Alibaba Cloud MaxCompute

Best Practices

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Generic conventions

Table -1: Style conventions

Style	Description	Example
	This warning information indicates a situation that will cause major system changes, faults, physical injuries, and other adverse results.	 Danger: Resetting will result in the loss of user configuration data.
	This warning information indicates a situation that may cause major system changes, faults, physical injuries, and other adverse results.	 Warning: Restarting will cause business interruption. About 10 minutes are required to restore business.
	This indicates warning information, supplementary instructions, and other content that the user must understand.	 Notice: Take the necessary precautions to save exported data containing sensitive information.
	This indicates supplemental instructions, best practices, tips, and other content that is good to know for the user.	 Note: You can use Ctrl + A to select all files.
>	Multi-level menu cascade.	Settings > Network > Set network type
Bold	It is used for buttons, menus , page names, and other UI elements.	Click OK.
`Courier font`	It is used for commands.	Run the `cd /d C:/windows` command to enter the Windows system folder.
Italics	It is used for parameters and variables.	`bae log list --instanceid` *Instance_ID*
[] or [a|b]	It indicates that it is a optional value, and only one item can be selected.	`ipconfig` *[-all|-t]*

Style	Description	Example
{} or {a|b}	It indicates that it is a required value, and only one item can be selected.	`swich {stand | slave}`

Contents

1 SQL

1.1 Basic differences with standard SQL and solutions

This article describes problems that occur frequently when users who are familiar with the relational database SQL use MaxCompute SQL. For specific MaxCompute SQL syntax, see *SQL Overview*.

Basic differences of MaxCompute SQL

Scenarios

- Transactions are not supported. (The commit and rollback actions are not supported. We recommend using the codes that have idempotence and support re-running. We also recommend using Insert Overwrite, instead of Insert Into, to write data.)
- Indexes and primary and foreign key constraints are not supported.
- Auto increment fields and default values are not supported. If the default value exists, assign the value when writing the data.

Table Partitioning

- A table supports 60,000 partitions.
- Otherwise an error is returned. If the partitions are list partitions and the query performs filtering based only on list partitions, an error may be returned if the total number of partitions exceeds 10,000.

Precision

- The Double type has precision. Therefore, we do not recommend that you directly join two Double fields using an equal sign (=). We recommend deducting one number from the other, and consider the two numbers as the same if their difference is smaller than a preset value, for example, `abs ( a1 - a2 )< 0 .000000001` .
- Currently, MaxCompute SQL supports the high-precision type Decimal. If you have higher precision requirements, you can store the data as the string type and use UDF to implement such calculation.

Data type conversion

- If two different field types need to be joined, to prevent unexpected errors, we recommend first converting the types before joining them. This also helps code maintenance.
- For implicit conversions of dates and strings, to input a string to a function that requires entering a date, you can convert between the string and date according to the `yyyy-mm-dd hh:mm:ss` format. For other formats, see *Date functions > TO_DATE*.

DDL difference and solutions

Table structure

- The partition column name cannot be changed. Only the value corresponding to the partition column can be changed.
- You can add columns but cannot delete columns and modify the data type of columns. You can add columns like this : `ALTER TABLE table_name ADD COLUMNS (col_name1 type1, col_name2 type2 …)`

  If you must delete columns or modify the column data types, here is the most secure way:

  1. Create a new table. For example: `CREATE TABLE new_table_name as SELECT c1, c2, c3 FROM table_name;`
  2. Delete your original table and rename your new table as the original one. For example: `ALTER TABLE new_table_name as RENAME TO table_name;` Then you need to insert your data manually into your new table.

DML difference and solutions

INSERT

- The most intuitive syntax difference is that insert into/overwrite is followed by the keyword Table.
- The field mapping of the data inserted into tables is not based on the alias of Select , but on the order of the fields of Select or the fields in the table.

UPDATE/DELETE

- Currently, the Update/Delete statements are not supported.
- If you want to perform Update, you may need to import source partition/table data into the new partition/table, and the corresponding update logic must be executed during the import process.

- If you want to perform Delete, you can drop the table to delete data. For non partition table, you can empty the table data through the `TRUNCATE TABLE table_name ;` statement. For partition table, you can delete partitions by `ALTER TABLE table_name DROP IF EXISTS PARTITION` (partition name='specific partition value'). You can also use `insert overwrite` statement to update or delete data.

SELECT

- The Select field in the Group by query is either the group field of Group By or the aggregate function to be used. From the logic perspective, if a non-group column and Group By Key have multiple records of data, the data cannot be displayed without the aggregate function.
- MaxCompute does not support Group by cube (group by with rollup). However, you can use the union clause to simulate Group by cube, for example, `select k1 , null , sum ( v ) from t group by k1 union all select k1 , k2 , sum ( v ) from t group by k1 , k2 ;`.

Subquery

Subqueries must have aliases. We recommend that all queries have aliases.

IN/NOT IN

- The data volume in the subquery following In/Not In and Exist/Not Exist cannot exceed 1000. To solve the problem. If the uniqueness of the results returned by the subquery is guaranteed in the business aspect, you can consider removing Distinct to improve the query performance.

10,000 results returned by MaxCompute SQL

- MaxCompute limits the number of data records returned by the separately executed Select clause. For the specific configurations, see *Other operations*. The maximum data number is set to 10,000. If the number of data records to be queried is large.

MAPJOIN

- The Join clause does not support Cartesian products. The Join clause must use the on clause to set the joining conditions. If you want to create broadcast tables for small tables, you must use MapJoin Hint. For more information.

ORDER BY

- Order By must be followed by Limit n. If you want to sort a large number of data records, or even sort the full table, you can set N to a large number. However, use this method with caution. Because the system does not have advantages of distributed systems, the performance may be affected. For more information.

UNION ALL

- The data types, quantities, and names of all columns involved in the UNION ALL calculation must be consistent. Otherwise, an exception is returned.
- The UNION ALL query must be nested by a subquery.

1.2 Learn to write SQL statements quickly

This article introduces you to maxcompute SQL through the way of course practice, allows you to quickly understand how SQL is written, and you know the difference between maxcompute SQL and standard SQL, please read in conjunction with the *MaxCompute SQL base documentation*.

Prepare a dataset

In the example the Emp/Dept table is used as the dataset. For the convenience of everybody's operation, provides the relevant maxcompute build table statements and data files (*emp table data files*, *dept table data file*), where you can create a table and upload the data yourself on the maxcompute project.

The DDL statements for creating an emp table are as follows:

```
CREATE   TABLE   IF   NOT   EXISTS   emp  (
  EMPNO   string ,
  ENAME   string  ,
  JOB   string  ,
  MGR   bigint  ,
  HIREDATE   datetime  ,
  SAL   double  ,
  COMM   double  ,
  DEPTNO   bigint  );
```

The DDL statements for creating a Dept table are as follows:

```
CREATE   TABLE   IF   NOT   EXISTS   dept  (
  DEPTNO   bigint  ,
  DNAME   string ,
```

```
    LOC   string );
```

SQL操作

Notes for SQL beginners

- If you use Group by, the Select part must be either group items or aggregate functions.
- Order by must be followed by Limit n.
- The Select expression does not support subqueries. You can rewrite the code to the Join clause to use subqueries.
- The Join clause does not support Cartesian projects and usage of MapJoin.
- Union all must use the format of subqueries.
- The In/Not in statements can correspond to only one column of subquery, and the number of rows of the returned results cannot exceed 1,000. Otherwise, rewrite the statements using Join.

Compile SQL programs to solve problems

Example 1: List all departments that have at least one employee.

To avoid a situation where the amount of data is too large, you often encounter 6th points in the problem point , you need to override using join. For example:

```
 SELECT   d . *
 FROM   dept   d
 JOIN  (
     SELECT   the   DISTINCT   deptno   AS   no
     FROM   emp
)  e
 on   d . deptno  =  e . no ;
```

Example 2: List all employees who have higher salaries than Smith.

This example is a typical scenario of MapJoin, as shown in the following code:

```
 SELECT  /*+  MapJoin ( a ) */  e . empno
    ,  e . ename
    ,  e . sal
 FROM   emp   e
 JOIN  (
     SELECT   MAX ( sal )  AS   sal
     FROM  ' emp '
     WHERE  ` ENAME ` = ' SMITH '
)  a
 ON   e . sal >  a . sal ;
```

Example 3: List the name and the immediate superior’s name of all employees.

Use non-equi join, as shown in the following code:

```
SELECT   a . ename
   ,  b . ename
FROM   emp   a
LEFT   OUTER   JOIN   emp   b
ON   b . empno  =  a . mgr ;
```

Example 4: List all jobs of which salaries are higher than 1500 yuan.

Use Having, as shown in the following code:

```
SELECT   emp . ' JOB '
   ,  MIN ( emp . sal )  AS   sal
FROM  ' emp '
GROUP   BY   emp . ' JOB '
HAVING   MIN ( emp . sal ) >  1500 ;
```

Example 5: List the number of employees of each department, and their average salary and average service year.

You can use many built-in functions for time processing, as shown in the following code:

```
SELECT   COUNT ( empno )  AS   cnt_emp
   ,  ROUND ( AVG ( sal ),  2 )  AS   avg_sal
   ,  ROUND ( AVG ( datediff ( getdate (),  hiredate , ' dd ')),  2
)  AS   avg_hire
FROM  ' emp '
GROUP   BY  ' DEPTNO ';
```

Example 6: List the names of first three employees who have the highest salaries and their ranks (Top n is frequently used).

The SQL statements are as follows:

```
SELECT  *
FROM  (
  SELECT   deptno
   ,  ename
   , sal
   ,  ROW_NUMBER ()  OVER  ( PARTITION   BY   deptno   ORDER   BY
sal   DESC )  AS   nums
  FROM   emp
)  emp1
WHERE   emp1 . nums  <  4 ;
```

Title 7: write down the number of people in each department in one SQL, clerk (clerk) the total number of people in the department accounted.

The SQL statement is as follows:

```
SELECT   deptno
   ,  COUNT ( empno )  AS   cnt
   ,  ROUND ( SUM ( CASE
      WHEN   job  = ' CLERK '  THEN   1
      ELSE   0
    END ) /  COUNT ( empno ),  2 )  AS   rate
FROM  ` EMP `
GROUP   BY   deptno ;
```

1.3 Demo: Modify incompatible SQL

The MaxCompute development team has completed the grayscale upgrade of MaxCompute 2.0 recently. The new version fully embraces open source ecosystems , supports more languages and functions, and enables faster operation. It also implements more rigorous syntax inspection, so that errors may be returned for some less rigorous syntax cases that can run normally in the earlier editor.

To enable smooth grayscale upgrade of MaxCompute 2.0, the MaxCompute framework supports rollback. If a task of MaxCompute 2.0 fails, it will be executed in MaxCompute 1.0. The rollback increases the E2E latency of the task. We recommend that you set `set odps . sql . planner . mode = lot ;` to manually disable the rollback function before submitting jobs, to avoid the impact resulting from the changes made to the MaxCompute rollback policy.

The MaxCompute team notifies the owners of problematic tasks by email or DingTalk based on the online rollback condition. Modify your SQL tasks immediately; otherwise, the tasks may fail. Check the following errors against your tasks to avoid task failure in case of missed notifications.

The following lists the syntaxes for which MaxCompute 2.0 may return errors.

group.by.with.star

SELECT * … GROUP BY… syntax is problematic.

In the earlier version of MaxCompute, `select * from group by key` is supported even when the columns that match * are not included in the GROUP BY key. Compatible with Hive, MaxCompute 2.0 prohibits this syntax unless the GROUP BY list is a column in all source tables. Examples:

Scenario 1: The GROUP BY key does not include all columns.

Incorrect syntax:

```
SELECT * FROM t GROUP BY key ;
```

Error message:

```
FAILED : ODPS - 0130071 :[ 1 , 8 ] Semantic analysis exception
- column reference t . value should appear in GROUP BY
  key
```

Correct syntax:

```
SELECT DISTINCT key FROM t ;
```

Scenario 2: The GROUP BY key includes all columns.

Not recommended syntax:

```
SELECT * FROM t GROUP BY key , value ; -- t has
columns key and value
```

Though MaxCompute 2.0 does not return an error, we recommend that you modify the syntax as follows:

```
SELECT DISTINCT key , value FROM t ;
```

bad.escape

The escape sequence is incorrect.

According to the MaxCompute documentation, in string literal, every ASCII character ranging from 0 to 127 must be written in the format of a backslash followed by three octal numbers. For example, 0 is written as \001, and 1 is written as \002. Currently, \01 and \0001 are considered as \001.

It may bring confusions to new users. For example, "\000" + "1" cannot written as "\0001". For users who migrate data from other systems to MaxCompute, incorrect data may be generated.

Note:

An error may be returned if numbers are appended to `\ 0 00`, for example, `\ 0001 - \ 0009 or \ 00001`.

MaxCompute 2.0 solves this problem. The script owner must correct the sequence, for example:

Incorrect syntax:

```
SELECT  split ( key , "\ 01 "),  value  like  "\ 0001 "  FROM  t ;
```

Error message:

```
FAILED :  ODPS - 0130161 :[ 1 , 19 ]  Parse  exception  -
unexpected  escape  sequence :  01
ODPS - 0130161 :[ 1 , 38 ]  Parse  exception  -  unexpected  escape
  sequence :  0001 -
```

Correct syntax:

```
SELECT  split ( key , "\ 001 "),  value  like  "\ 001 "  FROM  t ;
```

column.repeated.in.creation

Duplicate column names are detected during execution of the CREATE TABLE statement.

MaxCompute 2.0 returns an error when duplicate column names are detected when the CREATE TABLE statement is executed. For example:

Incorrect syntax:

```
CREATE  TABLE  t  ( a  BIGINT ,  b  BIGINT ,  a  BIGINT );
```

Error message:

```
FAILED :  ODPS - 0130071 :[ 1 , 37 ]  Semantic  analysis  exception
 -  column  repeated  in  creation :  a
```

Correct syntax:

```
CREATE  TABLE  t  ( a  BIGINT ,  b  BIGINT );
```

string.join.double

The data on both sides of the equal sign of a Join condition belongs to the String and Double types.

In the old version of MaxCompute, the String and Double type data is converted to the Bigint type at the cost of precision. 1.1 = “1” in a Join condition is considered as equal But compatible with Hive, MaxCompute 2.0 converts the String and Double type data to the Double type.

Syntax that is not recommended:

```
SELECT * FROM t1 JOIN t2 ON t1 . double_val ue = t2 .
string_val ue ;
```

Warning:

```
WARNING :[ 1 , 48 ] implicit conversion from STRING to
DOUBLE , potential data loss , use CAST function to
suppress
```

Recommended correction:

```
select * from t1 join t2 on t . double_val ue = cast (
t2 . string_val ue as double );
```

You can also convert the data as needed.

window.ref.prev.window.alias

Window functions reference other aliases in the select list of the same level.

Examples:

With rn absent from t1, the incorrect syntax is as follows:

```
SELECT row_number () OVER ( PARTITION BY c1 ORDER BY c1
) rn ,
row_number () OVER ( PARTITION by c1 ORDER BY rn ) rn2
FROM t1 ;
```

Error message:

```
FAILED : ODPS - 0130071 :[ 2 , 45 ] Semantic analysis exception
 - column rn cannot be resolved
```

Correct syntax:

```
SELECT row_number () OVER ( PARTITION BY c1 ORDER BY rn
) rn2
FROM
(
SELECT c1 , row_number () OVER ( PARTITION BY c1 ORDER
BY c1 ) rn
FROM t1
) tmp ;
```

select.invalid.token.after.star

Select * is followed by an alias.

The select list allows the use of * to select all the columns of a table, but * cannot be followed by any alias even if the expanded * has only one column. The new editor returns errors for similar syntaxes. For example:

Incorrect syntax:

```
select * as alias from dual ;
```

Error message:

```
FAILED : ODPS - 0130161 :[ 1 , 10 ] Parse exception - invalid
token ' as '
```

Correct syntax:

```
select * from dual ;
```

agg.having.ref.prev.agg.alias

The select list is preceded by an aggregate function alias when HAVING exists. Examples:

Incorrect syntax:

```
SELECT count ( c1 ) cnt ,
sum ( c1 ) / cnt avg
FROM t1
GROUP BY c2
HAVING cnt > 1 ;
```

Error message:

```
FAILED : ODPS - 0130071 :[ 2 , 11 ] Semantic analysis exception
- column cnt cannot be resolved
ODPS - 0130071 :[ 2 , 11 ] Semantic analysis exception -
column reference cnt should appear in GROUP BY key
```

s and cnt do not exist in source table t1, but MaxCompute of the old version does not return an error because HAVING exists. In MaxCompute 2.0, the prompt “column cannot be resolved” appears and an error is returned.

Correct syntax:

```
SELECT cnt , s , s / cnt avg
FROM
(
SELECT count ( c1 ) cnt ,
sum ( c1 ) s
FROM t1
```

```
 GROUP   BY   c2
 HAVING   count ( c1 ) >  1
)  tmp ;
```

order.by.no.limit

ORDER BY is not followed by the LIMIT statement.

By default, MaxCompute requires that ORDER BY be followed by the LIMIT statement to limit the number of data records. Because ORDER BY is used for full data sorting, the execution performance is low without the LIMIT statement. Examples:

Incorrect syntax:

```
select  *  from  ( select  *
from  ( select   cast ( login_user  _cnt   as   int )  as   uv , ' 3
'  as   shuzi
from   test_login  _cnt   where   type  = ' device '  and   type_name
 = ' mobile ')  v
order   by   v . uv   desc )  v
order   by   v . shuzi   limit   20 ;
```

Error message:

```
FAILED :  ODPS - 0130071 :[ 4 , 1 ]  Semantic   analysis   exception
-  ORDER   BY   must   be   used   with   a   LIMIT   clause
```

Correct syntax:

Add the LIMIT statement to the subquery “order by v.uv desc”.

In MaxCompute 1.0, the view inspection is not strict. For example, a view is created in a project which does not require LIMIT statement check (odps.sql.validate.orderby.limit=false).

```
CREATE VIEW dual_view AS SELECT id FROM dual ORDER
BY id ;
```

When you run the following statement to access the view:

```
SELECT * FROM dual_view ;
```

MaxCompute 1.0 does not return an error, whereas MaxCompute 2.0 returns the following error:

```
FAILED : ODPS - 0130071 :[ 1 , 15 ] Semantic analysis exception
 - while resolving view xdj . xdj_view_l imit - ORDER BY
  must be used with a LIMIT clause
```

generated.column.name.multi.window

Automatically generated aliases are used.

In the earlier version of MaxCompute, an alias is auto generated for every expression of the SELECT statement. The alias is displayed on the console. However, the earlier version does not guarantee that the alias generation rule is correct or remains unchanged. Therefore, we do not recommend that you use auto generated aliases.

In MaxCompute 2.0, a warning is given for use of auto generated aliases, but due to breadth of involvement such use is not prohibited for the moment.

In some cases, known changes are made to the alias generation rules in the different versions of MaxCompute. Some online jobs depend on the auto generated aliases. Queries may fail when MaxCompute performs version upgrade or rollback. If you have such problems, modify queries and explicitly specify the alias of the column of interest. Examples:

Not recommended syntax:

```
SELECT _c0 FROM ( SELECT count (*) FROM dual ) t ;
```

Recommended correction:

```
SELECT c FROM ( SELECT count (*) c FROM dual ) t ;
```

non.boolean.filter

Non-Boolean filter conditions are used.

MaxCompute prohibits the implicit conversion between the Boolean type and other data types. However, the earlier version of MaxCompute allows the use of Bigint type filter conditions in some cases. MaxCompute 2.0 prohibits the use of Bigint type filter conditions. If your scripts have Bigint type filter conditions, modify them promptly. Examples:

Incorrect syntax:

```
select id , count (*) from dual group by id having id
;
```

Error message:

```
FAILED : ODPS - 0130071 :[ 1 , 50 ] Semantic analysis exception
 - expect a BOOLEAN expression
```

Correct syntax:

```
select id , count (*) from dual group by id having id
 <> 0 ;
```

post.select.ambiguous

The GROUP BY, CLUSTER BY, DISTRIBUTE BY, and SORT BY statements reference columns with conflicting names.

In the old version of MaxCompute, by default, the system selects the last column of the select list as the operation object. MaxCompute 2.0 reports an error in this case. Make relevant modification timely. Examples:

Incorrect syntax:

```
select a , b as a from t order by a limit 10 ;
```

Error message:

```
FAILED : ODPS - 0130071 :[ 1 , 34 ] Semantic analysis exception
 - a is ambiguous , can be both t . a or null . a
```

Correct syntax:

```
select a as c , b as a from t order by a limit
  10 ;
```

The pushed change covers the statements with conflicting column names but the same syntax. Although there is no ambiguity, an error is often returned for these statements and a warning is triggered. We recommend that you make relevant modification.

duplicated.partition.column

Partitions with the same name are specified in a query.

In the earlier version of MaxCompute, no error is returned when two partition keys with the same name are specified. The latter partition key overwrites the former one. It causes confusion. MaxCompute 2.0 returns an error in this case.

Incorrect syntax:

```
insert overwrite table partition ( ds = ' 1 ', ds = ' 2 ')
select ... ;
```

In fact, ds = '1' is ignored during execution.

Correct syntax:

```
insert overwrite table partition ( ds = ' 2 ') select ... ;
```

Incorrect syntax:

```
create table t ( a bigint , ds string ) partitione d by
 ( ds string );
```

Correct syntax:

```
create table t ( a bigint ) partitione d by ( ds string
);
```

order.by.col.ambiguous

The ORDER BY clause references the duplicate aliases in the select list.

Incorrect syntax:

```
SELECT id , id
FROM dual
ORDER BY id ;
```

Correct syntax:

```
SELECT id , id id2
FROM dual
ORDER BY id ;
```

Remove the duplicate aliases before the ORDER BY clause can reference them.

in.subquery.without.result

colx does not exist in the source table if colx in subquery does not return any results.

Incorrect syntax:

```
SELECT * FROM dual
WHERE not_exist_ col IN ( SELECT id FROM dual LIMIT 0
);
```

Error message:

```
FAILED : ODPS - 0130071 :[ 2 , 7 ] Semantic analysis exception
- column not_exist_ col cannot be resolved
```

ctas.if.not.exists

The syntax of the target table is incorrect.

If the target table exists, the earlier version of MaxCompute does not check the syntax , whereas MaxCompute 2.0 does. Many errors may return in this case, for example:

Incorrect syntax:

```
CREATE TABLE IF NOT EXISTS dual
AS
SELECT * FROM not_exist_ table ;
```

Error message:

```
FAILED : ODPS - 0130131 :[ 1 , 50 ] Table not found - table
meta_dev . not_exist_ table cannot be resolved
```

worker.restart.instance.timeout

In the earlier version of MaxCompute, every time a UDF outputs a record, a write operation is triggered on the distributed file system, and a heartbeat packet is sent to Fuxi. If the UDF does not output any records for 10 minutes, the following error is reported:

```
FAILED : ODPS - 0123144 : Fuxi job failed - WorkerRest art
  errCode : 252 , errMsg : kInstanceM onitorTime out , usually
caused by bad udf performanc e .
```

The runtime framework of MaxCompute 2.0 supports vectoring. It processes multiple rows of a column at a time to improve the execution efficiency. Vectoring may cause the normal statements to time out in the case that a heartbeat packet is not sent to Fuxi within the specified time while multiple records are processed at a time. The interval between two output records does not exceed 10 minutes.

If a time-out error occurs, we recommend that you first check the UDF performance . It takes several seconds to process each record. If the UDF performance cannot be optimized, as a workaround, you can set the value of “batch row” manually. The default value is 1024.

```
set odps . sql . executione ngine . batch . rowcount = 16 ;
```

divide.nan.or.overflow

The old version of MaxCompute does not support division constant folding.

In the old version of MaxCompute, the physical execution plan for a statement is as follows:

```
EXPLAIN
Select if ( false , 0 / 0 , 1 . 0 )
FROM dual ;
In Task M1_Stg1 :
    Data source : meta_dev . dual
    TS : alias : dual
      SEL : If ( False , Divide ( UDFToDoubl e ( 0 ), UDFToDoubl
e ( 0 )), 1 . 0 )
        FS : output : None
```

The IF and Divide functions are retained. During execution, the first parameter of IF is set to “false”, and the expression of the second parameter Divide is not evaluated . Division by zero is normal.

MaxCompute 2.0 supports division constant folding. An error is returned. As shown in the following:

Incorrect syntax:

```
SELECT IF ( FALSE , 0 / 0 , 1 . 0 )
FROM dual ;
```

Error message:

```
FAILED : ODPS - 0130071 :[ 1 , 19 ] Semantic analysis exception
 - encounter runtime exception while evaluating function
 /, detailed message : DIVIDE func result NaN , two
params are 0 . 000000 and 0 . 000000
```

An overflow error may occur besides nan. For example:

Incorrect syntax:

```
SELECT IF ( FALSE , 1 / 0 , 1 . 0 )
```

```
FROM   dual ;
```

Error message:

```
FAILED :  ODPS - 0130071 :[ 1 , 19 ]  Semantic   analysis   exception
 -  encounter   runtime   exception   while   evaluating   function
/,  detailed   message :  DIVIDE   func   result   overflow ,  two
params   are   1 . 000000   and   0 . 000000
```

Correct syntax:

We recommend that you remove /0 and use valid constants.

A similar problem occurs in the constant folding of CASE WHEN, such as CASE WHEN TRUE THEN 0 ELSE 0/0. During constant folding in MaxCompute 2.0, all subexpressions are evaluated, causing incorrect division by zero.

CASE WHEN may involve more complex optimization scenarios, for example:

```
SELECT   CASE   WHEN   key  =  0   THEN   0   ELSE   1 / key   END
FROM  (
SELECT   0   AS   key   FROM   src
UNION   ALL
SELECT   key   FROM   src )  r ;
```

The optimizer pushes down the division operation to subqueries. A similar conversion is as follows:

```
M  (
SELECT   CASE   WHEN   0  =  0   THEN   0   ELSE   1 / 0   END   c1
FROM   src
UNION   ALL
SELECT   CASE   WHEN   key  =  0   THEN   0   ELSE   1 / key   END
c1   FROM   src )  r ;
```

Error message:

```
FAILED :  ODPS - 0130071 :[ 0 , 0 ]  Semantic   analysis   exception
-  physical   plan   generation   failed :  java . lang . Arithmetic
Exception :  DIVIDE   func   result   overflow ,  two   params   are
  1 . 000000   and   0 . 000000
```

An error is returned for the constant folding of the first clause of UNION ALL. We recommend that you transfer CASE WHEN in SQL to subqueries and eliminate useless CASE WHEN statements and /0.

```
SELECT   c1   END
FROM  (
SELECT   0   c1   END   FROM   src
UNION   ALL
```

```
SELECT   CASE   WHEN   key  =  0   THEN   0   ELSE   1 / key   END )
r ;
```

small.table.exceeds.mem.limit

The earlier version of MaxCompute supports Multi-way Join optimization. Multiple JOIN statements with the same Join key are merged for execution in the same Fuxi task, such as J4_1_2_3_Stg1 in the following example.

```
EXPLAIN
SELECT   t1 . *
FROM   t1   JOIN   t2   ON   t1 . c1  =  t2 . c1
JOIN   t3   ON   t1 . c1  =  t3 . c1 ;
```

The earlier version of MaxCompute has the following physical execution plan:

```
In   Job   job0 :
root   Tasks :  M1_Stg1 ,  M2_Stg1 ,  M3_Stg1
J4_1_2_3_S  tg1   depends   on :  M1_Stg1 ,  M2_Stg1 ,  M3_Stg1

In   Task   M1_Stg1 :
    Data   source :  meta_dev . t1

In   Task   M2_Stg1 :
    Data   source :  meta_dev . t2

In   Task   M3_Stg1 :
    Data   source :  meta_dev . t3

In   Task   J4_1_2_3_S  tg1 :
    JOIN :  t1   INNER   JOIN   unknown   INNER   JOIN   unknown
        SEL :  t1 . _col0 ,  t1 . _col1 ,  t1 . _col2
            FS :  output :  None
```

The earlier version of MaxCompute still keeps the physical execution plan when MapJoin Hints are added, and gives priority to applications in Multi-way Join optimization. It may ignore the user-specified MapJoin Hint.

```
EXPLAIN
SELECT  /*+ mapjoin ( t1 )*/  t1 . *
FROM   t1   JOIN   t2   ON   t1 . c1  =  t2 . c1
JOIN   t3   ON   t1 . c1  =  t3 . c1 ;
```

The physical execution plan of the earlier version of MaxCompute is the same as the preceding one.

The optimizer of MaxCompute 2.0 gives priority to the user-specified MapJoin Hint. In the preceding example, if the value of t1 is relatively higher, the following error is returned:

```
FAILED: ODPS-0010000:System internal error - SQL Runtime Internal
 Error: Hash Join Cursor HashJoin_REL… small table exceeds, memory
 limit(MB) 640, fixed memory used …, variable memory used …
```

We recommend that you remove the MapJoin Hint if MapJoin is not your expected behavior.

sigkill.oom

Like small.table.exceeds.mem.limit, if you specify a MapJoin Hint and your small tables are of a relatively larger size, in the earlier version of MaxCompute , multiple JOIN statements may be optimized by Multi-way Join and can be successfully executed. However, in MaxCompute 2.0, some users may set odps.sql. mapjoin.memory.max to prevent small tables from exceeding the size limit. Each MaxCompute worker has a fixed memory limit. If small tables are of a large size, MaxCompute workers may be killed because the memory limit exceeds. The error is similar to the following:

```
Fuxi job failed - WorkerRestart errCode:9,errMsg:SigKill(OOM), usually
 caused by OOM( out of memory).
```

We recommend that you remove MapJoin Hint and use Multi-way Join.

wm_concat.first.argument.const

According to the *Aggregate function* document, the first parameter of WM_CONCAT must be a constant. The old version of MaxCompute does not have strict check standards. For example, when the source table has no data, no error is returned even if the first parameter of WM_CONCAT is ColumnReference.

```
The function statement is as follows :
string wm_concat ( string separator , string str )
Descriptio n of parameters :
Separator : String - type constant . Constants of other
types or non - constants can cause exceptions .
```

MaxCompute 2.0 checks the validity of parameters during the planning phase. An error is returned if the first parameter of WM_CONCAT is not a constant. Examples:

Incorrect syntax:-

```
SELECT wm_concat ( value , ',') FROM src GROUP BY value ;
```

Error message:

```
FAILED: ODPS-0130071:[0,0] Semantic analysis
 exception - physical plan generation failed:
 com.aliyun.odps.lot.cbo.validator.AggregateCallValidator
$AggregateCallValidationException: Invalid argument type - The first
 argument of WM_CONCAT must be constant string.
```

pt.implicit.convertion.failed

srcpt is a partition table with two partitions:

```
CREATE TABLE srcpt ( key STRING , value STRING )
PARTITIONE D BY ( pt STRING );
ALTER TABLE srcpt ADD PARTITION ( pt =' pt1 ');
ALTER TABLE srcpt ADD PARTITION ( pt =' pt2 ');
```

For the preceding SQL statements, the constants of the IN INT type in the pt columns of the String type are converted to the Double type for comparison. Even if odps.sql.udf.strict.mode is set to “true” in the project, the old version of MaxCompute does not return an error and it filters out all pt columns, whereas in MaxCompute 2.0, an error is returned. Examples:

Incorrect syntax:

```
SELECT key FROM srcpt WHERE pt IN ( 1 , 2 );
```

Error message:

```
FAILED : ODPS - 0130071 :[ 0 , 0 ] Semantic analysis exception
- physical plan generation failed : java . lang . NumberForm
atExceptio n : ODPS - 0123091 : Illegal type cast - In
function cast , value ' pt1 ' cannot be casted from
String to Double .
```

We recommend that you avoid comparing String type partition columns and INT-type constants and convert INT-type constants to the String type.

having.use.select.alias

SQL specifies that the GROUP BY+HAVING clause precedes the SELECT clause. Therefore, the column alias generated by the SELECT clause cannot be used in the HAVING clause. For example:

Incorrect syntax:

```
SELECT id id2 FROM DUAL GROUP BY id HAVING id2 >
0 ;
```

Error message:

```
FAILED : ODPS - 0130071 :[ 1 , 44 ] Semantic analysis exception
 - column id2 cannot be resolvedOD PS - 0130071 :[ 1 , 44
] Semantic analysis exception - column reference id2
should appear in GROUP BY key
```

id2 is the column alias generated by the SELECT clause and cannot be used in the HAVING clause.

dynamic.pt.to.static

In MaxCompute 2.0, dynamic partitions may be converted to static ones by the optimizer. For example:

```
INSERT OVERWRITE TABLE srcpt PARTITION ( pt ) SELECT id ,
' pt1 ' FROM dual ;
```

is converted to:

```
INSERT OVERWRITE TABLE srcpt PARTITION ( pt =' pt1 ') SELECT
  id FROM dual ;
```

If the specified partition value is invalid (for example, '${bizdate}' is used), MaxCompute 2.0 returns an error during syntax check. For more information, For more information, see *Partition*.

Incorrect syntax:

```
INSERT OVERWRITE TABLE srcpt PARTITION ( pt ) SELECT id ,
'${ bizdate }' FROM dual LIMIT 0 ;
```

Error message:

```
FAILED : ODPS - 0130071 :[ 1 , 24 ] Semantic analysis exception
 - wrong columns count 2 in data source , requires 3
  columns ( includes dynamic partitions if any )
```

In the earlier version of MaxCompute, with LIMIT 0, no results are returned by the SQL statements, and no dynamic partitions are created. In this case, no error is returned.

lot.not.in.subquery

Processing of the null value of In subquery.

In the standard SQL IN operation, if the value list contains a null value, the returned value may be “null” or “true”, but cannot be “false”. For example, 1 in (null, 1, 2, 3) is “true”, whereas 1 in (null, 2, 3) is “null”, and null in (null, 1, 2, 3) is “null”. Likewise, for the NOT IN operation, if the value list contains a null value, the returned value may be “false” or “null”, but cannot be “true”.

MaxCompute 2.0 performs processing with a standard behavior. If you receive a notification on this problem, check your queries to determine whether the subqueries in the IN operation have a null value and whether the related behavior meets your expectation. If not, make relevant changes. Examples:

```
select * from t where c not in ( select accepted
from c_list );
```

Ignore this problem if “accepted” does not have null values. If a null value exists, c not in (select accepted from c_list) returns the value “true” in the earlier version, but returns a null value in the new version.

Correct syntax:

```
select * from t where c not in ( select accepted
from c_list where accepted is not null )
```

1.4 Export SQL operation result

This article provides examples to illustrate how to download the MaxCompute SQL computing results by using several methods.

Note:

The Java SDK is used as an example throughout this article.

You can use one of the following methods to export the SQL statement execution results:

- If the data volume is small, use *SQL Task* to list all query results.
- If you want to export the results of a specific table or partition, use *Tunnel*.
- If the SQL statements are complex, use Tunnel and SQL Task in combination.
- *DataWorks* allows you to conveniently run SQL statements and *Synchronize data*. It supports regular scheduling and task dependency configuration.DatadataDatadependency

- The Open Source Tool DataXhelps you easily export data from maxcompute to the target data source.

Use SQL Task to export data

SQL Task is the interface where the SDK calls maxcompute SQL directly, you can easily run SQL and get its return results.

`SQLTask . getResult ( i );` returns a list which can be iterated cyclically to obtain the complete SQL computing results. However, there is a flaw in this method. For more information, see the `SetProject READ_TABLE _MAX_ROW` maid feature mentioned in *other actions*.

Currently, you can adjust the maximum number of data records that the SELECT statement returns to the client up to 10,000. If you run the SELECT statement on a client or using SQL Task, the query results are appended with Limit N. Limit N does not apply to the CREATE TABLE XX AS SELECT statement or in the case that the results are solidified in a specific table through INSERT INTO/OVERWRITE TABLE.

Use Tunnel to export data

If you need to export a query that results in the entire contents of a table (or a specific partition) all of the content), you can do this through tunnel, see *command-line* tools for details, and the *tunnel SDK* written based on the SDK.

An example is provided to illustrate how to export data by using the Tunnel command line. You can compile the Tunnel SDK only when data cannot be exported using some command lines. For more information, see *Batch data tunnel overview*.

```
tunnel d wc_out c :\ wc_out . dat ;
2016 - 12 - 16 19 : 32 : 08 - new session : 2016121619
32082d3c9b 0a012f68e7 total lines : 3
2016 - 12 - 16 19 : 32 : 08 - file [ 0 ]: [ 0 , 3 ), c :\
wc_out . dat
downloadin g 3 records into 1 file
2016 - 12 - 16 19 : 32 : 08 - file [ 0 ] start
2016 - 12 - 16 19 : 32 : 08 - file [ 0 ] OK . total : 21
bytes
download OK
```

Use SQL Task and Tunnel to export data

SQL Task cannot export more than 10,000 records, whereas Tunnel can. You can use them in combination You can use them in combination to export data.

