

# Getting Started with Minitab Model Ops™

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# Overview

Minitab Model Ops™ provides the ability to use a variety of sophisticated models from Minitab® Statistical Software or Salford Predictive Modeler® to make predictions. By making those models accessible through external endpoints, Minitab Model Ops streamlines the incorporation of model results into external applications you use to make business decisions. Use those predictions to forecast your business with ease. With Minitab Model Ops, you deploy your models online so that you can get your results faster than ever. The model monitoring tools provide information so that you can make informed decisions about when to retrain or replace a model.

Minitab Model Ops has 4 main sections:

## Model Library

Import, deploy, and monitor models. For more information, go to [Model Library](#) on page 5.

## Endpoint Management

Assign deployed models to endpoints to access through standard HTTP requests. For more information, go to [Endpoint management](#) on page 21.

## API Keys

Provide permission to access endpoints. For more information, go to [Manage API Keys](#) on page 22.

## System Audit Log

Record actions that affect the status of models, endpoints, and API keys.

## Use Minitab Model Ops with Minitab Connect™

Minitab Connect empowers data users from across the enterprise with self-serve tools. Use those tools to transform diverse data into a governed network of data pipelines, to feed analytics initiatives and foster organization-wide collaboration. Use Minitab Model Ops and Connect together to create a seamless system where each update to your data in Connect starts a flow that brings near-instant predictions from Minitab Model Ops. Use those predictions in your analytics initiatives to deliver insights that inspire action. For information on establishing a flow that accesses Minitab Model Ops, go to [Common tasks with the Flow Tool](#) and select "Create a connection with Minitab Model Ops".

## Roles within Minitab Model Ops

Minitab Model Ops provides two roles: **User** and **Engineer**:

### User

Users have the following permissions:

- Import models
- Make predictions with deployed models
- View model monitoring reports
- View audit logs

Users can not deploy models, upload baseline data, upload stability data, manage endpoints, or manage API Keys.

### Engineer




**Engineers** have all the permissions that **Users** have. **Engineers** have the following additional permissions:

- Manage models
- Manage endpoints
- Manage API keys

Model management gives **Engineers** permission to deploy models, upload baseline data, and upload stability data. Engineers also have permission to change settings for model monitoring. The settings include the specification of email addresses to alert when the drift status of a model changes.

## Navigation within Minitab Model Ops

Use the buttons at the top left to easily switch between sections:

-  **Model Management**
-  **Endpoint Management**
-  **API Keys**
-  **System Audit Log**

People with the **User** role do not see the sections for **Endpoint Management** or **API Keys**.

## System requirements

### Connectivity

An internet connection is required.

### Supported browsers


Chrome, Chromium Edge, Safari

# Model Library

Minitab Statistical Software and Salford Predictive Modeler (SPM) create sophisticated predictive analytics models that you use for applications like prediction and forecasting. To deploy, predict and monitor with Minitab Model Ops, the first step is to import the model. After you import a model, the model is published. You can deploy a published model to an endpoint so that you can make predictions through standard HTTP requests. Monitor the drift and performance of your model with graphs and statistics that make relevant information clear.

## Import a model

Importing a model is like opening a file.

1. Sign in to Minitab Model Ops to open the **Model Library** .
2. Select **Import Model**.
3. Select the box next to **Select a File**.
4. Browse to and select a file that contains a model. Minitab Model Ops supports models from two types of files:
  - Minitab Project file (.mpx)
  - SPM Grove file (.grv)
5. In **Model Name**, enter a descriptive name for the file.
6. If you import a Minitab project file that contains multiple models, select the model from **Specify the model within the file**. The list contains all the supported models in the file.
7. Select **Import Model**.


## Import a model from Minitab Statistical Software for event/trial data

When you import a model with data in event/trial format, Minitab Model Ops requests additional information:

- Binary event probability threshold
- Event name
- Non-event name

The model assigns cases with an event probability higher than the threshold to the event class. Other cases belong to the non-event class. For models with a binary response format that do not use event/trial format, the threshold is always 0.5.

Tools that monitor drift and stability are unavailable for models for event/trial data.

1. Sign in to Minitab Model Ops to open the **Model Library** .
2. Select **Import Model**.
3. Select the box next to **Select a File**.
4. Browse to and select a Minitab project file that contains a model for event/trial data.
5. In **Model Name**, enter a descriptive name for the model.
6. If the file contains multiple models, select the model from **Specify the model within the file**. The list contains all of the supported models in the file.

7. In **Binary Event Probability Threshold**, enter a value between 0 and 1. The model assigns cases with an event probability greater than the threshold to the event class. For example, a value of 0.5 means that the model assigns a case to the event class when the probability of the event is higher than 0.5.
8. In **Event Name**, enter a descriptive name for the event class.
9. In **Non-event Name**, enter a descriptive name for the non-event class.
10. Select **Import Model**.

