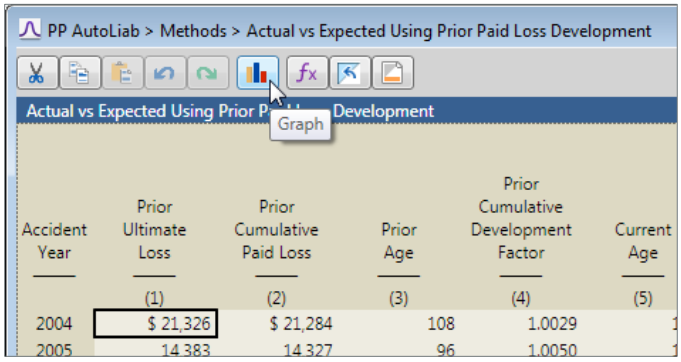
Although technically not methods, the Arius Actual vs. Expected objects are found under the **Methods** node in the **Object Library**. By classifying the Actual vs. Expected objects as methods, Arius can leverage the ability to designate one method column as the ultimate column so that this column can be referenced in formulas in other methods and reports.

There are also objects comparing results for several Actual vs. Expected approaches in the **Reports** node in the **Object Library**, in the appropriate folders.

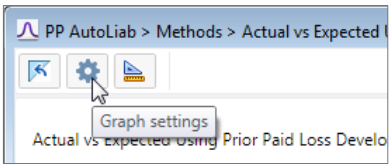
There are several Arius system collections for Actual vs. Expected objects available to enhance your diagnostic analysis. You will find these under the Navigation Pane's **Data Diagnostics** node by default, or you can add them from the Collection Library if they were not originally set up in your workflow. Collections also display samples of some of the many graphing permutations available to provide a visual representation of your analysis. A **Graph settings** icon accompanying each graph provides for quick customization. (See the next section, *Graphing the Average vs. Expected Results*.)

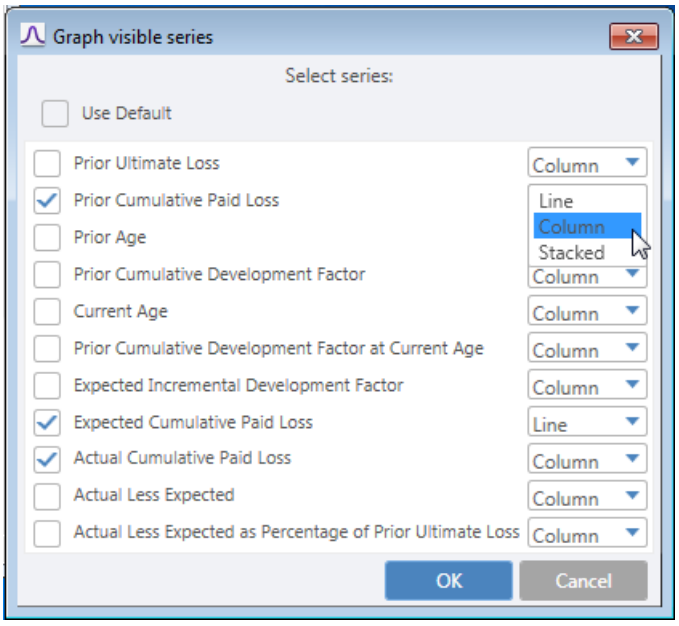
6. Graphing the Actual vs. Expected Results

Customizable graphs are available for each Actual vs. Expected method. Simply click on the Graph icon in the object ribbon to launch the graph.

