

HP Vertica Analytics Platform 6.1.x

Programmer's Guide

Doc Revision 3

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Programmer's Guide

Welcome to the HP Vertica Programmer's Guide. This book describes how to connect to an HP Vertica Analytics Platform database and run SQL statements.

Prerequisites

This document assumes that you have installed and configured HP Vertica as described in the Installation Guide. It assumes that you are familiar with the basic concepts and terminology of the SQL language and relational database management systems.

Syntax Conventions

The following are the syntax conventions used in the HP Vertica documentation.

Syntax Convention	Description
Text without brackets/braces	Indicates content you type, as shown.
< <i>Text inside angle brackets</i> >	Represents a placeholder for which you must supply a value. The variable is usually shown in italics. See <i>Placeholders</i> below.
[Text inside brackets]	Indicates optional items; for example, CREATE TABLE [<i>schema_name</i>] <i>table_name</i> The brackets indicate that the <i>schema_name</i> is optional. Do not type the square brackets.
{ Text inside braces }	Indicates a set of options from which you choose one; for example: QUOTES { ON OFF } indicates that exactly one of ON or OFF must be provided. You do not type the braces: QUOTES ON
Backslash \	Represents a continuation character used to indicate text that is too long to fit on a single line.
Ellipses ...	Indicate a repetition of the previous parameter. For example, option[,...] means that you can enter multiple, comma-separated options. Showing ellipses in code examples might also mean that part of the text has been omitted for readability, such as in multi-row result sets.
Indentation	Is an attempt to maximize readability; SQL is a free-form language.
<i>Placeholders</i>	Represent items that must be replaced with appropriate identifiers or expressions and are usually shown in italics.
Vertical bar	Is a separator for mutually exclusive items. For example: [ASC DESC] Choose one or neither. You do not type the square brackets.

HP Vertica Client Libraries

The HP Vertica client driver libraries provide interfaces for connecting your client applications (or third-party applications such as Cognos and MicroStrategy) to your HP Vertica database. The drivers simplify exchanging data for loading, report generation, and other common database tasks.

There are three separate client drivers:

- Open Database Connectivity (ODBC)—the most commonly-used interface for third-party applications and clients written in C, Python, PHP, Perl, and most other languages.
- Java Database Connectivity (JDBC)—used by clients written in the Java programming language.
- ActiveX Data Objects for .NET (ADO.NET)—used by clients developed using Microsoft's .NET Framework and written in C#, Visual Basic .NET, and other .NET languages.

Client Driver Standards

The HP Vertica client drivers are compatible with the following driver standards:

- The ODBC driver complies with version 3.5.1 of the ODBC standard.
- HP Vertica's JDBC driver is a type 4 driver that complies with the JDBC 3.0 standard. It is compiled using JDK version 1.5, and is compatible with client applications compiled using JDK versions 1.5 and 1.6.
- ADO.NET drivers conform to .NET framework 3.0 specifications.

The drivers do not support some of the optional features in the standards. See ***ODBC Feature Support*** (page [55](#)) and ***JDBC Feature Support*** (page [107](#)) and Using ADO.NET (page [161](#)) for details.

Client Driver and Server Version Compatibility

Usually, each version of the HP Vertica server is compatible with the previous version of the client drivers. This compatibility lets you upgrade your HP Vertica server without having to immediately upgrade your client software. However, some new features of the new server version may not be available through the old drivers.

The following table summarizes the compatibility of each recent version of the client drivers with the HP Vertica server versions.

Client Driver Version	Compatible Server Versions	Notes
4.0	4.0, 4.1	
4.1	4.1, 5.0, 5.1, 6.0, 6.1	There was no 5.0 client driver release, so the 5.0 server shipped with the 4.1 drivers.
5.1	5.1, 6.0, 6.1	

Client Driver Version	Compatible Server Versions	Notes
6.0	6.0, 6.1	
6.1	6.1	

Version 4.1 to 5.1 Client Driver Transition

The client driver libraries were completely rewritten for HP Vertica 5.1 to improve standards compatibility and support more platforms. As a result, some of the classes, functions, properties, and other elements of the driver APIs have been renamed or deprecated in favor of standard ones. See *Updating ODBC Client Code from Previous Driver Versions* (page 55), *Updating ADO.NET Client Code from Previous Driver Versions* (page 161), and *Updating JDBC Client Code from Previous Driver Versions* (page 108) for details on updating your pre-5.1 client code to work with the new client libraries.

