

IBM Predictive Solutions Foundation on Cloud  
Last updated: 2016-12-22

*User Guide*



**Note**

Before using this information and the product it supports, read the information in "Notices" on page 63.

**Product Information**

This document applies to Predictive Solutions Foundation on Cloud and may also apply to subsequent releases.

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# Chapter 1. Welcome to IBM Predictive Solutions Foundation on Cloud

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## What is IBM Predictive Solutions Foundation on Cloud?

IBM® Predictive Solutions Foundation on Cloud is a cloud-based solution that enables operations, manufacturing, production, and maintenance personnel in asset-intensive industries to employ predictive analytics to improve asset availability, increase throughput, minimize unplanned outages, and reduce maintenance costs.

### IBM Prescriptive Quality on Cloud

Prescriptive Quality on Cloud is a feature of Predictive Solutions Foundation on Cloud and includes a parametric entity and an inspection entity.

Prescriptive Quality on Cloud does the following things:

- Detects unfavorable changes in variable-type data, and provides information that facilitates diagnostics and alarm prioritization (parametric entity)
- Detects unfavorable changes in the quality of components (inspection entity)

IBM Research's Quality Early Warning System (QEWS) algorithm in Prescriptive Quality on Cloud detects emerging quality problems sooner and with fewer false alarms than is typically achieved by traditional statistical process control. To achieve earlier detection, QEWS is sensitive to subtle changes in data values, such as shifts that are small in magnitude or trends that grow slowly over time. For a given level of statistical confidence, QEWS typically needs fewer data points than traditional statistical process control.

Early detection of quality problems is essential where delayed detection can have significant negative consequences, such as in the following scenarios:

- Building a large inventory of defective products results in high scrap costs.
- Having widespread quality or reliability problems in the field results in damage to brand value.
- Compromised production of supply-constrained materials or components prevents on-time shipment.
- Compromised production of products with long manufacturing times results in shipment delays.

### Parametric entity

In the parametric entity, Quality Early Warning System for Variable Data (QEWSV) monitors variable-type data. Variables are defined for every operation per tool. Variables are equated with Measurement type, whose measurements are read at different time intervals during the sequence of the operation flow. This type of data is found in several industrial applications, including Supply Chain, Manufacturing, and Finance applications.

QEWSV identifies unfavorable trends in the data process. The focus is on providing timely detection of unacceptable process behavior while maintaining a pre-specified low rate of false alarms.

Variable values and evidence charts are plotted by using parametric results. The deviation or drift from target values are computed and analyzed to show whether the process sequence is adhering to normal operation limits.

## **Inspection entity**

In a manufacturing environment, defects can occur in a manufacturing process because of variations in factors like process, raw materials, design, and technology. The resulting low quality of products creates a larger inventory of defective lots, which leads to increased inspection effort.

A small delay in detecting a quality problem can result in large costs, lost opportunity, and lost brand value.

In the inspection entity, QEWS evaluates evidence to determine whether the rate of failures is at an acceptable level. QEWS highlights combinations for which the evidence exceeds a specified threshold. QEWS can detect emerging trends earlier than traditional statistical process control, such as trend analysis. QEWS maintains a specified low rate of false alarms. Post-warning analysis of charts and tables identifies the point of origin, the nature and severity of the problem, and the current state of the process.

The inspection entity analyzes data from the inspection, testing, or measurement of a product or process operation over time. The data can be obtained from the following sources:

- Suppliers (for example, the final manufacturing test yield of a procured assembly)
- Manufacturing operations (for example, the acceptance rate for a dimensional check of a machined component)
- Customers (for example, survey satisfaction ratings)

*Products* are the subjects of QEWS analyses. A product is typically a part or a part assembly, but it can also be a process or a material. Products might be used in larger finished assemblies, which QEWS calls resources. A product can be associated with any resource, process, material, location, or a combination of these entities during inspection analysis.

You can adjust the frequency at which data is captured and input to QEWS, and the frequency at which QEWS analyses are run, according to the requirements of each situation. For example, monitoring the quality levels of assemblies that are procured from a supplier might best be done on a weekly basis; monitoring the quality levels of units that are moving through a manufacturing operation might best be done on daily basis.

## **IBM Prescriptive Warranty on Cloud**

Prescriptive Warranty on Cloud is a feature of Predictive Solutions Foundation on Cloud that looks for conditions that lead to accelerated wear and replacement of manufactured products that are under warranty. Such conditions might include variations in the manufacturing process of the product, variations in the quality of vendors' materials that are used in the product, or the ways in which the product is used.

A small delay in detecting the conditions that lead to accelerated wear can cause more warranty claims and related losses. By understanding the factors that lead to warranty claims, you can take corrective actions such as the following actions:

- Improve manufacturing processes to prevent warranty claims.
- Recall faulty products or product batches that have safety implications.
- Set pricing for warranties and extended warranties.
- Evaluate vendors of the materials that are used in the product.

IBM Research's Quality Early Warning System for Lifetime applications (QEWSL) algorithm provides detection that is based on excessive replacement rate and evidence of wear-out.

#### **Replacement rate**

QEWS alerts you when the product's random failure rate exceeds a computed threshold. The threshold can reflect product reliability goals (for example, the product population in the field must not exceed a specified failure rate) or financial liability goals (for example, the cost of reimbursing product warranty claims must not exceed a specified total amount).

#### **Wear-out**

QEWS alerts you when it finds evidence that product failures are not random in time, but are indicative of wear-out. Wear-out means that products that are in customer use for a longer time fail more often than products that are in customer use for a shorter time. Because wear-out can have serious consequences, QEWS alerts you when it detects evidence of wear-out regardless of how many product units contributed to the detection.

QEWS enables warranty models that are based on sales, production, and manufacturing dates.

#### **Sales model**

The Sales model identifies variations in product wear and replacement rates according to the date of sale. The date of sale might correlate with in-service conditions, seasonal climatic conditions, a particular customer, or other important similarities.

For example, a product carries a one-year warranty. In cold conditions, the product becomes brittle and wears prematurely. In certain geographies, products that are sold and enter service in winter initially suffer rapid wear, followed by slower wear during the latter part of the warranty period. The opposite is true for products that are sold and enter service in summer. These seasonal variations affect the product wear rates and weighted replacement rates, which are detected early by QEWS.

#### **Production model**

The Production model identifies variations in product wear and replacement rates according to the production date of the product, not the resource in which the product is used. The production date of the product might correlate with the manufacturing equipment operator, the manufacturing process, or other important similarities.

For example, a faulty batch of products is produced during a particular period. The products are installed in resources that have different manufacturing dates. Although the resource manufacturing dates and the product production dates are unrelated, QEWS makes it easier to identify and understand the real cause of the warranty claims.

#### **Manufacturing model**

The Manufacturing model identifies variations in product wear and replacement rates according to the manufacturing date of the resource in which the product is used. The resource manufacturing date might correlate with assembly problems that occurred during a particular period.

For example, due to a short-term problem with the manufacturing process of a resource, some of the products that are used in the resource fail prematurely. Although the resource manufacturing dates and the product production dates are unrelated, QEWS makes it easier to identify and understand the real cause of the warranty claims.

You can adjust the frequency at which data is captured and input to QEWS, and the frequency at which QEWS analyses are run, according to the requirements of each situation. For example, monitoring data from a network of field service personnel might best be done on a monthly basis.

## **IBM Prescriptive Maintenance on Cloud**

Prescriptive Maintenance on Cloud is a feature of Predictive Solutions Foundation on Cloud that looks for patterns in how an equipment asset is used and the environment in which it is operating. It then correlates this information with any known failures in the equipment. These correlations are used to evaluate new data about the equipment asset, resulting in predictive scores that indicate the relative health of the equipment and the likelihood of future failures.

The ability to determine when maintenance should be performed on equipment assets leads to the following business benefits:

- You can estimate and extend the life of your assets.
- You can increase the return on your assets.
- You can optimize your maintenance, inventory, and resource schedules.

Prescriptive Maintenance on Cloud goes beyond both preventive and regularly scheduled maintenance to ensure asset performance, thereby enabling maximized value at every step of a process. Using Prescriptive Maintenance on Cloud, you can perform the following tasks:

- Predict the failure of an instrumented asset so that you can prevent costly unexpected downtime.
- Make adjustments to maintenance schedules and tasks to reduce repair costs and minimize downtime.
- Determine the most effective maintenance cycles.
- Identify the root cause of asset failure faster so that you can take corrective actions.

Instrumented assets generate data such as device ID, timestamp, temperature, and status code.

Examples of instrumented assets are manufacturing equipment, mining equipment, drilling equipment, farming equipment, security equipment, cars, trucks, trains, helicopters, engines, cranes, oil platforms, and wind turbines.

Data from instrumented assets and data from other sources such as maintenance records, maintenance logs, inspection reports, repair invoices and warranty claims can be collected and used in models that predict when an asset is likely to fail.



Prescriptive Maintenance on Cloud helps an organization optimize its maintenance program by developing a set of recommendations to carry out when specific changes in asset health are identified. These recommendations can be based upon analysis of historical maintenance records, best practices and procedures provided by subject matter experts, original equipment manufacturer recommendations, as well as analysis of correlations that indicate potential problems or pending asset failure. The goal of developing these optimized decisions or recommendations is to further improve maintenance practices. When an anomaly in asset performance is identified specific recommendations can be made to maintenance personnel in order to affect the most efficient remedy of the problem. In the case of a manufacturing organization which provides service or warranty support for products that are used by hundreds or thousands of customers, the ability to monitor asset performance in the field and proactively initiate a service call, in comparison to waiting for the client to initiate a repair request or warranty claim, can significantly transform the way the manufacturer provides service. With a better understanding of asset usage and performance in the field manufacturer may wish to modify its warranty program based upon asset usage or warranty costs. Additionally greater insight into asset usage and performance can help the manufacturer to optimize the parts inventory and locations so as to reduce the volume of inventory and identify locations to facilitate proactive customer service.

For example, an automobile assembly plant is a system that combines thousands of pieces of equipment with interlocking pieces. It is critical that such a system is able to work efficiently and produce safe, high quality products. Prescriptive Maintenance on Cloud looks for patterns in the usage and environmental information for equipment that correlate with failures that take place. These patterns are used to create predictive models to score incoming new data in order to predict the likelihood of failure. Scores that are generated from this information give an indication of the health of the piece of equipment. In addition, key performance indicators (KPIs) are collected, which are used for reporting. KPIs help to identify assets that do not conform to normal patterns of behavior. The plant employees can use dashboards and reports to monitor and track the lifecycle of each piece of equipment.

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## How is data backed up and restored?

IBM Open Platform redundancy is used to protect customer data in a big data environment. In addition, Tivoli® Storage Manager is used to back up data in the production environment, which includes Linux files and databases. Linux files include customer uploaded files and middleware/application configuration/log files. Databases include DB2® databases in an IBM Predictive Maintenance and Quality SaaS environment.

The following table shows the backup schedule for various aspects of the solution.

*Table 1. Backup schedule for solution data*

Data	Backup type	Frequency	Time (Central Time)	Retention period
Files	Full	Bi-weekly	00:00 - 03:00 on the 1st and 16th day of each month	5 weeks
	Incremental	Twice daily	00:00 - 03:00 and 12:00 - 15:00	14 days

Table 1. Backup schedule for solution data (continued)

Data	Backup type	Frequency	Time (Central Time)	Retention period
Databases	Full	Monthly	00:00 - 03:00 on the 1st day of each month	3 months
		Weekly	00:00 - 03:00 on Mondays	5 weeks
	Incremental	Daily	00:00 - 03:00	14 days

During the backup window, the solution is accessible but access performance is impacted.