## Supported model types

Minitab Model Ops supports models from Minitab Statistical Software 20.1 and newer and from SPM 8.3.2 and newer. Some model types from Minitab Statistical Software are from newer releases than 20.1.

## Supported models from Minitab Statistical Software

In Minitab Statistical Software, Minitab Model Ops supports all the models from the Predictive Analytics Module, some models from the Regression menu, and some models from the DOE menu. For more information on the Predictive Analytics Module, go to <https://www.minitab.com/products/minitab/predictive-analytics-module/>:

- Analyses from the Predictive Analytics Module:
  - Discover Best Model (Binary Response) (21 and newer)
  - Discover Best Model (Continuous Response) (21 and newer)
  - CART® Classification
  - Fit Model for TreeNet® Classification (20.2 and newer)
  - Discover Key Predictors for TreeNet® Classification
  - Random Forests® Classification (20.2 and newer)
  - CART® Regression
  - Fit Model for TreeNet® Regression (20.2 and newer)
  - Discover Key Predictors for TreeNet® Regression
  - Random Forests® Regression (20.2 and newer)
- Analyses from the Regression menu:
  - Fit Regression Model
  - Fit Binary Logistic Model
  - Fit Poisson Model

## Supported models from SPM

Minitab Model Ops supports models that you create with the following analyses in SPM:

- CART® Decision Tree
- Generalized PathSeeker®(GPS)/Generalized Lasso
- Logistic Regression
- MARS® Regression Splines
- RandomForests® Tree Ensembles
- TreeNet® Gradient Boosting Machine

Minitab Model Ops does not support the following features:

- Grove files that contain multiple models, including any grove files with multiple models from the **Automate** tab.

- Models that include lags of predictors as additional predictors.

Some model types have specific exceptions. Minitab Model Ops does not support the following options for the supported model types:

#### CART® Decision Tree

Models where the **Target Type** is **Unsupervised**.

Models where the **Automate Types** include **UNSUPERVISED**.

Models where the decision trees use the method of **Differential Lift**.

#### MARS® Regression Splines

Models with a **Target Type** of **Classification/Logistic Binary**.

#### RandomForests® Tree Ensembles

Models where the **Target Type** is **Unsupervised**.



#### TreeNet® Gradient Boosting Machine

Models with a **TreeNet Loss Function** of **Random Forests**.

Models with a **TreeNet Loss Function** of **Differential Lift Modeling**.

## Deploy a model

After you import a model, the status is **Published**. To access a model from its endpoint and make predictions, deploy the published model.

1. Sign in to Minitab Model Ops to open the **Model Library** .
2. Move your mouse pointer over a published model.
3. Select **Deploy** .
4. Select **Proceed**.

After you deploy the model, the status of the model changes to **Pending**. When deployment is complete, Minitab Model Ops displays the **Endpoint URL** for the model.

## Monitor a deployed model



Minitab Model Ops monitors the drift of a model.


In the Model Library, you can see a classification of a model's drift and see whether email alerts about drift are active.

Use the monitoring tools to get detailed information on drift for individual variables. For information on monitoring variables, go to [Work with models](#) on page 9.

## Drift classifications for models

The Drift column has 4 categories:



Icon	Status	Details
	Severe drift	The prediction drift is severe or a minimum number of predictor variables have severe drift.
	Moderate drift	The prediction drift is moderate or a minimum number of predictor variables have severe drift.

Icon	Status	Details
	Minimal drift	The drift is not severe or moderate.
Blank	No status	The model does not have baseline data or has data from less than 50% of the production period. The drift column is also blank for models that do not use tools that monitor the data. For more information, go to <a href="#">Work with models</a> on page 9.

If a model has severe or moderate drift, investigate whether to update the model. For information on how to specify the criteria for drift classification, go to [Work with models](#) on page 9.

## Email alerts for models

To the left of each model name is a bell.

Icon	Alert status
	Active
	Inactive

When an alert is active, Minitab Model Ops sends an alert email anytime the drift status for the model changes. To specify which email addresses receive the alert, select the model name, then select [Settings](#).



# Work with models

The predictions from your deployed models are powerful tools for the achievement of business goals, whether those goals are to identify prospective customers or to flag unusual behavior. Over time, changes in real-world conditions cause the accuracy of a model to decline. For example, a model that includes the number of daily newspapers a household receives probably performs very differently on data from 1970 than on data from 2020. For many applications, maximization of model accuracy is so important and conditions change so quickly that ongoing monitoring of models is necessary.

In addition to tools that monitor drift and stability of a model, the tools also monitor the model service.

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**Note:** Tools that monitor drift and stability are not available for models from Fit Binary Logistic Model in Minitab Statistical Software that use event/trial data.

