

Use the IBM Granite time series foundation models and forecast API to forecast future values

Use the time series forecast API and IBM Granite time series models that are available from watsonx.ai to forecast future values based on historic data.

Ways to develop

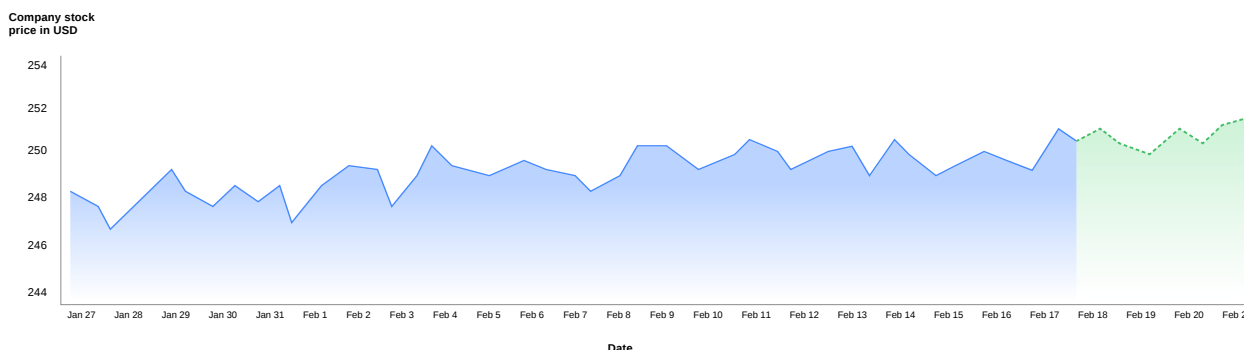
You can generate forecasts from time series foundation models by using these programming methods:

- REST API
- Python
- Node.js

Overview

Use the time series forecast API to pass historical data observations to a time series foundation model that can forecast future values with zero-shot inferencing. For example, you can use this method to forecast future values from time-based observations of the following types of data:

- Stock share prices and trading volumes
- Electrocardiogram (EKG) data or polysomnogram (PSG) records
- Temperature or seismographic data
- Network performance measurements



Supported foundation models

IBM Granite time series foundation models with the following model IDs are available to use for forecasting in watsonx.ai:

- **ibm/granite-ttm-512-96-r2**: Requires at least 512 data points per channel in the request.
- **ibm/granite-ttm-1024-96-r2**: Requires at least 1,024 data points per channel in the request.
- **ibm/granite-ttm-1536-96-r2**: Requires at least 1,536 data points per channel in the request.

The Granite time series models are compact pretrained models for multivariate time series forecasting from IBM Research, also known as Tiny Time Mixers (TTM).

The Granite time series models work best with data points in minute or hour intervals and generate a forecast dataset with 96 data points per channel by default. For best results, use the model that takes the most data points based on the data available to you.

For more information, see the [model card](#).

To programmatically get a list of the time series models that are available for use, you can use the [List the available foundation models](#) method in the watsonx.ai as a service API. Specify the `filters=function_time_series_forecast` parameter to return only the available time series models.

For example:

```
curl -X GET \
  '{url}/ml/v1/foundation_model_specs?version=2024-11-14&filters=function_time_series_forecast'
```

In the example, replace the `{url}` variable with the right value for your instance, such as `us-south.ml.cloud.ibm.com`.

Python

You can write code that uses the time series models to forecast data by using the watsonx.ai Python library. For more information, see the following references:

- [Time series model inference interface](#)
- [Get time series model specs method](#)

To learn more, see [Using the watsonx.ai Time Series Forecasting API to predict energy demand](#).

Sample Python notebook

[Use Time Series Foundation Models and timeseries data to predict energy demand](#)

Node.js

You can write code that uses the time series models to forecast data by using the watsonx.ai Node.js SDK. For more information, see the following resources:

- [TimeSeriesForecastParams](#)
- [timeseriesForecast](#)

To learn more, see the [code example](#).

