



Predictive Analytics 123 Setup Instructions

PV620 SV100

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Overview

Predictive Analytics 123 provides a forecast baseline based on historical data patterns. The solution cycles through multiple forecast methods based on Seasonality and Trend to determine the most accurate forecast. It creates and presents models to support forecasting, prediction, and what-if analysis to determine the most appropriate forecast scenario.

Getting Started

Use the following information to understand prerequisites and dependencies, plan your installation, and configure the database server.

Note: Before beginning setup, verify that the SQL server has table creation rights on the SQL database to create the custom tables.

Software Dependencies

The following table describes external software dependencies:

Component	Description
OneStream App for Windows	Predictive Analytics 123 is optimized to run in the OneStream App for Windows. This app has the same functionality as the browser-based version of OneStream while providing an enhanced display at faster speeds.
OneStream Data Science Package	This package contains the Python executable, the Python dependencies, and the Anaconda® Distribution software necessary to execute the code that runs the Predictive Analytics 123 financial prediction models.

Select the Predictive Analytics 123 Development Location

Before you begin the installation, you must decide whether to build Predictive Analytics 123 directly in the Production OneStream application or in a separate Development OneStream application. This section provides some key considerations for each option.

Production OneStream Application: The primary advantage of building Predictive Analytics 123 in your Production application is that you will not have to migrate the resulting work from a Development application. However, there are intrinsic risks when making design changes to an application that is being used in a Production capacity and this is seldom advised.

Note: It is strongly recommended that you implement Predictive Analytics 123 in the Development environment with a fresh copy of the Production application before starting work.

Development OneStream Application: As a Best Practice, use the Development OneStream application to build Predictive Analytics 123.

See Also: [Modifying MarketPlace Solutions](#)

Create the OneStream Development Application

1. Ensure that all the OneStream artifacts relating to Predictive Analytics 123 such as **Workflow Profiles** and **Entities** are in the Production application.
2. Copy your Production OneStream application to your Development environment and rename it. This Development version will be used for your Predictive Analytics 123 project.

Application Server Settings

You may need to edit the OneStream Application Server Configuration so users can create and change data in the additional database tables used by Predictive Analytics 123. If other MarketPlace Solutions (such as Specialty Planning) are already in the application, these adjustments may already exist.

Configure the OneStream XF Application Server

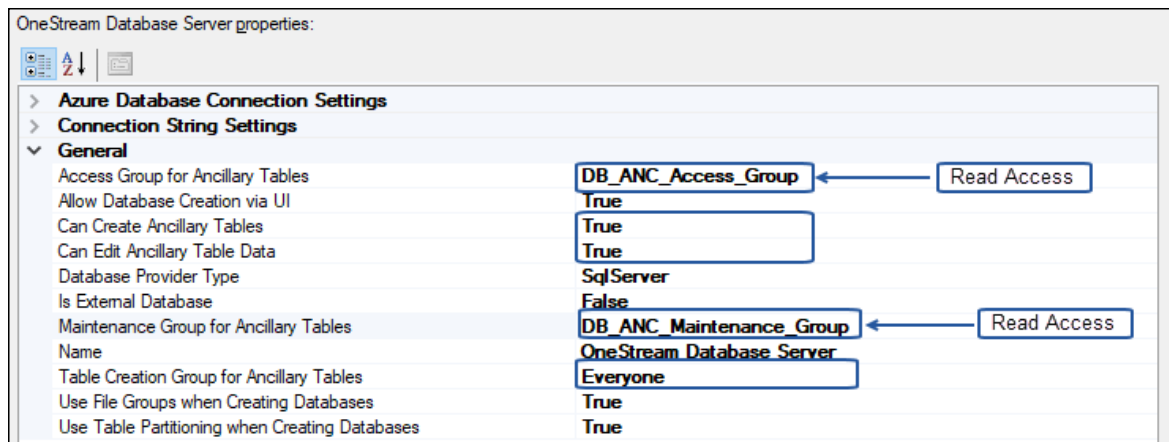
Be sure that these security group settings include those who will be working on and setting up Predictive Analytics 123 before you begin.

Note: Group settings are applicable to all Marketplace Solutions; it is important to keep the group names generic.

1. Start the OneStream Server Configuration Utility as an Administrator.
2. Select **Open Application Server Configuration File > Database**.
3. Edit the following **OneStream Database Server properties**:
 - Access Group for Ancillary Tables:** Select a group that includes those who will access records.
 - Can Create Ancillary Tables:** True
 - Can Edit Ancillary Table Data:** True

Maintenance Group for Ancillary Tables: Select a group who will edit and maintain tables.

Table Creation Group for Ancillary Tables: Administrators



4. Restart Internet Information Server.

Installation & Setup

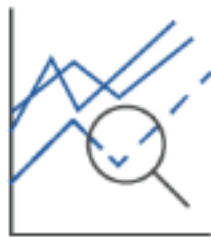
You must first download and install the OneStream Data Science software package before you begin the Predictive Analytics 123 setup process. This step is required in order to map the Python Configuration path during the Predictive Analytics 123 installation. Determine the best location to extract the package before beginning the process. The location must be free of file execution restrictions in order to run the Python code.

Important: OneStream cloud-based installations require OneStream Support assistance to deploy the Data Science package. [Contact OneStream Support](#) for assistance.

Install Predictive Analytics 123

When the Data Science package is installed and the directory path is known, install Predictive Analytics 123.

1. From the OneStream MarketPlace Dashboard, click **MarketPlace > Predictive Analytics 123**.



Predictive Analytics 123

2. On the Predictive Analytics 123 Solution page, select your OneStream platform version from the **Minimum Platform Version** dropdown list.
This selection automatically displays the appropriate solution version in the next box.
3. Select the most recent version from the **Solution Version** dropdown list and then click **Download**.

4. Log in to OneStream.
5. On the **Application** tab, click **Tools > Load/Extract**.
6. On the **Load** tab, locate the solution package using the **Select File** icons and click **Open**.
7. When the solution's file name appears, click **Load**.
8. Click **Close** to complete the installation.

Package Contents & Naming Conventions

The package filename contains multiple identifiers that correspond with the Platform. Renaming any of the elements contained in a Package is discouraged in order to preserve the integrity of the naming conventions.

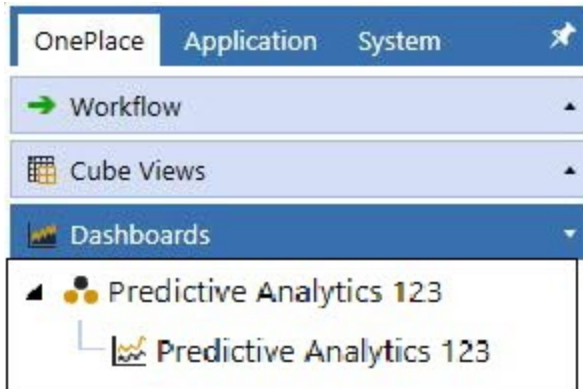
Example package name: PAM_PV6.2.0_SV100_PackageContents.zip

Identifier	Description
PAM	Solution ID
PV620	Minimum XF Platform version required to run solution
SV100	Solution version number
PackageContents	Filename

Predictive Analytics 123 Setup

The first time you run Predictive Analytics 123, you are guided through the table setup process.