In the event of a system failure that causes data damage or loss, IBM will help to restore the data to the recovery time points, according to its backup policy.

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## What's new

The What's new section contains a list of new, changed, and deprecated configuration features for this release. It also contains a cumulative list of similar information for previous releases. It will help you plan your application deployment strategies and the training requirements for your users.

To review an up-to-date list of environments that are supported by IBM products, see IBM Knowledge Center (<http://www.ibm.com/support/knowledgecenter>).

### New features in IBM Prescriptive Quality on Cloud

#### New features in the previous release

The following features were added or upgraded in the previous release of Prescriptive Quality:

- Supports duplicated file and variable names. Files that have the same file name as the uploaded file can be accepted during the uploading process. Files are parsed automatically after upload. The variables in event files are detected automatically, and therefore the user can see the variables from uploaded files directly. The user does not need to create a new variable. When the user runs an analysis, the data with same variable names are first merged and then the analysis is run based on the merged data.
- Supports the upload of Quality Early Warning System parameter files for variables. The parameters for a QEWS analysis can be organized in a file, and uploaded to the system directly. The user does not need to input the values in the user interface for each variable.
- Supports delete, preview, and download of the uploaded file. The uploaded files can be deleted, reviewed, and downloaded. In the previous release, the user could see only the list of the uploaded files.
- Supports add dimension during variable creation. Multiple dimensions can be attached to each variable type. For example, for the variable type height there can be two dimensions - product and operation. An analysis can be done for height of each product and operation. In the previous release, the user had to create variables for each product and operation manually.

- Supports move variable between groups and boards. A variable can be moved from a board and group to another board and group. In the previous release, the user had to remove the variable from the original board and group and add the variable to the destination board and group.
- Supports move group between boards. A group can be moved from a board to another board. In the previous release, the user had to remove the group and add the group and variables in the group to the destination board.
- Supports notification. When an event happens that needs the attention of the user, a notification shows in user interface.
- Supports a variables filter. The variables in a board can be filtered. When there are many variables in a board, the user can filter them according to a user-defined criteria.

## **New features in IBM Prescriptive Warranty on Cloud**

### **New features in the current release**

The following features are added or upgraded in the current release of Prescriptive Warranty:

- Provides the original IBM Research Quality Early Warning algorithm to detect emerging warranty problems. A new enhanced user experience provides simplified data onboarding and warranty analysis, and a quick clear alerting for warranty issues.
- The solution is offered on the new Big Data Platform that provides additional capabilities to run Spark jobs.

## **New features in IBM Prescriptive Maintenance on Cloud**

### **New features in the current release**

The following features are added or upgraded in the current release of Prescriptive Maintenance:

- A new enhanced Line of Business user experience provides a real-time analytical assessment of an asset's health and the probable window of failure. Optional integration with the IBM Watson™ IoT Platform offers a cost-effective means to connect, capture, and apply analytics to operational data that is generated by instrumented devices, equipment, and products.



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## Chapter 2. IBM Prescriptive Quality on Cloud

You can use Prescriptive Quality to upload data. With the data, you can view and analyze variables. You can also organize and track your variables.

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### Logging on

Log on to access IBM Prescriptive Quality on Cloud.

#### About this task

Provide your IBM ID to your local administrator. Your administrator is responsible for ensuring that you have the security access level that is appropriate to your role in your organization. Your administrator will also supply you with the web address URL for accessing the solution portal.

#### Procedure

1. Enter the URL in the address field of the browser.

**Note:** The fully qualified domain name is required in the URL, for example, `https://web_hostname/ibm/pq/` where `web_hostname` is the host name of the web server. If you use the IP address instead of the registered fully qualified domain name, some windows do not open correctly.

2. At the IBM ID log in page, enter your IBM ID and password. The Prescriptive Quality home page appears.

#### What to do next

Each time you close your browser window, you must enter your IBM ID and password to log in again.

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### Downloading the tutorial and sample data

IBM Prescriptive Quality on Cloud includes a tutorial and sample data.

#### About this task

The topic shows how to download the tutorial and sample data for a process engineer.

#### Procedure

1. Click the **User** icon and click **Tutorial download** to download the mp4 file for the steps for a process engineer.
2. Click **Sample data download** to download the sample data used for the tutorial.

---

### Uploading data files and previewing the data

On the home page, you can upload files for variable analysis and attribute analysis. Variable analysis and attribute analysis each require an event data file and an IBM Quality Early Warning System parameter file.

## About this task

When a file is uploaded, the system identifies the file type.

Variable event files and attribute event files are used to identify variables and attributes. When they are identified, variable types and attribute types appear in the Object list. (Parameter files cannot be used to identify variables and attributes. Variables and attributes in parameter files must also be in event files to be correctly identified.)

The variable event file can contain dimensional data and must also contain variable values and one timestamp column. The timestamp column must use one of the following time formats:

- dd/MM/yyyy HH:mm:ss
- yyyy/MM/dd H:mm:ss
- yyyy/M/d H:mm:ss
- d/M/yyyy H:mm:ss
- dd.MM.yyyy HH:mm:ss
- MM-dd-yyyy HH:mm:ss tt, where tt = AM or PM
- M/d/yyyy H:mm:ss tt, where tt = AM or PM
- yyyy-MM-dd HH:mm:ss

The attribute event file can contain dimensional data and must also contain ATTRIBUTE\_NAME, DATE, PRODUCED\_QTY, TESTED\_QTY, and FAILED\_QTY columns. The DATE column must use one of the following date formats:

- dd/MM/yyyy
- yyyy/MM/dd
- yyyy/M/d
- d/M/yyyy(

**Note:** M/d/yyyy format is assumed if no day is higher than 12 )

- dd.MM.yyyy
- MM-dd-yyyy
- M/d/yyyy
- yyyy-MM-dd

The variable parameter file can contain dimensional data as well as the following required and optional columns (not case-sensitive):

- QEWS\_ACCEPT\_LEVEL (required)
- QEWS\_SIGMA (required)
- QEWS\_TARGET (required)
- QEWS\_UNACCEPT\_LEVEL (required)
- QEWS\_VARIABLE or QEWS\_VARIABLE\_NAME (required)
- QEWS\_FALSE\_ALARM\_RATE (optional)
- QEWS\_NUMBER\_OF\_POINTS (optional)
- QEWS\_RUNTIME (optional)
- QEWS\_TYPE\_OF\_CONTROL (optional)

The attribute parameter file can contain dimensional data as well as the following required and optional columns (not case sensitive):

- QEWS\_ATTRIBUTE\_NAME (required)
- QEWS\_LAM0 (required)
- QEWS\_LAM1 (required)
- QEWS\_NUMBER\_OF\_VINTAGES (optional)
- QEWS\_PROB (optional)
- QEWS\_RUNDATE (optional)

**Important:**

- File names must not contain double pound symbols (##), less-than-greater-than symbols (<>), or square brackets ([]).
- Dimension column names must not contain special characters or spaces.
- Values in dimension columns must not contain colons (:), semicolons (;), or commas (,).
- Values in the ATTRIBUTE\_NAME column must not begin or end with a pound symbol (#) and must not contain double pound symbols (##) or semicolons (;).
- The QEWS\_RUNTIME column of parametric parameter must use the yyyy-MM-dd HH:mm:ss time format.
- The QEWS\_RUNDATE column of attribute parameter must use the yyyy-MM-dd date format.
- Files must not contain duplicate column names.
- In each file, date and time formats must be consistent, otherwise the file parser fails.
- During file upload, the file parser identifies file types by using the following rules. If the file contains a QEWS\_ATTRIBUTE\_NAME column, then it is an attribute parameter file. If the file contains a QEWS\_VARIABLE\_NAME or QEWS\_VARIABLE column, then it is a variable parameter file. If the file contains an ATTRIBUTE\_NAME column, then it is an attribute event file. Otherwise, it is a variable event file.

**Procedure**

1. Select **My Data > Files > Browse for file**, select the file, and select **Open**.
2. In the Progress pane, view the status of the upload.
3. In the Uploaded Files section, view the files. A file cannot be deleted while it is being parsed by the system. When the parsing is done, hover over the tags in each file card to see the object type, dimensions, and other information. (If the parsing fails, then an error message appears. Delete the file, correct the problem in the file, and upload again.)
4. To preview the data in the file, click **Preview**. The first 10 rows of the data are shown.

---

## Downloading data files

On the home page, you can download a data file that has been uploaded.

**Procedure**

1. Select **My Data > Connections > Files**.
2. In the Uploaded Files section, view the files.
3. From the list of files, click the menu button of the file and click **Download**.

---

## Deleting data files

On the home page, you can delete a data file that has been uploaded.

### About this task

When you delete a file, it does not delete the variables, parameters, or analysis results that relate to the file, but only deletes the file from the system.

### Procedure

1. Select **My Data > Connections > Files**.
2. In the Uploaded Files section, view the files.
3. From the list of files, click the menu button of the file and click **Delete**.

---

## Viewing object types

After an event data file is uploaded, you can view the detected variable types and attribute types.

### Procedure

1. Select **My Data > Objects > Variables** or **My Data > Objects > Attributes**.
2. View the analyzed variables or attributes. If a variable or attribute has a missing parameter, an alert is shown: **Missing Parameters**.

---

## Setting analysis parameters for a variable type

To run an IBM Quality Early Warning System parametric analysis, you first need to set the parameters.

### About this task

You can set the parameters by uploading a parameter file or by using the following procedure.

*Table 2. Parameter data types and descriptions*

Parameter name	Data type	Description and setting
<b>Runtime</b>	Time	The time point from when time is counted back for the number of points that are included in the analysis. The default value is the system time for when the analysis is run. The format must be yyyy-MM-dd HH:mm:ss.
<b>Sigma</b>	Double	The assumed standard deviation of the measurements. The value must be greater than zero.
<b>Target</b>	Double	The most desirable value for the center or mean measurement of the measured population.



Table 2. Parameter data types and descriptions (continued)

Parameter name	Data type	Description and setting
<b>Acceptable level</b>	Double	The deviation from the mean of the measurements that is acceptable. Typically this level is close to the Target value and reflects the amount of movement for the population mean around the target. Where there is low process capability this level coincides with the Target, indicating that there is no movement for the population mean.
<b>Unacceptable level</b>	Double	The deviation from the mean of the measurements that is unacceptable. You must have good detection capability for this level to work well. The unacceptable level must be further the Target than the acceptable level. Maintain a degree of separation between the acceptable and unacceptable levels of $0.2 \times \text{Sigma}$ .

Table 2. Parameter data types and descriptions (continued)

Parameter name	Data type	Description and setting
Type of control	int	<p>If Type_of_control = 1, then the control is one-sided. Only changes up or changes down are detected.</p> <p>If Type_of_control = 2, then the control is two-sided: both types of deviation from the Target are detected.</p> <p>For example: If Type_of_Control = 1 and Accept_Level &lt; Unaccept_Level, then only increased changes of the process mean are flagged. If Type_of_Control = 1 and Accept_Level &gt; Unaccept_Level, then only decreased changes of the process mean down are flagged.</p> <p>If Type_of_Control = 2 then you specify either Accept_Level &lt; Unaccept_Level or Accept_Level &gt; Unaccept_Level, with the understanding that the acceptable and unacceptable levels of the two-sided procedure are positioned symmetrically around the target.</p>
False alarm rate	Double	<p>The default value is 5000. The detection procedure produces a rate of false alarms of 1 per 5000 points when the population mean is located at the LAM0.</p>
Number of points	int	<p>Total number of points in the analysis. The default value is 100.</p>

### Procedure

1. Select **My Data > Variables** and select the variable that you want to set.
2. Click **Apply and Save**.

---

## Setting analysis parameters for an attribute type

To run an IBM Quality Early Warning System attribute analysis, you first need to set the parameters.