HP Vertica ODBC/JDBC Client Installers

The ODBC/JDBC client drivers are a separate installation from the ADO.NET drivers. (ADO.NET support is not available in Community Edition.) As noted in the compatibility table, the 6.x ODBC/JDBC client drivers do not support access to a non HP Vertica 6.x database and above. For example, you cannot use the new 6.x ODBC/JDBC client drivers to access an HP Vertica 5.x database. If you plan on having a mixed HP Vertica environment supporting both 5.x and 6.x HP Vertica database, consider keeping the 5.x drivers installed.

ODBC/JDBC Multiple Version Installations

The following ODBC/JDBC drivers are supported on a single machine:

- 4.x and 5.x ODBC/JDBC drivers can be installed on the same machine.
- 4.x and 6.x ODBC/JDBC drivers can be installed on the same machine.

It is not possible to have both 5.x and 6.x ODBC drivers on a single machine. If you install the 6.x version, it automatically overlays the existing 5.x installation, and any DSN defined against a 5.x HP Vertica database is not supported.

HP Vertica ADO.NET Client Installers

Prior to version 6.x, ADO.Net drivers must be uninstalled prior to installing a later version of the driver. The 6.x ADO.Net drivers require the HP Vertica database to be 6.0.0 or above. The ADO.NET 6.x driver only supports access to an HP Vertica 6.x server. The ADO.NET 4.x plug-in does not work with an HP Vertica 6.x server. If you plan on also using the ODBC bridge and you need to access both HP Vertica 5.x and 6.x databases, consider keeping the 5.x versions of the ODBC/JDBC drivers for the reasons stated previously.

Installing the HP Vertica Client Drivers

You must install the HP Vertica client drivers to access HP Vertica from your client application. The drivers create and maintain connections to the database and provide APIs that your applications use to access your data. The client drivers support connections using JDBC, ODBC, and **ADO.NET** (page [161](#)).

Client Driver Standards

The client drivers support the following standards:

- ODBC drivers conform to ODBC 3.5.1 specifications.
- JDBC drivers conform to JDK 5 specifications.
- ADO.NET drivers conform to .NET framework 3.0 specifications.

The remainder of this section explain the requirements for the HP Vertica client drivers, and the procedure for downloading, installing, and configuring them.

Driver Prerequisites

The following topics explain the system requirements for the client drivers. You need to ensure that your client system meets these requirements before installing and using the client drivers.

ODBC Prerequisites

There are several requirements your client systems must meet before you can install the HP Vertica ODBC drivers.

Operating System

The HP Vertica ODBC driver requires a supported platform. The list of currently-supported platforms can be found on the **myVertica portal** <http://my.vertica.com/>.

ODBC Driver Manager

The HP Vertica ODBC driver requires that the client system have a supported driver manager. See the **myVertica portal** <http://my.vertica.com/> for a list of supported driver managers.

UTF-8, UTF-16 and UTF-32 Support

The HP Vertica ODBC driver is a universal driver that supports UTF-8, UTF-16, and UTF-32 encoding. The default setting depends on the client platform. (see **Additional ODBC Driver Configuration Settings** (page [49](#)) for more information).

When using the driver with the DataDirect Connect driver manager, DataDirect Connect adapts to the ODBC driver's text encoding settings. You should configure the ODBC driver to use the encoding method that your application requires. This allows strings to be passed between the driver and the application without intermediate conversion.