1. In OneStream, click **OnePlace > Dashboards > Predictive Analytics 123 > Predictive Analytics 123**.



Step 1: Setup Tables

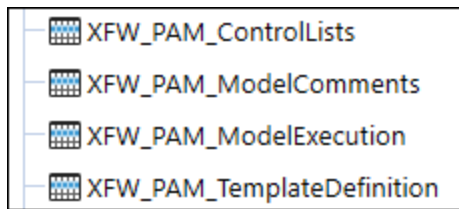
This step may be necessary when upgrading even if tables are already present. Predictive Analytics 123 will not drop any tables that already exist but will modify table structures and add any new ones if necessary.

2. When setup is complete, click **Step 2: Launch Solution** to begin.

Dashboard Maintenance Unit

XFW Predictive Analytics 123 (PAM)

The Dashboard Maintenance Unit provides the user interface for Predictive Analytics 123 and includes the Dashboard Groups, Components, Data Adapters, Parameters, and Files used to build the solution.



Business Rules

Business Rule	Description
PAM_DataMgmt	Extensibility Business Rule that manages the execution of the Run All functionality.
PAM_HelperQueries	Dashboard Dataset Business Rule that provides various data helper functions for populating charts, grids, and BI Viewer components.

PAM_ ParamHelper	Dashboard XFBR String Business Rule that provides conditional parameter processing functions that allow a parameter value to be interpreted and substituted with a different string.
PAM_ SolutionHelper	Dashboard Extender Business Rule that provides various helper functions for Predictive Analytics 123 such as management of the solution setup, configuration settings, and management of Predictive Models.

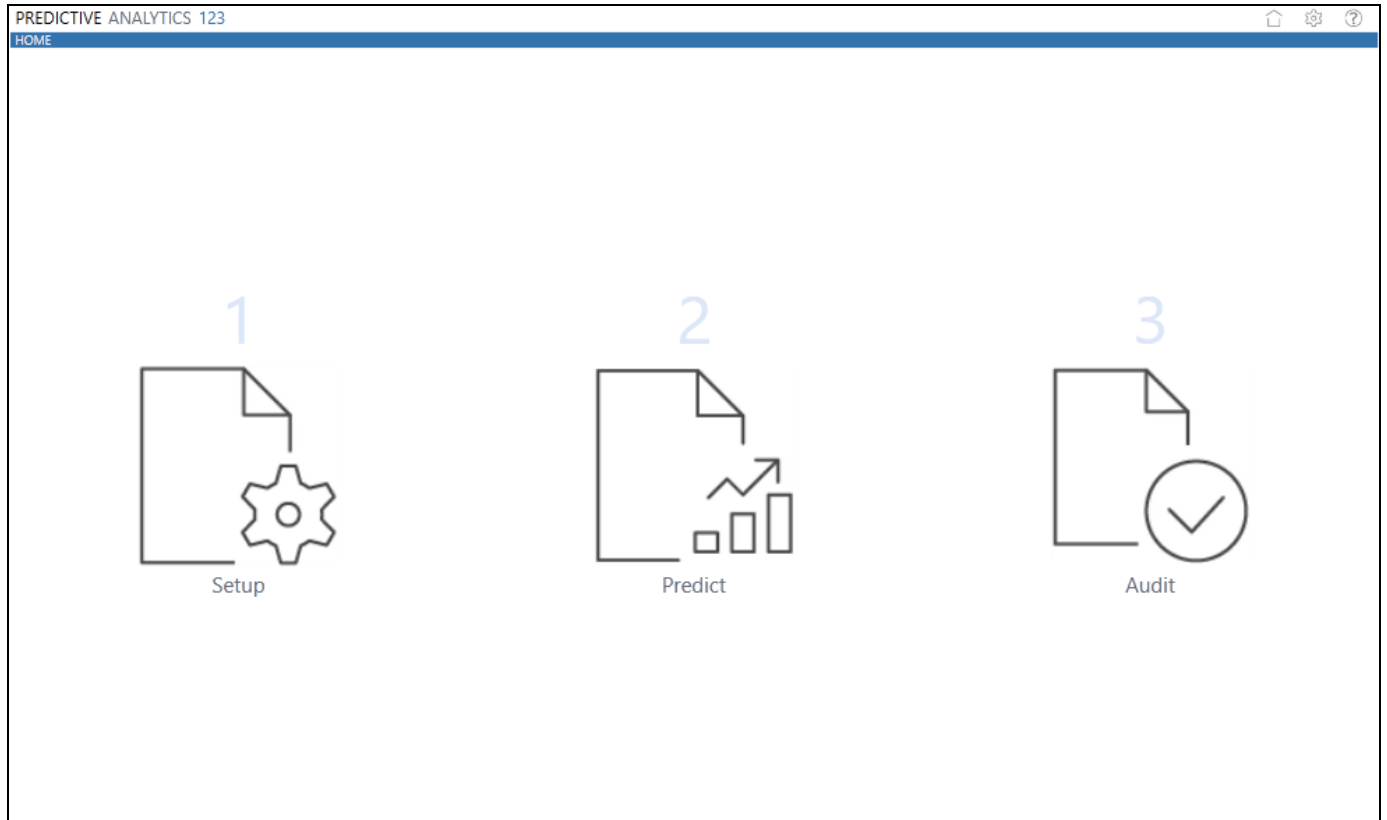
Home



The **Home** page contains Setup, Predict, and Audit.

Predictive Analytics 123 is grouped into three sections:

1. **Setup** establishes model groups by defining the types of models to run, the data source(s), and determining the length of the forecast. It ties these parameters into a designated Cube View through the template.
2. **Predict** displays the interactive mode that runs the models against a selected cell or all accounts in a Cube View. Results are graphically displayed and written back to either the same Cube View or a different target scenario.
3. **Audit** provides auditability into the entire application by logging what is run, by whom, and retains a comment log.



Settings

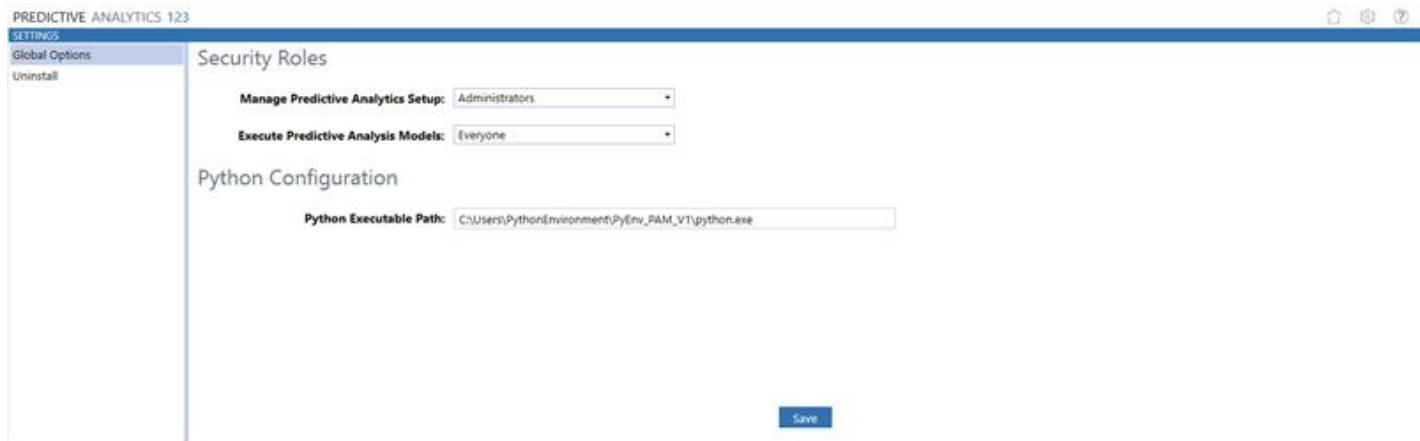


The **Settings** page contains the Global Options tab where you set key properties that guide Predictive Analytics 123 administration. It also contains Uninstall options.