## About this task

You can set the parameters by uploading a parameter file or by using the following procedure.

Table 3. Parameter data types and descriptions

Parameter name	Data type	Description and setting
QEWS_ATTRIBUTE_NAME	String	The name of the attribute to be analyzed. This is a mandatory parameter.
QEWS_LAM0	Double	The acceptable failure rate. Failure rate equals failed quantity divided by tested quantity. The range of LAM0 is (0,1). This is a mandatory parameter.
QEWS_LAM1	Double	The unacceptable failure rate. LAM1 must be greater than LAM0. The range of LAM1 is (0,1). This is a mandatory parameter.
QEWS_PROB	Double	The probability of not having a false alarm of failure rate. The range of PROB is (0,1). The default value is 0.99.
QEWS_NUMBER_OF_VINTAGES	Integer	The maximum number of vintages in the analysis. The default value is 100.
QEWS_RUNDATE	Date	The date from which time is counted back for the number of vintages that are included in the analysis. The format must be yyyy-MM-dd. The default value is the system date for when the analysis is run.

## Procedure

1. Select **My Data > Attributes** and select the attribute that you want to set.
2. Click **Apply and Save**.

---

## Selecting the objects for analysis

You can add each variable type or attribute type to a board in the board view and run an analysis by selecting dimensions.

## About this task

### Procedure

1. From the board view, click **Add objects**.
2. Select a variable from the Variables tab or select an attribute from the Attributes tab.
3. Select the dimensions to run with the object (variable or attribute).

You can select multiple dimensions to run at one time.

4. Click **Add**.

The system displays the analysis state of the new object.

## Results

During analysis, all existing dimension value combinations are detected and analyses are run for each combination. You can select **Add All** or **Custom Select** to define which combinations to add to the board or group.

---

## Organizing objects

You use boards to organize and track your objects. Within the boards, you can organize the objects into groups. You can edit the objects from within the boards and groups.

### Boards

Boards are used to organize objects. You create, view, and edit boards in the My Boards section.

Four color blocks exist in each board that reflect the quality risk of the objects in the board and the percentage of objects that are in the color block.

- Red - Has exceeded the notification threshold within the last 10 data points.
- Yellow - Within threshold but has data points that are nearing the alert threshold.
- Blue - Alerts were issued before the last 10 data points, but now returning to an acceptable condition.
- Grey - All data points are within threshold, or some points were out of threshold but recent points are within threshold.

For example, a red color block showing 39% means that 39% of the objects that are associated with the board exceeded the notification threshold within the last 10 data points.

### Creating a board

You can create a board and add objects to the board.

#### Procedure

1. From the home page, click the **Create New Board** button.
2. Type the name of the new board.
3. Click **Create**.
4. If you want to change the name of the board, click **Edit Name** and type the new name of the board.
5. Click **Save**.
6. Click **Add objects** to add an object to the board.

### Deleting a board

You can delete a board.

#### Procedure

1. Click the menu button of the board you want to delete.
2. Click **Delete**.

3. In the confirmation window, click **Delete**.

## Groups

You can view all the groups in a board by selecting the board. You can organize objects within the groups of a board.

In a board, select **New Group** to create a group. You can edit the name of the group at any time. To edit the name of the group, click the current name of the group, edit the name, and click the check mark. You can also go to the menu of the group and select **Edit Name** to change the name of the group.

You add objects to the groups as a way to organize your objects. To add any number of objects to the groups, go to the menu of the group and select **Add Objects**. After you add an object to a group, you can view the quality analysis of the object.

If you no longer want a group, you can delete it. If the group contained objects, the objects are still in the Your Objects section. Go to the menu of the group and click **Delete** to delete the group.

### Filtering boards

You can use the Quality Early Warning System alert level and all objects as filter criteria.

#### About this task

After saving, the filter tags will be shown on the top of the groups.

#### Procedure

1. From the Board view, click **Filter**.
2. Select the filter criteria from the Alert type and Object Type dialog boxes.
3. Click **Save**. The filter criteria shows.

### Editing the name of a group

You can change the name of a group in different ways.

#### Procedure

1. To open the group in edit mode, from the Groups view, click the name of the group you want to change.
2. Type the new name of the group and click the check mark icon.

### Adding an object to a group

After analyzing new objects, you can add all the analyzed objects to a group or make a selection of the objects.

#### About this task

If you choose to add a selection of objects, a dialog box guides you to make the selection.

#### Procedure

1. In the Groups view, click **Add Objects**.
2. Select the group to which you want to add the objects.

3. Select objects. You can select **Add All** or **Custom Select** to further define which combinations to add to the board or group.
  - To select all objects, click **Add All**.
  - To make a selection of objects, click **Custom Select**. Do all of the following steps.
4. A list of ungrouped objects opens. Select objects to add to the group.
5. Click **Add**.

### **Moving a group from one board to another**

A group can be moved from a board to another board, or to a new position in its present board.

#### **About this task**

If the target board contains the same group name as the group name to be moved, then you can merge with, or replace, the group in the target board.

#### **Procedure**

1. In the groups view, click the group menu and click **Move**.
2. Select the target board.
3. Select the position in the target board and click **Save**.
4. If a group exists with the same group name, you see a dialog box to make the selection:
  - **Merge** merges the group data in the target board with the data in the moved group.
  - **Replace** overwrites the group in the target board with the data in the moved group.
  - **Save anyway** automatically renames the moved group. The data of both groups is separately retained.

### **Deleting a group from a board**

A group can be deleted from a board.

#### **Procedure**

1. In the groups view, click the group menu and click **Delete**.
2. In the confirmation window click **Delete**.

### **Moving an object from one group to another**

An object can be moved from one group or board to another other group or board.

#### **About this task**

If the target board or group contains the same object name as the object name to be moved, decide whether you want to replace the object in the target.

You can drag an object or use the following steps.

#### **Procedure**

1. From the Object view, click the object menu and click **Move**.
2. Select the board, group, and position, then click **Save**.

### **Deleting an object from a group**

An object can be deleted from a group.

## Procedure

1. From the Object view, click the object menu and click **Delete**.
2. From the delete confirmation window, click **Delete**.

## Variable analysis reports

You can see the Prescriptive Quality report of a variable from a group.

Each analysis report has a color tag that gives information over the status of the variable. These are described in the following table:

Table 4. Variable status colors and condition

Label	Color	Condition
Acceptable	Grey	All data points are within threshold or there are some points out of threshold but recent points has gone back within threshold.
Caution	Amber	Within threshold but has points that are verging to alert threshold.
Alert	Red	Has exceeded the notification threshold within the last 10 data points.
Alert but improving	Blue	Alerts issued before the last 10 data points, verging back to an acceptable condition.

The report charts shows two charts:

### Variable Value Chart

Shows graphically the variable value, the target value and the upper and lower unacceptable level values.

### Evidence Chart

Shows graphically the trend over time for the number of data points. The default number is 100.

If the parameter for `Type_of_control` is set to 1 sided, then points outside the notification threshold, and in some cases even individual points within threshold for which the supplemental *Shewhart* test is violated, are marked with solid blue triangles and corresponds to the legend **Alert Lower** and **Alert Upper**.

If the parameter for the `Type_of_control` is set to 2 sided then points outside the upper notification threshold are marked with blue triangles and corresponds to the legend **Alert Upper**, and points outside the lower notification threshold violating points are marked with red triangles and corresponds to the legend **Alert Lower**.

Below the tag shows the title of the variable and the name of the predictive data model.

The time selector enables you to set the analysis date.

## Attribute analysis reports

You can see the Prescriptive Quality report for each attribute in a group.

*Vintage* represents a group of products or work pieces that you want to analyze together to find quality issues. The input data is aggregated to the vintage level and the analysis is performed at the vintage level. In each Prescriptive Quality analysis, vintage is identified by the DATE column (the same ATTRIBUTE\_NAME and the same dimension values are used), so vintage is synonymous with *vintage date*. The PRODUCED\_QTY, TESTED\_QTY, and FAILED\_QTY values reflect the vintage date.

The analysis identifies unacceptable levels of failure rate. Failure rate is calculated by  $FAILED\_QTY / TESTED\_QTY$  for the same vintage for the selected attribute and dimension value.

During analysis, the main algorithm is the *Weighted Pages* algorithm. Supplemental test #1 identifies unacceptably high numbers of failures in the last **n\_days\_active** calendar days (by default, **n\_days\_active** is 60). Supplemental test #2 is based on the last value of the Weighted Pages algorithm if the last vintage is within **n\_days\_active** calendar days. The test results are combined to establish a severity level that determines if an alarm should be triggered. The last good period is also determined to clearly identify a *bad regime* (a bad series of data) and a *good regime* (a good series of data).

The online article *Weighted Cumulative Sum Technique* by Emmanuel Yashchin provides more information about the Weighted Pages algorithm.

Each analysis report indicates the status of the analysis result, as described in the following table:

Table 5. Failure rate status colors and condition

Color	Label	Description	Chart characteristics	Rules
Red	Alert	Unforgiven violations exist. It's time to take action.	The blue curve is above its threshold and data points have blue triangles, or a "+" or "x" marker appears at the last vintage.	If (severity >= prob & forgiveness < 9 & (last_alerting_vintage within 6 days or supalarm1 = 1 or (supalarm1 = 2 & forgiveness = 0)))
Blue	Alert but improving	Recent forgiven violations exist, or unforgiven violations exist but the situation has improved.	The blue curve is above its threshold and data points have blue triangles, or a "W" marker appears at the last vintage.	Else if (severity >= prob & ((forgiveness = 9 & last_alerting_vintage within 20 days) or (forgiveness < 9 & supalarm1 = 0) or (1 < forgiveness < 9 & supalarm1 = 2)))
Amber	Caution	No unforgiven violations exist, but recent or last vintages are near high severity. Keep watch over this.	A "W" marker appears at the last vintage.	Else if (1 - severity >= (1 - prob) * fact_yellow & supalarm1 = 2)



Table 5. Failure rate status colors and condition (continued)

Color	Label	Description	Chart characteristics	Rules
Grey / No color	Acceptable	No issues exist, or the issues are old and the situation has returned to normal. No actions are required.	There are no "+", "x", or "W" markers. There might be blue triangle alerts that have been forgiven.	Else.

*Severity* is the maximum value of Weighted Pages and supplemental test #1 and #2. Severity is in the range (0,1). Severity 1 means that the degree of violation in the evidence trajectory is so strong that there is zero probability that the process is acceptable.

*Supalarm1* is determined by supplemental test #1: if supplemental test #1 severity is above *prob*, then it is 1; if supplemental test #1 severity is between *prob* and  $1-(1-prob)*fact\_yellow$ , then it is 2; otherwise it is 0.

*Forgiveness* is the level of evidence that failure rate has returned to an acceptable level following a violation. Forgiveness is in the range (0,9), where 9 means the violation is forgiven and 0 means that there is no evidence of returning to an acceptable level.

**Fact\_yellow** is set to 1.5.

The report contains the following charts:

#### Failure Rate Chart

The Failure Rate chart shows the failure rate values and the acceptable level of failure rate. The X-axis top scale represents the accumulated tested quantity. The X-axis bottom scale represents the sequence number of the vintage (from oldest to newest) counted from the attribute data.