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## Overview

The **Overview** for a model includes details about the model and service metrics.

## Model details

The model details provide basic information to identify and work with the model:

### Name

A descriptive name for the model the creator assigned upon import.

### Type

The software that created the model and the model type from the software.

### Created

The date and time of the model's creation.

### Created By

The name of the user who imported the model.

### Last Updated

The date and time of the last edit to the model, such as deployment or the enablement of alerts.

### Endpoint

The endpoint URL to use to access the model.

### Status

Whether the model is published or deployed. Only deployed models are accessible through endpoints.

### Alerts Enabled

A green checkmark if the model sends alerts about the drift status to specified email addresses.

### Monitoring Enabled

A green checkmark if tools are active that monitor drift and stability.

### Monitor Job Period

How often the drift statistics update with new data.

### Uptime

The number of days since the deployment of the model.

## Service metrics

Service metrics include measures of the health of the endpoint that you use to access the model.

### Endpoint Status Summary

The endpoint status summary shows the HTTP status code for each HTTP request. Codes in the range 200 to 299 represent successes. Codes in the range 400 to 599 represent errors. If the graph includes unexpected codes, investigate the cause.

### Response Time

The response time shows the time to complete HTTP requests. Usually, the line is relatively flat. If the graph includes an increasing trend or unexpected spikes, investigate the cause.

## Predict

Go to **Predict** to make predictions with a deployed model. **Predict** has 3 sections:

- The **Make Predictions** section is where you upload a file to make batch predictions.
- The **Schema** section provides information about the variables in the model to use to make correct files or HTTP requests.
- The **Test** section provides examples of HTTP requests for predictions through cURL and through an HTML form.

Each calculated prediction returns a correlation ID. Use the correlation ID to associate the score with an actual response value when you monitor the stability of a model.

You can make predictions through a file upload or through an HTTP request.

### Make batch predictions from a file

Usually, you upload a file to make predictions for a set of observations together. For example, an analyst deploys a model to predict the defect rate for a batch of incoming parts. The analyst stores the prediction measurements in a CSV file and uploads the file.


### Make near-real time predictions from an HTTP request

Usually, you use HTTP requests to make predictions in near-real time. For example, an analyst deploys a model to predict fraudulent transactions. The analyst uses HTTP requests to calculate a prediction in near-real time as soon as the data for a transaction are available.

## Make Predictions

Upload a CSV file to make predictions from the data. After the calculation, Minitab Model Ops sends an email with a new CSV file to the address in the **User Information**.

Use the following steps to make predictions.

1. Sign in to Minitab Model Ops to open the **Model Library** .
2. Select the name of a deployed model.
3. Select **Predict**.
4. Expand **Make Predictions**.
5. Select **Browse**.
6. Browse to and select a file that contains the prediction data. Select **Open**.
7. To include the predictor values and the predictions in the drift report for the model, select **Use prediction data to monitor the model**.

When you use the predictions to monitor the model, all those data use the date and time of prediction calculations on the reports. The file with the predictions contains correlation IDs that the reports use.

The contents of the file also depend on the type of the response variable.

- If the response type is categorical, then the file contains the predicted classes and event probabilities.
- If the response type is continuous, then the file contains the predicted values of the response.

## Requirements for prediction data

- Save the data with the same variable names that the model uses. The names are case-sensitive.
- Use the same type of data for columns with the same name in the model and in the data.
- Use the same number of rows of data in all the columns.
- Save the data in CSV format.
- Use UTF-8, UTF-8-BOM, or UTF-16-LE as the encoding.
- Use a comma as the delimiter.

## Example of prediction data

A healthcare provider operates a facility that provides substance abuse treatment services. One of the services is an outpatient detoxification program where a regular course of treatment can last from 1 to 30 days. A team responsible for staffing and supplies has a model that predicts the length of time a patient uses services. The information in [Schema](#) shows that the model uses the following predictor variables:

Name	Type	Data Type	Classes
Use alcohol	Categorical	text	yes, no
Primary abuse substance	Categorical	numeric	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Medication therapy	Categorical	text	yes, no
Use heroin	Categorical	text	yes, no
Referral source	Categorical	numeric	1, 2, 3, 4, 5, 6

A prediction data set has a column with the name of each predictor. The columns of predictors contain the data for the calculation of the predictions. If the team uses the prediction data to monitor drift, the drift report adds the data with the date and time of the request to calculate the predictions.

Use alcohol	Primary abuse substance	Medication therapy	Use heroin	Referral source
yes	4	yes	yes	5
yes	12	no	no	2
...	...	...	...	...

## Schema

The list of predictor variables provides information on the types of values that you use to make predictions. Use the variable names and types for the predictor variables and the response variable to verify the correct variables are in any data sets you prepare to make predictions, to monitor drift, and to monitor stability.