All global option settings are retained during solution upgrades.

Global Options

The **Settings > Global Options** page should be one of the first pages visited when configuring Predictive Analytics 123.



Assign User Group to Security Roles

1. On the **Settings** page, click **Global Options** and then select the user group from the dropdown list for each Security Role (the default value for all security roles is Administrators).
2. Click **Save**.

Security Role	Description
---------------	-------------

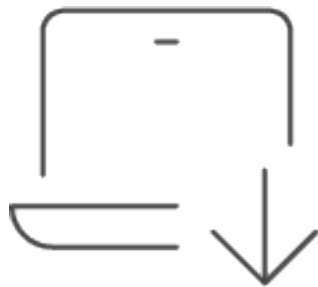
Manage Predictive Analytics Setup	Users in are Predictive Analytics 123 administrators who can manage security settings in the Global Options page and access the Setup page to create, edit, or delete templates.
Execute Predictive Analysis Models	Users can Run, Clear, and Delete models.

Configure the Predictive Analytics 123 Python Script

The Python Executable Path specifies the location of the unzipped Data Science package.

1. On the **Settings** page, click **Global Options** and then type or paste the full path of the Python Configuration for the file.
2. Click **Save**.

Predictive Analytics 123 Uninstall Options



Uninstall UI removes Predictive Analytics 123, including related dashboards and business rules but leaves the database and related tables in place. Use this option if you want to accept a Predictive Analytics 123 update without removing the data tables. The Predictive Analytics 123 Release Notes will indicate if an overinstall is supported.

For some releases, this step should be performed before accepting any new version of Predictive Analytics 123 since some of the Dashboard or other objects may have been renamed. Note that some Global Options will also be cleared as their values are stored in Parameters under Dashboards.



Uninstall Full removes all the related data tables, all data, Predictive Analytics 123 Dashboards, and Business Rules. Use this option to completely remove Predictive Analytics 123 or to perform an upgrade that is so significant in its changes to the data tables that this method is required.

Caution: The Uninstall procedure cannot be reversed.

Setup



The **Template Setup** page displays the **Template Definition List** which defines the Cube where the data comes from, the Cube View against which you want to run models, and where the results will be written.

Template Setup

The Template Setup page contains the following functions:

Add creates a new Template.

Edit updates an existing Template. Note that once a model is run, elements of the Cube View and Scenario section cannot be modified.

Copy creates a new Template based on the settings of the selected Template.

Delete removes the entire Template along with the associated model(s) and comments.

Clear removes the saved default models associated with the form but keeps the results of previously run models.

Note: The **Delete** function on the **Template Setup** page is different than the **Delete** function on the **Predict** page.

PREDICTIVE ANALYTICS 123									
TEMPLATE SETUP									
Template Definition List									
Name	Description	Access Group	Cube Name	Cube View	Source Scenario	Target Scenario	Reference Period	Historical Range	
Sales Forecast 2020 v2		Everyone	GolfStream	Sales Entity by Month	Actual	Target	2020M1	All	
Sales Forecast 2020 - Whatif Scenario 2		Everyone	GolfStream	Sales Entity by Month	Actual	What If 3	2020M1	All	
Sales Forecast 2020- Whatif Scenario 3		Everyone	GolfStream	Sales Entity by Month	Actual	What If 1	2020M1	All	
Sales Forecast 2020- Whatif Scenario 1		Everyone	GolfStream	Sales Entity by Month	Actual	What If 1	2020M1	All	
Sales Forecast 2020		Everyone	GolfStream	Sales Entity by Month	Actual	Target	2020M1	All	

Create a Template

Important: There must be at least one template saved in order to run a model.

1. On the Template Setup page, click **Add**.
2. Complete the information in each section of the **Template Add** box and click **Save**. See [Template Field Definitions](#) for detailed descriptions of the field-level options in this template.

The screenshot shows the 'Template Add' dialog box with the following sections and fields:

- 1 Information**
 - Name:
 - Description:
 - Access Group:
- 2 Cube View and Scenario**
 - Cube:
 - Cube View:
 - Source Scenario:
 - Target Scenario:
- 3 Time Range**
 - Reference Period:
 - Historical Range:
 - Forecast Range:
 - Prediction Write Start Period:
- 4 Model**
 - Default Model:
 - Seasonality Length:
 - Failure Resolution:
 - Save Default Model:
- 5 Run All**
 - Allow Run All Accounts:
 - Account Filter:

Buttons:

Template Field Definitions

1 Information	
Name	Descriptive name to identify the template.
Description (Optional)	Description of template.
Access Group	Name of the user group who can run/view models belonging to this template.
2 Cube View and Scenario	
Cube	Name of the Cube to run the models against for the template.
Cube View	Name of the specific Cube View in the Cube to be able to run the models against for this template. See Also: Cube View Setup

Note: The Cube View can only pull data from the Cube that was specified above. Pulling data from multiple Cubes for a single Cube View is not allowed in Predictive Analytics 123.

Source Scenario	Scenario specified as the source of historical data points used to generate predictive models.
Target Scenario	Scenario to write the results of the model execution.

Important: The Source Scenario and Target Scenario must have the same writable cells

3 Time Range	
Reference Period	The period to be used to identify the last period to be included in the historical dataset for models run on the specified account. Required for Run and Run All. The reference period used should also be included in the Cube View in order to be visible on the Predict page.
Historical Range	The number of data points to use in order to fit the models. Example: If the selected cell for the account is 2019M11, and Historical Range is 24, the historical datapoints to be used for fitting the models will be all the values from 2017M11 to 2019M11.

Important: A minimum of 18 months of data is necessary in order to return valid prediction models. For predictive models, particularly seasonality, 24 months of historical data are necessary (ARIMA models require 48 months). Rows missing the required number of historical months will be excluded from the prediction.

Forecast Range	The number of datapoints to run against, going forward from the selected cell.
Prediction Write Start Period	The number of periods forward from the selected cell period to begin writing forecasts. The template defaults to a write start of 1, which corresponds to the period directly after the selected cell period. Example: If the selected cell in the account is for 2005M11, and the Prediction Write Start Period is 5 with a Forecast Range of 12 months, 12 forecast values would be written beginning at 2006M4 through 2007M3.
4 Model	
Default Model	Determines the models to run for the template.
	Auto-Seasonality Models performs a grid search of all Seasonality specific models with all possible parameter subsets. <i>This method will return the best performing Seasonality specific models for the given account in the template.</i>
	Auto-All Models performs a grid search of all models with all possible parameter sub-sets. <i>This method will return the best performing models for the given account in the template.</i>
	Auto-Trend Models performs a grid search of all Trend specific models with all possible parameter sub-sets. <i>This method will return the best performing Trend specific models for the given account in the template.</i>
	If a specific type of model is selected in this section, a grid search of that specific model's parameter sub-sets will be performed. <i>This method will return the best performing parameter subset model of the specified model type.</i>

Seasonality Length	Sets the seasonality length for the data that the models will use as the seasonal cycle. This value can be specified by the user or Auto-Detect can be specified in which case the algorithm itself will determine the best seasonality length for the data.
Failure Resolution	Determines the models to run in the event the default model returns a Failure response.
Save Default Model	Saves the selection in Default Model .
5 Run All	
Allow Run All Accounts	Runs every account in the Cube View and determines the best model for each account according to the specifications set in the template editor.
Account Filter (Optional)	Follows the standard OneStream member filter, an admin can filter the Cube View accounts using the standard formulas present in the Member Filter Builder .