#### Evidence Chart

The Evidence Chart shows the time trend for the number of vintages. If the supplemental test #1 alarm is triggered, the last point of the evidence curve appears as "+". If the supplemental test #2 alarm is triggered, the last point of the evidence curve appears as "x". If supplemental test #1 or #2 alarm is in warning status, the last point of the evidence curve appears as "W".

## Modifying a parameter and rerunning an analysis

You can edit a parameter from the analyzed object and rerun the analysis.

### Procedure

1. From the object analysis report, click **View Parameter**.
2. The dialog box shows the current analysis parameters, click **Edit Parameters**.
3. Modify the values of the parameters that you need.
4. Click **Save and Run**.

---

## Notification

You can receive system notifications in IBM Prescriptive Quality on Cloud.

The notification icon shows the number of notifications and lists the notifications in chronological order.

The notification types are:

**File uploaded**

The user uploaded a file.

**File deleted**

The user deleted a file.

**Variable analysis complete**

An analysis of a variable is complete.

**Attribute analysis complete**

An analysis of an attribute is complete.

**Variable types added**

Variables were added to the system.

**Attribute added**

Attributes were added to the system.

**Missing parameters**

A number of variable types or attributes are missing parameter settings.

**Errors found**

Shows the cause of the error and indicates any missing parameters from an object, errors that were caused by the analysis of an object, and any system failure to run an analysis.

---

## Chapter 3. IBM Prescriptive Warranty on Cloud

You can use Prescriptive Warranty to upload data. With the data, you can view and analyze warranties. You can also organize and track your warranties.

---

### Logging on

Log on to access IBM Prescriptive Warranty on Cloud.

#### About this task

Provide your IBM ID to your local administrator. Your administrator is responsible for ensuring that you have the security access level that is appropriate to your role in your organization. Your administrator will also supply you with the web address URL for accessing the solution portal.

#### Procedure

1. Enter the URL in the address field of the browser.

**Note:** The fully qualified domain name is required in the URL, for example, `https://web_hostname/ibm/pw/` where `web_hostname` is the host name of the web server. If you use the IP address instead of the registered fully qualified domain name, some windows do not open correctly.

2. At the IBM ID log in page, enter your IBM ID and password. The Prescriptive Warranty home page appears.

#### What to do next

Each time you close your browser window, you must enter your IBM ID and password to log in again.

---

### Downloading the tutorial and sample data

IBM Prescriptive Warranty on Cloud includes a tutorial and sample data.

#### About this task

The topic shows how to download the tutorial and sample data.

#### Procedure

1. Click the **User** icon and click **Tutorial download** to download the mp4 file for the steps for a process engineer.
2. Click **Sample data download** to download the sample data that is used for the tutorial.

---

### Uploading data files and previewing the data

On the home page, you can upload sales event files, warranty event files, and parameter files to use with Prescriptive Warranty. You can upload the files one at a time or in a batch of up to 10 files. Batches can be of the same file type or of mixed types.

## About this task

The system parses each file to identify the file type. Warranty names are automatically identified from the sales event file and can be analyzed by using the uploaded data.

### Sales event file

The sales event file can contain dimensional information and must contain the following uppercase column names:

- PW\_NAME
- PW\_UNIQUE\_ID
- WARRANTY\_START\_DATE
- WARRANTY\_END\_DATE

#### Important:

- The file name must not contain double pound symbols (##), less-than-greater-than symbols (<>), or square brackets ([]).
- Dimension column names must not contain special characters or spaces.
- Values in dimension columns must not contain colons (:) or commas (,).
- The file must not contain duplicate column names.
- Values in the PW\_NAME column must not begin or end with a pound symbol (#) and must not contain double pound symbols (##).
- In the WARRANTY\_START\_DATE and WARRANTY\_END\_DATE columns, one of the following date formats must be used consistently within each file:
  - dd/MM/yyyy
  - yyyy/MM/dd
  - yyyy/M/d
  - d/M/yyyy (

**Note:** M/d/yyyy format is assumed if no day is higher than 12 )

  - dd.MM.yyyy
  - MM-dd-yyyy
  - M/d/yyyy
  - yyyy-MM-dd
  - dd/MM/yyyy HH:mm:ss
  - yyyy/MM/dd H:mm:ss
  - yyyy/M/d H:mm:ss
  - d/M/yyyy H:mm:ss
  - dd.MM.yyyy HH:mm:ss
  - MM-dd-yyyy HH:mm:ss tt, where tt = AM or PM
  - M/d/yyyy H:mm:ss tt, where tt = AM or PM
  - yyyy-MM-dd HH:mm:ss
- PW\_UNIQUE\_ID must be unique across all sales event files for each PW\_NAME. If duplicate PW\_UNIQUE\_ID values exist, the analysis will fail.

### Warranty event file

The warranty event file must contain the following uppercase column names (other columns are ignored):

- PW\_NAME
- CLAIM\_DATE
- PW\_UNIQUE\_ID

#### Important:

- The file name must not contain double pound symbols (##), less-than-greater-than symbols (<>), or square brackets ([]).
- The file must not contain duplicate column names.
- Values in the PW\_NAME column must not begin or end with a pound symbol (#) and must not contain double pound symbols (##).
- The CLAIM\_DATE column must use the same date format as used for the WARRANTY\_START\_DATE or WARRANTY\_END\_DATE columns.
- PW\_UNIQUE\_ID must be unique across all warranty event files for each PW\_NAME. If duplicate PW\_UNIQUE\_ID values exist, the analysis will fail.

### Parameter file

The parameter file must contain the following uppercase column names:

- QEWS\_PW\_NAME
- QEWS\_LAM0
- QEWS\_LAM1

Optionally, the parameter file can contain the following uppercase column names and can contain dimensional information if you want to further customize the analysis:

- QEWS\_PROB
- QEWS\_C0
- QEWS\_C1
- QEWS\_PROB\_C
- QEWS\_NUMBER\_OF\_POINTS
- QEWS\_RUNDATE

#### Important:

- The file name must not contain double pound symbols (##), less-than-greater-than symbols (<>), or square brackets ([]).
- The file must not contain duplicate column names.
- The QEWS\_PW\_NAME, QEWS\_LAM0, and QEWS\_LAM1 columns cannot contain only spaces or null values.
- Values in the QEWS\_PW\_NAME column must not begin or end with a pound symbol (#) and must not contain double pound symbols (##).
- The supported date format for the QEWS\_RUNDATE column is yyyy-MM-dd.
- If a dimension column contains only spaces or null values, then it is ignored.
- Values in dimension columns must not contain colons (:).

### Procedure

1. Select **My Data > Files > Browse for file**, select the file, and select **Open**.
2. In the Progress pane, view the status of the upload.
3. In the Uploaded Files section, view the files.
4. To view the uploaded file variable type and dimension information, hover over the tags in the right bottom of each file card.
5. To preview the data in the file click **Preview**. The first 10 rows of the data are shown.

---

## Downloading data files

On the home page, you can download a data file that has been uploaded.

### Procedure

1. Select **My Data > Connections > Files**.
2. In the Uploaded Files section, view the files.
3. From the list of files, click the menu button of the file and click **Download**.

---

## Deleting data files

On the home page, you can delete a data file that has been uploaded.

### About this task

When you delete a file, the operation does not delete the associated variables and parameters in the database, but only deletes the file from the system.

### Procedure

1. Select **My Data > Connections > Files**.
2. In the Uploaded Files section, view the files.
3. From the list of files, click the menu button of the file and click **Delete**.

---

## Viewing warranty types

After a sales event file is uploaded, you can view the detected warranty name.

### Procedure

1. Select **My Data > Warranties**.
2. View the analyzed warranties. If a warranty has a missing parameter, the warranty shows an alert: **Missing Parameters**. If a warranty is missing a warranty event file, the warranty shows an alert: **Missing Warranty File**.

---

## Setting analysis parameters for a warranty type

To run an IBM Quality Early Warning System warranty analysis, you first need to set the parameters.

### About this task

You can set the parameters by uploading a parameter file or by using the following procedure.

Table 6. Parameter data types and descriptions

Parameter name	Data type	Description and setting
QEWS_PW_NAME	String	The name of the warranty to be analyzed. This is a mandatory parameter.
QEWS_LAM0	Double	Acceptable replacement rate. Acceptable mean number of replacement actions per machine-month of service (RA/MM). Range of LAM0 is (0,1). This is a mandatory parameter.
QEWS_LAM1	Double	Unacceptable replacement rate. Unacceptable mean number of replacement actions per machine-month of service (RA/MM). LAM1 should be larger than LAM0. Range of LAM1 is (0,1). This is a mandatory parameter.
QEWS_PROB	Double	The probability of not having a false alarm of replacement rate. Range of PROB is (0,1). The default value is 0.99.
QEWS_C0	Double	Acceptable level of wear out index. The default value is 1.
QEWS_C1	Double	Unacceptable level of wear out index. The default value is 1.2. C1 should be larger than C0.
QEWS_PROB_C	Double	Probability of not having a false alarm of wear out index. Range of PROB_C is (0,1). The default value is 0.99.
QEWS_NUMBER_OF_POINTS	Int	The maximum number of vintages in the analysis. The default value is 5000.
QEWS_RUNDATE	Date	The default value is the system date for when the analysis is run. The date from when time is counted back for the number of vintages that are included in the analysis. The format must be yyyy-MM-dd.

### Procedure

1. Select **My Data > Warranties**, select the variable that you want to set.
2. Click **Apply and Save**.

---

## Selecting the warranties for analysis

You can add each warranty type to a board in the board view and run an analysis by selecting dimensions.

## About this task

### Procedure

1. From the board view, click **Add warranties**.
2. Select the warranty from the list.
3. Click **Add**.
4. Select the dimensions to run with the warranty. You can select multiple dimensions.

The system displays the analyzing state of the new warranty.

### Results

During analysis, all existing dimension value combinations are detected and analyses are run for each combination. You can select **Add All** or **Custom Select** to further define which combinations to add to the board or group.

---

## Organizing warranties

You use boards to organize and track your warranties. Within the boards, you can organize the warranties into groups. You can edit the warranties from within the boards and groups.

### Boards

Boards are used to organize warranties. You create, view, and edit boards in the My Boards section.

There are three different color blocks in each board that reflect the risk of the warranties of the board along with a percentage of warranties under that color block. Each warranty analysis has a color for replacement rate and a color for wearout index.

- Red - There are replacement rate violations or a wearout condition. It's time to take action.
- Yellow - The data is getting close to an alert. Keep watch over this.
- Grey - There are no issues to flag, or the issues are old and the situation has returned to normal.

For example, a red color block that shows 39% means that 39% of the replacement rate or wearout index of the warranties associated with that board have violations.

### Creating a board

You can create a board with its name, and add warranties to the new board.

#### Procedure

1. From the home page, click the **Create New Board** button.
2. Type the name of the new board.
3. Click **Create**.
4. If you want to change the name of the board, click **Edit Name** and type the new name of the board.
5. Click **Save**.
6. Click **Add warranties** to add the warranty to be associated to the board.

### Deleting a board

You can delete a board with its name.



### **Procedure**

1. Click on the menu button of the board you want to delete.
2. Click **Delete**.
3. In the confirmation window, click **Delete**.

## **Groups**

You can view all the groups in a board by selecting the board. You can organize warranties within the groups of a board.

In a board, select **New Group** to create a group. You can edit the name of the group at any time. To edit the name of the group in editable mode, click the current name of the group, edit the name, and select the check mark. You can also go to the menu of the group and select **Edit Name** to change the name of the group.