The sample code is as follows:

```
 private   static   final   String   accessId  = " userAccess  Id ";
 private   static   final   String   accessKey  = " userAccess  Key ";
 private   static   final   String   endPoint  = " http :// service .
 odps . aliyun . com / api ";
 private   static   final   String   project  = " userProjec  t ";
 private   static   final   String   sql  = " userSQL ";
 private   static   final   String   table  = " Tmp_ " +  UUID .
 randomUUID (). toString (). replace ("-", " _ ");// The   name   of
 the   temporary   table   is   a   random   string .
 private   static   final   Odps   odps  =  getOdps ();
 public   static   void   main ( String []  args ) {
 System . out . println ( table );
 runSql ();
 tunnel ();
}
/*
*  Download   the   results   returned   by   SQL   Task .
* */
 private   static   void   tunnel () {
 TableTunne  l   tunnel  =  new   TableTunne  l ( odps );
 try  {
 DownloadSe  ssion   downloadSe  ssion  =  tunnel . createDown
 loadSessio  n (
 project ,  table );
 System . out . println (" Session   Status   is  : "
+  downloadSe  ssion . getStatus (). toString ());
 long   count  =  downloadSe  ssion . getRecordC  ount ();
 System . out . println (" RecordCoun  t   is : " +  count );
 RecordRead  er   recordRead  er  =  downloadSe  ssion . openRecord
 Reader ( 0 ,
 count );
 Record   record ;
 while  (( record  =  recordRead  er . read ()) ! =  null ) {
 consumeRec  ord ( record ,  downloadSe  ssion . getSchema ());
}
 recordRead  er . close ();
}  catch  ( TunnelExce  ption   e ) {
 e . printStack  Trace ();
}  catch  ( IOExceptio  n   e1 ) {
 e1 . printStack  Trace ();
}
}
/*
*  Save   the   data   record .
*  If   the   data   volume   is   small ,  you   can   print   and
   copy   the   data   directly .   In   reality ,  you   can   use
 Java . io   to   write   the   data   to   a   local   file   or   a
   remote   data   storage .
* */
 private   static   void   consumeRec  ord ( Record   record ,
 TableSchem  a   schema ) {
 System . out . println ( record . getString (" username ")+","+
 record . getBigint (" cnt "));
}
/*
*  Run   an   SQL   statement   to   save   the   query   results
   to   a   temporary   table .  The   saved   results   can   be
 downloaded   using   Tunnel .
*  The   lifecycle   of   the   saved   data   is   1   day .  The
 data   does   not   occupy   much   storage   space   even   when
 an   error   occurs   while   you   delete   the   data .
```

```
* */
 private   static   void   runSql () {
 Instance   i ;
 StringBuil  der   sb  =  new   StringBuil  der (" Create   Table  ").
 append ( table )
. append ("  lifecycle   1   as  "). append ( sql );
 try  {
 System . out . println ( sb . toString ());
 i  =  SQLTask . run ( getOdps (),  sb . toString ());
 i . waitForSuc  cess ();
}  catch  ( OdpsExcept  ion   e ) {
 e . printStack  Trace ();
}
}
/*
*  Initialize   the   connection   informatio  n   of   the
 MaxCompute  ( formerly   ODPS )  instance .
* */
 private   static   Odps   getOdps () {
 Account   account  =  new   AliyunAcco  unt ( accessId ,  accessKey
 );
 Odps   odps  =  new   Odps ( account );
 odps . setEndpoin  t ( endPoint );
 odps . setDefault  Project ( project );
 return   odps ;
}
```

Use DataWorks to export data using synchronization

Using the preceding method, you can save the downloaded data. Other methods are required to create the data and implement the scheduling dependency between data creation and storage.

DataWorks allows you to *Configure a data synchronization task* and configure *Periodic running* and *Dependency among multiple tasks* to complete the process from data creation to storage.

An example is provided to illustrate how to use Data IDE to run SQL statements and configure a data synchronization task to create and export data.

Procedure

1. Create a workflow with an SQL node and a data synchronization node. Connect the two nodes and configure an inter-node dependency, with the SQL node as the data production node and the data synchronization node as the data export node.
2. Configure the SQL node.

> **Note:**
> Run an SQL statement to create a table before you configure synchronization. If no table exists, the synchronization task cannot be configured.

3. Perform the following to configure the data synchronization task.
   a. Select a Source.
   b. Select a Target.
   c. Map fields.
   d. Control the tunnel.
   e. Preview and Save.
4. After workflow scheduling is configured, save and submit the workflow. Click Test Run. If you do not configure workflow scheduling, you can use the default scheduling configuration directly. View the running log on data synchronization as as in the following figure.

```
2016 - 12 - 17   23 : 43 : 46 . 394  [ job - 15598025 ]  INFO
JobContain  er  -
Task   start   time  :  2016 - 12 - 17   23 : 43 : 34
Task   end   time  :  2016 - 12 - 17   23 : 43 : 46
Total   task   time  :  11s
Average   data   per   task  :  31 . 36   KB / s -
Write   speed  :  1 , 668   rec / s
Read   records  :  16 , 689
Failed   read - write   attempts  :  0
```

5. Run an SQL statement to view the data synchronization results.

1.5 Join on condition in MaxCompute(ODPS) SQL

One of the most common operations in MaxCompute(ODPS) SQL is join.

Overview

Currently MaxCompute offers several join types:

Type	Meaning
Inner join	Output data that matches the criteria of the Association
Left join	Outputs all records for the left table, and for the right table that matches the associated data, outputs the right table , there is no match, and the right table supplements null.
Right join	Outputs all records of the right table , for which the left table matches the associated data, for which the left table is output, no match, left table to fill in null.

Type	Meaning
Full join	Outputs all records for the left and right tables, for data that is not associated with , a null is added on the other side that is not associated.
Left Semi Join	For a single piece of data in the left table, if the right table has rows that match the criteria of the Association, the left table is output.
Left Anti Join	For a single piece of data in the left table , if for all rows in the right table, there is no data that matches the criteria of the Association, and the left table is output.

 Note:
User Defined Join specifies both input streams, and you can implements the logic of the join yourself, which is not discussed here.

Depending on the scenario, the user can use different Join types to implement the corresponding Association operation. But in the actual use process, it is often not clear to users that the filtering criteria are different in join on statements or in where, or think they're doing the same thing, for example, in a production environment, users can often be seen writing:

```
A  ( LEFT / RIGHT / FULL / LEFT   SEMI / LEFT   ANTI )  JOIN   B
ON   a . key  =  b . key   and   A . ds =' 20180101 '  and   B . ds
=' 20180101 ';
```

The intention of the user here is to get the data for a partition in A and B for the join operation., that is:

```
( Select  *  from   a   where   DS  = ' 20180101  ')
( LEFT / RIGHT / FULL / LEFT   SEMI / LEFT   ANTI )   JOIN
( SELECT  *  FROM   B   WHERE   ds =' 20180101 ')  B
 ON   a . key  =  b . key
```

However, for different Join types, the two may not be equivalent, not only can not push the partition conditions, results In a full table scan, and it can cause correctness problems. Here is a brief analysis of the filter conditions in:

1. Where condition of subquery
2. JOIN ON condition

3. Where condition after JOIN ON

The similarities and differences.

Principle

Let's start with the computed order of a join and a where condition,:

```
( SELECT  *  FROM   A   WHERE  { subquery_w  here_condi  tion }  A )
 A
 JOIN
( SELECT  *  FROM   B   WHERE  { subquery_w  here_condi  tion }  B )
 B
 ON  { on_conditi  on }
 WHERE  { where_cond  ition }
```

For example, the order of calculation is

1. Subquery`{ subquery_w  here_condi  tion }`.
2. The condition of the `{ on_conditi  on }` For the join.
3. The calculation of the join result collection, `{ where_cond  ition }`.

For different Join types, filter statements are placed in `{ subquery_w  here_condi  tion }`,`{ on_conditi  on }`, and `{ where_cond  ition }`, sometimes the results are consistent, and sometimes the results are inconsistent. The following discussion takes place:

Experiment

1. Prepare

   First construct table:

```
CREATE  TABLE  A  AS  SELECT  *  FROM  VALUES  ( 1 ,  20180101
),( 2 ,  20180101 ),( 2 ,  20180102 )  t  ( key ,  ds );
```

key	ds
1	20180101
2	20180101

key	ds
2	20180102

Table B:

```
CREATE TABLE B AS SELECT * FROM VALUES ( 1 , 20180101 ),( 3 , 20180101 ),( 2 , 20180102 ) t ( key , ds );
```

key	ds
1	20180101
3	20180101
2	20180102

Then their product of Descartes is:

a.key	a.ds	b.key	b.ds
1	20180101	1	20180101
1	20180101	3	20180101
1	20180101	2	20180102
2	20180101	1	20180101
2	20180101	3	20180101
2	20180101	2	20180102
2	20180102	1	20180101
2	20180102	3	20180101
2	20180102	2	20180102

2. Inner Join

   Conclusion: the filter conditions are equivalent in `{ subquery_w here_condi tion }`, `{ on_conditi on }`, and `{ where_cond ition }`.

   The processing logic of inner join is to product the left and right tables to the Descartes, then select the traveling line output that meets the on expression.

   a. In the first case, the subquery is filtered:

```
Select a . *, B .*
From
( Select * from a where DS = ' 20180101 ')
JOIN
( SELECT * FROM B WHERE ds =' 20180101 ') B
```

```
ON   a . key  =  b . key ;
```

It's very simple, and there's only one result:

a.key	a.ds	b.key	b.ds
1	20180101	1	20180101

b. In the second case, the JOIN condition is filtered:

```
SELECT   A .*,  B .*
FROM   A   JOIN   B
ON   a . key  =  b . key   and   A . ds =' 20180101 '  and   B .
ds =' 20180101 ';
```

There are nine results of Descartes, and there is only one result to satisfy the condition of on.

a.key	a.ds	b.key	b.ds
1	20180101	1	20180101

c. In the third case, the where condition filter after JOIN:

```
Select   a . *,  B  .*
FROM   A   JOIN   B
ON   a . key  =  b . key
WHERE   A . ds =' 20180101 '  and   B . ds =' 20180101 ';
```

For example, there are nine results of Descartes that meet the on `a . key = b . key` there are 3 results for key, respectively:

a.key	a.ds	b.key	b.ds
1	20180101	1	20180101
2	20180102	2	20180102
2	20180101	2	20180102

filter this result again `A . ds =' 20180101 '  and   B . ds =' 20180101 '`, results in only 1 Article.

a.key	a.ds	b.key	b.ds
1	20180101	1	20180101

As you can see, three different results have been obtained by placing the filter conditions in three different places.

3. Left join

   Conclusion: The filtering conditions are not necessarily equivalent in `{ subquery_w here_condi tion }`, `{ on_conditi on }`, and `{ where_cond ition }`.

   For the filter criteria for the left table, the ones placed in `{ subquery_w here_condi tion }` and `{ where_cond ition }` are equivalent.

   For the filter criteria for the right table, the ones placed in `{ subquery_w here_condi tion }` and `{ on_conditi on }` are equivalent.

   The processing logic of left join is to make the left and right tables a Descartes product, then for the moving line output that satisfies the on expression, for the rows in the left table that do not meet the on expression, the left table is output, and the right table supplements null.

   a. In the first case, the subquery is filtered:

```
SELECT A .*, B .*
From
( SELECT * FROM A WHERE ds =' 20180101 ') A
LEFT JOIN
( SELECT * FROM B WHERE ds =' 20180101 ') B
ON a . key = b . key ;
```

   After filtering, there are two on the left and one on the right and two on the results:

a.key	a.ds	b.key	b.ds
1	20180101	1	20180101
2	20180101	NULL	NULL

   b. In the second case, the JOIN condition is filtered:

```
SELECT A .*, B .*
FROM A JOIN B
ON a . key = b . key and A . ds =' 20180101 ' and B .
ds =' 20180101 ';
```

   There are nine results of Descartes, and only one result to satisfy the condition of on, the left table is null for the remaining two outputs of the Left table.

a.key	a.ds	b.key	b.ds
1	20180101	1	20180101

a.key	a.ds	b.key	b.ds
2	20180101	NULL	NULL
2	20180102	NULL	NULL

c. In the third case, the where condition filter after JOIN:

```
SELECT   A .*,  B .*
FROM   A   JOIN   B
ON   a . key  =  b . key
WHERE   A . ds =' 20180101 '  and   B . ds =' 20180101 ';
```

For example, there are nine results of Descartes that meet the ON `a . key = b . key` there are 3 results for key, respectively:

a.key	a.ds	b.key	b.ds
1	20180101	1	20180101
2	20180101	2	20180102
2	20180102	2	20180102

filter this result again `A . ds =' 20180101 '  and   B . ds =' 20180101 '`, results in only 1 Article.

a.key	a.ds	b.key	b.ds
1	20180101	1	20180101

As you can see, three different results have been obtained by placing the filter conditions in three different places.

4. Right join

The right join and left join are similar, just the difference between the left and right tables. Conclusion: The filtering conditions are not necessarily equivalent in `{ subquery_w here_condi tion }`, `{ on_conditi on }`, and `{ where_cond ition }`. For the filter criteria for the right table, the ones placed in `{ subquery_w here_condi tion }` and `{ where_cond ition }` are equivalent. For the filter criteria for the left table, the ones placed in `{ subquery_w here_condi tion }` and `{ on_conditi on }`are equivalent.

5. Full join

   Conclusion: The filter conditions are written in `{ subquery_w here_condi tion }`, `{ on_conditi on }`, and `{ where_cond ition }` are not equivalent.

   The processing logic of full join is to make the left and right tables a Descartes product, then for the moving line output that satisfies the on expression, for the rows that do not meet the on expression in the tables on both sides, outputs a table with data, with null on the other side.

   a. In the first case, the subquery is filtered:

```
SELECT A .*, B .*
From
( SELECT * FROM A WHERE ds =' 20180101 ') A
FULL JOIN
( SELECT * FROM B WHERE ds =' 20180101 ') B
ON a . key = b . key ;
```

   After filtering, there are two on the left and two on the right, and three on the right:

a.key	a.ds	b.key	b.ds
1	20180101	1	20180101
2	20180101	NULL	NULL
NULL	NULL	3	20180101

   b. In the second case, the JOIN condition is filtered:

```
SELECT A .*, B .*
FROM A FULL JOIN B ':
ON a . key = b . key and A . ds =' 20180101 ' and B .
ds =' 20180101 ';
```

   There are nine results of Descartes, and only one result to satisfy the condition of on, the left table is null for the remaining two outputs of the Left table. The remaining two outputs of the right table, the right table, and the left table, fill in null.

a.key	a.ds	b.key	b.ds
1	20180101	1	20180101
2	20180101	NULL	NULL
2	20180102	NULL	NULL
NULL	NULL	3	20180101

a.key	a.ds	b.key	b.ds
NULL	NULL	2	20180102

c. In the third case, the where condition filter after JOIN:

```
SELECT   A .*,  B .*
FROM   A   FULL   JOIN   B :
ON   a . key  =  b . key
WHERE   A . ds =' 20180101 '  and   B . ds =' 20180101 ';
```

For example, there are nine results of Descartes that meet the on `a . key = b . key` there are 3 results for key, respectively:

a.key	a.ds	b.key	b.ds
1	20180101	1	20180101
2	20180101	2	20180102
2	20180102	2	20180102

Then the data on the other side of the JOIN is output, and NULL is added to the other side and the result is:

a.key	a.ds	b.key	b.ds
1	20180101	1	20180101
2	20180101	2	20180102
2	20180102	2	20180102
NULL	NULL	3	20180101

filter this result again `A . ds =' 20180101 '  and   B . ds =' 20180101 '`, results in only 1 Article.

a.key	a.ds	b.key	b.ds
1	20180101	1	20180101

As you can see, like LEFT JOIN, there are three different results.

6. Left Semi Join

Conclusion: The filter conditions are written in `{ subquery_w here_condi tion }`, `{ on_conditi on }`, and `{ where_cond ition }` are not equivalent.

The processing logic for LEFT SEMI Join is for each record in the left table, all go to the right table to match, and if the match succeeds, the left table is output.

What you need to note here is that only the left table is output, therefore, the filter condition to the right cannot be written in the where condition after the JOIN. Left semi join is commonly used to implement the semantics of exists:

a. In the first case, the subquery is filtered:

```
SELECT A .*
FROM
( SELECT * FROM A WHERE ds =' 20180101 ') A
LEFT SEMI JOIN
( SELECT * FROM B WHERE ds =' 20180101 ') B
ON a . key = b . key ;
```

After filtering, there are two on the left and the right, which eventually fit `a . key = b . key` there is only one of the key:

a.key	a.ds
1	20180101

b. In the second case, the JOIN condition is filtered:

```
SELECT A .*
FROM A LEFT SEMI JOIN B
ON a . key = b . key and A . ds =' 20180101 ' and B .
ds =' 20180101 ';
```

For the three records on the left, there is also only one result that meets the on condition.

a.key	a.ds
1	20180101

c. In the third case, the where condition filter after JOIN:

```
Select .*
FROM A LEFT SEMI JOIN
( SELECT * FROM B WHERE ds =' 20180101 ') B
ON a . key = b . key
```

```
 WHERE   A . ds =' 20180101 ';
```

There is one on that can meet the on condition on the left:

a.key	a.ds
1	20180101

A. filter this result again `A . ds =' 20180101 '`, results remain 1 Article:

a.key	a.ds
1	20180101

As you can see, the left semi join and inner join are similar, no matter where the filter conditions are placed, the results were consistent.

7. Left Anti Join

Conclusion: The filter conditions are written in `{ subquery_w here_condi tion }`, `{ on_conditi on }`, and `{ where_cond ition }` are not equivalent.

For the filter criteria for the left table, the ones placed in `{ subquery_w here_condi tion }` and `{ where_cond ition }` are equivalent.

For the filter criteria for the right table, the ones placed in `{ subquery_w here_condi tion }` and `{ on_conditi on }` are equivalent, the right table expression cannot be placed in `{ where_cond ition }`.

The processing logic for left anti join is for each record in the left table, all go to match the right table, and if none of the records on the right table are matched successfully, the left table is output. Similarly, since only the left table is output, therefore, the filter condition to the right cannot be written in the where condition after the join. LEFT SEMI JOIN are often used to implement the semantics of not exists.

a. In the first case, the subquery is filtered:

```
 SELECT   A .*
 From
( SELECT  *  FROM   A   WHERE   ds =' 20180101 ')  A
 LEFT   ANTI   JOIN
( SELECT  *  FROM   B   WHERE   ds =' 20180101 ')  B
```

```
ON   a . key  =  b . key ;
```

After filtering, there are two on the left, two on the right and one on the results.

a.key	a.ds
2	20180101

b. In the second case, the JOIN condition is filtered:

```
SELECT   A .*
FROM   A   LEFT   ANTI   JOIN   B
ON   a . key  =  b . key   and   A . ds =' 20180101 '  and   B .
ds =' 20180101 ';
```

For the three records on the left, only the first one has the result of satisfying the ON condition, so output the remaining two records.

a.key	a.ds
2	20180101
2	20180102

c. In the third case, the WHERE condition filter after JOIN:

```
SELECT   A .*
FROM   A   LEFT   ANTI   JOIN
( SELECT  *  FROM   B   WHERE   ds =' 20180101 ')  B
ON   a . key  =  b . key
WHERE   A . ds =' 20180101 ';
```

There are two on conditions that can be passed ON the left:

a.key	a.ds
2	20180101
2	20180102

The result is filtered again for a `A . ds =' 20180101 '` and the result is 1.

a.key	a.ds
2	20180101

As you can see, in LEFT ANTI JOIN, the filter condition is placed in the JOIN ON condition and in the where condition before and after, and the result is different .

The above is a simple test of several different writing methods for a common scenario, without a specific deduction process, it will be more complex for

scenarios involving expressions that are not equivalent to each other, interested students can try to derive them themselves.

Online status

These results are derived from SQL standard semantic patterns. Some users will find that the results of the same statements in the online environment do not match expectations, this is due to some historical reasons and compatibility considerations. In the implementation of Outer Join, a flag is set at the project level, called `odps . sql . outerjoin . supports . filters`, if set to false, indicates that the on condition of Outer Join does not support filtering conditions, writing `{ on_conditi on }` will be treated as if it were written in `{ subquery_w here_condi tion }`, which is a non-standard behavior. Some users switch between two projects, it is caused by this that the same SQL runs differently in both projects.

It is hoped that everyone can write SQL according to the standard SQL semantics, in this way, you can ensure the portability of subsequent SQL.

View Project settings you can find the corresponding project and view the properties in the `project administra tion` in *http://adminconsole.odps.aliyun-inc.com/inn.view* .

Conclusion

The semantics of the filter conditions in different locations may vary greatly for the user, if you are simply filtering the data and then joining, you can simply remember the following points.

1. The inner join/left semi join can be written on both sides of the expression.
2. Left join/left anti join the filter criteria for the left table are to be put in `{ subquery_w here_condi tion }`or `{ where_cond ition }`, the filter criteria for the right table are to be placed in either `{ subquery_w here_condi tion }` or `{ on_conditi on }`.
3. Right join is opposite to left join, the filter criteria for the right table are to be placed either `{ subquery_w here_condi tion }` or `{ where_cond ition }`, the filter criteria for the left table are to be placed on `{ subquery_w here_condi tion }` or `{ on_conditi on }`.
4. Full outer join can only be placed in`{ subquery_w here_condi tion }`.

Of course, if you still think the rules are complicated, the best way to do this is to write the filter criteria to the subquery every time.

2 Data migration

2.1 Migrate data from Hadoop to MaxCompute

This topic describes how to use the data synchronization feature of DataWorks to migrate data from Hadoop to Alibaba Cloud MaxCompute.

Prepare the environment

1. **Build a Hadoop cluster.**

   Before data migration, you must ensure that your Hadoop cluster works properly. You can use Alibaba Cloud E-MapReduce to automatically build a Hadoop cluster.

   The version information of E-MapReduce Hadoop is as follows:

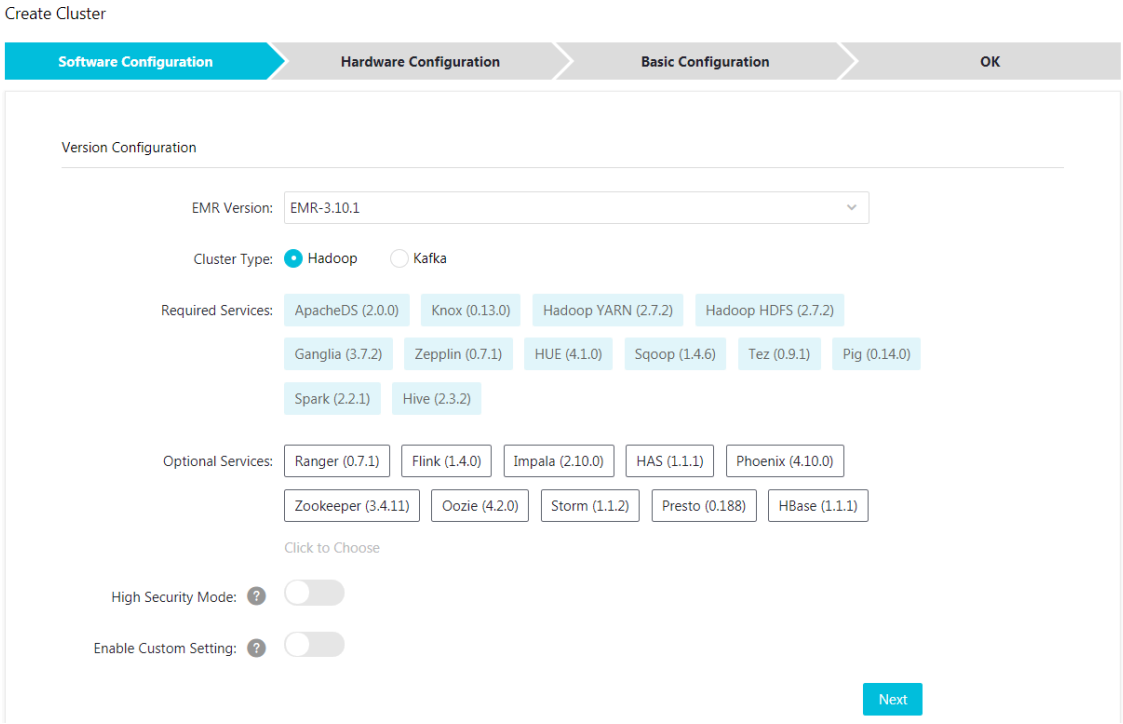
   E-MapReduce version: EMR-3.10.1 or 3.11.0

   Cluster type: Hadoop

   Software(for EMR-3.11.0): HDFS2.7.2 / YARN2.7.2 / Hive2.3.3 / Ganglia3.7.2 / Spark2.2.1 / HUE4.1.0 / Zeppelin0.7.3 / Tez0.9.1 / Sqoop1.4.6 / Pig0.14.0 / ApacheDS2.0.0 / Knox0.13.0

   The network type of the Hadoop cluster is classic. The region is China East 1 (Hangzhou). The ECS compute resource of the master instance group is configured with an Internet IP address and an intranet IP address. The high availability mode

is set to No (a non-HA mode). The following figure shows the configuration for EMR -3.10.1.



2. MaxCompute

   For more information, see *Activate MaxCompute*.

   Activate MaxCompute and create a project. In this topic, create a project named bigdata_DOC in China East 1 (Hangzhou) and enable the related DataWorks services for this project.

Prepare data

1. Create test data on the Hadoop cluster.

   In the E-MapReduce console, go to the Hadoop cluster page and use Notebook to create a notebook task. The table creation Hive statements in this example are as follows:

```
CREATE   TABLE   IF   NOT
EXISTS   hive_doc_g  ood_sale (

create_tim  e   timestamp ,

category   STRING ,

brand   STRING ,

buyer_id   STRING ,

trans_num   BIGINT ,
```

```
 trans_amou  nt   DOUBLE ,

 click_cnt   BIGINT

)

 PARTITIONE  D   BY  ( pt   string )  ROW   FORMAT
 DELIMITED   FIELDS   TERMINATED   BY  ','  lines   terminated   by
 '\ n '
```

Click run. The test table `hive_doc_g ood_sale` is then successfully created on the E-MapReduce Hadoop cluster.

Insert the test data. You can select data from OSS or other data sources, or manually insert a small amount of test data. The following data can be manually inserted:

```
 insert   into
 hive_doc_g  ood_sale   PARTITION ( pt  = 1  )  values (' 2018 - 08
 - 21 ',' Coat ',' Brand   A ',' lilei ', 3 , 500 . 6 , 7 ),(' 2018
 - 08 - 22 ',' Fresh   food ',' Brand   B ',' lilei ', 1 , 303 , 8
 ),(' 2018 - 08 - 22 ',' Coat ',' Brand   C ',' hanmeimei ', 2 , 510
 , 2 ),( 2018 - 08 - 22 ,' Toiletries ',' Brand   A ',' hanmeimei ',
 1 , 442 . 5 , 1 ),(' 2018 - 08 - 22 ',' Fresh   food ',' Brand   D
 ',' hanmeimei ', 2 , 234 , 3 ),(' 2018 - 08 - 23 ',' Coat ',' Brand
   B ',' jimmy ', 9 , 2000 , 7 ),(' 2018 - 08 - 23 ',' Fresh   food
 ',' Brand   A ',' jimmy ', 5 , 45 . 1 , 5 ),(' 2018 - 08 - 23 ','
 Coat ',' Brand   E ',' jimmy ', 5 , 100 . 2 , 4 ),(' 2018 - 08 - 24
 ',' Fresh   food ',' Brand   G ',' peiqi ', 10 , 5560 , 7 ),(' 2018
 - 08 - 24 ',' Sanitary   ware ',' Brand   F ',' peiqi ', 1 , 445 .
 6 , 2 ),(' 2018 - 08 - 24 ',' Coat ',' Brand   A ',' ray ', 3 , 777
 , 3 ),(' 2018 - 08 - 24 ',' Sanitary   ware ',' Brand   G ',' ray
 ', 3 , 122 , 3 ),(' 2018 - 08 - 24 ',' Coat ',' Brand   C ',' ray
 ', 1 , 62 , 7 ) ;
```

After inserting the data, you can use the `select * from hive_doc_g ood_sale where pt = 1 ;` statement to check whether the data exists in the Hadoop cluster table for migration.

2. Use DataWorks to create a destination table.

   In the DataWorks console, click the MaxCompute project, and choose Data Development > New > Create Table.

   In the displayed window, enter the following table creation SQL statements:

```
CREATE   TABLE   IF   NOT   EXISTS   hive_doc_g  ood_sale (
   create_tim  e   string ,
   category   STRING ,
   brand   STRING ,
   buyer_id   STRING ,
   trans_num   BIGINT ,
   trans_amou  nt   DOUBLE ,
   click_cnt   BIGINT
  )
```

```
    PARTITIONE  D   BY  ( pt   string ) ;
```

When creating a table, pay attention to the mapping between the Hive data type and the MaxCompute data type.

The data synchronization feature of DataWorks does not support `timestamp` data. Therefore, in the DataWorks table creation statements, create_time is set to a string value. You can also use the odpscmd Command Line (CLI) tool to create a table. For more information about how to install and configure the tool, see *Install and configure a client*. The table creation process is as follows.

```
odps@ bigdata_DOC>CREATE TABLE IF NOT EXISTS hive_doc_good_sale(
   create_time timestamp,
   category STRING,
   brand STRING,
   buyer_id STRING,
   trans_num BIGINT,
   trans_amount DOUBLE,
   click_cnt BIGINT
   )
   PARTITIONED BY (pt string) ;
                >               >               >               >
        >               >               >               >
 >
ID = 20180906110540873gev1bpim
OK
odps@ bigdata_DOC>drop table hive_doc_good_sale;
Confirm to "drop table hive_doc_good_sale;" (yes/no)? yes

ID = 20180906110825180gxh66292
```

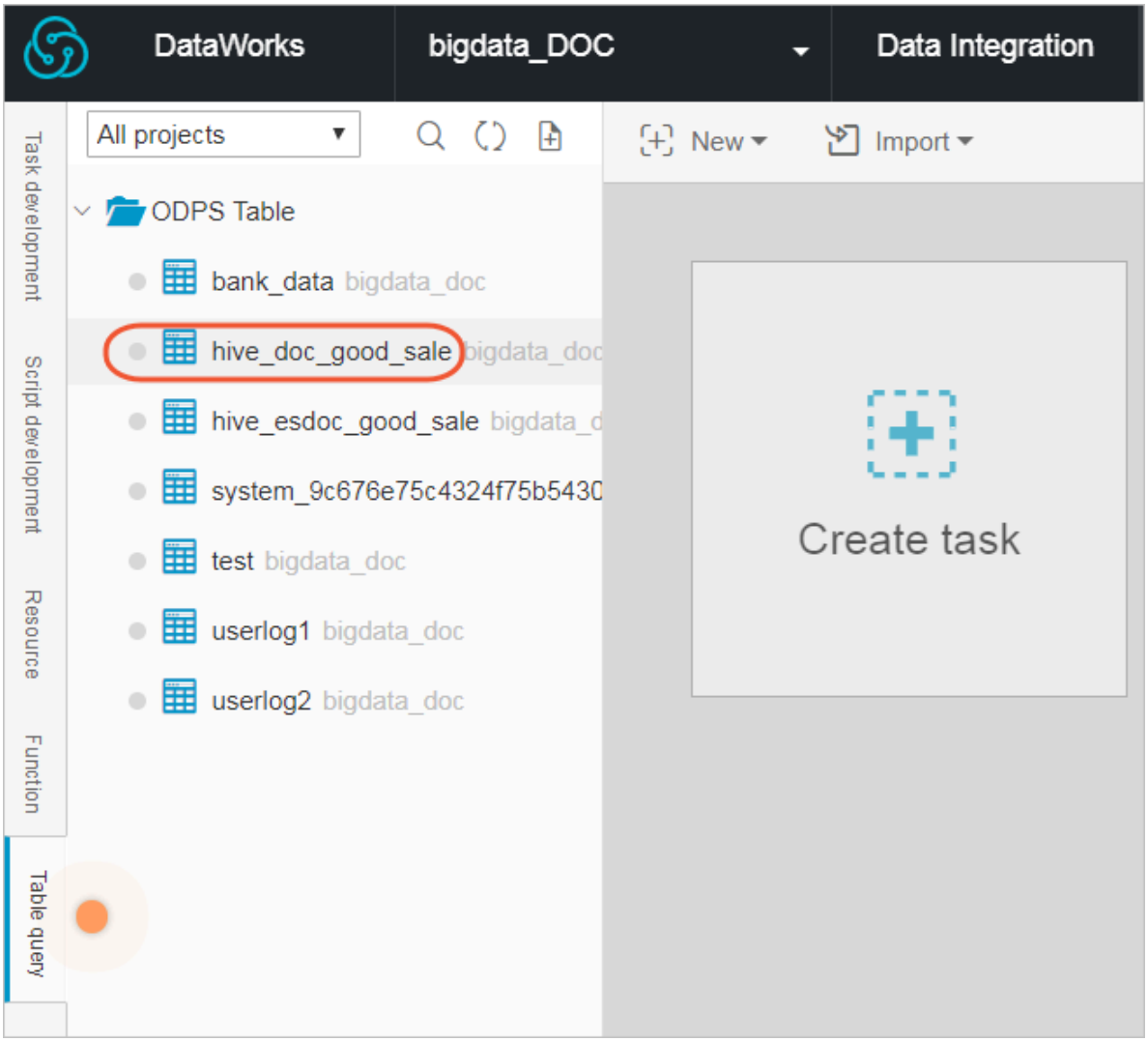
Note:

Considering the compatibility of the Hive and MaxCompute data types, we recommend that you run the following command on the odpscmd client:

```
  set   odps . sql . type . system . odps2 = true ; set
```

```
odps . sql . hive . compatible = true ;
```

After the table is created, you can choose Data Development > Table Query in the DataWorks console to view the table created in MaxCompute, as shown in the following figure.



Synchronize data

1. Create a custom resource group.

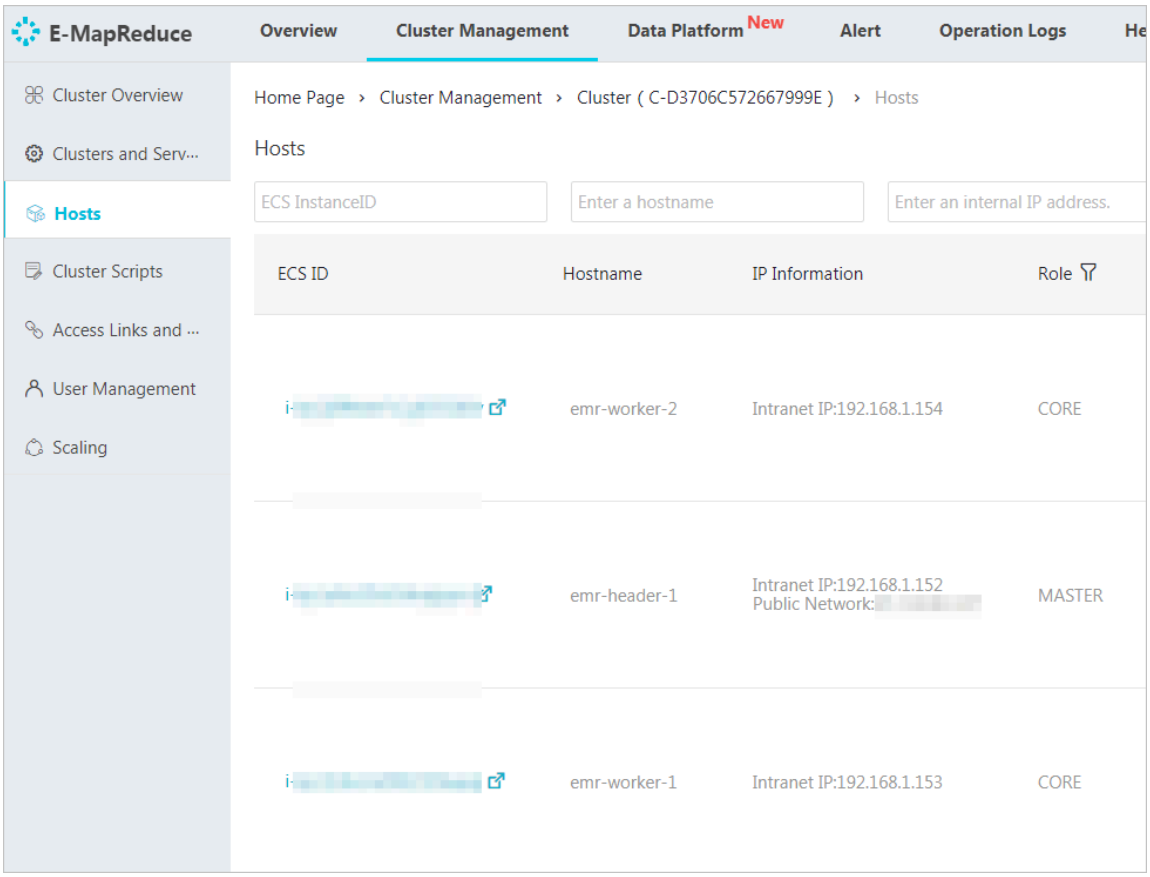
   In most cases, the network between the project data node of MaxCompute and the data node of the Hadoop cluster is not connected. You can customize a resource group to execute the synchronization task of DataWorks on the master node of the

Hadoop cluster. (In general, the network between the master node and the data node on the Hadoop cluster is connected).

a. View the data node of the Hadoop cluster.

   On the home page of the E-MapReduce console, choose Cluster Management > Cluster > Hosts. You can view the data node of the Hadoop cluster. As shown in the following figure, the host name of the master node on the E-MapReduce

Hadoop cluster (non-HA mode) is emr-header-1, and the host name of the data node is emr-worker-X.