Cube View Setup Notes

- Predictive Analytics 123 will only write prediction model results for Base level accounts.
- For Predictive Analytics 123 to write prediction model results to forecasted cells in a Cube View, set **Can Modify Data** to **True**.
- Users must be in the **Access** and **Maintenance** security groups of the Cube View where predictive models will be run.

Important: Data must be controlled using Cube View settings or it will be overwritten by prediction model results.

Assign Cube View Bound Parameters

Bound Parameters are required to apply predictive models to a Cube View. To assign Bound Parameters in OneStream, click **Application > Cube Views > General Settings > Navigation Links**.

Tip: Set parameters once in a Cube View and then use the **Copy** button on the Cube View page to create a new one from a template.

Designer **Advanced**

Name Sales Prediction (PAM) **Description**

POV

General Settings

- Sharing
- Common
- Header Text
- Header Size
- Header Overrides
- Report
- Navigation Links

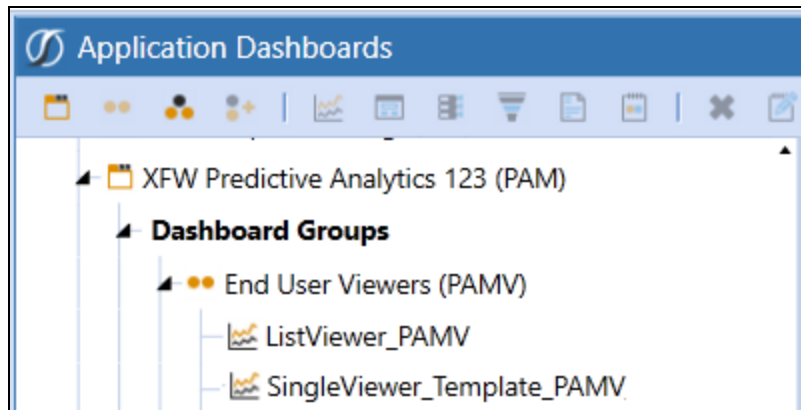
Linked Cube Views	
Linked Cube Views	
Bound Parameter Names	
Entity Bound Parameter Name	E_PAMME
Consolidation Bound Parameter Name	
Scenario Bound Parameter Name	S_PAMME
Time Bound Parameter Name	T_PAMME
View Bound Parameter Name	V_PAMME
Account Bound Parameter Name	A_PAMME
Flow Bound Parameter Name	F_PAMME
Origin Bound Parameter Name	O_PAMME
IC Bound Parameter Name	I_PAMME
UD1 Bound Parameter Name	U1_PAMME
UD2 Bound Parameter Name	U2_PAMME
UD3 Bound Parameter Name	U3_PAMME
UD4 Bound Parameter Name	U4_PAMME
UD5 Bound Parameter Name	U5_PAMME
UD6 Bound Parameter Name	U6_PAMME
UD7 Bound Parameter Name	U7_PAMME
UD8 Bound Parameter Name	U8_PAMME

Bound Parameter Name	Value
Entity	E_PAMME
Consolidation	<i>Not used</i>
Scenario	S_PAMME
Time	T_PAMME
View	V_PAMME
Account	A_PAMME
Flow	F_PAMME
Origin	O_PAMME
IC	I_PAMME
UD1	U1_PAMME
UD2	U2_PAMME
UD3	U3_PAMME
UD4	U4_PAMME
UD5	U5_PAMME
UD6	U6_PAMME
UD7	U7_PAMME
UD8	U8_PAMME

Apply Predictive Analytics 123 to Forms

There are two end user Dashboards in the **XFW Predictive Analytics 123 (PAM)** Dashboard Group:

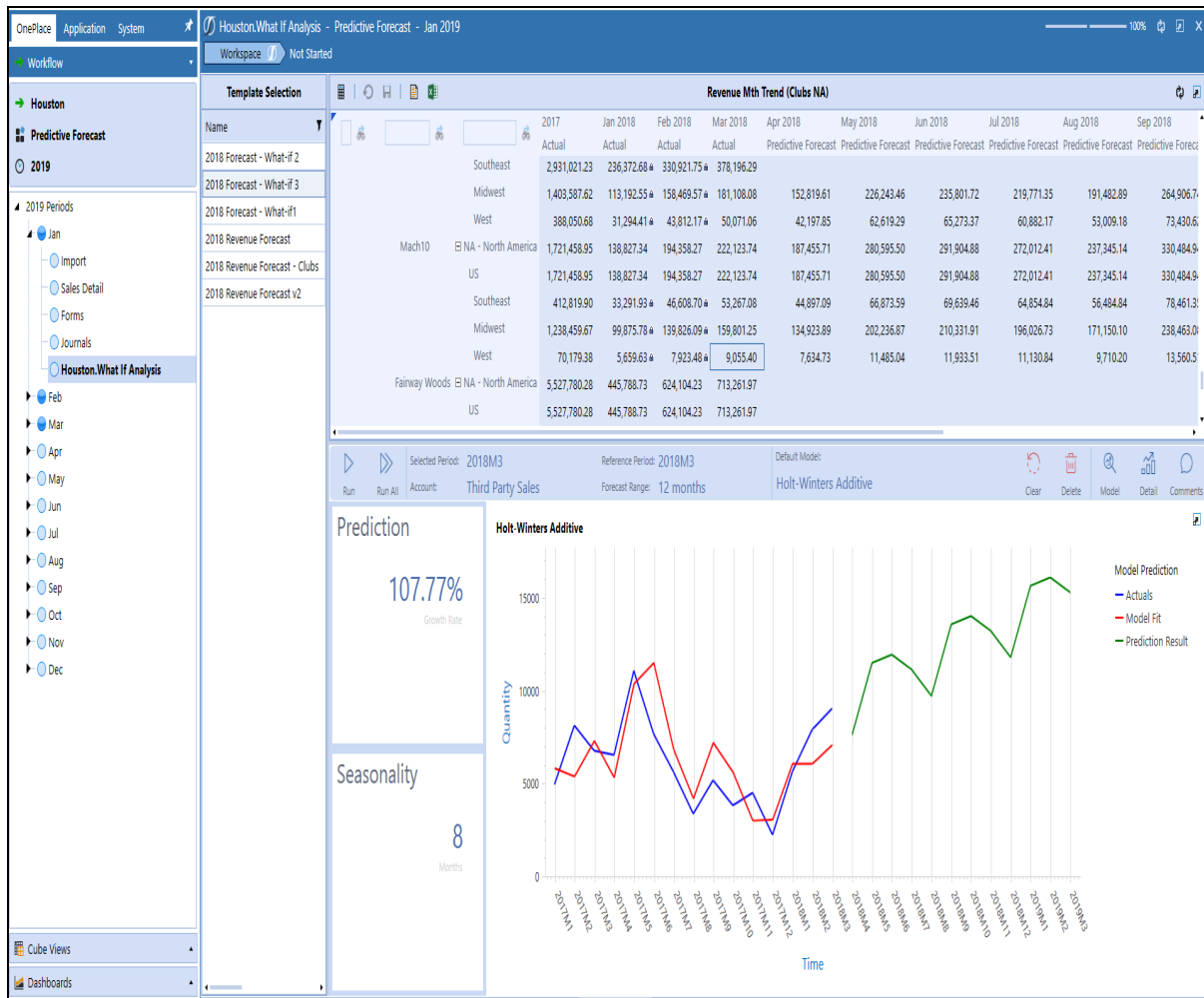
1. ListViewer_PAMV
2. SingleViewer_Template_PAMV



Set Up List View

The List View dashboard contains the information from the Predictive Analytics 123 Predict page including the Template Selection list. This dashboard can be embedded into a workspace inside of a workflow.