See Also

Client Driver Install Procedures (page [19](#))

Programming ODBC Client Applications (page [54](#))

Creating an ODBC Data Source Name (DSN) (page [29](#))

Microsoft Connectivity Pack/ADO.NET Prerequisites

The HP Vertica driver for the Microsoft Connectivity Pack and ADO.NET requires the following software and hardware components:

Operating System

The HP Vertica Microsoft Connectivity Pack and ADO.NET driver requires a supported Windows operating system. The list of supported platforms can be found in the Supported Platforms document at <http://www.vertica.com/documentation> (<http://www.vertica.com/documentation>).

Memory

HP Vertica suggests a minimum of 512MB of RAM.

.NET Framework

The requirements for the .NET framework for the Microsoft Connectivity Pack and ADO.NET in HP Vertica can be found in the Supported Platforms document at <http://www.vertica.com/documentation> (<http://www.vertica.com/documentation>).

If you are using Windows 2008 R2, then the .NET framework is included as part of the operating system. However, the .NET framework is not enabled by default. You must enable the .NET framework on Windows 2008 R2. See the following page for details on enabling the .NET framework in Windows 2008 R2:

<http://blogs.msdn.com/b/sqlblog/archive/2010/01/08/how-to-install-net-framework-3-5-sp1-on-windows-server-2008-r2-environments.aspx>

<http://blogs.msdn.com/b/sqlblog/archive/2010/01/08/how-to-install-net-framework-3-5-sp1-on-windows-server-2008-r2-environments.aspx>

Visual Studio (optional)

The Microsoft Connectivity Pack and ADO.NET installer provides a Visual Studio 2008 plugin called *Visual Studio Shell Integration*. The plugin allows you to use HP Vertica as a Visual Studio Data Source. The connection properties for the plugin are the same as ***ADO.NET connection properties*** (page [166](#)). **You must have Visual Studio 2008 and the Visual Studio 2008 SDK installed prior to installing the HP Vertica Microsoft Connectivity Pack/ADO.NET client driver.** Once the plugin is installed, you can access it from within Visual Studio 2008 at Data > Add New Data Source... > Database.

The Microsoft Connectivity Pack/ADO.NET installer provides Microsoft Business Intelligence Studio (BIDS) components. These component require Visual Studio be installed and SQL Server is installed with the BIDS shared feature. See below for additional details about BIDS.

Microsoft SQL Server (optional)

Version 6.0.0.1+ of the Microsoft Connectivity Pack/ADO.NET installer provides an enhanced HP Vertica .NET data-provider that enables support for the following:

- Microsoft Analysis Services (SSAS)
- Integration Services (SSIS) - which provides SQL Server Type Mappings to map data types between HP Vertica and SQL Server.
- Reporting Services (SSRS)
- Microsoft Business Intelligence Development Studio (BIDS)

To use the enhanced HP Vertica .NET data provider, SQL Server must be installed prior to installing the MICROSOFT CONNECTIVITY PACK/ADO.NET client driver, and the following optional components must be installed on the SQL Server:

- For SSAS functionality - install the Analysis Services Instance Feature
- For SSRS - install the Reporting Services Instance Feature
- For SSIS (Data Type Mappings) - install the SQL Server Integration Services Shared Feature
- For BIDS - install the Business Intelligence Development Studio Shared Feature (also requires that Microsoft Visual Studio 2008 be installed prior to installing the MICROSOFT CONNECTIVITY PACK/ADO.NET Client Driver)

See Also

[Installing ADO.NET Driver on Windows](#)

[Microsoft Connectivity Pack](#)

[Using ADO.NET](#) (page [161](#))

Python Prerequisites

Python is a free, agile, object-oriented, cross-platform programming language designed to emphasize rapid development and code readability. Python has been released under several different open source licenses.

HP Vertica's ODBC driver is tested with Python version 2.4. It should work with versions 2.4 through 2.7. It may also work with Python version 3.0, but this is untested.

Python Driver

HP Vertica requires the pyodbc driver module. See your system's Python documentation for installation and configuration information.

Supported Operating Systems

The HP Vertica ODBC driver requires one of the operating systems listed in ***ODBC Prerequisites*** (page [15](#)).

For usage and examples, see ***Using Python*** (page [211](#)).