You can also click the ECS ID of the master node, click Connect on the displayed ECS details page, and run the hadoop dfsadmin –report command to view the data node, as shown in the following figure.

```
DFS Used%: 0.05%
Under replicated blocks: 0
Blocks with corrupt replicas: 0
Missing blocks: 0
Missing blocks (with replication factor 1): 0

-------------------------------------------------
Live datanodes (2):

Name: 10.31.122.189:50010 (emr-worker-1.cluster-74503)
Hostname: emr-worker-1.cluster-74503
Decommission Status : Normal
Configured Capacity: 333373341696 (310.48 GB)
DFS Used: 155725824 (148.51 MB)
Non DFS Used: 325541888 (310.46 MB)
DFS Remaining: 332892073984 (310.03 GB)
DFS Used%: 0.05%
DFS Remaining%: 99.86%
Configured Cache Capacity: 0 (0 B)
Cache Used: 0 (0 B)
Cache Remaining: 0 (0 B)
Cache Used%: 100.00%
Cache Remaining%: 0.00%
Xceivers: 1
Last contact: Thu Sep 06 19:41:01 CST 2018

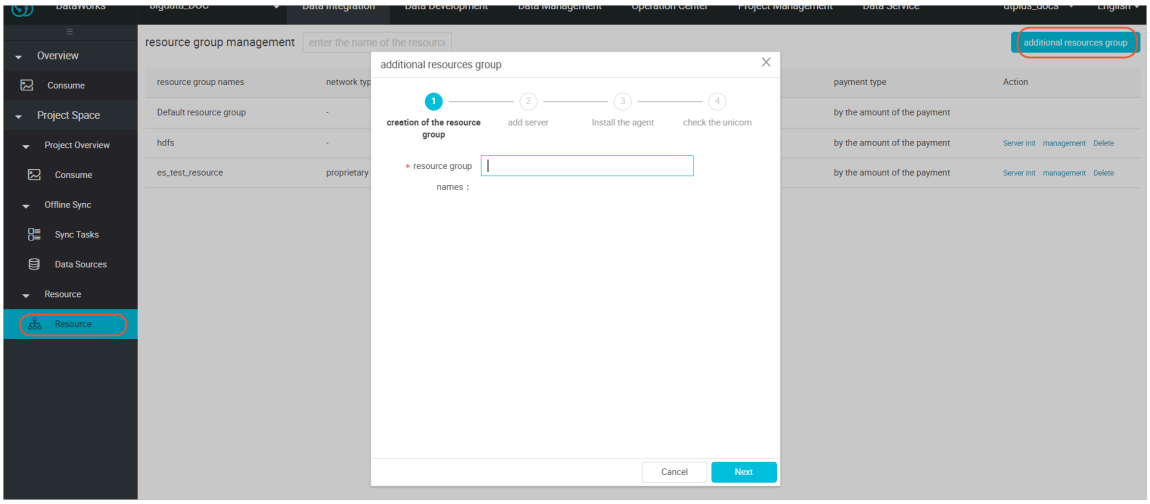

Name: 10.81.78.209:50010 (emr-worker-2.cluster-74503)
Hostname: emr-worker-2.cluster-74503
Decommission Status : Normal
Configured Capacity: 333373341696 (310.48 GB)
DFS Used: 155725824 (148.51 MB)
Non DFS Used: 325451776 (310.38 MB)
DFS Remaining: 332892164096 (310.03 GB)
DFS Used%: 0.05%
DFS Remaining%: 99.86%
Configured Cache Capacity: 0 (0 B)
Cache Used: 0 (0 B)
Cache Remaining: 0 (0 B)
Cache Used%: 100.00%
Cache Remaining%: 0.00%
Xceivers: 1
Last contact: Thu Sep 06 19:41:02 CST 2018
```

As shown in the preceding figure, the data node has only an intranet address and cannot communicate with the default resource group of DataWorks. Therefore, you need to customize a resource group and set the master node to a node that executes the synchronization task of DataWorks.

b. Create a custom resource group.

In the DataWorks console, go to the Data Integration page, select Resource Group, and click New Resource Groups, as shown in the following figure.

For more information about how to customize a resource group, see *Add task resources*.



When you add a server, you need to enter the information such as the ECS UUID and machine IP address. (For a classic network, enter the sever name. For a VPC network, enter the server UUID. You can add scheduling resources only for classic networks in China East 2 (Shanghai) in DataWorks V2.0. In other regions, select the VPC network type when you add a scheduling resource group regardless of whether your network type is classic or VPC.) Set the machine IP address to the Internet IP address of the master node because the intranet IP address may be inaccessible. The ECS UUID must be connected to the master node management terminal, which can be obtained by running the dmidecode | grep UUID command, as shown in the following figure. (You can use the same method if your Hadoop cluster is not built on E-MapReduce.)

After adding the server, make sure that the network between the master node and DataWorks is connected. If you are using an ECS server, you must set the server security group. If you are using an intranet IP address for

communication, set the server security group. For more information, see *Adding security groups*.

If you are using an Internet IP address, you can directly set the Internet ingress and egress under Security Group Rules(In practical application scenarios, we recommend that you set detailed bypass rules for your data security.)

After completing the preceding steps, install the custom resource group agent as prompted. If the state is available, the custom resource group is added successfully.

If the state is unavailable, you can log on to the master node, and run the `tail - f / home / admin / alisataskn ode / logs / heartbeat . log` command to check whether the heartbeat message between DataWorks and the master node has timed out, as shown in the following figure.

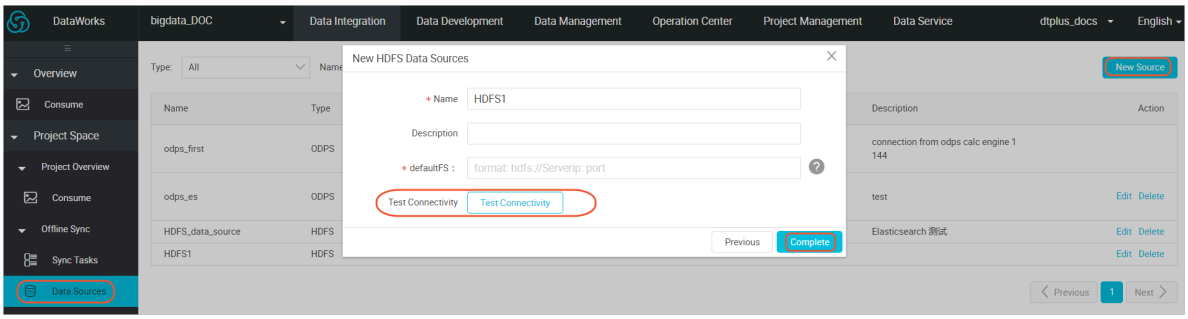
2. Create a data source.

   For more information about how to create a data source in DataWorks, see *Configuring Data Source*.

   After you create a project in DataWorks, the data source is set to `odps_first` by default. Therefore, you only need to add a Hadoop cluster data source. To do so, perform the following steps: On the Data Integration page of DataWorks, choose Data Source > New Source, and select HDFS.

   In the displayed window, enter the data source name and defaultFS. If the E-MapReduce Hadoop cluster is an HA cluster, the address is IP:8020 of hdfs://emr-header-1. If the E-MapReduce Hadoop cluster is a non-HA cluster, the address is IP:9000 of hdfs://emr-header-1. In this topic, emr-header-1 is connected to

DataWorks through the Internet. Therefore, enter the Internet IP address and open the security group.

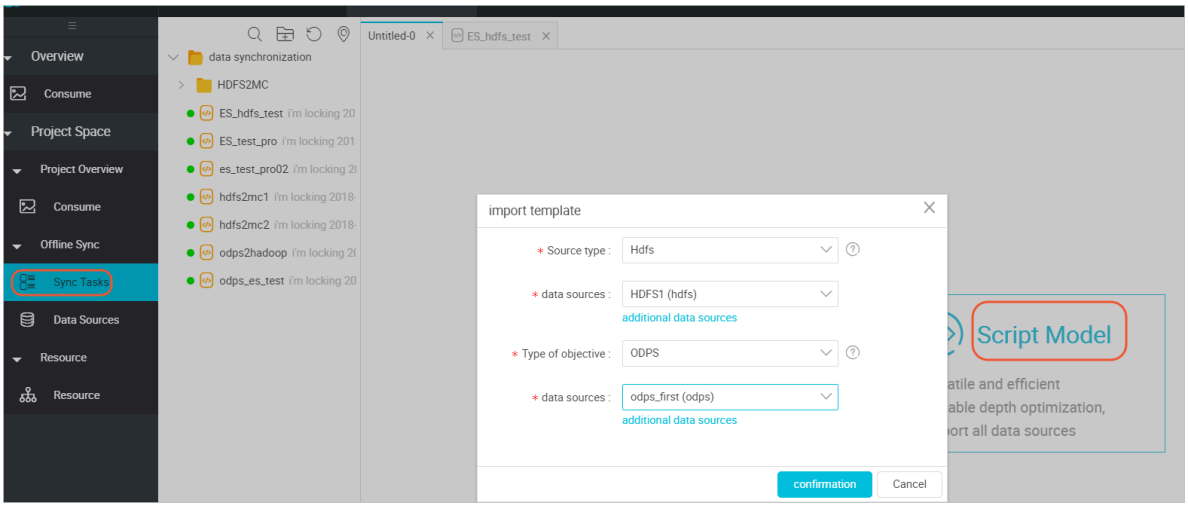


After the configuration is completed, click Test Connectivity. If Test connectivity successfully is displayed, the data source is added successfully.

> **Note:**
> If the network type of the E-MapReduce Hadoop cluster is VPC, the connectivity test is not supported.

3. Configure the data synchronization task.

   On the Data Integration page of DataWorks, click Sync Tasks and create a script mode. In the displayed window, select a data source, as shown in the following figure.



After the template is imported, the synchronization task is converted to the script mode. For more information, see *Script Mode*.

When you configure the data synchronization task script, the data types of the DataWorks synchronization task and the Hive table are as follows.

Data type in the Hivetable	Data type in DataX / DataWorks

TINYINT,SMALLINT,INT,BIGINT	Long
FLOAT,DOUBLE,DECIMAL	Double
String,CHAR,VARCHAR	String
BOOLEAN	Boolean
Date,TIMESTAMP	Date
Binary	Binary

The code details are as follows:

```
{
  " configurat  ion ": {
    " reader ": {
      " plugin ": " hdfs ",
      " parameter ": {
        " path ": "/ user / hive / warehouse / hive_doc_g  ood_sale
 /",
        " datasource ": " HDFS1 ",
        " column ": [
          {
            " index ":  0 ,
            " type ": " string "
          },
          {
            " index ":  1 ,
            " type ": " string "
          },
          {
            " index ":  2 ,
            " type ": " string "
          },
          {
            " index ":  3 ,
            " type ": " string "
          },
          {
            " index ":  4 ,
            " type ": " long "
          },
          {
            " index ":  5 ,
            " type ": " double "
          },
          {
            " index ":  6 ,
            " type ": " long "
          }
        ],
        " defaultFS ": " hdfs :// 121 . 199 . 11 . 138 : 9000 ",
        " fieldDelim  iter ": ",",
        " encoding ": " UTF - 8 ",
        " fileType ": " text "
      }
    },
    " writer ": {
      " plugin ": " odps ",
      " parameter ": {
        " partition ": " pt = 1 ",
```

```
        " truncate ":  false ,
        " datasource ": " odps_first ",
        " column ": [
          " create_tim  e ",
          " category ",
          " brand ",
          " buyer_id ",
          " trans_num ",
          " trans_amou  nt ",
          " click_cnt "
        ],
        " table ": " hive_doc_g  ood_sale "
      }
    },
    " setting ": {
      " errorLimit ": {
        " record ": " 1000 "
      },
      " speed ": {
        " throttle ":  false ,
        " concurrent ":  1 ,
        " mbps ": " 1 ",
        " dmu ":  1
      }
    }
  },
  " type ": " job ",
  " version ": " 1 . 0 "
}
```

The path parameter indicates the place where the data is stored in the Hadoop cluster. You can log on to the master node and run the `hdfs  dfs  - ls  / user / hive / warehouse / hive_doc_g  ood_sale` command to confirm the place. For a partition table, you do not need to specify the partitions. The data synchronization feature of DataWorks can automatically recurse to the partition path, as shown in the following figure.

```
[root@emr-header-1 logs]# hdfs dfs -ls /user/hive/warehouse/hive_doc_good_sale/
Found 1 items
drwxr-x--x   - hive hadoop          0 2018-09-03 17:46 /user/hive/warehouse/hive_doc_good_sale/pt=1
```

After the configuration is completed, click Run. If a message is displayed indicating that the task is executed successfully, the synchronization task is completed. If a message is displayed indicating that the task failed to be executed, copy the logs for further troubleshooting.

Verify the results

In the DataWorks console, choose Data Development > Table Query and select the `hive_doc_g  ood_sal e` table. You can check whether the Hive data has been synchronized to MaxCompute. You can also create a table query task, enter the

`select * FROM hive_doc_good_sale where pt = 1;` script in the task, and click Run to query the results.

You can also enter `select * FROM hive_doc_good_sale where pt = 1;` in the odpscmd CLI tool to query the table results.

Migrate data from MaxCompute to Hadoop

To migrate data from MaxCompute to Hadoop, perform the preceding steps but exchange the reader and writer objects in the synchronization script. The following is an example:

```
{
  " configurat  ion ": {
    " reader ": {
      " plugin ": " odps ",
      " parameter ": {
      " partition ": " pt = 1 ",
      " isCompress ":  false ,
      " datasource ": " odps_first ",
      " column ": [
        " create_tim  e ",
        " category ",
        " brand ",
      " buyer_id ",
      " trans_num ",
      " trans_amou  nt ",
      " click_cnt "
    ],
    " table ": " hive_doc_g  ood_sale "
    }
  },
  " writer ": {
    " plugin ": " hdfs ",
    " parameter ": {
    " path ": "/ user / hive / warehouse / hive_doc_g  ood_sale ",
    " fileName ": " pt = 1 ",
    " datasource ": " HDFS_data_  source ",
    " column ": [
      {
        " name ": " create_tim  e ",
        " type ": " string "
      },
      {
        " name ": " category ",
        " type ": " string "
      },
      {
        " name ": " brand ",
        " type ": " string "
      },
      {
        " name ": " buyer_id ",
        " type ": " string "
      },
      {
        " name ": " trans_num ",
```

```
          " type ": " BIGINT "
        },
        {
          " name ": " trans_amou  nt ",
          " type ": " DOUBLE "
        },
        {
          " name ": " click_cnt ",
          " type ": " BIGINT "
        }
      ],
      " defaultFS ": " hdfs :// 47 . 99 . 162 . 100 : 9000 ",
      " writeMode ": " append ",
      " fieldDelim  iter ": ",",
      " encoding ": " UTF - 8 ",
      " fileType ": " text "
      }
    },
    " setting ": {
      " errorLimit ": {
        " record ": " 1000 "
    },
    " speed ": {
      " throttle ":  false ,
      " concurrent ":  1 ,
      " mbps ": " 1 ",
      " dmu ":  1
    }
    }
},
" type ": " job ",
" version ": " 1 . 0 "
}
```

Before executing the preceding synchronization task, you must set the Hadoop cluster. For more information, see *Configure HDFS Writer*. After executing the synchronization task, you need to manually copy the synchronized files.

2.2 Migrate data from RDS to MaxCompute to implement dynamic partitioning

This topic describes how to use the data synchronization feature of DataWorks to automatically create partitions and dynamically migrate data from RDS to MaxCompute.

Preparations

1. *Activate MaxCompute* and *Create a project* in China (Beijing).

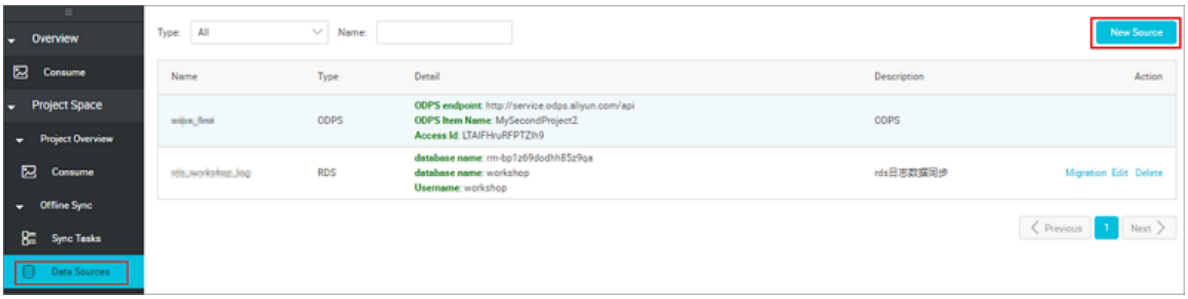
Note:

If you are using DataWorks for the first time, you need to complete the operations described in *Preparation*. For example, you need to get your account ready, set the project role, and configure the project.

2. Add data sources.

   Add *RDS* as the data source and add *ODPS* as the destination data source for receiving the RDS data.

   After completing the settings, click New Source on the data integration page. Then, added data sources are displayed, as shown in the following figure.



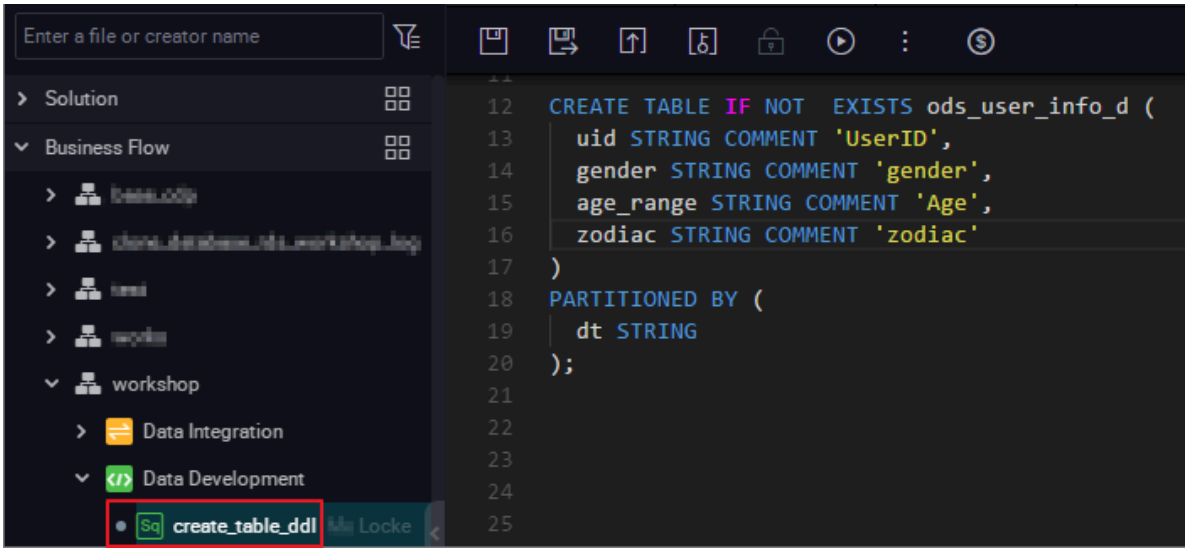
Create a partition

After the preparations are completed, the data in RDS needs to be synchronized to MaxCompute on a daily basis, so that the date-based partition can be automatically created. For more information about how to configure a data synchronization task, see *Data development and O&M in DataWorks*.

1. Create a destination table.

   In the ODPS database, create a destination table named ods_user_info_d. This table corresponds to a table in RDS. Under Data Development, right-click Create ODPS

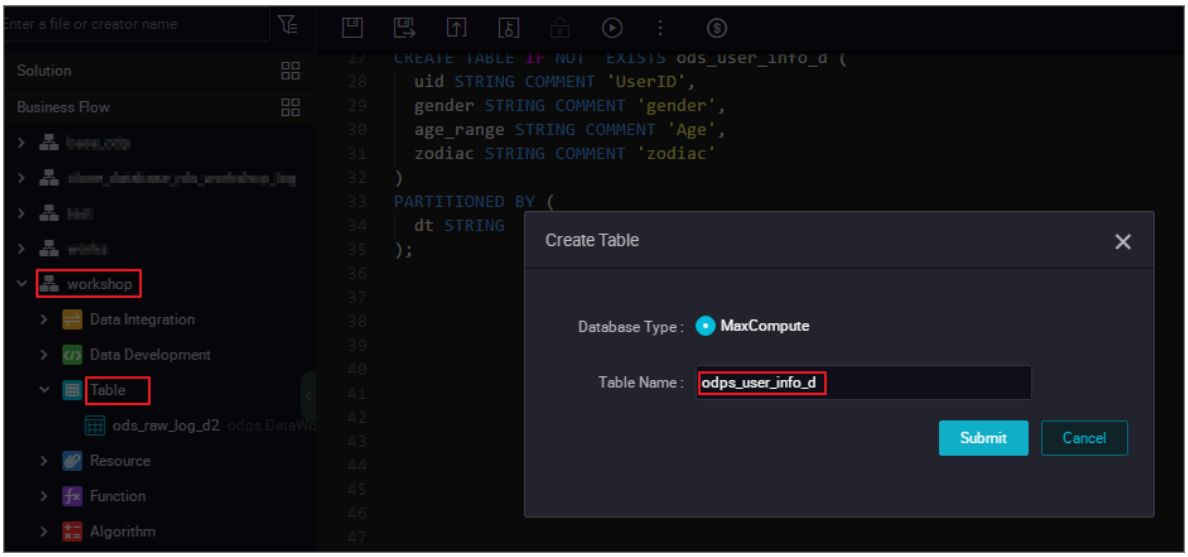
SQL Node, create a node named create_table_ddl, and enter the table creation statements, as shown in the following figure.



The SQL statements are as follows:

```
CREATE TABLE IF NOT EXISTS ods_user_i nfo_d (
uid STRING COMMENT ' UserID ',
gender STRING COMMENT ' gender ',
age_range STRING COMMENT ' Age ',
zodiac STRING COMMENT ' zodiac '
)
PARTITIONE D BY (
dt STRING
);
```

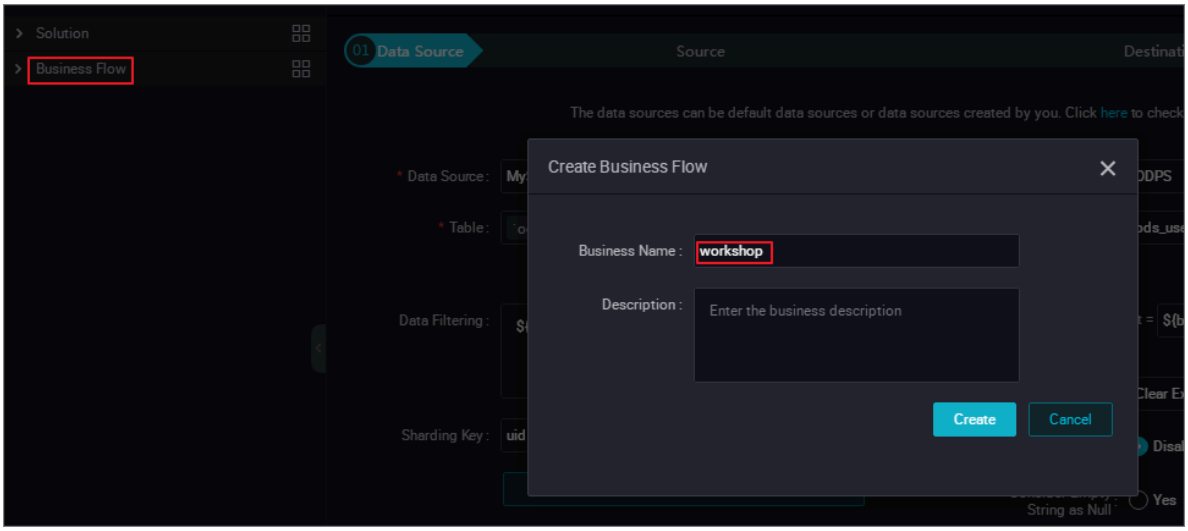
You can also choose Business Flow > Table and select Create Table, as shown in the following figure.



For more information, see *Create a table and upload data*.

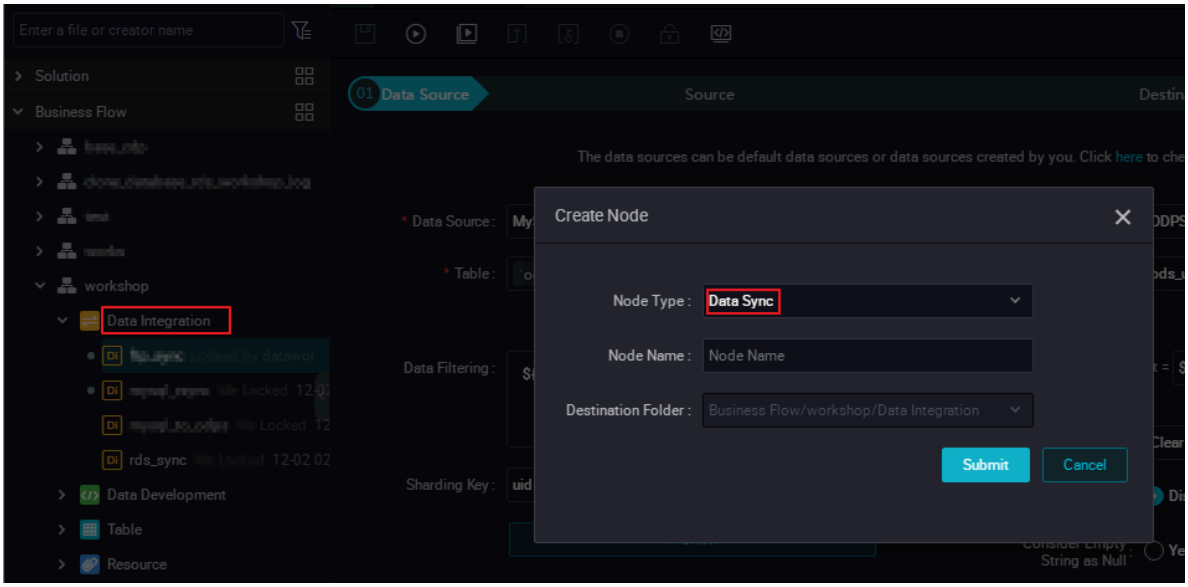
2. Create a business flow.

   Log on to the DataWorks console and click Data Analytics. Right-click Business Flow and select Create Business Flow to create a workshop, as shown in the following figure.

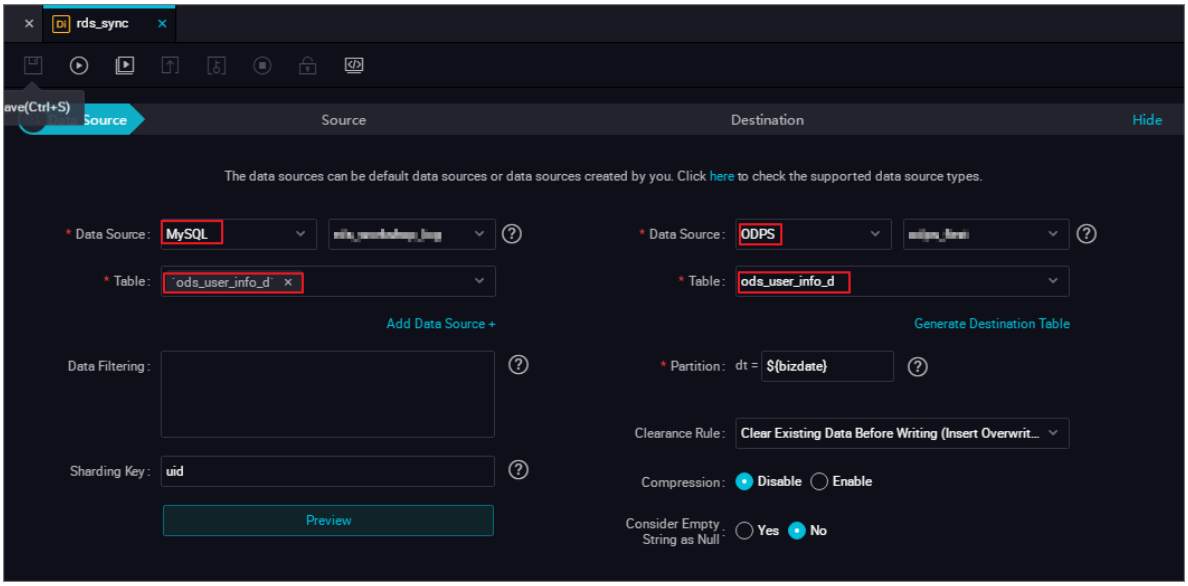


3. Create and configure a synchronization task node.

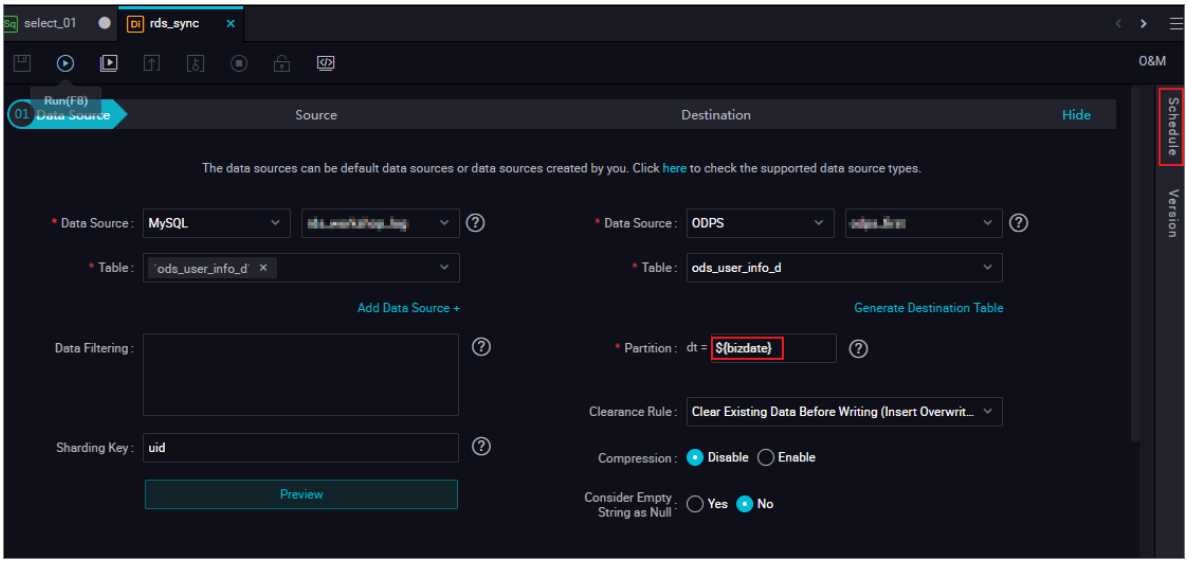
   Create a synchronization node named rds_sync under the workshop business flow, as shown in the following figure.



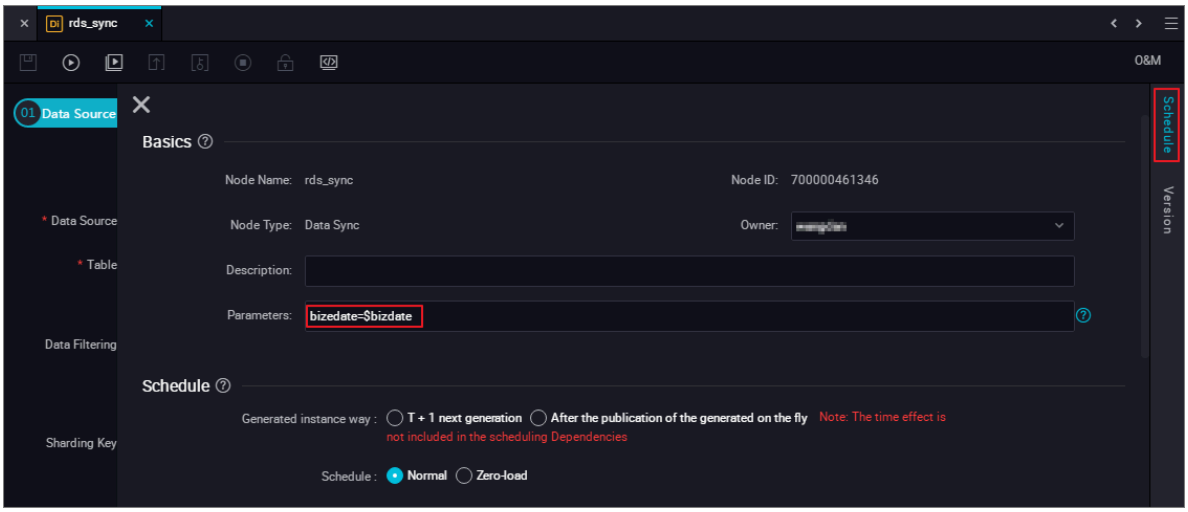
4. Select the data source and data destination, as shown in the following figure.



5. Set the parameters, as shown in the following figure.



Click Schedule. On the displayed Basics page, the default value of `Parameters` is `${ bizdate }` in yyyymmdd format, as shown in the following figure.



Note:

By default, the value of `Parameters` corresponds to the value of Partition on the Destination tab page. The partition date is called business date. In most cases, users process the business data generated in the previous day. Therefore, when the data synchronization task is scheduled and executed, the partition date is automatically replaced with the date one day before the task execution date.

To use the task execution date as the partition value (partition date), you must customize the parameter.

- The custom parameter can be configured in different formats. You can select a date and a format as needed. The custom parameter can be set in one of the following formats:
  - N years later: `$[ add_months ( yyyymmdd , 12 * N )]`
  - N years ago: `$[ add_months ( yyyymmdd ,- 12 * N )]`
  - N months ago: `$[ add_months ( yyyymmdd ,- N )]`
  - N weeks later: `$[ yyyymmdd + 7 * N ]`
  - N months later: `$[ add_months ( yyyymmdd , N )]`
  - N weeks ago: `$[ yyyymmdd - 7 * N ]`
  - N days later: `$[ yyyymmdd + N ]`
  - N days ago: `$[ yyyymmdd - N ]`
  - N hours later: `$[ hh24miss + N / 24 ]`
  - N hours ago: `$[ hh24miss - N / 24 ]`
  - N minutes later: `$[ hh24miss + N / 24 / 60 ]`
  - N minutes later: `$[ hh24miss - N / 24 / 60 ]`

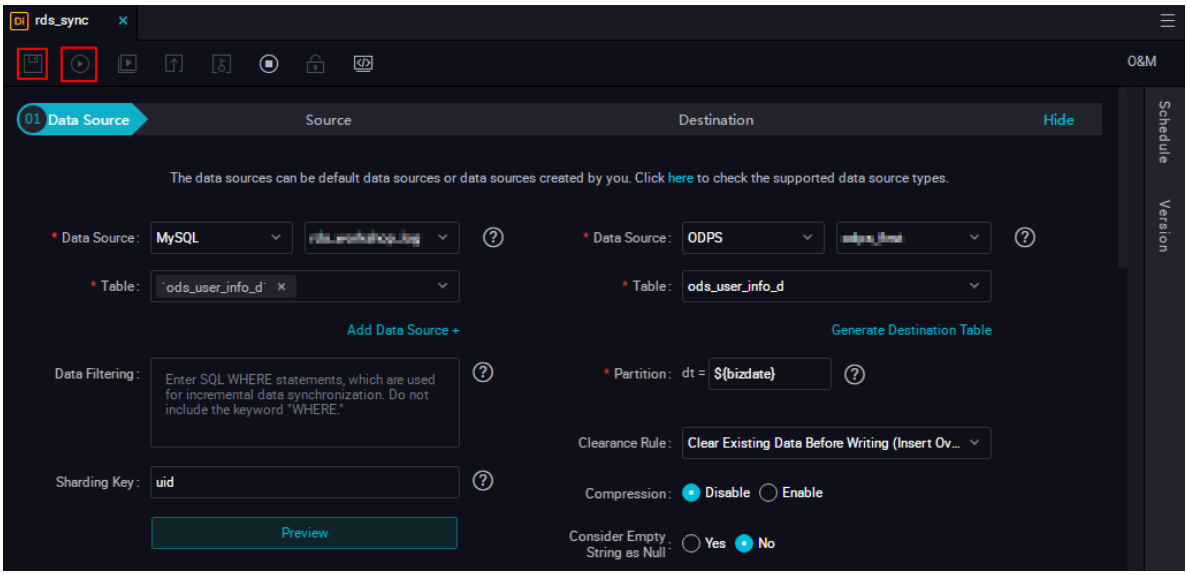
 Note:

- You need to use brackets ([]) to edit the value calculation formula of the custom parameter, for example, `key1 =$[ yyyy - mm - dd ]`.
- The default calculation unit of the custom parameter is day. For example, `$[ hh24miss - N / 24 / 60 ]` indicates `( yyyymmddhh 24miss -( N / 24 / 60 * 1 day ))`. The hour, minute, and second are in the format of hh24miss.
- The calculation unit of add_months is month. For example, `$[ add_months ( yyyymmdd , 12 N )- M / 24 / 60 ]` indicates `( yyyymmddhh 24miss -( 12 * N * 1 month ))-( M / 24 / 60 * 1 day )`. The year, month, and day are in the format of `yyyymmdd` .

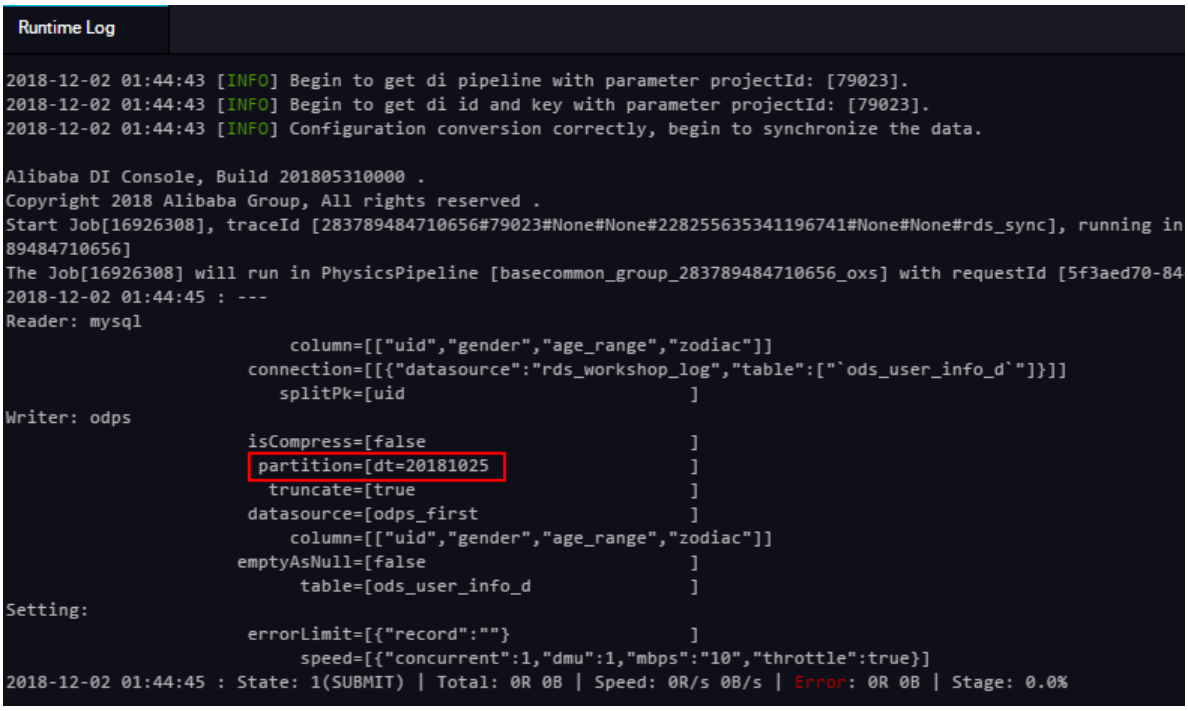
For more information, see *Parameter configuration*.