1. In OneStream, click **Application > Presentation > Dashboards**.
2. Click **Dashboard Maintenance Units > XFW Predictive Analytics 123 (PAM) > Dashboard Groups > End User Viewers (PAMV) > ListViewer_PAMV**.
3. (Optional) On the **ListViewer_PAMV** dashboard, click **Rename** to rename the dashboard.
4. Click **Save**.
5. Click **Run** to verify that the dashboard opens correctly.



Set Up Single View

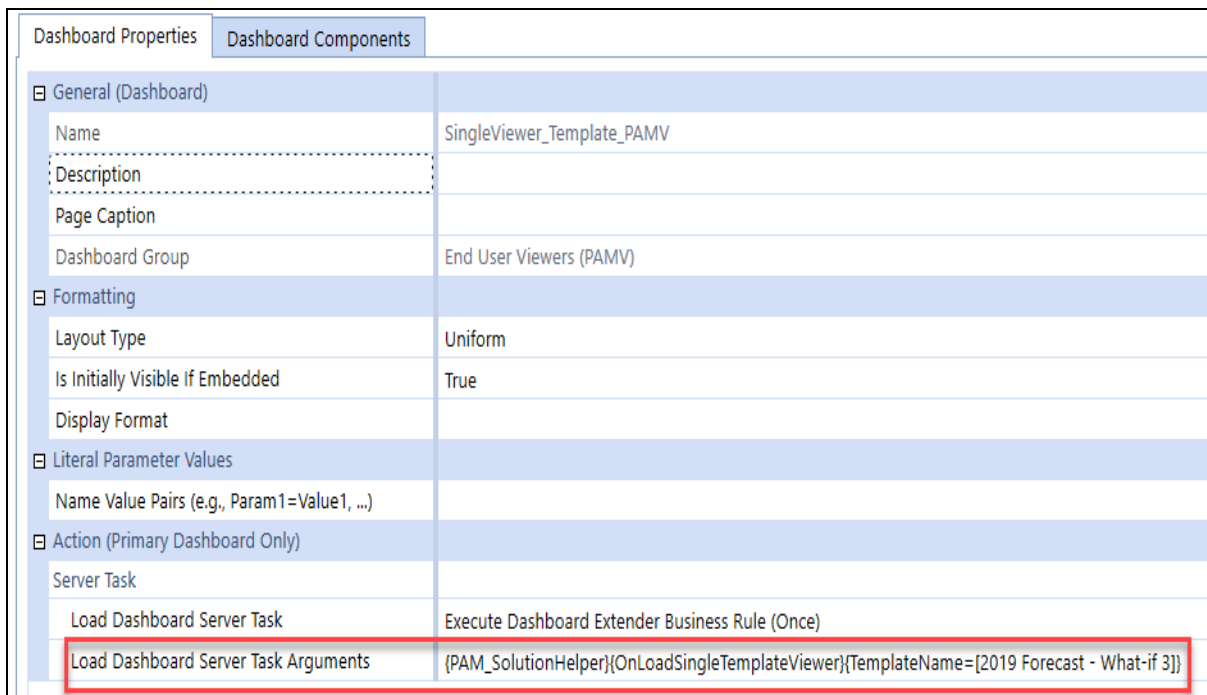
The Single View dashboard contains the information from the Predictive Analytics 123 **Predict** page excluding the Template Selection form.

1. In OneStream, click **Application > Presentation > Dashboards**.
2. Click **Dashboard Maintenance Units > XFW Predictive Analytics 123 (PAM) > Dashboard Groups > End User Viewers (PAMV)**.
3. Select **SingleViewer_Template_PAMV** and click **Copy** on the top toolbar.

4. Click the **Paste** on the top toolbar.
A new dashboard called SingleViewer_Template_PAMV_Copy displays.
5. Select the SingleViewer_Template_PAMV_Copy and click **Rename** in the top toolbar.

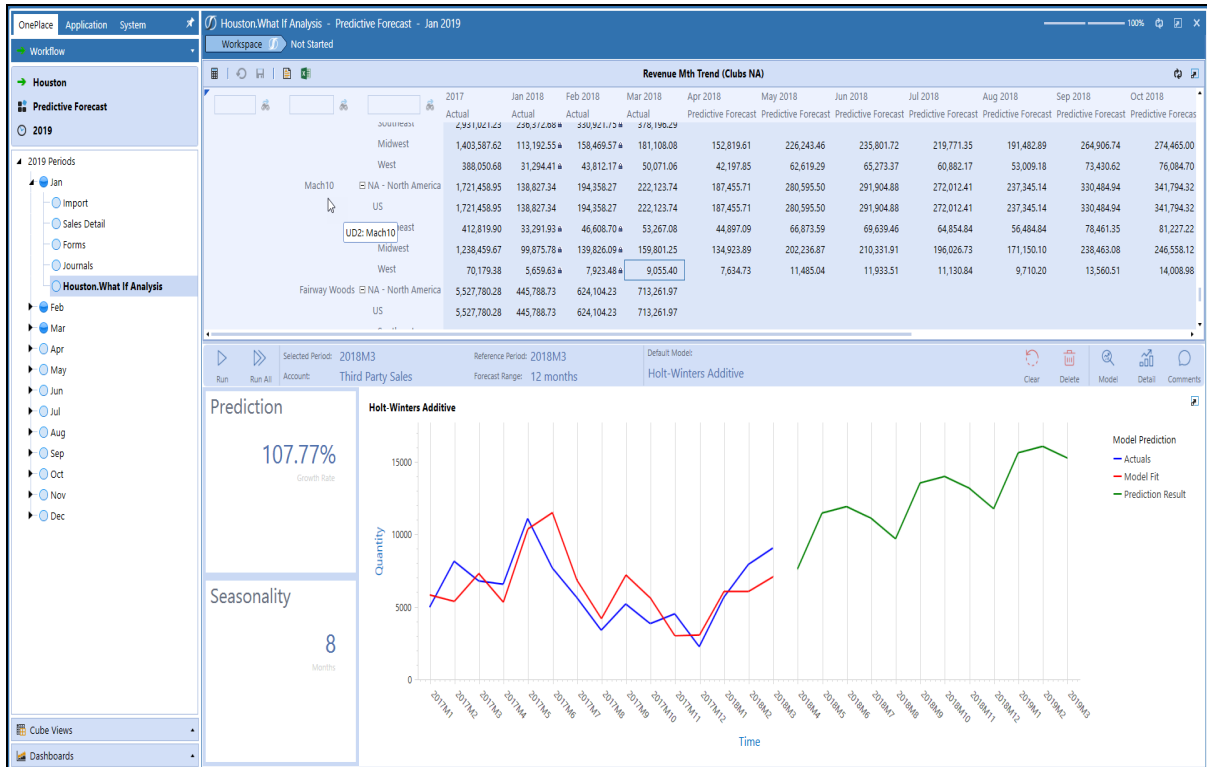
Tip: Replace the word "Template" in the name for the name of the Predictive Analytics 123 template that will be embedded into this single view. Be sure to remove spaces in the template name.

6. Click **Save** and navigate to the new dashboard.
7. In the **Dashboard Properties** pane, expand **Action (Primary Dashboard Only)**.



8. Type the exact name of the template to embed in the dashboard in the Load Dashboard Server Task Arguments field.
9. Click **Save**.

