Graph Engine Service

User Guide

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Contents

1 GES Overview

Graph Engine Service (GES) facilitates query and analysis of multi-relational graph data structures. It is particularly well suited for scenarios requiring analysis of rich relationships, including social network analysis, marketing recommendations, social listening, information distribution, and fraud detection.

This document describes how to operate and analyze graph data on the GES management console.

2 Permissions Management

2.1 Creating a User

If you need to assign different permissions to employees in your enterprise to access GES resources, Identity and Access Management(IAM) is a good choice for fine-grained permissions management.

With IAM, you can:

- Create IAM users for your employees within your account based on your company's organizational structure. This allows each employee to have their own security credentials and access to GES resources.
- Grant users only the permissions required to perform a given task.
- Entrust an account or cloud service to perform professional and efficient O&M on your GES resources.

If your account does not need individual IAM users, you may skip over this section.

Permission Type

Type

- Roles: A type of coarse-grained authorization mechanism that defines permissions related to user responsibilities. There are only a limited number of roles. When using roles to grant permissions, you need to also assign dependency roles. However, roles are not an ideal choice for fine-grained authorization and secure access control.
- Policies: A type of fine-grained authorization mechanism that defines permissions required to perform operations on specific cloud resources under certain conditions. Policies allow for more flexible permissions control than roles. They allow you to meet requirements for more secure access control. For example, you can grant GES users only the permissions for managing a certain type of cloud servers.

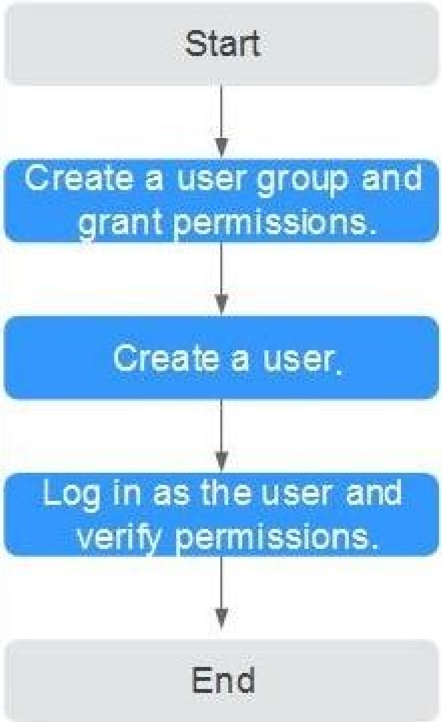
NOTE

GES ReadOnlyAccess is a policy.

Procedure

This section describes how to use a group to grant permissions to a user. **Figure 2-1** shows the process.

Figure 2-1 Granting GES permissions



1. Create a user group and assign permissions.

   Create a user group on the IAM console, and assign the **GES ReadOnlyAccess** policy to the group.

2. Create a user and add it to a user group.

   Create a user on the IAM console and add the user to the group created in step 1.

3. Log in as the user you created and verify permissions.

   Log in to the management console using the user your created and verify the user permissions.

   - Choose **Service List** > **Graph Engine Service** to enter the GES management console, and click **Create Graph** in the upper right corner to create a graph. If you cannot create one, the **GES ReadOnlyAccess** policy has taken effect.
   - Choose any other service in **Service List**. If a message appears indicating that you have insufficient permissions to access the service, the **GES ReadOnlyAccess** policy has taken effect.

2.2 Policy Permissions

2.2.1 Policy

IAM supports both system-defined and custom policies.

System-defined Policies

System-defined policies cover various common actions of a cloud service. System-defined policies can be used to assign permissions to user groups, but they cannot be modified.

The system-defined policies for GES include **GES FullAccess**, **GES Development**, and **GES ReadOnlyAccess**. These policies are recommended as they can cover most of the role assignments your will need in most scenarios. For details, see **GES System-defined Policy**.

Custom Policies

If the supplied system policies are unable to meet your needs, you can create custom policies for more refined control. You can create custom policies in the visual editor or using a JSON editor. For details, see **GES Custom Policy**.

2.2.2 System-Defined Policies

Table 2-1 GES system-defined policies

Policy Name	Description
GES FullAccess	Permissions for all operations on GES, including creating, deleting, accessing, and updating graphs. **NOTE** • Users with the permissions of this policy also need the following policy permissions granted: **Tenant Guest**, **Server Administrator**, and **VPC Administrator**. • To use resources stored on OBS for other services, you need the **OBS OperateAccess** permission. OBS is a global service. You can find the corresponding OBS policy in the **Global service project** scope.
GES Development	Operator permissions for all operations except creating, deleting, resizing, and expanding graphs. **NOTE** • To use resources stored on OBS for other services, you need the **OBS OperateAccess** permission. OBS is a global service. You can find the corresponding OBS policy in the **Global service project** scope.
GES ReadOnlyAccess	Read-only permissions for viewing resources, such as graphs, metadata, and backup data. **NOTE** To use resources stored on OBS for other services, you need the **OBS OperateAccess** permission. OBS is a global service. You can find the corresponding OBS policy in the **Global service project** scope.

NOTE

It takes about 13 minutes for an OBS role to take effect after being applied to a user or group. A policy takes about 5 minutes.

Table 2-2 Common operations supported by each system-defined policy

Operation	GES FullAccess	GES Development	GES ReadOnlyAccess	Resource
Querying the graph list	Yes	Yes	Yes	-
Querying graph details	Yes	Yes	Yes	graphName
Creating graphs	Yes	No	No	graphName
Accessing graphs	Yes	Yes	No	graphName
Stopping graphs	Yes	Yes	No	graphName
Starting graphs	Yes	Yes	No	graphName
Deleting graphs	Yes	No	No	graphName
Importing Incremental data to graphs	Yes	Yes	No	graphName
Exporting graphs	Yes	Yes	No	graphName
Clearing graphs	Yes	Yes	No	graphName
Upgrading graphs	Yes	Yes	No	graphName
Resizing a Graph	√	No	No	graphName
Expanding a Graph	√	No	No	graphName
Restarting a Graph	√	Yes	No	graphName
Binding EIPs	Yes	Yes	No	graphName
Unbinding an EIP	Yes	Yes	No	graphName
Querying backups of all graphs	Yes	Yes	Yes	-
Querying backups of a graph	Yes	Yes	Yes	-
Adding backups	Yes	Yes	No	backupName

Operation	GES FullAccess	GES Development	GES ReadOnlyAccess	Resource
Deleting a graph backup	Yes	Yes	No	backupName
Querying the metadata list	Yes	Yes	Yes	-
Querying metadata	Yes	Yes	Yes	metadataName
Verifying metadata	Yes	Yes	No	-
Adding metadata	Yes	Yes	No	metadataName
Deleting metadata	Yes	Yes	No	metadataName
Querying task statuses	Yes	Yes	Yes	-
Querying the task list	Yes	Yes	Yes	-
Configuring fine-grained permissions	√	Yes	No	-
Configuring user groups	√	Yes	No	-
Importing IAM users	√	Yes	No	-
Viewing user details	√	Yes	Yes	-

2.2.3 Custom Policies

In addition to the system-defined policies of GES, you can also create your own custom policies.

You can create custom policies using the visual editor or by editing a JSON file:

- Visual editor: Just select the relevant cloud services, actions, resources, and request conditions. You do not need to understand policy syntax.
- JSON: You can create a policy using a JSON file or edit the JSON file for an existing policy.

Examples

- Example 1: Allowing users to query and operate graphs

```
{
    "Version": "1.1",
    "Statement": [
        {
            "Effect": "Allow",
            "Action": [
                    "ges:*:get*",
                    "ges:*:list*",
                    "ges:graph:operate"
            ]
        }
    ]
}
```

- Example 2: Preventing graph deletion

  A deny policy must be used in conjunction with other policies to take effect. If the policies assigned to a user contain both "Allow" and "Deny", the "Deny" permissions take precedence over the "Allow" permissions.

  If you need to assign the **GES FullAccess** policy to a user but also forbid that user from deleting graphs, you can create a custom policy that blocks graph deletion, and then assign both policies to the group the user belongs to. The user will be granted full access based on the system policy, but the custom policy will then override the permission allowing graph deletion. The following is an example of a deny policy:

```
{
      "Version": "1.1",
      "Statement": [
            {
          "Effect": "Deny",
                  "Action": [
                        "ges:graph:delete"
                  ]
            }
      ]
}
```

- Example 3: Authorizing users to perform operations on graphs whose name prefix is **ges_project** (**ges_project** names are case insensitive) and access the graph list

```
{
    "Version": "1.1",
    "Statement": [
        {
            "Effect": "Allow",
            "Action": [
                "ges:graph:create",
                "ges:graph:delete",
                "ges:graph:access",
                "ges:graph:getDetail"
            ],
            "Resource": [
                "ges:*:*:graphName:ges_project*"
            ]
        },
        {
            "Effect": "Allow",
            "Action": [
                "ges:graph:list"
            ]
        }
    ]
}
```

- Example 4: Authorizing users to operate only some graph resources, but allowing them to view all resources

  The policy consists of the following two parts:

  – Part 1: Authorizing users to perform operations on resources whose name prefix is **ges_project**. The resources include graphs and backups.

  – Part 2: Authorizing users to query the graph, backups, tasks, and metadata lists, and view job details

```
{
    "Version": "1.1",
    "Statement": [
        {
            "Action": [
                "ges:backup:delete",
                "ges:graph:access",
                "ges:graph:operate",
                "ges:graph:delete",
                "ges:graph:create",
                "ges:backup:create",
                "ges:graph:getDetail"
            ],
            "Resource": [
                "ges:*:*:backupName:ges_project*",
                "ges:*:*:graphName:ges_project*"
            ],
            "Effect": "Allow"
        },
        {
            "Action": [
                "ges:graph:list",
                "ges:backup:list",
                "ges:jobs:list",
                "ges:metadata:list",
                "ges:jobs:getDetail"
            ],
            "Effect": "Allow"
        }
    ]
}
```

2.3 Role Permissions

Roles can be used for fairly coarse-grained permissions control. They grant service-level permissions based on user responsibilities. GES does not support custom roles. The following system roles are available.

Table 2-3 System roles

Role Name	Description
Tenant Guest	Regular tenant users ● Permissions: querying GES resources ● Scope: project-level service

Role Name	Description
GES Administrator	GES administrator ● Permissions: performing any operations on GES resources ● Scope: project-level service **NOTE** If you have the **Tenant Guest**, **Server Administrator**, and **VPC Administrator** permissions, you can perform any operations on GES resources. If you do not have the **Tenant Guest** or **Server Administrator** permission, you cannot use GES properly. ● If you need to bind or unbind an EIP, you need the **Security Administrator** permissions to create agencies. ● If GES needs to interact with OBS, for instance, when creating and importing data, OBS permissions are required. For details, see **Common GES operations supported by each OBS policy**. When granting OBS permissions, specify the permission scope as global service resources.
GES Manager	GES manager ● Permissions: performing any operations on GES resources other than creating, deleting graphs, resizing, and expanding graphs ● Scope: project-level service **NOTE** If you have both **Tenant Guest** and **Server Administrator** permissions, you can perform any operations on GES resources except for creating and deleting graphs. If you do not have the **Tenant Guest** permission, you cannot use GES properly. ● If you need to bind or unbind an EIP, you need the **Security Administrator** and **Server Administrator** permissions. ● If GES needs to interact with OBS, for instance, when importing data, OBS permissions are required. For details, see **Common GES operations supported by each OBS policy**. When granting OBS permissions, specify the permission scope as global service resources.
GES Operator	Regular GES users ● Permissions: viewing and accessing GES resources ● Scope: project-level service **NOTE** ● If you have both the **GES Operator** and **Tenant Guest** permissions, you can view and access GES resources. If you do not have the **Tenant Guest** permissions, you cannot view resources or access graphs. ● To interact with OBS, for instance, to view the metadata, you need the OBS permissions. For details, see **Common GES operations supported by each OBS policy**.

Table 2-4 Common GES operations supported by each role

Operation	GES Administrator	GES Manager	GES Operator	Tenant Guest
Creating graphs	Yes	No	No	No
Deleting graphs	Yes	No	No	No
Querying graphs	Yes	Yes	Yes	Yes
Accessing graphs	Yes	Yes	Yes	No
Importing data	Yes	Yes	No	No
Creating metadata	Yes	Yes	No	No
Viewing metadata	Yes	Yes	Yes	Yes
Copying metadata	Yes	Yes	No	No
Editing metadata	Yes	Yes	No	No
Deleting metadata	Yes	Yes	No	No
Clearing data	Yes	Yes	No	No
Backing up graphs	Yes	Yes	No	No
Restoring graphs from backups	Yes	Yes	No	No
Deleting backups	Yes	Yes	No	No
Querying backups	Yes	Yes	Yes	Yes
Starting graphs	Yes	Yes	No	No
Stopping graphs	Yes	Yes	No	No
Upgrading graphs	Yes	Yes	No	No

Operation	GES Administrator	GES Manager	GES Operator	Tenant Guest
Exporting graphs	Yes	Yes	No	No
Viewing results in the task center	Yes	Yes	Yes	Yes
Resizing a graph	√	No	No	×
Expanding a graph	√	No	No	×
Restarting a graph	√	Yes	No	×
Configuring fine-grained permissions	√	Yes	No	×
Configuring user groups	√	Yes	No	×
Importing IAM users	√	Yes	No	×
Viewing user details	√	Yes	Yes	√

Table 2-5 Common GES operations supported by each OBS policy

GES Operation	Dependent OBS Permission
Viewing metadata	**OBS Viewer** policy or **OBS Buckets Viewer** role
Creating, importing, copying, editing, and deleting metadata	**OBS Operator** policy or **Tenant Administrator** role
Creating, importing, and exporting graphs	**OBS Operator** policy or **Tenant Administrator** role

Table 2-6 Common GES operations supported by each IAM policy

GES Operation	Dependent IAM Permission
Importing IAM users	**iam:users:listUsers** (custom policy), **IAM ReadOnlyAccess** (system policy), or **Server Administrator** role

GES Operation	Dependent IAM Permission
Creating or editing a user group	**iam:users:listUsers** (custom policy), **IAM ReadOnlyAccess** (system policy), or **Server Administrator** role

3 Metadata Operations

3.1 Graph Data Formats

3.1.1 Static Graph

Before importing graph data, familiarize yourself with the graph data formats supported by GES.

- GES only supports the loading of raw graph data in the standard CSV format. If your raw data is not in this format, convert it to CSV.
- GES graph data consists of the vertex, edge, and metadata files.
  - Vertex files store vertex data.
  - Edge files store edge data.
  - Metadata is used to describe the formats of data in vertex and edge files.

Concept Description

Graph data is imported through a property graph model in GES, so you must learn the concept of the property graph.

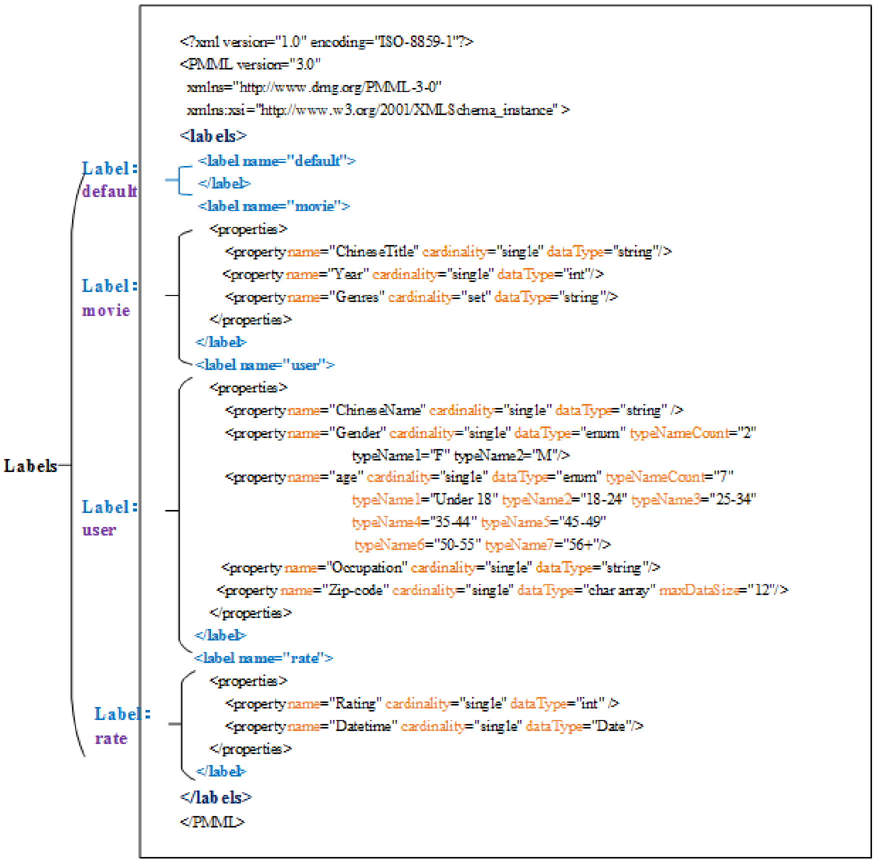
A property graph is a directed graph consisting of vertices, edges, labels, and properties.

- A vertex is also called a node, and an edge is also called a relationship. Nodes and relationships are the most important entities.
- Metadata describes vertex and edge properties. It contains multiple labels, and each label consists of one or more properties.
- Vertices with the same label belong to a group or a set.
- Each vertex or edge can have only one label.

Metadata

The following figure shows the metadata structure.

Figure 3-1 Metadata structure




```xml
<?xml version="1.0" encoding="ISO-8859-1"?>
<PMML version="3.0"
 xmlns="http://www.dmg.org/PMML-3-0"
 xmlns:xsi="http://www.w3.org/2001/XMLSchema_instance" >
<labels>
  <label name="default">
  </label>
  <label name="movie">
    <properties>
      <property name="ChineseTitle" cardinality="single" dataType="string"/>
      <property name="Year" cardinality="single" dataType="int"/>
      <property name="Genres" cardinality="set" dataType="string"/>
    </properties>
  </label>
  <label name="user">
    <properties>
      <property name="ChineseName" cardinality="single" dataType="string" />
      <property name="Gender" cardinality="single" dataType="enum" typeNameCount="2"
                typeName1="F" typeName2="M"/>
      <property name="age" cardinality="single" dataType="enum" typeNameCount="7"
                typeName1="Under 18" typeName2="18-24" typeName3="25-34"
                typeName4="35-44" typeName5="45-49"
                typeName6="50-55" typeName7="56+"/>
      <property name="Occupation" cardinality="single" dataType="string"/>
      <property name="Zip-code" cardinality="single" dataType="char array" maxDataSize="12"/>
    </properties>
  </label>
  <label name="rate">
    <properties>
      <property name="Rating" cardinality="single" dataType="int" />
      <property name="Datetime" cardinality="single" dataType="Date"/>
    </properties>
  </label>
</labels>
</PMML>
```

GES metadata is stored in an XML file and is used to define vertex and edge properties.

It contains labels and properties.

- **Label**

  A label is a collection of properties. It describes formats of property data contained within a vertex or an edge.

  NOTE

  If the same property **name** is defined in different labels, the **cardinality** and **dataType** of the properties in different labels must be the same.

- **Property**

  A property refers to the data format of a single property and contains three fields.

  – **Property name**: name of a custom property. The value can contain 1 to 256 characters and cannot contain special characters (<>&).

    NOTE

    A label cannot contain two properties with the same name.

  – **cardinality**: composite type of data. The options are **single**, **list**, and **set**.

    ▪ **single** indicates that the data of this property has a single value, such as a digit or a character string.

NOTE

If **value1;value2** is of the **single** type, it is regarded as a single value.

- **list** and **set** indicate that data of this property consists of multiple values separated by semicolons (;).
  - **list**: The values are placed in sequence and can be repeated. For example, **1;1;1** contains three values.
  - **set**: The values are in random sequence and must be unique. Duplicate values will be overwritten. For example, **1;1;1** contains only one value (1).

NOTE

list and **set** do not support values of the **char array** data type.

– **dataType**: Data type. The following table lists the data types supported by GES.

Table 3-1 Supported data types

Type	Description
char	Character
char array	Fixed-length string. Set the maximum length using the **maxDataSize** parameter. **NOTE** • You can set **maxDataSize** to limit the maximum length of the string. For details, see **Metadata structure**. • Only **single** supports the data type. • If the property data is a string, you are advised to set **dataType** to char array. If the data type is set to **string**, the import is slower.
float	Float type (32-bit float)
double	Double floating point type (64-bit float point)
bool	Boolean type. Available values are **0/1** and **true/false**.
long	Long integer (value range: **-2^63** to **2^63-1**)
int	Integer (value range: **-2^31** to **2^31-1**)
date	Date. Currently, the following formats are supported: • YYYY-MM-DD HH:MM:SS • YYYY-MM-DD **NOTE** The value of MM or DD must consist of two digits. If the day or month number contains only one digit, add 0 before it, for example, 05/01.
enum	Enumeration. Specify the number of the enumerated values and the name of each value. For details, see **Metadata structure**.

Type	Description
string	Variable-length string **NOTE** The data import efficiency can be very low if the string is too long. You are advised to use a char array instead. You can set the length of a char array as needed. It is recommended that the length be less than or equal to 32 characters.

The following figure shows a metadata example:

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<PMML version="3.0"
  xmlns="http://www.dmg.org/PMML-3-0"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema_instance" >
  <labels>
    <label name="default">
    </label>
    <label name="movie">
        <properties>
            <property name="movieid" cardinality="single" dataType="int" />
            <property name="title" cardinality="single" dataType="string"/>
            <property name="genres" cardinality="single" dataType="string"/>
        </properties>
    </label>
    <label name="user">
        <properties>
            <property name="userid" cardinality="single" dataType="int" />
            <property name="gender" cardinality="single" dataType="string"/>
            <property name="age" cardinality="single" dataType="enum" typeNameCount="7"
            typeName1="Under 18" typeName2="18-24" typeName3="25-34" typeName4="35-44"
typeName5="45-49"
             typeName6="50-55" typeName7="56+"/>
            <property name="occupation" cardinality="single" dataType="enum" typeNameCount="21"
            typeName1="other or not specified" typeName2="academic/educator" typeName3="artist"
typeName4="clerical/admin" typeName5="college/grad student"
             typeName6="customer service" typeName7="doctor/health care" typeName8="executive/
managerial" typeName9="farmer" typeName10="homemaker"
              typeName11="K-12 student" typeName12="lawyer" typeName13="programmer"
typeName14="retired" typeName15="sales/marketing"
               typeName16="scientist" typeName17="self-employed" typeName18="technician/engineer"
typeName19="tradesman/craftsman" typeName20="unemployed"
                typeName21="writer"/>
            <property name="Zip-code" cardinality="single" dataType="char array" maxDataSize="12"/>
        </properties>
    </label>
    <label name="rate">
        <properties>
            <property name="Rating" cardinality="single" dataType="int" />
            <property name="Datetime" cardinality="single" dataType="string"/>
        </properties>
    </label>
  </labels>
</PMML>
```

Vertex Files

A vertex file contains the data of each vertex. A vertex of data is generated for each behavior. The following is an example. **id** is the unique identifier of a set of vertex data.

```
id, label, property 1, property 2, property 3, ...
```

NOTE

- The vertex ID cannot contain hyphens (-).
- You do not need to set the data type of the vertex ID. It is of the string type by default.
- Do not add spaces before or after a label. Use commas (,) to separate information. If a space is identified as a part of a label, the label may fail to be identified. In this case, the system may display a message indicating that the label does not exist.

Example:

```
Vivian, user, Vivian, F, 25-34, artist, 98133
Eric, user, Eric, M, 18-24, college/grad student, 40205
```

Edge Files

An edge file contains the data of each edge. An edge of data is generated for each behavior. The graph size in GES is defined by the quantity level of the edges, for example, one million edges. The following is an example. **id 1** and **id 2** are the IDs of the two endpoints (vertices) of an edge.

```
id 1, id 2, label, property 1, property 2, ...
```

Example:

```
Eric,Lethal Weapon,rate,4,2000-11-21 15:33:18
Vivian,Eric,friends
```

3.2 Importing a Metadata File

3.2.1 Preparing Metadata

Preparing Metadata on a Local PC

You need to prepare a metadata file on your PC and import the file to GES for subsequent use.

The metadata file must be in XML format.

(Optional) Importing Metadata to OBS

You can upload a prepared metadata file to an OBS bucket to import it to GES.

The procedure is as follows:

1. Log in to the OBS console and create an OBS bucket. If you already have a bucket, ensure that the OBS bucket and GES are in the same region.
2. Upload the prepared file to the OBS bucket. The metadata file must be in XML format.

3.2.2 Importing Data From a Local Path or OBS

1. On the GES management console, click **Metadata Management** in the navigation tree on the left.
2. On the **Metadata Management** page, click **Import** in the upper left corner.

3. In the **Import** dialog box, select **Local** or **OBS** for **Type** to import a metadata file form a local path or OBS.
   – Import a metadata file from a local path.

     Select Local File: Click **Upload** to select the metadata file.

     NOTE

     The file must be in the XML format.

     Name: Enter a name for the metadata.

     Storage Path: Select an OBS path for storing the metadata file.
   – Import a metadata file from OBS.

     Select File Path: Select the metadata file from OBS.

     NOTE

     - The file must be in the XML format.
     - Ensure that you have uploaded the metadata file to your OBS bucket.

     Name: Enter a name for the metadata.
4. Click **OK** to import the metadata.

   If the import is successful, the metadata file is displayed on the **Metadata Management** page.

3.3 Creating a Metadata File

If you currently have no metadata file, you can create metadata files on GES.

Procedure

1. On the **Metadata Management** page, click **Create Metadata File** in the upper right corner.
2. Configure the following parameters on the displayed page:
   – **Name**: Enter the metadata file name. The default file format is XML.
   – **Storage Path**: Select an OBS path for storing the metadata file. If you create metadata for the first time, you need to enable OBS. (You are advised to obtain user authorization and automatically create OBS buckets for the metadata.)
   – **Definition**: Metadata models can be built manually or in a visualized manner.

     Manual: Click **Add Label**. Define the label name and label type. Click **Add** under the label name to add a property. You can also click **Up** or **Down** to sort properties. **Table 3-2** lists the property parameters. For details about other metadata information, see **Graph Data Formats**.

     NOTE

     1. Multiple labels are allowed. Click **Add label** to add labels as needed.
     2. There are three types of labels: vertex, edge, and general-purpose (both vertex and edge).

     Visual:

- Adding a vertex label: Drag a circle to the canvas to add a vertex. Click the vertex in the canvas to define its name, description, and properties.
- Adding an edge label: Click a connection point on a vertex and drag it to the connection point of another vertex to create an edge. Define its name, description, source vertex, target vertex, and properties. **Table 3-2** lists the property parameters.

Table 3-2 Property parameters

Name	Description
Property Name	Name of a property. It contains 1 to 256 characters. Special characters such as angle brackets (<>) and ampersands (&) are not allowed.
Cardinality	Composite type of data • **Single value**: indicates that the property has a single value, such as a digit or a string. • **Multiple values**: indicates that the property has multiple values separated by semicolons (;). You can determine whether to allow repetitive values.
Data Type	Data type of the property values. Available values are **char**, **float**, **double**, **bool**, **long**, **int**, **date**, **enum**, **string**, and **char array**. For details, see **Static Graph**. **NOTE** Only the single-value property supports the **char array** type.
Operation	Click **Remove** to delete a property.

3. Click **OK**. The created metadata file will be displayed on the **Metadata Management** page.

   On the **Metadata Management** page, you can view the storage path, status, and modification time of the metadata.

3.4 Copying a Metadata File

If you edit a metadata file, the original metadata file will be overwritten. To avoid loss of the original metadata, you can sabe a copy of the file before editing it.

Procedure

1. GES provides two methods for you to copy a metadata file on the **Data Management** page.
   - Click the metadata file name. On the details page, click **Copy**.
   - Click **Copy** in the **Operation** column of the target metadata file.
2. Specify the metadata file name and storage path.

   Name: Enter the name of the copied metadata file. The default file format is XML.

Storage Path: Enter an OBS path for storing the metadata file.

3. Click **OK**.

   The copy of the metadata file will be displayed on the **Metadata Management** page.

3.5 Editing a Metadata File

If the metadata file you imported or created needs to be modified, you can directly modify its labels and properties.

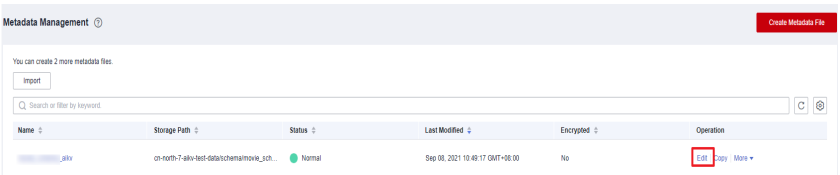
NOTE

After the metadata file is edited, the original metadata file will be overwritten. To avoid data loss, you are advised to save a copy of the metadata file before editing it.

Procedure

1. GES provides two methods for you to edit a metadata file on the **Data Management** page.
   - Click the metadata file name. On the metadata details page, click **Edit**.
   - Click **Edit** in the **Operation** column of the target metadata file.

   Figure 3-2 Clicking Edit

2. On the editing page:
   - On the **Manual** tab, you can add labels and properties, change label names, and sort properties by clicking **Up** and **Down**.
   - On the **Visual** tab, you can drag a vertex to the canvas to add a label, or click a vertex or edge to modify the label information.
3. After the modification is complete, click **OK**.

3.6 Searching for a Metadata File

On the **Metadata Management** page, enter the name of the metadata file you want to search.

3.7 Deleting a Metadata File

If a metadata file becomes invalid, locate it in the metadata file list on the **Metadata Management** page, click **More** in its **Operation** column, and select **Delete**.

NOTE

Deleted data cannot be recovered. Exercise caution when performing this operation.

4 Creating Graphs

4.1 Methods to Create a Graph

Create a graph on the GES console.

You have two options to choose from: **customizing a graph** and **creating a dynamic graph**. By default, the former is used.

- Custom graph: This is a default graph creation method that fully meets your requirements.
- Dynamic graph: By default, the **dynamic graph analysis function** is enabled for graphs created in this mode.

NOTE

You must create a dynamic graph to use the function. This function cannot be enabled for custom graphs and template-based graphs.

4.2 Creating a Custom Graph

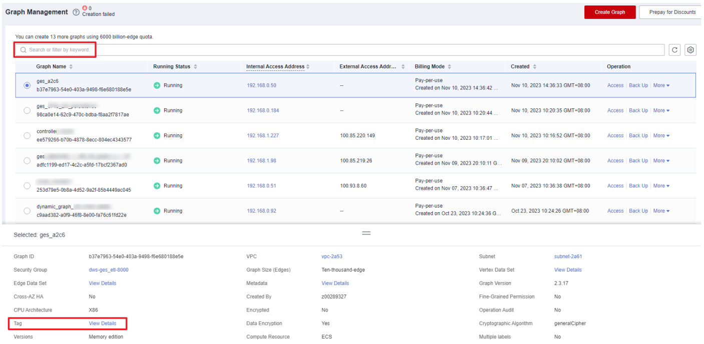
1. Log in to the GES console and click **Create Graph** in the upper right corner of the **Overview** page.
2. On the **Create Graph** page, set the following parameters:
   a. In the **Configure** step, set the graph name and software version.

Parameter	Description
Graph Name	You can set a name or use the default name. After a graph is created, its name cannot be changed. The graph name must: • Contain 4 to 50 characters and start with a letter. • Be case-insensitive. • Contain only letters, digits, and underscores (_).

Parameter	Description
GES Software Version	The system uses the latest version by default, and only the default version is available.

b. Specify the network information, including **VPC**, **Subnet**, **Security Group**, **Enterprise Project**, and **Public Network Access**.

Parameter	Description
VPC	A VPC is a secure, isolated, and logical network environment. Select the VPC for which you want to create the graph and click **View VPC** to view the name and ID of the VPC. **NOTE** If your account has VPCs, a VPC will be automatically selected. You can change it as needed. If no VPC is available, you need to create a VPC. After the VPC is created, it will be automatically selected.
Subnet	A subnet provides dedicated network resources that are logically isolated from other networks for network security. Select the subnet for which you want to create the graph to enter the VPC and view the name and ID of the subnet.
Security Group	A security group implements access control for ECSs that have the same security protection requirements in a VPC. ● Click **View Security Group** to learn security group details.
Public Network Access	The public network access to the graph. Set this parameter as you need. **Do not use**: A graph instance without an elastic IP (EIP) cannot be accessed over the Internet. However, the graph instance can be accessed through ECSs deployed on a private network. **Buy now**: GES automatically allocates an EIP with exclusive bandwidth to the graph instance so that the graph instance can be accessed over the Internet using the EIP. In addition, GES uses the tenant permission to automatically create an agency with the prefix of **ges_agency_default** in the project to support EIP binding. **Specify**: Select an EIP to allow the graph instance to be accessed over the Internet.

Parameter	Description
Tag	Tags for a resource. Enter a tag key and value, and click **Add** to add the tag. You can view the added tag in the graph details and search for graphs by tag on the **Graph Management** page.  **NOTE** It is recommended that you use TMS's predefined tag function to add the same tag to different cloud resources.
Security Mode	If you enable the security mode, communications will be encrypted when you access a graph instance, and only HTTPS can be used when you call APIs. This function affects GES performance.
Cryptographic Algorithm	Available values are as follows: ● General cryptographic algorithms (SM series cryptographic algorithms not supported) are used by all components to store and transmit sensitive data. These algorithms that do not have special requirements. ● SM series commercial encryption algorithm (compatible with the international general algorithm) is supported. Sensitive data of all components is stored using this algorithm. The SM series commercial encryption algorithm and international algorithm can be used for data transmission.

c. Set graph parameters.

Parameter	Description
Cross-AZ HA	Whether to support cross-AZ cluster. If this function is enabled, graph instances are distributed in different AZs to enhance reliability.

<table>
<tr><th>Parameter</th><th>Description</th></tr>
<tr><td>Purpose</td><td>Purpose of the graph to be created.
Enterprise production: High reliability and concurrency are supported, suitable for production and large-scale applications.
Developer learning: A complete function experience is offered, suitable for developer learning.</td></tr>
<tr><td>Versions</td><td>GES editions.
● Memory edition: The capacity is limited and a maximum of 10 billion edges are supported. Storage and compute based on memory storage. This edition is preset with a variety of algorithms, and Gremlin and Cypher query languages are supported.
● Database edition: The storage capacity is unlimited. Storage and compute based on distributed key-value databases. This edition has higher performance and has unlimited capacity, but it supports only the Cypher queries.</td></tr>
<tr><td>Compute Resource</td><td>Type of compute resources.
An elastic cloud server (ECS) is a computer system that has complete hardware, an operating system (OS), and network functions and runs in a secure, isolated environment.</td></tr>
<tr><td>CPU Architecture</td><td>Currently, GES supports X86 and Kunpeng.</td></tr>
<tr><td>Graph Size (Edges)</td><td>Available options based on your resource quota.
Different graph specifications are displayed for Enterprise production and Developer learning.
● Development learning: Currently, there is only 10-thousand-edge graphs are available for this purpose, regardless of the edition.
● Enterprise production: The specifications vary depending on the edition.
– Memory edition: Available options are million-edge, 10-million-edge, 100-million-edge, billion-edge, billion-edge-pro, and 10-billion-edge.
– Database edition: Available options are billion-edge, 10-billion-edge, and 100-billion-edge.
NOTE
Graph size, which is based on the number of edges. The value is not accurate. If there are a large number of vertices and properties, you are advised to apply for graphs with a larger size.</td></tr>
</table>

Parameter	Description
Vertex ID Type	Only fixed-length string and hash types are available for graphs of the database edition. ● Fixed-length string: Vertex IDs are used for internal storage and compute. Specify the length limit. If the IDs are too long, the query performance can be reduced. Specify the length limit based on your dataset vertex IDs. If you cannot determine the maximum length, set the ID type to Hash. ● Hash: Vertex IDs are converted into hash code for storage and compute. There is no limit on the ID length. However, there is an extremely low probability, approximately 10^(-43), that the vertex IDs will conflict. **NOTE** If you cannot determine the maximum length of a vertex ID, set this parameter to **Hash**.

d. **Advanced Settings**: Set this parameter to **Default** or **Custom**.

- **Default**: Use the default values.
- **Custom**:
  - If you choose the memory edition, the options include **Encrypt Instance**, **Full-Text Indexing**, **Operation Audit**, and **Fine-Grained Permission**.

Parameter	Description
Encrypted Instance	Whether to encrypt a graph instance. **Key Source** is default to **KMS**. **KMS Key**: Select the key as needed. **NOTE** Some functions will be affected if you disable or delete a KMS key.
Full-Text Index	Whether to enable full-text search, fuzzy search, prefix search, and regular expression match. **NOTE** Currently, only billion-edge-pro and 100-billion-edge (database edition) graphs support this feature.
Fine-Grained Permission	Whether to enable fine-grained permission management. If this function is enabled, the traverse, read, and write permissions can be set for specific attributes each label.

3. Click **Next**. The **Confirm** page is displayed.
4. Confirm the information and click **Submit** to create the graph.

5. After the submission is successful, the **Finish** tab page is displayed. You can click **Back to Task Center** to view the status and running result of the created graph.

4.3 Creating a Dynamic Graph

1. Log in to the GES console and click **Create Graph** in the upper right corner of the **Overview** page.
2. On the displayed page, click the **Create Dynamic Graph** tab. The page for creating a dynamic graph is displayed.
3. Set required parameters by referring to **Creating a Graph Without Using a Template**.

   By default, the **Dynamic graph analysis capability** is enabled for dynamic graphs.

4. Click **next**. On the **Confirm** page that is displayed, confirm the information and click **Submit** to create the graph.
5. After the submission is successful, the **Finish** tab page is displayed. You can click **Back to Task Center** to view the status and running result of the created graph.
6. For details about how to use dynamic graphs, see **Dynamic Graphs**.

4.4 Starting a Graph

Scenario

You can start graphs in **Stopped** status in the graph list so that they can be accessed and analyzed again.

Graphs in **Running** status cannot be started.

Procedure

Step 1 Log in to the GES management console.

Step 2 In the navigation tree on the left, select **Graph Management**.

Step 3 Locate the target graph in the graph list and choose **More** > **Start** in the **Operation** column.

- If the graph to be started has backups, a dialog box is displayed indicating that you can select either of the following methods to start the graph:
  - **Restore Last Graph**: Restart the graph that stopped running.
  - **Start Backup**: Start the graph using the backup data.

  After selecting a startup method, click **Yes**. The graph status becomes **Preparing** and the progress is displayed.
- If the graph to be started does not have backups, the graph status changes to **Preparing** and the progress is displayed after you click **Start**.

Step 4 After the graph is started, the status changes from **Preparing** to **Starting**. Wait several minutes. When the startup is successful, the graph status is switched to **Running**.

----End

4.5 Stopping a Graph

Scenario

If you do not need to use a graph, you can stop it. After the graph is stopped, you cannot access it.

NOTE

Resources are not released after you stop the graph.

Procedure

Step 1 Log in to the GES management console.

Step 2 In the navigation tree on the left, select **Graph Management**.

Step 3 Locate the target graph in the graph list and choose **More** > **Stop** in the **Operation** column.

Step 4 The graph status changes to **Stopping**. Wait several minutes. When the graph is successfully stopped, the graph status is switched to **Stopped**.

----End

4.6 Accessing Graphs

Scenario

On the **Graph Management** page, you can click **Access** to query and analyze a created graph.

Procedure

On the **Graph Management** page, view all created graphs and click **Access** in the **Operation** column of a target graph.

4.7 Importing Incremental Data

Scenario

After you create a graph, you need to import graph data. If you need to add new graph data, you can import data to the graph.

NOTE

- To prevent failures in restoring the imported graph data during system restart, do not delete the data stored on OBS when the graph is in use.
- The default separator of data columns is comma (,). You cannot define a separator.

Procedure

Step 1 Log in to the GES management console.

Step 2 In the navigation pane on the left, choose **Graph Management**.

Step 3 In the graph list, locate the target graph, click **More** in the **Operation** column, and select **Import**.

Step 4 In the **Import** dialog box that is displayed, set the following parameters:

- **Metadata**: Select an existing metadata file or create one. For details, see **Creating a Metadata File**.
- **Edge Data**: Select the corresponding edge data set.
- **Vertex Data**: Select the corresponding vertex data set. If you leave it blank, the vertices in the **Edge Data** set are used as the source of **Vertex Data**.
- **Log Storage Path**: Stores vertex and edge data sets that do not comply with the metadata definition, as well as detailed logs generated during graph import.
- **Edge Processing**: Includes **Allow repetitive edges**, **Ignore subsequent repetitive edges**, **Overwrite previous repetitive edges**, and **Ignore labels on repetitive edges**.

  Edge Processing: Repetitive edges have the same source and target vertices. When labels are considered, repetitive edges must have the same source and target vertices and the same labels.

  - **Allow repetitive edges**: Multiple edges may exist between a source vertex and a target vertex.
  - **Ignore subsequent repetitive edges**: If there are multiple edges between a source vertex and a target vertex, only the first edge read is retained.
  - **Overwrite previous repetitive edges**: If there are multiple edges between a source vertex and a target vertex, only the last edge read is retained.
  - **Ignore labels on repetitive edges**: If labels are ignored, edges with the same source vertex and target vertex are repetitive edges.
- **Import Type**: The value can be **Online import** or **Offline import**.

NOTE

- Graphs of the database edition support **multi-graph management**, and you need to select a graph name. **Edge Processing** and **Import Type** are not supported.
- The edge and vertex data sets can only be stored in English paths and folders.
- Currently, you can import the edge and vertex data sets only from OBS. You need to store data files in an OBS bucket..
- The sequence of the properties and labels in the selected edge or vertex data set must be the same as the sequence in the selected metadata file. Otherwise, **The edge/vertex data file does not match the metadata file** is displayed in the upper right corner and the graph fails to be created. For details about the graph data format, refer to **Graph Data Formats**.
- You need to import the graph data (including the metadata file, and edge and vertex data sets) in the format specified in the template. The template contains a copy of movie information. You can click **Download** to download and import it.

Step 5 Click **OK**.

----End

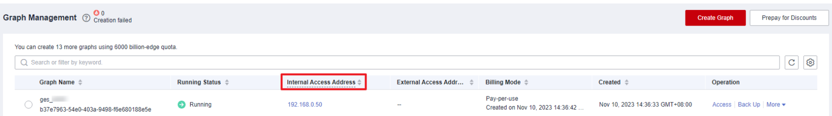
5 Managing Graphs

5.1 Graph Management Overview

On the **Graph Management** page, you can view the name, running status, internal access address, external access address, and creation time of a graph.

NOTE

To view the **internal access address** is the floating IP address for accessing the graph instance. You can click the IP address to view the list of physical IP addresses of the graph instance. To prevent service interruption caused by floating IP address switchover, poll the physical IP addresses to access the graph instance.



Click  next to a graph name to view the graph information, including **Graph ID**, **VPC**, **Subnet**, **Security Group**, **Graph Size (Edges)**, **Vertex Data Set**, **Edge Data Set**, **Metadata**, **Graph Version**, **Cross-AZ HA**, **Created By**, **Fine-Grained Permission**, **CPU Architecture**, **Encrypted**, and **Operation Audit**.

5.2 Viewing a Failed Graph

If the ECS quota is insufficient, graphs may fail to be created. You can view failed graphs on the **Graph Management** page.

Procedure

Step 1 In the navigation tree on the left, select **Graph Management**.

Step 2 In the upper left corner of the displayed page, view the number of graphs that fail to be created next to **Graph Management**.

Step 3 Click  to view the name, running status, and creation time of the graph that fails to be created. You can also delete the failed graph.

NOTE

Graphs that fail to be created will occupy quotas if they are not deleted.

Step 4 Click **View Details** in the **Operation** column to go to the **Task Center** page. View the start time, end time, failure cause, and job ID of the failed creation task.

NOTE

Asynchronous task details can be retained only for one month. You cannot view information about graphs created more than one month ago.

----End

5.3 Backing Up and Restoring Graphs

5.3.1 Backing Up a Graph

To ensure data security, back up the graph data so that you can restore it when faults occur.

Procedure

You can perform the backup operation on the **Graph Management** page or the **Backup Management** page.

1. Graph management operations
   a. Log in to the GES management console. In the navigation tree on the left, select **Graph Management**.
   b. Locate the target graph in the graph list and select **Back Up** in the **Operation** column.
   c. In the dialog box displayed, click **OK**.

      NOTE

      On the **Graph Management** page, the backup operation can be performed only on the selected graph. The associated graph cannot be changed.

   d. In the navigation tree on the left, click **Backup Management**. You can view the backup task in the backup list.

      If **Status** is **Backing up**, wait several minutes. When **Status** is switched to **Succeeded**, the backup is successful.
2. Backup management operations
   a. Log in to the GES management console. In the navigation tree on the left, select **Backup Management**.
   b. In the upper right corner of the **Backup Management** page, click **Create Backup**.
   c. In the **Create Backup** dialog box, set **Associated Graph** (a graph created by the current user) and click **OK** to start the backup.

      NOTE

      You can select an **Associated Graph** for the backup. However, if there is only one graph, you cannot change the value of **Associated Graph**.

d. In the backup list, you can view the data being backup up or newly backed up.

   If **Status** is **Backing up**, wait several minutes. When **Status** is switched to **Succeeded**, the backup is successful.

e. Go to the **Backup Management** page, view the backup name and type, name, status, and size of the associated graph, CPU architecture, creation time, end time, backup size, and backup duration.

5.3.2 Restoring a Graph

If the graph data being edited is incorrect, you can load the backup data to restore the graph data for analysis.

NOTE

Ten-thousand-edge graphs and graphs of the database edition cannot be automatically backed up. You need to back up a graph and restore data from the manul backup. For graphs of other sizes, you can restore data from an automatic backup or manual backup.

The procedure is as follows:

Step 1 Log in to the GES management console and choose **Backup Management** from the navigation pane on the left.

Step 2 On the **Backup Management** page displayed, locate the row containing your desired backup and click **Restore** in the **Operation** column.

Step 3 In the **Restore** dialog box, select **This operation will overwrite the target graph. After the restoration starts, the target graph will be restarted using the backup**. Then, click **Yes**.

Step 4 After a message is prompted indicating that the restoration is successful, you can access the target graph and obtain the restored data on the **Graph Management** page.

----End

5.3.3 Deleting a Backup

If backup data is no longer used, you can delete it as needed.

The procedure is as follows:

Step 1 Log in to the GES management console and choose **Backup Management** from the navigation pane on the left.

Step 2 In the backup list, select the backup data to be deleted and click **Delete** in the **Operation** column.

Step 3 In the displayed dialog box, click **Yes** to delete the data.

NOTE

1. Deleted data cannot be recovered. Exercise caution when performing this operation.
2. You cannot delete the automatic backup data of a graph that has not been deleted.

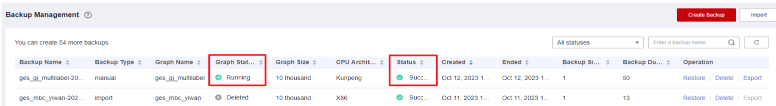
----End

5.3.4 Exporting a Backup to OBS

To migrate GES data across regions, you can export backup files to OBS.

NOTE

- Graphs of the database edition do not support this function.
- Only graphs of memory edition 2.3.16 or later support this function. To export graphs of an earlier version, you need to upgrade the graphs by referring to **Upgrading a Graph**, and then export the graphs.