6. Perform the test run.

   Click Save to save all configurations, and click Run, as shown in the following figure.

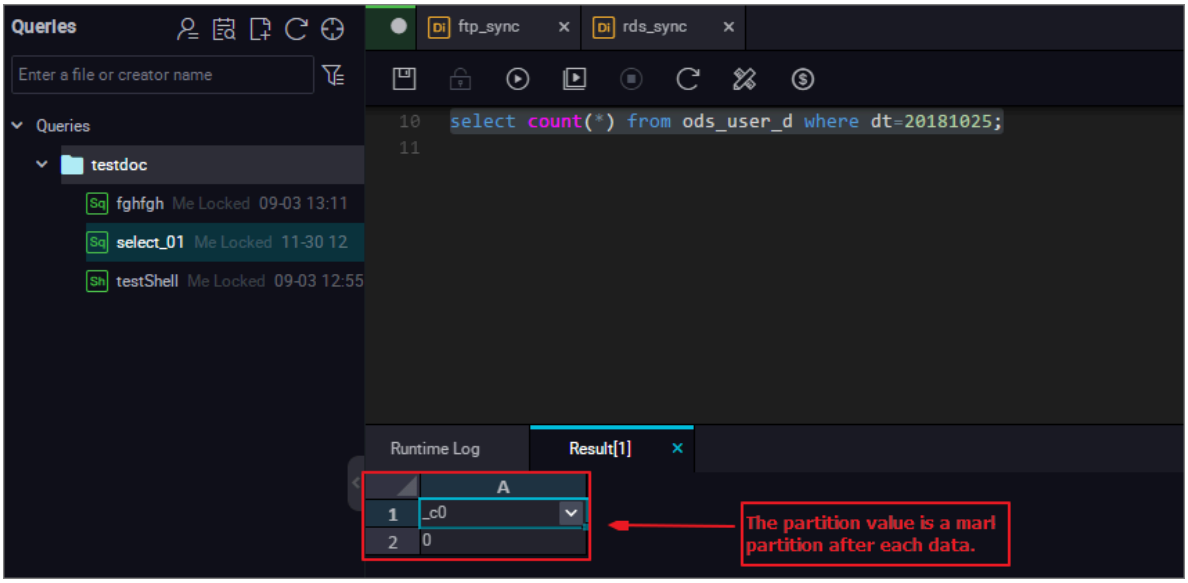


   View the running log, as shown in the following figure.



   In the sample log shown in the preceding figure, the partition value in MaxCompute (whose printed name is ODPS) is dt=20181025. This indicates that

the partition value is automatically replaced. Verify that the data is successfully migrated to the ODPS table, as shown in the following figure.



Note:

In MaxCompute 2.0, parameter settings are required for partition table query. Full query is not supported. The SQL statements are as follows:

```
-- Check whether the data is successful ly written to MaxCompute .
select count (*) from ods_user_i nfo_d where dt = business date ;
```

For more information about the `SELECT` command, see *Introduction to the SELECT syntax*.

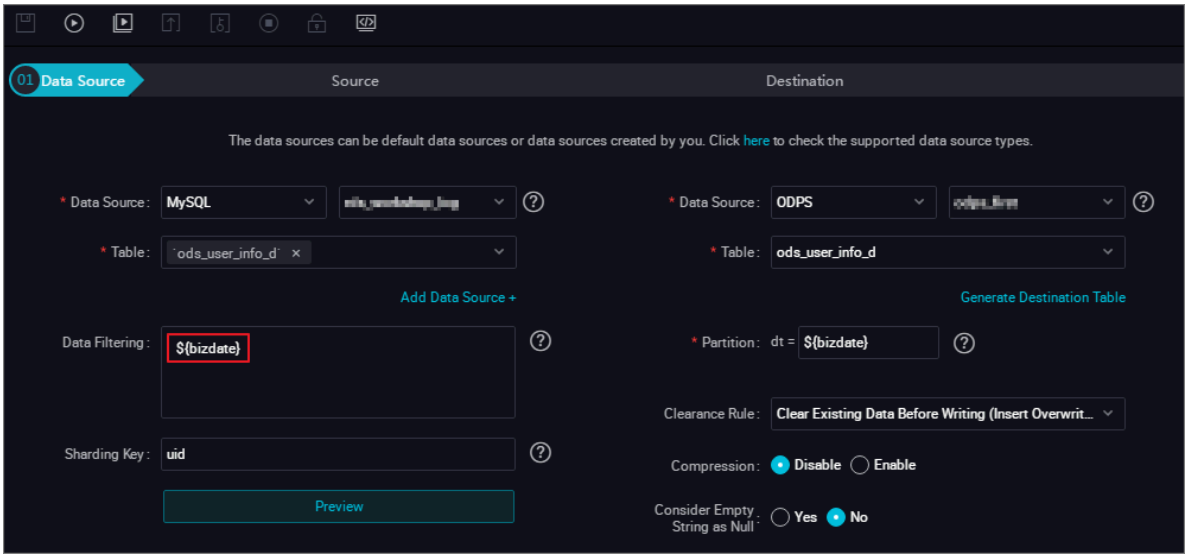
Now the data has been migrated to the ODPS table and a partition value has been successfully created. Then, when the task is executed at scheduled time, the data in RDS is automatically synchronized to the date-based partition in MaxCompute.

Data patching

If you have many historical data that is generated before the execution date, and you want to implement automatic synchronization and partitioning, you can log on to the DataWorks console, click Maintenance Center, select the data synchronization node, and click Patch Data.

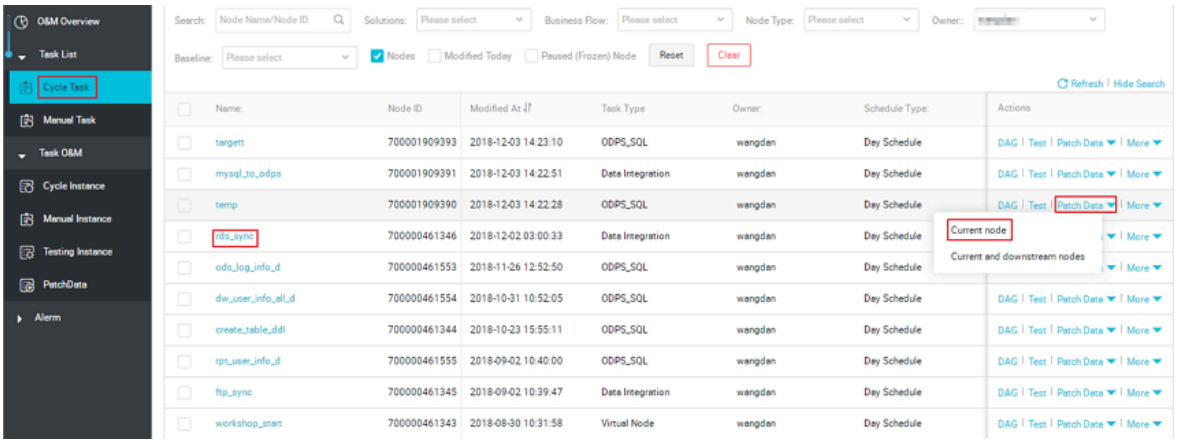
1. Filter the historical data in RDS by date. For example, filter the historical data generated on 2018-09-13, so that the data can be automatically synchronized to the

20180825 partition in MaxCompute. You can use a WHERE clause to filter data in RDS, as shown in the following figure.

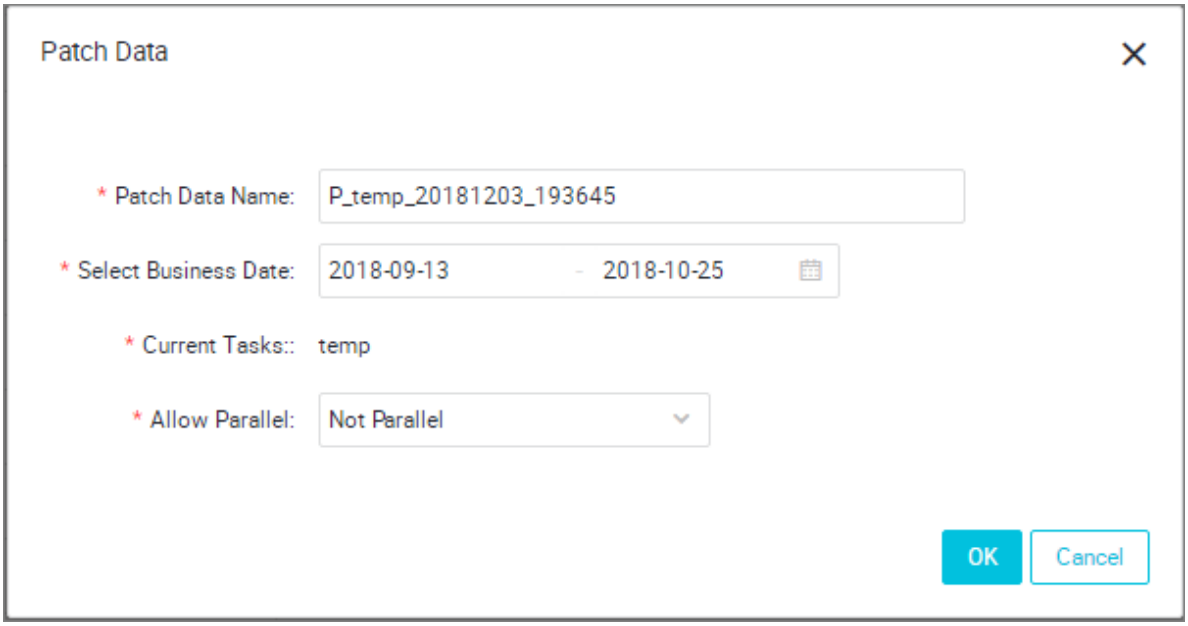


2. Perform data patching.

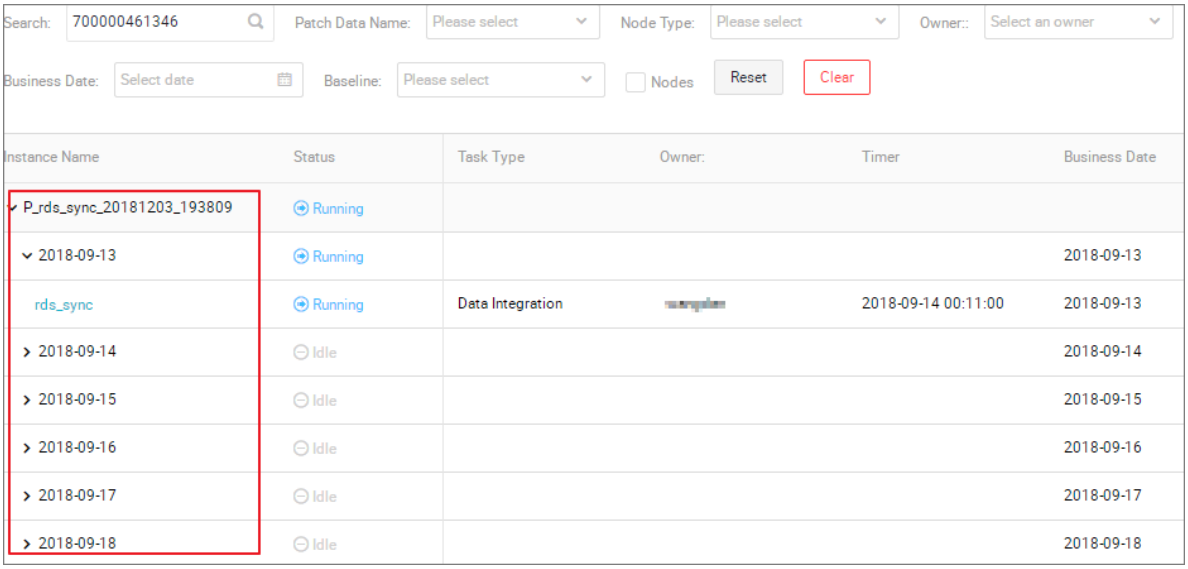
   Choose Save > Submit. After the data is submitted, choose Maintenance Center > Task List > Cycle Task, select the rds_sync node, and choose Patch Data > Current node, as shown in the following figure.



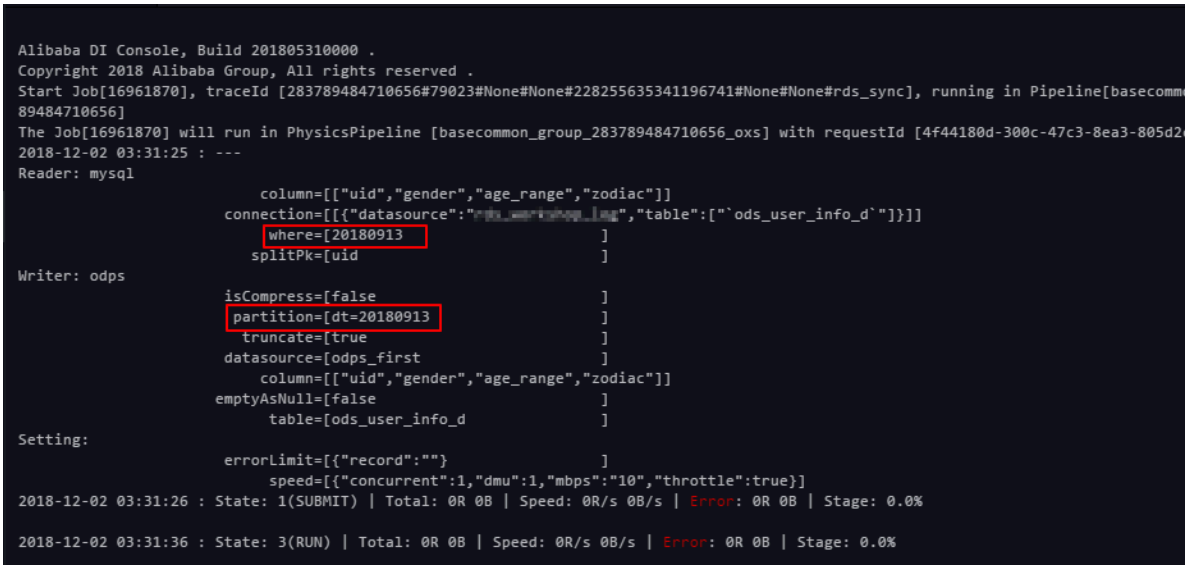
3. On the displayed Patch Data page, select the business date, and click OK, as shown in the following figure.



4. Multiple synchronization task instances are generated at the same time and executed in sequence, as shown in the following figure.



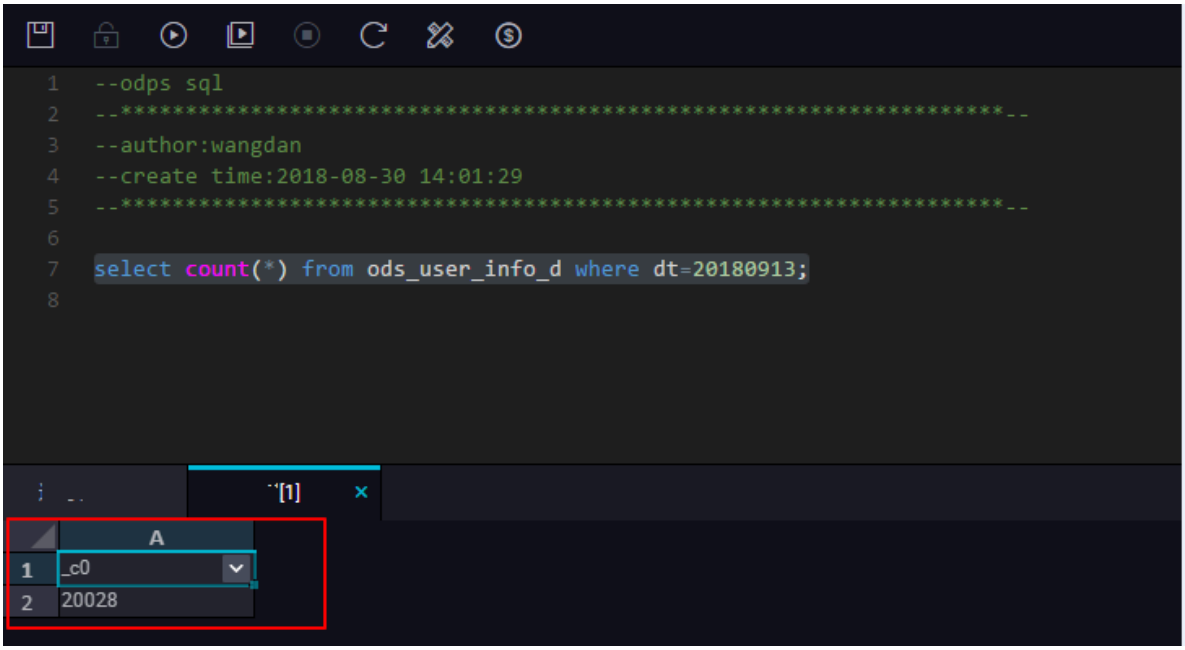
5. View the running log. You can see the process of extracting data from RDS, as shown in the following figure.



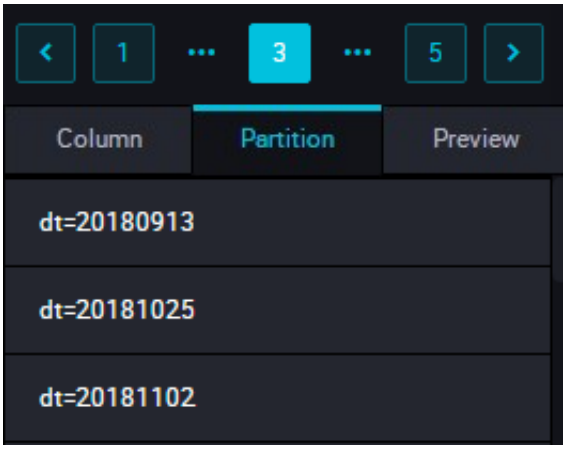
A partition has been automatically created in MaxCompute.

6. View the results.

   You can check whether the data is written successfully, whether a partition is created, and whether the data is synchronized to the partition table, as shown in the following figure.



   Query the partition information, as shown in the following figure.



   Note:

   In MaxCompute 2.0, parameter settings are required for partition table query. The partition column needs to be updated to the business date. If the task execution date is 20180717, the business date is 20180716. The SQL statements are as follows:

```
-- Check whether the data is successful ly written
 to MaxCompute .
```

```
select count (*) from ods_user_i nfo_d where dt =
business date ;
```

Create a partition by non-date field using hash

If a huge volume of data needs to be processed, or if a full amount of data is partitione d according to a non-date field (such as province) at the first time, a data partition cannot be created automatically during data integration. Therefore, you can use the hash algorithm to save the same values in an RDS field to the corresponding partition in MaxCompute.

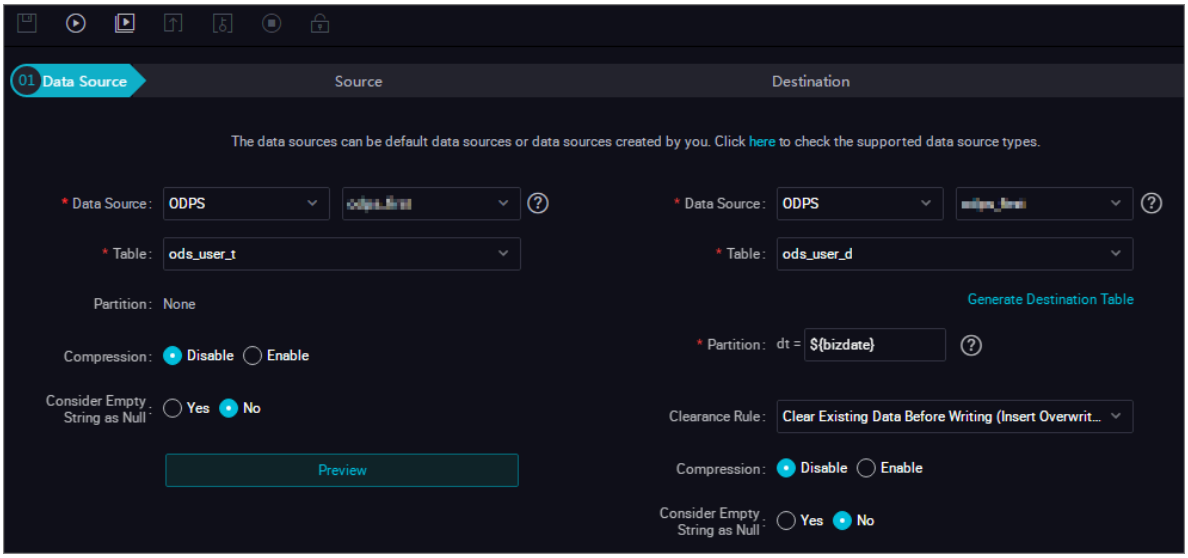
The procedure is as follows:

1. Synchronize the full amount of data to a temporary table in MaxCompute. Create an SQL script node and choose Run > Save > Submit.

   The SQL statements are as follows:

   ```
   drop table if exists ods_user_t ;
   CREATE TABLE ods_user_t (
           dt STRING ,
    uid STRING ,
           gender STRING ,
           age_range STRING ,
           zodiac STRING );
   insert overwrite table ods_user_t select dt , uid ,
   gender , age_range , zodiac from ods_user_i nfo_d ;-- Save
   the data in the ODPS table to the temporary table
   .
   ```

2. Create a synchronization task node named mysql_to_odps to synchronize the full amount of RDS data to MaxCompute without setting the partition, as shown in the following figure.

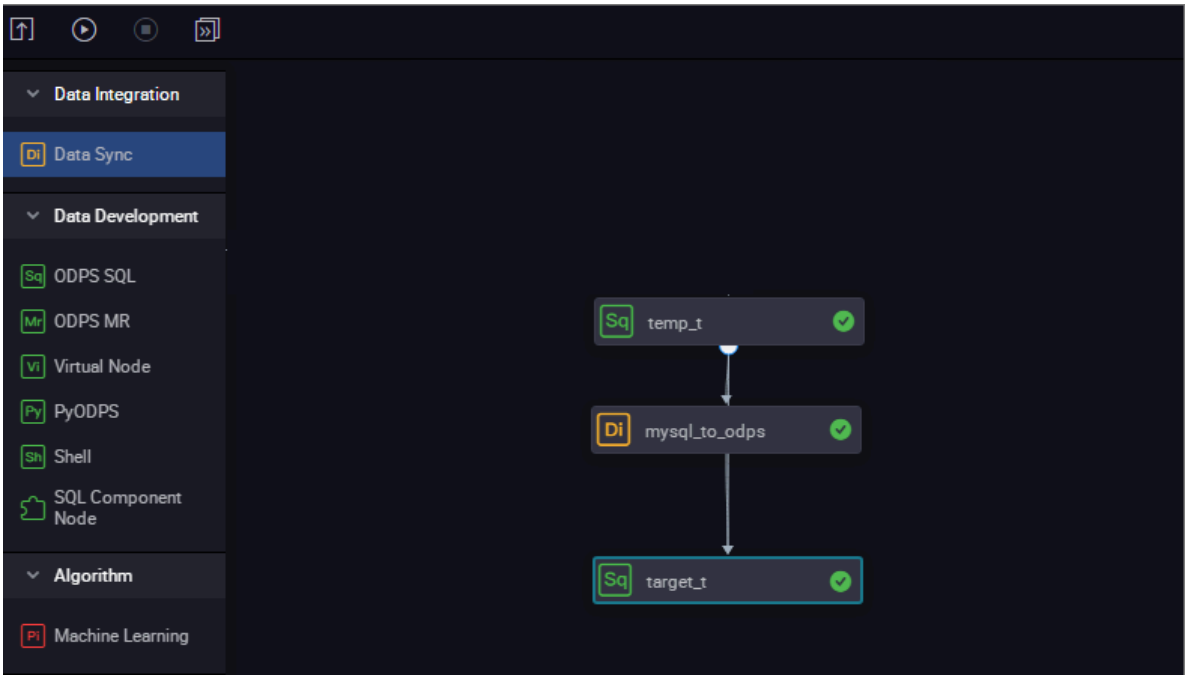


3. Use SQL statements to dynamically create a partition for the destination table. The SQL statements are as follows:

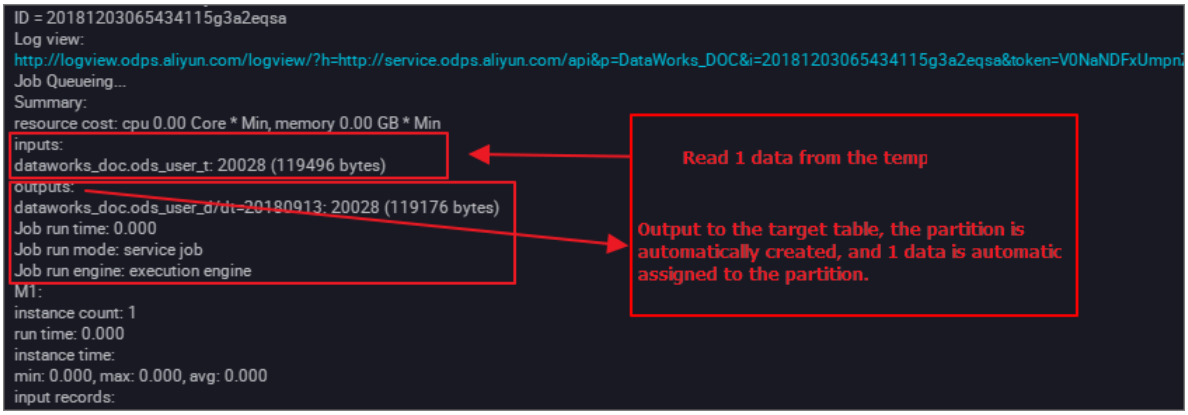
```
 drop   table   if   exists   ods_user_d ;
// Create   a   partition   table  ( the   destinatio  n   table )
 in   ODPS .
  CREATE   TABLE   ods_user_d  (
  uid   STRING ,
         gender   STRING ,
         age_range   STRING ,
         zodiac   STRING
)
 PARTITIONE  D   BY  (
  dt   STRING
);
// Execute   the   dynamic   partitioni  ng   SQL   statements   to
   automatica  lly   create   a   partition   according   to   the
   dt   field   in   the   temporary   table .  The   partition
 value   is   automatica  lly   created   for   a   data   record
 .  Data   records   that   share   the   same   dt   value   have
 the   same   partition   field   value .
// For   example ,  some   data   records   share   the   value
   20180913   in   the   dt   field .  As   a   result ,  a
 partition   is   automatica  lly   created   in   the   MaxCompute
   partition   table   with   a   partition   value   of   20181025
 .
// The   dynamic   partitioni  ng   SQL   statements   are   as
 follows :
// A   date_time   field   is   added   in   the   select   field ,
 indicating   that   a   partition   is   automatica  lly   created
   according   to   this   field .
 insert   overwrite   table   ods_user_d   partition ( dt ) select
 dt , uid , gender , age_range , zodiac   from   ods_user_t ;
// After   the   import   is   completed ,  you   can   delete   the
   temporary   table   to   reduce   excessive   storage   costs .
 drop   table   if   exists   ods_user_t ;
```

In MaxCompute, you can synchronize data using SQL statements. For more information about the SQL statements. see *How to use partition tables in Alibaba Cloud MaxCompute.*

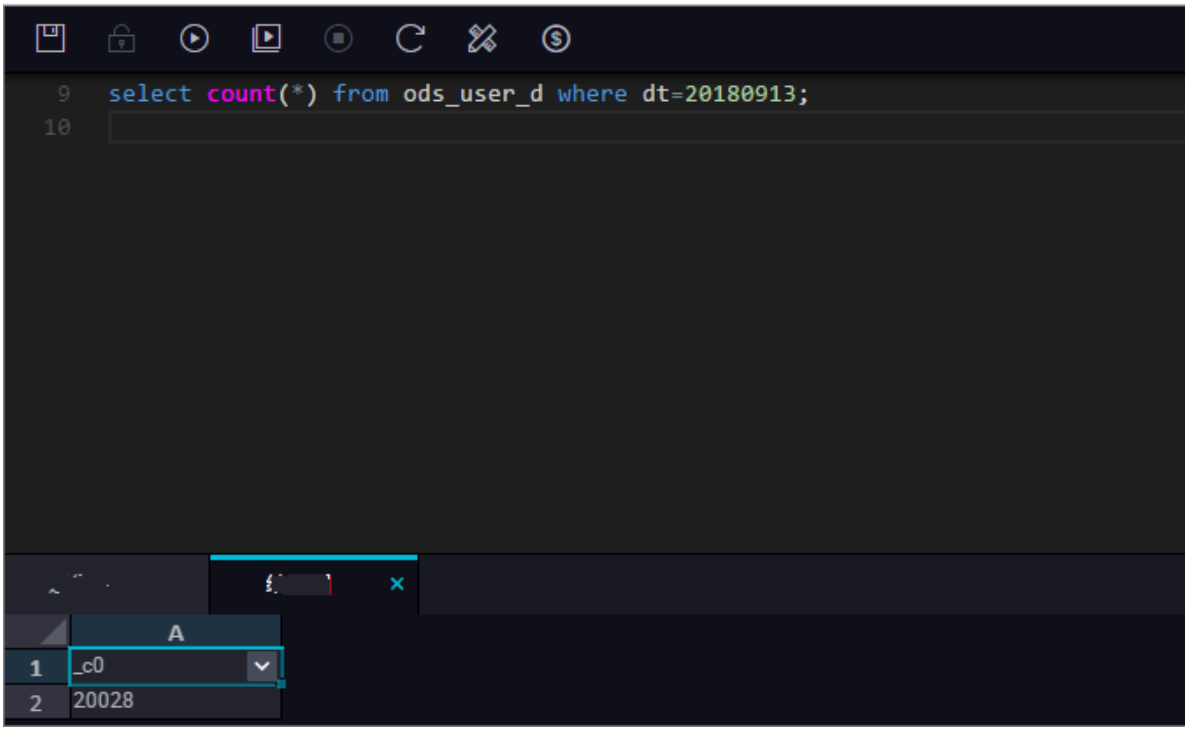
4. Configure the three nodes to form a workflow and execute these nodes in sequence, as shown in the following figure.



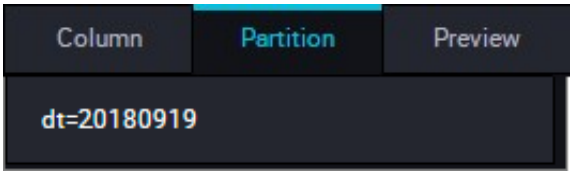
5. View the execution process. The last node represents the process of dynamic partitioning, as shown in the following figure.



View data. Dynamic partitioning is completed automatically. Data records with the same date are synchronized to the same partition, as shown in the following figure.



Query the partition information, as shown in the following figure.



You can follow the preceding steps to name a partition using the province field.

The data synchronization feature of DataWorks supports automatic data operations, including data synchronization, data migration, and data synchronization task

scheduling. For more information about scheduling configuration, see *Time attributes* in Scheduling Configuration.

2.3 Migrate JSON data from MongoDB to MaxCompute

This topic describes how to use the data integration feature of DataWorks to extract JSON fields from MongoDB to MaxCompute.

Preparations

1. Prepare an account.

   Create a user in the database in advance to add data sources in DataWorks. In this example, you can run the `db . createUser ({ user :" bookuser ", pwd :" 123456 ", roles :[" root "]})` command to create a user named `bookuser .` The password of the user is `123456` , and the permission is `root .`

2. Prepare data.

   Upload data to your MongoDB. In this example, Alibaba Cloud ApsaraDB for MongoDB is used. The network type is VPC. (An Internet IP address is required for MongoDB to communicate with the default resource group of DataWorks.) The test data is as follows:

```
{
    " store ": {
        " book ": [
            {
               " category ": " reference ",
               " author ": " Nigel   Rees ",
               " title ": " Sayings   of   the   Century ",
               " price ":  8 . 95
            },
            {
               " category ": " fiction ",
               " author ": " Evelyn   Waugh ",
               " title ": " Sword   of   Honour ",
               " price ":  12 . 99
            },
            {
                " category ": " fiction ",
                " author ": " J .  R .  R .  Tolkien ",
                " title ": " The   Lord   of   the   Rings ",
                " isbn ": " 0 - 395 - 19395 - 8 ",
                " price ":  22 . 99
            }
        ],
        " bicycle ": {
            " color ": " red ",
            " price ":  19 . 95
        }
    },
```

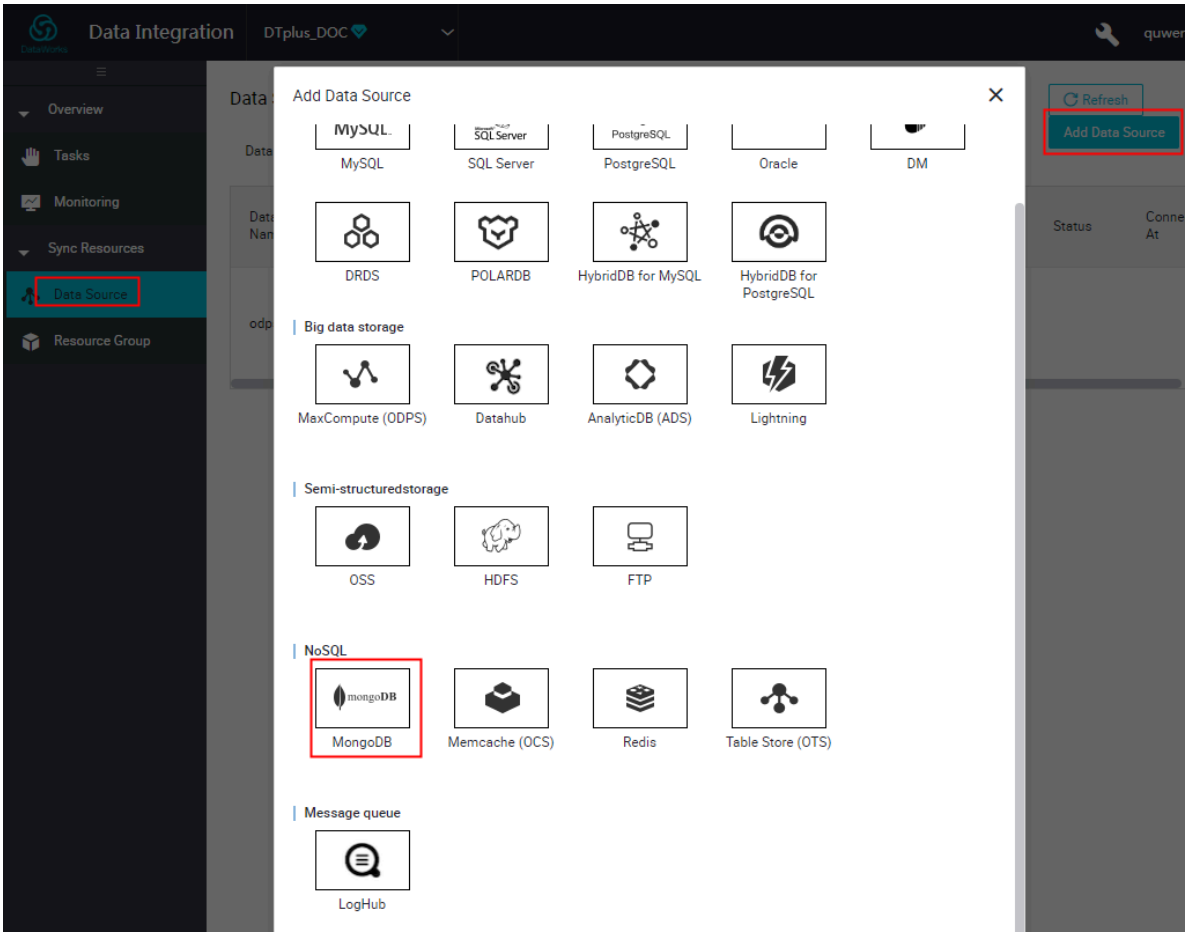
```
    " expensive ":  10
}
```

Log on to the DMS console of MongoDB. In this example, the database name is `admin` and the collection is `userlog` . You can run the `db . userlog . find (). limit ( 10 )` command in the query window to view the uploaded data.