- Click **Run** verify that the template name was correctly specified. This newly created Template Dashboard can now be embedded into a workspace inside of a workflow.



- Click **Save**.

Predict



The **Predict** page displays the interactive mode that runs the models against a selected cell or all accounts in a Cube View. Results are graphically displayed and written back to either a Cube View or a different target scenario.

Run Prediction Models

To run the model with respect to the selected cell:

1. In the **Template Selection** panel, select a template.

Note: Templates could be restricted based on the current user's access level and the Access Group associated with the template in the template definition step.

2. Click on the cell in the account to run models for.
You can only run against cells that are within the reference period as defined in the setup.
3. Click **Run**.
If the cell for that account already has models run on the selected template, the lower panes will be prepopulated.

Note: The **Run** button is hidden until a cell is selected but Run All is always visible.

In order for a growth rate to be displayed as a non-NAN value it is required that the forecast period is equal to or longer than the total number of historical values.

After the model(s) are run against the selected cell, a graph of the results and the Prediction growth rate display in the lower pane:

Run All runs every available option and then determines the best model for each account according to the specifications set in the template editor.

Selected Period: The period chosen to run the model against.

Account: The account name.

Reference Period: The period to be used to identify the last period to be included in the historical dataset for models run on the specified account.

Forecast Range: The number of datapoints to run against, going forward from the selected cell.

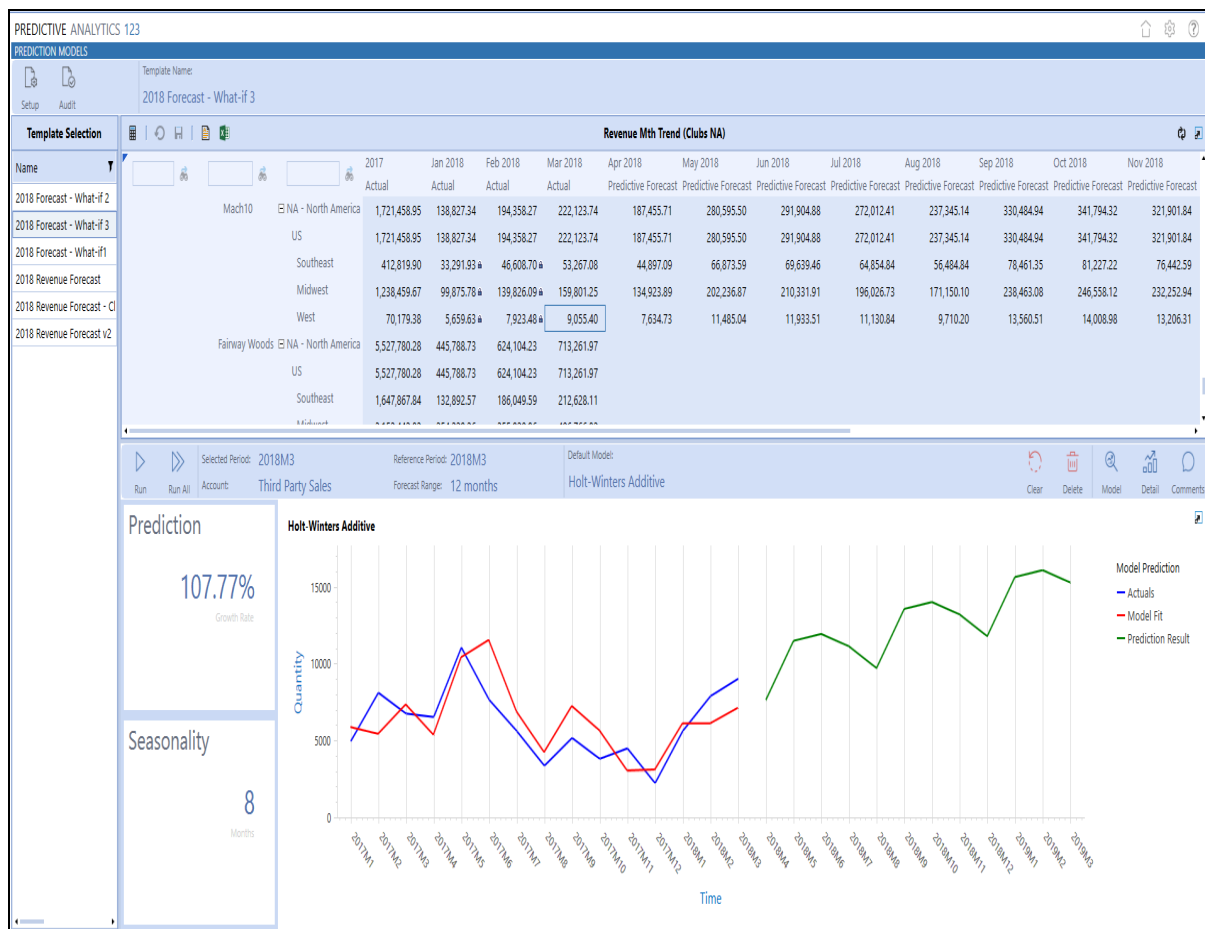
Default Model: Determines the models to run for the template.

The **Clear** button removes the saved default models associated with the form but keeps the results of previously run models.

The **Delete** button removes the associated model(s) and comments but does not delete the Template.

The **Model** button brings you back to the original lower pane with the graph and the Prediction/Actual Forecast rates.

The **Detail** button populates the lower pane with each of the best models returned (scrollable pane on the left, but only scrollable if there are multiple models returned) as well as the associated Mean Absolute Percent Error and Mean Percent Error next to them. Also, the graph for whichever model is selected on the left pane displays on the right pane.



Model Comments

The **Comments** button opens a dialog that allows for a user to add/save a comment on the account model run(s). If there are already comments associated with that account and template, there will be a prepopulated table in this section. The table displays the comment, the username associated, and the time stamp. However, if there is not yet a comment, the table will not be prepopulated.

The screenshot shows a window titled "Model Comments" with a blue header. Below the header, there are two fields: "Account:" with the value "Third Party Sales" and "Selected Period:" with the value "2018M3". Below these fields is a table with three columns: "Comment", "User", and "Time Stamp (UTC)". The table contains one row of data. At the bottom of the window, there is a form to add a new comment, consisting of a plus icon, the label "Add", and a text input field.