**Name**

Use the name of the variable to assign values for prediction. Also use the name of the variable in any data sets that you prepare to monitor drift and stability. The tools that monitor models identify variables with identical names in data sets with the variables that the model uses.

**Type**

Use the type of predictor variable to determine the type of values to enter for predictors. For categorical data types, enter values that are in **Classes**. For continuous types, enter a number.

**Data Type**

Use the type to verify that the data type in any HTTP requests or data sets are the same as the variable type in the model.

**Classes**

Use the classes to see the values of the variable. Only categorical variables have classes. Use the class values to make predictions.


**Test**

Minitab Model Ops provides examples to make predictions through a standard HTTP request. The examples are for cURL and for an HTML form. You can use any tool or language that makes HTTP requests to make predictions.

The sample code includes a place for an API key: `apikey=API_KEY`. To use the sample code, replace `API_KEY` with the password given when you create a revokable API key.

**Copy code for an HTML form**

Each deployed model includes a sample form that you can customize.


1. Sign in to Minitab Model Ops to open the **Model Library** .
2. Select a model name.
3. Select **Predict**.
4. In **Test**, select **HTML Form**.
5. Enter values for each predictor in the sample form.
6. At the bottom of the form, click **Test**.

For a model with a continuous response, the result is the predicted value. For a model with a categorical response, the result is the predicted class.

You can copy the code for the sample form or download the sample form as an HTML file. You can further customize the form by editing the HTML. Replace `API_KEY` with the password given when you create a revokable API key.

**Copy code for cURL**

The model details contain cURL commands that you can copy to access the model through GET or POST.

1. Sign in to Minitab Model Ops to open the **Model Library** .
2. Select a model name.
3. Select **Predict**.
4. In **Test**, select **Curl GET** or **Curl POST**.

5. Copy the code for **GET** or **POST**.

Customize the cURL commands to meet your needs. Be sure to replace API\_KEY with the password given when you create a revokable API key.

## Date/time formats for predictors and timestamps

Minitab Statistical Software recognizes many date and time formats. When Minitab Statistical Software recognizes a date or time format for a predictor in a model, you enter the predictor value in one of the following formats to score a model. Any excluded information is the equivalent of entering 0 for the value. For example, if enter a format without minutes and seconds, the minutes and seconds are 0. The scoring is correct even if the format in the standard HTTP request and the format in the original data are different.

### Date: yyyy-MM-dd

The time information is optional. For calendar dates, use 4 digits for the year (yyyy), 2 digits for the month (MM), and 2 digits for the day (dd). Separate the year, month, and day with dashes. For example, 2050-08-14 is August 14 of the year 2050. Because this format does not include time or time zone information, the time is midnight and the time zone is Coordinated Universal Time (UTC).

### Date and time: yyyy-MM-dd'T'HH:mm:ss

To combine dates and times, separate the 2 parts with an uppercase letter T. The format for date information matches the yyyy-MM-dd format.

The time format uses 2 digits for the hours (HH), 2 digits for the minutes (mm), 2 digits for the seconds (ss) Enter the hours in 24-hour format. Separate the hours, minutes, and seconds with colons.

Because this format does not specify a time zone, the time zone is Coordinated Universal Time (UTC). For example, 2050-08-14T08:30:00 is 8:30 in the morning in the time zone that is Coordinated Universal Time (UTC) on August 14 of the year 2050.

### Date and time with time zone: yyyy-MM-dd'T'HH:mm:ssXX

You can add the time zone (XX) for the time with one of the following formats:

#### Sign and 4 digits

Specify the time zone with a positive or negative sign and 4 digits, such as -0700. For example, 2050-08-14T08:30:35-0700 is 35 seconds past 8:30 in the morning in a time zone that is 7 hours before Coordinated Universal Time (UTC) on August 14 of the year 2050.

#### Sign and 4 digits with a colon

Specify the time zone with a positive or negative sign and 4 digits with a colon, such as -07:00. For example, 2050-08-14T08:30:35-07:00 is 35 seconds past 8:30 in the morning in a time zone that is 7 hours before Coordinated Universal Time (UTC) on August 14 of the year 2050.

#### Sign and 2 digits

Specify the time zone with a positive or negative sign and 2 digits, for example -07. For example, 2050-08-14T08:30:35-07 is 35 seconds past 8:30 in the morning in a time zone that is 7 hours before Coordinated Universal Time (UTC) on August 14 of the year 2050.

#### Letter Z

The letter Z specifies that the information is in Coordinated Universal Time (UTC). For example, 2050-08-14T08:30:00.000Z is 8:30 in the morning in the time zone that is Coordinated Universal Time (UTC) on August 14 of the year 2050.