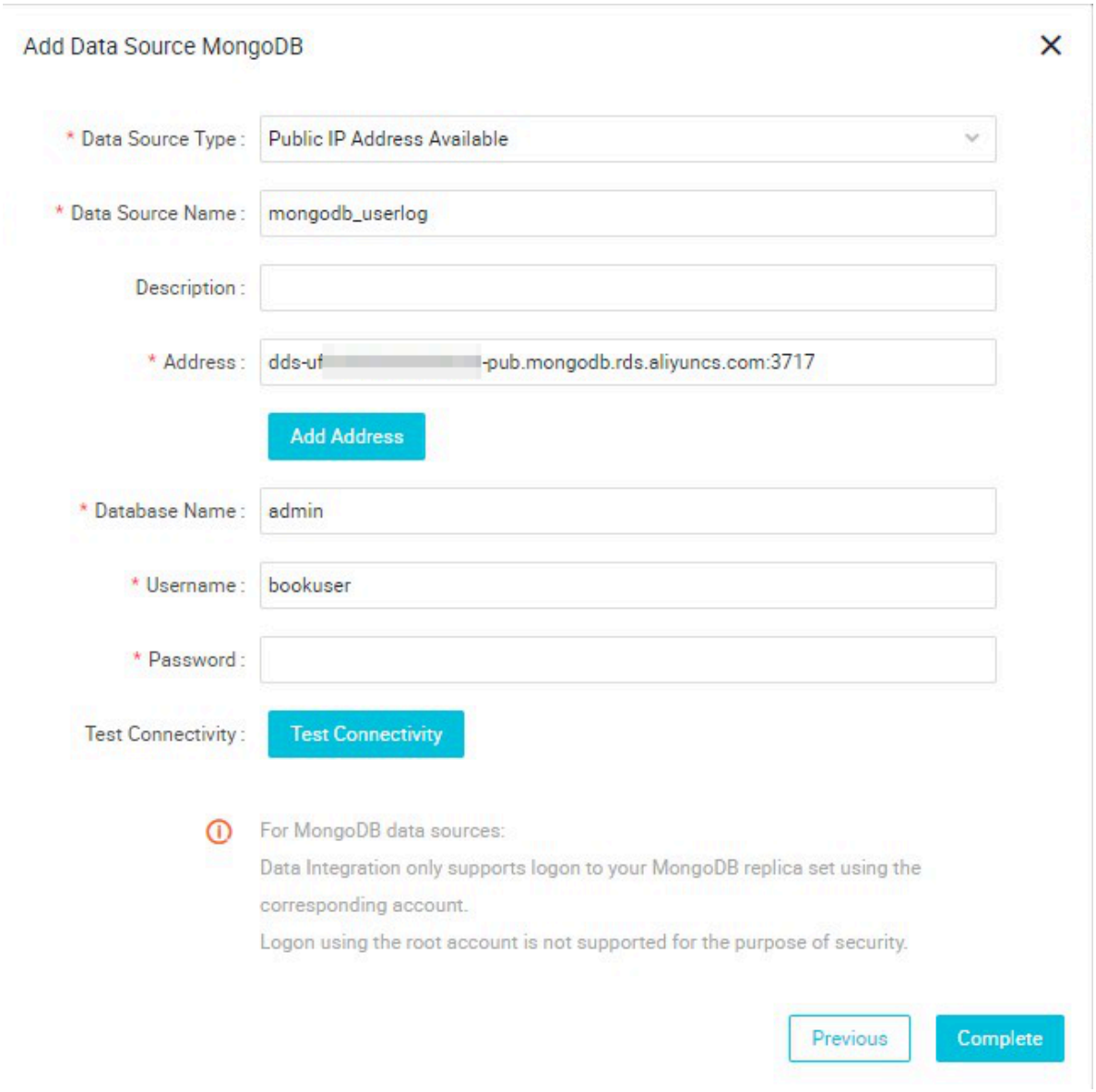
Use DataWorks to extract data to MaxCompute

- 1. Add a MongoDB data source.

  In the DataWorks console, go to the *Data Integration* page and add a *MongoDB* data source.



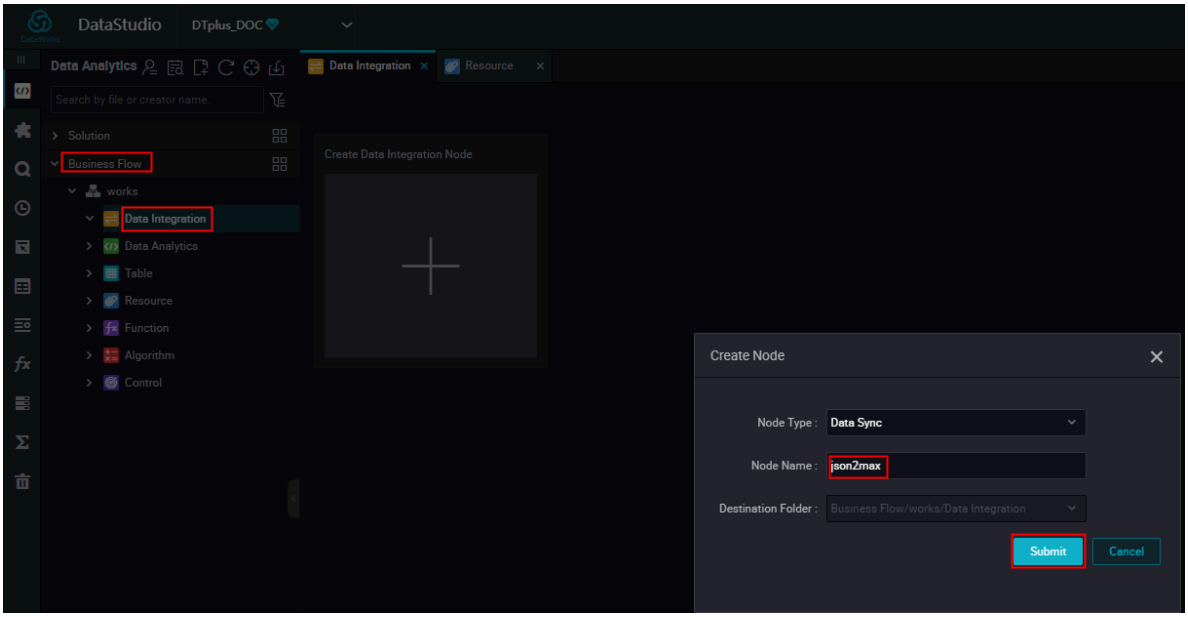
  The parameters are shown in the following figure. Click Complete after the connectivity test is successful. In this example, the network type of MongoDB is VPC. Therefore, the Data Source Type must be set to Public IP Address Available.



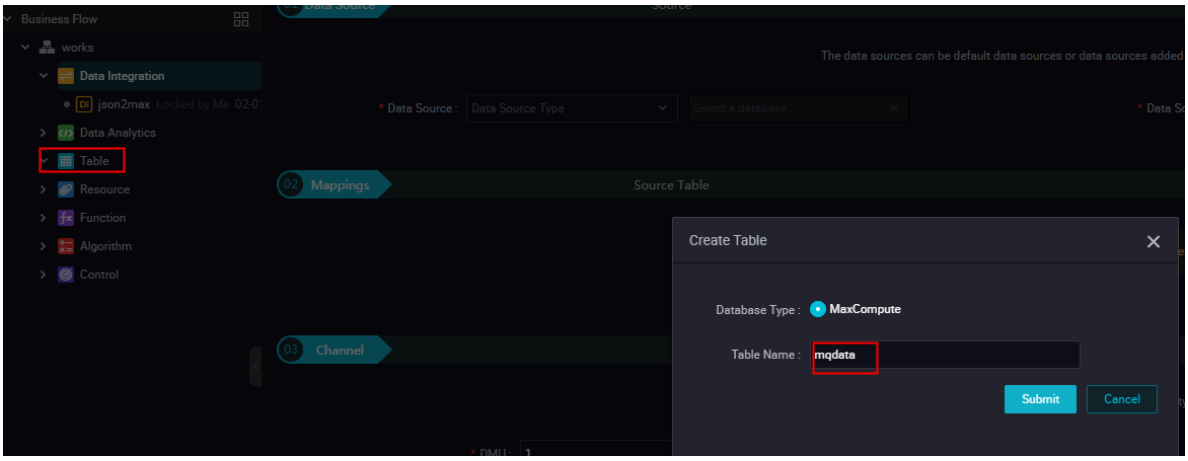
To obtain the IP address and the port number, log on to the and click the target instance. Example parameters are shown in the following figure.

- 2. Create a data synchronization task.

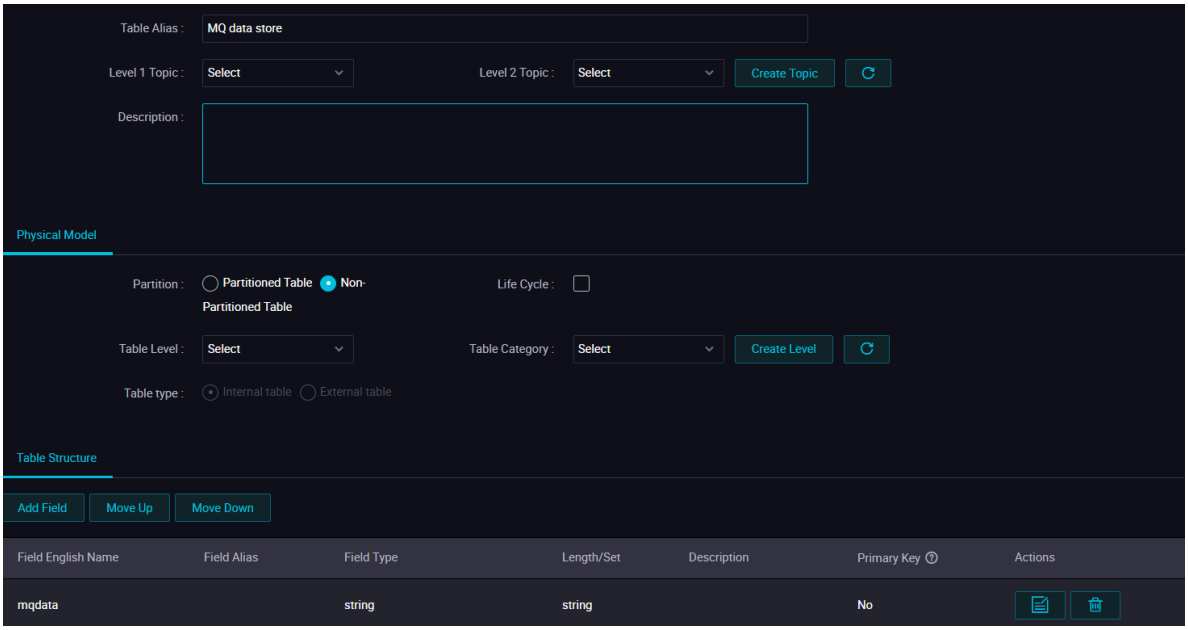
  In the DataWorks console, create a data synchronization node. For more information, see *Configure OSS Reader*.



  At the same time, create a table named mqdata in DataWorks to store JSON data. For more information, see *Create a table*.



  You can set the table parameters on the graphical interface. The mqdata table has only one column, which is named MQ data. The data type is string.



- 3. Set the parameters.

  After creating a table, you can set the data synchronization task parameters on the graphical interface. First, set the destination data source to odps_first and the destination table to mqdata. Then, set the original data source to MongoDB and select mongodb_userlog. After completing the preceding settings, click Switch to script mode. The following is an example of the code in script mode:

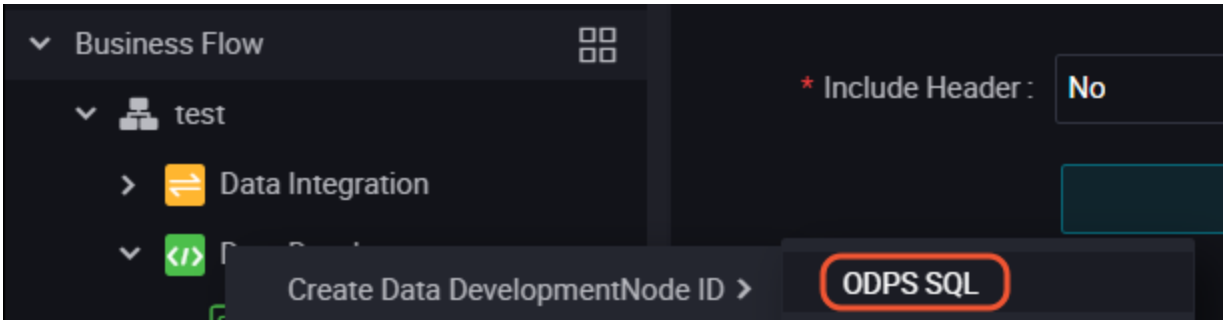
```
{
    " type ": " job ",
    " steps ": [
        {
            " stepType ": " mongodb ",
            " parameter ": {
                " datasource ": " mongodb_us  erlog ",
// Data   source   name
                " column ": [
                    {
                        " name ": " store . bicycle . color ", //
JSON   field   path .  In   this   example ,  the   value   of
color   is   extracted .
                        " type ": " document . document . string
" // The   number   of   fields   in   this   line   must   be
the   same   as   that   in   the   preceding   line  ( the   name
  line ).  If   the   JSON   field   is   a   level - 1   field
,  for   example ,  the   expensive   field   in   this   topic ,
enter   the   string .
                    }
                ],
                " collection  Name  // Collection   name ": "
userlog "
            },
            " name ": " Reader ",
            " category ": " reader "
        },
        {
```

```
            " stepType ": " odps ",
            " parameter ": {
                " partition ": "",
                " isCompress ":  false ,
                " truncate ":  true ,
                " datasource ": " odps_first ",
                " column ": [
                        " mqdata " // Table   column   name   in
 MaxCompute
                ],
                " emptyAsNul  l ":  false ,
                " table ": " mqdata "
            },
            " name ": " Writer ",
            " category ": " writer "
        }
    ],
    " version ": " 2 . 0 ",
    " order ": {
        " hops ": [
            {
                " from ": " Reader ",
                " to ": " Writer "
            }
        ]
    },
    " setting ": {
        " errorLimit ": {
            " record ": ""
        },
        " speed ": {
            " concurrent ":  2 ,
            " throttle ":  false ,
            " dmu ":  1
        }
    }
}
```

After completing the preceding settings, click Run. If the following information is displayed, the code has run successfully.

Verify the result

Create an ODPS SQL node in your *Business Flow*.



Enter the `SELECT * from mqdata ;` statement to view the data in the mqdata table. You can also run the `SELECT * from mqdata ;` command on the *MaxCompute client* to view the data.

2.4 Migrate JSON data from OSS to MaxCompute

This topic describes how to use the data integration feature of DataWorks to migrate JSON data from OSS to MaxCompute and use the built-in string function GET_JSON_OBJECT of MaxCompute to extract JSON information.

Preparations

- **Upload data to OSS.**

  Convert your JSON file to a TXT file and upload it to OSS. The following is a JSON file example:

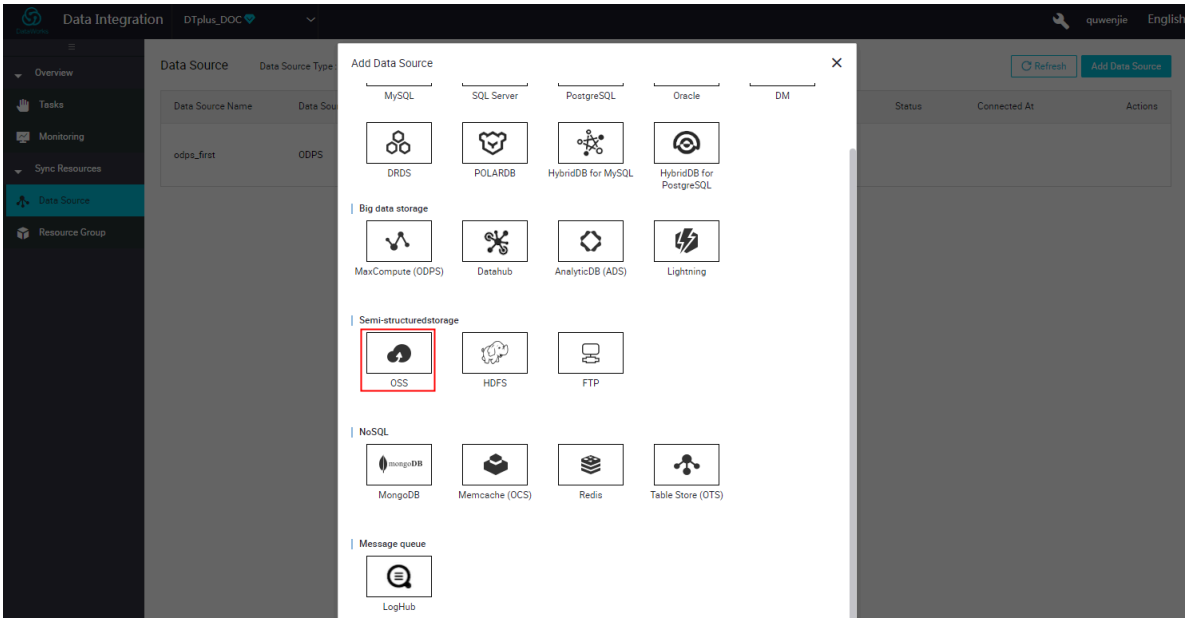
```
{
    " store ": {
        " book ": [
            {
               " category ": " reference ",
               " author ": " Nigel   Rees ",
               " title ": " Sayings   of   the   Century ",
               " price ":  8 . 95
            },
            {
               " category ": " fiction ",
               " author ": " Evelyn   Waugh ",
               " title ": " Sword   of   Honour ",
               " price ":  12 . 99
            },
            {
                " category ": " fiction ",
                " author ": " J .  R .  R .  Tolkien ",
                " title ": " The   Lord   of   the   Rings ",
                " isbn ": " 0 - 395 - 19395 - 8 ",
                " price ":  22 . 99
            }
        ],
        " bicycle ": {
            " color ": " red ",
            " price ":  19 . 95
        }
    },
    " expensive ":  10
}
```

  Upload the *applog . txt* **file to OSS. In this example, the OSS bucket is located in China (Shanghai).**

Use DataWorks to migrate JSON data from OSS to MaxCompute

- 1. Add an OSS data source.

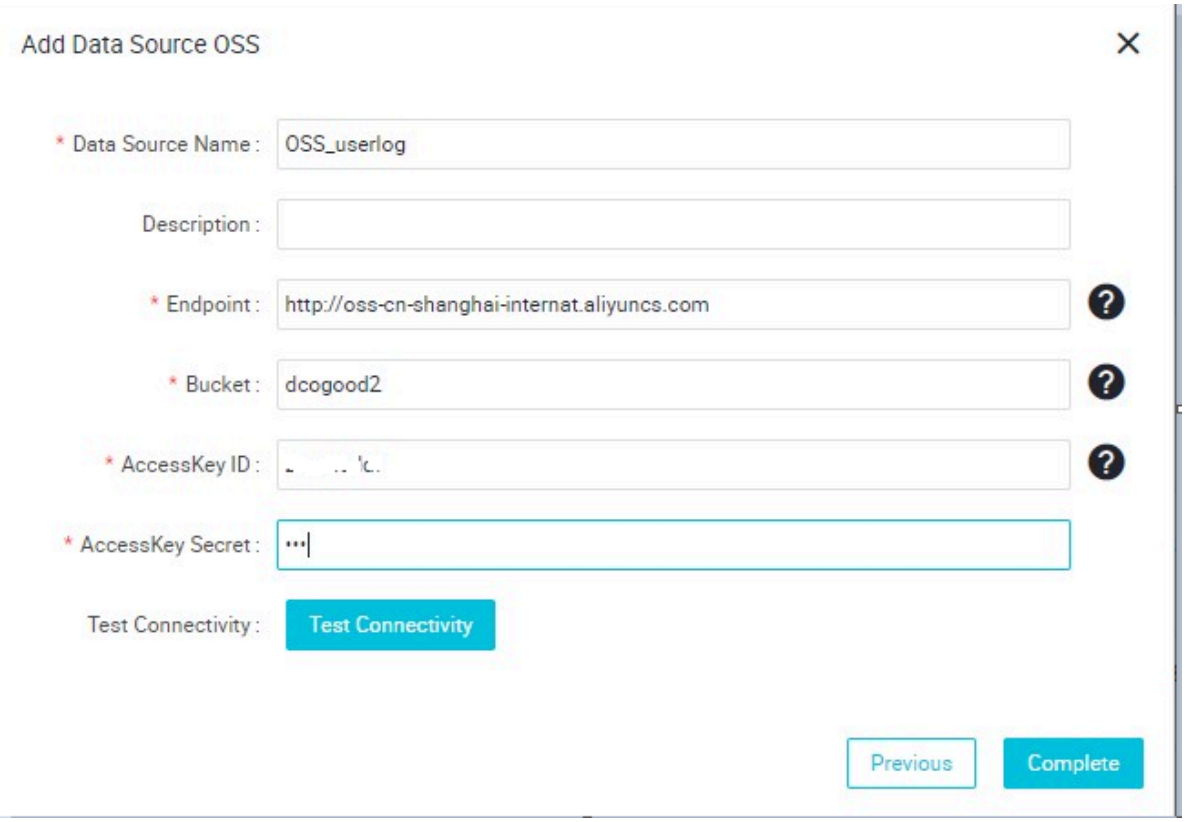
  In the DataWorks console, go to the *Data Integration* page and add an OSS data source. For more information, see *Configure OSS data source*.



  The parameters are shown in the following figure. Click Complete after the connectivity test is successful. The endpoints in this topic include `http://oss-cn-shanghai.aliyuncs.com` and `http://oss-cn-shanghai-internal.aliyuncs.com`.

  Note:

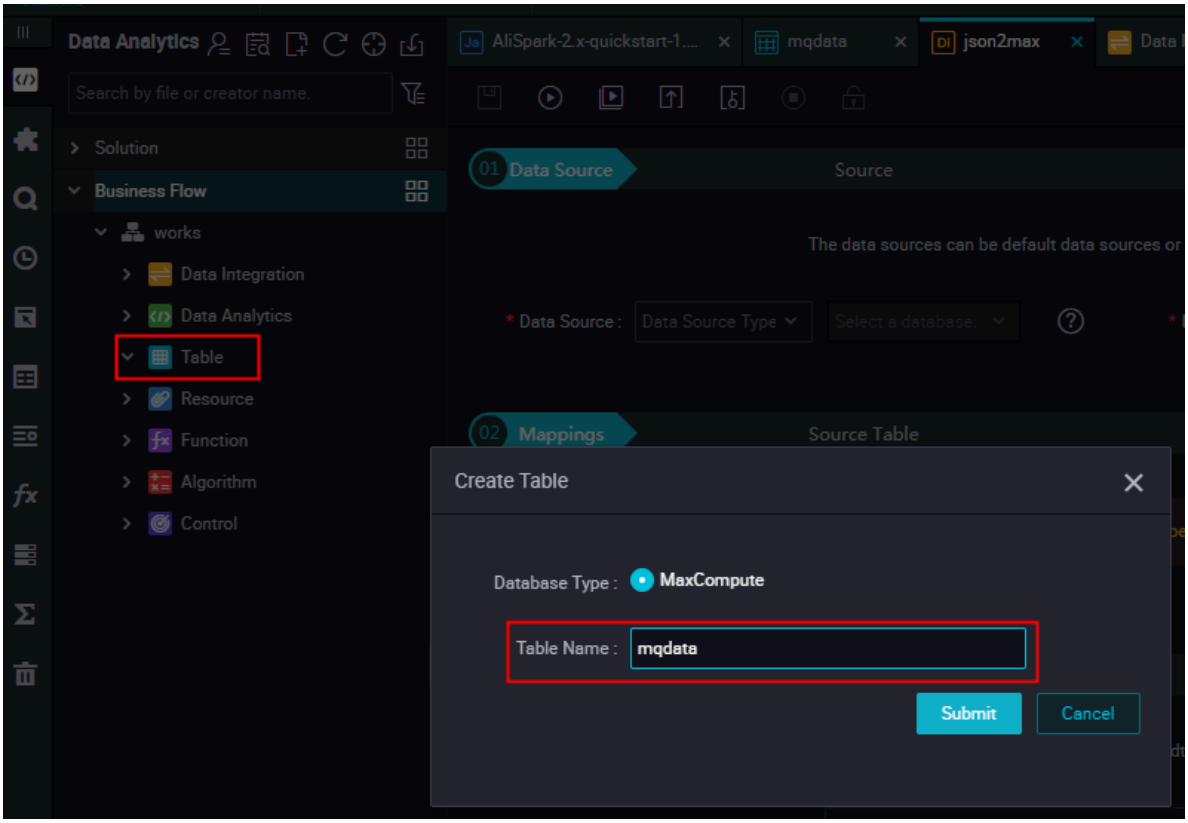
Because the OSS and DataWorks projects are located in the same region, the intranet endpoint `http://oss-cn-shanghai-internal.aliyuncs.com` is used.



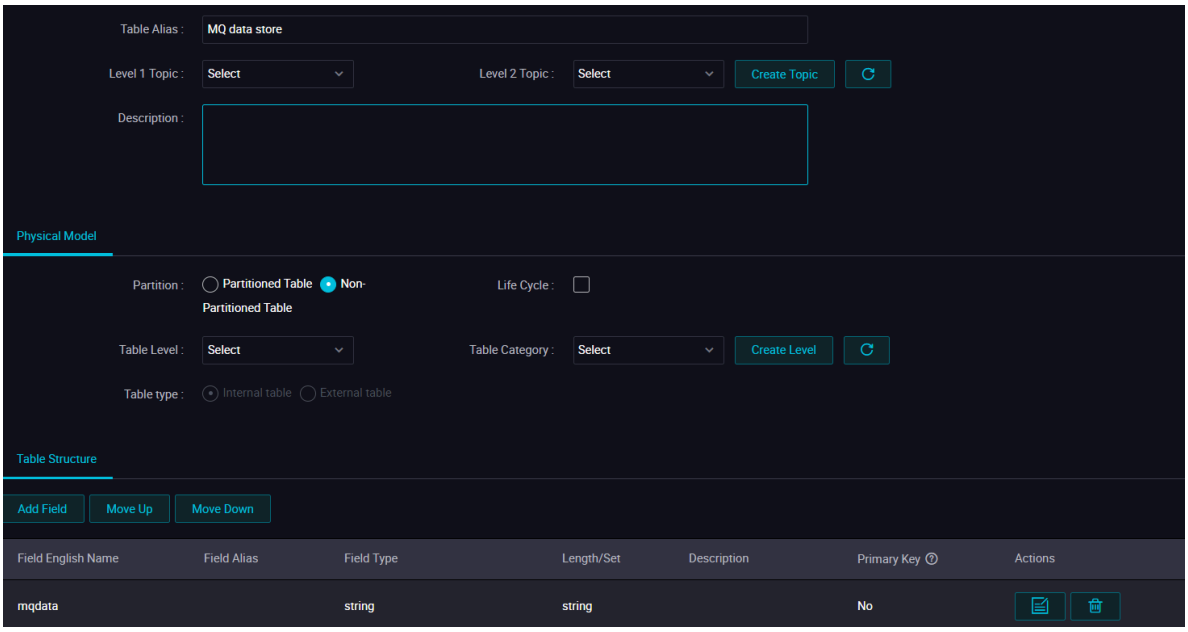
- **2. Create a data synchronization task.**

  In the DataWorks console, create a data synchronization node. For more information, see *Configure OSS Reader*. At the same time, create a table named

mqdata in DataWorks to store the JSON data. For more information, see *Create a table*.



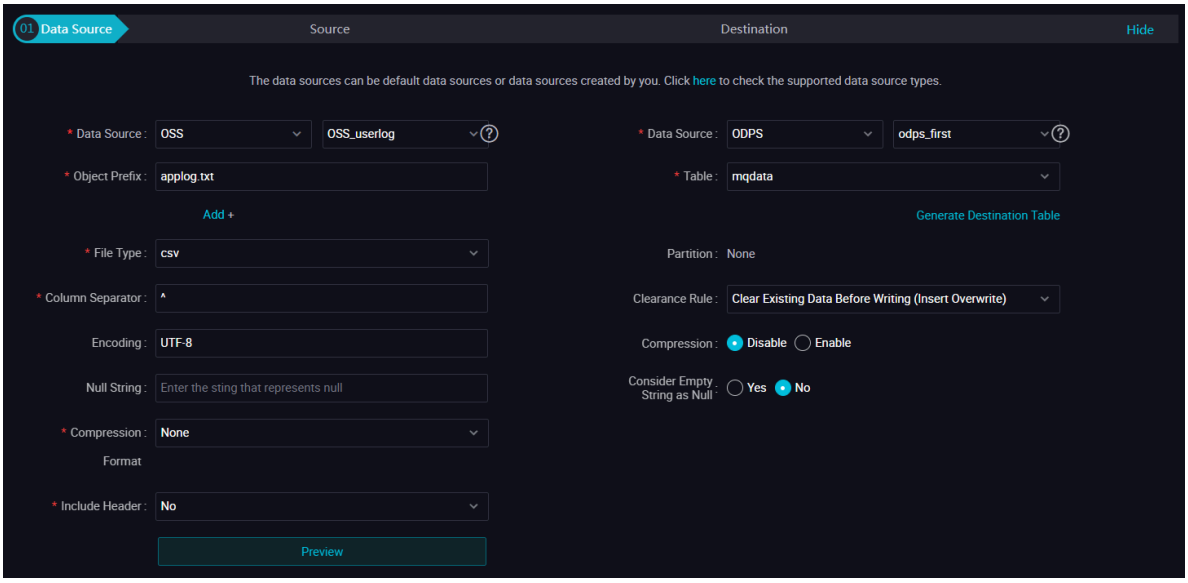
You can set the table parameters on the graphical interface. The mqdata table has only one column, which is named MQ data. The data type is string.



- 3. Set the parameters.

  After creating a table, you can set the data synchronization task parameters on the graphical interface, as shown in the following figure. First, set the destination data

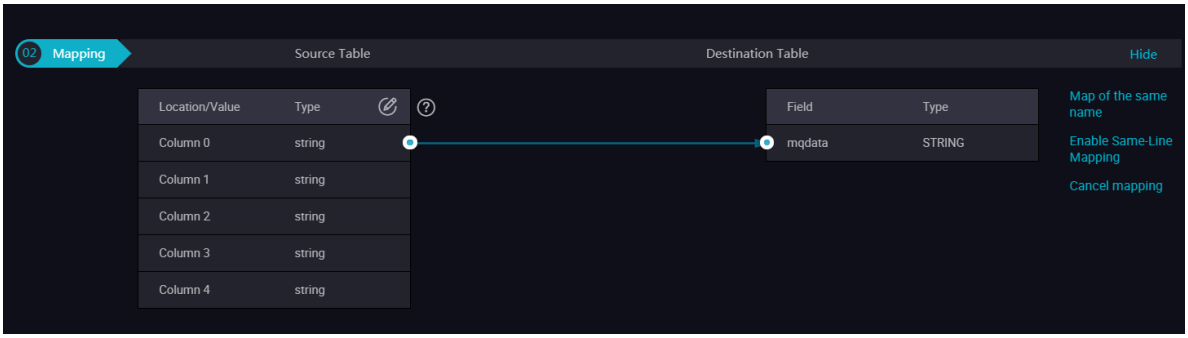
source to odps_first and the destination table to mqdata. Then, set the original data source to OSS and enter the file path and name as the object prefix.



Note:

You can set the column delimiter to caret (^) or any other character that is not contained in the TXT file. DataWorks supports multiple column delimiters for the TXT data sources in OSS. Therefore, you can use characters such as %&%#^$$^% to separate the data into a column.

Select Enable Same Line Mapping.



Click the script switching button in the upper-left corner to switch to the script mode. Set fileFormat to `" fileFormat ":" binary "`. The following is an example of the code in script mode:

```
{
    " type ": " job ",
    " steps ": [
        {
            " stepType ": " oss ",
            " parameter ": {
                " fieldDelim  iterOrigin ": "^",
```

```
                " nullFormat ": "",
                " compress ": "",
                " datasource ": " OSS_userlo  g ",
                " column ": [
                    {
                        " name ":  0 ,
                        " type ": " string ",
                        " index ":  0
                    }
                ],
                " skipHeader ": " false ",
                " encoding ": " UTF - 8 ",
                " fieldDelim  iter ": "^",
                " fileFormat ": " binary ",
                " object ": [
                    " applog . txt "
                ]
            },
            " name ": " Reader ",
            " category ": " reader "
        },
        {
            " stepType ": " odps ",
            " parameter ": {
                " partition ": "",
                " isCompress ":  false ,
                " truncate ":  true ,
                " datasource ": " odps_first ",
                " column ": [
                    " mqdata "
                ],
                " emptyAsNul  l ":  false ,
                " table ": " mqdata "
            },
            " name ": " Writer ",
            " category ": " writer "
        }
    ],
    " version ": " 2 . 0 ",
    " order ": {
        " hops ": [
            {
                " from ": " Reader ",
                " to ": " Writer "
            }
        ]
    },
    " setting ": {
        " errorLimit ": {
            " record ": ""
        },
        " speed ": {
            " concurrent ":  2 ,
            " throttle ":  false ,
            " dmu ":  1
        }
    }
}
```

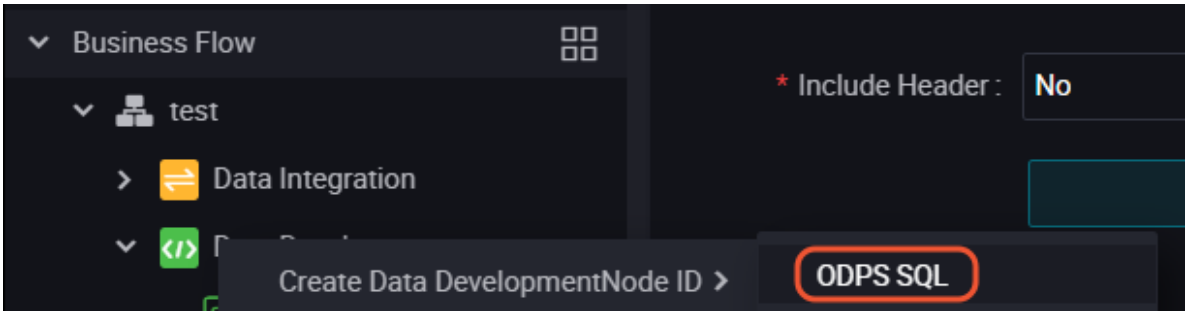
Note:

In this step, after the JSON file is synchronized from OSS to MaxCompute, data in the file is saved in the same row. That is, data in the JSON file shares the same field. You can use the default values for other parameters.

After completing the preceding settings, click run.

Verify the result

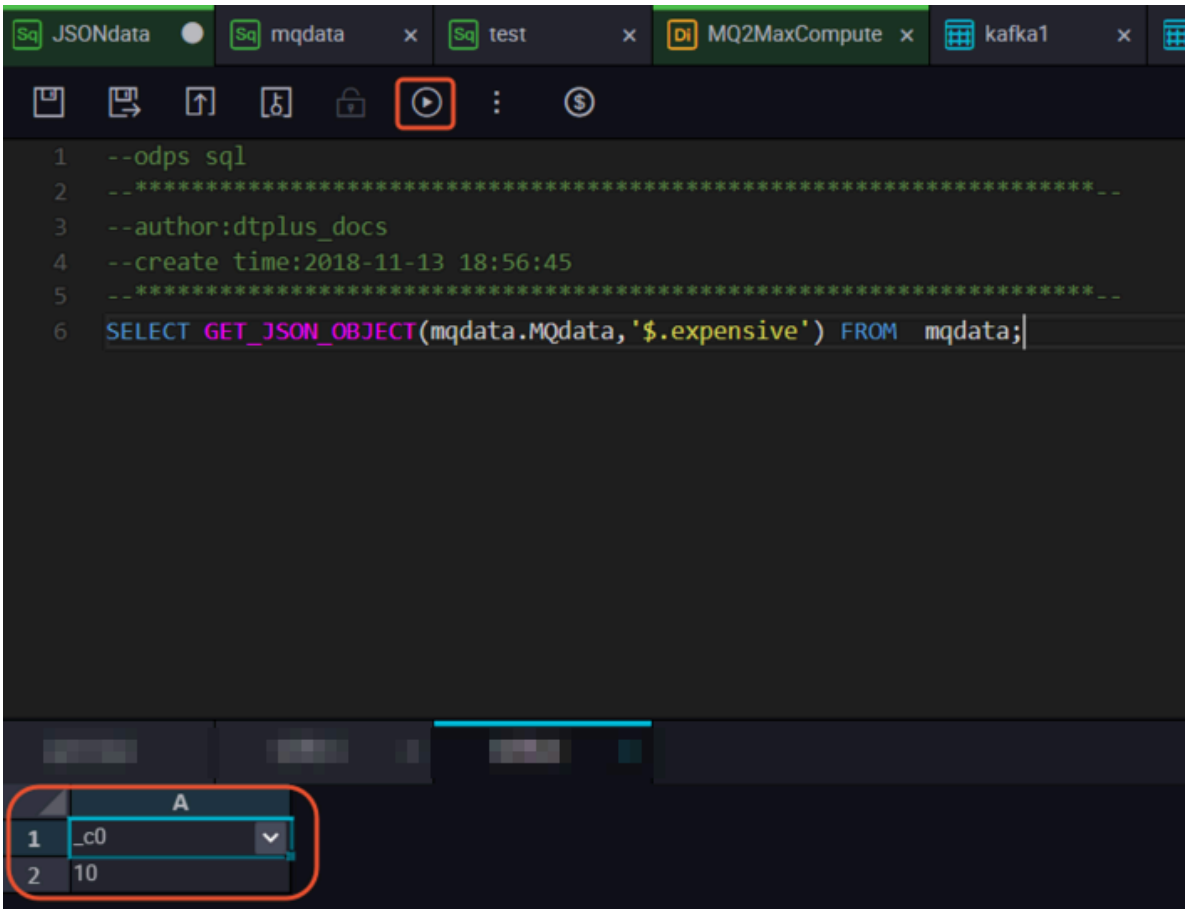
1. Create an ODPS SQL node in your *Business Flow*.



2. Enter the `SELECT * from mqdata ;` statement to view the data in the mqdata table.

> **Note:**
> You can also run the `SELECT * from mqdata ;` command on the *MaxCompute client* to view the data and perform subsequent steps.

3. Verify that the data imported to the table is correct and use `SELECT GET_JSON_O BJECT ( mqdata . MQdata ,'$. expensive ') FROM mqdata ;` to obtain the value of `expensive` in the JSON file.



Additional information

To verify the result, you can also use the built-in string function *GET_JSON_OBJECT* in MaxCompute to obtain the JSON data as needed.

3 Data development

3.1 Use Eclipse to develop a Java-based UDF

This topic describes how to develop a Java-based user-defined function (UDF) by using the Eclipse-integrated ODPS plug-in.