You add warranties to the groups as a way to organize your warranties. To add any number of warranties to the groups, go to the menu of the group and select **Add Warranty**. Once you add a warranty to a group, you can view the Prescriptive Warranty analysis of the warranty.

If you no longer want a group, you can delete it. If the group had warranties, the warranties are still in the Your Warranties section. Go to the menu of the group and select **Delete** to delete the group.

### **Filtering boards**

You can use the Quality Early Warning System alert level and all warranties as filter criteria.

#### **About this task**

After saving, the filter tags will be shown on the top of the groups.

### **Procedure**

1. From the Board view, click **Filter**.
2. Select the filter criteria from the Alert type and Warranty Type dialog boxes.
3. Click **Save**. The filter criteria shows.

### **Editing the name of a group**

You can change the name of a group in different ways.

### **Procedure**

1. To open the group in edit mode, from the Groups view, click the name of the group you want to change.
2. Type the new name of the group and click the check mark icon.

### **Adding a warranty to a group**

You can add warranties to a group.

#### **About this task**

If you choose to add a selection of warranties, a dialog box guides you to make the selection.

### Procedure

1. In the Groups view, click **Add Warranties to this group**.
2. Select the warranty from the list.
3. Click **Add**.

### Moving a group from one board to another

A group can be moved from a board to another board.

#### About this task

If the target board contains the same group name as the group name to be moved, then you can merge with, or replace, the group in the target board.

### Procedure

1. In the groups view, click the group menu and click **Move**.
2. Select the target board and click save.
3. If a group already exists with the same group name, you see a dialog box to make the selection:
  - **Merge** - merges the group data in the target board with the data in the moved group.
  - **Replace** - overwrites the group in the target board with the data in the moved group.
  - **Save anyway** - automatically renames the moved group. The data of both groups are separately retained.

### Deleting a group from a board

A group can be deleted from a board.

### Procedure

1. In the groups view, click the group menu and click **Delete**.
2. In the confirmation window, click **Delete**.

### Moving a warranty from one group to another

A warranty can be moved from one group or board to another other group or board.

#### About this task

If the target board or group contains the same warranty name as the warranty name to be moved, then you must decide if you replace the warranty in the target.

You can move a warranty by drag and drop or by using the following steps.

### Procedure

1. From the Warranties view, click the warranty menu and click **Move**.
2. Select the board, group, and position, then click **Save**.

### Deleting a warranty from a group

A warranty can be deleted from a group.

### Procedure

1. From the Warranties view, click the warranty menu and click **Delete**.
2. From the delete confirmation window, click **Delete**.

## Analysis reports

You can see the Prescriptive Warranty report for each warranty in a group.

The following analyses are performed on the data:

### Replacement rate

Replacement rate algorithms look for unacceptable levels of replacements. The main algorithm is the *Weighted Pages* algorithm. Supplemental test #1 identifies unacceptably high numbers of failures in the last **n\_days\_active** calendar days (by default, **n\_days\_active** is 60). Supplemental test #2 is based on the last value of the *Weighted Pages* algorithm if the last vintage is within **n\_days\_active** calendar days. The test results are combined to establish a severity level that determines if an alarm should be triggered. The last good period is also determined to clearly identify a *bad regime* (a bad series of data) and a *good regime* (a good series of data).

### Wearout

Wearout algorithms look for early wearout of parts. The *Weighted Pages* algorithm is used to monitor the Weibull shape parameter for monthly aggregated vintages.

The online article *Weighted Cumulative Sum Technique* by Emmanuel Yashchin provides more information about the *Weighted Pages* algorithm.

Each analysis report indicates the status of replacement rate and wearout, as described in the following tables:

Table 7. Replacement rate status colors and condition

Color	Label	Description	Chart characteristics	Rules
Red	Alert	Unforgiven violations exist, or recent or last vintages are at high severity. It's time to take action.	The green curve is above its threshold and data points have green triangles, or a "+" or "x" marker appears at the last vintage.	$(severity\_main > prob0 \ \& \ forgiveness < 9)$ or $(severity\_sup1 > prob0 \ \text{or} \ severity\_sup2 > prob0)$
Amber	Caution	No unforgiven violations exist, but recent or last vintages are near high severity. Keep watch over this.	A "W" marker is at the last vintage. There might also be green triangle alerts that were forgiven.	Else if $((1 - severity\_sup1 \leq (1 - prob0) * fact\_yellow) \ \text{or} \ (1 - severity\_sup2 \leq (1 - prob0) * fact\_yellow))$
Grey / No color	Acceptable	No issues exist, or the issues are old and the situation has returned to normal. No actions are required.	There are no "+", "x", or "W" markers. There might be green triangle alerts that have been forgiven.	Else.

Table 8. Wearout status colors and condition

Color	Label	Description	Chart characteristics	Rules
Red	Alert	A wearout condition exists. It's time to take action.	The severity of wearout is more than prob_c. There might also be red triangle alerts.	$severity\_w > prob\_c$
Amber	Caution	The data is getting close to an alert. Keep watch over this.	The severity of wearout is in the warning range. The pink evidence curve is near its threshold.	$1 - severity\_w \leq (1 - prob\_c) * fact\_yellow$ && $severity\_w \leq prob\_c$
Grey / No color	Acceptable	No issues exist. No actions are required.	The severity of wearout is in the acceptable range. The pink evidence curve is under its threshold.	$1 - severity\_w > (1 - prob\_c) * fact\_yellow$

*Severity\_main* is the severity of the Weighted Pages scheme for replacement rate. *Severity\_sup1* is determined by supplemental test #1. *Severity\_sup2* is determined by supplemental test #2 for replacement rate. *Severity\_w* is the severity for the wearout index. Values 0 and 1 are possible for severity value. In practice, 1 means that the degree of violation in the evidence trajectory is so strong that the probability of obtaining such a level of evidence under the acceptable process assumption is zero.

*Forgiveness* is the level of evidence that replacement rate has returned to an acceptable level following a violation. Forgiveness is in the range (0,9), where 9 means the violation is forgiven and 0 means that there is no evidence of returning to an acceptable level.

**Fact\_yellow** is set to 1.5.

The report contains two charts:

#### Replacement Rate Chart

Shows the Replacement Rate and Monthly Wearout Indices values. The left Y-axis represents the Replacement Rate and the right Y-axis represents the Monthly Wearout Indices. The top X-axis scale represents the accumulated machine months and the bottom X-axis scale represents the sequence number of the vintage (from oldest to newest) counted from the warranty data.

*Vintage* represents a group of products or work pieces that you want to analyze together to find warranty issues. In each Prescriptive Warranty analysis, vintage is identified by the WARRANTY\_START\_DATE column (the same PW\_NAME and the same dimension values are used).

**Tip:** If you want to use another date to group the products as a vintage (for example, manufacturing date), you can rename the appropriate date column as WARRANTY\_START\_DATE.

*Machine month* represents the number of months that any of the products of that vintage were in service during their warranty period. For example, a three-year warranty period for a product can contain up to 36 service months.

*Replacement rate* is calculated by claim counts/machine months.

*Monthly Wearout Indices* represents Weibull shape parameter "c" of consolidated vintages, by month. If  $c=1$ , no wearout exists; if  $c<1$ , the hazard rate is decreasing; if  $c>1$ , the hazard rate is increasing (that is, wearout exists).

### Evidence Chart

Shows the trend over time for the Replacement Rate and the Monthly Wearout Indices. The green curve represents the Replacement Rate, and green straight dotted line is the threshold for it. The pink curve is for the Monthly Wearout Indices, and the pink straight line is the threshold for it.

If the supplemental test #1 alarm is triggered, then a "+" marker appears on the last point of the replacement rate evidence curve. If the supplemental test #2 alarm is triggered, then a "x" marker appears on the last point of the replacement rate evidence curve. If supplemental test #1 or #2 alarms are in warning status, then a "W" marker appears on the last point of the replacement rate evidence curve. Supplemental test #1 and #2 are used to detect recently developed bad conditions earlier.

### Modifying a parameter and rerunning an analysis

You can edit a parameter from the analyzed warranty and rerun the analysis.

#### Procedure

1. From the warranty analysis report, click **View Parameter**.
2. The dialog box shows the current analysis parameters, click **Edit Parameters**.
3. Modify the values of the parameters that you need.
4. Click **Save and Run**.

---

## Notification

You can receive system notifications in IBM Prescriptive Warranty on Cloud.

The notification icon shows the number of notifications that you have received and show in chronological order.

The notification types are:

#### **File uploaded**

A system notification indicates the user has completed uploading a file.

#### **File deleted**

A system notification indicates the user has deleted a file.

#### **Analysis complete**

A system notification indicates an analysis of a warranty is complete.

#### **Warranty Added**

A system notification shows that warranties are added to the system.

#### **Missing Parameters**

A number of warranties are missing parameter settings.

**Errors found**

Shows errors and the cause of each error. Errors may be caused by failures during file upload, failures during analysis of a warranty, or other reasons.

---

## Chapter 4. IBM Prescriptive Maintenance on Cloud

You can use Prescriptive Maintenance on Cloud to upload data. With the data, you can view and analyze the maintenance requirements of equipment assets. You can also organize and track your equipment assets.

---

### Logging on

Log on to access IBM Prescriptive Maintenance on Cloud.

#### About this task

Provide your IBM ID to your local administrator. Your administrator is responsible for ensuring that you have the security access level that is appropriate to your role in your organization. Your administrator will also supply you with the web address URL for accessing the solution portal.

#### Procedure

1. Enter the URL into the address field of the browser.

**Note:** The fully qualified domain name is required in the URL, for example, `https://web_hostname/ibm/pm/` where `web_hostname` is the host name of the web server. If you use the IP address instead of the registered fully qualified domain name, some windows do not open correctly.

2. At the IBM ID log in page, enter your IBM ID and password. The Prescriptive Maintenance home page appears.

#### What to do next

On first use, you see a Welcome screen in which you can do the following things:

- Get a tour of the main elements of the software.
- View a tutorial video.
- View the documentation.
- Download sample data.
- Load sample data.

After first use, you can click the **User** icon to access these functions.

Each time you close your browser window, you must enter your IBM ID and password to log in again.

---

### Downloading the tutorial and sample data

IBM Prescriptive Maintenance on Cloud includes a tutorial and sample data.

#### About this task

The topic shows how to download the tutorial and sample data.

## Procedure

1. Click the **User** icon and click **Tutorial download** to download the mp4 file for the steps for a process engineer.
2. Click **Sample data download** to download the sample data that is used for the tutorial.

---

## Uploading data files and previewing the data

On the home page, you can upload event files and entity property files to use with Prescriptive Maintenance on Cloud. You can upload the files one at a time.

### About this task

The system parses each file to identify the file type.

#### Entity property file

The entity property file describes asset detail information and associates an asset with an asset type.

*Table 9. Key columns in the entity property file*

Default column name (sample data)	Description
NEXT_PM	The next planned maintenance date for an asset. The margin value is the predicted failure date minus NEXT_PM.
MF_DATE	The manufacture date of an asset.
WELL_MAINTAIN	Determines whether an asset is well maintained: <ul style="list-style-type: none"><li>• A well maintained asset's margin value is greater than 0 and less than WELL_MAINTAIN.</li><li>• An over-maintained asset's margin value is greater than WELL_MAINTAIN.</li><li>• An under-maintained asset's margin value is less than 0.</li></ul>

#### Important:

- The file must not contain repeated column names.
- The file must contain an `asset_id` column. The `asset_id` column cannot contain empty or null values.
- The `nextMaintenance` and `manufacturedDate` columns must use one of the following date formats consistently within each file:
  - yyyy-MM-dd hh:mm:ss
  - dd/MM/yyyy HH:mm:ss
  - yyyy/MM/dd H:mm:ss
  - yyyy/M/d H:mm:ss
  - d/M/yyyy H:mm:ss
  - dd.MM.yyyy HH:mm:ss
  - MM-dd-yyyy HH:mm:ss tt, where tt = AM or PM

#### Event file

The event file records failure events and asset operating data. Event data must be in a continuous time series that is recorded at a second, minute,



hourly, or daily level. Prescriptive Maintenance on Cloud does not support longer-interval time series such as weekly or monthly.