### Date and time with fractional seconds and time zone: yyyy-MM-dd'T'HH:mm:ss.SSSXX

You can add milliseconds to the time information. Separate the milliseconds from the seconds with a period mark. Enter 3 digits for the milliseconds (SSS). For example, 2050-08-14T08:30:00.761-0700 is 761 milliseconds after 8:30 in the morning in a time zone that is 7 hours before Coordinated Universal Time (UTC) on August 14 of the year 2050.

## Drift


The drift report compares the distribution of the variables in the baseline data to the variables in the production data for deployed models. On the drift report, the production data are the data that have scores since the deployment of the model. Tools that monitor drift are unavailable for DOE models and Event/Trial models from Minitab Statistical Software.

### Requirements for baseline data

- Save the data with the same variable names that the model uses. The names are case-sensitive.
- Use the same type of data for columns with the same name in the model and in the data.
- Save a column with the name *prediction-score* with the predictions for each row. The name is case-sensitive. For a categorical response, the prediction score is a class value.
- Use the same number of rows of data in all the columns.
- Save the data in one of the following formats:
  - Minitab Worksheet file (.MWX)
  - Comma separated values (.CSV)

### Upload baseline data for a model

Use the following steps to import baseline data.

1. Sign in to Minitab Model Ops to open the [Model Library](#) .
2. Select the name of a model.
3. Select **Drift**.
4. Select **Upload Baseline Data**.
5. Select **Browse**.
6. Browse to and select a file that contains the baseline data for the model. Select **Upload**.

After you upload the baseline data, the dashboard compares the baseline data to the production data. To use a different data set, select [Replace Baseline Data](#). Allow at least 15 minutes for the report to process.

### Example of baseline data

A healthcare provider operates a facility that provides substance abuse treatment services. One of the services is an outpatient detoxification program where a regular course of treatment can last from 1 to 30 days. A team responsible for staffing and supplies has a model that predicts the length of time a patient uses services. The information in [Schema](#) shows that the model uses the following predictor variables:

Name	Type	Data Type	Classes
Use alcohol	Categorical	text	yes, no
Primary abuse substance	Categorical	numeric	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Medication therapy	Categorical	text	yes, no
Use heroin	Categorical	text	yes, no
Referral source	Categorical	numeric	1, 2, 3, 4, 5, 6

The baseline data set for the drift calculations has a column with the name of each predictor and a column with the name *prediction-score*. The columns of predictors contain the data for training the model. The column with the name *prediction-score* contains the predicted length of stay for each patient in the baseline data.

Use alcohol	Primary abuse substance	Medication therapy	Use heroin	Referral source	prediction-score
yes	4	yes	yes	5	20.11
yes	12	no	no	2	16.69
...	...	...	...	...	...

## Interpret the drift report

Drift measures the similarity between your baseline data and the production data. Typically, the more alike your baseline data and production data, the more likely the model performance on the production data is similar to the performance on the baseline data. Use differences between the baseline data and the production data to determine when to try to improve the model.

### Drift

Upload the baseline data set for a model to compare the values of the variables to values in production data. If the values of the response variable or predictor variables drift so far that the baseline data are different from the production data, investigate whether to retrain or replace the model.

The drift report includes the following results:

- Population Stability Indices (PSI) for the latest production period.
- Graphs and statistics about the distribution of the data.
- Time series plot that shows PSI by production period.

### 1. Look at the drift status of the variables

The first column after the name of the variable displays the drift status according to the settings of the report. If there is enough data to determine the drift status, the drift status is minimal, moderate or severe. If the report includes more than one production period, the drift status is for the most recent production period.

If the drift for a response variable is moderate or severe, you almost always want to examine the drift more closely.

If the drift for one or more predictor variables is severe, consider the number of variables and their importance. Examination of the drift almost always follows severe drift in a single predictor variable that is extremely important in the model relative to the other variables. Similarly, moderate drift in multiple variables almost always demands further examination.

If the drift for all of the variables is minimal, usually you use the model without further examination of the drift in the variables.

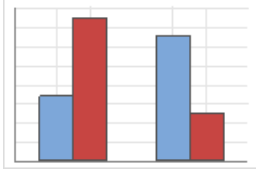
The report also displays the Population Stability Index (PSI). By default, the report identifies moderate drift as a PSI over 0.1 and severe drift as a PSI over 0.2. The 0.1 value is a traditional threshold for when to retrain a model. The 0.2 value is a traditional threshold for when to replace a model. In the settings for a model, you can customize these thresholds to correspond to appropriate values for your model.

### 2. Compare the distribution of the baseline data and the production data

Use the graphs to see how the distribution of the baseline data and the production data differ. Use process knowledge to assess how much effect the drift in that variable is likely to have on the model. Expand the row for a variable to see the baseline data and the production data overlaid on the same graph and to see more detailed information about the distribution of the data. If the report includes more than one production period, then the distribution of the production data uses the data from the most recent production period.