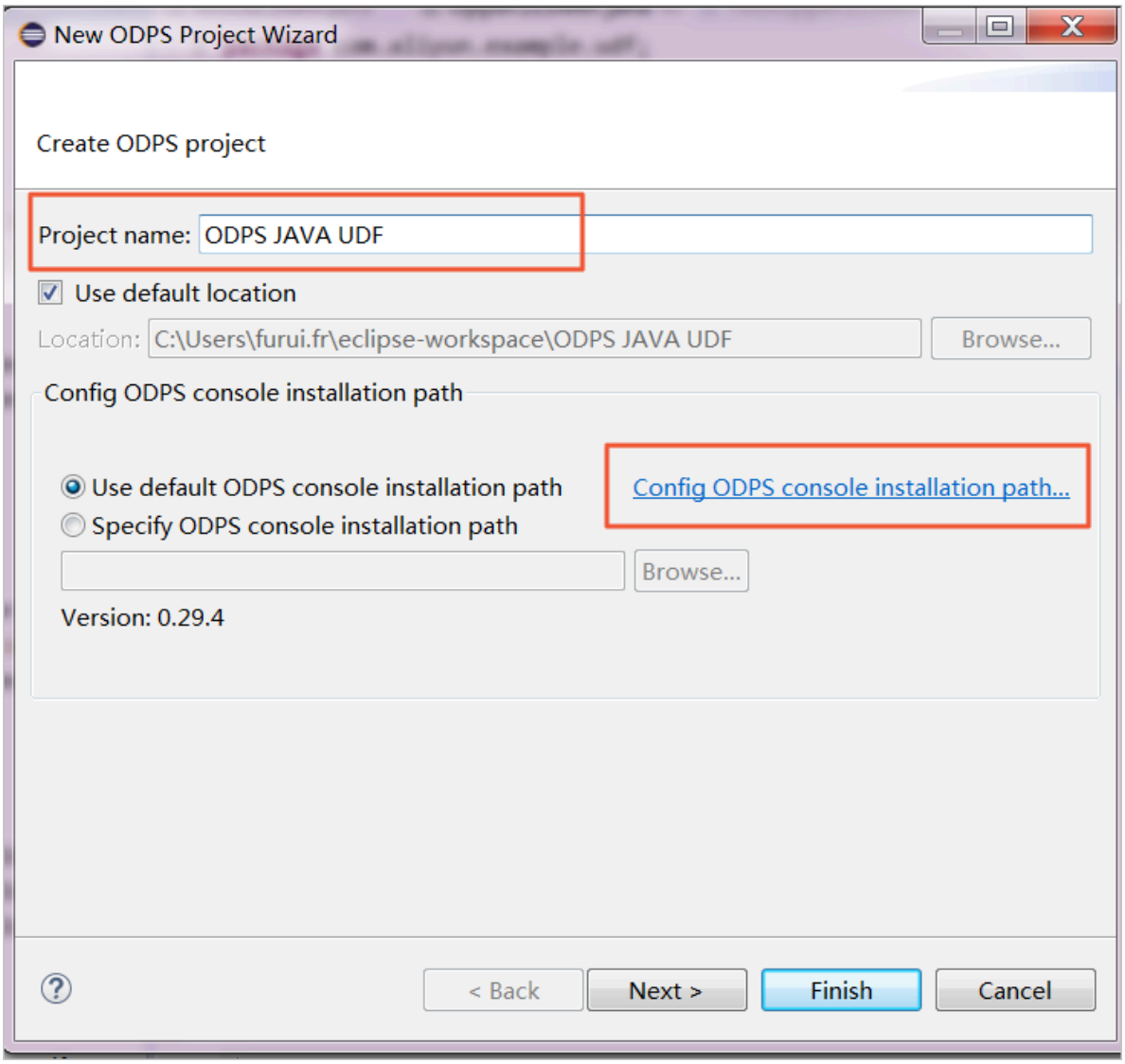
Preparations

Before developing a Java-based UDF using Eclipse, you need to make the following preparations:

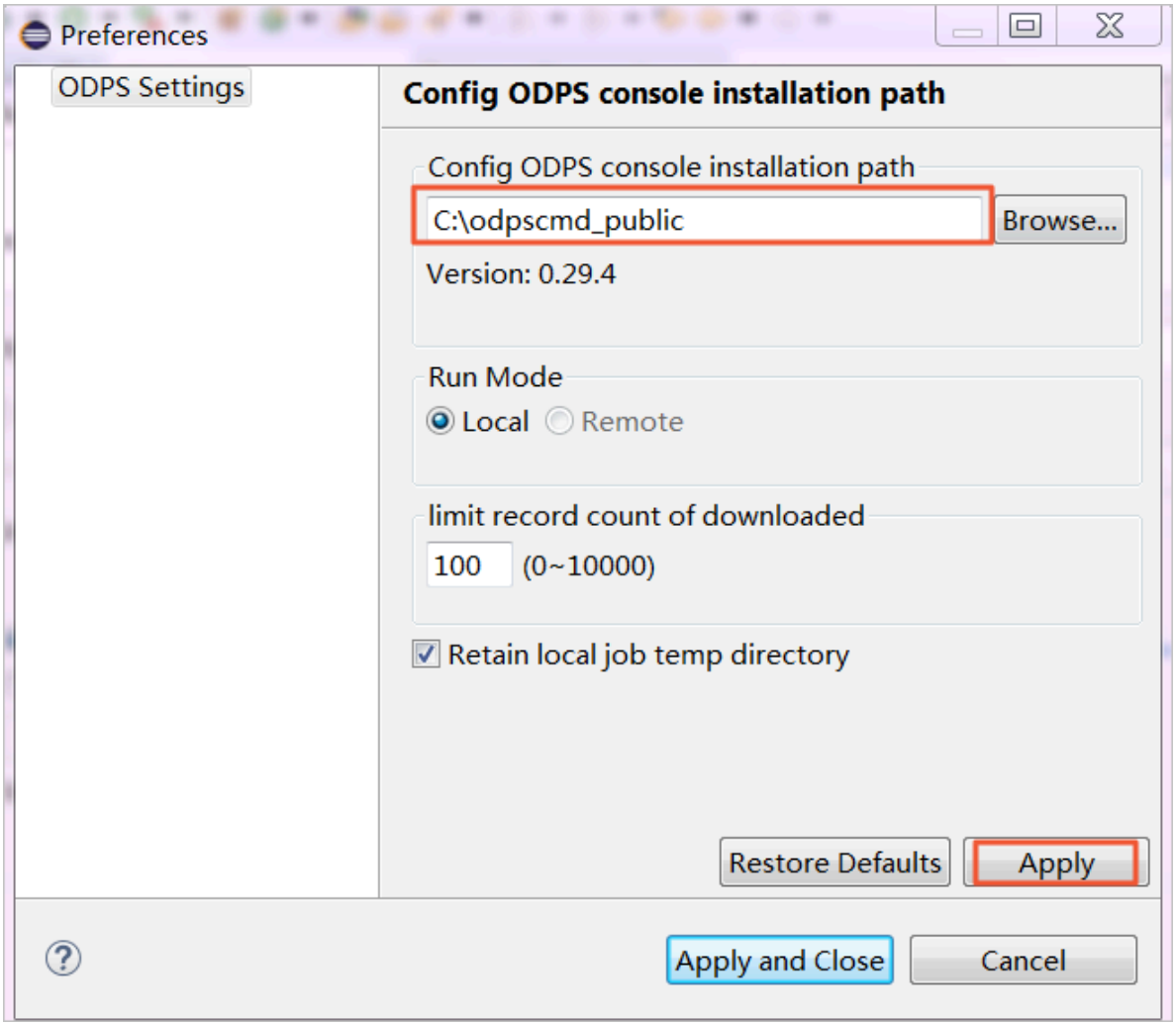
1. **Use Eclipse to install the *ODPS plug-in*.**

2. Create an ODPS project.

   In Eclipse, choose File > New > ODPS Project, enter the project name, and click Config ODPS console installation path to configure the installation path of the *odpscmd client*.



   Enter the installation package path and click Apply. The ODPS plug-in automatically parses the version of the odpscmd client.

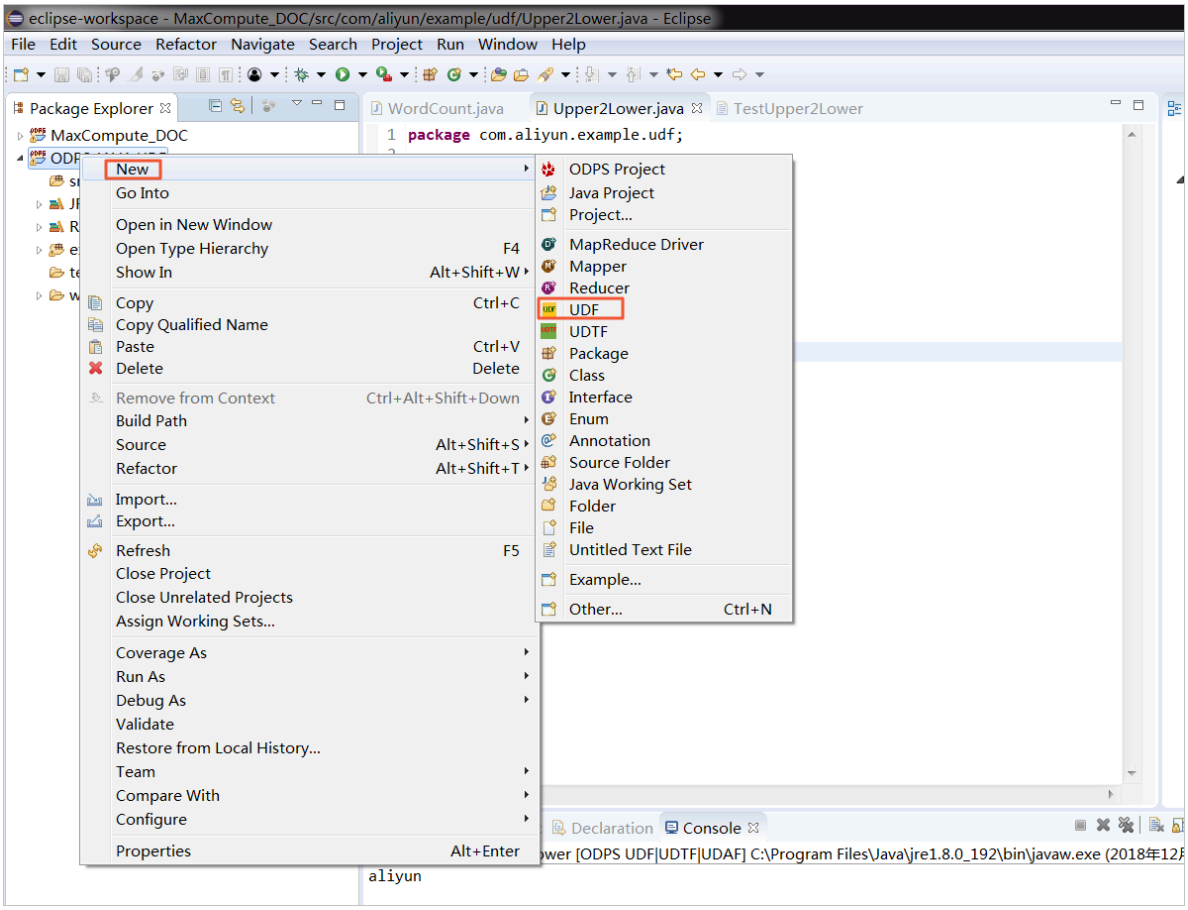


Click Finish.

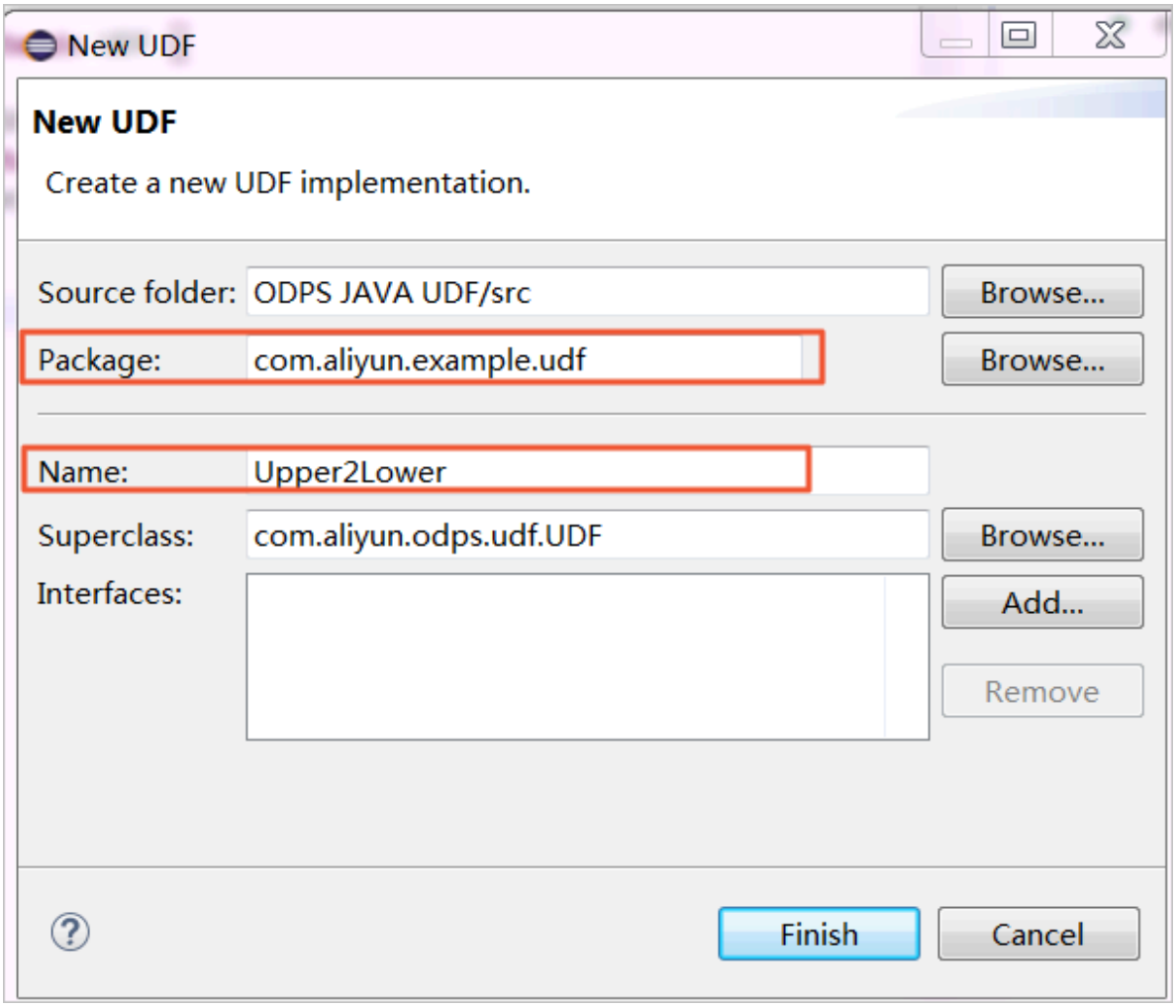
Procedure

- 1. Create a Java-based UDF in the ODPS project.

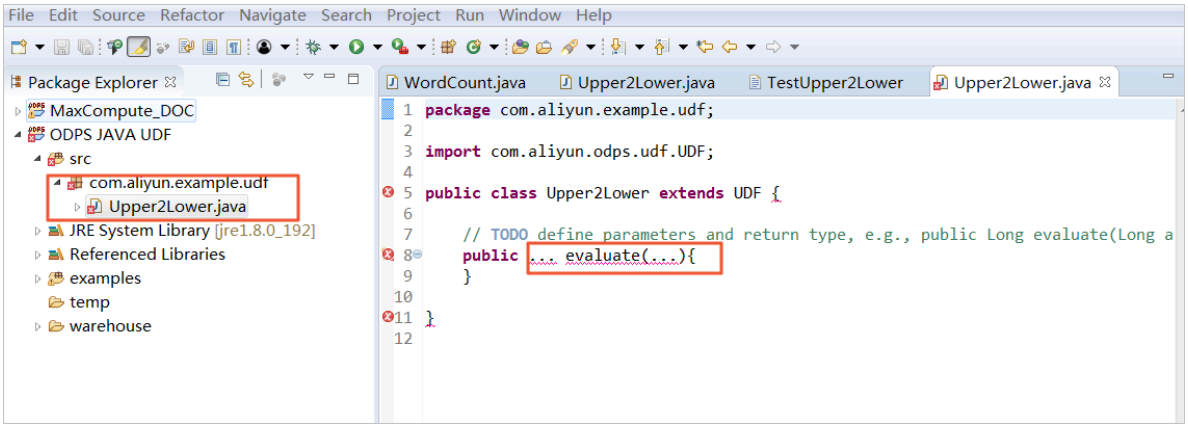
  One the Package Explorer pane, right-click the ODPS Java-based UDF project you have created, and choose New > UDF.



  Set the UDF package to com.aliyun.example.udf and name to Upper2Lower, and click Finish.

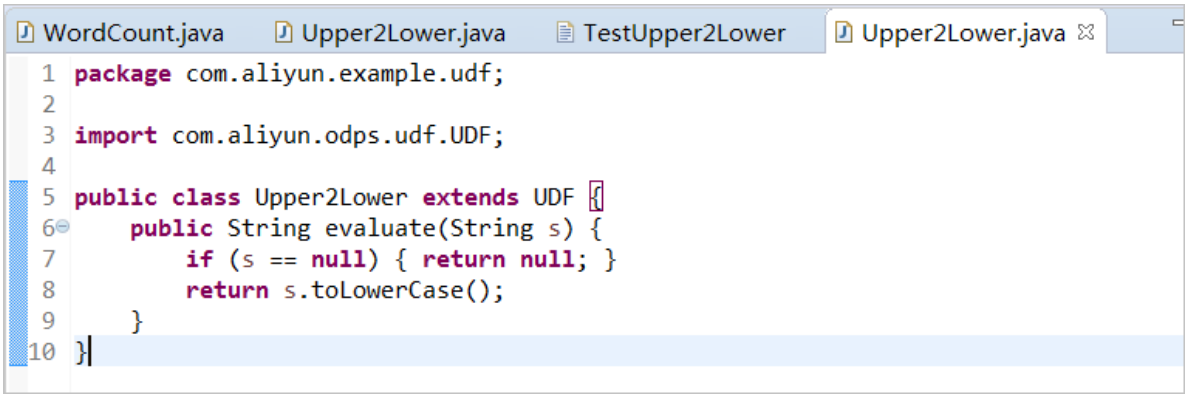


An automatic Java code is generated after you create a UDF. Do not change the name of the evaluate() function.



- 2. Implement the evaluate() function contained in the UDF file.

  Write the function code to be implemented into the evaluate() function. Do not change the name of the evaluate() function. The following is an example of how to convert uppercase letters to lowercase letters.




```
package com . aliyun . example . udf ;

import com . aliyun . odps . udf . UDF ;

public class Upper2Lowe r extends UDF {
    public String evaluate ( String s ) {
        if ( s == null ) { return null ; }
        return s . toLowerCas e ();
    }
}
```

  Save the code.

Test the Java-based UDF code

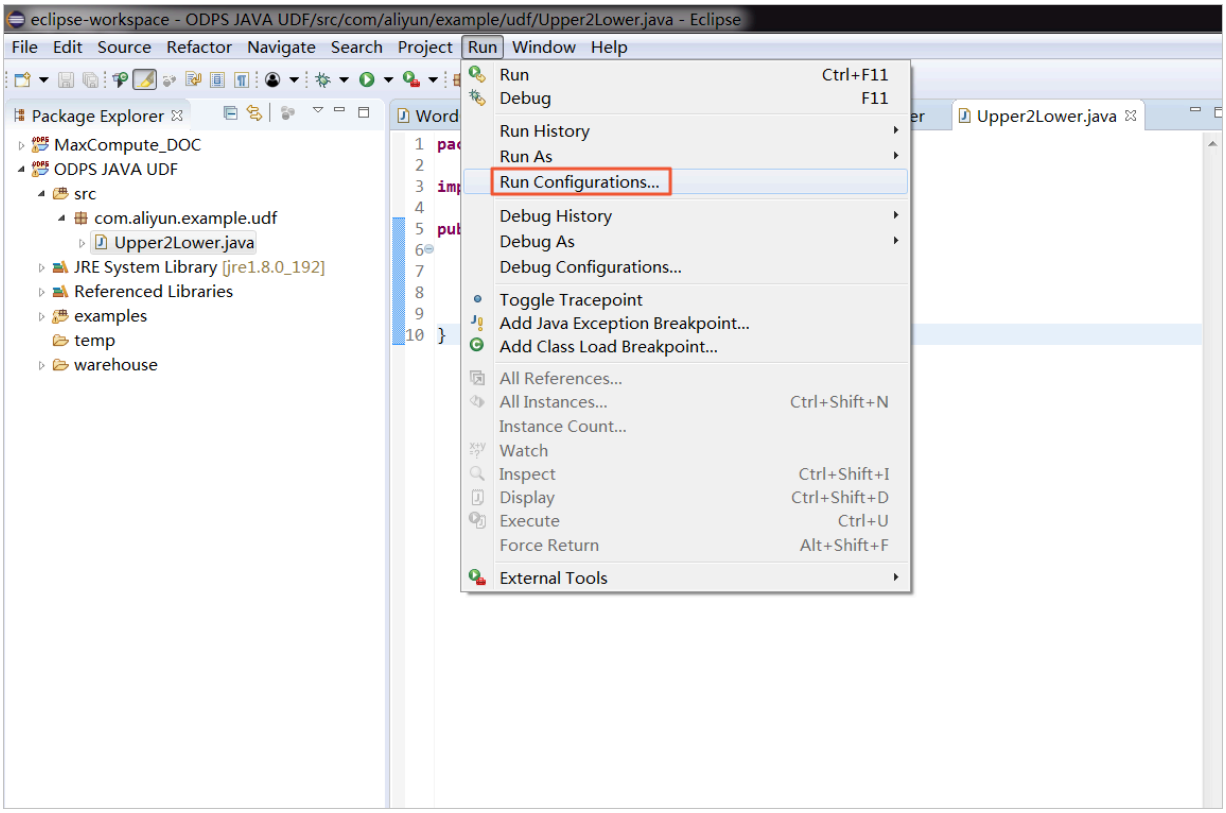
Before testing the Java-based UDF code, store some uppercase letters on MaxCompute. Create a test table named upperABC using the `create table upperABC ( upper string );` SQL statement on the odpscmd client.

```
odps@ MaxCompute_DOC>create table upperABC(upper string) ;

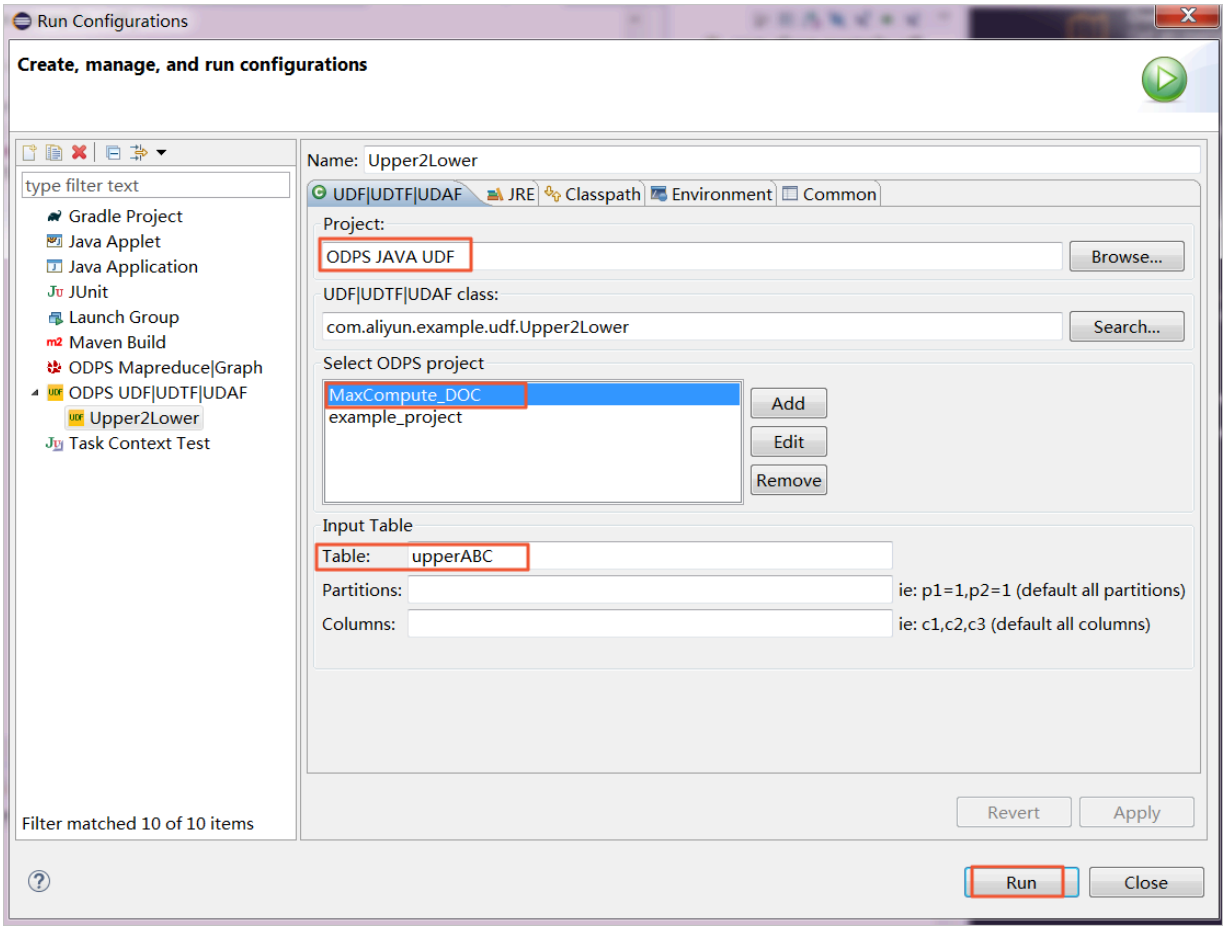
ID = 20181214094323883gb23j292
OK
```

Use the `insert into upperABC values (' ALIYUN ');` SQL statement to insert the string of uppercase letters 'ALIYUN'.

Choose Run > Run Configurations to set the test parameters.



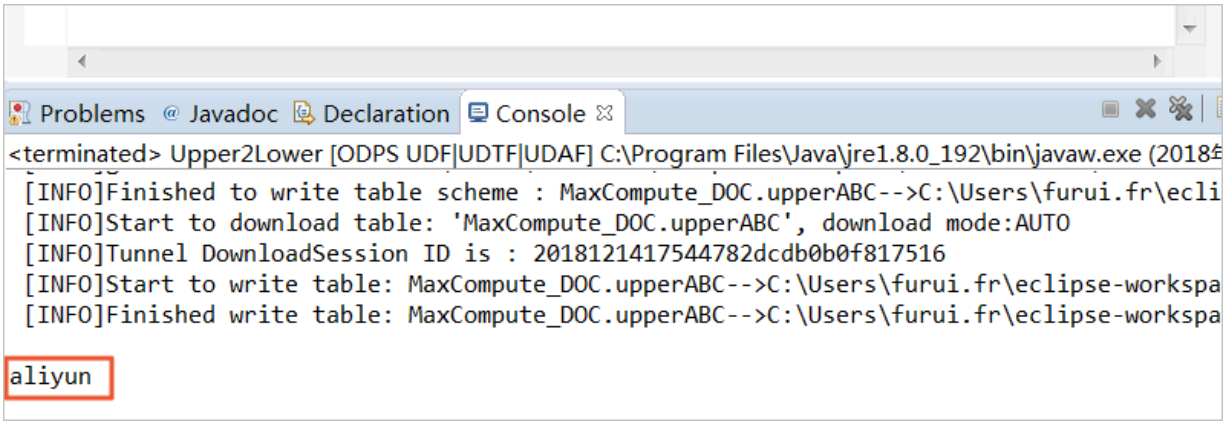
Set the test parameters. Set Project to the name of the Java ODPS project you have created, and set Select ODPS project to the MaxCompute project name. Note that the project name needs to match the name of that connected to the odpscmd client. Set Table to upperABC. After completing all the settings, click Run.



You can view the test result in the Console pane, as shown in the following figure.

Note:

Eclipse obtains the string of uppercase letters from the table and converts them to a string of lowercase letters, which is 'aliyun'. However, the uppercase letters stored on MaxCompute are not converted.

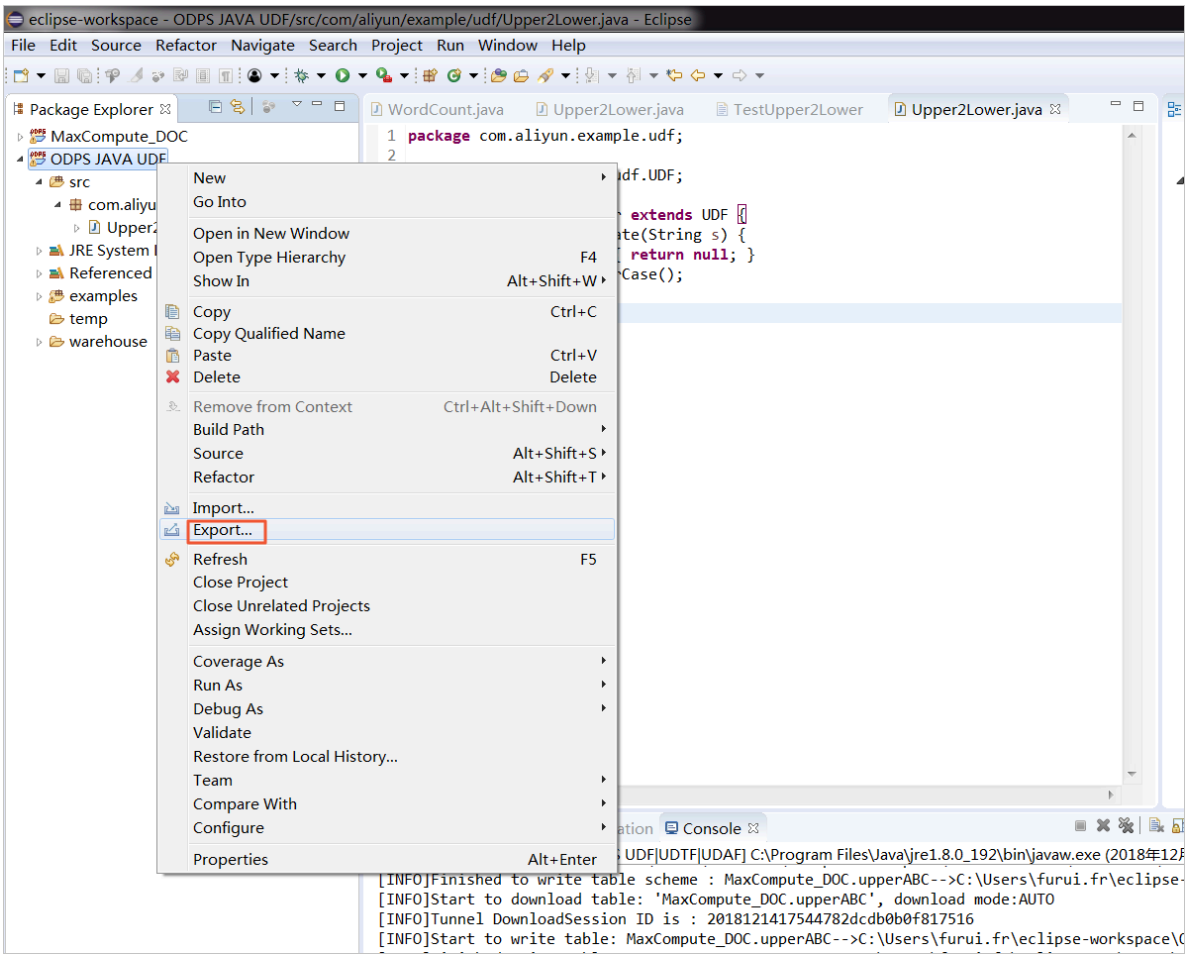


Use the Java-based UDF

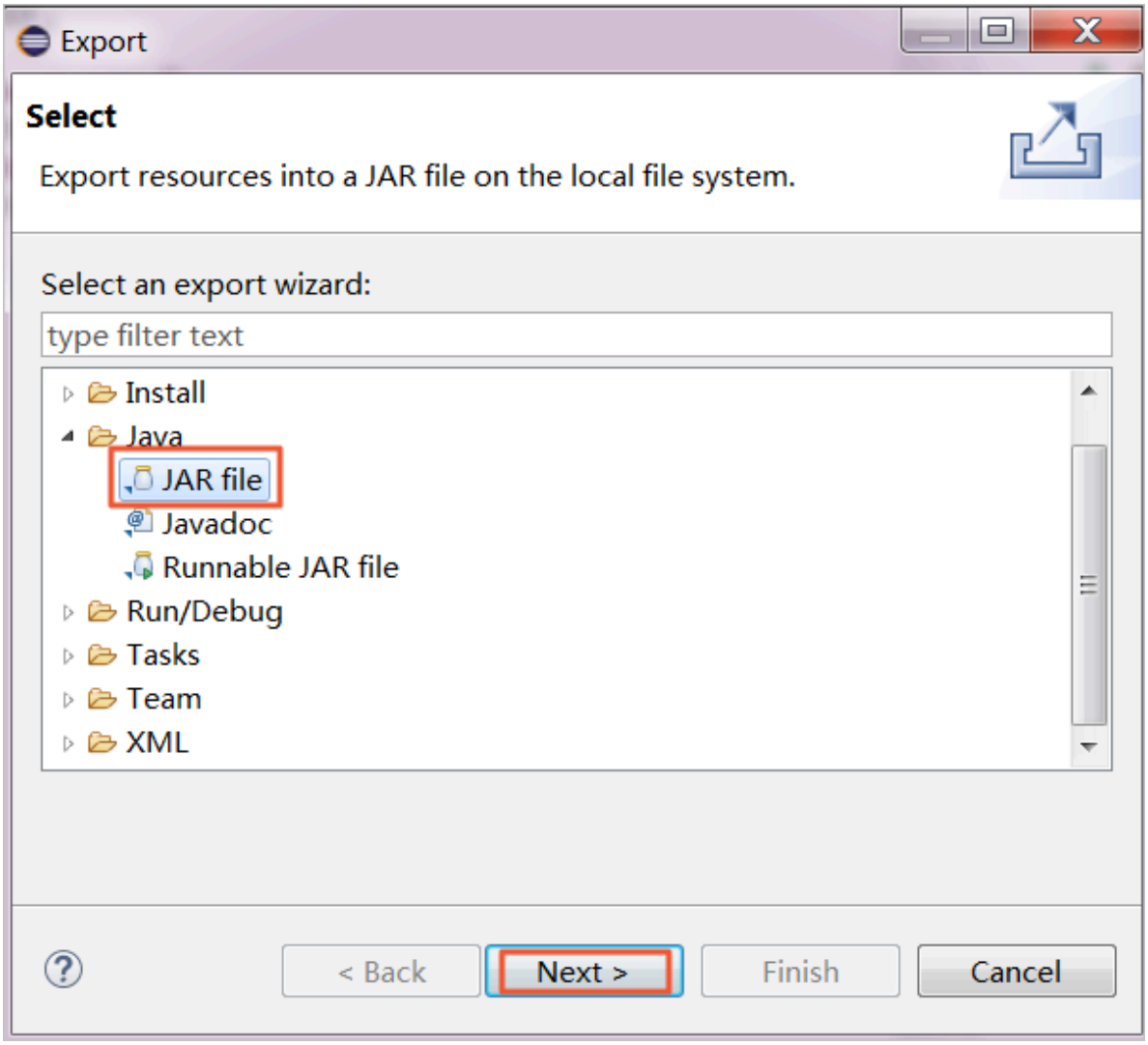
You can use the Java-based UDF after the test is successful. The procedure is as follows:

1. Export the JAR package.

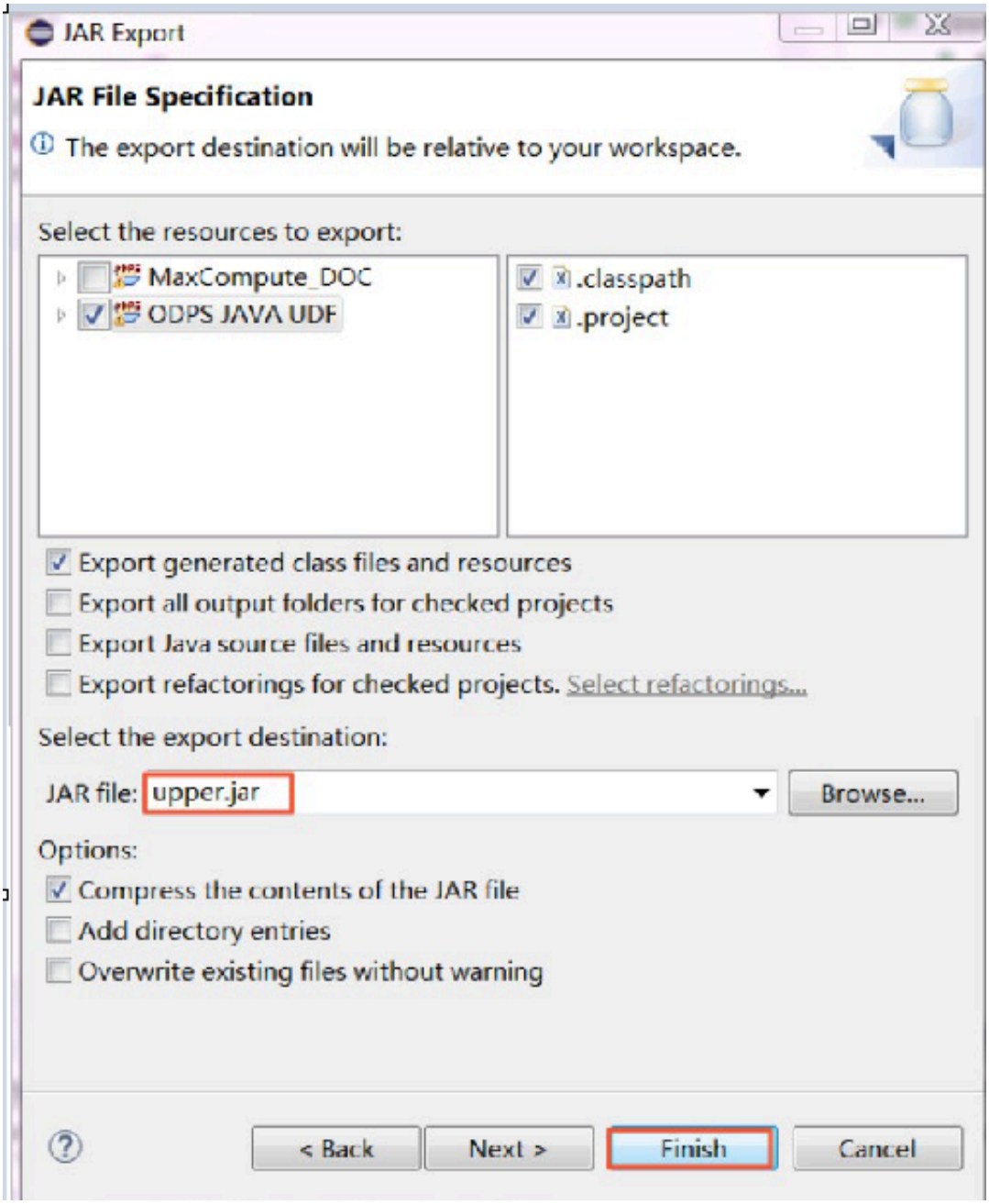
   Right-click the ODPS project you have created and select Export.