**Important:**

- The file must not contain repeated column names.
- The file must contain an `asset_id` column. The `asset_id` column cannot contain empty or null values.
- The file must record failure events.
- The `failurEvent`, `maintenancEvent`, and `repairEvent` columns must be of type `flag`.
- The file must contain a timestamp column.
- `is_fail` is a keyword for a failure event field in an event file. If you use `is_fail` as a column name for another field, it will be renamed as `is_fail_renamed`. In the analysis results, the failure event field will be renamed as `is_fail`.

**Procedure**

1. Select **My Data > Files > Browse for file**, select the file, and select **Open**.
2. In the Progress pane, view the status of the upload.
3. In the Uploaded Files section, view the files.
4. To view the uploaded file variable type and dimension information, hover over the tags in the right bottom of each file card.
5. To preview the data in the file, click **Preview**. The first 10 rows of the data are shown.

---

## Downloading data files

On the home page, you can download a data file that has been uploaded.

**Procedure**

1. Select **My Data > Connections > Files**.
2. In the Uploaded Files section, view the files.
3. From the list of files, click the menu button of the file and click **Download**.

---

## Deleting data files

On the home page, you can delete a data file that has been uploaded.

**About this task**

When you delete a file, the operation does not delete the associated events in the database, but only deletes the file from the system.

**Procedure**

1. Select **My Data > Connections > Files**.
2. In the Uploaded Files section, view the files.
3. From the list of files, click the menu button of the file and click **Delete**.

---

## Analysis results

You can select an asset type and then see the analyses for all equipment assets of that type.

On the asset panel, click the asset type menu and select an asset type.

Equipment assets are grouped by the following categories:

**All Assets**

All equipment assets, or all equipment assets of the selected type.

**Over Maintained**

Scheduled maintenance is long before the predicted failure of the asset.

**Well Maintained**

Scheduled maintenance is close to the predicted failure of the asset.

**Under Maintained**

Scheduled maintenance is long after the predicted failure of the asset.

**Needs Data**

More data is required to perform an analysis for the asset.

Each equipment asset appears on a separate card that provides important indicators of asset health:

**Top Driver**

The variable that is most likely to cause asset failure.

**Margin**

The number of days' difference between the next scheduled maintenance and the next predicted failure of the asset.

**Attention:** Negative margin means that the asset is predicted to fail before the next scheduled maintenance.

**Graph** The graph gives a concise visual reference of asset health:

- The gray horizontal bar indicates the total top driver count before the next predicted failure of the asset.
- The dark portion of the horizontal bar indicates the current top driver count.

**Attention:** If the entire horizontal bar is dark, then the asset is already past its next predicted failure.

- The vertical bar indicates the current average top driver count for this asset type.
- If the horizontal bar ends with a triangle point, then the current top driver count is more than twice the average top driver count for this asset type.

You can sort the cards based on Margin, or filter the cards based on Top Driver or Asset Property Type.

Click a card to open a window that shows more analysis results for the asset, including the following details:

- The number of days until the next scheduled maintenance date.

- All drivers (that is, variables that contribute to asset failure). A driver whose name ends with \_LTD is derived from an existing field by accumulating between failure events.
- The maintenance history of the asset.
- A histogram of all drivers or a particular driver.

**Tip:** Specify a time scale or drag the time window below the histogram to view a particular period of time.

---

## Notification

You can receive system notifications in IBM Prescriptive Maintenance on Cloud.

The notification icon shows the number of notifications that you have received and show in chronological order.

The notification types are:

**File uploaded**

A system notification indicates the user has completed uploading a file.

**File deleted**

A system notification indicates the user has deleted a file.

**Analysis complete**

A system notification indicates an analysis of an asset is complete.

**Asset added**

A system notification shows that assets were added to the system.

**Errors found**

Shows errors and the cause of each error. Errors may be caused by failures during file upload, failures during analysis of an asset, or other reasons.



---

## Appendix A. Integration with IBM Maximo

IBM Prescriptive Maintenance on Cloud uses historical maintenance and metric data to make predictions about asset failure based on the current state of the asset. IBM Maximo<sup>®</sup> is an application that supports device maintenance. It can be the source of some or all of the asset data that is needed by Prescriptive Maintenance.

### Overview

Asset data from Maximo may be provided to PM either as a file (csv) or through a http interface. The csv format may be most convenient for a large historical data set while the http interface is convenient for ongoing updates.

Maximo provides the capability to define and filter the data for export to PM. In general, the exported data fields correspond to the columns of a csv file for upload to PM. Thus they include timestamp, asset id, failure, maintenance, and metric data.

Maximo integration capabilities are defined using several components. Object Structures define the data fields. Publish Channels can determine when the data is exported and can filter which data to include. End Points determine the export method (ex. File or HTTP). And External Systems combine a Publish Channel with an End Point.

### Work Orders

Maximo Work Orders can be an import source of maintenance data for the PM application. This includes asset failure, asset repair or replace, and routine maintenance. The following is a description of a set of Maximo External System artifacts that allow export of this work order data to PM.

### Object Structure – PMEX\_WORKORDER

The PMEX\_WORKORDER Object Structure includes the following fields of WORKORDER. The extended fields (PMEX\_) are added as non-persistent attributes of WORKORDER.

- ASSETNUM
- SITEID
- WORKTYPE
- FAILDATE
- FAILURECODE
- STATUS
- STATUSDATE
- PMEX\_TIMESTAMP
- PMEX\_ASSET\_ID
- PMEX\_IS\_FAIL
- PMEX\_IS\_MAINTENANCE
- PMEX\_IS\_REP\_REPLACE
- WELL\_MAINTAIN

IBM Prescriptive Maintenance on Cloud needs the values of timestamp, asset\_id, is\_fail, is\_maintenance, is\_rep\_replace. By default, IBM Prescriptive Maintenance on Cloud will infer these values. Asset\_id is the combination of ASSETNUM+SITEID. If there is a FAILURECODE then is\_fail is TRUE and the timestamp is FAILDATE (otherwise timestamp is STATUSDATE). If the WORKTYPE is CM or EM then is\_rep\_replace is TRUE and otherwise if it is PM then is\_maintenance is TRUE.

This default mapping can be overridden by using a publish channel to explicitly set the value of any of the fields beginning with PMEX\_.

## Meters

Maximo meters can provide metric data that the PM application uses to train and score asset failure models.

### Object Structure – PMEX\_METER

The PMEX\_METER Object Structure includes the following fields of ASSETMETER. The extended fields (PMEX\_) are added as non-persistent attributes of ASSETMETER.

- SITEID
- METERNAME
- LASTREADING
- LASTREADINGDATE
- PMEX\_TIMESTAMP
- PMEX\_ASSET\_ID
- PMEX\_METRIC\_NAME
- PMEX\_METRIC\_VALUE

IBM Prescriptive Maintenance on Cloud uses Maximo meters as metrics. It needs the values of timestamp and asset\_id. It also needs the metric name and value. By default, IBM Prescriptive Maintenance on Cloud will infer these values. Asset\_id is the combination of ASSETNUM+SITEID. Timestamp is LASTREADINGDATE. The metric name is the METERNAME and the metric value is LASTREADING.

As with the work order, this default mapping can be overridden by using a publish channel to explicitly set the value of any of the fields beginning with PMEX\_.

## Endpoints

The object structures for IBM Prescriptive Maintenance on Cloud can be exported using an HTTP or Flat File (csv) endpoint. A Flat File endpoint may be more appropriate for a large amount of historical data while an HTTP endpoint is ideal for automatically exporting new data.

The HTTP endpoint must be configured with the URL, username, and password for IBM Prescriptive Maintenance on Cloud. It must also include the header “content-type application/xml” and the http method “POST”.

## Summary

IBM Maximo is an application with powerful capabilities to support asset maintenance. Historical data in IBM Maximo can be used to train and score predictive models in IBM Prescriptive Maintenance on Cloud. The resulting "days to failure" prediction in Prescriptive Maintenance can provide a valuable insight to help optimize asset maintenance and thus provide efficient and productive asset use.





---

## Appendix B. Integration with Internet of Things

IBM Prescriptive Maintenance on Cloud integrates with IBM Watson IoT Platform to make predictions about asset failure based on the current state of the asset.

### Configure your organization in IBM Watson IoT Platform

Before integrating IBM Prescriptive Maintenance on Cloud with IoT, you must configure your organization in IBM Watson IoT Platform. This guide does not explain how to create device types and device ids.

You must add ASSET\_ID in the **Metadata** field of a device id. This metadata is used to determine with which asset id this device is associated. For example,

```
{
  "ASSET_ID": "JK84-JAS-144"
}
```

Next, send data to devices. IBM Prescriptive Maintenance on Cloud supports receiving simple JSON data only. See the following example. The timestamp and asset id are added automatically when generating files:

```
{
  "is_fail": "true",
  "temperature_flag": "true",
  "event_count": "3"
}
```

### Add Integration

Before integrating with IBM Watson IoT Platform, you need to create an integration in IBM Prescriptive Maintenance on Cloud. You must enter the organization ID, API key, and authentication token to connect to IBM Watson IoT Platform. After connecting to an organization, you can select the devices from which to receive data.

In IBM Prescriptive Maintenance on Cloud, in the **IoT** tab, click **Add Integration**. Enter the organization ID, API key, and authentication token to connect to an organization. You can create only one integration for each organization.

Once connected to the organization, select the devices from which you want to receive data. Select **Add all data from all devices**, or click **Select Devices/Types/Events** to select specific devices.

Set **Analysis Interval** to Daily. The analysis interval is how often IBM Prescriptive Maintenance on Cloud triggers IoT data analysis. Only the Daily interval is supported.

### Analyze IoT data

After an integration with IBM Watson IoT Platform is created, IBM Prescriptive Maintenance on Cloud receives data from that integration and starts analyzing daily, at midnight.

You can disconnect from the integration by clicking **Disconnect**. IBM Prescriptive Maintenance on Cloud stops receiving data from that integration. You can reconnect to integration by clicking **Connect**.

You can pause analysis data from an integration by clicking **Pause Analysis**. IBM Prescriptive Maintenance on Cloud stops analyzing data from that integration. You can continue analysis by clicking **Continue Analysis**. During a pause, IBM Prescriptive Maintenance on Cloud can still receive data from that integration.

---

## Appendix C. Application programming interface

---

### Upload a file

Enables users to upload a file.