- You need to back up the graph on the **Graph Management** page so that the graph can be displayed on the **Backup Management** page. For details, see **Backing Up a Graph**.
- On the **Backup Management** page, only graphs whose **Graph Status** is **Running** and **Status** is **Successful** can be exported to OBS. Otherwise, the **Export** button is unavailable.



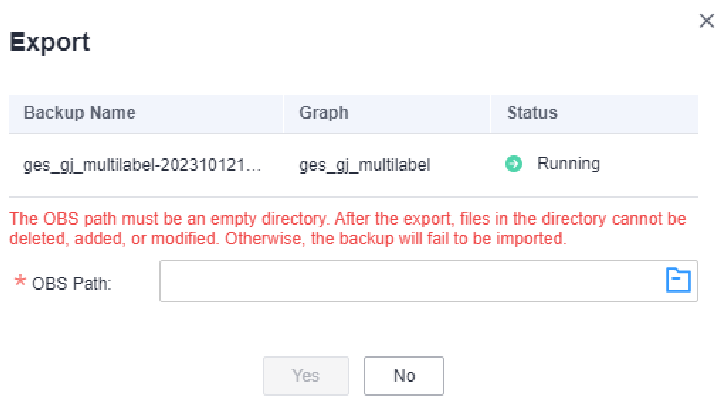
Step 1 Log in to the GES management console and choose **Backup Management** from the navigation pane on the left.

Step 2 In the backup list, select the backup to be exported and click **Export** in the **Operation** column.

Step 3 In the dialog box that is displayed, verify that the backup information is correct and select an OBS path.

Note that the OBS export path can only be an empty directory, and after the export, the graph data files under that directory cannot be deleted, added, or modified. Otherwise, the backup will fail when importing from OBS to the graph.

Figure 5-1 Exporting a backup to OBS



Step 4 Click **OK** to back up the graph.

NOTE

Storing backup files in OBS will incur charges. For details, see .

Step 5 After the task is delivered, you can view its execution status on the **Task Center** page.

----End

5.3.5 Importing a Backup from OBS

You can import a backup file exported to OBS to a graph. After the import is successful, you can use the backup to restore the graph instance.

NOTE

- Graphs of the database edition do not support this function.
- Only graphs of memory edition 2.3.16 or later support this function. To export graphs of an earlier version, you need to upgrade the graphs by referring to **Upgrading a Graph**, and then import the graphs.

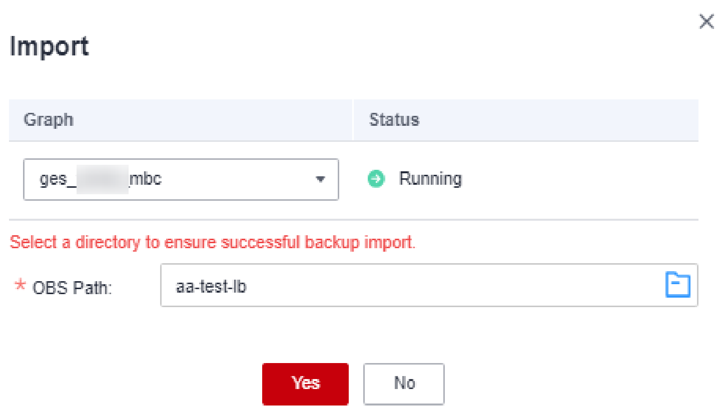
The procedure is as follows:

Step 1 Log in to the GES management console and choose **Backup Management** from the navigation pane on the left.

Step 2 In the upper right corner of the page displayed, click **Import**.

Step 3 In the dialog box that is displayed, select the graph to be imported and the OBS path where the backup is stored, and click **OK** to import the backup.

Figure 5-2 Importing a backup



NOTE

Select a directory (folder) to ensure successful backup import.

Step 4 After the task is delivered, you can view its execution status on the **Task Center** page.

----End

5.4 Upgrading a Graph

Because the GES software is upgraded continuously, graphs of earlier versions can also be upgraded to the new version.

The procedure is as follows:

Step 1 Log in to the GES management console and choose **Graph Management** from the navigation pane on the left.

Step 2 Locate the target graph in the graph list and choose **More** > **Upgrade** in the **Operation** column.

Step 3 In the displayed dialog box, select a version from the **Version List** and determine whether to select **Forcible Upgrade**.

NOTE

If **Forcible Upgrade** is selected, all in-progress tasks will be interrupted. Exercise caution when performing this operation.

Step 4 Click **OK**. The graph status changes to **Upgrading**. Wait several minutes, the status will become **Running** after the upgrade is successful.

NOTE

If the upgrade fails, the graph automatically rolls back to the source version.

----End

5.5 Exporting a Graph

You can export graph data to a custom OBS directory.

The procedure is as follows:

Step 1 Log in to the GES management console and choose **Graph Management** from the navigation pane on the left.

Step 2 Locate the target graph in the graph list and choose **More** > **Export** in the **Operation** column.

Step 3 In the lower part of the page that is displayed, select a storage path. (For a graph of the database edition, you also need to select the graph name.)

Step 4 Click **OK**. The graph status changes to **Exporting**. Wait several minutes, the status will become **Running** after the export is successful.

You can check whether the data is exported successfully in the selected OBS path.

NOTE

If you choose to export CSV files to your local host, the files are opened using the spreadsheet software by default. You are advised to open the files in a text editor. If the data contains special characters such as plus signs (+), minus signs (-), equal signs (=), and at signs (@), the data will be parsed into formulas by the software. To ensure system security, pay attention to the following when opening such files:

1. Do not select **Enable Dynamic Data Exchange Server Launch (not recommended)**.
2. Do not select **Enable** or **Yes** if a dialog box indicating a security issue is displayed.

----End

5.6 Restarting a Graph

You need to restart a graph in the following cases:

1. If you access a graph in the **Running**, **Importing**, **Exporting**, or **Clearing** status and an unknown exception occurs, you can restart the graph.
2. You can restart a graph that is stuck in a state. For example, if a graph stuck in the **Exporting** status for a long time because the data to be exported is too much. You can restart the graph to stop exporting.

The procedure is as follows:

Step 1 Logging In to the GES Management Console.

Step 2 In the navigation pane on the left, choose **Graph Management**. On the displayed page, locate the graph to be restarted and choose **More** > **Restart** in the **Operation** column.

Step 3 In the displayed dialog box, check the name of the graph to be restarted.

NOTE

Restarting a graph will forcibly terminate the running task. For an import task, only partial data can be imported.

Step 4 Click **OK**. The graph status changes to **Stopping**. After several minutes, the graph status changes to **Running**.

----End

5.7 Resizing a Graph

If the storage capacity, computing capability, or service capability of a graph cannot meet service requirements, you can resize the graph.

NOTE

- Currently, 10,000-edge and 10-billion-edge graphs cannot be resized.
- After the graph is resized, you need to re-create all indexes.

The procedure is as follows:

Step 1 Log in to the management console.

Step 2 In the navigation pane on the left, choose **Graph Management**. On the displayed page, locate the target graph and choose **More** > **Resize** in the **Operation** column.

Step 3 In the displayed dialog box, select the target specifications. You can only select higher specifications. For example, a graph with 1 million edges can be changed to 10 million, 100 million, 1 billion, or 10 billion edges.

Step 4 Click **OK**. The graph status changes to **Preparing for resize**. After several minutes, the graph status changes to **Resizing**. When the resize is complete, the graph status changes to **Running**.

----End

5.8 Expanding a Graph

Graph expanding increases the maximum number of concurrent read-only requests that can be processed, without changing the graph size.

NOTE

- Currently, 10,000-edge and 10-billion-edge graphs cannot be expanded.
- Graphs cannot be resized after expansion. If you want to resize and expand the graph, resize the graph before you expand it.

The procedure is as follows:

Step 1 Log in to the management console.

Step 2 In the navigation pane, choose **Graph Management**. On the displayed page, locate the target graph and choose **More** > **Expand** in the **Operation** column.

NOTE

Only a running graph can be expanded.

Step 3 In the displayed dialog box, set the number of nodes to be added.

Step 4 Click **OK**. The graph status changes to **Expanding**. Wait several minutes, the status will become **Running** after the expansion is successful.

----End

5.9 Binding and Unbinding an EIP

Binding an EIP

To access GES over the Internet, you can bind an Elastic IP Address (EIP) to your instance.

The procedure is as follows:

Step 1 Log in to the GES management console.

Step 2 In the navigation tree on the left, select **Graph Management**.

Step 3 Locate the target graph in the graph list and choose **More** > **Bind EIP** in the **Operation** column.

Step 4 On the displayed **Bind EIP** page, select an available EIP.

Step 5 Click **OK**.

----End

Unbinding an EIP

If you do not need to use the EIP, you can unbind the EIP to release network resources.

The procedure is as follows:

Step 1 Log in to the GES management console.

Step 2 In the navigation tree on the left, select **Graph Management**.

Step 3 Locate the target graph in the graph list and choose **More** > **Unbind EIP** in the **Operation** column.

Step 4 In the displayed dialog box, click **Yes**.

----End

5.10 Clearing Data

If unnecessary data is imported or the imported data volume exceeds the graph size, you can clear the data.

In addition, if you delete data by mistake using Gremlin or Cypher commands, you can clear the broken data and import the correct data again.

NOTE

This operation will clear all vertex and edge data of the graph. Exercise caution when performing this operation.

The procedure is as follows:

Step 1 Log in to the GES management console and choose **Graph Management** from the navigation pane on the left.

Step 2 Locate the target graph in the graph list and choose **More** > **Clear Data** in the **Operation** column.

Step 3 In the dialog box that is displayed, select or deselect **Clear the metadata in the graph**. (For a database edition graph, you need to select the graph name first.)

NOTE

- If you clear graph metadata, the graph will be reset, and all data and running tasks will be cleared.
- Deleted metadata cannot be recovered. Exercise caution when performing this operation.

Step 4 Click **Yes**.

----End

5.11 Deleting a Graph

If you have analyzed the graph data, you can delete the graph to release resources.

NOTE

Backups of a graph will be also deleted after the graph is deleted, and data cannot be recovered. Exercise caution when performing this operation.

The procedure is as follows:

Step 1 Log in to the GES management console.

Step 2 In the navigation tree on the left, select **Graph Management**.

Step 3 Locate the target graph in the graph list and choose **More** > **Delete** in the **Operation** column.

Step 4 In the **Delete Graph** dialog box displayed, determine:

- Whether to delete the EIPs bound to the graph instance. If no EIPs are bound, this option is unavailable. If you do not select the EIPs, the EIPs are retained by default.
- Whether to delete graph backups. By default, one automated backup and two manual backups are retained, occupying the backup quota. If you do not select the backups, the backups are retained by default.

Step 5 Click **OK**.

----End

5.12 Viewing Monitoring Metrics

It takes a period of time for transmitting and displaying data. The GES status displayed in the Cloud Eye monitoring data is the status obtained 5 to 10 minutes before. You can view the monitoring data of a newly created graph 5 to 10 minutes later.

Prerequisites

- The created graph is running properly.
- The graph has been properly running for at least 10 minutes. For a newly created graph, you need to wait for a while before viewing its metrics.
- You can view monitoring data of **graphs in the running, importing, exporting, and clearing states**.

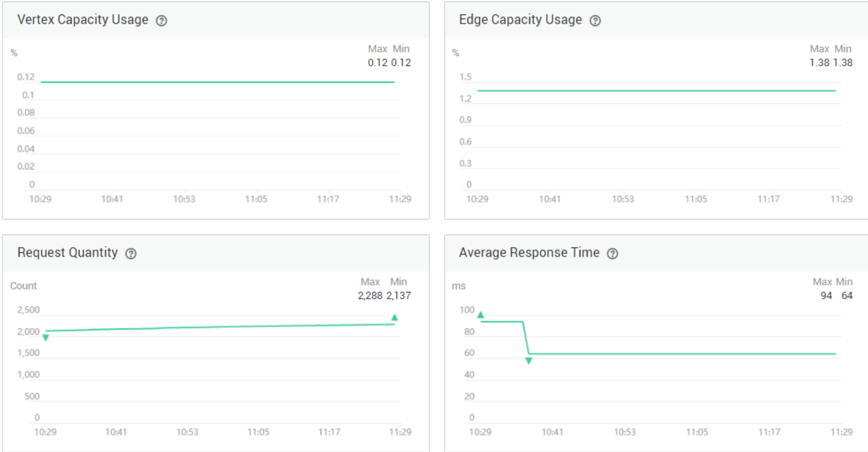
Viewing Monitoring Metrics

Step 1 Log in to the management console.

Step 2 In the navigation pane, choose **Graph Management**. In the **Operation** column, choose **More** > **View Metrics**. The Cloud Eye management console is displayed.

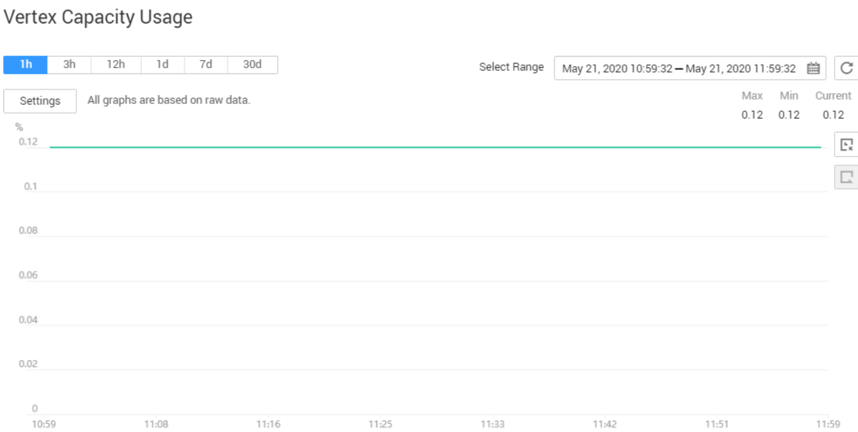
Step 3 On the monitoring page for GES, you can view the figures of all monitoring metrics.

Figure 5-3 Viewing monitoring metrics



Step 4 To view the monitoring curve in a longer time range, click **Full Image** to view a chart in a bigger view.

Figure 5-4 Zoomed in graph



Step 5 The system allows you to select a fixed time range or use automatic refresh.

1. Fixed time ranges include **Last 1 hour**, **Last 3 hours**, **Last 12 hours**, **Last 24 hours**, and **Last 7 days**.

----End

5.13 Querying Schema

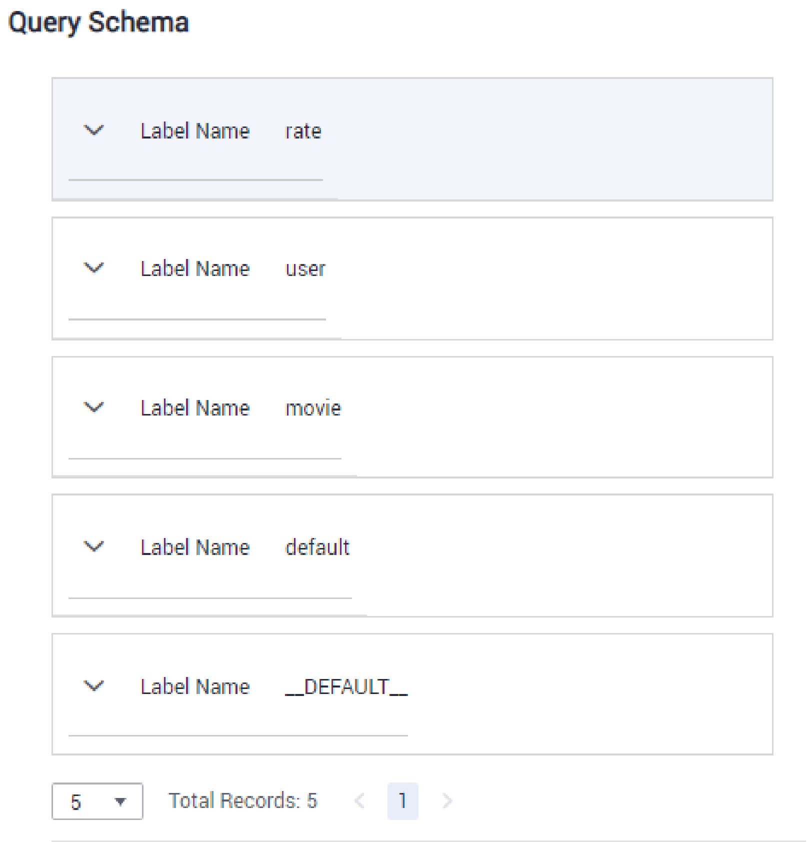
Query the metadata of a graph. The metadata contains labels and properties.

The procedure is as follows:

Step 1 Log in to the management console.

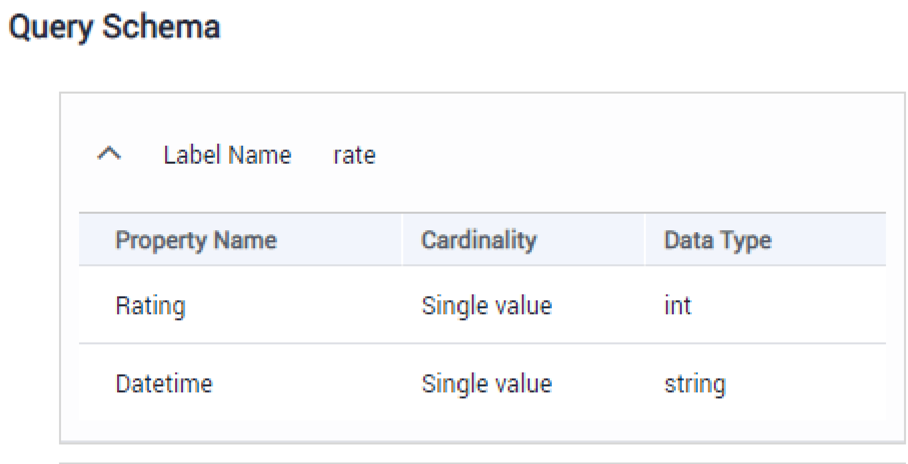
Step 2 In the navigation pane, choose **Graph Management**. In the **Operation** column, choose **More > Query Schema**. A window is displayed, showing the labels contained in the metadata of the current graph.

Figure 5-5 Querying schema



Step 3 To view the properties contained in a label, click of each label.

Figure 5-6 Viewing properties in labels



----End

6 Accessing and Analyzing Graph Data

6.1 Graph Editor

The graph editor consists of a graph analysis area (algorithm library, metadata tab, operation tab, and graph exploration), canvas, query text box, result display pane, and filtering and property tabs.

Table 6-1 Graph editor

Area	Description
Exploration pane	Graph exploration tools, for example, path expansion. For details about the functions, see **Exploring Graphs**.
Operations	Operations executed by API calls. For details, see **Adding Custom Operations**.
Schema	Metadata operations, such as adding, hiding, importing, and exporting data. For details, see **Editing Schema**.
Algorithms	Algorithms supported by GES. You can set the properties of each algorithm in this area. **Table 6-2** describes the functions of the algorithm library. **NOTE** After you select an algorithm in the algorithm library and execute it, the canvas displays the sampling sub-graph that contains the key result. The execution result is incomplete. To obtain the complete returned result, call the corresponding API.
Canvas	Graph structure of data. Shortcut operations are preset in the drawing area for you to easily analyze the graph data. **Table 6-3** describes the functions of the drawing area.
Query box	1. Gremlin query statements 2. Cypher query statements 3. DSL query statements

Area	Description
Result display pane	There are two tab pages: ● **Running Record** where you can **View Running Records**. ● **Query Result** where you can **Viewing Query Results**.
Filter and Property area	On the canvas, select a vertex and right-click it. Then, choose **View Property** from the shortcut menu to view the Filter and Property area.

Figure 6-1 Algorithm Library

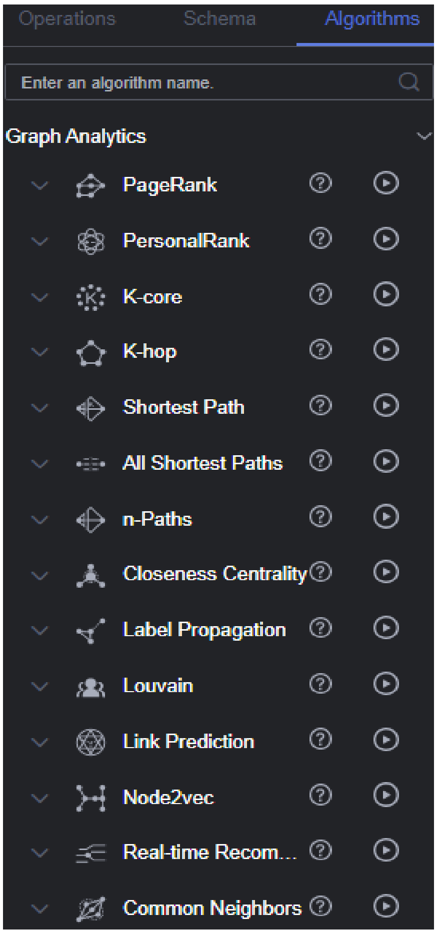
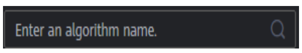


Table 6-2 Algorithm library description

Interface Element	Description
	Enter the algorithm name to quickly find it.
	Expand the algorithm parameter configuration area.
	Run the algorithm.

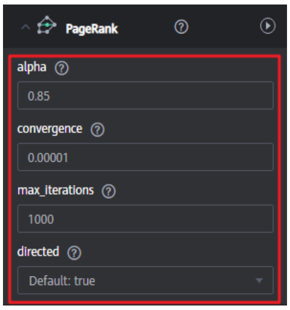
Interface Element	Description
	Set the properties of an algorithm. Different algorithms have different properties. For details, see **Algorithms**.

Figure 6-2 Canvas

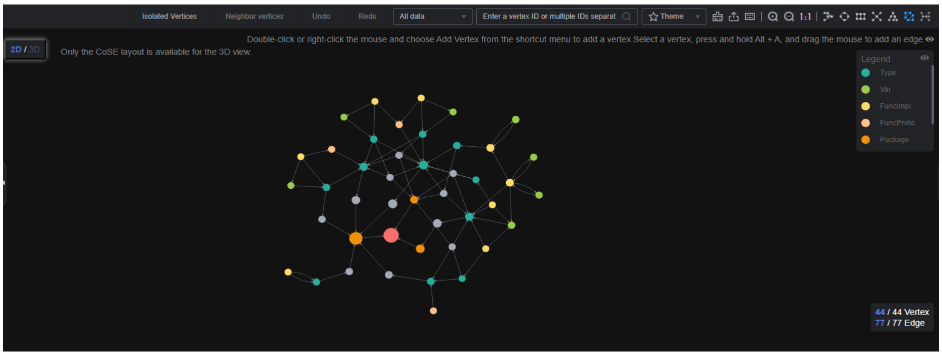
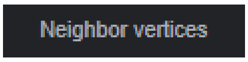
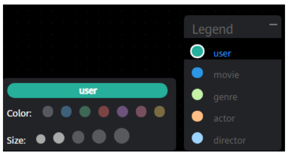
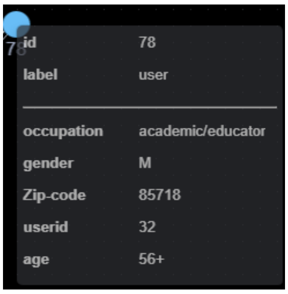
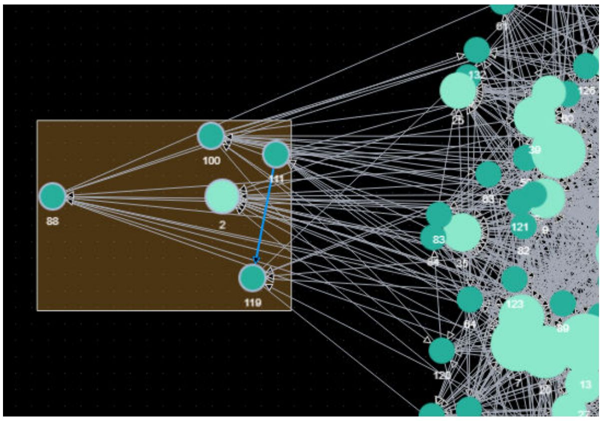
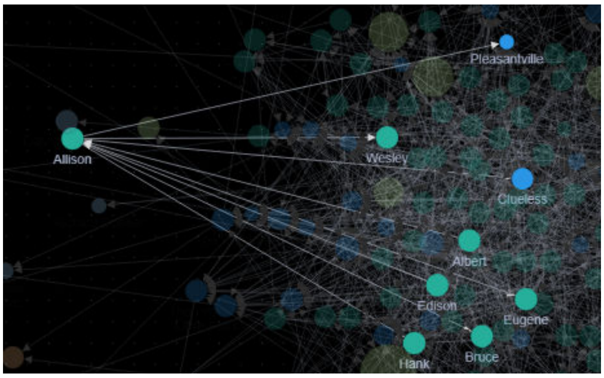


Table 6-3 Canvas description

Interface Element	Description
	Row 1: **13** indicates the number of vertices displayed on the current canvas and **886813** indicates the total number of vertices in the entire graph. Row 2: **9** indicates the number of edges displayed on the current canvas and **892773** indicates the total number of edges in the entire graph.
	An isolated vertex is a vertex that is not an endpoint of any edge. ● To display isolated vertices in a selected area, press **Ctrl** and click and drag to select an area on the canvas, and then click **Isolated Vertices**. ● To display all isolated vertices in the canvas, click **Isolated Vertices**.
	Select a vertex in the canvas and click neighbor vertices to view all vertices associated.

Interface Element	Description
Undo	Cancel the previous operation.
Redo	Redo the canceled previous operation.
All data	Select **All data** or **Current data**. ● **All data** indicates all data of a graph. ● **Current data** indicates the data rendered on the canvas.
Theme	You can change the theme of the GES editor. Three themes are supported: light, dark, and system.
Enter a vertex ID or multiple IDs separat	After you select **All data** or **Current data**, enter the node ID in the search box, for example, **2**. Press **Enter** or click the query icon to search for the corresponding vertex and render it to the canvas. **NOTE** ● Currently, only a single vertex ID can be entered. ● If you choose **Current data** from the drop-down list, vertices on the current canvas are highlighted.
	Click **Clear** to clear all content on the canvas.
	Export the canvas content as a PNG or CSV file (snapshot or vertex and edge file of the current canvas).
	Keyboard shortcuts ● Ctrl+E: Select an associated entity. ● Ctrl+'+': Zoom in. ● Ctrl+'-': Zoom out ● Ctrl+Z: Undo an operation. ● Ctrl+A: Select all. ● Ctrl+Delete: Clear the canvas. ● Delete: Hide vertices. ● Ctrl+Click: Select multiple vertices and edges.
	Zoom in the graph. You can zoom in a graph to at most 600%.
	Zoom out the graph. You can zoom out a graph to 5%.

Interface Element	Description
	Automatic screen adaptation When the displayed graph data is too large (cannot be completely displayed) or too small, you can click this button to quickly adjust it based on the screen size.
	Whether to display legends
	Quick layout switchover. From left to right: **Force directed**, **Circle**, **Grid**, **Radial-tree**, **Hierarchical**, **CoSE**, and **Double-core**. Figure **Force directed** shows how the graph looks on the canvas. **NOTE** The **Double-core** takes effect only when two nodes are selected.
	Click a vertex to select the color and size, which is a good way to mark data.
	Vertex details. Move the cursor to a non-virtualized vertex. The ID, label, and properties of this vertex are displayed. **NOTE** A maximum of six properties of a vertex can be displayed in the pop-up window.
Shortcut operations in the drawing area	**Box-select: Shift + Left-click and drag** All vertices in the box are selected, as illustrated in the following figure. 

<table>
<tr><th>Interface Element</th><th>Description</th></tr>
<tr><td></td><td>Multi-select: Ctrl + Left-click and drag
All vertices in the box are selected and highlighted, as illustrated in the following figure.

</td></tr>
<tr><td></td><td>Select/Deselect: Ctrl + Left-click
Press Ctrl and left-click a vertex or an edge to select and highlight it. Press Ctrl and left-click the vertex or edge again to deselect it.</td></tr>
<tr><td></td><td>Select all: Ctrl + A
Select and highlight all vertices and edges.</td></tr>
<tr><td></td><td>Select associated vertices and edges: Ctrl + E
Select a vertex and press Ctrl + E to highlight all vertices and edges associated with it.</td></tr>
<tr><td></td><td>Hide: Delete
Quickly hide a vertex or an edge.</td></tr>
<tr><td></td><td>Adaptation: Ctrl + F
Automatically zoom in or out all vertices and edges based on the current screen width and height.</td></tr>
<tr><td></td><td>Zoom out: -
Press the - key on the keyboard to zoom out the graph.</td></tr>
<tr><td></td><td>Zoom in: = (+)
Press the + key on the keyboard to zoom in the graph.</td></tr>
<tr><td></td><td>Deselect: Esc
Deselect all selected and highlighted vertices and edges.</td></tr>
</table>

Interface Element	Description
	Zoom in and zoom out: Scroll the mouse wheel forwards and backwards. Scroll the mouse wheel to zoom in or out the graph.

Figure 6-3 Force directed

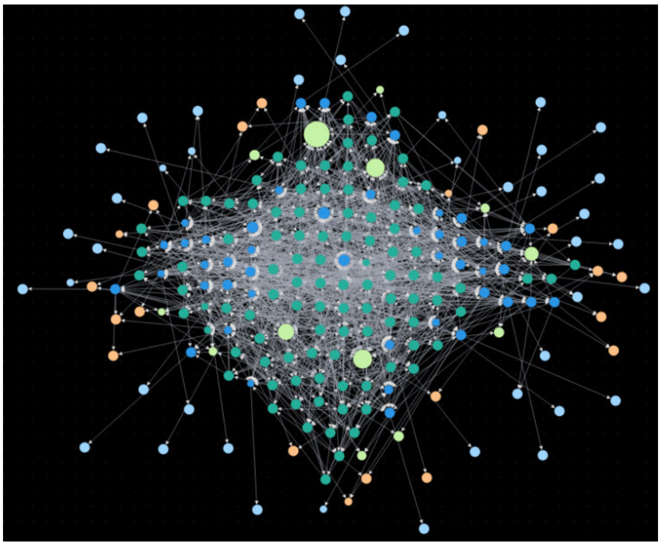


Figure 6-4 Circle

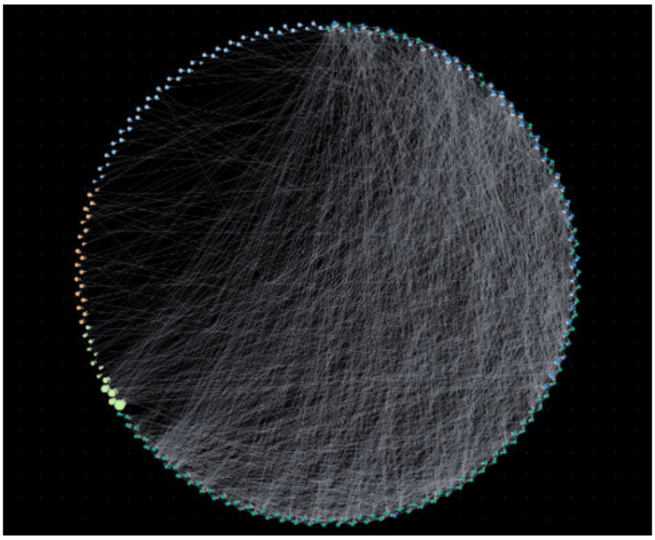


Figure 6-5 Grid

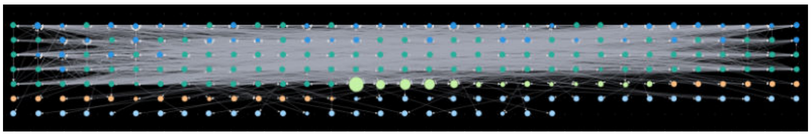


Figure 6-6 Radial-tree

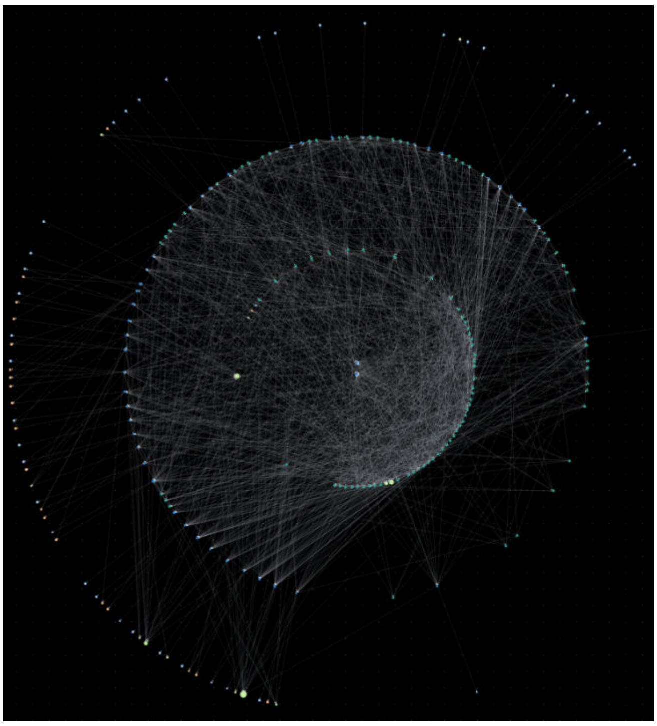


Figure 6-7 Hierarchical

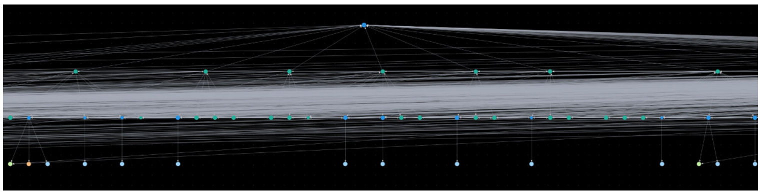


Figure 6-8 CoSE

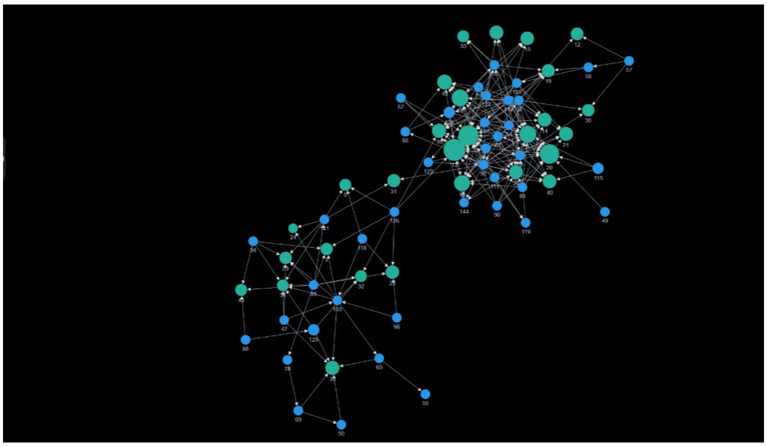
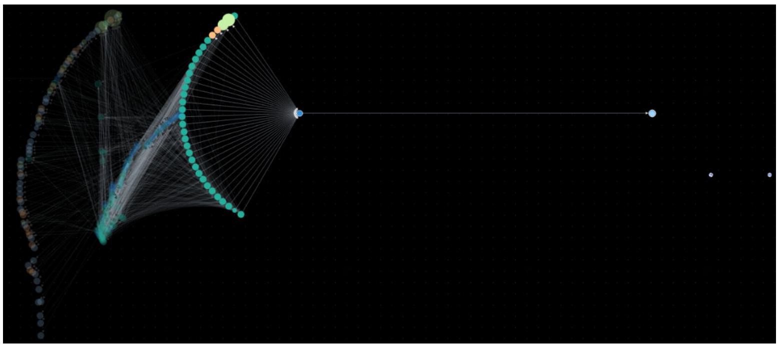


Figure 6-9 Double-core



6.2 Accessing the GES Graph Editor

You can use the graph editor to query and analyze graphs. It has extensive built-in algorithms for customers to use in different scenarios of different fields. In addition, it is compatible with the Gremlin and Cypher query languages and supports open APIs. GES is easy to use even for zero-based users.

The procedure is as follows:

1. Log in to the GES management console and choose **Graph Management** from the navigation pane on the left.
2. On the **Graph Management** page, select the graph to be accessed and click **Access** in the **Operation** column.

   You can analyze the graph data on the graph editor. For details, see **Graph Editor**.

6.3 Dynamic Graphs

6.3.1 Timeline

If you want to view vertex and edge changes over time, a timeline is required to convert a static graph into a dynamic graph. This also allows you to get dynamic analysis result.

NOTE

To use this function, you need to create a dynamic graph. For details, see **Creating a Dynamic Graph**.

Setting a Timeline

1. Log in to the GES console and choose **Graph Management** from the navigation pane on the left. On the displayed page, locate the dynamic graph and click **Access** in the **Operation** column.
2. On the displayed graph editor page, set the following parameters in the **Timeline Settings** dialog box:

NOTE

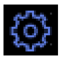
The parameters set here will be synchronized to those in **Community Evolution** and **Temporal BFS**.

- **Start Time Property**: Name of the start time property that is a property of the imported or created metadata. The default value is **startTime**. The name must be of the date, long, or int type.
- **Start**: Start time of the dynamic graph. The start time must be earlier than or equal to the end time.
- **End Time Property**: Name of the end time property that is a property of the imported or created metadata. The default value is **endTime**. The name must be of the date, long, or int type.
- End: End time of the dynamic graph.
- **Advanced Settings**: Use **Default** settings or **Custom** settings.
  - **Default**: Use the default settings.
  - **Custom**: Set the display duration of vertices and edges in the graph and the display priority of labels.
    - **Vertex/Edge Display**: How long the vertices and edges in an algorithm result will be displayed on the canvas. This function is supported for **Temporal BFS** only. The value must be a timestamp in seconds. The default value is **604800** (7 days).

    This function is used to the returned vertex and edge data that contains the start time only.

3. Click **OK**.

NOTE

If you want to modify the timeline parameters, click  in the lower left corner of the canvas.

6.3.2 Community Evolution

The community evolution algorithm generates a dynamic graph that shows structure changes of a community over time. The procedure to use this algorithm is as follows:

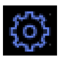
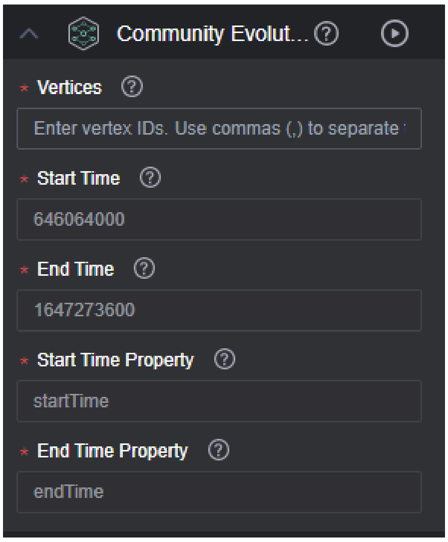
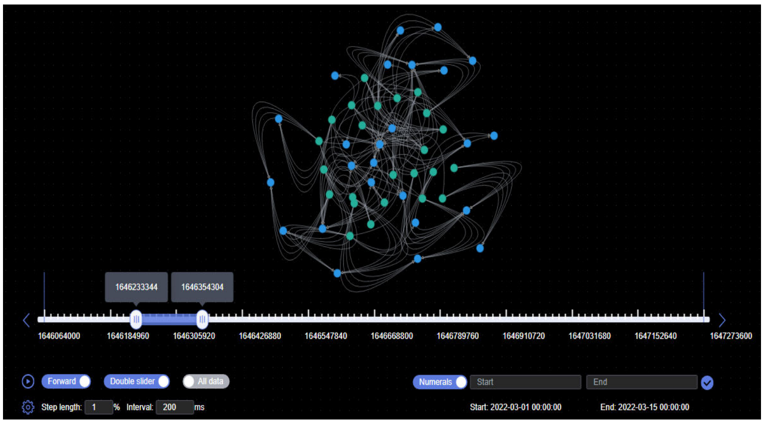
1. Set parameters in the **Community Evolution** drop-down list in the **Temporal** tab of the **Graph Analysis** area on the left of the graph editor page.
   - Set the start time, end time, and their properties. For details see **Setting a Timeline**. To modify the parameters, click  in the lower left corner of the canvas.
   - **Vertices**: IDs of vertices in the community. You can enter a maximum of 100,000 vertex IDs. Use commas (,) to separate them.

Figure 6-10 Community evolution

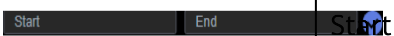
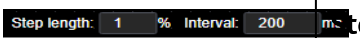
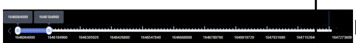


2. Click  on the right of **Community Evolution**. The running result is displayed on the canvas.

Figure 6-11 Dynamic graph



UI Element	Description
	Start playback.
	Playback direction of the dynamic graph. If you toggle on this switch, the playback will be forward. If you toggle off this switch, the playback will be backward.

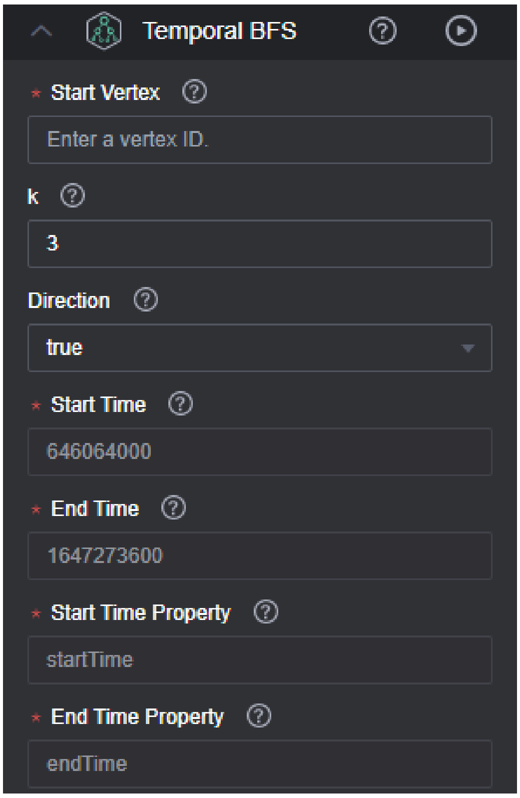
UI Element	Description
	Whether the playback uses the double slider  ● Toggled on (by default): Two sliders are used for playback. The start and end sliders move forward or backward at the same time, and the length of the time window represented by the distance between the sliders remains unchanged. ● Toggled off: Only the one slider is used for playback. – If the playback is forward, the start slider is fixed and end slider moves froward on the timeline. – If the playback is backward, the end slider is fixed and start slider moves backwards on the time line.
	Whether data displayed on the canvas contains static data. If you toggle on this switch, only dynamic data is displayed. Static data refers to the data that does not change over time.
	Whether the timeline uses dates or timestamps. ● By default, this switch is toggled on, which means that you need to enter timestamps to specify the duration. ● If you toggle this switch off, you enter dates and time to specify the duration.
	Start time and end time of the duration you want to view graph data changes
	Timeline settings. For details about how to set the parameters, see **Setting a Timeline**.
	**Step length**: Length of each step that the slider moves on the timeline **Interval**: Interval between two steps
	Timeline

6.3.3 Temporal BFS

Temporal breadth-first search (BFS) algorithm searches for associated vertices based on temporal message passing and temporal BFS algorithms, and outputs the visit time of each vertex and the distance from the vertex to the source start vertex. The procedure to use this algorithm is as follows:

1. In the **Temporal** tab of the **Graph Analysis** area on the left of the graph editor page, click **Temporal BFS**, and set the parameters in the drop-down list.
   – Set the start time, end time, and their properties. For details see **Setting a Timeline**. To modify the parameters, click the settings icon in the lower left corner of the canvas.
   – **Start Vertex**: ID of the start vertex
   – **k**: Traversal depth, indicating the maximum number of vertices in a traversal. The value ranges from 1 to 100. The default value is **3**.
   – **Direction**: Whether the traversal is performed along the directions of edges in the graph. The value can be **true** (default value) or **false**.
     - **true**: Traversal is performed along edge directions.
     - **false**: Edge directions will not be considered in the traversal.

Figure 6-12 Temporal BFS



2. Click the run icon on the right of **Temporal BFS**. The running result is displayed on the canvas. In this algorithm, a single slider is used for playback. As shown in **Figure 6-13** and **Figure 6-14**, the vertices in the dynamic graph are increases over time.