REST API

Use the time series forecast method of the watsonx.ai REST API to forecast future values based on historical data.

Before you begin, review the data requirements and learn more from sample requests.

- [Data requirements](#)
- [Billing information](#)
- [Request example](#)
- [Response example](#)
- [Example results](#)

API reference

For details, see the [API reference documentation](#).

REST API data requirements

A time series is a collection of data points that are collected over time.

You use the following schema to describe the data that you include in the API request payload:

```
"schema": {
  "timestamp_column": "{date-column-name}",
  "id_columns": [
    "{series-name}",
    "{series-name}"
  ],
  "freq": "{time-interval}"
```

```

"target_columns": [
  "{channel-name}",
  "{channel-name}",
  "{channel-name}"
]
},

```

To use the Granite time series models to forecast future values, the data that you submit for analysis must meet the following requirements:

- The recorded data must be numerical, such as temperatures or stock share prices.
- Your data must include enough data points of historical context for the model to be able to make a prediction. Each time series foundation model specifies a required minimum number of data points per channel in the request. If you specify more than the required number, the model uses the most recent data points up to the model requirement and ignores the rest.
- There must be an equal number of items in the arrays that are specified for the **date**, **id_columns**, and **target_columns** that are included in the request body. You cannot skip a data point or specify **null** as the data point. Check your data before you submit the request.
- Although the service accepts most common date and time formats, when you specify dates with time stamps in ISO 8601 format (**2024-11-12T15:06:35**), you avoid the confusion that can arise due to differences in date formatting conventions. For example, does 11/12/2024 mean November 12 or December 11? Specify dates in ISO 8601 format with the coordinated universal time (UTC) offset (**2024-11-12T15:06:35+0000**) to avoid apparent duplicates or missing timestamps in the generated forecasting results.
- Sample the data at a uniform frequency. For example, data can be observed in increments of 1 minute, 1 hour, or 1 day. No error is generated if your timestamps are not uniform, but the quality of your results might be poor. The generated forecast data is also formatted with the frequency that you specify with the **freq** parameter.

For example, if you specify a frequency of one day ("**freq**" : "**1D**"), your time stamps probably look something like this:

```

"date": [
  "2024-11-15T15:06:35",
  "2024-11-16T15:06:35",
  ...
]

```

If the frequency is 5 minutes ("**freq**" : "**5min**"), each date time stamp is likely 5 minutes apart.

```

"date": [
  "2024-11-15T15:06:35",
  "2024-11-15T15:11:35",
  ...
]

```

For supported values for date and time abbreviations in the frequency parameter, see [Period aliases](#) in the documentation for the pandas library.

- If you include data points from more than one source for analysis, each data point must provide a unique identifier to indicate which *series*, or collection of observations, it belongs to.

For example, if you are analyzing shopping trends, you might be interested in sales figures from multiple stores during the holiday season. The following table shows two series, A and B. Series A shows the sales per day for location A and series B shows the sales per day for location B.

Table 1. Sample sales data

Date	Series ID	Sales total (USD)
7 December 2023	A	\$24,988
7 December 2023	B	\$63,788
8 December 2023	A	\$41,855
8 December 2023	B	\$105,678
...

Although the table shows observations from two days, your request must include between 512 to 1,536 data points, depending on the model you use. When the data from the table is submitted to the API, it is formatted as follows:

```

...
"data": {
  "date": [
    "2024-12-07T00:00:00",
    "2024-12-07T00:00:00",
    "2024-12-08T00:00:00",
    "2024-12-08T00:00:00",
    ...
  ],
  "ids": [
    "A",
    "B",
    "A",
    "B",
    ...
  ],
  "sales-usd": [
    24988,
    63788,
    41855,
    105678,
    ...
  ]
}

```

- You can forecast by using multivariate data points, meaning data points that measure different factors during the same time interval.