   On the displayed page, select JAR file and click Next.

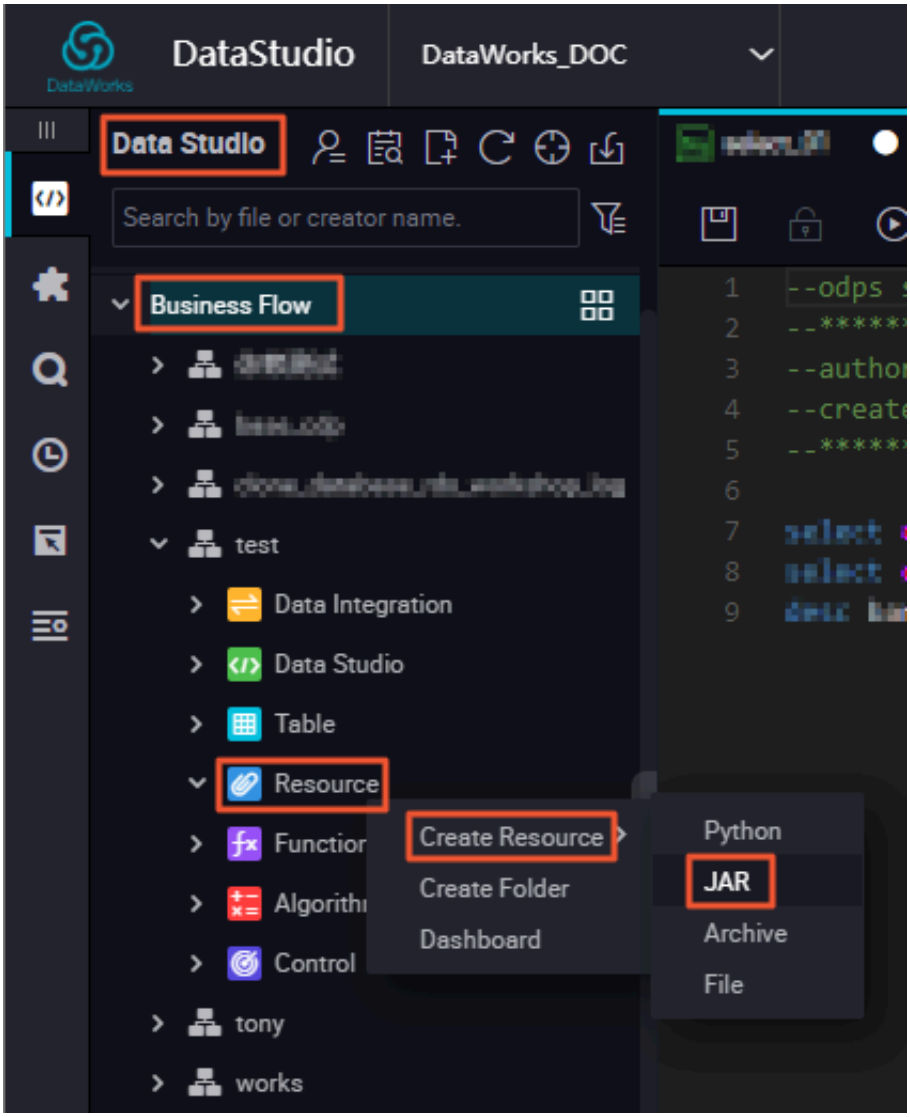


Enter the JAR package name and click Finish. Then, the JAR package is exported to your workspace directory.

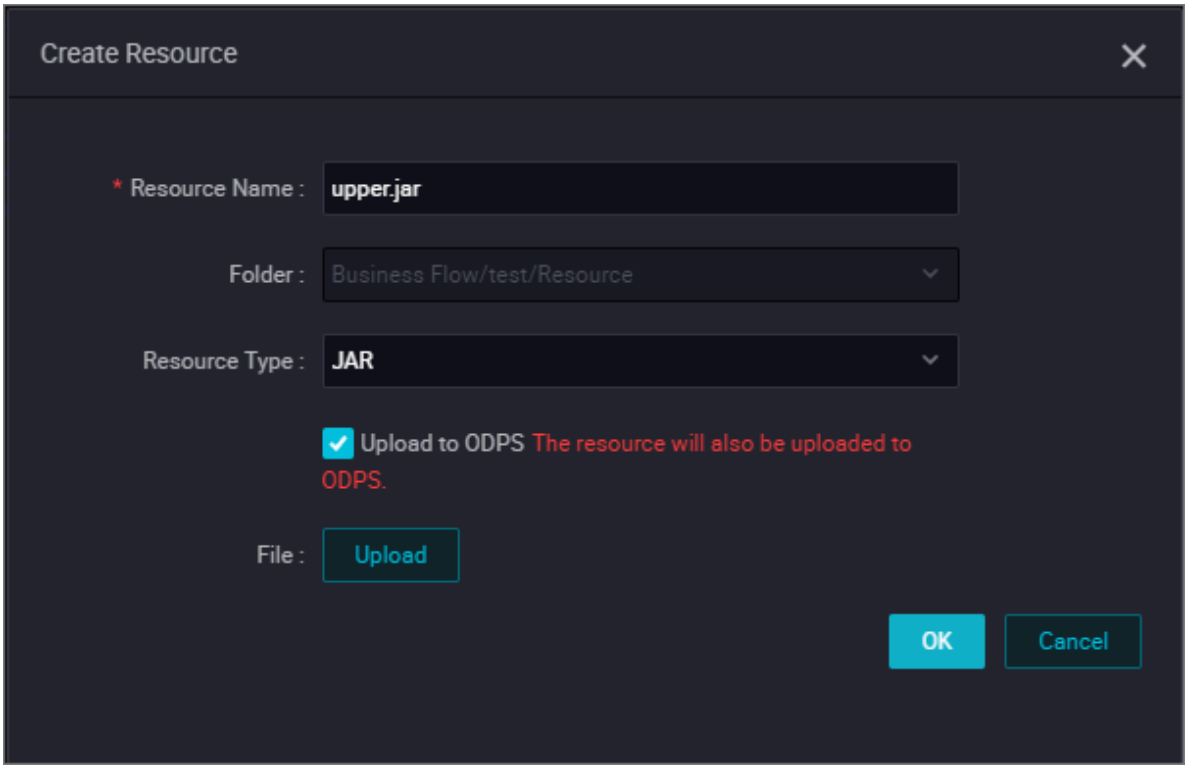

JAR Export
JAR File Specification
The export destination will be relative to your workspace.
Select the resources to export:
MaxCompute_DOC
ODPS JAVA UDF
.classpath
.project
Export generated class files and resources
Export all output folders for checked projects
Export Java source files and resources
Export refactorings for checked projects. Select refactorings...
Select the export destination:
JAR file: upper.jar
Browse...
Options:
Compress the contents of the JAR file
Add directory entries
Overwrite existing files without warning
< Back
Next >
Finish
Cancel

2. Upload the JAR package to DataWorks.

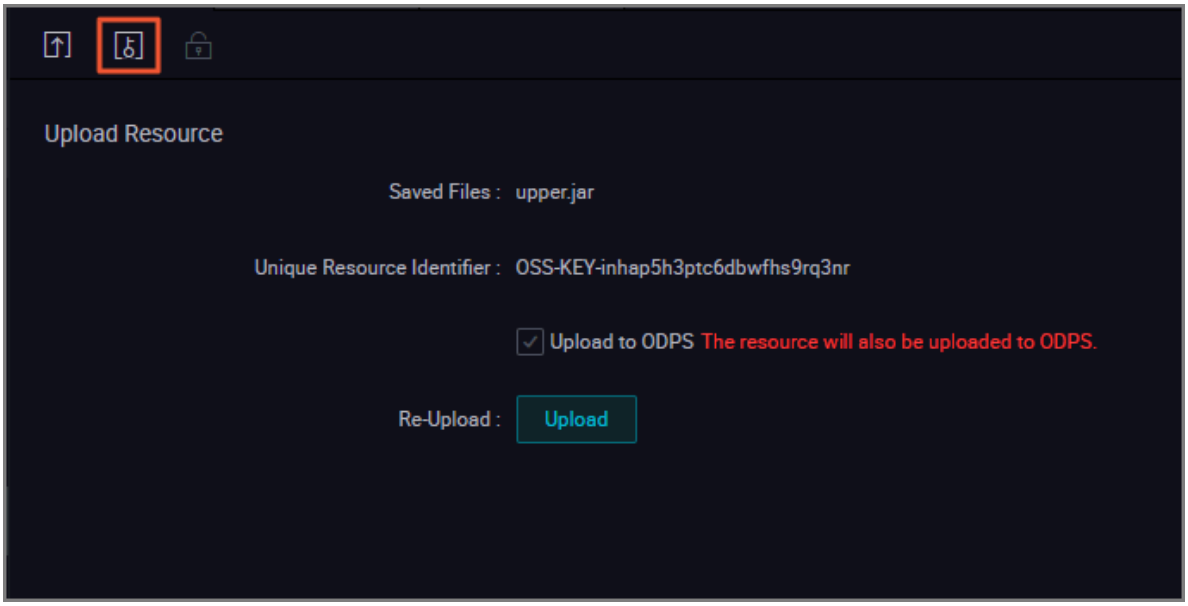
   Log on to the DataWorks console, find the MaxCompute_DOC project, and go to the *Data Studio* page. Choose Business Flow > Resource > Create Resource > JAR and create a *JAR resource*.



   On the displayed page, upload the JAR package you have exported.



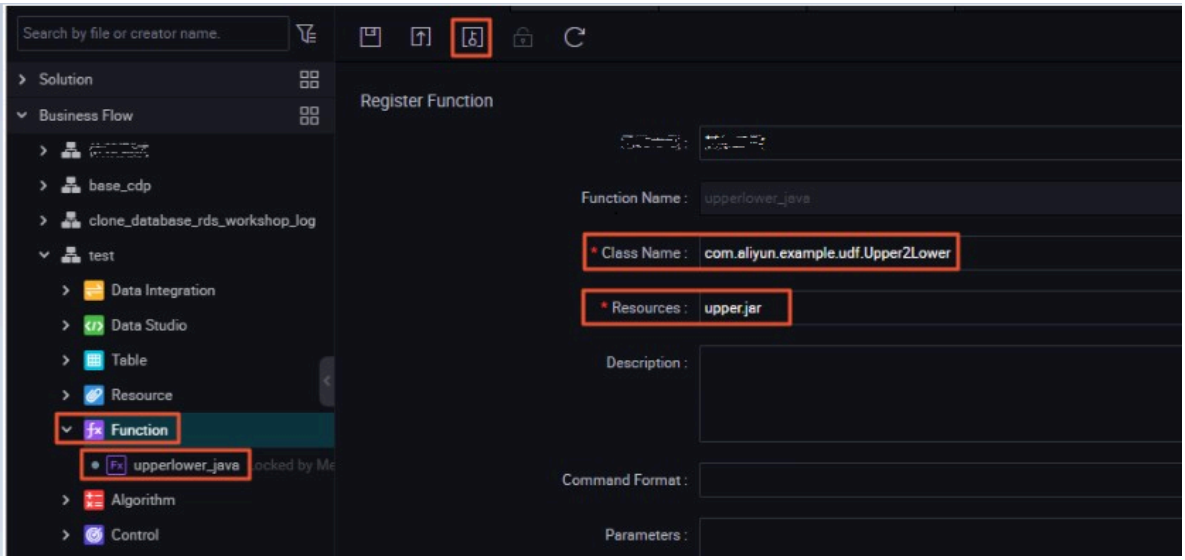
The JAR package is uploaded to DataWorks. To upload it to MaxCompute, click the JAR package and click Submit and Unlock.



You can run the `list resources` command on the odpscmd client to view the uploaded JAR package.

3. Create a resource function.

   After uploading the JAR package to your MaxCompute project, choose Business Flow > Function > Create Function and create a *function* named upperlower_Java. After completing these settings, click Save and Submit and Unlock.



   You can run the `list functions` command on the odpscmd client to view the registered function. Then, the upperlower_Java Java-based UDF registered using Eclipse can be used.

Check the Java-based UDF

In the odpscmd CLI, run the `select upperlower _Java (' ABCD ') from dual ;` command. In the following figure, the output is abcd, indicating that the function has converted a string of uppercase letters to lowercase letters.

Additional information

For more information about how to develop Java-based UDFs, see *Java UDF*.

To use IntelliJ IDEA to develop a Java-based UDF, see *Use IntelliJ IDEA to develop a Java-based UDF*.

3.2 Use IntelliJ IDEA to develop a Java-based UDF

This topic describes how to use IntelliJ IDEA to develop a Java-based user-defined function (UDF). IntelliJ IDEA is an integrated development environment that can be used for developing Java programs.

Prerequisites

1. Prepare the IntelliJ IDEA development tool. For more information, see *Install IntelliJ IDEA and configure MaxCompute Studio*.
2. *Connect to a MaxCompute project* through IntelliJ IDEA MaxCompute Studio.
3. Make sure that you have successfully connected to the MaxCompute project. Once completed, *create a MaxCompute Java module*.

You can develop a Java-based UDF after your development environment has been prepared. The following is an example of how to develop a UDF for converting uppercase letters to lowercase letters.

> Note:
> For more information about Java-based UDF development, see *Java-based UDF*.

Procedure

1. Create a Java-based UDF project.

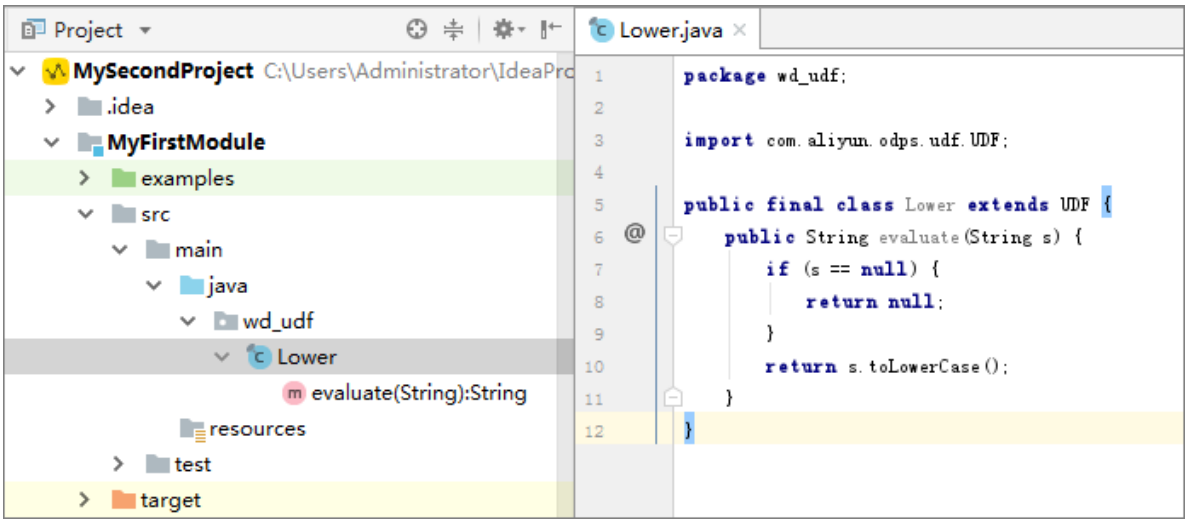
   In the IntelliJ IDEA, right-click the MaxCompute Java module directory, choose src > main > java > New and click MaxCompute Java, as shown in the following figure.

   Set Name to `package name . file name`, select UDF for Kind, and click OK, as shown in the following figure.

   > Note:
   > - Name: The name of the MaxCompute Java class you have created. If you have not created a package, you can enter packagename.classname and a package will be automatically generated.
   > - Kind: The project type. The project types that are supported are user-defined functions (such as UDF, UDAF, and UDTF), MapReduce (such as Driver, Mapper, and Reducer), and non-structural development frameworks (such as Storage Handler and Extractor).

2. Edit the Java-based UDF code.

   You can edit the porjectLower code in the Java-based UDF project you have created, as shown in the following figure.



   The following is example code:

```
package  < package   name >;
import   com . aliyun . odps . udf . UDF ;
public   class   Lower   extends   UDF  {
   public   String   evaluate ( String   s ) {
      if  ( s  ==  null ) {
          return   null ;
     }
      return   s . toLowerCas  e ();
   }
}
```

   Note:

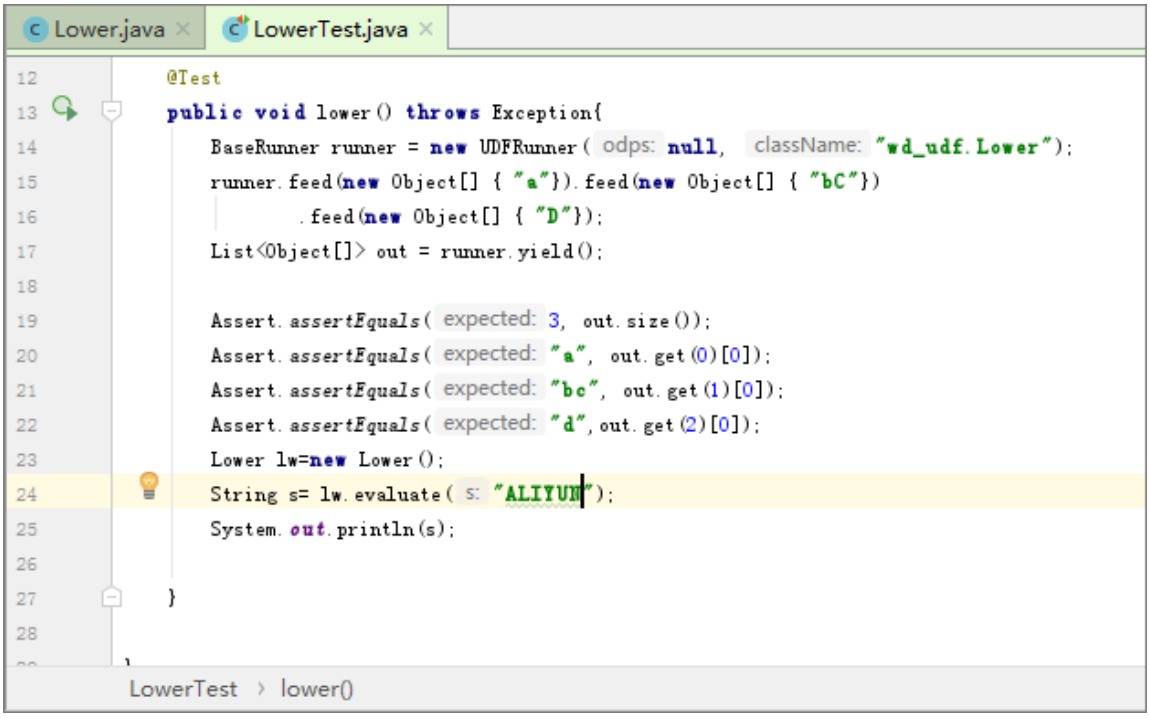
   You can customize the code template in your IntelliJ IDEA as needed. The method is as follows: Choose Settings > Editor > File Code Templates and modify the target template in MaxCompute on the code tab page.

3. Test the UDF.

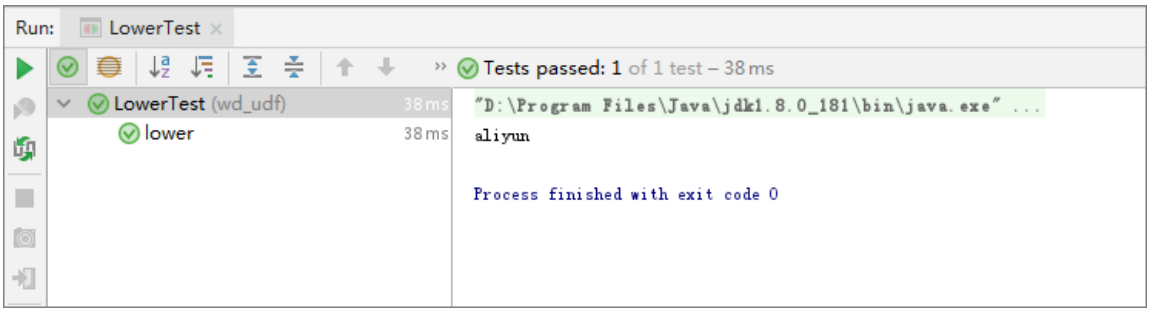
   After developing the Java-based UDF, you can test it through unit testing (UT) or local running. The procedure is as follows:

   a) Unit testing

   Your module project contains several UT examples under the examples directory. You can follow these examples when you perform UT.



   The following figure shows the test result.



   As you can see from the preceding figure, the string of uppercase letters 'ALIYUN' was converted to the lowercase letter string of 'aliyun'.

   b) Local running

   To run the Java-based UDF in your IntelliJ IDEA, you need to specify and test the data source by using either of the following methods:

   - Use MaxCompute Studio and Tunnel to downlaod table data from the specified project and save the data to your warehouse directory.

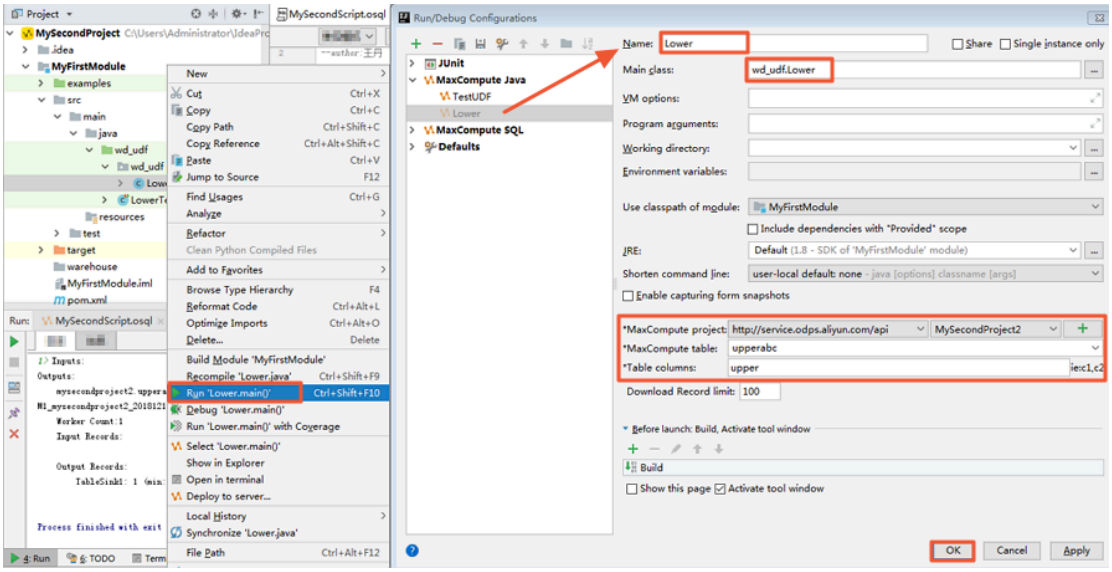
- Use the UDF project to provide the mock project and the table data. Then , you can customize the data source according to example_project in the warehouse directory.

Procedure

A. Before testing the Java-based UDF code, store some uppercase letters on MaxCompute. Create a test table named upperABC by using a script file or the `create table upperABC ( upper string );` SQL statement on the odpscmd client, as shown in the following figure.

```
--create time:2018-12-18 17:19
CREATE TABLE `MySecondProject2`.`upperABC` (
    `upper` string )
;
insert into upperABC values('ALIYUN');
```

B. Right-click the UDF class and select Run 'class name.main()'. The run configurations dialog box is displayed, as shown in the following figure.



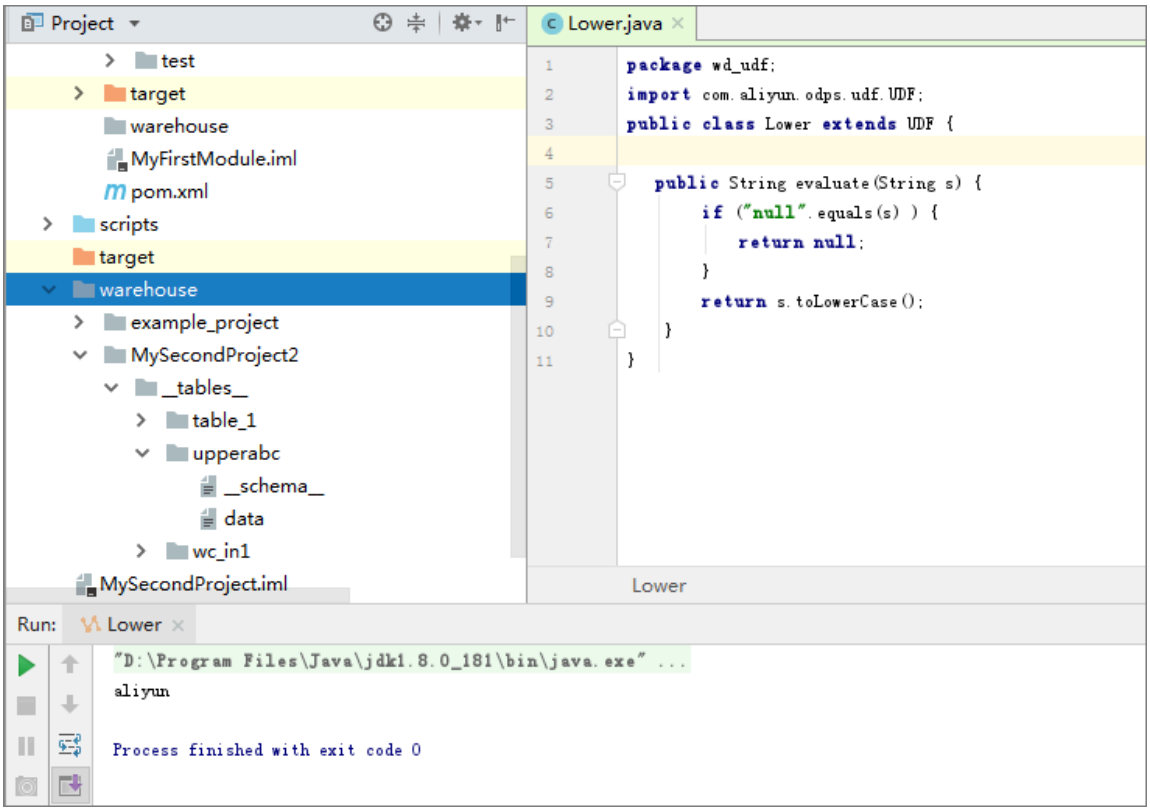
Note:

- UDF, UDAF, and UDTF are generally used to run SELECT SQL statements for specific columns. As a result, you need to configure the MaxCompute project, table, and columns before using these functions. Note that the metadata is obtained from the mock project under the project explorer and warehouse. Debugging for complex types is also supported.
- If the table data under the specified project is not downloaded and saved to your warehouse, then you need to download the data first before

continuing. 100 pieces of data are downloaded automatically. If you require more data, you can configure the download record limit.

- The framework for UDF local running uses data in specified columns of the warehouse as input and runs the function locally. You can view the log output and results in the console.
- If you are using the mock project or if your data is already downloaded, you can run the UDF directly.

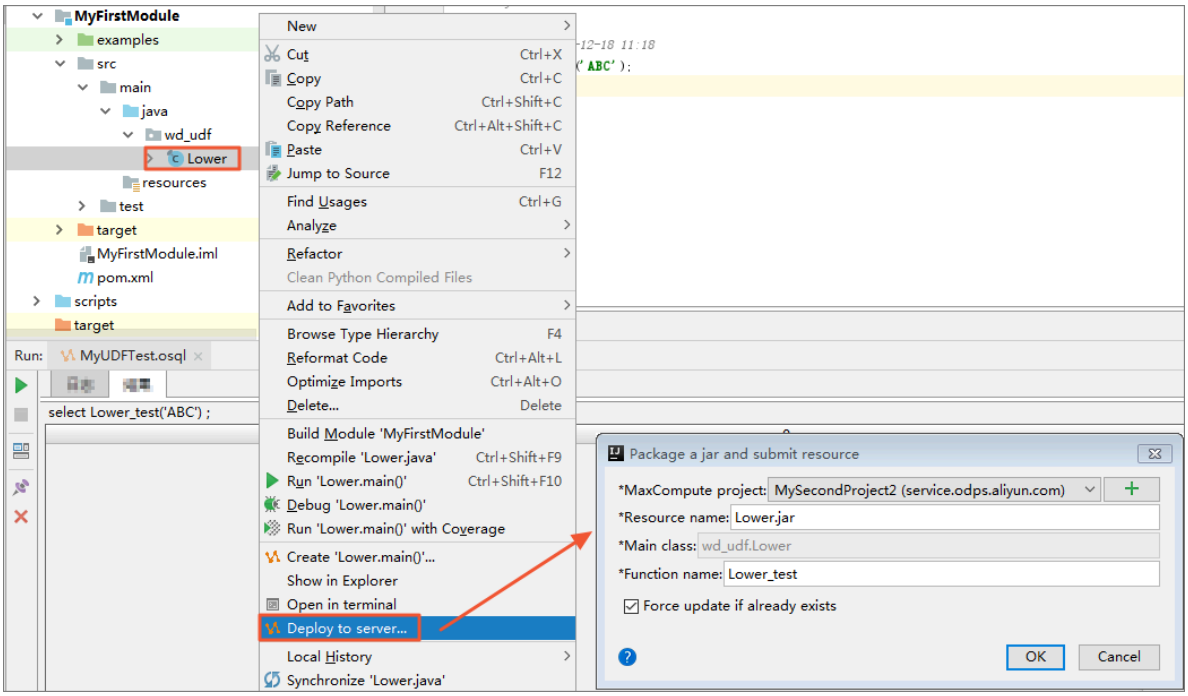
Click OK. The following figure shows the result.



4. Publish the UDF.

   After the `Lower.java` test is successful, pack this file into a JAR package and upload the package to MaxCompute. To publish a UDF to a server, you need to pack this file, add a resource, and register the function. IntelliJ IDEA MaxCompute Studio makes publishing a UDF easier in that this program can help you to run a maven clean package command, upload the JAR package, and register the UDF in sequence. The procedure to do so is as follows: Right-click the Java file of the UDF and select Deploy to server. In the displayed dialog box, select the target

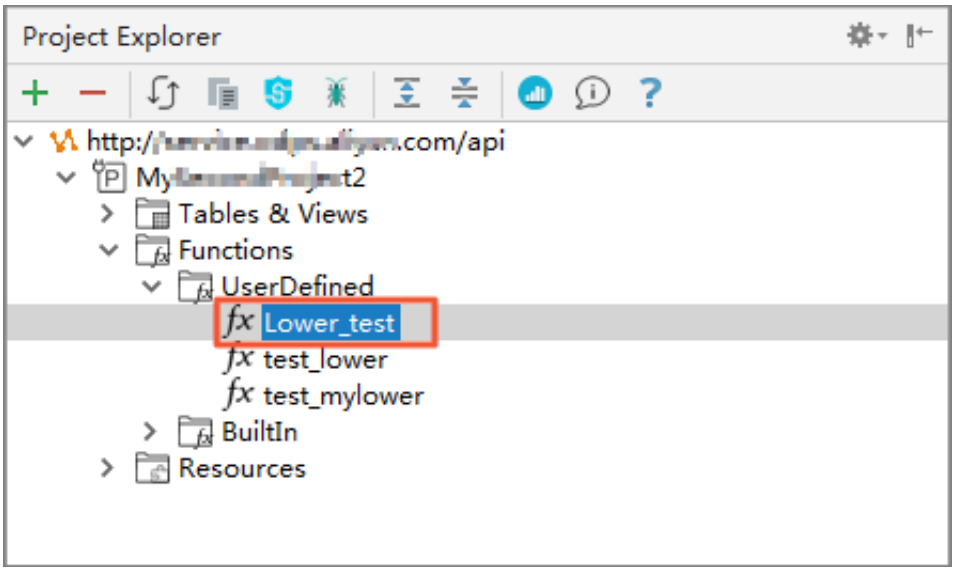
MaxCompute project and enter the `Function name` and the `Resource name`. You can change the resource name as needed. The following is an example.



Note:

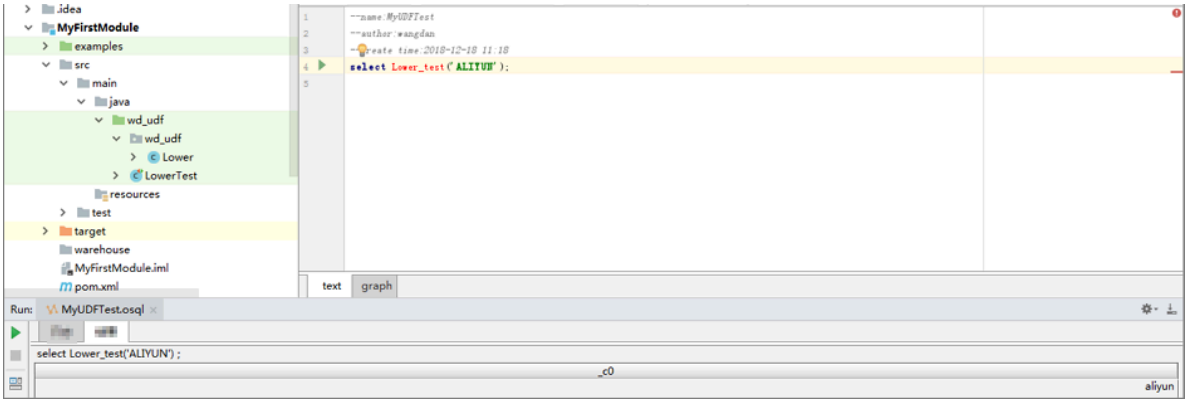
For more information about how to pack, upload, and register a UDF, see *Pack, upload, and register*.

After completing the settings, click OK. You can find the registered function in the connected MaxCompute project, as shown in the following figure.



5. Use the UDF.

   You can use the UDF after it is successfully registered. In the module project, open the SQL script and run the `select Lower_test (' ALIYUN ');` command. The result is shown in the following figure.



   You can also run the `select Lower_test (' ALIYUN ') from uppperABC ;` command on the odpscmd client to test the Java-based UDF. If the following information is displayed, the Lower_test Java-based UDF developed by using IntelliJ IDEA works properly.

What's next

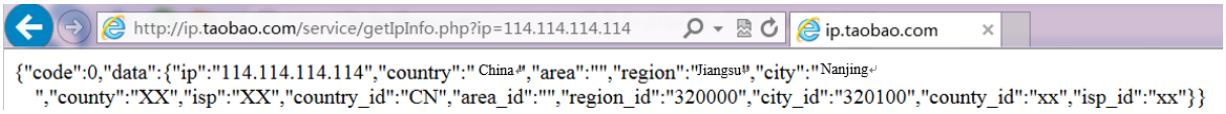
To use Eclipse to develop a Java-based UDF, see *Use Eclipse to develop a Java-based UDF*.

3.3 Use MaxCompute to analyze IP sources

This topic describes how to use MaxCompute to analyze IP sources. The procedure includes downloading and uploading data from an IP address library, writing a user-defined function (UDF), and writing a SQL statement.

Background

The query APIs of *Taobao IP address library* are *IP address strings*. The following is an example.



HTTP requests are not directly allowed in MaxCompute. However, you can query IP addresses in MaxCompute using one of the following methods:

1. Run a SQL statement and then initiate an HTTP request. This method is inefficient. The request will be rejected if the query frequency is lower than 10 QPS.
2. Download the IP address library to the local server. This method is inefficient and will affect the data analysis in data warehouses.
3. Maintain the IP address library regularly and upload it to MaxCompute. This method is relatively effective. However, you need to maintain the IP address library regularly.

The following further describes the third method.

Download an IP address library

1. You need to obtain data from an IP address library. This section provides a *demo of an incomplete UTF-8 IP address library*.
2. Download the UTF-8 IP address library and check the data format, as shown in the following figure.

```
0,16777215,"0.0.0.0","0.255.255","","Intranet IP","Intranet IP","Intranet IP"
16777216,16777471,"1.0.0.0","1.0.0.255","Australia","","","",""
16777472,16778239,"1.0.1.0","1.0.3.255","China","Fujian","Fuzhou","Telecom"
```

The first four strings of data are the starting and ending IP addresses, among which the first two are decimal integers and the second two are expressed in dot-decimal notation. The decimal integer format is used to check whether an IP address belongs to the target network segment.