Figure 6-13 Running result

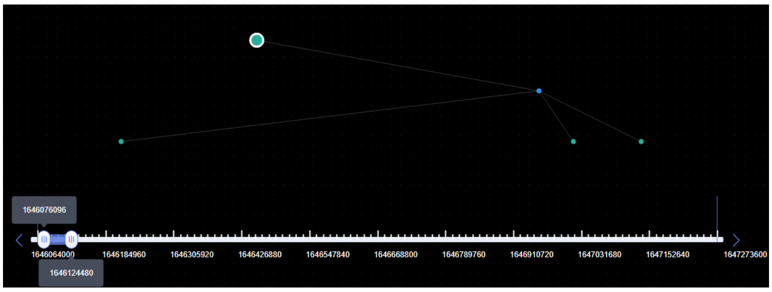
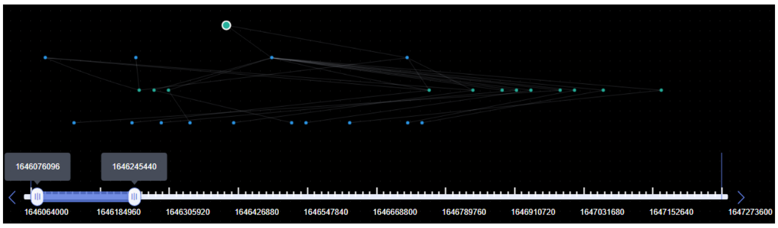


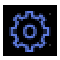
Figure 6-14 Running result



6.3.4 Temporal Paths

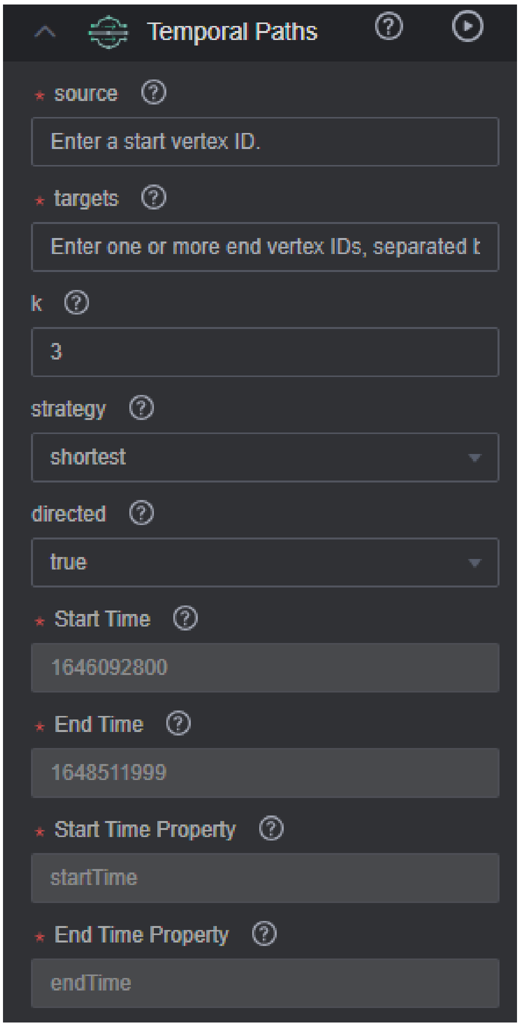
Temporal paths that start from a vertex to the target node show the trend of increment (or non-decrement) of vertices and edges over time on the canvas. The paths follow the order of information transmission on dynamic graphs, the passing time of an edge on a path must be later than or the same as that of the previous edge.

For this feature, you can use the **strategy** parameter to adjust whether the temporal path with the shortest distance or the temporal path that reaches the target node as early as possible is searched for. The procedure is as follows:

1. In the **Temporal Paths** tab of the **Graph Analysis** area on the left of the graph editor page, click **Temporal BFS**, and set the parameters in the drop-down list.
   - Set the start time, end time, and their properties. For details see **Setting a Timeline**. To modify the parameters, click  in the lower left corner of the canvas.
   - **source**: ID of the start node
   - **targets**: set of end node IDs. Multiple end node IDs can be configured.
   - **k**: Traversal depth, indicating the maximum number of vertices in a traversal. The value ranges from 1 to 100. The default value is **3**.
   - **strategy**: execution strategy of the algorithm. The value can be **shortest** or **foremost**.
     - **shortest**: the temporal path with the shortest distance is returned
     - **foremost**: the temporal path that reaches the target node as early as possible is returned
   - **directed**: Whether the traversal is performed along the directions of edges in the graph. The value can be **true** (default) or **false**.

- **true**: Traversal is performed along edge directions.
- **false**: Edge directions will not be considered in the traversal.

Figure 6-15 Temporal paths



2. Click on the right of **Temporal Paths**. The execution results are displayed on the canvas. As shown in **Figure 6-16** and **Figure 6-17**, the vertices in the dynamic graph change over time.

Figure 6-16 Execution result 1

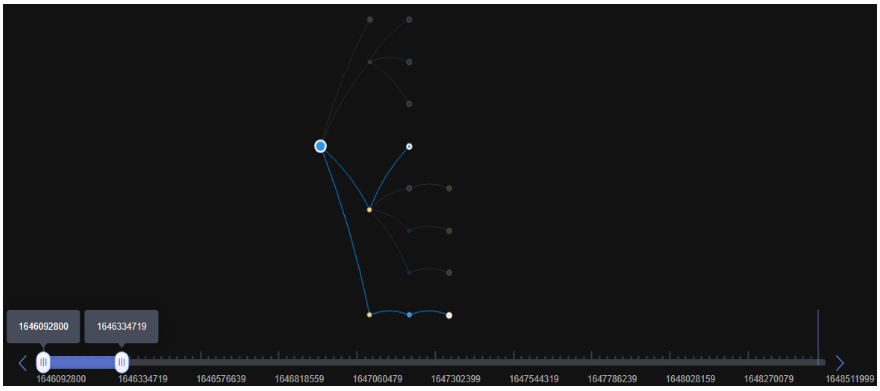
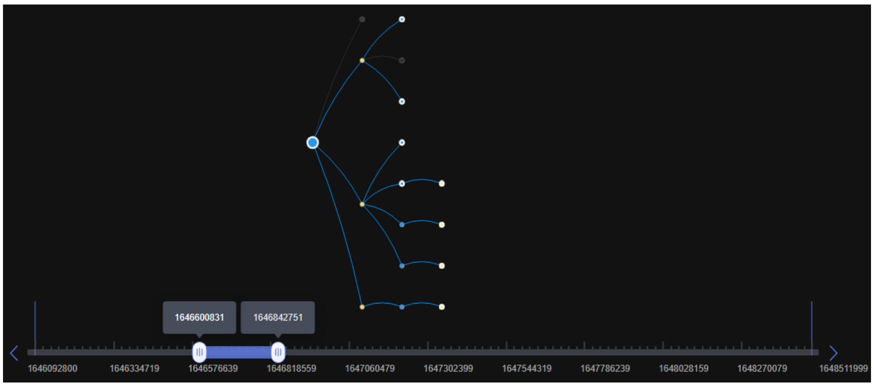


Figure 6-17 Execution result 2



6.4 Graph Exploration

Handful graph exploration tools facilitate your analysis.

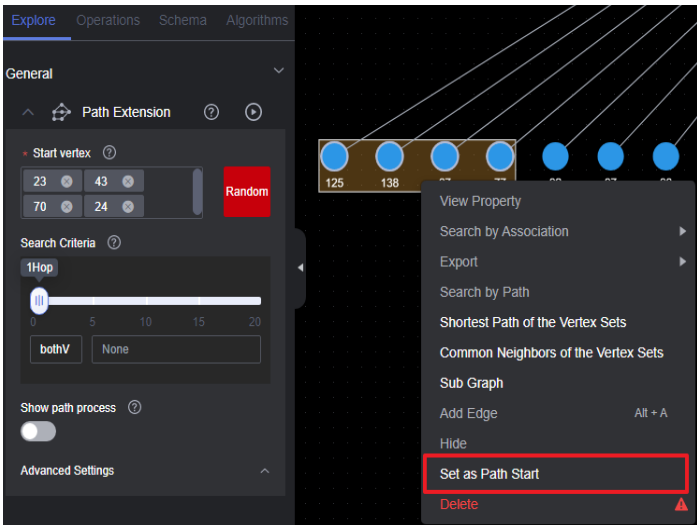
Path Extension

Filters are added to query APIs to search for the desired k-hop vertices or edges.

In the **Path Extension** area on the left of the GES graph editor, set the following parameters:

- **Start Vertex**: IDs of start vertices. You can use any of the following methods to query the vertices:
  a. Press and hold **Shift** and drag a rectangle using the left mouse button to select desired vertices, right-click a vertex, and choose **Set as Path Start** from the shortcut menu. The **Path Extension** will be displayed. The IDs of the selected vertices are automatically filled in the **Start Vertex** box. In this box, you can add or delete vertex IDs. After you finish selecting, click . The query result is displayed on the canvas.

Figure 6-18 Selecting start vertices



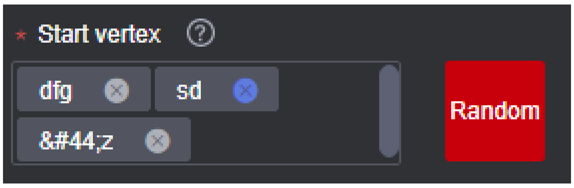
b. Random selection: Click **Random** next to the start vertex box. The system automatically selects vertices in the graph and enters vertex IDs. You can add or delete vertex IDs in the box. After you finish selecting, click . The query result is displayed on the canvas.

c. Specifying one start vertex: Enter the ID of a vertex in the text box and press **Enter**.

d. Specifying a batch of start vertices: Enter IDs of desired vertices in the text box and separate them with commas (,). Then, press **Enter**. A window is displayed when you enter many vertex IDs so you can view them clearly.

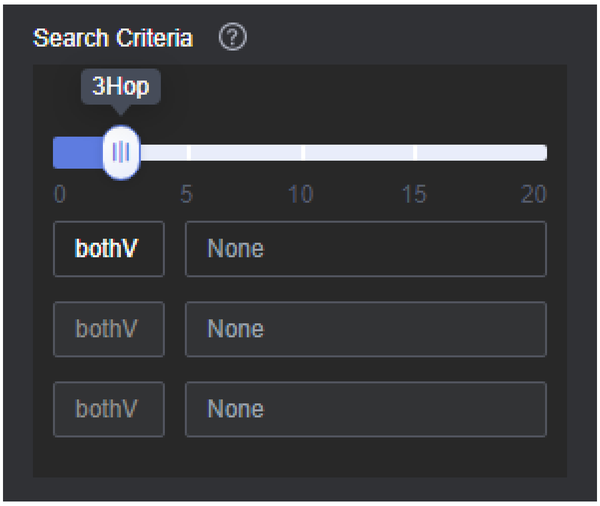
NOTE

Do not enter the same vertex ID repeatedly or an empty value. If the entered vertex ID name contains commas (,), replace the commas with ",".



- **Search Criteria**: Each row in the list corresponds to a query type and criterion of each hop. If there are more hops than criteria, the criteria will be repeated.

Figure 6-19 Search criteria



Refer to the following description to set the search criteria:

- Hop count: Number of search criteria.
- Search criterion: Each hop has a search criterion. Click a search statement text box. The **Search Settings** window is displayed. Enter a search statement.

  The following search criteria operators are available:

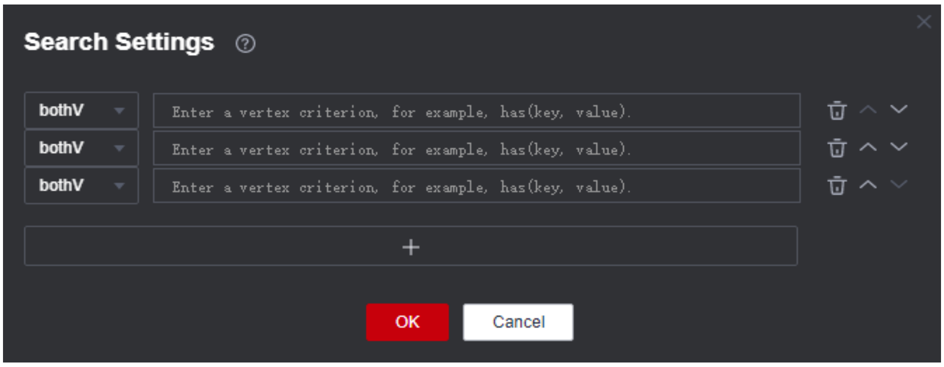
  has: A property key or the value of a property key must be contained.

  hasLabel: The label value must be one of the specified values.

  and: Conditions A and B (can be nested) must be met.

  or: Either condition A or B (can be nested) must be met.

  Figure 6-20 Search settings

NOTE

1. To view a sample criterion, double-click a blank text box. Regular search statements are as follows:

   has(PropertyName): Search for a vertex that has **PropertyName**.

   has(PropertyName, PropertyValue): Search for a vertex that has a property whose name is **PropertyValue**.

   hasLabel(LabelName1,LabelName2): Search for a vertex that has a label whose value is **LabelName1** or **LabelName2**

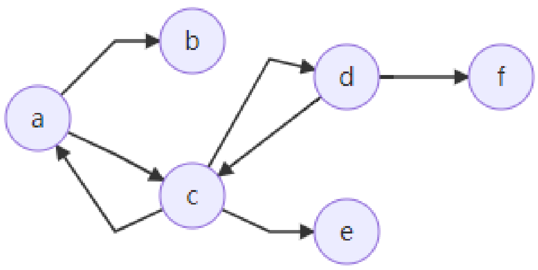
   or(has('name', 'peter'), has('age', '30')): Search for a vertex whose **name** is **Peter** or **age** is **30**.

   and(has('person'),or(has('name','peter'),has('age','30')): Search for a vertex whose **name** is **peter** and **age** is **30**.
2. If there is only one search criterion, the delete, up, and down buttons are grayed out. The first criterion cannot be upshifted, and the last criterion cannot be downshifted. The maximum number of search criteria is 20 (that is, the maximum number of hops).

- **Show path process**: Whether the vertices that are not on the final path will be displayed. This is disabled by default.
- **Advanced Settings**: You can set the expansion strategy here.

  Currently the following traversal methods are available for graph expansion:
  - **ShortestPath**: This method traverses all the shortest paths from the start vertex to every vertex in the graph. This effectively suppresses the exponential growth of the query volume in multi-hop queries.
  - **Walk**: Duplicate vertices are not filtered during traversal.

  NOTE



As shown in the figure, the third-hop neighbor of vertex **a** is queried.

If you use the walk method, the paths are: **a->c->a->b**, **a->c->d->f**, **a->c->d->c**, and **a->c->a->c**.

Vertices **a** and **c** appear repeatedly in the paths such as **a->c->a->b** and **a->c->d->c**. Using **ShortestPath** can reduce duplicate paths, speed up the query process, and reduce the number of queries in this process.

For **ShortestPath**, the query process generates the **a->c->d->f** path only.

6.5 Multi-Graph Management (Database Edition)

When you create a database graph, it is automatically upgraded to a multi-graph cluster. This cluster can have multiple graph instances, each allocated with different data. This allows you to analyze multiple graphs simultaneously.

In the graph engine editor, you can manage the graph instances in the graph cluster by clicking the dropdown menu next to the cluster name in the upper left corner of the page to switch between graph instances.

Figure 6-21 Multi-graph management

NOTE

Only graphs of the database edition support this function.

Adding or Deleting a Graph

1. After the database graph cluster is created, the graph engine editor page is displayed. For details, see **Accessing the GES Graph Editor**.
2. In the upper left corner of the page, click **Add Graph**. In the dialog box displayed, enter the graph name and select the vertex ID type.

   Currently, two vertex ID types are supported: fixed-length string and hash.

   – Fixed-length string: Vertex IDs are used for internal storage and compute. Specify the length limit. If the IDs are too long, the query performance can be reduced. Specify the length limit based on your dataset vertex IDs. If you cannot determine the maximum length, set the ID type to Hash.
   – Hash: Vertex IDs are converted into hash code for storage and compute. There is no limit on the ID length. However, there is an extremely low probability, approximately 10^(-43), that the vertex IDs will conflict.

   NOTE

   1. If you cannot determine the maximum length of a vertex ID, set this parameter to **Hash**.
   2. If you select the fixed-length string (fixedLengthString), you also need to enter the length of the vertex ID.

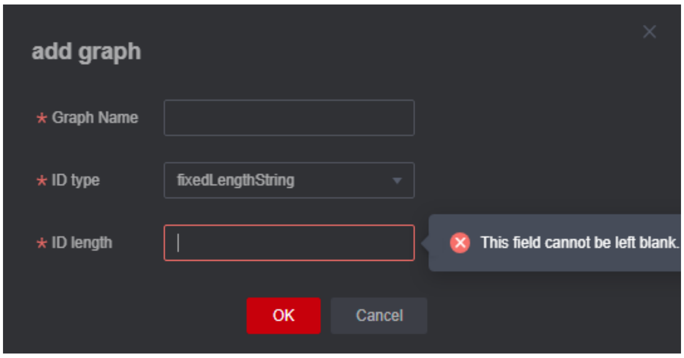
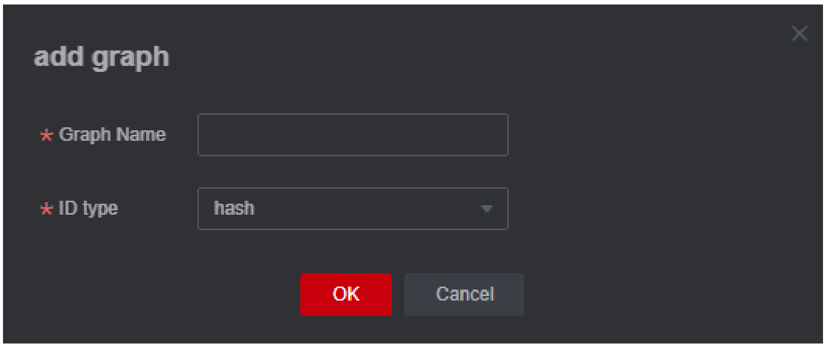
   

Figure 6-22 Adding a graph



3. After setting the parameters, click **OK**.
4. To delete a graph instance, click **Delete Graph**.

6.6 Adding Custom Operations

You can add custom operations executed by calling APIs. You can create shortcut operation sets.

Procedure

1. In the **Operations** tab on the left of the graph editor, click **Edit** . The **Add Operation** button is displayed.
2. Click **Add Operation** and set the following parameters in the displayed dialog box:
   - **Name**: Enter a name for the custom operation.
   - **API Type**: **cypher**, **gremlin**, **algorithm**, and **path_query** are supported.
   - **Request Body**: Enter the request body for the calling the API.
   - **Description**: Add a description for the operation.
3. Click **OK**. These parameters cannot be changed after the operation is added.
4. The new custom operation is displayed in the **Operations** tab. You can click the run button to execute the operation and view the results on the canvas.

6.7 Editing Schema

Adding a Label

In the metadata list on the left of the graph editor, click  to add a label.

- **Label Name**: name of the label to be added.
- **Type**: You can select a label type (vertex, edge, or general-purpose). General-purpose indicates that a label can represent either a vertex or an edge.
- **Custom vertex style**: You can define the color and mark of a label to distinguish vertices.

- Add properties. By default, only the first added property is displayed on the canvas. You can manually adjust the property to be displayed. The canvas will respond in real time.

Counting Vertices and Edges

On the **Schema** tab of the GES editor, click **Refresh Vertex and Edge Count**. The system counts the total number of vertices and edges in the current graph. You can also view the last count time.

Modifying a Label

In the metadata file list, click the metadata file for which you want to modify the label. The metadata label details page is displayed.

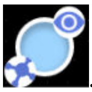
- You can modify the label's property name, cardinality, and data type.
- To hide or delete a property, click the hide or remove button in the **Operation** column.
- If you accidentally deleted or incorrectly modified a property, simply click the reset button to revert back to the last saved data.

Confirm the modification and click **Save**.

Hiding a Label

- Hide all vertices and edges of a label.

  In the metadata list on the left of the graph editor, click the eye button next to metadata to hide all vertices and edges of the metadata in the analysis result.
- Hide the vertices and edges of a selected label

  On the canvas, click any vertex in the graph. The selected vertex is displayed as .

  –  is a label-based hide button. You can click this button next to a label to hide the vertices and edges of the selected label. That is, these vertices and edges are not displayed or dimmed on the canvas.

  –  is a label-based display button. You can click the button to display the vertices and properties of the label.

Importing and Exporting Labels

You can import the metadata, edge data, and vertex data of a graph to or export them from an OBS bucket.

- Import: Click **Import** in the metadata list. In the dialog box that is displayed, set **Metadata**, **Edge Data**, **Vertex Data**, **Log Storage Path**, **Edge Processing**, and **Import Type**, and click **OK** to import the data from the OBS bucket to a graph.

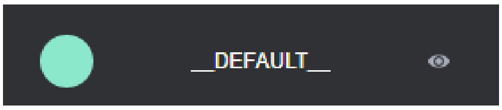
- **Log Storage Path**: Stores vertex and edge data sets that do not comply with the metadata definition, as well as detailed logs generated during graph import.
- **Edge Processing**: Includes **Allow repetitive edges**, **Ignore subsequent repetitive edges**, **Overwrite previous repetitive edges**, and **Ignore labels on repetitive edges**. Repetitive edges have the same source vertex and target vertex. When labels are considered, repetitive edges must have the same source and target vertices and the same labels.

- Export: Click **Export** in the metadata list. In the dialog box that is displayed, set **Metadata Name**, **Vertex Data Set**, **Edge Data Set**, and **Export Path**, and click **OK** to export the data to the OBS bucket.

Deleting a Label

NOTE

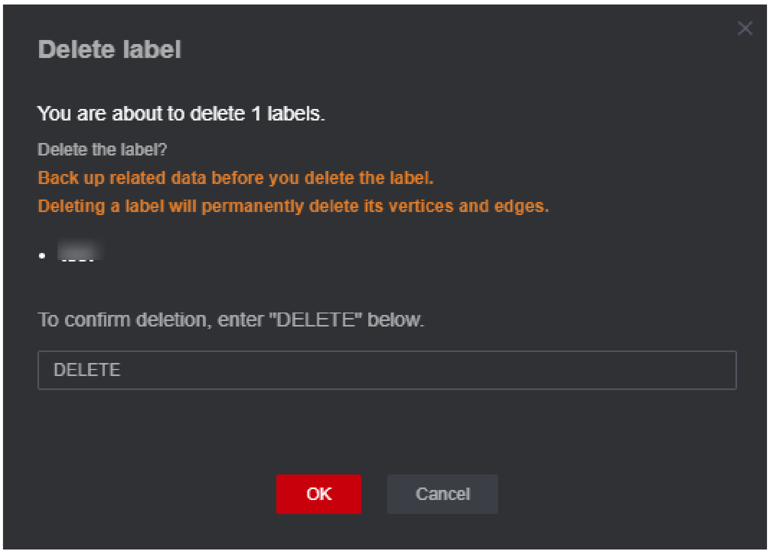
1. After this API is called, all data associated with the label will be deleted. Exercise caution when performing this operation.
2. If the graph version is earlier than 2.2.18, schema labels cannot be deleted.
3. Schema labels cannot be deleted from graphs of the database edition.
4. The default label _**DEFAULT**_ cannot be deleted.



To delete a label, do the following:

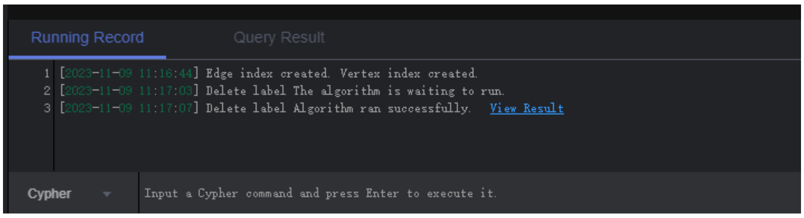
1. To delete a label, click the deletion icon next to the schema on the **Schema** tab on the left of the graph engine editor.
2. In the dialog box that is displayed, read the message carefully, confirm the name of the label to be deleted, enter **DELETE** in the text box, and click **OK**.

Figure 6-23 Confirming the deletion



3. During the deletion, the result of deleting the label algorithm is displayed in the result display pane below the canvas.

Figure 6-24 Results display



During the deletion, the filtering function on the **Filtering** tab is unavailable.

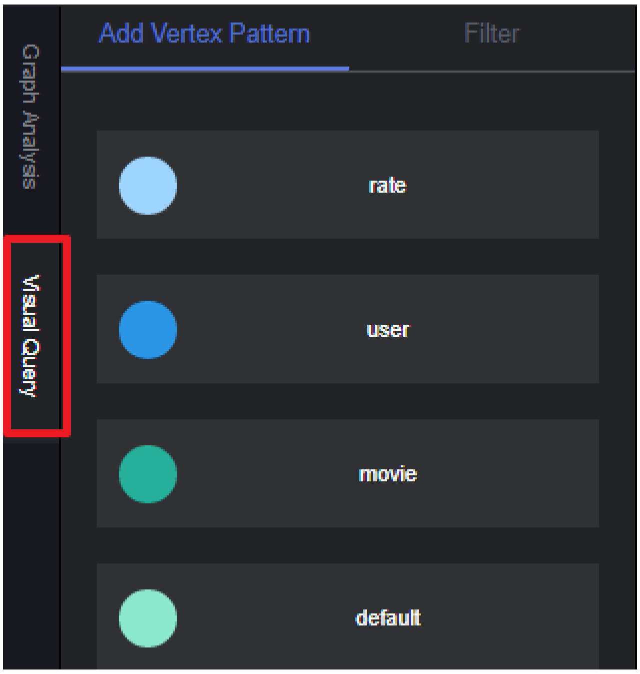
6.8 Visual Query

In the graph editor, you can create graph query statements by dragging and dropping vertices and edges, and preview the query results without writing any code.

Procedure

1. In the left pane of the graph editor, click the **Visual Query** tab.

Figure 6-25 Visual query



2. Add a vertex to the canvas.
   a. In the **Add Vertex Pattern** tab, all vertex labels and edge labels of the graph are displayed. Each label is displayed as a card that can be dragged to the canvas. Select a vertex label and drag it to the canvas.

      The Cypher query statement below changes with your operations.

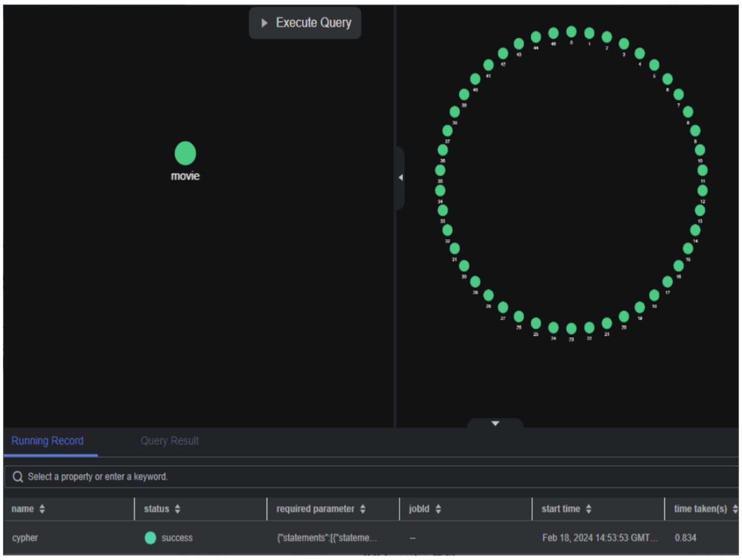
      NOTE

      These vertex labels and edge labels are the same as those in the metadata list in **Editing Schema**.

b. Drag the labels you want to use for the query to the canvas and click **Execute Query**. The graph result is displayed on the right of the canvas.

   You can view the running records of the Cypher query statement in the **Running Record** tab below the canvas. Click **Query Result** to view the result.

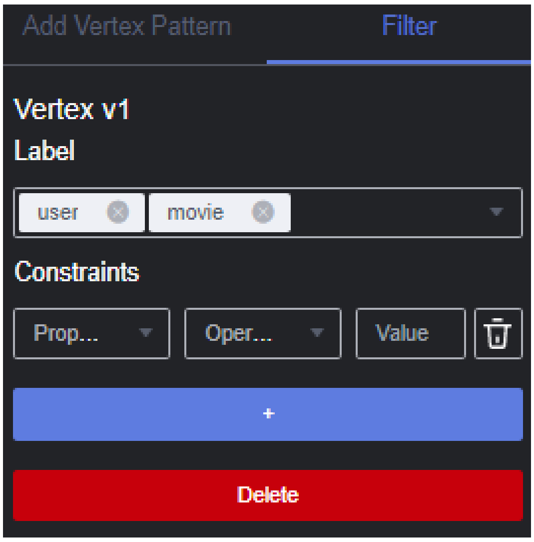
   Figure 6-26 Query result

3. Add a vertex filter.

   Click a vertex in the canvas. The **Filter** tab page is displayed in the left pane. On the **Filter** tab, specify labels, vertex ID, and property search criteria to search for the vertex labels you want to view on the canvas.

   Figure 6-27 Adding a vertex search criterion

   – Vertex V1: Cypher variable ID (vertex identifier in the Cypher query statement below the canvas), which is named based on the sequence in which vertices are dragged to the canvas, for example, V1, V2, and more alike.

- **Label**: Set one or more labels to search for target vertices. The logical operator between each two labels is OR.
- Vertex ID: It is equivalent to a filter criterion. After adding a vertex ID to a vertex label, you can click **Query** to query the vertex labels with the same vertex ID.
- **Constraints**: Specify a property contained in the vertex label. Currently, a property with multiple values is not supported.
  - **Property**: Property contained in the label.
  - Operator: Comparison operators (>,>=,<,<=,=,<>), null judgment operators (is null, is not null), and string comparison operators (starts with, ends with, contains) are supported.

    NOTE

    starts with searches for a property that starts with a specified string; **ends with** searches for a property that ends with a specified string; contains searches for a property that contains a specified string.
  - **Value**: Property value. The attribute value type must be the same as that in the metadata. If the attribute value is of the character type, you need to use single quotation marks ('').
  - : Delete the constraint.
- **+** button: Add a criterion.
- **Delete**: Delete the added criterion.

Click **Execute Query** in the canvas again. The query result is displayed on the right of the canvas.

4. Add an edge (connect two vertices on the canvas):

   Double-click a vertex. After the border of the vertex turns red (do not move the cursor out of the red border), click and drag a line from the vertex to another vertex.

   The Cypher query statement below changes with your operations.

Figure 6-28 Red border of a vertex

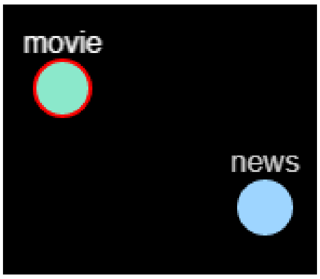
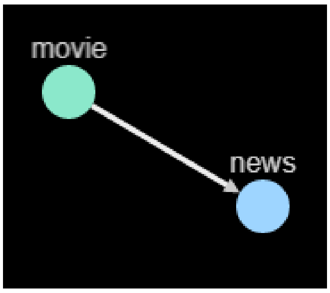


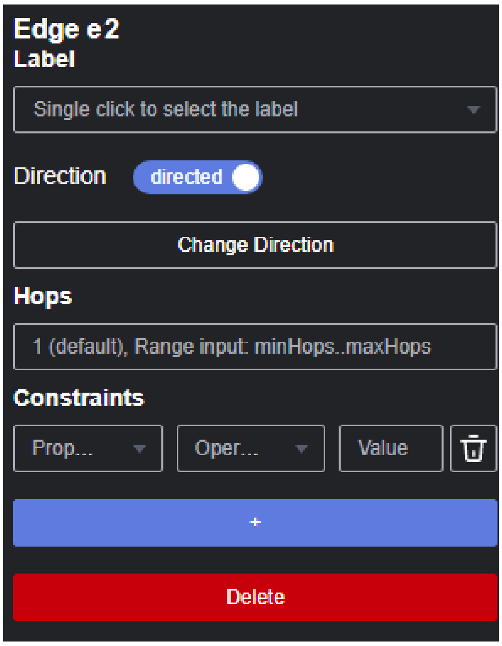
Figure 6-29 Adding an edge



5. Add an edge filter.

   Click an edge in the canvas. The **Filter** tab page is displayed in the left pane. On the **Filter** tab, specify labels, direction, hops, and property search criteria to search for the edge labels you want to view on the canvas.

Figure 6-30 Adding an edge filter



- **Edge e2**: Cypher variable ID, which is named based on the sequence in which edges are added to the canvas, for example, e1, e2, and more alike.
- **Label**: Set one or more labels to search for target edges. The logical operator between each two labels is OR.
- **Direction**: Select the direction contained in the edge label.

  When the slider is toggled on, the edge is a directed one. When the slider is toggled off, the edge is undirected (or called bidirectional).

  If the edge is directed, the arrow on the canvas indicates the direction of the edge. You can click **Change Direction** to change the direction of the selected edge on the canvas.
- **Hops**: The default value is **1**. The value range is [0, 20). You can specify a number or a range.
  - If you enter an integer, it will be used as the number of hops in the edge pattern.

- If you enter two integers in the format of *minHops*..*maxHops*, for example, **2..3**, the number of hops in the edge pattern is within the range of [2,3].

– **Constraints**: Specify a property contained in the edge label. Currently, a property with multiple values is not supported.

- **Property**: Property contained in the label.
- Operator: Comparison operators (>,>=,<,<=,=,<>), null judgment operators (is null, is not null), and string comparison operators (starts with, ends with, contains) are supported.

  NOTE

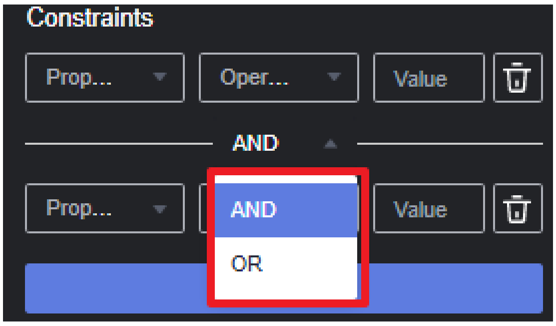
  starts with searches for a property that starts with a specified string; **ends with** searches for a property that ends with a specified string; contains searches for a property that contains a specified string.

- **Value**: Property value. The attribute value type must be the same as that in the metadata. If the attribute value is of the character type, you need to use single quotation marks ('').
- : Delete the constraint.

– + button: Add a criterion.

If there is more than one criterion, click next to AND to set the logical operator (AND or OR).

Figure 6-31 Selecting a logical operator



NOTE

The priority of AND is higher than OR. The suggested calculation sequence is as follows:

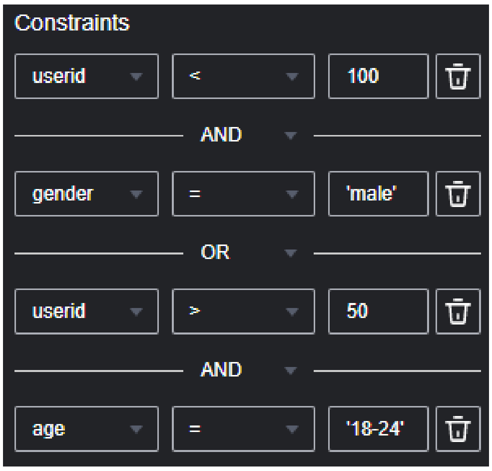
1. Arrange all AND operations first.
2. Then, perform all OR operations.

In the following example, the edge search criterion is **userid < 100 AND gender = 'male' OR userid > 50 AND age = '18-24'**.

The operation sequence is:

(userid < 100 AND gender = 'male') and (userid > 50 AND age = '18-24') are operated first, and result1 and result2 are recorded respectively.

Then, **result1 OR result2** is operated.



- **Delete**: Delete the added criterion.

Click **Execute Query** in the canvas again. The query result is displayed on the right of the canvas.

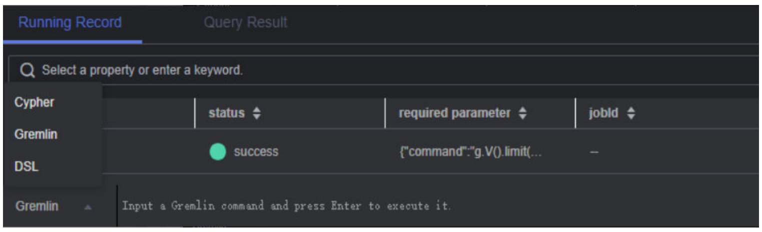
6.9 Gremlin Query

Gremlin is a graph traversal language in the open source graph calculation framework of Apache TinkerPop. You can use Gremlin to query, modify, and traverse graph data as well as filter properties.

The procedure is as follows:

1. Log in to the GES graph editor. For details, see **Accessing the GES Graph Editor**.
2. In the graph data query area, click the drop-up button to choose **Gremlin**. Enter a query statement and press **Enter** to run the statement.

Figure 6-32 Switching to Gremlin query



Gremlin Statement

Typical query commands are as follows:

- Querying vertices

  g.V().limit(100): This command is used to query all vertices and return only 100 vertices. You can also use the **range (x, y)** operator to obtain vertices within the specified quantity.

  g.V().hasLabel('movie'): This command is used to query vertices whose label value is **movie**.

  g.V('11'): This command is used to query the vertex whose ID is **11**.

  NOTE

  1. The **g.V ()** is not recommended because the query result cannot be completely displayed if the vertex scale is large.
  2. To prevent query timeout due to a large data volume, add the **limit** parameter and set it less than **1,000**.

- Querying edges

  g.E(): This command is used to query all edges. You are not advised using this command without filter criteria or limit to the returned results.

  g.E('55-81-5'): This command queries the edge whose ID is **55-81-5**.

  g.E().hasLabel('rate'): This command queries edges whose label value is **rate**.

  g.V('46').outE('rate'): This command queries the edge whose ID is **46** and all its labels are **rate**.

- Querying properties

  g.V().limit(3).valueMap(): This command is used to query all properties of a vertex. (You can specify a parameter to query only one vertex. All properties of the vertex will be displayed in one row.)

  g.V().limit(1).label(): This command is used to query the label of a vertex.

  g.V().limit(10).values('userid'): This command is used to query the **name** property of a vertex. (You can leave the parameter blank to query all properties. Each property value is displayed in one row, without the key).

- Adding a vertex

  g.addV('user').property(id,'600').property('age','18-24'): This command adds a vertex whose label is **user**, ID is **600**, and age ranges from **18** to **24**.

- Deleting a vertex

  g.V('600').drop(): This command deletes the vertex whose ID is **600**.

- Adding an edge

  g.addV('user').property(id,'501').property('age','18-24')

  g.addV('movie').property(id,'502').property('title','love')

  g.addE('rate').property('Rating', '4').from(V('501')).to(V('502'))

  The preceding commands add two vertices and an edge. The two vertex IDs are 501 and 502.

- Deleting an edge

  g.E('501-502-0').drop(): This command deletes the edge whose ID is **501-502-0**.

NOTE

1. You can press the up and down arrow keys in the text box to view historical query commands.
2. When you enter a syntax keyword, the system automatically displays historical statements with the same keyword.

Figure 6-33 Historical queries

3. Keywords in the text box are displayed in different colors.
   - Reserved words in gray

     Note: A reserved word is predefined in the syntax system of a programming language. Reserved words vary depending on programming languages.
   - String values in orange
   - Delimiters in red. Regular delimiters including square brackets **[]**, curly brackets **{}**, parenthesis **()**, commas (**,**), and semicolons (**;**).
   - Variables in green

Figure 6-34 Gremlin keywords

Gremlin Syntax Optimization

GES integrates the OLTP function of Gremlin, enhances some features, and optimizes the strategy.

- **Enhanced Text Predicate**

  g.V().has('name', Text.textSubString('xx'))

Predicate	Description
textSubString	Substring
textCISubString	Substring that ignores cases
textFuzzy	Fuzzy match
textPrefix	Prefix query
textRegex	Regular expression match

NOTE

When specifying a schema, do not name the attributes **id**, **label**, **property**, or **properties**.

When you do Gremlin queries with many steps, the results will be converted into a map. Two identical keys are not allowed in a map structure. If multiple identical keys are inserted into a map, the key value will be overwritten or this operation is canceled. If you set an attribute name to **id**, **label**, **property**, or **properties**, the returned results will be incomplete because in many queries the graph ID is returned together with the attribute ID.

Reference

Table 6-4 shows how Gremlin in GES differs from open source Gremlin.

Table 6-4 GES Gremlin differences

Difference	Description
Vertex and Edge IDs	An edge ID consists of the source vertex ID, target vertex ID, and index that distinguishes duplicate edges. The three parts are connected by hyphens (-), for example, sid-tid-index. Edge and vertex IDs must be the string type.
User Supplied IDs	Users can only provide vertex IDs without hyphens (-).
Vertex Property IDs	Both edge and vertex properties do not have IDs. The returned IDs are vertex IDs.
Vertex and Edge Property	Vertex and edge properties are defined by metadata files in GES. Therefore, you cannot add or delete properties, but you can use **property()** and **remove()** to modify property values. The value set by **property()** is determined by the corresponding parameter. **remove()** converts string properties into empty strings, digital properties into 0, and list properties into empty lists.
Variables	The GES graph structure does not support the **variables** feature.
Cardinality	GES supports the single and list cardinality. The value type of a vertex property is defined by the metadata file. Therefore, no new property is added when you set the property value.
Transactions	During GES Gremlin implementation, transactions are not explicitly used.

You can use the **feature** function to view the supported Gremlin features. If **false** is displayed, GES does not support the feature. If **true** is displayed, GES supports the feature.