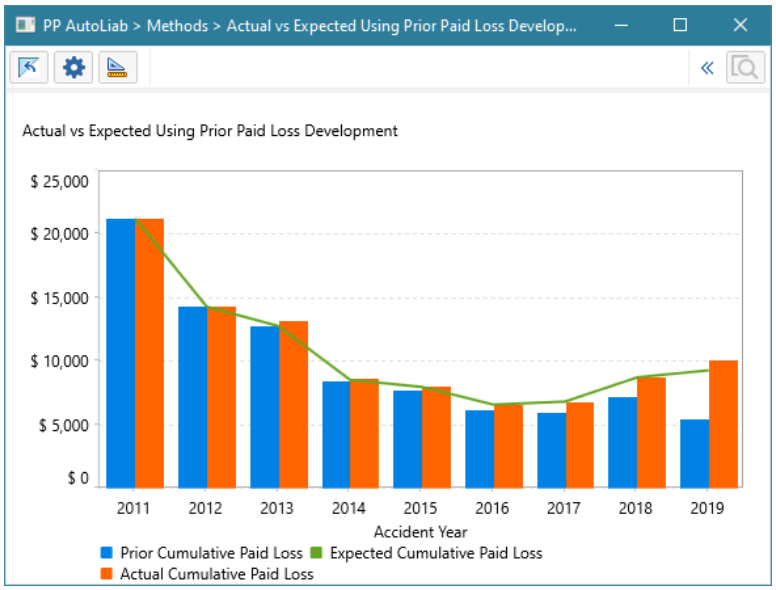


You can customize graphs by clicking on the **Graph settings** icon from the graph ribbon, then check the boxes beside the data you would like to display and select the format, as shown below.





This is the resulting graph for the object and selections above:



7. Using Actual vs. Expected at Year-End

If you plan to use the Direct approach and/or Indirect approach using selected patterns, you will not need to select anything other than the standard development patterns and ultimates you selected as part of your most recent analysis in Arius.

If you plan to use the Indirect approach using implied patterns, you will also need to select Ratio to Ultimate patterns before you prepare your most recent Arius analysis file for the new period.

Below are the steps to populate the AvE objects for Paid Loss, in two different scenarios, as examples.

- Scenario 1 assumes an analysis at 12/31/2019 with a 12-24-36 structure being updated at 12/31/2020 with a 12-24-36 structure.
- Scenario 2 assumes an analysis at 9/30/2020 with a 9-21-33 structure being rolled forward to 12/31/2020 with a 9-21-33 structure.

Similar steps will be necessary for each data element (e.g., Incurred Loss, Open Claims, etc.) for which you want to populate Actual vs. Expected objects.

Scenario 1: 12/31/2019 to 12/31/2020 with 12-24-36 structure

- Original file at 12/31/2019 with 12-24-36 development periods
- Roll forward to 12/31/2020 with 12-24-36 development periods

In the 2019 file

1. Select 12-24-36 Paid Loss Development factors.
2. Select Ultimate Loss.
3. If using Indirect AvE using implied pattern, select 12-24-36 Cumulative Paid Loss to Ultimate Loss factors (Exhibit 65 under EXHIBITS | LOSSES |OTHER RATIOS).
4. Save this file.

Create and update the 2020 file

5. Open the 2019 file and select MODIFY STRUCTURE | APPEND NEW EVALUATION, making sure to uncheck the **Clear All Assumptions** box. This action will automatically save your selected 12/31/2019 development factors to the Historical Factor Library, which can then be retrieved by the GetPriorSDF function used in the AvE methods.
6. Save this file with a new name.
7. Select 12-24-36 Paid Loss Development factors.
8. If using Indirect AvE using implied pattern, select 12-24-36 Cumulative Paid Loss to Ultimate Loss factors (Exhibit 65 under EXHIBITS | LOSSES | OTHER RATIOS).

Scenario 2: 9/30/2020 to 12/31/2020 with 9-21-33 structure

- Original file at 9/30/2020 with 9-21-33 development periods
- Roll forward to 12/31/2020 with 9-21-33 development periods (last diagonal is a partial period and interpolation is activated)

In the 9/30 file

1. Select 9-21-33 Paid Loss Development factors.
2. Select Ultimate Loss.
3. If using Indirect Actual vs. Expected using implied pattern, select 9-21-33 Cumulative Paid Loss to Ultimate Loss factors (Exhibit 65 under EXHIBITS | LOSSES | OTHER RATIOS).
4. Save this file.

Create and update 12/31 file

5. Open the 9/30 file and select MODIFY STRUCTURE | APPEND NEW EVALUATION, making sure to uncheck the **Clear All Assumptions** box. This action will automatically save your selected 9/30/2019 development factors to the Historical Factor Library, which can then be retrieved by the GetPriorSDF function used in the AvE methods.
6. Click the Project Settings icon and, in the Data Parameters section of Data Structure, change the Length of Last Calendar Period (in Months) field to 3.
7. Save this file with a new name.
8. Load new data into the latest diagonal.
9. Select 12-24-36 (interpolated) Paid Loss Development factors.
10. If using Indirect Actual vs. Expected using implied patterns, select 12-24-36 (interpolated) Cumulative Paid Loss to Ultimate Loss factors (Exhibit 65 under EXHIBITS | LOSSES | OTHER RATIOS).