The graph that shows the distribution depends on whether the variable is categorical or continuous. The report displays a bar chart for categorical variables. The bar chart gives the percentage of data in each category.

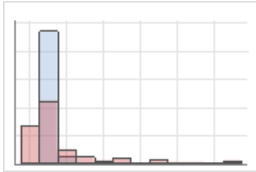
### Bar chart of drift for a categorical variable



In this bar chart of a response variable with severe drift, a bar chart displays that the response variable for the baseline data had 75% good prospects and 25% poor prospects. The production data has 34% good prospects and 66% poor prospects. This severe drift usually indicates a need to try to improve the performance of the model on data that is different from the baseline data.

The report displays a histogram for continuous variables. The histogram helps with the identification of minimum, maximum, and typical values in a variable.

### Histogram of drift for a continuous variable

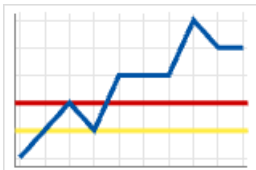


In this histogram of an important predictor variable with severe drift, the histogram and descriptive statistics show a maximum of 5 in the baseline data set. The maximum of the predictor variable is 500 in the production data set. This severe drift usually indicates a need to retrain or replace the model to try to improve the performance of the model on data that is different from the baseline data.

## 3. Examine the drift over time

The report includes a time series plot of drift (PSI) across production periods. A yellow line shows the threshold for moderate drift. A red line shows the threshold for severe drift. Usually, you look for patterns that indicate a need to update the model.

### Time series plot of PSI



In this plot, the PSI of the variable shows an increasing trend that crosses the threshold for severe drift and remains high. This severe drift usually indicates the need to retrain or replace the model to try to improve the performance of the model on data that is different from the baseline data.

## Details about the Population Stability Index (PSI)

PSI measures the difference in distributions between 2 samples. Model development requires data that exists, so models are not always robust to future changes. A larger value of PSI represent a greater change in the distribution of a variable between 2 samples. Traditionally, a PSI value of 0.1 shows that 2 distributions are moderately different. A PSI value of 0.2 shows that 2 distributions are severely different. Investigation of the reasons for these differences and their effect on the model's performance usually follows the calculation of a PSI value that shows at least a moderate difference in a variable. For different applications, consider whether to change the thresholds based on how well they correspond to model performance. For example, PSI tends to increase as sample sizes increase, so the possibility exists that larger thresholds are appropriate for a process with hundreds of observations per production period.

The calculation of PSI compares the percentages of data in the same categories for two samples of data. Use the following steps to calculate the PSI for a continuous variable:



1. Divide the baseline data into 10 bins, each containing 10% of the data:

$$B = \lfloor n/10 \rfloor + 1$$

where

$B$  the number of observations in the bin  
 $n$  the number of observations in the data set

and

$$\lfloor n/10 \rfloor$$

is the floor of  $n/10$ .

2. Move any tied values in the baseline data that are in different bins into the first bin that contains the value. If necessary, change the endpoints of the bins to create contiguous non-empty bins. If the last bin is less than 50% of  $B$ , then move those observations to the previous bin.
3. Calculate the percentage of the production data in the same bins as the baseline data.
4. Calculate the PSI statistic with the following equation:

$$S = \sum_{i=1}^j [(t - p) \ln \left( \frac{t}{p} \right)]$$

where

$S$  the Population Stability Index (PSI)  
 $j$  the number of bins, usually 10  
 $t$  the proportion of the baseline data in the bin, usually 0.10  
 $p$  the percent of the production data in the bin

For a categorical variable, each level is a bin. Otherwise, the calculation is the same.

## Stability


To monitor stability, upload a data set with values for the response variable for a deployed model. Tools that monitor stability are unavailable for DOE models and Event/Trial models from Minitab Statistical Software.

### Requirements for stability data

- Include the response variable in a column with the name *actual-response*. The name is case-sensitive.
- Include the correlation ID that corresponds to the prediction for the actual value. Use the name *mtb-correlation-id* for the column of correlation IDs. The name is case-sensitive.
- Use the same number of rows in the columns.
- Save the data in one of the following formats:
  - Minitab Worksheet file (.MWX)
  - Comma separated values (.CSV)

### Upload stability data

Use the following steps to import stability data.

1. Sign in to Minitab Model Ops to open the **Model Library** .
2. Select the name of a model.
3. Select **Stability**.

4. Select **Create Stability Report**.
5. Browse to and select a file that contains the stability data. Select **Upload**.

After you upload the stability data, use the statistics and graphs to assess the performance of the model. To replace the stability data with an updated version, select **Replace Stability Data**. Allow at least 5 minutes for the report to process.