```
gremlin> graph.features()
==>FEATURES
```

NOTE

Currently, the following step commands are not supported:

- tryNext()
- explain()
- tree()

6.10 Cypher Query

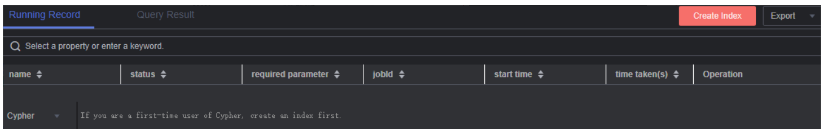
Cypher is a declarative graph query language. You can use Cypher statements to obtain query result and modify data in GES.

The procedure is as follows:

1. Access the GES graph editor. For details, see **Accessing the GES Graph Editor**.
2. Use label-based vertex and edge indexes during Cypher query.

   If this is your first time using Cypher, click **Create Index** in the upper right corner of the result display area. You do not need to perform this operation in subsequent operations.

   Figure 6-35 Creating an index

   NOTE

   After an index is created, wait for 30 seconds for the index to take effect and then perform Cypher query.

3. In the graph data query area, enter the query statement and press **Enter**.

Cypher Statements

The following are typical query statements.

- Querying a vertex

  match (n:movie) return n: Query the vertex whose label is **movie**.

  match (n) return n limit 100: Query details about 100 vertices.

  match (n{Occupation:'artist'}) return id(n), n.Gender limit 100: Query the first 100 vertices whose **Occupation** is **artist**, and return their IDs and genders.

  match (n) where id(n)='Vivian' return n: Query the vertex whose ID is **Vivian**.

  match (n) return n skip 50 limit 100: Query all vertices of a graph. Skip the first 50 vertices, and return a total of 100 vertices.

- Querying an edge

match (n)-[r]->(m) return r, n, m: Query all edges. Return the edges and vertices at both ends.

match (n)-[r:rate]->(m) return r, n, m: Query the edges whose label is **rate**.

match (n)-[r:rate|:friends]-(m) where id(n)='Vivian' return n,r,m: Query all edges whose start vertex is **Vivian** and edge label is **rate** or **friends**.

- Searching by path

  match p=(n:user)--(m1:user)--(m2:movie) return p limit 100: Query the paths whose start vertex is **user**, first-hop end vertex is **user**, and second-hop end vertex is **movie**. Returns the first 100 paths.

- Aggregating and deduplicating based on groups

  match (n) return count(*): Query the number of all vertices in a graph.

  match (n:user) return n.Gender, count(n): Collect statistics on the number of **user** vertices in every gender.

  match (n:user) return distinct n.Occupation: Return deduplicated occupations of all **user** vertices.

- Sorting

  match (n:user) return id(n) as name order by name: Change IDs of all **user** vertices to **name**, and sort the vertices by **name**.

- Creating a vertex

  create(n:movie{_ID_:'The Captain', Year:2019})return n: Create a vertex whose ID is **The Captain**, label is **movie**, and **Year** is **2019**. Return the vertex.

  create(n:movie{_ID_:'The Captain', Year:2019})-[r:rate]->(m:movie{_ID_:'The Climbers',Title: 'The Climbers', Year:2019}) return r: Create two vertices and their associated edges.

- Creating an edge

  match (n),(m) where id(n)= 'The Captain' and id(m)= 'Lethal Weapon' create (n)-[r:rate]->(m) return r : Create an edge whose label is **rate** between two vertices with specified IDs. (You are advised to use this query in 2.2.21 and later versions.)

- Modifying properties

  match (n) where id(n)= 'The Captain' set n.Title= 'The Captain' return n: Search for the vertex whose ID is **The Captain** and change the attribute **Title** to **Ji Zhang**.

- Deleting a vertex

  match (n) where id(n)=' The Captain' delete n: Search and delete the vertex whose ID is **The Captain**.

  match (n) where id(n)=' "detach delete n": Search for the vertex whose ID is **The Captain**. Delete the vertex and its edges.

- Querying a schema

  If you call **db.schema()** independently, only the schema metadata of the vertices is returned. Multiple isolated vertices are displayed on the canvas.

NOTE

1. You can press the up and down arrow keys in the text box to view historical query commands.
2. When you enter a syntax keyword, the system automatically displays historical statements with the same keyword.

Figure 6-36 Historical queries

3. Keywords in the text box are displayed in different colors.
   - Reserved words in gray

     Note: A reserved word is predefined in the syntax system of a programming language. Reserved words vary depending on programming languages.
   - String values in orange
   - Key-value pairs in purple. They are of the non-string type in the *key*:*value* format.
   - Delimiters in red. Regular delimiters including square brackets **[]**, curly brackets **{}**, parenthesis **()**, commas (**,**), and semicolons (**;**).
   - Variables in green

Figure 6-37 Cypher keywords

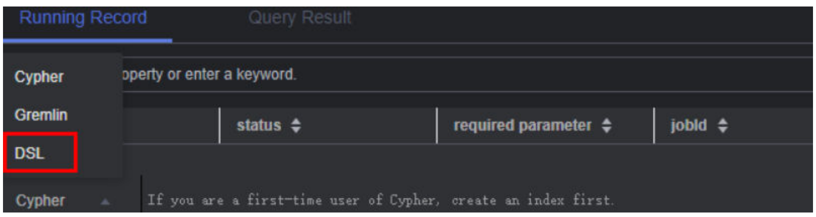
6.11 DSL Query

DSL is a graph query language. You can use DSL statements to query and compute graphs, helping you design and run algorithms at low costs. This function applies only to graphs of 2.3.14 or later.

The procedure is as follows:

1. Log in to the GES graph editor. For details, see **Accessing the GES Graph Editor**.
2. In the graph data query area, click the drop-up button to choose **DSL**. Enter a query statement and press **Enter** to run the statement.

Figure 6-38 Switching to DSL query



Common DSL Query Statements

The following are typical query statements.

- Querying a vertex

  Match<Vertex> v(['Vivian','Eric']);return v: Query vertices whose IDs are **Vivian** and **Eric**.
- Querying neighbor vertices in *N* hops

  Match<Vertex> v(['Vivian']);v.repeat(bothV()).times(2).emit();return v: Query all neighbor vertices in two hops in both directions of a vertex whose ID is **Vivian**.
- Returning a subgraph

  Match<Vertex> v(['Vivian','Eric']); return v.subgraph(): Return vertices Vivian and Eric and the edge set between them.
- Other statements

  Match<Vertex> v(); v.pick(1); return v: Randomly match and return one vertex.

  Match<Vertex> v(); v.pattern('match (n:user) return n'); return v: // Use Cypher statements to query and return the vertex set.

NOTE

1. You can press the up and down arrow keys in the text box to view historical query commands.
2. When you enter a syntax keyword, the system automatically displays historical statements with the same keyword.
3. Keywords in the text box are displayed in different colors.
   - Reserved words in gray

     Note: A reserved word is predefined in the syntax system of a programming language. Reserved words vary depending on programming languages.
   - String values in orange
   - Key-value pairs in purple. They are of the non-string type in the *key*:*value* format.
   - Delimiters in red. Regular delimiters including square brackets **[]**, curly brackets **{}**, parenthesis **()**, commas (**,**), and semicolons (**;**).
   - Variables in green

Figure 6-39 DSL keywords

6.12 Analyzing Graphs Using Algorithms

You can analyze graphs using basic graph algorithms, graph analysis algorithms, and graph metric algorithms.

The procedure is as follows:

1. Log in to the GES graph editor. For details, see **Accessing the GES Graph Editor**.
2. In the algorithm library area, you can select an algorithm and set its parameters.

   Algorithm List shows the algorithms supported by GES and **Algorithms** describes the algorithm details.
3. Run the algorithm. You can view the query result after the analysis is complete.

   NOTE

   Only the results of 500 vertices are displayed due to the size of the result display area. If you want to view the complete query results of global iterative algorithms, such as the PageRank algorithm, you can call the algorithm APIs.
4. Adjust the parameters, and run the algorithm again. PageRank value is different this time, but the top ranking does not change.
5. Perform association prediction to obtain the association degree.

6.13 Analyzing Graphs on the Canvas

The canvas intuitively displays the graph data. You can also edit and analyze data in this area. For details about the shortcut keys and interface elements on the canvas, see **Table 6-3**.

The procedure is as follows:

Step 1 Log in to the GES graph editor. For details, see **Accessing the GES Graph Editor**.

Step 2 On the canvas, right-click a vertex or an edge, and perform the following operations:

- **View Property**

  Select **View Property** to view the property information about the selected vertex or edge on the **Property** tab page.
- **Search by Association**

  You can select **OUT**, **IN**, and **ALL** to expand vertices related to the current vertex.
  - **OUT**: Query the vertices using this vertex as the source vertex.
  - **IN**: Query the vertices using this vertex as the target vertex.
  - **ALL**: Query all vertices of **OUT** and **IN**.
- **Export**

  Export the graph displayed on the canvas.
- **Search by Path**

  Query paths between two vertices. All possible paths are listed.

  Procedure: Hold down **Ctrl** and click two vertices. The first is the source vertex and the second is the target vertex. Then, Right-click and choose **Search by Path** from the shortcut menu.

NOTE

This option is valid only when two vertices are selected. Otherwise, it is dimmed.

After this function is executed, the canvas is cleared, and then the queried vertex and edge data is returned and rendered in the canvas. A path is formed based on the selected two vertices.

- **Shortest Path of the Vertex Sets**
  a. Hold down **Shift** and box-select a group of vertices (a single vertex or multiple vertices).
  b. Hold down **Shift** and box-select another group of vertices (a single vertex or multiple vertices).
  c. Right-click in the selection box and choose **Shortest Path of the Vertex Sets** from the shortcut menu.
  d. In the dialog box that is displayed, you can edit the selected two sets of vertices and click **+** to quickly add vertices.
  e. Click **Run**. The shortest paths between two vertex sets are returned.
- **Common Neighbors of Vertex Sets**
  – Function

    By box-selecting the common neighbors of two vertex sets, you can intuitively discover the objects associated with the two sets.
  – Procedure
    i. Hold down **Shift** and box-select two vertex sets.
    ii. Right-click a vertex set and choose **Common Neighbors of Vertex Sets** from the shortcut menu.
    iii. In the displayed dialog box, confirm the vertices in the vertex set. You can add or delete vertices and determine whether to carry additional parameters. Then, click **Run**.

       NOTE

       The **Carrying additional constraints** option allows you to limit the result set:
       - If this option is not selected, the found common neighbors are the intersection of the neighbors corresponding to the source vertex set and target vertex set.
       - If this option is selected, the found common neighbors are not only the intersection of the neighbors corresponding to the source vertex set and target vertex set, but each vertex in the common neighbor set has at least two neighboring vertices in the source vertex set and target vertex set.
    iv. Display the result.
- **Sub Graph**: Press and hold **Ctrl** and select some vertices. The edges between those vertices and the selected vertices form a new graph.
- **Add Edge**: You can add an edge using either of the following methods:
  a. Hold down **Ctrl**, select any two vertices on the canvas, right-click the selected vertices, and choose **Add Edge** from the shortcut menu to add an edge between the vertices. By default, the vertex selected first is the source vertex, and that selected later is the target vertex. After the edge is added, you can select the label of the edge and set the edge properties.

b. Select a vertex, press **Alt+A**, drag the cursor to the target vertex, and left-click to add an edge.

- **Hide**: Hide the selected vertex.
- **Delete**: Delete a vertex, an edge, multiple vertices, and multiple edges, or delete edges and vertices in batches.
  - To delete a vertex /edge, select the vertex/edge and delete it.
  - To delete multiple vertices/edges, press **Ctrl** to select the vertices/edges and delete them.
  - To delete vertices and edges in batches, hold down **Shift** and drag the left key of the mouse to select multiple vertices and edges and delete them.

  After you click **Delete**, a confirmation dialog box is displayed. Confirm information about the vertices and edges you want to delete and click **OK**.

  NOTE

  The vertices and edges will be permanently deleted and cannot be restored. Exercise caution when performing this operation.

Step 3 View the details about a vertex.

Move the cursor to a non-virtualized vertex. The ID, label, and properties of this vertex are displayed.

NOTE

A maximum of six properties of a vertex can be displayed in the pop-up window. .

----End

6.14 Graph Display in 3D View

The 3D view of a graph provides you intuitive analysis experience.

NOTE

Constraints:

1. The 3D view is available for 1-billion-edge graphs only.
2. Currently, only PagePank and PersonalRank algorithms are available in the 3D view. You can still use Cypher queries and Gremlin queries. For other algorithms or functions, switch to the 2D view.

Displaying a Graph in 3D View

The following example shows how to view results of the PagePank algorithm in the 3D view graph:

1. In the algorithm area on the left of the graph editor, select the PagePank algorithm and set required parameters.
2. Run the algorithm. After the analysis is complete, you can view the result in the canvas.

3. Click 

in the upper left corner of the canvas to switch to the 3D view.

6.15 Filter Criteria

You can set filter criteria to filter graph data.

The procedure is as follows:

1. Log in to the GES graph editor. For details, see **Accessing the GES Graph Editor**.
2. Click  on the right of the canvas, or select a vertex on the canvas, right-click it , and choose **View Property**, to display the **Filtering and Property** page.
3. In the **Filtering** area, set the filtering conditions and click **Filter**.
   - **Match**: **Vertex** is selected by default. Possible values are **Vertex** and **Edge**.
   - **Type**: **All types** is selected by default. You can select the vertex or edge type from the drop-down list. The type is defined by the metadata file you upload.
   - **Add filtering condition**: Click **Add filtering condition** to select a property and choose a condition (**Less than**, **Greater than**, **Equal to**, **Not equal to**, **In range**, **Existent**, **Non-existent**, **Greater than or equal to**, or **Less than or equal to**). Properties are defined by the metadata file you upload. You can add multiple filtering conditions or click **Delete** to delete set conditions.
4. After the execution is complete, the filtering result is displayed in the drawing area and result area.

6.16 Editing Properties

The **Property** tab displays information about the properties of the selected vertices and edges. You can edit the properties of a single vertex or edge.

The procedure is as follows:

1. Right-click a vertex/edge on the canvas and choose **View Property** from the shortcut menu. The **Property** tab is displayed on the right, showing the properties of the selected vertex/edge.

   If the selected vertex has multiple labels, you can click the drop-down box next to the label to view the properties of other labels.
2. Click  next to the property to edit it.

   Click **Edit All** at the bottom of the property area to edit all the displayed properties. Click **Save All**.

3. Click after you finish editing.

NOTE

In the **Property** tab, only the properties of a single vertex or edge can be edited. In the **Schema** tab of the metadata area, you can add or delete all properties of a tag, as described in section **Editing Schema**.

6.17 Statistics Display

To view the number of tags and vertex weights of specified vertices and edges, you can select the vertices and edges on the canvas. For details about the concepts of vertices and edges, see **Graph Data Formats**.

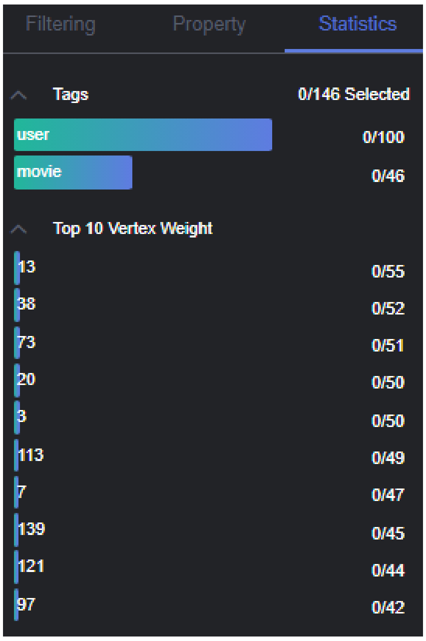
To display statistics, perform the following steps:

1. Log in to the GES graph editor. For details, see **Accessing the GES Graph Editor**.
2. Click on the right side of the canvas. The **Filter**, **Property**, and **Statistics** tabs are displayed. Click the **Statistics** tab.
   - **Tags**: Statistics on all tags, and the number of vertices and edges of each tag on the current canvas
   - **Top 10 Vertex Weight**: Top 10 vertices with the largest number of edges in the current graph

   In the following example, there are two tags: **user** and **movie**. There are 100 vertices tagged with **user** and 46 vertices tagged with **movie**.

   In the example graph, the vertex whose ID is 13 has the largest weight. There are 55 edges in total. The vertex ranked at 10 is vertex 97. There are 42 edges in total.

Figure 6-40 Tag statistics



3. Press **Shift** and drag the left key of the mouse to select vertices and edges in the graph. The tags of the selected vertices and edges are displayed along with the top 10 vertices with the highest weights among the selected verities.

6.18 View Running Records

The system logs your operations in a table, allowing you to review the execution progress and completion time when analyzing data.

The procedure is as follows:

1. Log in to the GES graph editor. For details, see **Accessing the GES Graph Editor**.
2. After executing a Gremlin/Cypher/DSL query or algorithm analysis, the operation record name, status, request parameters, job ID, start time, and duration will be displayed under the **Running Record** tab. Clicking the **Query Result** tab will take you to the query results page, where you can view the complete results of the operation.

Figure 6-41 Running Record tab

3. You can also export running records in **json**, **csv**, or **excel** format.

6.19 Viewing Query Results

After data analysis is complete, you can directly view the result on the canvas or on the **Query Result** tab page.

The procedure is as follows:

1. Log in to the GES graph editor. For details, see **Accessing the GES Graph Editor**.
2. Perform a Gremlin/Cypher/DSL query or algorithm analysis and check the query results on the **Query Result** tab page.

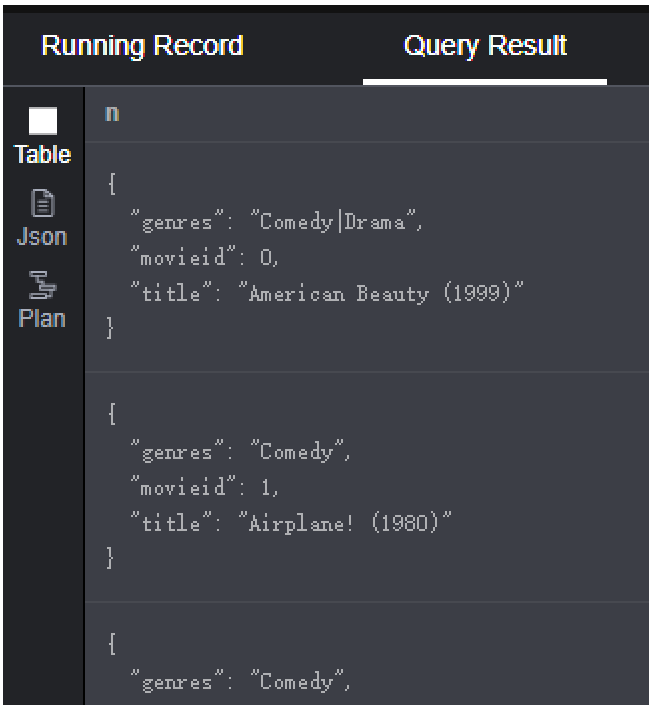
   If the returned results are too large to be fully displayed on the canvas and result area, you can click the export button in the upper right corner to download the analysis results. Currently, three export formats are supported: **json**, **csv**, and **excel**.

   – Run a Gremlin command. The command output is quickly displayed. For example, if you run the **g.V().limit(100)** command, the result is as follows:

Figure 6-42 Gremlin output

– Run a Cypher command. The command output is quickly displayed. For example, if you run the **match (n) return n limit 100** command, the result is as follows:

Figure 6-43 Cypher output

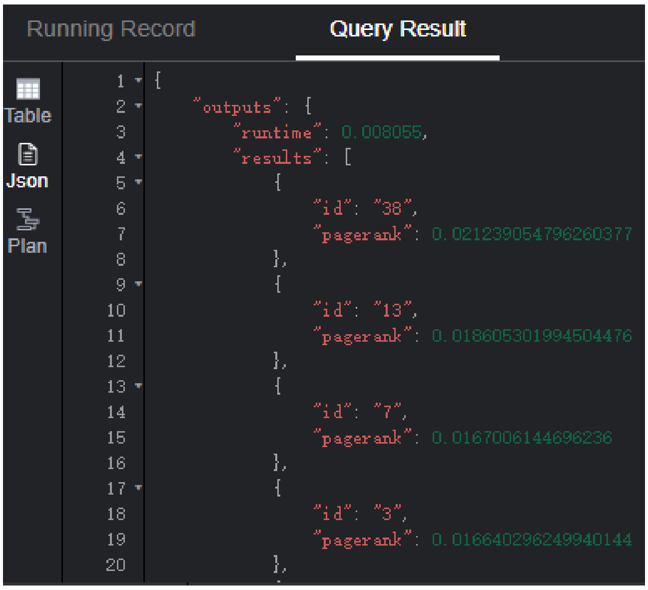


– Run a DSL command to display its execution result. For example, if you enter the query command **Match<Vertex> v(); v.pick(1); return v**, the query result is as follows:

Figure 6-44 DSL output

– Run an algorithm. The running time and result are displayed. For example, if you run PageRank, the result is as follows:

Figure 6-45 Algorithm output

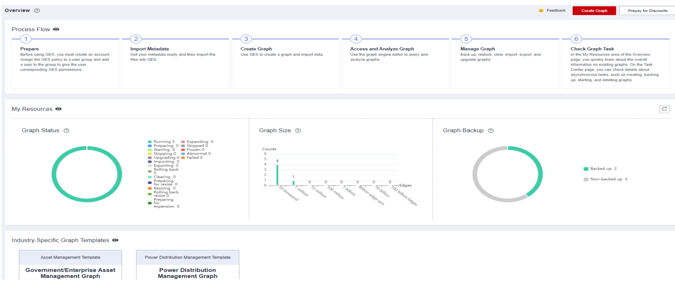


7 Viewing Graph Tasks

7.1 Graph Overview

The **Overview** page displays resource information, including **Graph Status**, **Graph Size**, and **Graph Backup**, enabling you to quickly learn the information about existing graphs.

Figure 7-1 Overview



Graph Status

The **Graph Status** pane displays the number of graphs in different statuses. Currently, the system supports the following statuses.

Table 7-1 Graph statuses

Status	Description
Running	Indicates running graphs. Graphs in this status can be accessed.
Preparing	Indicates graphs whose ECSs are being created or started.
Starting	Indicates graphs being started.
Stopping	Indicates graphs being stopped.
Upgrading	Indicates graphs being upgraded.

Status	Description
Importing	Indicates graphs being imported.
Exporting	Indicates graphs being exported.
Rolling back	Indicates graphs being rolled back.
Clearing	Indicates graphs being cleared.
Preparing for resize	Indicates graphs preparing for resize.
Resizing	Indicates graphs being resized.
Rolling back resize	Indicates graphs where resize is being rolled back.
Preparing for expansion	Indicates graphs preparing for expansion.
Expanding	Indicates graphs being expanded.
Stopped	Indicates stopped graphs. Graphs in this status cannot be accessed, but can be restarted.
Abnormal	Indicates abnormal graphs. Graphs in this status cannot be accessed.
Failed	Indicates graphs failed to be created.

Graph Size

The **Graph Size** pane displays the number of graphs in different sizes. Currently, the system supports the following eight sizes.

NOTE

Only graph names and the number of graphs are displayed.

Table 7-2 Graph sizes

Size	Description
10 thousand	Indicates that the number of edges of a graph cannot exceed 10 thousand.
1 million	Indicates that the number of edges of a graph cannot exceed 1 million.
10 million	Indicates that the number of edges of a graph cannot exceed 10 million.
100 million	Indicates that the number of edges of a graph cannot exceed 100 million.

Size	Description
1 billion	Indicates that the number of edges of a graph cannot exceed 1 billion.
1 billion pro	Indicates that the number of edges of a graph cannot exceed 2 billion.
10 billion	Indicates that the number of edges of a graph cannot exceed 10 billion.
100 billion	Indicates that the number of edges of a graph cannot exceed 100 billion.

Graph Backup

You can back up graphs to prevent data loss. The **Graph Backup** pane displays the numbers of graphs with and without backups.

Table 7-3 Backup statuses