For example, you might be interested in both sales and returns from one store during the holiday season. The following table shows a few entries from two *channels*, or different dimension or aspects of the recorded data. One channel shows the sales per day and the other channel shows the returns per day.

Table 2. Sample sales and returns data

Date	Sales (USD)	Returns (USD)
7 December 2023	\$63,788	\$14,788
8 December 2023	\$105,678	\$25,678
...

Although the table shows observations from two days, your request must include between 512 to 1,536 data points, depending on the model you use. The `id_column` field is omitted because the data is coming from the same series, a collection of observations from a single store. When the data from the table is submitted to the API, it is formatted as follows:

```

...
"data": {
  "date": [
    "2024-12-07T00:00:00",
    "2024-12-07T00:00:00",
    "2024-12-08T00:00:00",
    "2024-12-08T00:00:00",
    ...
  ],
  "sales": [
    63788,
    105678,
    ...
  ],
  "returns": [
    14788,
    25678,
    ...
  ]
}

```

- You can forecast by using multivariate data points from more than one series of observations. For example, you can effectively combine the previous two scenarios to forecast sales and returns for both store A and store B.

The data in the request might look something like this:

```

"data": {
  "date": [

```

```

    "2024-12-07T00:00:00",
    "2024-12-07T00:00:00",
    "2024-12-08T00:00:00",
    "2024-12-08T00:00:00",
    ...
  ],
  "ids": [
    "A",
    "B",
    "A",
    "B",
    ...
  ],
  "sales-usd": [
    24988, // sales for store A on 7 December 2024
    63788, // sales for store B on 7 December 2024
    41855,
    105678,
    ...
  ],
  "returns": [
    3997, // returns for store A on 7 December 2024
    14788, // returns for store B on 7 December 2024
    5768,
    25678,
    ...
  ]
]

```

Billing information

Charges for foundation model forecasting are calculated by using the following equations:

- Input calculation: **context length x number of series x number of channels**
- Output calculation: **prediction length x number of series x number of channels**

These equations use the following values:

- *Context length* refers to the number of historical data points that a time series foundation model uses as input to make predictions.

For example, when the context length is **1536**, the model uses the past 1536 data points, such as stock prices over the past 1536 days, to make predictions. The context length is determined by the foundation model that is used for forecasting.

- A *series* is a collection of observations made sequentially over time.

For example, when comparing stock prices for many companies, the observed stock price history for each company is a separate series. The set of series to be measured is specified in the **ID_column** segment of the API request body.

- *Channels* are specific features or variables within a time series dataset. In multivariate time series data, each channel represents a different dimension or aspect of the recorded data.

For example, in a stock price dataset, channels might include opening price, closing price, volume, and moving averages. Each measured variable represents a separate channel. The channels to be measured are specified in the **target_columns** segment of the API request body.

- *Prediction length* is the number of future data points for the model to predict. When the requested prediction length is **96**, the model forecasts the next 96 data points.

For example, the model predicts stock prices for the next 96 days. The prediction length can be specified by including the **prediction_length** parameter in the API request.

REST API example

This example uses the **granite-ttm-1536-96-r2** model to forecast total energy demand for the country of Portugal per hour from 30 September 2024 to 2 December 2024. The dataset used in the example is sourced from the [European Network of Transmission System Operators for Electricity \(ENTSO-E\)](#) website. To see the data, go to [this page](#) on the ENTSO-E site, select Portugal as the country, and then choose 29 September 2024 as the date with the default time zone (CET).

The API request does not specify a **prediction_length** parameter. Therefore, the default length for the foundation model is used, which means the time series model will predict future values for energy demand over the next 96 hours.

The request body is divided into two sections:

- Schema: Specifies which datasets will be included and which fields to analyze.
- Data: The data to be analyzed.

The **schema** section looks like this:

```
"schema": {
  "freq": "1h",
  "timestamp_column": "Time (CET/CEST)",
  "target_columns": [
    "Actual Total Load [MW]"
  ]
},
```

You might notice that there is no **id_columns** object included in the schema. In this example, data from only one series of observed data is being submitted, which means the **id_columns** object can be omitted from the schema. However, if your request includes data from more than one source, you must include the **id_columns** object to identify the source of each data point.