## Interpret the stability report

Upload a data set with correlation IDs and response values to monitor the performance of the model over time with statistics like R-squared and Area Under the ROC Curve (AUC). If the performance of the model decreases, investigate whether to retrain or replace the model.

## Assess the current performance of the model

The statistic that measures the performance of the model depends on the scale of the response variable. This value takes into account the data from all periods. Use your knowledge of the process to determine whether the performance of the model is adequate. If the model performance is inadequate, consider whether to retrain or replace the model. For example, analysts want a model to have an AUC of at least 0.88. The stability report shows that the AUC is 0.78. The analysts consider how to improve the model.

## Stability calculations

Select what the points on the time series plot represent.

### Independent samples

Each calculation on the plot represents calculations for data from a single sample. Use this option to see how the status of the model at a single time period. The numbers above the plot give the cumulative value of each statistic for all the data.

### Cumulative samples

Each calculation on the plot represents all the data from that period and earlier. Use this option to see the performance of the model across all the data.

## Measures of performance for models with categorical response variables

### AUC

The area under the ROC curve values typically range from 0.5 to 1. Larger values indicate a better classification model. When the model can perfectly separate the classes, then the area under the curve is 1. When the model cannot separate the classes better than a random assignment, then the area under the curve is 0.5.

For a multinomial response, the AUC is set to 0 under certain conditions:

- If a class is missing from the actual values, then the AUC for that class is 0. For example, if a model includes the classes 1 to 5 but the stability data do not include any actual values of 4, then the AUC for 4 is 0.
- If every class is the same, then the AUC for all classes is 0. For example, if a model includes the classes 1 to 5 but the actual values are all 2, then the AUC is 0 for all classes.

## Measures of performance for models with continuous response variables

### R-squared

The higher the  $R^2$  value, the better the model fits your data.

## MAD

The mean absolute deviation (MAD) expresses accuracy in the same units as the data, which helps conceptualize the amount of error. Outliers have less of an effect on MAD than on  $R^2$ . Smaller values indicate a better fit.

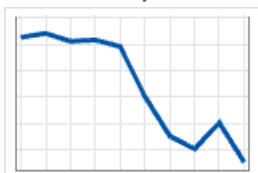
## Examine the performance over time

If the data cover multiple production periods, then the report includes a time series plot of the measures of model performance. Usually, you look for patterns that indicate a need to retrain or replace the model.

For a multinomial response, the AUC is set to 0 under certain conditions:

- If a class is missing for a period, then the AUC for that class is 0 for that period. For example, if a model includes the classes 1 to 5 but period 9 does not include any actual values of 4, then the AUC for 4 in period 9 is 0.
- If every class in a production period is the same, then the AUC for all classes is 0. For example, suppose that a model includes the classes 1 to 5 but the actual values for period 7 all equal 2. Then, the AUC is 0 for all of the classes in period 7.


### Time series plot of AUC



In this plot, the trend in the AUC decreases. Analysts plan to retrain the model before the performance becomes inadequate.

## Settings

Go to **Settings** to specify default settings, alert thresholds, and addresses to receive email alerts.

1. Sign in to Minitab Model Ops to open the **Model Library** .
2. Select the name of a model.
3. Select **Settings**.

In **Settings**, make the following selections.

### Default Settings

#### Production Data Period

Select how much data to include by default in graphs that show the distribution of the production data for drift.

#### Drift Monitor

Shows that the measure of drift on reports is the Population Stability Index (PSI).

### Stability Report: Configuration

#### Stability Calculations

Select the default display for the points on the time series plot of the stability report. You can change the display on any individual report.

### Independent samples

Each calculation on the plot represents calculations for data from a single sample. Use this option to see how the status of the model at a single time period. The numbers above the plot give the cumulative value of each statistic for all the data.

### Cumulative samples

Each calculation on the plot represents all the data from the lag period on the time series plot. Use this option to see the performance of the model with more data at each point.

### Stability Lag Period

Shows that two weeks is the length of time to show on the time series plot on the stability report.

### Drift Report: Variable Thresholds

Enter the values of PSI that indicate moderate drift and severe drift. The default values are traditional thresholds. The threshold for moderate drift traditionally identifies when to retrain the model. The threshold for severe drift traditionally identifies when to replace the model. Enter smaller values to change the drift status in response to smaller differences between the baseline data and the production data. Enter larger values to change the drift status for larger differences between the baseline data and the production data.

### Drift Report: Overall Drift

Specify the criteria to determine when a model shows moderate drift and severe drift.

#### Moderate Drift

##### Prediction drift shows moderate drift

Select this option so that the model drift is moderate when the drift for the response variable is moderate.

##### variables show moderate drift

Select this option so that the model drift is moderate when the drift for at least the number of predictor variables that you specify have moderate drift.