Upload data from the IP address library

1. Create a table data definition language (DDL) on the *MaxCompute client*, or *create a table on the GUI* in DataWorks.

```
 DROP   TABLE   IF   EXISTS   ipresource  ;

 CREATE   TABLE   IF   NOT   EXISTS   ipresource
(
     start_ip   BIGINT
    , end_ip   BIGINT
    , start_ip_a  rg   string
    , end_ip_arg   string
    , country   STRING
    , area   STRING
    , city   STRING
    , county   STRING
    , isp   STRING
```

```
);
```

2. Run the *Tunnel commands* to upload the ipdata.txt.utf8 file, which is stored on the D drive.

```
odps @ workshop_d emo > tunnel upload D :/ ipdata . txt .
utf8 ipresource ;
```

You can use the `select count (*) from ipresource ;` SQL statement to view the uploaded data. Generally, the quantity of data increases in the library due to regular updates and maintenance.

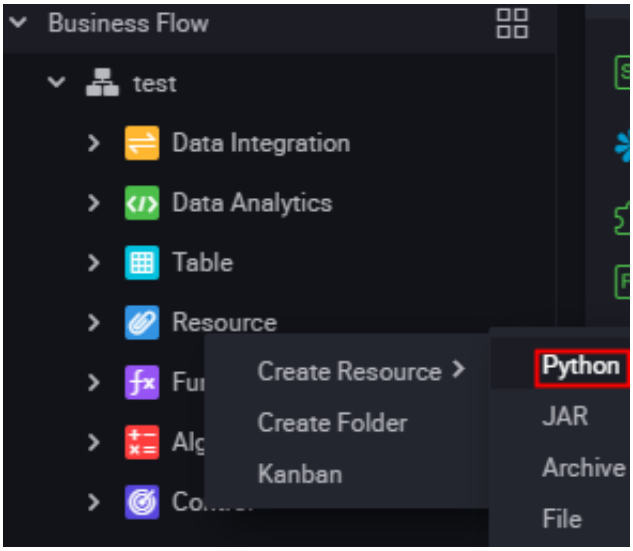
3. Use the `select * from ipresource limit 10 ;` SQL statement to view the first 10 pieces of data in the ipresource table, as shown in the following figure.

```
Job Queueing...
+------------+------------+--------------+------------+---------+------+------+--------+------+
| start_ip   | end_ip     | start_ip_arg | end_ip_arg | country | area | city | county | isp  |
+------------+------------+--------------+------------+---------+------+------+--------+------+
| 3395369026 | 3395369026 | "202.97.56.66" | "202.97.56.66" | "China" | "Hunan" | "Changsha" | "" | "Telecom" |
| 3395369027 | 3395369028 | "202.97.56.67" | "202.97.56.68" | "China" | "Heilongjiang" | "" | "" | "Telecom" |
| 3395369029 | 3395369029 | "202.97.56.69" | "202.97.56.69" | "China" | "Anhui" | "Hefei" | "" | "Telecom" |
| 3395369030 | 3395369030 | "202.97.56.70" | "202.97.56.70" | "China" | "Hunan" | "Changsha" | "" | "Telecom" |
| 3395369031 | 3395369033 | "202.97.56.71" | "202.97.56.73" | "China" | "Heilongjiang" | "" | "" | "Telecom" |
| 3395369034 | 3395369034 | "202.97.56.74" | "202.97.56.74" | "China" | "Hunan" | "Changsha" | "" | "Telecom" |
| 3395369035 | 3395369036 | "202.97.56.75" | "202.97.56.76" | "China" | "Heilongjiang" | "" | "" | "Telecom" |
| 3395369037 | 3395369037 | "202.97.56.77" | "202.97.56.77" | "China" | "Jiangsu" | "Nanjing" | "" | "Telecom" |
| 3395369038 | 3395369038 | "202.97.56.78" | "202.97.56.78" | "China" | "Hunan" | "Changsha" | "" | "Telecom" |
| 3395369039 | 3395369040 | "202.97.56.79" | "202.97.56.80" | "China" | "Heilongjiang" | "" | "" | "Telecom" |
+------------+------------+--------------+------------+---------+------+------+--------+------+
```

Write a UDF

1. Choose Data Studio > Business Flow > Resource. Right-click Resource and choose Create Resource > Python. In the displayed dialog box, enter the name of the

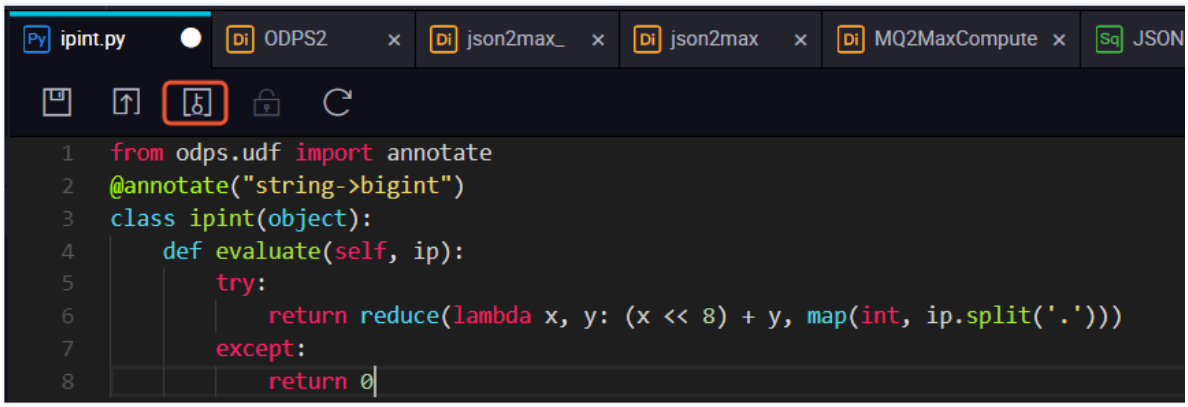
Python resource, select Upload to ODPS and click OK, as shown in the following figure.



2. Write code for the Python resource. The following is an example:

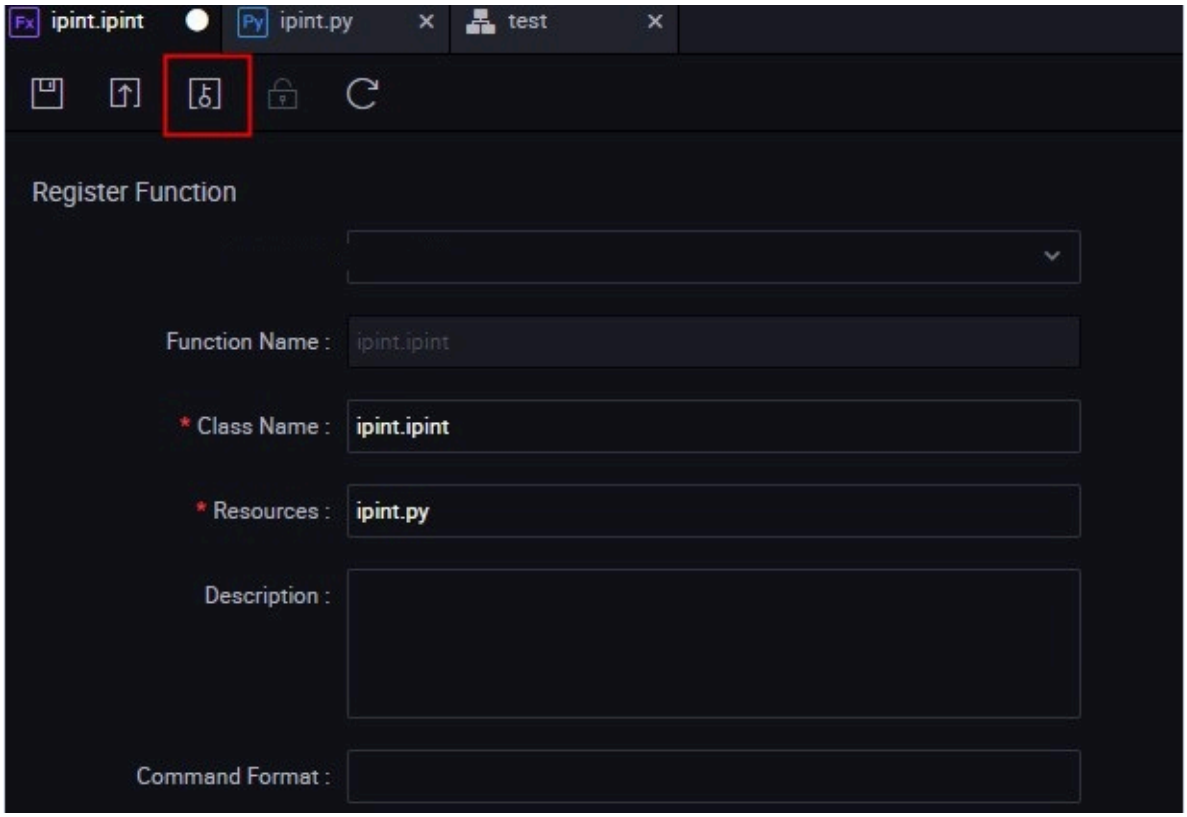
```
 from   odps . udf   import   annotate
@ annotate (" string -> bigint ")
 class   ipint ( object ):
  def   evaluate ( self ,  ip ):
   try :
    return   reduce ( lambda   x ,  y : ( x  <<  8 ) +  y ,  map (
int ,  ip . split ('.')))
   except :
    return   0
```

Click Submit and Unlock.

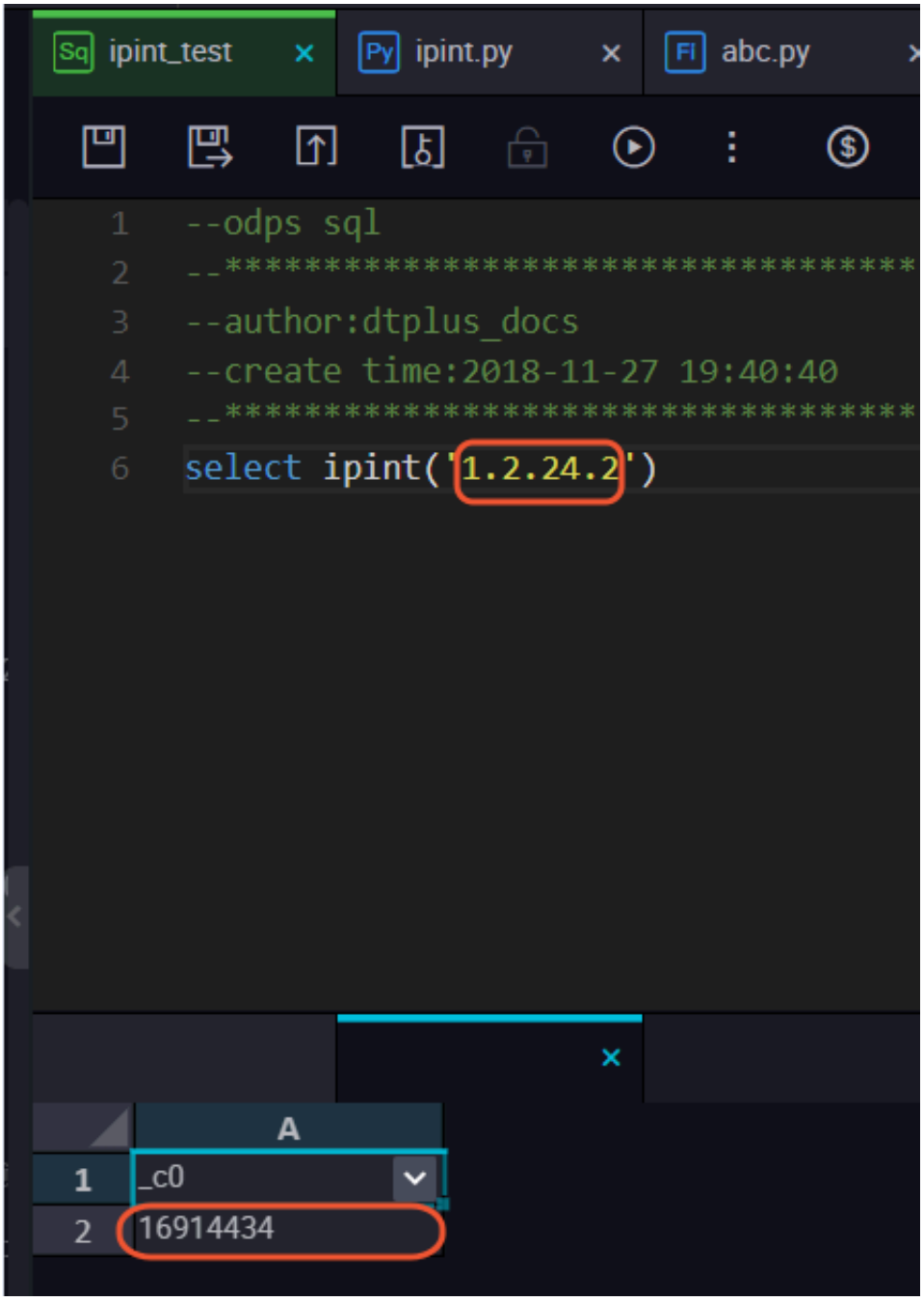


3. Choose Data Studio > Business Flow > Function. Right-click Function and select Create Function.

   Set the function class name to `ipint . ipint`, and the folder to the resource name, and click Submit and Unlock.



4. Create an ODPS SQL node and run the SQL statement to check whether the ipint function works as expected. The following is an example.



You can also create a local *ipint . py* file and use the *MaxCompute client* to upload the resource.

```
odps @ MaxCompute _DOC > add py D :/ ipint . py ;
OK : Resource ' ipint . py ' have been created .
```

After uploading the resource, use the client to *register the function*.

```
odps @ MaxCompute _DOC > create function ipint as ipint .
ipint using ipint . py ;
Success : Function ' ipint ' have been created .
```

The function can be used after registration. You can use `select ipint (' 1 . 2 . 24 . 2 ');` on the client to test the function.

Note:

You can perform *cross-project authorization* to share the UDF with other projects under the same Alibaba Cloud account.

1. Create a package named ipint.

```
odps @ MaxCompute _DOC > create package ipint ;
OK
```

2. Add the UDF to the package.

```
odps @ MaxCompute _DOC > add function ipint to package
ipint ;
OK
```

3. Allow a bigdata_DOC project to install the package.

```
odps @ MaxCompute _DOC > allow project bigdata_DO C to
install package ipint ;
OK
```

4. Switch to a bigdata_DOC project that needs to use the UDF and install the package.

```
odps @ MaxCompute _DOC > use bigdata_DO C ;
odps @ bigdata_DO C > install package MaxCompute _DOC .
ipint ;
OK
```

5. Then, the UDF can be used. If a user (such as Bob) of the bigdata_DOC project wants to access the resource, the administrator can grant the access permission to the user by using the ACL.

```
odps @ bigdata_DO C > grant Read on package MaxCompute
_DOC . ipint to user aliyun $ bob @ aliyun . com ; -- Use
the ACL to grant the package access permission to
Bob .
```

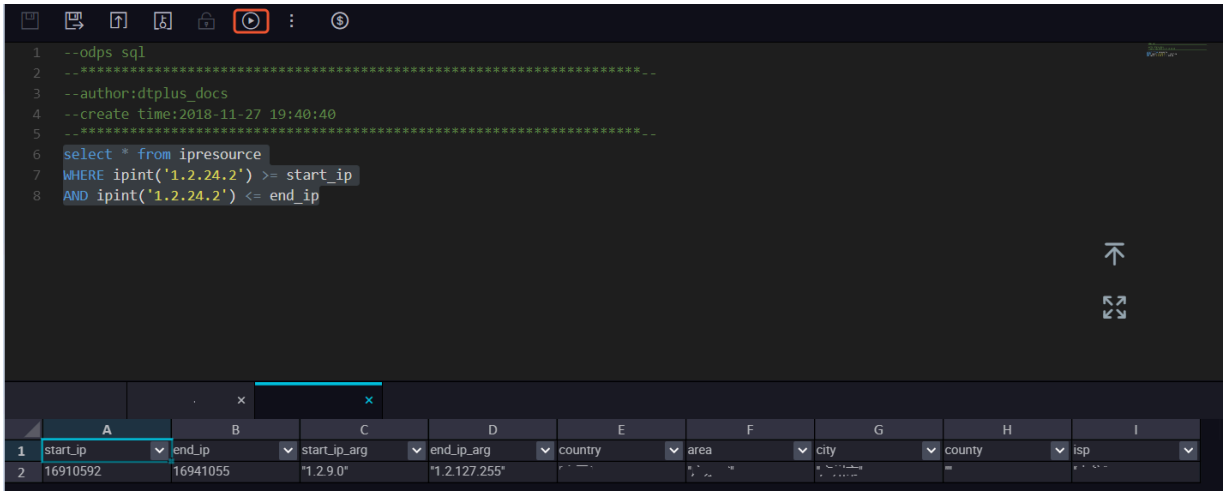
Use the IP address library in SQL

Note:

This section uses the IP address 1.2.254.2 as an example. You can use a specific field to query an IP address as needed.

You can use the following SQL code to view the test result:

```
select  *  from   ipresource
WHERE   ipint (' 1 . 2 . 24 . 2 ') >=  start_ip
AND   ipint (' 1 . 2 . 24 . 2 ') <=  end_ip
```



To ensure the data accuracy, you can regularly obtain data from the Taobao IP address library to maintain the ipresource table.

3.4 Upload files exceeding 10 MB to DataWorks

This topic describes how to upload a JAR package or resource file exceeding 10 MB to DataWorks when running a MapReduce job.

Methods:

1. Upload resources exceeding 10 MB through the *MaxCompute CLI client*. Before you can upload the resource, first complete the following procedure.
   - Download the MaxCompute CLI client. For more information, see *Client*.
   - Set AccessKeys and endpoints for the MaxCompute CLI client. For more information, see *Install and configure a client*.

   Run the following command on the MaxCompute CLI client:

   ```
   // Add   resources .
    add   jar   C :\ test_mr \ test_mr . jar  - f ;
   ```

2. Currently, resources uploaded through the MaxCompute CLI client cannot be viewed in the resource list in the DataWorks console. You can view and confirm the resources by running the list resources command.

   ```
   // View   resources .
   ```

```
 list   resources ;
```

3. **Reduce the JAR file size and run the MapReduce jobs on DataWorks on your local server. You need to keep only one main function.**

```
 jar
- resources   test_mr . jar , test_ab . jar  -- The   list
 resources   command   directly   runs   after   the   function   is
   registered   on   the   MaxCompute   CLI   client .
- classpath   test_mr . jar  -- Size   reduction   policy :  A
 mapper   and   a   reducer   that   are   related   to   the   main
   function   are   required   to   submit   the   size   reduction
   policy   to   a   gateway .  The   third - party   dependency
 is   not   required .  Other   resources   can   be   stored   on
 the   resources   directory .
 com . aliyun . odps . examples . mr . test_mr   wc_in   wc_out ;
```

With the preceding methods, you can use the scheduling feature to run MapReduce jobs exceeding 10 MB on DataWorks regularly.

4 Compute optimization

4.1 SQL optimization

- **Where condition in Join statement**

  When you join two tables, the Where condition of the primary table can be written at the end of the statement, but the restriction condition of the partition in the secondary table cannot be written in the Where condition. We recommend that you write it in the ON condition or subquery. The partition restrictions of the primary table can be written in the Where condition (it is better to filter by subquery first). Several SQL examples are as follows:

```
select * from A join ( select * from B where dt =
20150301 ) B on B . id = A . id where A . dt = 20150301 ;
select * from A join B on B . id = A . id where B .
dt = 20150301 ; -- Not allowed .
select * from ( select * from A where dt = 20150301 ) A
  join ( select * from B where dt = 20150301 ) B on B
. id = A . id ;
```

  The Join operation in the second statement runs first, data volume becomes larger and the performance can be decreased. Therefore, the second statement must be avoided.

- **Data skew**

  The root cause of data skew is that the amount of data processed by some Workers is much larger than that of other Workers. This means running hours of some Workers are higher than the average, which leads to job delay.

  .

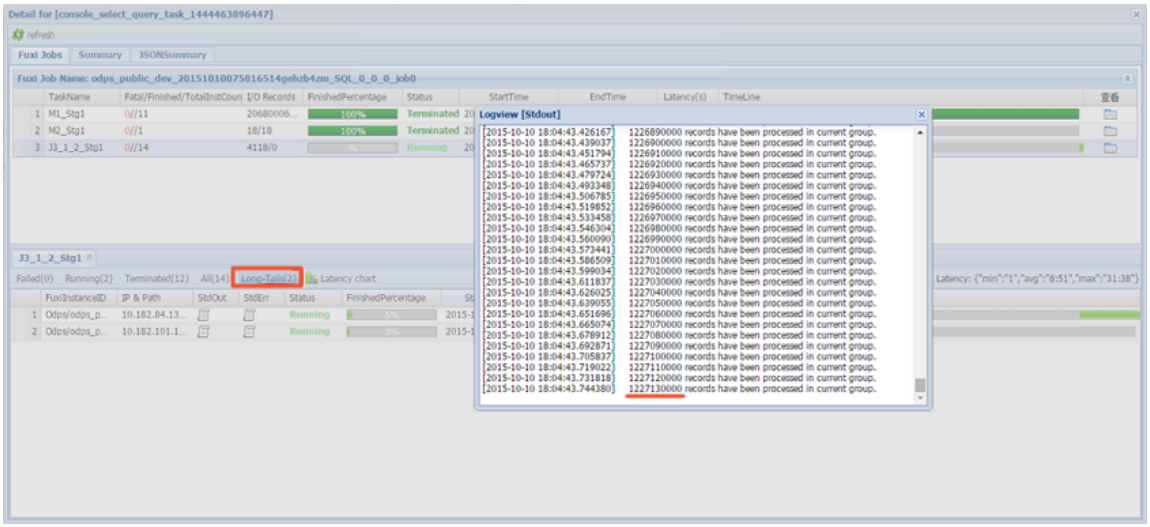
  - **Data skew caused by Join**

    Data can be skewed by a Join operation when the Join key distribution is uneven. For the preceding example, to join a large table A and a small table B, run the

following statement: For the preceding example, to join a large table A and a small table B, run the following statement:

```
select * from A join B on A . value = B . value ;
```

Copy the logview link to enter the web console page, and double-click the Fuxi job that runs the Join operation. You can see a long tail in the Long-Tails tab, which indicates that the data has been skewed, as shown in the following figure:



You can optimize the statement by the following methods:

- Since table B is a small table and does not exceed 512 MB, you can optimize the preceding statement into mapjoin statement.

```
select /*+ MAPJOIN ( B ) */ * from A join B on A
. value = B . value ;
```

- Handle the skewed key with a separate logic. For example, a large number of null key values in both tables will usually cause data skew. It is necessary to filter out the null data or add a random number before the Join operation, for example:

```
select * from A join B
on case when A . value is null then concat ('
value ', rand () ) else A . value end = B . value ;
```

If you know that the data is skewed, but you cannot work out what is causing it, a general solution can be used to test the data skew. See the following example:

```
select * from a join b on a . key = b . key ; -- This
Leads to data skew .
Now you can run the following statements :
``` sql
select left . key , left . cnt * right . cnt from
```
```

```
( select   key ,  count (*)  as   cnt   from   a   group   by   key
 )  left
 join
( select   key ,  count (*)  as   cnt   from   b   group   by   key
 )  right
 on   left . key = right . key ;
```

Check the distribution of keys to discover whether data skew happens when A joins B.

- Group by skew

  Group by skewing can be caused when the key distribution of group by is uneven.

  Suppose a table A has two fields: key and value. The data volume in the table is large enough, and the value distribution of key is uneven. Run the following statement:

  ```
  select   key , count ( value )  from   A   group   by   key ;
  ```

  You can see the long tail on the web console page. To solve this problem, you must set the anti-skew parameters before running SQL statement `set   odps . sql . groupby . skewindata = true` must be added into the SQL statement.

- Data skew caused by incorrect use of dynamic partitions

  Dynamic partitions of SQL in MaxCompute add a Reduce function by default, which is used to merge the same partition data. The benefits are as following.

  - Reduce small files generated by MaxCompute and improve the efficiency of processing.
  - Reduce the memory occupied when a Worker outputs many files.

  When partition data is skewed, using the Reduce function lead to the appearance of long tails. The same data can only be processed by a maximum of 10 Workers, so large volume of data results in long tails, for example:

  ```
  insert   overwrite   table   A2   partition ( dt )
  select
  split_part ( value ,'\ t ', 1 )  as   field1 ,
  split_part ( value ,'\ t ', 2 )  as   field2 ,
  dt
  from   A
  where   dt =' 20151010 ';
  ```

  In this case, we recommend that you do not use dynamic partition, and modify the statement in the following way:

  ```
  ```

```
insert overwrite table A2 partition ( dt =' 20151010 ')
select
split_part ( value ,'\ t ', 1 ) as field1 ,
split_part ( value ,'\ t ', 2 ) as field2
from A
where dt =' 20151010 ';
```

- Window function optimization

  If you use window functions in your SQL statement, each window function typically forms a Reduce job. If window functions are too many, they consume resources. In some specific scenarios, you can optimize window functions.

  - The content after the over keyword must be the same, with the similar grouping and sorting conditions.
  - Multiple window functions must run on the same SQL layer.

  Window functions that meet these two conditions merge into Reduce implementation. An SQL example is as follows:

```
select
rank () over ( partition by A order by B desc ) as
rank ,
row_number () over ( partition by A order by B desc )
as row_num
from MyTable ;
```

- Convert the subquery to Join

  A subquery is shown as follows:

```
SELECT * FROM table_a a WHERE a . col1 IN ( SELECT
col1 FROM table_b b WHERE xxx );
```

  If the number of col1 returned by the table_b subquery in this statement exceeds 1,000, the system reports an error: `rrecords returned from subquery exceeded limit of 1 , 000` . In this case, you can use the Join statement instead:

```
SELECT a . * FROM table_a a JOIN ( SELECT DISTINCT
col1 FROM table_b b WHERE xxx ) c ON ( a . col1 = c
. col1 )
```

  Note:

  - If there is no Distinct keyword in the statement, and the result of the subquery c returns the same col1 value, it may cause the larger number of results of table_a.

- The Distinct subquery can lead the whole query to fall into one Worker. If the subquery data is large, it may cause the whole query to be slower.If you have already made sure the col1 values are distinct in the subquery from the business, for example, by querying the primary key field, then performance can only be improved by removing the Distinct keyword.
- If you have already made sure the col1 values are distinct in the subquery from the business, for example, querying by the primary key field, to improve performance the Distinct keyword can only be removed.

4.2 Optimize long tail computing

Long tail is a common and difficult problem in distributed computing. The workload of each node is different when data is distributed unevenly. The whole task does not end until the work on the slowest node is complete.

To address this problem, you can distribute a piece of task to multiple workers for execution, rather than designate a worker to run the heaviest task. This article describes how to address typical cases of long tail.

Join long tail

Cause:

When the Key of a Join statement has a large amount of data, a long tail occurs.

Solution:

You can solve the problem in four steps:

- Verify that one or both of the tables are not small tables. If one table is large and the other small, you can use the mapjoin statement to cache the small table. For the syntax and relevant description, see *Introduction to the SELECT Syntax*. If the job is a MapReduce job, you can use the resource table function to cache the small table.
- If both tables are relatively large, reduce duplicated data as much as possible.
- If the problem persists, consider service optimization to avoid the calculation of Cartesian product on the two keys with a large data volume.
- Small table leftjoin large table, odps direct leftjoin is slow. At this point, you can first small the table and the large table mapjoin, so that you can get the intersecti on between the small table and the big table, and this intermediate table must not be greater than the large table (as long as there is not a large key tilt not very large

). The small table then performs a leftjoin with this intermediate table, and the effect is equal to the larger table of the small leftjoin.

Group By long tail

Cause

When a Key of the Group By statement has a large amount of computations, a long tail occurs.

Solution:

You can solve the problem in either of the following ways:

- Rewrite the SQL statement and add random numbers to split the long key. As shown in the following:

```
SELECT   Key , COUNT (*)  AS   Cnt   FROM   TableName   GROUP   BY
  Key ;
```

Provided that the Combiner is skipped, data is shuffled from the M node to the R node. Then, the R node performs the Count operation. The execution plan is M > R . If you want to redistribute work to the key with the long tail, modify the statement as follows:

```
--  Assume   that   the   key   with   the   long   tail   is
 KEY001 .
 SELECT   a . Key
  ,  SUM ( a . Cnt )  AS   Cnt
 FROM  (
   SELECT   Key
    ,  COUNT (*)  AS   Cnt
 FROM   TableName
 GROUP   BY   Key ,
   CASE
     WHEN   Key  = ' KEY001 '  THEN   Hash ( Random ()) %  50
     ELSE   0
    END
)  a
 GROUP   BY   a . Key ;
```

The execution plan is changed to M > R > R. The execution lengthens, but the consumed time may reduce because the long-tail key is processed in two steps.

Note:

If you use the preceding method to add an R execution step for solving a long tail problem that is not serious, the consumed time may increase.

- Set system parameters as follows:

```
set   odps . sql . groupby . skewindata = true .
```

Parameter setting is a universal optimization method, but the results are not satisfying because this method does not consider specific services. You can rewrite the SQL statement in a more efficient manner based on the actual data.

Distinct long tail

When a long tail occurs in a Distinct statement, the Key splitting method does not apply. You can consider other methods.

Solution:

```
-- Original   SQL   statement ,  with   the   null   UID   skipped
 SELECT   COUNT ( uid )  AS   Pv
    ,  COUNT ( DISTINCT   uid )  AS   Uv
 FROM   UserLog ;
```

Rewrite the statement as follows:

```
 SELECT   SUM ( PV )  AS   Pv
    ,  COUNT (*)  AS   UV
 FROM  (
     SELECT   COUNT (*)  AS   Pv
       ,  uid
     FROM   UserLog
     GROUP   BY   uid
)  a ;
```

The Distinct statement is rewritten to a Count statement to relieve the computing pressure on a single Reducer. This solution also enables Group By statement optimization and Combiner execution, greatly improving the performance.

Long tail of a dynamic partition

Cause:

- To sort the data of small files, the dynamic partition function starts a Reduce task in the final stage of execution. A long tail occurs when the data written by the dynamic partition function is skewed.
- Misuse of the dynamic partition function often results in long tails.

Solution:

If the target partition for data write is determined, you can specify this partition during the Insert operation, instead of using the dynamic partition function.

Remove long tails using the Combiner

For MapReduce jobs, it is a common practice to use the Combiner to remove long tails . This practice has been mentioned in the WordCount example. The Combiner can reduce the volume of data shuffle from the Mapper to the Reducer, thus sufficiently reduce the overhead of network transfer. The optimization is automatically done for MaxCompute SQL statements.

Note:

The Combiner only supports optimization for Map. You must make sure that the results of Combiner execution are the same. For example, in WordCount, the results are the same for two (KEY,1)s and one (KEY,2). For example, in average value calculation, (KEY,1) and (KEY,2) cannot be directly merged into (KEY,1.5) in the Combiner.

Remove long tails using system optimization

In addition to the Local Combiner, you can use the optimization method provided by MaxCompute to remove long tails. For example, the following content (+N backups) is logged during the task running process:

```
M1_Stg1_jo  b0 : 0 / 521 / 521 [ 100 %]  M2_Stg1_jo  b0 : 0 / 1 / 1
[ 100 %]  J9_1_2_Stg  5_job0 : 0 / 523 / 523 [ 100 %]  J3_1_2_Stg
1_job0 : 0 / 523 / 523 [ 100 %]  R6_3_9_Stg  2_job0 : 1 / 1046 / 1047
[ 100 %]
M1_Stg1_jo  b0 : 0 / 521 / 521 [ 100 %]  M2_Stg1_jo  b0 : 0 / 1 / 1
[ 100 %]  J9_1_2_Stg  5_job0 : 0 / 523 / 523 [ 100 %]  J3_1_2_Stg
1_job0 : 0 / 523 / 523 [ 100 %]  R6_3_9_Stg  2_job0 : 1 / 1046 / 1047
[ 100 %]
M1_Stg1_jo  b0 : 0 / 521 / 521 [ 100 %]  M2_Stg1_jo  b0 : 0 / 1 / 1
[ 100 %]  J9_1_2_Stg  5_job0 : 0 / 523 / 523 [ 100 %]  J3_1_2_Stg
1_job0 : 0 / 523 / 523 [ 100 %]  R6_3_9_Stg  2_job0 : 1 / 1046 / 1047
(+ 1   backups )[ 100 %]
M1_Stg1_jo  b0 : 0 / 521 / 521 [ 100 %]  M2_Stg1_jo  b0 : 0 / 1 / 1
[ 100 %]  J9_1_2_Stg  5_job0 : 0 / 523 / 523 [ 100 %]  J3_1_2_Stg
1_job0 : 0 / 523 / 523 [ 100 %]  R6_3_9_Stg  2_job0 : 1 / 1046 / 1047
(+ 1   backups )[ 100 %]
```

There total number of Reducers is 1,047, of which 1,046 are complete. The last one is incomplete. After the system identifies this condition, it starts a new Reducer to run the same data. Then, the system takes the data of the Reducer which completes first and combines the data to the result set.

Remove long tails using service optimization

The preceding optimization methods cannot solve all problems. You can analyze your services to find a better solution,the example is as follows:

- A large amount of noisy data may exist in reality. For example, you want to check the behavior data in the access record of each user by visitor ID. You must remove crawler data first, even though crawlers become increasingly difficult to identify ; otherwise, the crawler data may easily cause a long tail during the calculation process. A similar case is when you associate data by a specific xxid, you must check whether the field for association is null.
- Special services exist. For example, ISV operation records differ greatly from common user records in terms of data volume and behavior. You can use a special method to analyze and handle the ISV operation records for major accounts independently.
- When data distribution is uneven, do not use a constant field as the Distribute by field for full sorting.

4.3 Computing optimization program for long period indicators

Experiment background

E-commerce companies such as TaoBao have all kinds of perspectives and procedures regarding user data analysis. E-commerce data warehouse and business analysis often require the calculation of various indicators such as the number of visitors in last few days, buyers, and regular customers.

The calculation of these indicators is based on the data that has accumulated on the e-commerce platform or the online store over a period. This article assumes that the data for calculation is stored in MaxCompute.

In general, these indicators are calculated using the log detail table. The following code calculates the number of visitors of the product in the past 30 days:

```
select   item_id  -- Item   ID
 , count ( distinct   visitor_id )  as   ipv_uv_1d_  001
from   Log   detail   table   that   stores   the   data   about
the   visits   to   the   item
where   ds  <= ${ bdp . system . bizdate }
and   ds  >= to_char ( dateadd ( to_date (${ bdp . system . bizdate
},' yyyymmdd '),- 29 ,' dd '),' yyyymmdd ')
```

```
group   by   item_id ;
```

Note:
All the variables in the code are the scheduling variables of DataWorks. They are only applicable to the scheduling tasks of DataWorks. This condition applies in the rest of this article.

The preceding code has a serious problem when many logs are generated every day. Massive Map Instance are required and may exceed the 99999 quantity limit, affecting the execution of the map task and subsequent operations.

The need for massive map instances is owing to the large volume of log data per day, not to mention the log data generated over a period of 30 days. The SELECT operation requires more map instances than permitted by the upper limit, causing abnormal code execution.

Tutorial goal

The impact on performance resulting from the calculation of long-period indicators can be minimized in either of the following ways:

- **Reduce the data volume to avoid a summary of data from multiple days.**
- **Create a temporary table and make a summary of 1D data to remove duplicate data and thus reduce the data volume on a daily basis.**

Tutorial scheme

Procedure

1. **Create a medium table and make a daily summary.**

   In the preceding example, you can create a medium table with a granularity of item_id+visitor_id for daily summary. Record this table as A. For example:

```
insert   overwrite   table   mds_itm_vs  r_xx ( ds ='${ bdp .
system . bizdate } ')
select   item_id , visitor_id , count ( 1 )  as   pv
  from
  (
  select   item_id , visitor_id
  from   Log   detail   table   that   stores   the   data   about
  the   visits   to   the   item
  where   ds  =${ bdp . system . bizdate }
  group   by   item_id , visitor_id
```

```
  )  a ;
```

2. Calculate the data from multiple days, and use the medium table to make a summary.

   Make a 30-day summary on Table A, as shown in the following code:

```
select   item_id
       , count ( distinct   visitor_id )  as   uv
       , sum ( pv )  as   pv
  from   mds_itm_vs  r_xx
  where   ds  <= '${ bdp . system . bizdate } '
  and   ds  >=  to_char ( dateadd ( to_date ('${ bdp . system .
bizdate } ',' yyyymmdd '),- 29 ,' dd '),' yyyymmdd ')
  group   by   item_id ;
```

Impact and consideration

In the preceding method, the detailed data of daily access logs is deduplicated to reduce the data volume while improving the performance. A weakness of this method is the need to read data from N partitions for every calculation of multi-day data.

To avoid repeated data reads, you can compress the data in the N partitions into one partition which contains all historical data.

To do this, you can calculate long-period indicators in an incremental and accumulati ve way.

Use cases

Calculate the number of regular customers of the store for the past one day. A regular customer is defined as a buyer who has purchased items at the store over a period, such as the past 30 days.

The number of regular buyers is calculated as follows:

```
select   item_id  ---- Item   ID
       , buyer_id   as   old_buyer_  id
from   Detail   table   that   stores   the   data   about   buyers
and   purchased   items
where   ds  < ${ bdp . system . bizdate }
and   ds  >= to_char ( dateadd ( to_date (${ bdp . system . bizdate
},' yyyymmdd '),- 29 ,' dd '),' yyyymmdd ')
group   by   item_id
       , buyer_id ;
```

Improvement:

- Maintain a table as table A to record the relationship between buyers and purchased items. Specifically, record the first purchase period, the last purchase

period, the total number of purchased items, and the total amount of the purchases in this table.

- Update the data of Table A every day based on the payment detail log for the past one day.
- To determine whether a person is a regular buyer, check whether the last purchase time is within the past 30 days. This deduplicates data relationship pairs and reduces the volume of input data.