**URL** /ibm/pm/service/apiWrapper

**Method**

The request type POST

**URL parameters**

apiName=file\_upload

Username=myblueid

**Success response**

200 OK or "result":["error\_message":"File upload failed"]

**Sample call**

```
curl -k -X post --user myblueid:myblueidpassword --connect-timeout 600 -F file=@c:\inputdata_4_1M_part.csv "https://pm.predictivesolutionsapps.ibmcloud.com/ibm/pm/service/apiWrapper?apiName=file_upload&Username=myblueid"
```

---

### Get Maximo readings

**URL** /ibm/pm/service/apiWrapper

**Method**

The request type POST

**URL parameters**

apiName="Maximo"

Username=<username>

**Data parameters**

```
<?xml version="1.0" encoding="UTF-8"?><PublishPM_METER xmlns="http://www.ibm.com/maximo" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" creationDateTime="2016-10-07T15:14:01-04:00" transLanguage="EN" baseLanguage="EN" messageID="4279195.1475867641786120246" maximoVersion="7 6 20151202-1713 V7603-143" event="1"><PM_METERSet><ASSETMETER action="Replace"><ASSETMETERID>21</ASSETMETERID><ASSETNUM>11430</ASSETNUM> <LINEARASSETMETERID>0</LINEARASSETMETERID><METERNAME>0-PRESSUR</METERNAME><NEWREADING changed="1">750</NEWREADING> <NEWREADINGDATE changed="1">2016-10-07T15:13:00-04:00</NEWREADINGDATE><READINGTYPE></READINGTYPE><SITEID>BEDFORD</SITEID></ASSETMETER></PM_METERSet></PublishPM_METER>
```

**Success response**

200 OK {}

**Sample call**

```
https://pm.predictivesolutionsapps.ibmcloud.com/ibm/pm/service/apiWrapper?apiName=maximo&Username=T5
```

**Notes** Use this API with basic authentication header. Use IBM ID credentials.

---

## Retrieve result

Downloads the analysis result data for one asset.

**URL** /ibm/pm/service/apiWrapper

**Method**

The request type POST

**Data parameters**

```
{  
  "apiName": "file_download",  
  "Assetid": "JK84-JAS-142",  
  "Username": "demouser"  
}
```

**Success response**

```
attachment;filename="JK84-JAS-142.csv"
```

**Sample call**

```
curl -X post -u myblueid:myblueidpassword -o filename.csv -v  
"https://servername/ibm/pm/service/apiWrapper?apiName=file_download  
&Assetid=JK84-JAS-141&Username=myblueid"
```

**Notes** Use this API with basic authentication header. Use IBM ID credentials.

---

## Appendix D. Troubleshooting IBM Prescriptive Quality on Cloud

This section contains troubleshooting information for Prescriptive Quality.

---

### Cannot open the Prescriptive Quality web site

The URL that was provided by your administrator does not open.

In your browser, add the URL to the list of trusted sites, clear the browsing history cache, and try again.

---

### File upload or parsing fails

When you attempt to upload an event file or a parameter file, the upload or parse fails.

Event and parameter files must meet the criteria that are described in “Uploading data files and previewing the data” on page 9.

If the upload failed, correct the problems in the file, save the file, and upload it again. If parsing failed, decide whether you want to keep the file on the system; if not, delete it and upload the correct file.

---

### Event file is identified as a variable parameter file

An event file is mistakenly identified as a variable parameter file.

The event file must not contain any of the following column names (case-insensitive), which are reserved exclusively for variable parameter files:

- QEWS\_VARIABLE or QEWS\_VARIABLE\_NAME
- QEWS\_TARGET
- QEWS\_ACCEPT\_LEVEL
- QEWS\_UNACCEPT\_LEVEL
- QEWS\_SIGMA

After the column names are removed, save the file and upload it again. It will be correctly identified as an event file.

---

### Event file is identified as an attribute parameter file

An event file is mistakenly identified as an attribute parameter file.

The event file must not contain any of the following column names (case-insensitive), which are reserved exclusively for attribute parameter files:

- QEWS\_ATTRIBUTE\_NAME
- QEWS\_LAM0
- QEWS\_LAM1

After the column names are removed, save the file and upload it again. It will be correctly identified as an event file.

---

## Variable event file is identified as an attribute event file

A variable event file is mistakenly identified as an attribute event file.

The variable event file must not contain any of the following column names (case-sensitive), which are reserved exclusively for attribute event files:

- `ATTRIBUTE_NAME`
- `DATE`
- `PRODUCED_QTY`
- `TESTED_QTY`
- `FAILED_QTY`

After the column names are removed, save the file and upload it again. It will be correctly identified as a variable event file.

---

## Parameters are missing for a variable

Parameters are missing for a variable.

Confirm that you uploaded a parameter file that contains the parameters that are required for the variable. The variable name must be in the `QEWS_VARIABLE` or `QEWS_VARIABLE_NAME` column. You can upload a new parameter file that contains the required values, or you can edit the parameters in Prescriptive Quality on Cloud by clicking the variable.

---

## Parameters are missing for an attribute

Parameters are missing for an attribute.

Confirm that you uploaded an attribute parameter file that contains the parameters that are required for the attribute. The attribute name must be in the `QEWS_ATTRIBUTE_NAME` column. You can upload a new parameter file that contains the required values, or you can edit the parameters in Prescriptive Quality on Cloud by clicking the attribute.

---

## Variable analysis fails

In Notifications, the message appears: An error occurred when analyzing the variable.

The error might have one of the following causes:

- The **target**, **sigma**, **accept\_level**, **unaccept\_level**, **type\_of\_control**, **false\_alarm\_rate**, or **number\_of\_points** parameter values are not numbers. Change the values to numbers.
- The **sigma** parameter value is less than or equal to 0. Change the value to be greater than 0.
- The **target**, **accept\_level**, or **unaccept\_level** parameter values do not satisfy the following requirements: If **accept\_level** is greater than **target**, then **unaccept\_level** must be greater than or equal to **accept\_level**. If **accept\_level** is less than **target**, then **unaccept\_level** must be less than **accept\_level**.

- The **false\_alarm\_rate** parameter value is less than 1. Change the value to be greater than or equal to 1.
- The **type\_of\_control** parameter value is not in the range (1,2). Change the value to be in the range (1,2).
- The **number\_of\_points** parameter value is less than 1. Change the value to be greater than or equal to 1.
- The **runtime** parameter value uses an unsupported date format. It must use the yyyy-MM-dd HH:mm:ss date format.
- The variable event data contains too many data points or dimension values. Reduce the number of variables or reduce the number of data points in each variable.
- Apache HBase is not running correctly, Apache Kafka is not running correctly, or tenant permissions are not set correctly. Contact your administrator to correct these issues.

---

## Attribute analysis fails

In Notifications, the message appears: An error occurred when analyzing the attribute.

The error might have one of the following causes:

- The **lam0**, **lam1**, **prob**, or **number\_of\_vintages** parameter values are not numbers. Change the values to numbers.
- The **lam0** parameter value is greater than or equal to **lam1**. Change the value to be less than **lam1**.
- The **prob** parameter value is not in the range (0,1). Change the value to be in the range (0,1).
- The **number\_of\_vintages** parameter value is less than 1. Change the value to be greater than or equal to 1.
- The **rundate** parameter value uses an unsupported date format. It must use the yyyy-MM-dd date format.
- The attribute event data contains too many data points or dimension values. Reduce the number of attributes or reduce the number of data points in each attribute.
- Apache HBase is not running correctly, Apache Kafka is not running correctly, or tenant permissions are not set correctly. Contact your administrator to correct these issues.

---

## Report page is blank

When you view analysis reports, the report page is blank.

Nothing is shown in the report page if no successful run exists for any date for object and dimension values.





---

## Appendix E. Troubleshooting IBM Prescriptive Warranty on Cloud

This section contains troubleshooting information for Prescriptive Warranty.

---

### Cannot open the Prescriptive Warranty web site

The URL that was provided by your administrator does not open.

In your browser, add the URL to the list of trusted sites, clear the browsing history cache, and try again.

---

### File upload fails with error message

One of the following error messages appears when you upload a file:

*Table 10. File upload error messages and corrective actions*

Error message	Action
The file [file name] upload failed. The file name contains an invalid character [character]	Check the file name. The <> and ## characters are not supported in file name.
The column name contains invalid character [character]	Check column title in the file. The following characters are not supported in column title: ' " < > = # . % * ; : tab -
File parser Failed: column name should be Uppercase for [file name]	Change all column titles to uppercase in the file.
File parser Failed: invalid character [character] at row [number] in column [column title] for [file name]	Check all dimension values in the file. The colon character (:) is not supported in dimension value.
File parser Failed: no PW_NAME found for [file name]	Check if blank values exist in the PW_NAME column.
File parser Failed: null value at row [number] in QEWS_PW_NAME, QEWS_LAM0 or QEWS_LAM1 for [file name]	Check your parameter file if blank or null values exist in the QEWS_PW_NAME, QEWS_LAM0 or QEWS_LAM1 columns.

Table 10. File upload error messages and corrective actions (continued)

Error message	Action
File parser Failed: invalid Date format in [column title] for [file name] or File parser Failed: more than one Date format detected in [column title] for [file name]	<p>Check the date format in columns WARRANTY_START_DATE, WARRANTY_END_DATE and CLAIM_DATE. The following date formats are supported:</p> <ul style="list-style-type: none"> <li>• dd/MM/yyyy HH:mm:ss</li> <li>• yyyy/MM/dd H:mm:ss</li> <li>• yyyy/M/d H:mm:ss</li> <li>• d/M/yyyy H:mm:ss</li> <li>• dd.MM.yyyy HH:mm:ss</li> <li>• MM-dd-yyyy HH:mm:ss tt where tt = AM or PM</li> <li>• M/d/yyyy H:mm:ss tt where tt = AM or PM</li> <li>• yyyy-MM-dd HH:mm:ss</li> <li>• d/M/yyyy</li> <li>• M/d/yyyy</li> <li>• dd.MM.yyyy</li> <li>• dd/MM/yyyy</li> <li>• yyyy/MM/dd</li> <li>• yyyy/M/d</li> <li>• MM-dd-yyyy</li> <li>• yyyy-MM-dd</li> </ul>
File parser Failed: invalid character '#' in PW_NAME QEWS_PW_NAME for [file name]	Check value in column PW_NAME or QEWS_PW_NAME. '#' cannot be used as the beginning or end character.
File parser Failed: date value is later than current date at row [number] in [column title] for [file name]	Check date value in columns WARRANTY_START_DATE, WARRANTY_END_DATE or CLAIM_DATE. Future dates are not supported.
The file [file name] upload failed with file parser error or File parser Failed: unrecognized file type for [file name]	<p>Check whether the file satisfies the following requirements:</p> <ul style="list-style-type: none"> <li>• For sales event data, the columns PW_NAME, PW_UNIQUE_ID, WARRANTY_START_DATE, WARRANTY_END_DATE exist and column values are valid.</li> <li>• For warranty event data, the columns PW_NAME, PW_UNIQUE_ID, CLAIM_DATE exist and column values are valid.</li> <li>• For parameter data, the columns PW_NAME, QEWS_LAM0, QEWS_LAM1 exist and column values are valid. If the column QEWS_RUNDATE exists, it must use the yyyy-MM-dd date format.</li> </ul>
The file [file name] upload failed or Exception	A system exception or environment problem occurred. Contact your administrator.

If the upload progress bar stops at 69% for a long time, check if your file contains a large volume data. If possible, divide the data into several smaller files and then upload them again.

---

## Warranty event file is identified as a sales event file

A warranty event file is mistakenly identified as a sales event file.

Warranty event files must not contain any of the following column names (case-sensitive), which are reserved exclusively for sales event files:

- *WARRANTY\_START\_DATE*
- *WARRANTY\_END\_DATE*

After the above column names have been removed, save the file and upload it again. It will be correctly identified as a warranty event file.

---

## Sales or warranty event file is identified as a parameter file

A sales or warranty event file is mistakenly identified as a parameter file.