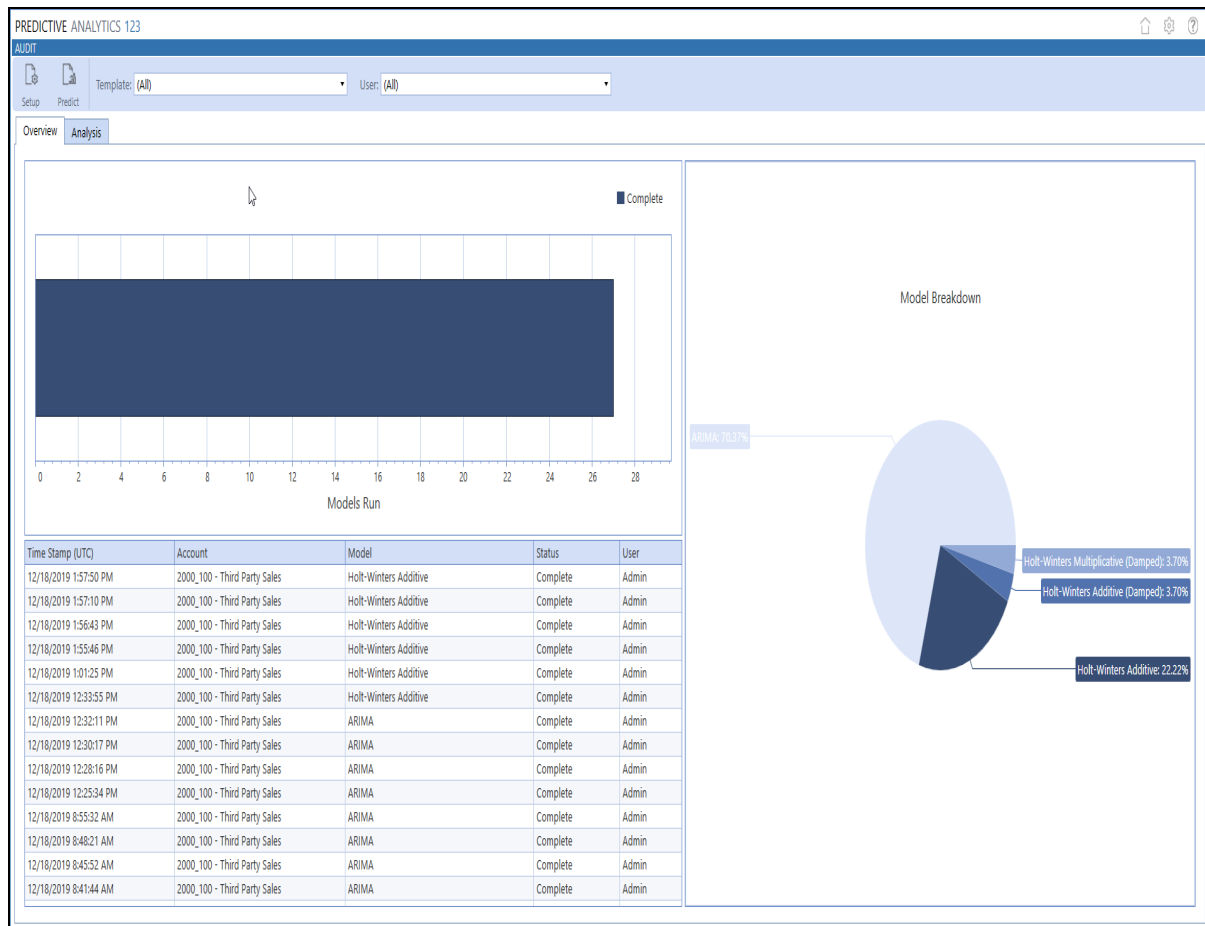
Comment	User	Time Stamp (UTC)
Made an adjustment to 2019 M1 for the expected revenue increase	Admin	12/18/2019 2:20:16 PM

Note: Comments are associated with both the account of the Cube View and the currently selected template.

Audit



The **Audit** page is three sections of report-style data that displays information such as the number of models run per account, the types of models, who ran each model, which model was run, the target scenario, and the creation date of the model run. This information is summarized on the **Overview** tab with detail in the **Analysis** tab.




Analysis

The **Analysis** tab contains the following information:

- Commentary provides all commentary by Account and Cube View.
- Model Executions provides all single account model executions by Cube View.
- Run All Statistics provides statistics of all Run-All account model executions by Cube View.

Help & Miscellaneous Information

 This page contains solution documentation.

Optimal Display Settings

OneStream and MarketPlace solutions frequently require the display of multiple data elements for proper data entry and analysis. Therefore, the recommended screen resolution is a minimum of 1920 x 1080 for optimal rendering of forms and reports.

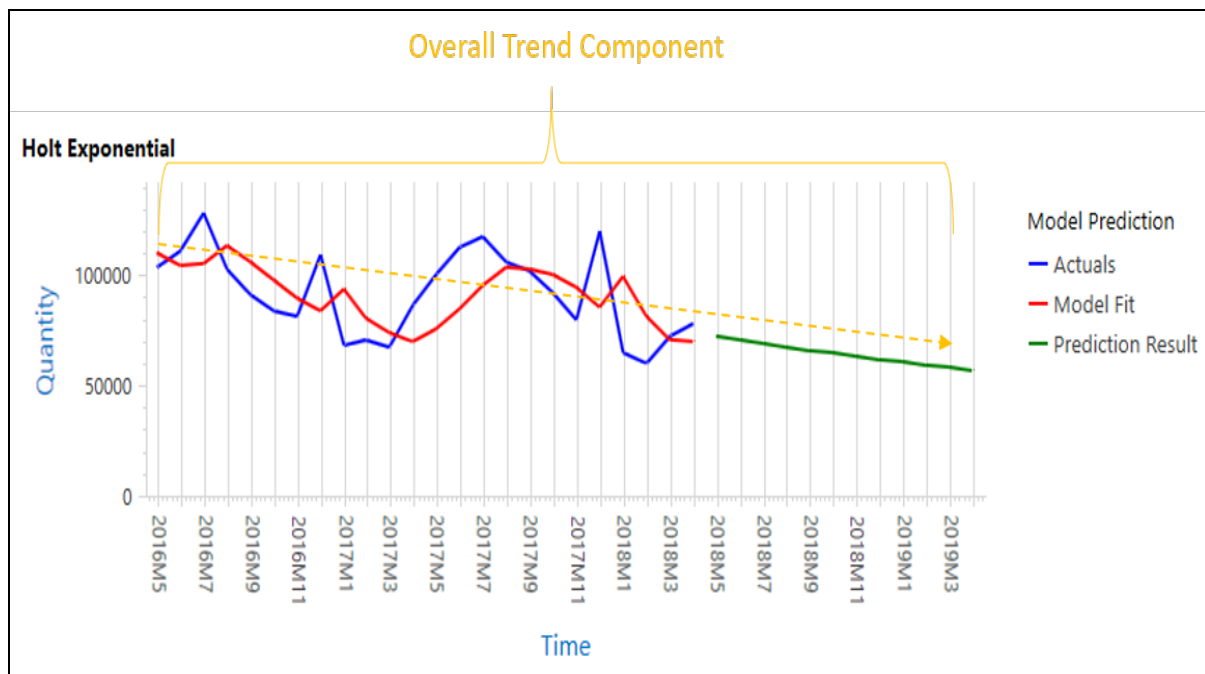
MarketPlace Solution Modification Considerations

A few cautions and considerations regarding modification of MarketPlace Solutions:

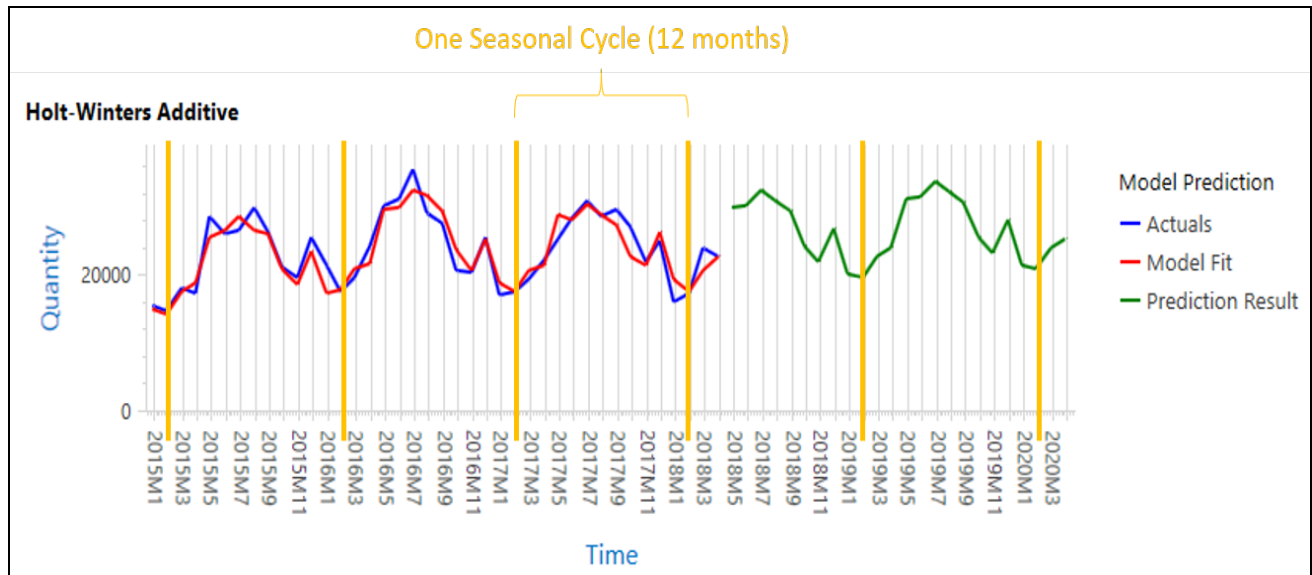
- Major changes to Business Rules or custom tables within a MarketPlace Solution will not be supported through normal channels as the resulting solution is significantly different from the core solution.
- If changes are made to any Dashboard object or Business Rule, consider renaming it or copying it to a new object first. This is important because if there is an upgrade to the MarketPlace Solution in the future and the customer applies the upgrade, this will overlay and wipe out the changes. This also applies when updating any of the standard reports and Dashboards.
- If modifications are made to a MarketPlace Solution, upgrading to later versions will be more complex depending on the degree of customization. Simple changes such as changing a logo or colors on a Dashboard do not impact upgrades significantly. Making changes to the custom database tables and Business Rules, which should be avoided, will make an upgrade even more complicated.

Appendix A: Trend and Seasonality Definitions

A **Trend** is a general systematic linear or nonlinear component that changes over time and does not repeat. The following graph shows the result of the Holt Exponential method applied to an overall trend component.



The **Seasonality** or seasonal cycle of a dataset is the number of points that occur in one cycle of data. Common seasonal cycles include 12 months (yearly) and 3 months (quarterly).



Appendix B: Forecasting Methods

Simple Exponential Smoothing

This forecasting method develops a model where the prediction is a weighted linear sum of recent past observations. Exponential Smoothing models explicitly use an exponentially decreasing weight when considering past observations. Single Exponential Smoothing only requires one parameter alpha, also called the smoothing factor or smoothing coefficient. Alpha controls the rate of influence of the observations at each prior timestep. The parameter is handled inside of the algorithm and thus is unspecified by a user.

Note: Simple Exponential Smoothing Models are best at handling data with no clear trend or seasonal components.

Holt Linear

This forecasting method is an extension of Simple Exponential Smoothing (See "Simple Exponential Smoothing" above) that adds the ability to capture the trend of the time series. This method is commonly referred to as Double Exponential Smoothing because it uses an additional smoothing factor beta in order to handle the influence of the overall trend. The method is broken into two variations, [Additive](#) and [Multiplicative](#).

Note: Holt-Linear Models are capable of handling data with a trend component but not seasonal components.

Holt-Linear Additive

In this variation, the smoothing factor beta is expressed in absolute terms in the scale of the observed series. The additive method is preferred when the seasonal variations are changing proportionally to the level of the series.

Holt-Linear Multiplicative

In this variation, the smoothing factor beta is expressed in relative terms or as a percentage. The multiplicative method is preferred when the seasonal variations are changing disproportionately to the level of the series.

Holt-Winters Exponential

This forecasting method is also an extension of Double Exponential Smoothing (see Holt Linear) that adds the ability to capture the seasonality of the time series data. This method is commonly referred to as Triple Exponential Smoothing. In addition to the alpha and beta parameters found in Double Exponential Smoothing, there is an added smoothing seasonal parameter gamma used to handle the influence of the overall seasonality. The method is broken into two variations based on the handling of the parameter gamma:

Seasonal Additive

The seasonal additive model is an extension of the Holt-Winters Exponential Additive Model. The Seasonal Additive model does not contain a trend equation, or parameter beta, and instead only applies the seasonal parameter gamma using the additive method.

Note: The Seasonal Additive model is only capable of handling data with a Seasonal component but no Trend Component.

Holt-Winters Exponential Multiplicative

In this variation, the seasonal parameter gamma is expressed in relative terms or as a percentage. In order to account for the seasonality, the trend equation of the series is seasonally adjusted by dividing each value by the seasonal parameter gamma. The multiplicative method is preferred when the seasonal variations are changing disproportionately to the level of the series.

Holt-Winters Damped Method

An extension of the Holt-Winters Exponential (Additive and Multiplicative), the damped method is used for long-term forecasts. For long-term forecasts, a Holts-Winters Exponential model will, by nature, increase or decrease indefinitely into the future. With the addition of a damping parameter between 0 and 1, this long-term increase or decrease can be minimized, and accurate long-term predictions can be maintained. The damping parameter is handled inside of the algorithm and thus is unspecified by a user.

Note: Holt-Winters Exponential Models are capable of handling data with both trend and seasonal components.

Seasonal Multiplicative

The seasonal multiplicative model is an extension of the Holt-Winters Exponential Multiplicative Model. The Seasonal Multiplicative model removes trend equation, or parameter beta, and instead only applies the seasonal parameter gamma, using the multiplicative method.

Note: The Seasonal Multiplicative model is only capable of handling data with a Seasonal component but no Trend Component.

Autoregressive Integrated Moving Average (ARIMA)

The “Autoregressive Integrated Moving Average” model is a non-seasonal time series method that combines three techniques when producing predictions. The first, corresponding to the “AR”, indicates the autoregressive component. This component regresses the desired variable over its previous values. The order of this portion of the model is specified by the parameter p . The second, corresponding to the “MA”, indicates the moving average component and is a regression of the desired variable’s errors over its previous values. The order of this portion of the model is specified by the parameter q . The third, corresponding to the “I”, indicates the integrated or differencing component and is a differencing of each value and its previous value. The order of this portion (number of times to perform differencing) is denoted by the parameter d . The differencing “I” component is performed before the “AR” and “MA” components are fit. The overall ARIMA is the combination of each of these three components into one condensed model.

Note: The ARIMA model is only capable of handling data with a trend component but no seasonal component.

Seasonal Autoregressive Integrated Moving Average (SARIMA)

The SARIMA model is a seasonal time series method and is an extension of the ARIMA modelling method. It contains the same three components of the ARIMA, however, a SARIMA adds an additional seasonal autoregressive, seasonal differencing, and seasonal moving-average component to the overall model in order to account for the recurring cycle of the data. The parameters for each of these additional seasonal components are denoted by P , D , and Q respectively. The SARIMA also takes in a seasonal parameter s which accounts for the length of a singular cycle in the data.

Appendix C: Predictive Analytic Metrics

Metrics

y_i = i 'th actual datapoint value

\hat{y}_i = i 'th predicted datapoint value

n = total number of datapoints

Mean Percentage Error (MPE)

Defined as the average of the percent errors, or the average percent difference between the predicted values and the actual values.

Mean Absolute Percentage Error (MAPE)

Defined as the average of the absolute percent errors, or the average absolute percent difference between the predicted values and the actual values. Like MAE, MAPE is not sensitive to outliers, and thus is best used when outliers are to be ignored.