Backup Status	Description
Backed up	Indicates the number of graphs that are backed up.
Non-backed up	Indicates the number of graphs that are not backed up.

7.2 Task Center

7.2.1 Management Plane Task Center

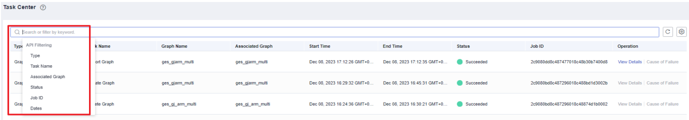
If you want to view details about creating, backing up, starting, backing up, importing, exporting, and upgrading tasks, you can go to the **Task Center** page.

The procedure is as follows:

1. In the navigation pane on the left, click **Task Center**.
2. On the **Task Center** page, view the task type, task name, graph name, associated graph, start time, end time, status, and running result.
3. In the **Running Result** column, click **View Details** to view the detailed information. You can also click **Cause of Failure** or **Job ID**.

   If the status of a data import task is **Partially successful**, you can click **View Details** to view information such as the type of data that fails to be imported and the number of rows that fail to be imported. To view the cause of failure, check the log path (optional) specified when you import the graph because failure logs are uploaded to the path.
4. On the **Task Center** page, search for a task in any of the following ways:

Figure 7-2 Searching for a task



a. Selecting the task type
b. Selecting the task name
c. Entering an associated graph
d. Entering a task status
e. Entering a task ID
f. Setting the time

7.2.2 Service Plane Task Center

The task center allows you to view details about the historical tasks and asynchronous tasks that are being executed.

The procedure is as follows:

1. In the navigation pane, choose **Graph Management**. On the displayed page, locate the target graph and choose **More** > **Task Center** in the **Operation** column.

   NOTE

   - The query task center is available for graphs of version 2.2.23 and later.
   - You can access the query task center of graphs that are in the running, importing, exporting, or clearing states only.

2. In the upper left corner of the **Task Center** page, select a node from the drop-down list to view details about the asynchronous tasks that are being executed or have been executed. The following task information is displayed:
   - **Job ID**: Job ID of an asynchronous task
   - **Graph Name**: name of graphs of the database edition
   - **Task Type**: Type of the asynchronous task, including **ImportGraph** and **VertexQuery**
   - **Original Request**: Original request body sent by the user
   - **Status**: Task status, which can be **Suspended**, **Running**, **Succeeded**, or **Failed**
   - **Progress**: Progress of the task
   - **Start Time**: Time when the task starts. If the task does not start, the start time is empty.
   - **End Time**: Time when the task ends. If the task does not end, the end time is empty.
   - **Operation**: You can suspend the task.
   - **Running Result**: You can view the task details. If the task fails, you can view the failure cause.

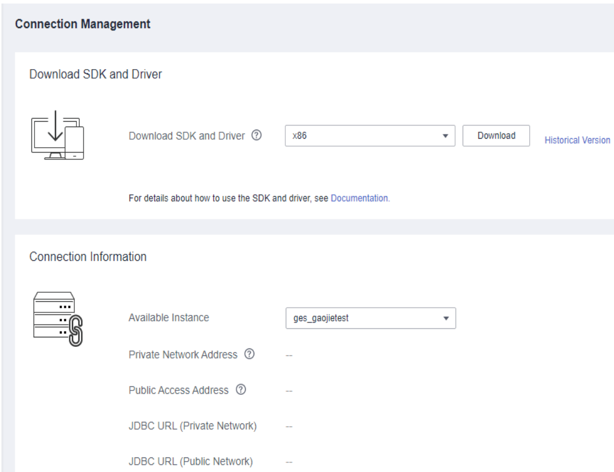
3. To view details about an asynchronous task, search the task by its job ID using the search box in the upper right corner of the page.

7.3 Managing Connections

After you create a graph instance, you can download the required SDK and driver and view the connection information of the graph.

In the navigation pane on the left, click **Connection Management**. The **Connection Management** page is displayed.

Figure 7-3 Connection management page



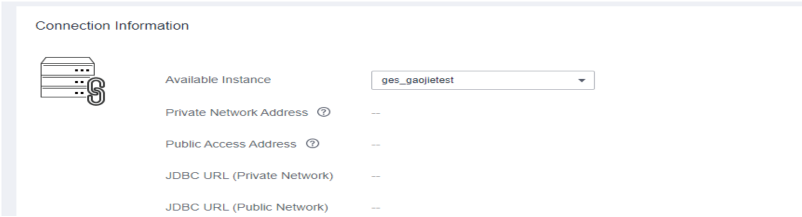
Downloading SDK and Driver

Figure 7-4 SDK and driver

- Download an SDK and driver
  - The SDK encapsulates the service plane APIs. You are advised to use the SDK to access graph instances.
  - You need to download the Cypher-JDBC driver for Cypher API access. For details, see "Using the Cypher JDBC Driver to Access GES".
- Select the CPU architecture supported by the cluster. Currently, **x86** and **Arm** are available. Click **Download** to download the SDK.
- Click **Historical Version** to view historical SDK and driver versions and CPU architecture of the driver. You can click **Download** in the **Operation** column to download the historical driver.

Connection Information

Figure 7-5 Instance information



Select the name of a created graph instance to view the following information:

- **Private Network Address**: ECSs in the same private network can connect to the graph instance using the private network address.
- **Public Access Address**: You can use the public access address (EIP) to access the graph instance through the Internet. You can bind an EIP to or unbind one from a graph instance.
- **JDBC URL (Private Network)**: Configure this parameter when the JDBC driver executor and the graph instance are in the same private network.
- **JDBC URL (Public Network)**: Configure this parameter when the JDBC driver executor can access the graph instance (with an EIP bound) through the Internet.

8 Configuring Permissions

8.1 Configuring Granular Permissions

GES graph instances support granular permission control. You can set the traverse, read, and write permissions for specific properties of specific labels. You are allowed to manage these permissions of a specific label or property of a graph and grant them to a user group.

NOTE

- This function allows you to set granular permissions for graphs of version 2.2.21 or later. You can **upgrade a graph** of an earlier version to 2.2.21 or a later version and then set granular permissions.
- Configuring fine-grained permissions for the graph requires IAM user viewing permissions and **GES Manager** or higher permissions. If there is no IAM user viewing permission, refer to **User Details** to import IAM users.

Procedure

1. Before setting granular permissions, configure the user group first. For details, see **Configuring a User Group**.
2. In the navigation pane, choose **Granular Permissions** > **Permission Configuration**.
3. On the **Permission Configuration** page, you can view the graph name, permission status, enabling time, and operations that can be performed on a graph in the **Running** status.

   NOTE

   1. Only graphs in the **Running** status are displayed on this page.
   2. You can set permissions only when its status is **Disabled**.
   3. You can search for graphs by their names in the upper right corner of the page.
4. Select the graph for which you want to set permission and click **Set** in the **Operation** column. The **Set Permission** page is displayed. You can create metadata permissions and granular permissions on this page.

5. Click **Create** under **Metadata Write Permission** to create permission. After the metadata write permission is created, all labels of the metadata can be modified.
6. Click **Create Policy** under **Granular Permission Policy** to set granular permissions for a graph. You can set label- and property-level graph permissions and grant them to user groups.
   - **Policy Name**: You can set a name or use the default name.
   - **View**: You can configure permissions in form or code view.
   - **Permissions**: You can select labels whose traversal permission will be granted to a certain group of users. You can set read and write permissions of the label properties.

     NOTE

     To use the Cypher query function, you need to configure the metadata permission and select the read and write permissions for all labels (including the default label **__DEFAULT__**) when configuring the graph permission.
7. Click **Save**. The **Set Permission** page is displayed. You can view the created permission policy in the **Granular Permission Policy** pane.

   NOTE

   In this case, the **Associate User Group** in the **Operation** column is unavailable. You need to enable granular permissions before associating the policy with a user group.
8. Click **Enable Permissions** in the upper right corner of the page to enable fine-grained permissions for the graph. Alternatively, you can return to the **Permission Configuration** page, locate the graph for which the fine-grained permission has been set, and click **Enable** in the **Operation** column. The permission status changes to **Enabled**.
9. Click **Set** in the **Operation** column to associate the created granular permission with a user group.
10. Click **OK**. On the **Granular Permission Policy** pane, you can view the number of users who have been granted the permission.

8.2 User Groups

You can create and manage user groups, and check whether a user group has been associated with permissions.

The procedure is as follows:

1. On the **User Groups** page, click **Create User Group** in the upper right corner. The **Create User Group** page is displayed.
2. Set the user group name and add group members.
   - **Name**: Set a name for the user group or use the default name.
   - **Members**: All IAM users created under your account are displayed in this area. Select members you want to add to the user group. The selected members are displayed on the right.
     - Click on the left of User/ID to view all group members at a time or clear all selected group members.

- Click ☐ on the left of User/ID to select all users on the current page.

NOTE

If the IAM user is not found due to insufficient permissions, manually import the IAM user by referring to **User Details**.

3. Click **Save** in the lower right corner. The user group is created. The created user group is displayed on the **User Groups** page. You can edit or delete the user group.

NOTE

You are not allowed to delete user groups that have been associated with granular permissions.

8.3 User Details

You can view the granular permissions of all IAM users created within your account.

The procedure is as follows:

1. On the **User Permissions** page, click ⌄ next to the target username to view it fine-grained permissions.
2. Click the permission name to view the details.
3. If you do not have such permission, you can click Import IAM User in the upper right corner to manually import IAM users.

   In the **Import IAM User** dialog box, enter the ID and username of the IAM user to be added and click **OK**. The system will add the IAM user to GES so that the IAM user can be selected in the user group.

9 O&M Monitoring and Alarm Reporting

9.1 Monitoring Metrics

By using the O&M monitoring function of the graph instance, you can check the instance status, available resources, and real-time resource consumption.

Table 9-1 lists the monitoring metrics for GES.

Table 9-1 GES monitoring metrics

Monitored Object	Metric	Description	Value Range	Monitoring Period (Original Metric)
Instance overview metrics	Cluster Information	Size and CPU architecture	String	-
	Cluster Capacity	Total and used vertices and edges, and usage	≥ 0	Real-time
	Cluster Node	Node type, available quantity, and total quantity	≥ 0	Real-time
	Cluster Request Statistics	Number of waiting and running read and write requests on an instance	≥ 0	Real-time
Instance alarm metrics	Alarm Statistics	Number of critical, major, minor, and info alarms on an instance	≥ 0	5 min
Instance workload metrics	QPS	Number of requests processed by an instance per second	≥ 0	5 min

Monitored Object	Metric	Description	Value Range	Monitoring Period (Original Metric)
Resource consumption metrics of graph instances	Average CPU Usage	Average CPU usage of the active node	0%–100%	5 min
	Memory Usage	Average memory usage of the active node	0%–100%	5 min
	Disk Usage	Average disk usage of the active node	0%–100%	5 min
	Disk I/O Usage	Average disk I/O usage of the active node	0%–100%	5 min
	Network I/O Usage	Average network I/O usage of the active node	0%–100%	5 min
Overview	Node Name	Name of a node	String	-
	CPU Usage (%)	CPU usage of a node	0%–100%	5 min
	Memory Usage (%)	Memory usage of a node	0%–100%	5 min
	Average Disk Usage (%)	Disk usage of a node	0%–100%	5 min
	IP Address	Service IP address of a node	String	5 min
	Disk I/O (KB/S)	Disk I/O of a node, in KB/s	≥ 0KB/s	5 min
	TCP Protocol Stack Retransmission Rate (%)	Retransmission rate of TCP packets per unit time	0%–100%	5 min
	Status	Status of a node	Running/ Faulty	5 min
Disks	Node Name	Name of a node	String	5 min
	Disk Name	Name of a disk on a node	String	5 min
	Disk Capacity (GB)	Capacity of a disk on a node, in GB	≥ 0 GB	5 min
	Disk Usage (%)	Disk usage of a node	0%–100%	5 min

Monitored Object	Metric	Description	Value Range	Monitoring Period (Original Metric)
	Disk Read Rate (KB/S)	Disk read rate of a node, in KB/s	≥ 0KB/S	5 min
	Disk Write Rate (KB/S)	Disk write rate of a node, in KB/s	≥ 0KB/S	5 min
	I/O Wait Time (ms)	Average waiting time for each I/O request, in ms	≥ 0 ms	5 min
	I/O Service Time (ms)	Average processing time for each I/O request, in ms	≥ 0 ms	5 min
	I/O Usage (%)	Disk I/O usage of a host	0%–100%	5 min
Networks	Node Name	Name of a node	String	5 min
	NIC Name	Name of the NIC on a node	String	5 min
	NIC Status	NIC status	up/down	5 min
	NIC Speed	Working rate of a NIC, in Mbit/s	≥ 0	5 min
	Received Packets	Number of packets received by a NIC	≥ 0	5 min
	Transmitted Packets	Number of packets transmitted by a NIC	≥ 0	5 min
	Lost Received Packets	Number of lost packets received by a NIC	≥ 0	5 min
	Receive Rate (KB/S)	Number of bytes received by a NIC per unit time, in KB/s	≥ 0KB/s	5 min
	Transmit Rate (KB/S)	Number of bytes transmitted by a NIC per unit time, in KB/s	≥ 0KB/s	5 min
Performance	Cluster CPU Usage	Average CPU usage of the active node	0%–100%	5 min
	Cluster Memory Usage	Average memory usage of the active node	0%–100%	5 min

Monitored Object	Metric	Description	Value Range	Monitoring Period (Original Metric)
	Cluster Disk Usage	Average disk usage of the active node	0%–100%	5 min
	Cluster Disk I/O	Average disk I/O of the active node	0%–100%	5 min
	Cluster Network I/O	Average network I/O of the NIC of the active node	0%–100%	5 min
	Tomcat Connection Usage	HTTP connection usage of the active node	0%–100%	5 min
	Cluster Swap Disk Usage	Swap partition disk usage of the active node	0%–100%	5 min
	JVM Heap Memory Usage	JVM heap memory usage of the active node	0%–100%	5 min
	Read Requests in Running Queue	Number of running read requests on the current instance	≥ 0	5 min
	Read Requests in Blocked Queue	Number of blocked read requests on the current instance	≥ 0	5 min
Real-Time Queries	Request ID	ID of the current query request	String	Real-time
	Job Name	Name of the current query job	String	Real-time
	Request Parameters	Request parameters for the current query	String	Real-time
	Progress	Progress of the current query	0%–100%	Real-time
	Blocking Duration (S)	Blocking duration of the current query, in seconds	≥ 0	Real-time
	Started	Start time of the current query	String	Real-time
	Ended	End time of the current query	String	Real-time

Monitored Object	Metric	Description	Value Range	Monitoring Period (Original Metric)
	Running Duration	Running duration of the current query, in seconds	≥ 0	Real-time
Historical Queries	Job ID	ID of a historical query job	String	Real-time
	Type	Type of a historical query job	String	Real-time
	Original Request	Original request for a historical query	String	Real-time
	Status	Status of a historical query job	String	Real-time
	Progress	Execution progress of a historical query job	0%–100%	Real-time
	Start Time	Start time of a historical query job	String	Real-time
	End Time	End time of a historical query job	String	Real-time
	Running Result	Execution results of a historical query job	String	Real-time

9.2 Graph Instance O&M Monitoring

GES offers a multi-dimensional O&M monitoring interface that guarantees the smooth operations of graph instances. This feature gathers, monitors, and analyzes disk, network, and OS metrics utilized by graph instances, along with key cluster performance metrics. It promptly identifies significant database faults and performance issues and provides recommendations to optimize and resolve them.

NOTE

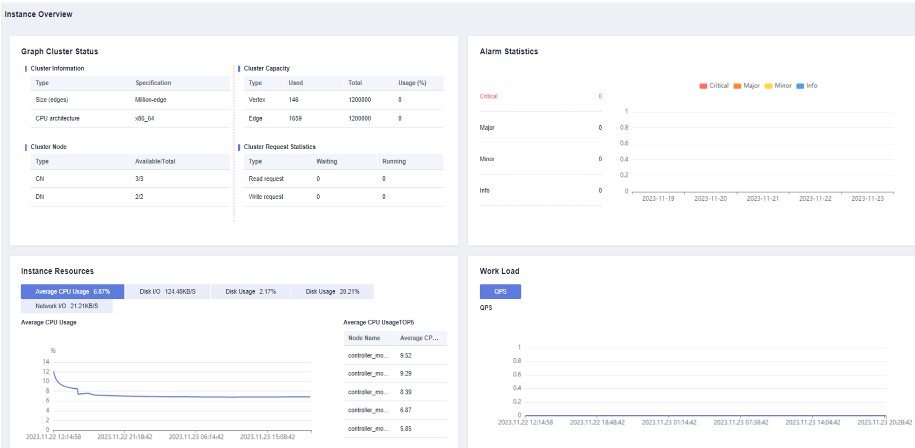
- The graph instance O&M monitoring dashboard supports only graphs of version 2.3.17 or later.
- The ten-thousand-edge size is for development learning and does not support the O&M monitoring dashboard.
- Database edition graph databases do not support graph instance monitoring.

O&M Monitoring Page

1. Log in to the GES management console. In the navigation pane on the left, choose **Graph Management**.

2. In the graph list, locate the target graph instance, click **More** in the **Operation** column, and select **View Metric** to access the **Instance Overview** page. For details about monitoring metrics, see **Monitoring Metrics**.

Figure 9-1 Instance Overview page



Instance Overview

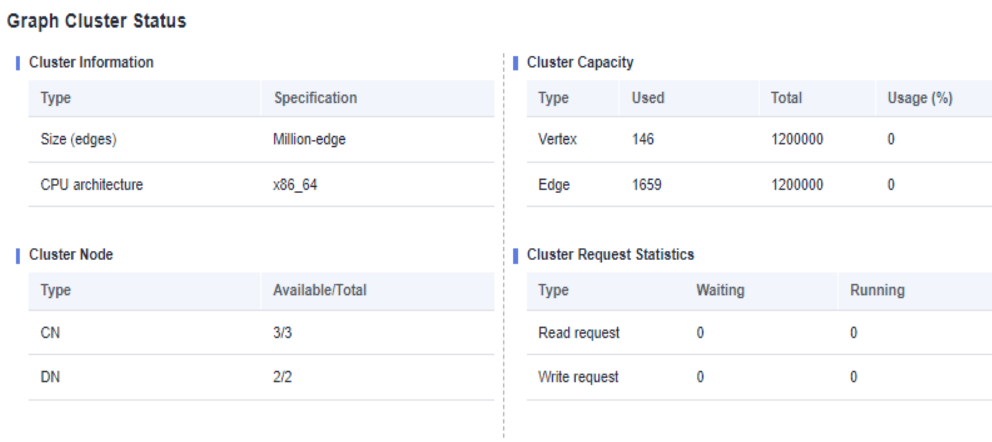
On the **Instance Overview** page of a graph instance, you can check the graph instance status, real-time resource consumption, alarm statistics, and service workload. The functions of these areas are as follows:

- Graph Cluster Status

  In this area, you can check the basic information, cluster capacity, and number of requests of the current graph instance.

  a. **Cluster Information**: includes graph size and CPU architecture.
  b. **Cluster Capacity**: includes the number of used and total vertices and edges, as well as the usage.
  c. **Cluster Node**: includes the number of available/total CNs/DNs.
  d. **Cluster Request Statistics**: includes the number of waiting read requests, running read requests, waiting write requests, and running write requests.

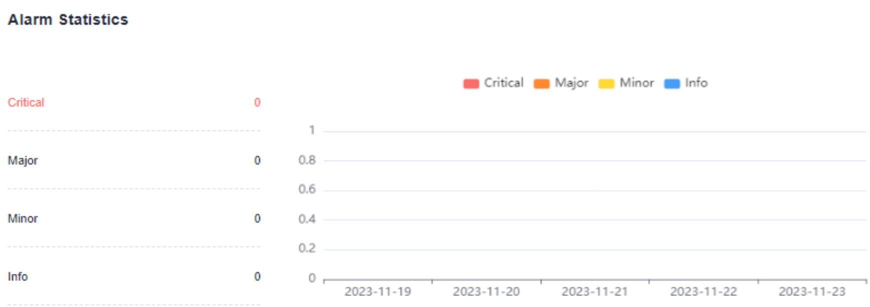
Figure 9-2 Graph Cluster Status



- Alarm Statistics

  In this area, you can check all alarms that are not cleared for the current instance and all alarms generated for the instance in the last seven days.

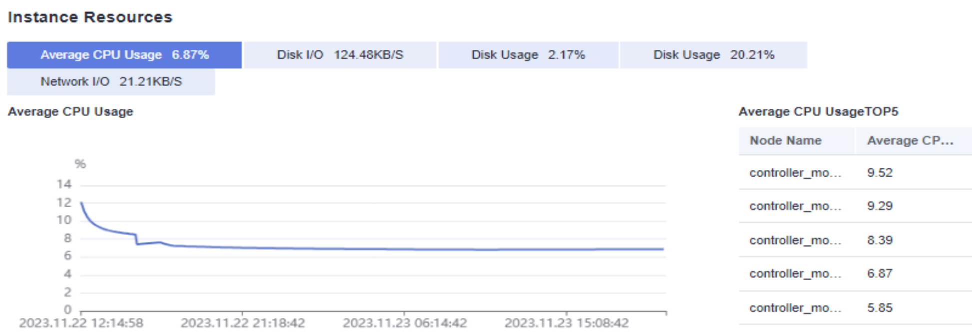
  Figure 9-3 Alarm Statistics



- Instance Resources

  In this area, you can check the resource usage of the current instance, including the CPU usage, disk I/O, disk usage, memory usage, and network I/O. You can click a resource metric to view its change trend in the last 72 hours and the top 5 nodes with the highest usage of the resource at the current time.

  Figure 9-4 Instance Resources



- Workload

  In this area, you can check the change trend of the database service load metric QPS in the last 72 hours.

Figure 9-5 Workload

9.3 Monitoring

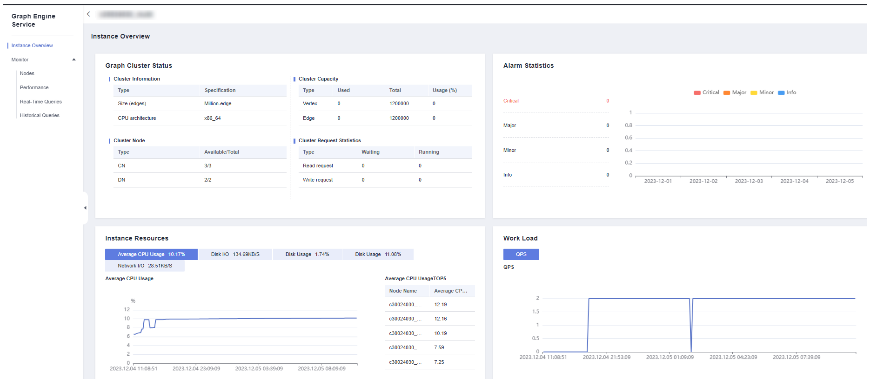
9.3.1 Nodes

In the navigation pane on the left of the O&M monitoring page, choose **Monitoring** > **Nodes**. The node monitoring page is displayed, showing the real-time consumption of nodes, memory, disks, disk I/O, and network I/O.

- Overview

  On the **Overview** page, you can check the key resources of a specified node based on the node name, including the node name, CPU usage (%), memory usage (%), average disk usage (%), IP address, disk I/O (KB/s), TCP protocol stack retransmission rate (%), network I/O (KB/s), node status, and node monitoring status.

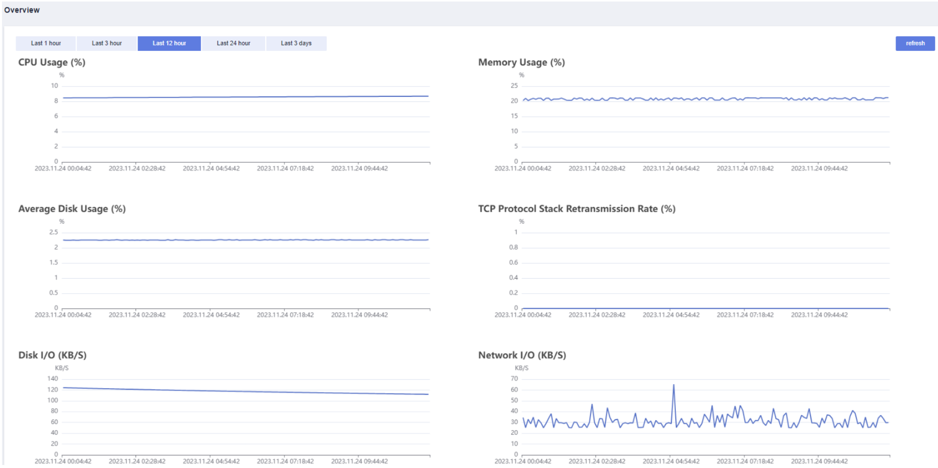
  Figure 9-6 Overview page

  You can click **Monitor** on the right of the row where a specified node is located to access the monitoring overview page and check the performance metric topology of the node in a specified period.

  The period options are **Last 1 hour**, **Last 3 hour**, **Last 12 hour**, **Last 24 hour**, and **Last 3 days**. If you stay on the page for a long time, you can click **Refresh** in the upper right corner to update the monitoring data.

Figure 9-7 Node monitoring page

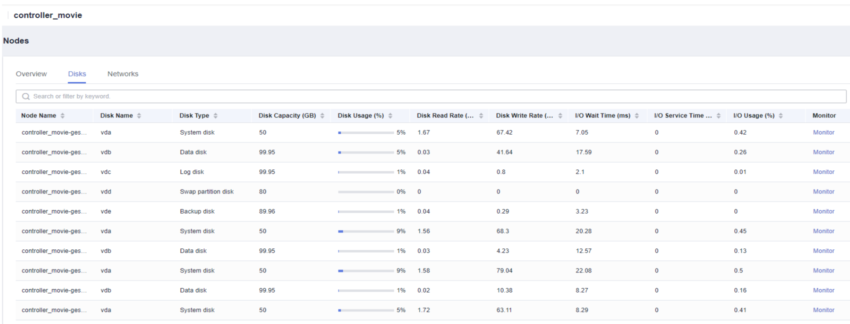


- Disks

  On the **Disks** tab page, you can check the real-time disk usage of a node based on the node name and disk name. The metrics include **Node Name**, **Disk Name**, **Disk Type**, **Disk Capacity (GB)**, **Disk Usage (%)**, **Disk Read Rate (KB/s)**, **Disk Write Rate (KB/s)**, **I/O Wait Time (ms)**, **I/O Service Time (ms)**, **I/O Usage (%)**, and **Monitor**.

  The disk types include system disk, data disk, log disk, swap partition disk, and backup disk.

Figure 9-8 Disks tab page

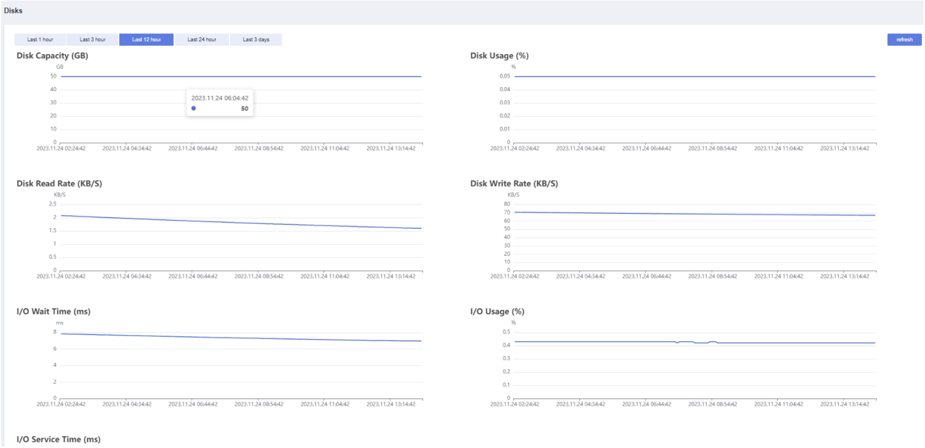


Node Name	Disk Name	Disk Type	Disk Capacity (GB)	Disk Usage (%)	Disk Read Rate (...	Disk Write Rate (...	I/O Wait Time (ms)	I/O Service Time ...	I/O Usage (%)	Monitor
controller_movie-ges...	vda	System disk	50	5%	1.67	67.42	7.05	0	0.42	Monitor
controller_movie-ges...	vdb	Data disk	99.95	5%	0.03	41.64	17.59	0	0.26	Monitor
controller_movie-ges...	vdc	Log disk	99.95	1%	0.04	0.8	2.1	0	0.01	Monitor
controller_movie-ges...	vdd	Swap partition disk	80	0%	0	0	0	0	0	Monitor
controller_movie-ges...	vde	Backup disk	89.96	1%	0.04	0.29	3.23	0	0	Monitor
controller_movie-ges...	vda	System disk	50	9%	1.56	68.3	20.28	0	0.45	Monitor
controller_movie-ges...	vdb	Data disk	99.95	1%	0.03	4.23	12.57	0	0.13	Monitor
controller_movie-ges...	vda	System disk	50	9%	1.58	79.04	22.08	0	0.5	Monitor
controller_movie-ges...	vdb	Data disk	99.95	1%	0.02	10.38	8.27	0	0.16	Monitor
controller_movie-ges...	vda	System disk	50	5%	1.72	63.11	8.29	0	0.41	Monitor

  You can click **Monitor** on the right of the row where a specified node is located to access the monitoring overview page and check the performance metric topology of the disk in a specified period.

  The options are **Last 1 hour**, **Last 3 hour**, **Last 12 hour**, **Last 24 hour**, and **Last 3 days**. If you stay on the page for a long time, you can click **Refresh** in the upper right corner to update the monitoring data.

Figure 9-9 Disks page



NOTE

According to the disk usage displayed on the page, the sum of the used disk space and available disk space is not equal to the total disk space. This is because a small amount of space is reserved in each default partition for system administrators to use. Even if common users have run out of space, system administrators can log in to the system and use their space required for solving problems.

The disk capacity is collected by running the **df** command on Linux. The following is an example:

```
[Ruby@host-10-0-16-43 8_1_0]# df -x tmpfs -x devtmpfs
Filesystem      1K-blocks    Used  Available Use% Mounted on
/dev/sda4       569616888 5757444  540228616   2% /
/dev/sda2          999320  107584     822924  12% /boot
/dev/sda1          204580    8368     196212   5% /boot/efi
/dev/sdd       3513495364  390076 3513105288   1% /var/chroot/DWS/data1
/dev/sde       3513495364  274192 3513221172   1% /var/chroot/DWS/data2
/dev/sdb       3513495364   34224 3513461140   1% /var/chroot/DWS/data3
/dev/sdc       3513495364   34224 3513461140   1% /var/chroot/DWS/data4
[Ruby@host-10-0-16-43 8_1_0]#
```

```
/dev/sda4: Used(5757444) + Available(540228616) != Total(569616888)
```

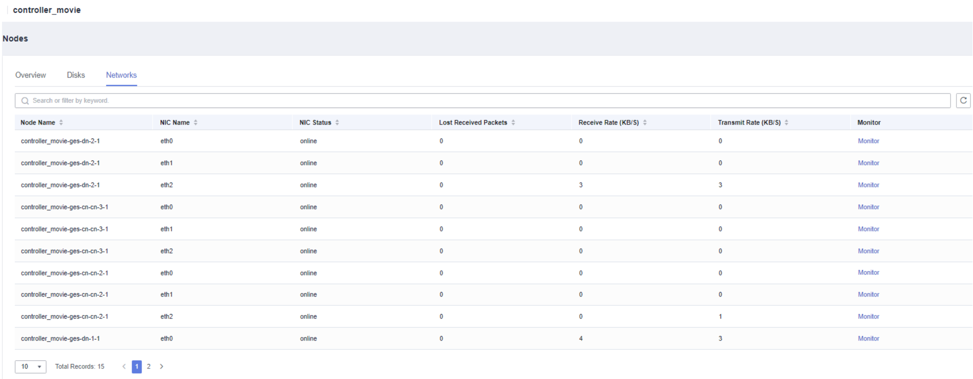
The parameters are as follows:

- **Filesystem**: path name of the device file corresponding to the file system. Generally, it is a hard disk partition.
- **IK-blocks**: number of data blocks (1,024 bytes) in a partition.
- **Used**: number of data blocks used by the disk.
- **Available**: number of available data blocks on the disk.
- **Use%**: percentage of the space used by common users. Even if the space is used up, the partition still reserves the space for system administrators.
- **Mounted on**: mount point of the file system.

- Networks

  On the **Networks** tab page, you can check the real-time network resource consumption of a node based on the node and NIC name. The metrics include **Node Name**, **NIC Name**, **NIC Status**, **Lost Received Packets**, **Receive Rate (KB/S)**, **Transmit Rate (KB/S)**, and **Monitor**.

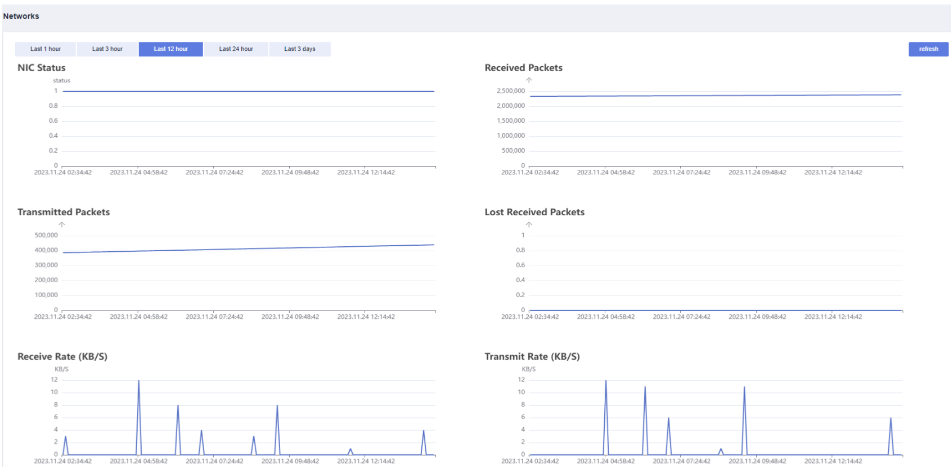
Figure 9-10 Networks tab page



You can click **Monitor** on the right of the row where a specified node is located to access the monitoring overview page and check the performance metric topology of the network in a specified period.

The options are **Last 1 hour**, **Last 3 hour**, **Last 12 hour**, **Last 24 hour**, and **Last 3 days**. If you stay on the page for a long time, you can click **Refresh** in the upper right corner to update the monitoring data.

Figure 9-11 Networks page



9.3.2 Performance

In the navigation pane on the left of the O&M monitoring page, choose **Monitoring** > **Performance**. The performance monitoring page displays the trends of the following performance metrics:

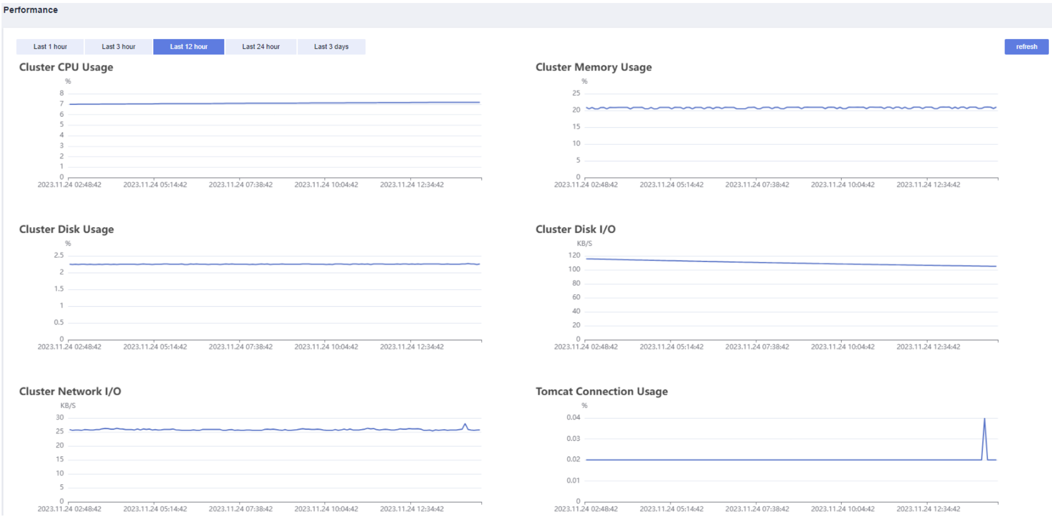
- CPU Usage (%)
- Memory Usage (%)
- Disk Usage (%)
- Disk I/O (KB/s)
- Network I/O (KB/s)
- Tomcat Connection Usage (%)
- Swap Disk Usage

- JVM Heap Memory Usage
- Read Requests in Running Queue
- Read Requests in Blocked Queue

You can select a time range to check the performance trends within this range.

The options are **Last 1 hour**, **Last 3 hour**, **Last 12 hour**, **Last 24 hour**, and **Last 3 days**. If you stay on the page for a long time, you can click **Refresh** in the upper right corner to update the monitoring data.

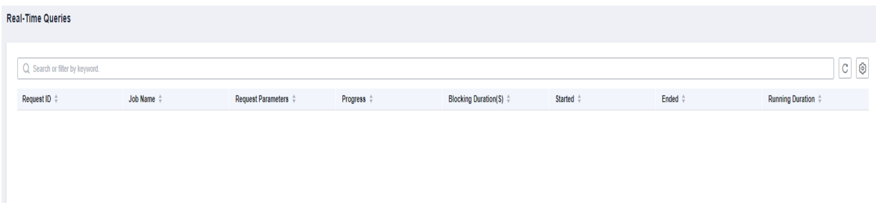
Figure 9-12 Performance page



9.3.3 Real-Time Queries

In the navigation pane on the left of the O&M monitoring page, choose **Monitoring** > **Real-Time Queries**. The **Real-Time Queries** page is displayed, showing the real-time information about all queries running on the instance. The information includes **Request ID**, **Job Name**, **Request Parameters**, **Progress**, **Blocking Duration (S)**, **Started**, **Ended**, and **Running Duration**.

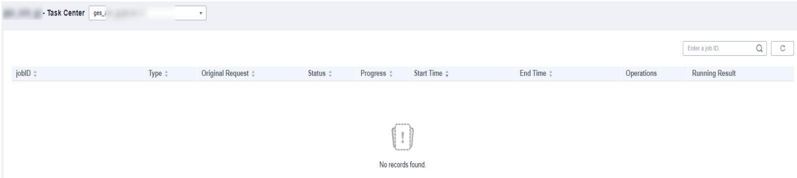
Figure 9-13 Real-Time Queries page



9.3.4 Historical Queries

In the navigation tree on the left of the O&M monitoring page, choose **Monitoring** > **History Queries**. The **History Queries** page is displayed, showing details about historical asynchronous tasks running on the graph instance (the same as those displayed in the task center on the service plane).

Figure 9-14 Historical Queries page



9.4 Monitoring Clusters Using Cloud Eye

This section describes metrics reported by GES to Cloud Eye as well as their namespaces, lists, and dimensions. You can use APIs provided by Cloud Eye to query the metric information generated for GES.

Namespace

SYS.GES

Monitoring Metrics

Table 9-2 GES metrics

Metric ID	Metric	Description	Value Range	Monitored Object
ges001_vertex_util	Vertex Capacity Usage	Vertex usage in a graph instance. The value is the ratio of used vertices to the total vertices. Unit: %	0–100 Type: float	GES instance
ges002_edge_util	Edge Capacity Usage	Edge usage of a graph instance. The value is the ratio of the used edges to the total edges. Unit: %	0–100 Type: float	GES instance
ges003_average_import_rate	Average Import Rate	Average rate of importing vertices or edges to a graph instance Unit: count/s	0–400000 Type: float	GES instance
ges004_request_count	Request Quantity	Number of requests received by a graph instance Unit: count	≥ 0 Type: integer	GES instance

Metric ID	Metric	Description	Value Range	Monitored Object
ges005_average_response_time	Average Response Time	Average response time of requests received by a graph instance Unit: ms	≥ 0 Type: integer	GES instance
ges006_min_response_time	Minimum Response Time	Minimum response time of requests received by a graph instance Unit: ms	≥ 0 Type: integer	GES instance
ges007_max_response_time	Maximum Response Time	Maximum response time of requests received by a graph instance Unit: ms	≥ 0 Type: integer	GES instance
ges008_read_task_pending_queue_size	Length of the Waiting Queue for Read Tasks	Length of the waiting queue for read requests received by a graph instance. This metric is used to view the number of read requests waiting in the queue. Unit: count	≥ 0 Type: integer	GES instance
ges009_read_task_pending_max_time	Maximum Waiting Duration of Read Tasks	Maximum waiting duration of read requests received by a graph instance Unit: ms	≥ 0 Type: integer	GES instance
ges010_pending_max_time_read_task_type	Type of the Read Task That Waits the Longest	Type of the read request that waits the longest in a graph instance. You can find the corresponding task name in GES documents.	≥ 1 Type: integer	GES instance
ges011_read_task_running_queue_size	Length of the Running Queue for Read Tasks	Length of the running queue for read requests received by a graph instance. This metric is used to view the number of running read requests. Unit: count	≥ 0 Type: integer	GES instance

Metric ID	Metric	Description	Value Range	Monitored Object
ges012_read_task_running_max_time	Maximum Running Duration of Read Tasks	Maximum running duration of read requests received by a graph instance Unit: ms	≥ 0 Type: integer	GES instance
ges013_running_max_time_read_task_type	Type of the Read Task That Runs the Longest	Type of the read request that runs the longest in a graph instance. You can find the corresponding task name in GES documentation.	≥ 1 Type: integer	GES instance
ges014_write_task_pending_queue_size	Length of the Waiting Queue for Write Tasks	Length of the waiting queue for write requests received by a graph instance. This metric is used to view the number of write requests waiting in the queue. Unit: count	≥ 0 Type: integer	GES instance
ges015_write_task_pending_max_time	Maximum Waiting Duration of Write Tasks	Maximum waiting duration of write requests received by a graph instance Unit: ms	≥ 0 Type: integer	GES instance
ges016_pending_max_time_write_task_type	Type of the Write Task That Waits the Longest	Type of the write request that waits the longest in a graph instance. You can find the corresponding task name in GES documents.	≥ 1 Type: integer	GES instance
ges017_write_task_running_queue_size	Length of the Running Queue for Write Tasks	Length of the running queue for write requests received by a graph instance. This metric is used to view the number of running write requests. Unit: count	≥ 0 Type: integer	GES instance

Metric ID	Metric	Description	Value Range	Monitored Object
ges018_write_task_running_max_time	Maximum Running Duration of Write Tasks	Maximum running duration of write requests received by a graph instance Unit: ms	≥ 0 Type: integer	GES instance
ges019_running_max_time_ write_task_type	Type of the Write Task That Runs the Longest	Type of the write request that runs the longest in a graph instance. You can find the corresponding task name in GES documentation.	≥ 1 Type: integer	GES instance
ges020_computer_resource_usage	Computing Resource Usage	Compute resource usage of each graph instance Unit: %	0–100 Type: float	GES instance
ges021_memory_usage	Memory Usage	Memory usage of each graph instance Unit: %	0–100 Type: float	GES instance
ges022_iops	IOPS	Number of I/O requests processed by each graph instance per second Unit: count/s	≥ 0 Type: integer	GES instance
ges023_bytes_in	Network Input Throughput	Data input to each graph instance per second over the network Unit: byte/s	≥ 0 Type: float	GES instance
ges024_bytes_out	Network Output Throughput	Data sent to the network per second from each graph instance Unit: byte/s	≥ 0 Type: float	GES instance
ges025_disk_usage	Disk Usage	Disk usage of each graph instance Unit: %	0–100 Type: float	GES instance
ges026_disk_total_size	Total Disk Size	Total data disk space of each graph instance Unit: GB	≥ 0 Type: float	GES instance

Metric ID	Metric	Description	Value Range	Monitored Object
ges027_disk_used_size	Disk Space Used	Used data disk space of each graph instance Unit: GB	≥ 0 Type: float	GES instance
ges028_disk_read_throughput	Disk Read Throughput	Data volume read from the disk in a graph instance per second Unit: byte/s	≥ 0 Type: float	GES instance
ges029_disk_write_throughput	Disk Write Throughput	Data volume written to the disk in a graph instance per second Unit: byte/s	≥ 0 Type: float	GES instance
ges030_avg_disk_sec_per_read	Average Time per Disk Read	Average time per disk read for a graph instance Unit: second	≥ 0 Type: float	GES instance
ges031_avg_disk_sec_per_write	Average Time per Disk Write	Average time per disk write for a graph instance Unit: second	≥ 0 Type: float	GES instance
ges032_avg_disk_queue_length	Average Disk Queue Length	Average I/O queue length of the disk in a graph instance Unit: count	≥ 0 Type: integer	GES instance

Dimensions

Key	Value
instance_id	GES instance

Mapping Between Task Types and Names

Table 9-3 Mapping between task types and names

Type	Name
100	Querying vertices
101	Creating a vertex
102	Deleting a vertex

Type	Name
103	Modifying a vertex property
104	Adding a vertex label
105	Deleting a vertex label
200	Querying edges
201	Creating an edge
202	Deleting an edge
203	Modifying an edge property
300	Querying schema details
301	Adding a label
302	Modifying a label
303	Querying a label
304	Modifying a property
400	Querying graph details
401	Clearing graphs
402	Incrementally importing graph data online
403	Creating a graph
405	Deleting a graph
406	Exporting graphs
407	filtered_khop
408	Querying path details
409	Incrementally importing graph data offline
500	Creating a graph backup
501	Restoring a graph from a backup
601	Creating an index
602	Querying indexes
603	Updating an index
604	Deleting an index
700	Running an algorithm

Viewing Instance Monitoring Information

1. Log in to the GES management console and choose **Graph Management**.
2. In the graph list, locate the row that contains the target graph, choose **More**, and select **View Metric** to access the Cloud Eye management console. By default, the graph instance monitoring information is displayed.

   You can select a monitoring metric name and time range to check the performance curve.

Creating an Alarm Rule

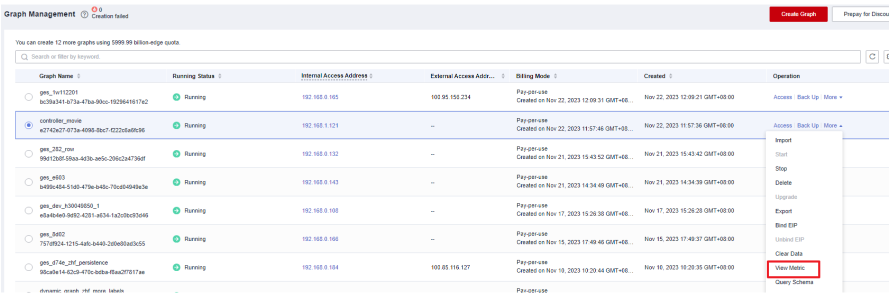
By setting alarm rules for GES, you can customize monitoring objects and notification policies to promptly understand the operational status of GES and serve as an early warning.

Alarm rule settings for GES include parameters such as alarm rule name, monitoring object, monitoring metrics, alarm threshold, monitoring cycle, and notification sending.

This part describes how to set an alarm rule for GES.

1. Log in to the GES management console and choose **Graph Management** from the navigation pane on the left.
2. Locate the row containing the target instance, choose **More** in the **Operation** column, and select **View Metric** to access the Cloud Eye management console and check the GES monitoring information.

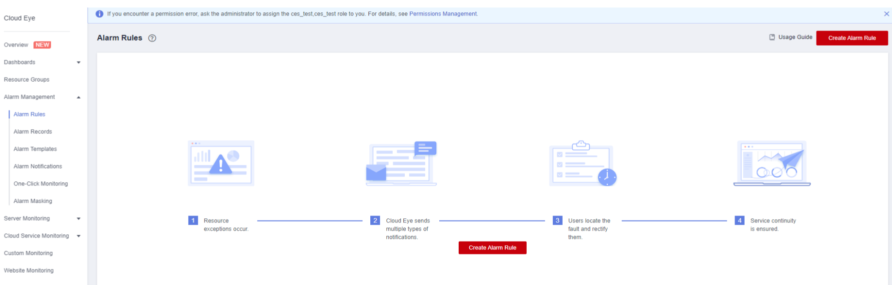
   Figure 9-15 Selecting View Metrics

   NOTE

   Ensure that the status of the instance whose monitoring information you want to view is **Running**. Otherwise, you cannot create an alarm.

3. In the navigation pane on the left of the Cloud Eye management console, choose **Alarm Management** > **Alarm Rules**. On the page displayed, click **Create Alarm Rule** in the upper right corner or in the middle.

4. On the **Create Alarm Rule** page, set parameters as prompted.
   a. Setting alarm parameters

Figure 9-16 Setting parameters

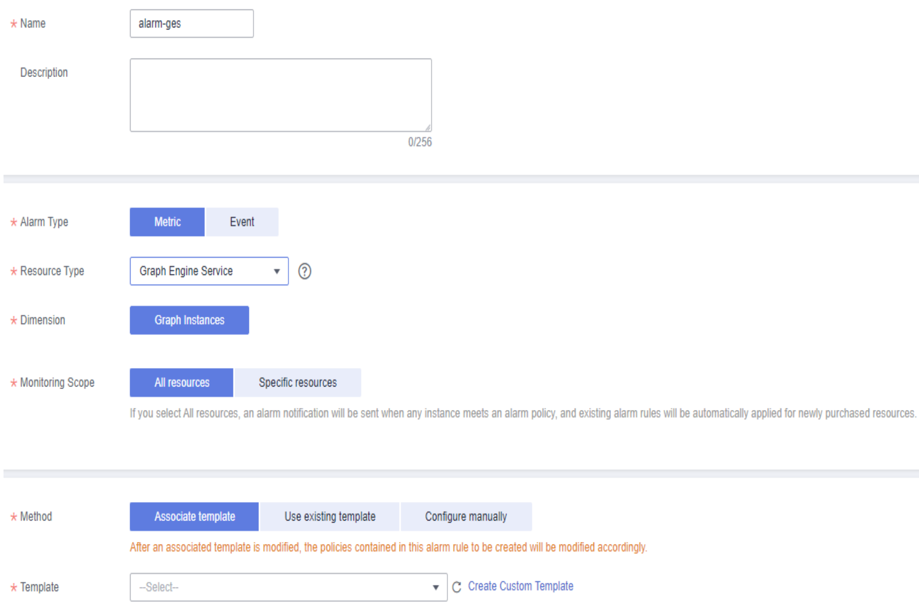


Table 9-4 Alarm parameters

Parameter	Description	Example Value
Alarm Type	Alarm type the alarm rule applies to. The value can be **Metric** or **Event**.	Metric
Resource Type	Name of the cloud service the alarm rule is created for	Graph Engine Service
Dimension	Metric dimension of the selected resource type. Select **Graph Instance**.	Graph Instance
Monitoring Scope	Resource scope the alarm rule applies to. Select **Specified resources** and select one or more monitored objects. Click **Select Specific Resources** and select the cluster instance you have created.	Specific resources

Parameter	Description	Example Value
Method	You can create an alarm rule by using the template or manually creating it. ● If no alarm template is available, set **Method** to **Create manually** and configure related parameters to create an alarm rule. ● If you have available alarm rule templates, set **Method** to **Use template**, so that you can use a template to quickly create alarm rules.	Create manually
Method	There are three options: **Associate template**, **Use existing template**, and **Configure manually**.	Associate template
Template	This parameter is available only when **Use template** is selected. Select the template to be used. If no alarm template is available, click **Create Custom Template** to create one that meets your requirements.	-
Alarm Policy	This parameter is available only when **Configure manually** is selected for **Method**. Set the policy that triggers an alarm. For example, trigger an alarm if the CPU usage equals to or is greater than 80% for 3 consecutive periods. For details about GES monitoring metrics, see **Monitoring Metrics**.	-
Alarm Severity	Alarm severity, which can be **Critical**, **Major**, **Minor**, or **Informational**.	Major

b. Configure the alarm notification parameters as prompted.

Figure 9-17 Setting alarm notification parameters

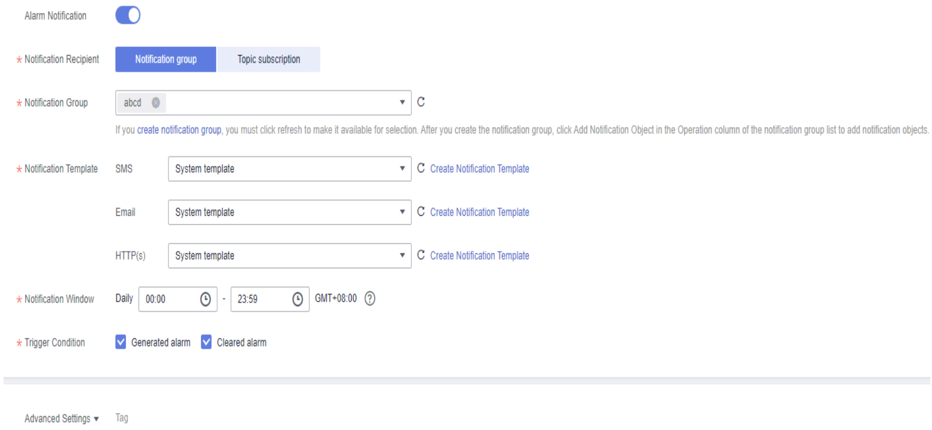


Table 9-5 Alarm notification parameters

Parameter	Description	Example Value
Alarm Notification	Whether to send email, SMS, HTTP, or HTTPS notifications to users when an alarm is triggered You can enable (recommended) or disable this function.	Enable this function
Notification Recipient	You can select **Notification group** or **Topic subscription**.	Topic subscription
Notification Object	This parameter is mandatory when **Notification Recipient** is set to **Topic subscription**. Name of the topic the alarm notification is to be sent to. If you have enabled **Alarm Notification**, select a topic. If no desirable topics are available, create one first, whereupon the SMN service is invoked. For details about how to create a topic, see .	SMN topic
Notification Group	This parameter is mandatory when **Notification Recipient** is set to **Notification group**. You can select or create a notification group. After creating a notification group, you need to click **Add Notification Recipient** in the **Operation** column of the notification group list to add group members and notification methods.	Notification group name

Parameter	Description	Example Value
Notification Template	You can select a system template or create a custom notification template.	System template
Notification Window	Notifications are sent only within the notification window specified in the alarm rule. For example, if **Notification Window** is set to **00:00–08:00**, Cloud Eye sends notifications only within this period.	-
Trigger Condition	Condition for triggering the alarm notification. You can select **Generated alarm** (when an alarm is generated), **Cleared alarm** (when an alarm is cleared), or both.	-

5. Click **Create**. After the alarm rule is created, if the metric data reaches the specified threshold, Cloud Eye will immediately inform you that an exception has occurred.

Transferring Data to OBS

On Cloud Eye, raw metric data is only stored for two days. However, if you subscribe to OBS, you can synchronize the raw data and extend the storage period.

10 Algorithms

10.1 Algorithm List

To meet the requirements of various scenarios, GES provides extensive basic graph algorithms, graph analytics algorithms, and graph metrics algorithms. The following table lists the algorithms:

Table 10-1 Algorithm List

Algorithm	Description
PageRank	PageRank, also known as web page ranking, is a hyperlink analysis algorithm used to rank web pages (nodes) based on their search engine results. PageRank is a way of measuring the relevance and importance of web pages (nodes).
PersonalRank	PersonalRank is also called Personalized PageRank. It inherits the idea of the classic PageRank algorithm and uses the graph link structure to recursively calculate the importance of each node. However, unlike the PageRank algorithm, to ensure that the access probability of each node in the random walk can reflect user preferences, the PersonalRank algorithm returns each hop to the source node at a **(1-alpha)** probability during random walk. Therefore, the relevance and importance of network nodes can be calculated based on the source node (the higher the PersonalRank value, the higher the correlation/importance of the source node).
K-core	K-core is a classic graph algorithm used to calculate the number of cores of each node. The calculation result is one of the most commonly used reference values for determining the importance of a node so that the propagation capability of the node can be better understood.

Algorithm	Description
K-hop	K-hop is an algorithm used to search all nodes in the k layer that are associated with the source node through breadth-first search (BFS). The found sub-graph is the source node's ego-net. The K-hop algorithm returns the number of nodes in the ego-net.
Shortest Path	The Shortest Path algorithm is used to find the shortest path between two nodes in a graph.
All Shortest Paths	The All Shortest Paths algorithm is used to find all shortest paths between two nodes in a graph.
Filtered Shortest Path	This algorithm searches for the shortest path that meets the filter criteria between vertices. If there are multiple shortest paths, any one of them is returned.
SSSP	The SSSP algorithm finds the shortest paths from a specified node (source node) to all other nodes.
Shortest Path of Vertex Sets	The Shortest Path of Vertex Sets algorithm finds the shortest path between two vertex sets. It can be used to analyze the relationships between blocks in scenarios such as Internet social networking, financial risk control, road network transportation, and logistics delivery.
n-Paths	The n-Paths algorithm is used to find the *n* paths between two vertices on the k layer of a graph. It applies to scenarios such as relationship analysis, path design, and network planning.
Closeness Centrality	Closeness centrality is the average distance from a node to all other reachable nodes. It can be used to measure the time for transmitting information from this node to other nodes. A small **Closeness Centrality** within a node corresponds to a central location of the node.
Label Propagation	The Label Propagation algorithm is a graph-based semi-supervised learning method. Its basic principle is to predict the label information about unlabeled nodes using that of the labeled nodes. This algorithm can create graphs based on the relationships between samples. Nodes include labeled data and unlabeled data, and the edge indicates the similarity between two nodes. Node labels are transferred to other nodes based on the similarity. Labeled data is like a source used to label unlabeled data. Greater node similarity corresponds to an easier label propagation.
Louvain	Louvain is a modularity-based community detection algorithm with high efficiency and effect. It detects hierarchical community structures and aims to maximize the modularity of the entire community network.

Algorithm	Description
Link Prediction	This algorithm is used to calculate the similarity between two nodes and predict their relationship based on the Jaccard measurement method.
Node2vec	By invoking the Word2vec algorithm, the Node2vec algorithm maps nodes in the network to the Euclidean space, and uses vectors to represent the node characteristics. The Node2vec algorithm generates random steps from each node using the rollback parameter **P** and forward parameter **Q**. It combines BFS and DFS. The rollback probability is proportional to 1/P, and the forward probability is proportional to 1/Q. Multiple random steps are generated to reflect the network structures.
Real-time Recommenda tion	The Real-time Recommendation algorithm is based on the random walk model and is used to recommend nodes that are similar (have similar relationships or preferences) to the input node. This algorithm can be used to recommend similar products based on historical browsing data or recommend potential friends with similar preferences.
Common Neighbors	Common Neighbors is a basic graph analysis algorithm that obtains the neighboring nodes shared by two nodes and further speculate the potential relationship and similarity between the two nodes. For example, it can intuitively discover shared friends in social occasions or products that interest both nodes in the consumption field.
Connected Component	A connected component stands for a sub-graph, in which all nodes are connected with each other. Path directions are involved in the strongly connected components and are not considered in the weakly connected components. **NOTE** This algorithm generates weakly connected components.
Degree Correlation	The Degree Correlation algorithm calculates the Pearson correlation coefficient between the source vertex degree and the target vertex degree of each edge. It is used to indicate whether the high-degree nodes are connected to other high-degree nodes in a graph.
Triangle Count	The Triangle Count algorithm counts the number of triangles in a graph without considering the edge directions. More triangles mean higher node association degrees and closer organization relationships.
Clustering Coefficient	The clustering coefficient is a measure of the degree to which nodes in a graph tend to cluster together. Evidence suggests that in most real-world networks, and in particular social networks, nodes tend to create tightly knit groups characterized by a relatively high density of ties.

Algorithm	Description
Betweenness Centrality	Betweenness centrality is a measure of centrality in a graph based on shortest paths. The Betweenness Centrality algorithm calculates shortest paths that pass through a vertex.
Edge Betweenness Centrality	The Edge Betweenness Centrality algorithm calculates shortest paths that pass through an edge.
Origin-Destination Betweenness Centrality	The Origin-Destination Betweenness Centrality algorithm calculates shortest paths that pass through a (an) vertex/edge, with the origin and destination specified.
Circle Detection with a Single Vertex	This algorithm solves a classic graph problem: detecting loops in a graph. Vertices on looped paths reflect the importance of the vertices. This algorithm is suitable for transportation analysis and financial risk control.
Common Neighbors of Vertex Sets	This algorithm obtains vertex set neighbors, that are, the intersection of two vertex sets (groups). They are objects that are associated with both sets, for example, common friends, common products of interest, and persons contacting with both communities. You can use neighbors to further speculate potential relationships and the degree of the connection between two vertices.
All Shortest Paths of Vertex Sets	This algorithm is used to discover all shortest paths between two vertex sets. It can be used to analyze the relationships between blocks in scenarios such as social networking, financial risk control, road networks and transportation, and logistics delivery.
Filtered Circle Detection	This algorithm searches for all circles that meet a specified filter criteria in the graph. It is applicable to scenarios such as detecting round-trip transfers and anti-money laundering for financial risk control, locating abnormal links in network routes, and risk identification in enterprise finance guarantee.
Subgraph Matching	This algorithm is used to find all subgraphs of a given small graph that is isomorphic to a given large graph. This is a basic graph query operation and is intended to explore important substructures of a graph.
Filtered All Pairs Shortest Paths	This algorithm is used to search for the shortest path between any two vertices in the graph that meets the condition. In a specific application scenario, you need to set a start vertex set (**sources**) and end vertex set (**targets**) as input for this algorithm. This algorithm returns the required shortest paths between the start and the end vertex sets.
Filtered All Shortest Paths	This algorithm allows you to search query results of the Shortest Path algorithm for the paths that meet the conditions between two vertices in a graph.

Algorithm	Description
TopicRank	The TopicRank algorithm is one of commonly used algorithms for ranking topics by multiple dimensions. For example, this algorithm is applicable to rank complaint topics obtained through a government hotline.
Filtered n-Paths	The filtered n-Paths algorithm is used to find no more than n k-hop loop-free paths between the source and target vertices. The start vertex (source), end vertex (target), number of hops (k), number of paths (n), and filter criteria (filters) are the parameters for the algorithm.
Temporal Paths	Different from path analysis on static graphs, the Temporal Paths algorithm combines the order of information transmission on dynamic graphs. The passing time of an edge on a path must be later than or the same as that of the previous edge, showing the increment (or non-decrement) of time.

10.2 PageRank

Overview

PageRank, also known as web page ranking, is a hyperlink analysis algorithm used to rank web pages (nodes) based on their search engine results. PageRank is a way of measuring the relevance and importance of web pages (nodes).

- If a web page is linked to many other web pages, the web page is of great importance. That is, the PageRank value is relatively high.
- If a web page with a high PageRank value is linked to another web page, the PageRank value of the linked web page increases accordingly.

Application Scenarios

This algorithm applies to scenarios such as web page sorting and key role discovery in social networking.

Parameter Description

Table 10-2 PageRank algorithm parameters

Parameter	Mandatory	Description	Type	Value Range	Default Value
alpha	No	Weight coefficient (also called damping coefficient)	Double	A real number between 0 and 1 (excluding 0 and 1)	0.85

Parameter	Mandatory	Description	Type	Value Range	Default Value
convergence	No	Convergence	Double	A real number between 0 and 1 (excluding 0 and 1)	0.00001
max_iterations	No	Maximum iterations	Int	1-2,000	1000
directed	No	Whether an edge is directed	Bool	**true** or **false**	true

NOTE

- **alpha** determines the jump probability coefficient, also called damping coefficient, which is a computing control variable in the algorithm.
- **convergence** indicates the upper limit of the sum of each absolute vertex change between an iteration and the last iteration. If the sum is less than the value of this parameter, the computing is considered converged and the algorithm stops.
- When the convergence is set to a large value, the iteration will stop quickly.

Precautions

When the convergence is set to a large value, the iteration will stop quickly.

Example

Select the algorithm in the algorithm area of the graph engine editor. For details, see **Analyzing Graphs Using Algorithms**.

Set parameters **alpha** to **0.85**, **coverage** to **0.00001**, **max_iterations** to **1,000**, and **directed** to **true**. The sub-graph formed by top nodes in the calculation result is displayed on the canvas. The size of a node varies with the PageRank values. The JSON result is displayed in the query result area.

10.3 PersonalRank

Overview

PersonalRank is also called Personalized PageRank. It inherits the idea of the classic PageRank algorithm and uses the graph link structure to recursively calculate the importance of each node. However, unlike the PageRank algorithm, to ensure that the access probability of each node in the random walk can reflect user preferences, the PersonalRank algorithm returns each hop to the source node at a **(1-alpha)** probability during random walk. Therefore, the relevance and importance of network nodes can be calculated based on the source node. (The higher the PersonalRank value, the higher the correlation/importance of the source node.)

Application Scenarios

This algorithm applies to fields such as product, friend, and web page recommendations.

Parameter Description

Table 10-3 PersonalRank algorithm parameters

Parameter	Mandatory	Description	Type	Value Range	Default Value
source	Yes	Node ID	String	-	-
alpha	No	Weight coefficient	Double	A real number between 0 and 1 (excluding 0 and 1)	0.85
convergence	No	Convergence	Double	A real number between 0 and 1 (excluding 0 and 1)	0.00001
max_iterations	No	Maximum iterations	Int	1-2,000	1000
directed	No	Whether an edge is directed	Bool	**true** or **false**	true

NOTE

- **alpha** determines the jump probability coefficient, also called damping coefficient, which is a computing control variable in the algorithm.
- **convergence** defines the sum and upper limit of absolute values of each vertex in each iteration compared with the last iteration. If the sum is less than the value, the computing is considered to be converged and the algorithm stops.

Precautions

When the convergence is set to a large value, the iteration will stop quickly.

Example

Select the algorithm in the algorithm area of the graph engine editor. For details, see **Analyzing Graphs Using Algorithms**.

Set **source** to **Lee**, **alpha** to **0.85**, **convergence** to **0.00001**, **max_iterations** to **1000**, and **directed** to **true**. The sub-graph formed by top nodes in the calculation result is displayed on the canvas. The size of a node varies with the PersonalRank values. The JSON result is displayed in the query result area.

10.4 K-core

Overview

K-core is a classic graph algorithm used to calculate the number of cores of each node. The calculation result is one of the most commonly used reference values for determining the importance of a node so that the propagation capability of the node can be better understood.

Application Scenarios

This algorithm applies to scenarios such as community discovery and finance risk control.

Parameter Description

Table 10-4 K-core algorithm parameters

Parameter	Mandatory	Description	Type	Value Range	Default Value
k	Yes	Number of cores The algorithm returns nodes whose number of cores is greater than or equal to k.	Int	Greater than or equal to 0	-

Precautions

None

Example

Set parameter **k** to **10**. The sub-graph formed by nodes whose number of cores is greater than or equal to 10 in the calculation result is displayed on the canvas. The color of a node varies with the number of cores. The JSON result is displayed in the query result area.

10.5 K-hop

Overview

K-hop is an algorithm used to search all nodes in the k layer that are associated with the source node through breadth-first search (BFS). The found sub-graph is the source node's **ego-net**. The K-hop algorithm returns the number of nodes in the ego-net.

Application Scenarios

This algorithm applies to scenarios such as relationship discovery, influence prediction, and friend recommendation.

Parameter Description

Table 10-5 K-hop algorithm parameters

Parameter	Mandatory	Description	Type	Value Range	Default Value
k	Yes	Number of hops	Integer	1-100	-
source	Yes	Node ID	String	-	-
mode	No	Direction: ● OUT: Hop from the outgoing edges. ● IN: Hop from the incoming edges. ● All: Hop from edges in both directions.	String	OUT, IN, ALL	OUT

Precautions

- A larger k value indicates a wider node coverage area.
- According to the six degrees of separation theory, all people in social networks will be covered after six hops.
- BFS searches information based on edges.

Example

Select the algorithm in the algorithm area of the graph engine editor. For details, see **Analyzing Graphs Using Algorithms**.

Calculate the sub-graph formed by the three hops starting from the Lee node.

Set parameters **k** to **3**, **source** to **Lee**, and **mode** to **OUT**. The sub-graph is displayed on the canvas, and the JSON result is displayed in the query result area.

10.6 Shortest Path

Overview

The Shortest Path algorithm is used to find the shortest path between two nodes in a graph.

Application Scenarios

This algorithm applies to scenarios such as path design and network planning.

Parameter Description

Table 10-6 Shortest Paths algorithm parameters

Parameter	Mandatory	Description	Type	Value Range	Default Value
source	Yes	Enter the source ID of a path.	String	-	-
target	Yes	Enter the target ID of a path.	String	-	-
directed	No	Whether an edge is directed	Bool	**true** or **false**	false
weight	No	Weight of an edge	String	Empty or null character string ● Empty: The default weight and distance are **1**. ● Character string: The attribute of the corresponding edge is the weight. When the edge does not have corresponding attribute, the weight is **1** by default. **NOTE** The weight of an edge must be greater than **0**.	-

Parameter	Mandatory	Description	Type	Value Range	Default Value
timeWindow	No	Time window used for time filtering	Json	For details, see **Table 10-7**. **NOTE** **timeWindow** does not support the shortest path with weight. That is, parameters **timeWindow** and **weight** cannot be both specified.	-

Table 10-7 timeWindow parameters

Parameter	Mandatory	Description	Type	Value Range	Default Value
filterName	Yes	Name of the time attribute used for time filtering	String	Character string: The attribute on the corresponding vertex/ edge is used as the time.	-
filterType	No	Filtering by vertex or edge	String	V: Filtering by vertex E: Filtering by edge BOTH: Filtering by vertex and edge	BOTH
startTime	No	Start time	String	Date character string or timestamp	-
endTime	No	End time	String	Date character string or timestamp	-

Precautions

This algorithm only returns one shortest path.

Example

Calculate the shortest path from the Lee node to the Alice node.

Set parameters **source** to **Lee**, **target** to **Alice**, **weight** to **weights**, and **directed** to **false**. The shortest path is displayed on the canvas, and the JSON result is displayed in the result area.

10.7 All Shortest Paths

Overview

The All Shortest Paths algorithm is used to find all shortest paths between two nodes in a graph.

Application Scenarios

This algorithm applies to scenarios such as path design and network planning.

Parameter Description

Table 10-8 All Shortest Paths algorithm parameters

Parameter	Mandatory	Description	Type	Value Range	Default Value
source	Yes	Enter the source ID of a path.	String	-	-
target	Yes	Enter the target ID of a path.	String	-	-
directed	No	Whether an edge is directed	Bool	**true** or **false**	false

Precautions

None

Example

Set parameters **source** to **Lee**, **target** to **Alice**, and **directed** to **false**. The calculation result is displayed on the canvas and the JSON result is displayed in the query result area.

10.8 Filtered Shortest Path

Overview

The Filtered Shortest Path algorithm is used to search for the shortest path that meets the filtering criteria between two vertices. If there are multiple shortest paths, any one of them is returned.

Application Scenarios

This algorithm applies to path design and network planning. It generates the shortest path based on vertex and edge filtering criteria.

Parameter Description

Table 10-9 Filtered Shortest Path algorithm parameters

Parameter	Mandatory	Type	Description
source	Yes	String	Enter the source vertex ID of a path.
target	Yes	String	Enter the target vertex ID of a path.
directed	No	Boolean	Whether to consider the edge direction The default value is **false**.

Precautions

This algorithm only returns one shortest path.

10.9 SSSP

Overview

The SSSP algorithm finds the shortest paths from a specified node (source node) to all other nodes.

Application Scenarios

This algorithm applies to scenarios such as path design and network planning.

Parameter Description

Table 10-10 SSSP algorithm parameters

Parameter	Mandatory	Description	Type	Value Range	Default Value
source	Yes	Node ID	String	-	-
directed	No	Whether to consider the edge direction	Bool	**true** or **false**	true