The **data** section includes information about the energy demand per hour for the country of Portugal as shown in the following table.

Table 3. Sample energy consumption data

Date and time (date)	Total energy demand (MW)
2024-09-30T00:00:00	4941
2024-09-30T01:00:00	4640
2024-09-30T02:00:00	4443

The granite-ttm-1536-96-r2 model requires at least 1,536 data points per channel in the request to ensure that there is enough data for the model to predict future values. Although the table shows 3 data points, the request body contains 1,536 data points.

In the following example, replace the **{url}** variable with the right value for your instance, such as **us-south.ml.cloud.ibm.com**. Add your own bearer token and project ID.

REST API request example

```
curl -X POST \
  'https://{region}.ml.cloud.ibm.com/ml/v1/time_series/forecast?version=2025-02-10' \
  --header 'Accept: application/json' \
  --header 'Content-Type: application/json' \
  --header 'Authorization: Bearer eyJraWQiOi...' \
  --data '{
    ...
  }'
```

The data payload contains the following JSON snippet:

```
{
  "model_id": "ibm/granite-ttm-1536-96-r2",
  "project_id": "51f3a990-4372-4ac3-9ddb-ed99d9b50840",
  "schema": {
    "freq": "1h",
    "timestamp_column": "Time (CET/CEST)",
    "target_columns": [
      "Actual Total Load [MW]"
    ]
  },
  "data": {
    "Time (CET/CEST)": [
      "2024-09-30T00:00:00",
```

"2024-09-30T01:00:00",
"2024-09-30T02:00:00",
"2024-09-30T03:00:00",
"2024-09-30T04:00:00",
"2024-09-30T05:00:00",
"2024-09-30T06:00:00",
"2024-09-30T07:00:00",
"2024-09-30T08:00:00",
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REST API response example

The following response is returned for the example request.

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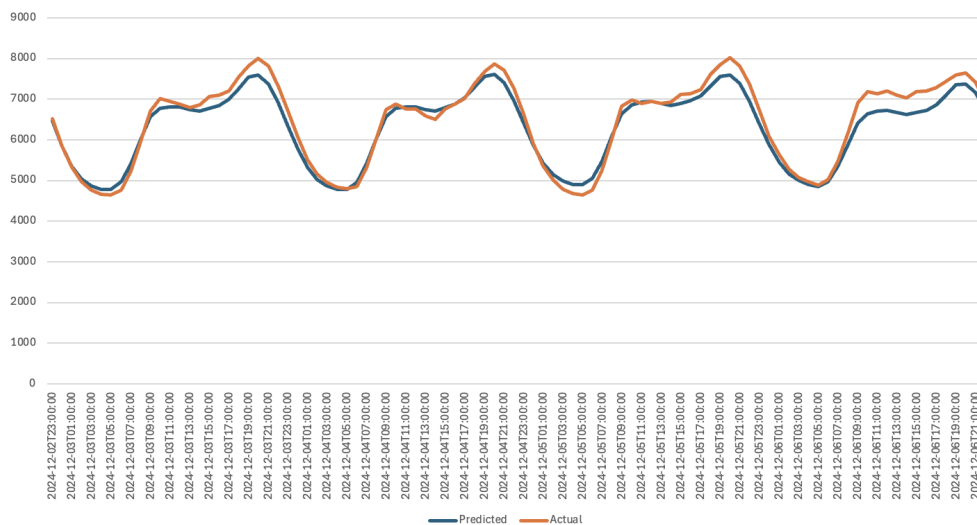
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REST API example results

The time series model predicted future values for energy demand in Portugal over the next 96 hours.

The graph in the following screenshot shows the forecasted energy demand compared to the actual energy demand over that same time frame.



Learn more

- [API reference](#)