Sales and warranty event files must not contain any of the following column names (case-sensitive), which are reserved exclusively for parameter files:

- *QEWS\_PW\_NAME*
- *QEWS\_LAM0*
- *QEWS\_LAM1*

After the above column names have been removed, save the file and upload it again. It will be correctly identified as a sales or warranty event file.

---

## Parameters are missing for a warranty

Parameters are missing for a warranty.

Confirm that you uploaded a parameter file that contains the parameters that are required for the warranty. The warranty name must be in the *QEWS\_PW\_NAME* column. You can upload a new parameter file that contains the required values, or you can edit the parameters in Prescriptive Warranty on Cloud by clicking the warranty.

---

## Warranty event file is missing for a warranty

Warranty event file is missing for a warranty.

Confirm that you uploaded a warranty event file that contains the following column names (case-sensitive):

- *PW\_NAME*
- *PW\_UNIQUE\_ID*
- *CLAIM\_DATE*

---

## Analysis fails

The message An error occurred when analyzing the warranty displays in notifications.

The error might have one of the following causes:

- Values of parameters lam0, lam1, prob, c0, c1, prob\_c, number\_of\_points are not numbers. Change the values to numbers.
- lam0 in parameters is greater than lam1. Change the value of lam0 or lam1 in parameters.
- c0 in parameters is greater than c1. Change the value of c0 or c1 in parameters.
- lam0 or lam1 in parameters is not in range (0,1).
- There are too many dimension values in your sales event data.
- hbase is not running correctly, kafka is not running correctly, or tenant permissions are not set correctly. Contact your administrator to correct these issues.

If the data contains many warranties and many data points in each warranty, it is possible for Prescriptive Warranty on Cloud to time out while it is running an analysis. To prevent such a failure, reduce the number of warranties or reduce the number of data points in each warranty, and try again.

---

## Analysis result

Here is an explanation of some analysis results that can occur.

- If the latest date's run for a warranty+dimension values fails, the UI shows that the latest run date failed.
- If the warranty+dimension is being rerun, the UI shows the latest date's run result.
- Wearout color coding is not red even when there are some wearout alerts in evidence chart. The wearout color coding is decided by severity of wearout. If it is  $> \text{prob\_c}$ , then color coding is red; if it is  $< 1 - (1 - \text{prob\_c}) * 1.5$ , then color coding is gray. Otherwise, it is yellow.

## Appendix F. Troubleshooting IBM Prescriptive Maintenance on Cloud

This section contains troubleshooting information for Prescriptive Maintenance on Cloud.

The following table shows possible error messages and corrective actions:

*Table 11. Prescriptive Maintenance on Cloud error codes, messages, explanations, and corrective actions*

Error code	Error message	Explanation	Action
PM-W-0003	The file <b>X</b> uploaded successfully	File uploaded successfully to the data lake and finished parser.	
PM-W-0004	The file <b>X</b> was deleted	The file deleted successfully from the data lake and Hbase.	
PM-W-0005	The File <b>X</b> upload failed	Exception happened during file upload to the data lake.	Check that the file contains the correct timestamp column and other required fields. Event files require failure event, timestamp, and asset id fields. Entity property files require asset type, asset id.
PM-W-0021	There is no asset_id column in the file <b>X</b>	ASSET_ID is a required column in Prescriptive Maintenance data. But file parser can not find it from uploaded file.	Add ASSET_ID column in the file which report this error and upload it again.
PM-W-0022	There is no timestamp column in the file <b>X</b>	Timestamp is a required column in Prescriptive Maintenance data. But file parser can not find it from x file.	Add timestamp column in x file and upload it again.
PM-W-0023	There are repeated column names in the file <b>X</b>	File parser found duplicated column names in x file.	Remove or rename duplicated column name in x file, and upload it again.
PM-W-0024	The type of failurEvent, maintenancEvent or repairReplaceEvent column in the file <b>X</b> is not correct	File parser use translation file to parse x file and find failureEvent, maintenanceEvent or repairReplaceEvent didn't contain flag value (True/False).	Edit translation file map correct flag value fields to these specified columns. Or edit x file to make these columns contain flag value (True/False).

Table 11. Prescriptive Maintenance on Cloud error codes, messages, explanations, and corrective actions (continued)

Error code	Error message	Explanation	Action
PM-W-0025	The type of nextMaintenance or manufacturedDate column in the file <b>X</b> is not correct	File parser use translation file to parser the data find nextMaintenance or manufacturedDate didn't contain timestamp value.	Edit translation file map correct timestamp fields to these specified columns. Or edit data to make these columns contain correct timestamp data(True/False)
PM-W-0026	There is no asset_type column in the file. Choose a column as the asset_type	File parser find user upload file is a entity property file. But this file didn't contain ASSET_TYPE column.	Add one more column ASSET_TYPE in this file or use translation file to map one column to asset_type.
PM-W-0027	None of the assets in the file <b>X</b> have an asset type. Upload an entity property file and manually trigger the analysis	User didn't upload entity property file related with asset_id in event data.	Upload entity property file contain asset_type information for asset_id in event data.
PM-W-0030	Successfully disconnected from the IBM Watson IoT Platform	Disconnected from IoT platform.	
PM-W-0031	You haven't connected to this organization	User disconnect from a unconnected IoT organization.	Refresh UI and disconnect option disappear.
PM-W-0032	You already connected to this organization	User try to connect to IoT organization which has already been connected to.	Refresh UI and connect option disappear.
PM-W-0033	Successfully connected to the IBM Watson IoT Platform	User connected to IoT platform.	
PM-W-0034	You must create a connection to this organization before attempting to connect	User try to connect to an IoT platform which connection definition haven't been created yet.	Create a IoT connection in IoT UI and then connect to it.
PM-W-0035	Successfully deleted connection	User delete one IoT connection.	
PM-W-0036	An error occurred when deleting an IoT connection	An exception happen when delete IoT connection.	Disconnect to IoT platform first then delete this connection again.
PM-W-0039	An error occurred while analyzing file <b>X</b>	A timeout error occurred when analyzing file x	Rerun analyzing by click retrain button on UI.

Table 11. Prescriptive Maintenance on Cloud error codes, messages, explanations, and corrective actions (continued)

Error code	Error message	Explanation	Action
PM-W-0040	File <b>X</b> upload failed with file parser	Error happen when system cannot parse File x	Check file format matches with translation file and upload it again.
PM-W-0041	You already added integration to organization <b>X</b>	User try to add a new integration connection which already existed.	User can edit old one to make the change. IoT platform on support one connection from a client.
PM-W-0043	An error occurred when saving the translation file	User uses invalid JSON file as translation file.	Check translation file is in correct JSON format.
PM-W-0044	The API Key or Authentication Token is wrong	Failed to authenticate with IoT platform with input API key and authentication token.	Check API key and Authentication token input correctly.
PM-W-0045	You must disconnect from IoT platform before saving this integration	User try to save integration while it connected.	Disconnect from IoT platform and then edit the connection.
PM-W-0046	There is no dataFile object in the translation file	User may delete dataFile object in translation file	dataFile object is required in translation file. User need to add it back or fix incorrect spelling.
PM-W-0047	There is no entityPropertyFile object in the translation file	User may delete entityPropertyFile object in translation file	entityPropertyFile object is required in translation file. User need to add it back or fix incorrect spelling.
PM-W-0048	The dataFile object is not a valid json object	After user edit translation file dataFile object is not a valid JSON object.	User need to fix the format of dataFile object in translation file before save it or replace it.
PM-W-0049	The entityPropertyFile object is not a valid json object	After user edit translation file entityPropertyFile object is not a valid JSON object.	User need to fix the format of entityPropertyFile object in translation file before save it or replace it.
PM-W-0050	You must provide failureEvent, maintenanceEvent and repairReplaceEvent in the dataFile object	After user edit translation file failureEvent, MaintenanceEvent or repairReplaceEvent can not be found in dataFile object.	User need to add failureEvent, MaintenanceEvent and repairReplaceEvent in dataFile object.

Table 11. Prescriptive Maintenance on Cloud error codes, messages, explanations, and corrective actions (continued)

Error code	Error message	Explanation	Action
PM-W-0051	You must provide assetType, nextMaintainance, manufacturedDate and wellMaintainThreshold in the entityPropertyFile object	After user edit translation file assetType, nextMaintainance, manufacturedDate or wellMaintainThreshold can not be found in entityPropertyFile object.	User need to add assetType, nextMaintainance, manufacturedDate and wellMaintainThreshold in dataFile object.
PM-W-0052	We found "key": "value" pairs in the translation file that duplicate column titles in the file <b>X</b>. "key" must use a different name than column titles	User use a column name in file x as Key in translation file.	Change either column name in file x or Key in translation file.
PM-W-0053	<b>X</b> rows contain an empty asset id in the uploaded file <b>Y</b>	Asset id is null in File Y	Provide a value for Asset id in File Y, and upload it again.
PM-W-0055	No asset type was found for <b>X</b> assets in event file <b>Y</b>	System didn't found asset type related to x number of assets in file Y.	Upload an entity property file contain relation between asset and its asset type.
PM-W-0056	The schema in file <b>X</b> does not match the previous model, so we cannot score the model. You must manually train a new model	Auto scoring process found uploaded file x columns didn't match previous trained model.	Edit file x to make columns consistent with previous model, or click retrain button to retrain a new model.
PM-W-0057	There is no failure event in file <b>X</b>	Prescriptive maintenance analysis require failure event in event file, but file x doesn't have it. File x will automatically delete from system.	Add failure event in file x then upload it again.
PM-W-0058	The event data for asset type <b>X</b> is not sufficient to build a model	To build analytic model it required at least 10 record. But data for asset type x doesn't have enough data.	Upload more data for asset type x and click retrain button to analysis it.
PM-W-0059	The model is not accurate for asset type <b>X</b>	Analytic model is built, but the model accuracy is very low.	Upload more historical event data and click retrain to analysis.
PM-W-0060	Event data for asset type <b>X</b> cannot fit a model	Asset type x can't build a model with current event data	Upload more historical event data and click retrain to analysis.



Table 11. Prescriptive Maintenance on Cloud error codes, messages, explanations, and corrective actions (continued)

Error code	Error message	Explanation	Action
PM-W-0061	The model built successfully, but the entity property file did not contain the next planned maintenance date. Margin cannot be calculated.	Entity property for this model doesn't contained next planned maintenance date. Model score cannot complete without that date.	Upload new entity property file contained next planned maintenance date. And click retain to analysis.
PM-W-0062	The asset type <b>X</b> was analyzed successfully	Asset type x has finished analysis successful.	
PM-W-0063	The asset type <b>X</b> was scored successfully	Asset type x has finished score successful.	
PM-W-0064	The asset type <b>X</b> analysis failed	Asset type x fail to analysis.	Click retrain to analyze. If problem still exist contact support, and provide event data and entity property data for further troubleshooting.
PM-W-0065	The asset type <b>X</b> scoring failed	Asset type x fail to score.	Make sure data schema is consistent with previous build model. And click retrain button. If problem still exist contact support, and provide event data and entity property data for further troubleshooting.
PM-W-0066	The uploaded file <b>X</b> is not a valid json file	User uploaded file x is doesn't contained correct JSON format	Check file x and fix incorrect format.
PM-W-0067	The asset id <b>X</b> scoring failed	Asset id x score failed	Make sure the asset contains event data and that the data schema is consistent with the previous build model. Click the retrain button. If problem still exists, contact support and provide event data and entity property data for further troubleshooting.
PM-W-0068	The asset id <b>X</b> scoring successfully	Asset id x score successfully	



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