Example

Calculate the shortest paths from the Lee node to other nodes.

Set parameters **source** to **Lee** and **directed** to **true**.

10.10 Shortest Path of Vertex Sets

Overview

The Shortest Path of Vertex Sets algorithm finds the shortest path between two vertex sets.

Application Scenarios

This algorithm applies to block relationship analysis in Internet social networking, financial risk control, road network transportation, and logistics delivery scenarios.

Parameter Description

Table 10-11 Shortest Path of Vertex Sets algorithm parameters

Parameter	Mandatory	Description	Type	Value Range	Default Value
sources	Yes	Source vertex ID set	String	The value is in the standard CSV format. IDs are separated by commas (,), for example, **Alice, Nana**. The maximum ID number is 100,000.	-
targets	Yes	Target vertex ID set	String	The value is in the standard CSV format. IDs are separated by commas (,), for example, **Alice, Nana**. The maximum ID number is 100,000.	-
directed	No	Whether an edge is directed	Bool	**true** or **false**	false
timeWindow	No	Time window used for time filtering	Json	For details, see **Table 10-12**.	-

Table 10-12 timeWindow parameters

Parameter	Mandatory	Description	Type	Value Range	Default Value
filterName	No	Name of the time attribute used for time filtering	String	Character string: The attribute on the corresponding vertex/ edge is used as the time.	-
filterType	No	Filtering by vertex or edge	String	V: Filtering by vertex E: Filtering by edge BOTH: Filtering by vertex and edge	BOTH
startTime	No	Start time	String	Date character string or timestamp	-
endTime	No	End time	String	Date character string or timestamp	-

NOTE

If a vertex ID contains commas (,), add double quotation marks to it. For example, when **Paris, je taime** and **Alice** IDs are used as sources, the ID set is **"Paris, je taime",Alice"**.

Example

Set parameters **directed** to **true**, **sources** to **"Alice,Nana"**, and **targets** to **"Lily,Amy"**. The JSON result is displayed in the query result area.

10.11 n-Paths

Overview

The n-Paths algorithm is used to find the *n* paths between two nodes within the layers of relationships in a graph.

Application Scenarios

This algorithm applies to scenarios such as relationship analysis, path design, and network planning.

Parameter Description

Table 10-13 n-Paths algorithm parameters

Parameter	Mandatory	Description	Type	Value Range	Default Value
source	Yes	Enter the source ID of a path.	String	-	-
target	Yes	Enter the target ID of a path.	String	-	-
directed	No	Whether an edge is directed	Bool	**true** or **false**	false
n	No	Number of paths	Int	1-100	10
k	No	Number of hops	Int	1-10	5

Example

Set parameters **source** to **Lee**, **target** to **Alice**, **n** to **10**, **k** to **5**, and **directed** to **false**. The calculation result is displayed on the canvas and the JSON result is displayed in the query result area.

10.12 Closeness Centrality

Overview

Closeness centrality of a node is a measure of centrality in a network, calculated as the reciprocal of the sum of the length of the shortest paths between the node and all other reachable nodes in a graph. It can be used to measure the time for transmitting information from this node to other nodes. The bigger the node's **Closeness Centrality** is, the more central the location of the node will be.

Application Scenarios

This algorithm is used in key node mining in social networking.

Parameter Description

Table 10-14 Closeness Centrality algorithm parameters

Parameter	Mandatory	Description	Type	Value Range	Default Value
source	Yes	Enter the ID of the node to be calculated.	String	-	-

Example

Set parameter **source** to **Lee** to calculate the closeness centrality of the Lee node. The JSON result is displayed in the query result area.

10.13 Label Propagation

Overview

The Label Propagation algorithm is a graph-based semi-supervised learning method. Its basic principle is to predict the label information about unlabeled nodes using that of the labeled nodes. This algorithm can create graphs based on the relationships between samples. Nodes include labeled data and unlabeled data, and the edge indicates the similarity between two nodes. Node labels are transferred to other nodes based on the similarity. Labeled data is like a source used to label unlabeled data. The greater the node similarity is, the easier the label propagation will be.

Application Scenarios

This algorithm applies to scenarios such as information propagation, advertisement recommendation, and community discovery.

Parameter Description

Table 10-15 Label Propagation algorithm parameters

Parameter	Mandatory	Description	Type	Value Range	Default Value
convergence	No	Convergence	Double	A real number between 0 and 1 (excluding 0 and 1)	0.00001
max_iterations	No	Maximum iterations	Int	1-2,000	1,000

Parameter	Mandatory	Description	Type	Value Range	Default Value
initial	No	Name of the property used as the initialization label on a vertex	String	Null or character string ● Null: Each vertex is allocated with a unique initialization label. This method is applicable to scenarios where no vertex label information exists. ● Character string: The value of the property field corresponding to each vertex is used as the initialization label (the type is string, and the initialization label field is set to null for a vertex with unknown labels). This method is applicable to scenarios where some vertex labels are marked to predict unknown vertex labels.	-

Parameter	Mandatory	Description	Type	Value Range	Default Value
				NOTE If the value of **initial** is not null, the number of vertices with initialization labels must be greater than 0 and less than the total number of vertices.	

Precautions

Label Propagation uses IDs as labels by default.

Example

Set parameters **coverage** to **0.00001** and **max_iterations** to **1,000**, the sub-graphs with different labels are displayed on the canvas. The color of a node varies with labels. The JSON result is displayed in the query result area.

10.14 Louvain

Overview

Louvain is a modularity-based community detection algorithm with high efficiency and effect. It detects hierarchical community structures and aims to maximize the modularity of the entire community network.

Application Scenarios

This algorithm applies to scenarios such as community mining and hierarchical clustering.

Parameter Description

Table 10-16 Louvain algorithm parameters

Parameter	Mandatory	Description	Type	Value Range	Default Value
convergence	No	Convergence	Double	A real number between 0 and 1 (excluding 0 and 1)	0.00001

Parameter	Mandatory	Description	Type	Value Range	Default Value
max_iterations	No	Maximum iterations	Int	1-2,000	100
weight	No	Weight of an edge	String	Empty or null character string ● Empty: The default weight and distance are **1**. ● Character string: The attribute of the corresponding edge is the weight. When the edge does not have corresponding attribute, the weight is **1** by default. **NOTE** The weight of an edge must be greater than **0**.	weight

Precautions

This algorithm generates only the final community result and does not save the hierarchical results.

Example

Set parameters **coverage** to **0.00001** and **max_iterations** to **100**, the sub-graphs of different communities are displayed on the canvas. The color of a node varies with communities. The JSON result is displayed in the query result area.

10.15 Link Prediction

Overview

This algorithm is used to calculate the similarity between two nodes and predict their relationship based on the Jaccard measurement method.

Application Scenarios

This algorithm applies to scenarios such as friend recommendation and relationship prediction in social networks.

Parameter Description

Table 10-17 Link Prediction algorithm parameters

Parameter	Mandatory	Description	Type	Value Range	Default Value
source	Yes	Enter the source ID.	String	-	-
target	Yes	Enter the target ID.	String	-	-

Example

Set parameters **source** to **Lee** and **target** to **Alice** to calculate the association between two nodes. The JSON result is displayed in the query result area.

10.16 Node2vec

Overview

By invoking the Word2vec algorithm, the Node2vec algorithm maps nodes in the network to the Euclidean space, and uses vectors to represent the node characteristics.

The Node2vec algorithm generates random steps from each node using the rollback parameter **P** and forward parameter **Q**. It combines BFS and DFS. The rollback probability is proportional to 1/P, and the forward probability is proportional to 1/Q. Multiple random steps are generated to reflect the network structures.

Application Scenarios

This algorithm applies to scenarios such as node function similarity comparison, structural similarity comparison, and community clustering.

Parameter Description

Table 10-18 Node2vec algorithm parameters

Parameter	Mandatory	Description	Type	Value Range	Default Value
P	No	Rollback parameter	Double	-	1
Q	No	Forward parameter	Double	-	1
dim	No	Mapping dimension	Int	1 to 200, including 1 and 200	50
walkLength	No	Random walk length	Int	1 to 100, including 1 and 100	40
walkNumber	No	Number of random walk steps of each node.	Int	1 to 100, including 1 and 100	10
iterations	No	Number of iterations	Int	1 to 100, including 1 and 100	10

Precautions

None

Example

Set parameters **P** to **1**, **Q** to **0.3**, **dim** to **3**, **walkLength** to **20**, **walkNumber** to **10**, and **iterations** to **40** to obtain the three-dimensional vector display of each node.

10.17 Real-time Recommendation

Overview

The Real-time Recommendation algorithm is based on the random walk model and is used to recommend nodes that are similar (have similar relationships or preferences) to the input node.

Application Scenarios

This algorithm can be used to recommend similar products based on historical browsing data or recommend potential friends with similar preferences.

It is applicable to scenarios such as e-commerce and social networking.

Parameter Description

Table 10-19 Real-time Recommendation algorithm parameters

Parameter	Mandatory	Description	Type	Value Range	Default Value
sources	Yes	Node ID. Multiple node IDs separated by commas (,) are supported (standard CSV input format).	String	The number of source nodes cannot exceed 30.	-
alpha	No	Weight coefficient. A larger value indicates a longer step.	Double	A real number between 0 and 1 (excluding 0 and 1)	0.85
N	No	Total number of walk steps	Int	1-200,000	10,000
nv	No	Parameter indicating that the walk process ends ahead of schedule: minimum number of access times of a potential recommended node **NOTE** If a node is accessed during random walk and the number of access times reaches **nv**, the node will be recorded as the potential recommended node.	Int	1-10	5
np	No	Parameter indicating that the walk process ends ahead of schedule: number of potential recommended nodes **NOTE** If the number of potential recommended nodes of a source node reaches **np**, the random walk for the source node ends ahead of schedule.	Int	1-2,000	1000

Parameter	Mandatory	Description	Type	Value Range	Default Value
label	No	Expected type of the vertex to be output. **NOTE** ● Expected type of the vertex to be output. If the value is null, the original calculation result of the algorithm is output without considering the vertex type. ● If the value is not null, vertices with the **label** are filtered from the calculation result.	String	Node label	-
directed	No	Whether to consider the edge direction	Bool	**true** or **false**	true

NOTE

alpha determines the jump probability coefficient, also called damping coefficient, which is a computing control variable in the algorithm.

Precautions

In the end conditions, the smaller the values of **nv** and **np**, the faster the algorithm ends.

Example

Set parameters **sources** to **Lee**, **alpha** to **0.85**, **N** to **10,000**, **nv** to **5**, **np** to **1,000**, **directed** to **true**, and **label** to null.

The sub-graph formed by top nodes in the calculation result is displayed on the canvas. The size of a node varies with the final scores. The JSON result is displayed in the query result area.

10.18 Common Neighbors

Overview

Common Neighbors is a basic graph analysis algorithm that obtains the neighboring nodes shared by two nodes and further speculate the potential relationship and similarity between the two nodes. For example, it can intuitively discover shared friends in social occasions or products that interest both nodes in the consumption field.

Application Scenarios

This algorithm applies to scenarios such as e-commerce and social networking.

Parameter Description

Table 10-20 Common Neighbors algorithm parameters

Parameter	Mandatory	Description	Type	Value Range	Default Value
source	Yes	Enter the source ID.	String	-	-
target	Yes	Enter the target ID.	String	-	-

Precautions

None

Example

Set parameters **source** to **Lee** and **target** to **Alice**. The calculation result is displayed on the canvas and the JSON result is displayed in the query result area.

10.19 Connected Component

Overview

A connected component stands for a sub-graph, in which all nodes are connected with each other. Path directions are involved in the strongly connected components and are not considered in the weakly connected components. This algorithm generates weakly connected components.

Parameter Description

None

Example

Run the algorithm to calculate the connected component to which each node belongs. The JSON result is displayed in the query result area.

10.20 Degree Correlation

Overview

The Degree Correlation algorithm calculates the Pearson correlation coefficient between the source vertex degree and the target vertex degree of each edge. It is used to indicate whether the high-degree nodes are connected to other high-degree nodes in a graph.

Application Scenarios

This algorithm is often used to measure the structure features of a graph.

Parameter Description

None

Example

Run the algorithm to calculate the degree correlation of a graph. The JSON result is displayed in the query result area.

10.21 Triangle Count

Overview

The Triangle Count algorithm counts the number of triangles in a graph. More triangles mean higher node association degrees and closer organization relationships.

Application Scenarios

This algorithm is often used to measure the structure features of a graph.

Parameter Description

Parameter	Mandatory	Description	Type	Value Range
statistics	No	Whether to export only the total statistical result. ● **true**: Export only the statistical result. ● **false**: Export the number of triangles corresponding to each vertex.	Boolean	**true** or **false**. The default value is **true**.

Instructions

The edge direction and multi-edge situation are not considered.

Example

Enter **statistics = true**. The JSON result is displayed in the query result area.

10.22 Clustering Coefficient

Overview

The clustering coefficient is a measure of the degree to which nodes in a graph tend to cluster together. Evidence suggests that in most real-world networks, and in particular social networks, nodes tend to create tightly knit groups characterized by a relatively high density of ties. This algorithm is used to calculate the aggregation degree of nodes in a graph.

Application Scenarios

This algorithm is often used to measure the structure features of a graph.

Parameter Description

None

Instructions

The multi-edge situation is not considered.

Example

Run the algorithm to calculate the clustering coefficient of a graph. The JSON result is displayed in the query result area.

10.23 Betweenness Centrality

Overview

Betweenness centrality is a measure of centrality in a graph based on shortest paths. This algorithm calculates shortest paths that pass through a vertex.

Application Scenarios

The Betweenness Centrality algorithm can be used for tracing man-in-the-middle in social networks and risk control networks and identifying key vertices in transportation networks. This algorithm is widely used for social networking, financial risk control, transportation networking, and city planning.

Parameter Description

Table 10-21 Algorithm parameters

Parameter	Mandatory	Description	Type	Value Range	Default Value
directed	No	Whether an edge is directed	Boolean	The value can be **true** or **false**.	true
weight	No	Weight of an edge	String	The value can be an empty string. If this parameter is left blank, the weight and distance of this edge are **1** by default. You can set this parameter to a property of the edge, and the property value will be the weight. If the edge does not have the specified property, the weight is **1** by default. **NOTE** The weight of an edge must be greater than **0**.	-
seeds	No	Vertex ID	String	If the graph is large, betweenness calculation can be slow. You can set **seeds** to the sampling nodes for approximate calculation. The more **seeds** nodes, the closer results to the accurate calculation. The number of vertices cannot be greater than 100,000.	-
k	No	Number of samples	Integer	If the graph is large, betweenness calculation can be slow. You can set **k** to randomly select k sampling vertices from the graph. The larger value, the closer results to the accurate calculation. The value cannot be greater than 100,000.	-

NOTE

When you perform approximate betweenness calculation, either **seeds** or **k** must be specified. If both are specified, **seeds** vertices will be sampled by default and **k** will be ignored.

Precautions

None

Example

Set **weight="length"**, **directed=true**, **seeds ="Lee,Alice"** and view the result.

10.24 Edge Betweenness Centrality

Overview

The Edge Betweenness Centrality algorithm calculates shortest paths that pass through an edge.

Application Scenarios

The Edge Betweenness Centrality algorithm can be used for key relationship mining. It is applicable to social networking, financial risk control, transportation networking, and city planning.

Parameter Description

Table 10-22 Algorithm parameters

Parameter	Mandatory	Description	Type	Value Range	Default Value
directed	No	Whether an edge is directed	Boolean	The value can be **true** or **false**.	true

Parameter	Mandatory	Description	Type	Value Range	Default Value
weight	No	Weight of an edge	String	The value can be an empty string. If this parameter is left blank, the weight and distance of this edge are **1** by default. You can set this parameter to a property of the edge, and the property value will be the weight. If the edge does not have the specified property, the weight is **1** by default. **NOTE** The weight of an edge must be greater than **0**.	-
seeds	No	Vertex ID	String	If the graph is large, betweenness calculation can be slow. You can set **seeds** to the sampling nodes for approximate calculation. The more **seeds** nodes, the closer results to the accurate calculation. The number of vertices cannot be greater than 100,000.	-
k	No	Number of samples	Integer	If the graph is large, betweenness calculation can be slow. You can set **k** to randomly select k sampling vertices from the graph. The larger value, the closer results to the accurate calculation. The value cannot be greater than 100,000.	-

NOTE

When you perform approximate edge-betweenness calculation, either **seeds** or **k** must be specified. If both are specified, **seeds** vertices will be sampled by default and **k** will be ignored.

Precautions

None

Example

Set **weight="length"**, **directed=true**, **seeds ="Lee,Alice"** and view the result.

10.25 Origin-Destination Betweenness Centrality

Overview

The Origin-Destination Betweenness Centrality algorithm calculates shortest paths that pass through a vertex/edge, with the origin and destination (OD) specified.

Application Scenarios

OD Betweenness Centrality can be used for tracing man-in-the-middle in social networks and risk control networks and identifying key vertices in transportation networks. It is suitable for simulating busy transportation sections during peak hours. It is also widely used for social networking, financial risk control, transportation networking, and city planning.

Parameter Description

Table 10-23 Algorithm parameters

Parameter	Mandatory	Description	Type	Value Range	Default Value
directed	No	Whether an edge is directed	Boolean	The value can be **true** or **false**.	true
weight	No	Weight of an edge	String	The value can be an empty string. If this parameter is left blank, the weight and distance of this edge are **1** by default. You can set this parameter to a property of the edge, and the property value will be the weight. If the edge does not have the specified property, the weight is **1** by default. **NOTE** The weight of an edge must be greater than **0**.	-

Parameter	Mandatory	Description	Type	Value Range	Default Value
OD_pairs	No	Pairs of OD vertices	String	The value must be in the standard CSV format. The start vertex (origin) and end vertex (destination) are separated by commas (,), and the start and end vertex pairs are separated by newline characters (\n), for example, **Alice,Nana\nLily,Amy**.	-
seeds	No	ID of the hot spot vertex	String	Data that will be imported when the data of OD vertex pairs is unknown. The value is in the standard CSV format. IDs are separated by commas (,), for example, **Alice, Nana**. A maximum of 30 IDs are allowed.	-
modes	No	Hot spot vertex type	String	• **IN**: The hot spot vertex ID is used as the start vertex ID. • **OUT**: The hot spot vertex ID is used as the end vertex ID.	-
attendees	No	Number of participants at each hot spot in **seeds**	String	The value is in the standard CSV format. Numbers are separated by commas (,), for example, **10,20**. The value ranges from 1 to 1,000,000.	-

NOTE

When you perform approximate OD-Betweenness calculation, either **OD_pairs** or **seeds** must be specified. If both are specified, the **OD_pairs** vertices will be used for calculation by default and **seeds** will be ignored.

Precautions

None

Example

Ser **weight=length**, **directed=true**, **OD = Alice,Nana\nLily,Amy** and view the result.

10.26 Circle Detection with a Single Vertex

Overview

This algorithm solves a classic graph problem: detecting loops in a graph. The vertices on a loop (circle) are import.

Application Scenarios

This algorithm is widely used for transportation networking and financial risk control.

Parameter Description

Table 10-24 Algorithm parameters

Parameter	Mandatory	Description	Type	Value Range	Default Value
source	Yes	ID of the given vertex	String	-	-
min_circle_length	No	Minimum circle length	Int	[3,15]	3
max_circle_length	No	Maximum circle length. The value must be bigger than **min_circle_length**.	Int	[3,15]	10
limit_circle_number	No	Maximum number of circles you want to search for	Int	[1,100000]	100

10.27 Common Neighbors of Vertex Sets

Overview

The Common Neighbors of Vertex Sets algorithm can find common neighbors of two vertex sets, and intuitively discover an object jointly associated with both sets, for example, a common friend in a social occasion, a product that is of common interest, a person who has been contacted by community groups. In this way, the algorithm infers the potential relationship and degree of association between the vertex sets.

Application Scenarios

This algorithm applies to graph analysis such as relationship mining and product/friend recommendations.

Parameter Description

Table 10-25 Common Neighbors of Vertex Sets algorithm parameters

Parameter	Mandatory	Description	Type	Value Range	Default Value
sources	Yes	Source vertex ID set	String	The value is in the standard CSV format. IDs are separated by commas (,), for example, **Alice, Nana**. The maximum ID number is 100,000.	-
targets	Yes	Target vertex ID set	String	The value is in the standard CSV format. IDs are separated by commas (,), for example, **Alice, Nana**. The maximum ID number is 100,000.	-

Precautions

None

Example

Enter **sources=Alice,Nana** and **targets=Mike,Amy**. The calculation result is displayed on the canvas and the JSON result is displayed in the query result area.

10.28 All Shortest Paths of Vertex Sets

Overview

The Shortest Path of Vertex Sets algorithm finds the shortest path between vertex sets.

Application Scenarios

This algorithm can be used to analyze relationships between blocks in scenarios such as Internet social networking, financial risk control, road network traffic, and logistics delivery.

Parameter Description

Table 10-26 All Shortest Paths of Vertex Sets algorithm parameters

Parameter	Mandatory	Description	Type	Value Range	Default Value
sources	Yes	Source vertex ID set	String	The value is in the standard CSV format. IDs are separated by commas (,), for example, **Alice, Nana**. The maximum ID number is 100,000.	-
targets	Yes	Target vertex ID set	String	The value is in the standard CSV format. IDs are separated by commas (,), for example, **Alice, Nana**. The maximum ID number is 100,000.	-
directed	No	Whether to consider the edge direction	Boolean	**true** or **false**. It is a Boolean value.	false

Precautions

If a vertex ID contains commas (,), add double quotation marks to it. For example, when **Paris, je taime** and **Alice** IDs are used as sources, the ID set is **"Paris, je taime",Alice"**.

Example

Set parameters **directed** to **true**, **sources** to **"Alice,Nana"**, and **targets** to **"Lily,Amy"**. The JSON result is displayed in the query result area.

10.29 Filtered Circle Detection

Overview

The Filtered Circle Detection algorithm finds all circles that meet the filter criteria.

Application Scenarios

The Filtered Circle Detection algorithm is applicable to scenarios such as cyclic transfer detection and anti-money laundering in financial risk control, abnormal connection detection in network routing, and loan risk identification in enterprise guarantee circles.

Parameter Description

Table 10-27 Parameter description

Parameter	Mandatory	Description	Type	Value Range	Default Value
sources	No	Set of source vertex IDs to be queried	String	-	The value is in the standard CSV format. IDs are separated by commas (,), for example, **Alice, Nana**.
n	No	Upper limit of the number of enumerated circles that meet the filter criteria	Int	[1,100000]	100
statistics	No	Whether to export the number of circles that meet the filter criteria	Boolean	**true** or **false**	false
batch_number	No	Number of source vertices for batch processing	Int	[1,1000]	10

Parameter	Mandatory	Description	Type	Value Range	Default Value
output_format	No	Output format	String	**vertexId**, **edgeId**, or **edgeObject**	edgeObject
filters	Yes	Filter criteria. Each element in the array corresponds to the filter criteria of each layer.	Json	-	-

10.30 Subgraph Matching

Overview

The subgraph matching algorithm is used to find all subgraphs of a given small graph that is isomorphic to a given large graph. This is a basic graph query operation and is intended to explore important substructures of a graph.

Application Scenarios

This algorithm is applicable to fields such as social network analysis, bioinformatics, transportation, crowd discovery, and anomaly detection.

Parameter Description

Table 10-28 Subgraph matching parameters

Name	Mandatory	Description	Type	Value Range
edges	Yes	Edge set of the subgraph to be matched. The vertex ID must be a non-negative integer.	String	The value is in standard CSV format. The start and end vertices of an edge are separated by a comma (,), and edges are separated by a newline character (\n). For example, **1,2\n2,3**.

Name	Mandatory	Description	Type	Value Range
vertices	Yes	Label of each vertex on the subgraph to be matched.	String	The value is in standard CSV format. Vertices and their labels are separated by commas (,), and labels are separated by newline characters (\n). For example, **1,BP\n2,FBP\n3,CP**.
directed	No	Whether the graph is directed	Bool	The value can be **true** or **false**. The default value is **true**.
n	No	Maximum number of subgraphs to be searched for	Int	The value range is [1,100000]. The default value is **100**.
batch_number	No	Number of queries processed in batches each time	Int	The value range is [1,1000000]. The default value is **10000**.
statistics	No	Whether to display the number of all subgraphs that meet the conditions	Bool	The value can be **true** or **false**. The default value is **false**.

10.31 Filtered All Pairs Shortest Paths

Overview

The Filtered All Pairs Shortest Paths algorithm is used to search for the shortest path between any two vertices in the graph that meets the condition. In a specific application scenario, you need to set a start vertex set (**sources**) and end vertex set (**targets**) as input for this algorithm. This algorithm returns the required shortest paths between the start and the end vertex sets.

Application Scenarios

This algorithm applies to relationship mining, path planning, and network planning.

Parameter Description

Table 10-29 Filtered All Pairs Shortest Paths algorithm parameters

Name	Mandatory	Description	Type	Value Range	Default
sources	Yes	Set of start vertex IDs. The value is in the standard CSV input format, that is, multiple vertex IDs are separated by commas (,).	String	The number of source vertices cannot exceed 10,000. -	-
targets	Yes	Set of end vertex IDs. The value is in the standard CSV input format, that is, multiple vertex IDs are separated by commas (,).	String	The number of target vertices cannot exceed 10,000. -	-
directed	No	Whether the edges are directed	Bool	The value can be **true** or **false**.	-
cutoff	No	Maximum length	Int	1-100	6
path_limit	No	Maximum number of paths	Int	● For synchronous tasks: The value ranges from 1 to 100000. The default value is **100000**. ● For asynchronous tasks: The value ranges from 1 to 1000000. The default value is **1000000**. 1000000	100000/1000000

Example

Configure the parameters as follows: **directed=true**, **sources="Alice,Vivian"**, **targets="Jay,Bonnie"**, and set the edge search condition **labelName=friends**. The shortest paths between each pair of start and end vertices are returned in JSON format.

10.32 Filtered All Shortest Paths

Overview

The Filtered All Shortest Paths algorithm allows you to search query results of the Shortest Path algorithm for the paths that meet the conditions between two vertices in a graph.

Application Scenarios

This algorithm applies to scenarios such as relationship mining, path planing, and network planning.

Parameter Description

Table 10-30 Filtered All Shortest Paths algorithm parameters

Parameter	Mandatory	Description	Type	Value Range	Default Value
source	Yes	Source vertex ID	String	-	-
target	Yes	Target vertex ID	String	-	-
directed	No	Whether an edge is directed	Bool	The value can be **true** or **false**.	false

Example

Configure the parameters as follows: **directed=true**, **source="Alice"**, **target="Jay"**, and set the search condition to **labelName=friends**. The results are returned in JSON format.

10.33 TopicRank

Overview

TopicRank algorithm is one of commonly used algorithms for ranking topics by multiple dimensions.

Application Scenarios

This algorithm is applicable to rank hot topics. For example, it can be used to rank complaint topics obtained through a government hotline.

Parameter Description

Table 10-31 TopicRank algorithm parameters

Name	Mandatory	Description	Type	Value Range	Default
sources	Yes	Vertex ID. You can specify multiple IDs in CSV format and separate them with commas (,).	String	Currently, a maximum of 100000 IDs are allowed.	-
actived_p	No	Initial weight of the source vertices	Double	The value ranges from 0 to 100000.	1
default_p	No	Initial weight of a non-source vertices	Double	The value ranges from 0 to 100000.	1
filtered	No	Whether to filter results	Boolean	The value can be **true** or **false**.	false
only_neighbors	No	Whether to display only the neighboring vertices of the sources	Boolean	The value can be **true** or **false**.	false
alpha	No	Weight coefficient	Real number	A real number between 0 and 1	0.85
convergence	No	Convergence	Real number	A real number between 0 and 1	0.00001

Name	Mandatory	Description	Type	Value Range	Default
max_iterations	No	Maximum iterations	Positive integer	The value ranges from 1 to 2000.	1000
directed	No	Whether the edges are directed	Boolean	The value can be **true** or **false**.	true
num_thread	No	Number of threads	Positive integer	1-40	4

Example

Configure **sources="20190110004349,20190129023326,20190107003294,20190129023391"**, **filtered = true**, **only_neighbors=true**, **alpha=0.85**, **convergence=0.00001**, **max_iterations=1000**, **directed=true**, and **label="Topic"** to obtain the topic ranking result.

10.34 Filtered n-Paths

Overview

The filtered n-Paths algorithm is used to find no more than n k-hop loop-free paths between the source and target vertices. The start vertex (source), end vertex (target), number of hops (k), number of paths (n), and filter criteria (filters) are the parameters for the algorithm.

Application Scenarios

Any network

Parameter Description

Table 10-32 filtered_n_paths parameters

Parameter	Mandatory	Description	Type	Value Range	Default Value
source	Yes	Source vertex	String	Internal vertices	None

Parameter	Mandatory	Description	Type	Value Range	Default Value
target	Yes	Target vertex	String	Internal vertices	None
k	Yes	Number of hops	Int	[2,6]	2
n	Yes	Number of paths	Int	[1,1000]	1

10.35 Temporal Paths

Overview

Different from path analysis on static graphs, the Temporal Paths algorithm combines the order of information transmission on dynamic graphs. The passing time of an edge on a path must be later than or the same as that of the previous edge, showing the increment (or non-decrement) of time.

- Temporal paths do not meet transitivity: If there is one temporal path from the vertex i to the vertex j, and there is one temporal path from the vertex j to the vertex k, it does not indicate that there is one temporal path from the vertex i to the vertex k. So, in terms of solving a problem, solving a path on a dynamic graph is more complex than on a static graph, and the calculation is much more difficult. However, temporal path analysis is widely used in actual life, for example, calculating a travel route and simulating/searching for an information propagation path.
- Temporal Paths can be classified into Shortest, Foremost, and Fastest Temporal Paths based on the problem-solving objective.
  - **Shortest Temporal Paths**: indicates the temporal path with the shortest distance.
  - **Foremost Temporal Paths**: indicates the temporal path that reaches the target node as early as possible.
  - **Fastest Temporal Paths**: indicates the temporal path that takes the shortest time.

Application Scenarios

It is applicable to scenarios such as epidemic or disease transmission source tracing, information transmission and public opinion analysis, time sequence-based path planning, and fund circulation path.

Parameter Description

Table 10-33 Temporal Paths parameters

Parameter	Mandatory	Description	Type	Value Range	Default Value
source	Yes	Source vertex ID	String	-	-
targets	Yes	Target vertex ID set	String	The value is in CSV format. IDs are separated by commas (,), for example, **Alice,Nana**. The number of IDs cannot exceed 100,000.	1000
directed	No	Whether an edge is directed	Boolean	The value can be **true** or **false**.	false
k	No	Maximum depth	Integer	1 to 100, including 1 and 100	3
strategy	No	Algorithm policy	String	The value can be **shortest**, **foremost**, or **fastest**. (Note: **fastest** is not supported currently.) ● **shortest**: Runs the **shortest temporal paths** algorithm to return the temporal path with the shortest distance. ● **foremost**: Runs the **foremost temporal paths** algorithm to return the temporal path that reaches the target node as early as possible. ● **fastest**: Runs the **fastest temporal paths** algorithm to return the temporal path that takes the shortest time.	shortest

Table 10-34 dynamicRange description

Parameter	Mandatory	Description	Type	Value Range	Default Value
start	Yes	Start time for dynamic analysis	Date/Integer	-	-
end	Yes	End time for dynamic analysis	Date/Integer	-	-
time_props	Yes	Time properties for dynamic analysis	Object	-	-

Table 10-35 time_props description

Parameter	Mandatory	Description	Type	Value Range	Default Value
stime	Yes	Name of the start time property	String	-	-
etime	Yes	Name of the end time property	String	-	-

Precautions

Temporal path analysis needs to be performed on dynamic graphs.

Example

Select the algorithm in the algorithm area of the graph engine editor. For details, see **Analyzing Graphs Using Algorithms**.

1. To set the dynamic time range parameters, run the following command:
   start=1646092800, end =1646170716, stime="startTime", etime="endTime"
2. Set the parameters of the temporal paths algorithm.
   source="Person00014"

targets="Person00055,Person00058,Person00052,Person00061,Person00060,Place00032,Place00016,Place00026,Place00015,Place00043"

directed="false"

k="5"

3. Select the algorithm search policy **shortest** or **foremost**. Click **Run** to run the temporal paths algorithm. The graph engine calculates and returns the temporal analysis path based on the selected algorithm search policy. The path dynamically extends with the time axis until it reaches the target node. The JSON results are displayed in the query result area.