#### Severe Drift

##### Prediction drift shows severe drift

Select this option so that the model drift is severe when the drift for the response variable is severe.

##### variables show severe drift

Select this option so that the model drift is severe when at least the number of predictor variables that you specify have severe drift.

### Alerts: Email Configuration


Specify one or more email addresses to receive alerts when the drift status of a model changes. Separate multiple email addresses with spaces.

# Endpoint management

While Minitab Model Ops creates an endpoint for every deployed model, you can also create an endpoint and assign any deployed model to that endpoint. For example, when you update a model, you can assign the latest model to an endpoint that had the previous model. Any processes that use the endpoint now use the updated model.



## Add an endpoint

Add an endpoint to assign a different model to the endpoint at different times. Endpoints have 1 model at a time.

1. Sign in to Minitab Model Ops.
2. Select **Endpoint Management** .
3. Select **Add Endpoint**.
4. In **Endpoint Name**, enter a descriptive name for the endpoint. The system endpoint name uses a version of the name that removes unsupported characters, such as spaces.
5. In **Select Model Deployment**, select from the list of deployed models to assign the selected model to the endpoint. The list of models is in alphabetical order by name, with uppercase letters before lowercase letters.
6. Select **Done**.



## Edit an endpoint

Edit an endpoint to change the deployed model.

1. Sign in to Minitab Model Ops.
2. Select **Endpoint Management** .
3. Move your mouse pointer over an endpoint.
4. Select **Edit** .
5. In **Select Model Deployment**, select from the list of deployed models to assign the selected model to the endpoint. The models are in alphabetical order by name, with uppercase letters coming before lowercase letters.
6. Select **Done**.

## Remove an endpoint

Remove an endpoint to make the endpoint inaccessible. You cannot undo this action.


1. Sign in to Minitab Model Ops.
2. Select **Endpoint Management** .
3. Move your mouse pointer over an endpoint.
4. Select **Remove** .

# Manage API Keys

API keys provide access to your endpoint from external systems and applications, such as web forms. To grant temporary access to an endpoint, create a revokable API key. Access to the endpoint ends when the API key expires or when an authorized user revokes the API key.

## Add a revokable API key

Add a revokable API key to provide access that ends when the key expires or when an authorized user revokes the key.

1. Sign in to Minitab Model Ops.
2. Select **API Keys** .
3. Select **Create API Key**.
4. In **Key Name**, enter a name for the key.
5. Select an expiration date for the key. The maximum duration of a key is 1 year.
6. Select 1 or more scopes for the API key:

### Manage Models

Permit the key to publish models and to delete undeployed models.

### Score Models



Permit the key to send a scoring request or to upload a file for batch scoring.

7. Select **Create**.

The list of API keys is in order of expiration date.

## Revoke a temporary API key

Revoke a temporary API key to prevent use of the key for access to endpoints.


1. Sign in to Minitab Model Ops.
2. Select **API Keys** .
3. Move your mouse pointer over an API key.
4. Select **Revoke Key** .

# Audit logs

Minitab Model Ops provides a system-wide audit log and audit logs for each model in the library.


## System audit log

The audit log for the system records actions that affect the status of models, endpoints, and API keys. Use the following steps to view the audit log for the system:

1. Sign in to Minitab Model Ops.
2. Select **System Audit Log** .

## Model audit log

The audit log for the model records actions on the model. If you remove a model from the library, the log for that model is irretrievable. Use the following steps to view the audit log for a model:

1. Sign in to Minitab Model Ops to open the **Model Library** .
2. Select a model name.
3. Select **Audit Log**.

## Audit log information

The log records the following items for each action. Expand an item to see additional details for the action.

### Timestamp

The date and time of the action.

### User

The name from the **User Information** for the account for Minitab Model Ops. Sometimes, the name of the **User** identifies a background service that performs an action.

### Action

This value records the action. For example, if a user publishes a model, the action is PublishModel.

### Result

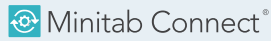
This value records whether the action succeeds or fails. Actions that fail have no effect.

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## Data Transformation



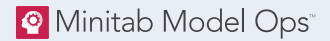
Powerful statistical and predictive analytics everyone can use



Data access, automation, and governance for comprehensive insights

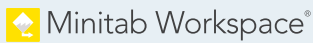


Machine Learning and Predictive analytics software

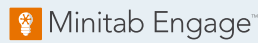


Model lifecycle management on a simple yet powerful platform

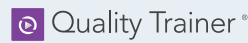
## Visual Business Tools



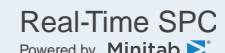
Visual tools to ensure process and product excellence



Start, track, manage, and execute innovation and improvement initiatives



Master statistics and Minitab anywhere with online training



Powered by 

Monitor, respond, and deliver immediate quality and process monitoring

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