Perl Prerequisites

Perl is a free, stable, open source, cross-platform programming language licensed under its Artistic License, or the GNU General Public License (GPL).

Your Perl scripts access HP Vertica through its ODBC driver, using the Perl Database Interface (DBI) module with the ODBC Database Driver (DBD::ODBC). The HP Vertica ODBC driver is known to be compatible with these versions of Perl:

- 5.8
- 5.10

Later Perl versions may also work.

Perl Drivers

The following Perl driver modules have been tested with the HP Vertica ODBC driver:

- The DBI driver module, version 1.609
- The DBD::ODBC driver module, version 1.22

Other versions may also work.

Supported Client Systems

The HP Vertica ODBC driver requires one of the operating systems and driver managers listed in [ODBC Prerequisites](#) (page 15).

PHP Prerequisites

PHP is a widely-used general-purpose scripting language that is especially suited for Web development and can be embedded into HTML. PHP is licensed under the PHP License, an open-source BSD-style license certified by the Open Source Initiative.

PHP Modules

The following PHP modules are required:

- php
- php-odbc
- php-pdo
- UnixODBC (if you are using the Unix ODBC driver)
- libiodbc (if you are using the iODBC driver)

Supported Client Systems

The HP Vertica ODBC driver requires one of the operating systems and driver managers listed in [ODBC Prerequisites](#) (page 15).

Installing the Client Drivers

How you install client drivers depends on the client's operating system:

- For Linux and UNIX clients, you must first *install a Linux driver manager* (page 19). After you have installed the driver manager, there are two different ways to install the client drivers:
 - On Red Hat Enterprise Linux 5, 64-bit and SUSE Linux Enterprise Server 10/11 64-bit, you can use the HP Vertica client RPM package to install the ODBC and JDBC drivers as well as the vsql client.
 - On other Linux platforms and UNIX-like platforms you can download the ODBC and JDBC drivers and install them individually.

Note: The ODBC and JDBC client drivers are installed by the server .rpm files. If you have installed HP Vertica Analytics Platform on your Linux system for development or testing purposes, you do not need to download and install the client drivers on it—you just need to configure the drivers. To use ODBC, you need to create a DSN (see *Creating an ODBC DSN for Linux, Solaris, AIX, and HP-UX* (page 29)). To use JDBC, you need to add the JDBC client driver to the Java CLASSPATH (see *Modifying the Java CLASSPATH* (page 26)).

- On Windows clients, download the 32-bit or 64-bit client installer. The installer provides the ODBC and JDBC drivers.
- There is an additional Windows installer for the MICROSOFT CONNECTIVITY PACK/ADO.NET client driver. 32-bit and 64-bit versions of the installer are available. ADO.NET is only available for the Enterprise edition of HP Vertica.

The remainder of this section describes how to install client drivers on different operating systems.

Installing Driver Managers Linux and other UNIX-like Platforms

If your client platform does not already have a ODBC driver manager, you need to install one before you can use the HP Vertica ODBC client driver. The driver manager provides an interface between your client operating system and the ODBC drivers. See the **Supported Platforms** (<http://myvertica.vertica.com>) documentation at <http://www.vertica.com/documentation> (<http://www.vertica.com/documentation>) for a list of driver managers that are supported on each of the client platforms.

HP Vertica provides reference implementations of supported driver managers in binary format. These binaries are built by HP Vertica and used when testing the product. The driver managers are not modified by HP Vertica and are built with the default settings.

The driver managers can be downloaded from the Download tab of the **myVertica portal** <http://my.vertica.com/>.

HP Vertica provides these binaries as a convenience for users in the event that the supported versions of the driver managers cannot be easily obtained from the original developers. There is no benefit to using the HP Vertica provided binaries if you installed the same or a compatible version of the supported driver-manager as part of your operating system.

The binaries provided by HP Vertica must be installed and configured manually. For example, the .so files must be in a directory that is in the operating system's "lib" search path, for example, /usr/lib, or other location specified by the shell's library search path variable (LD_LIBRARY_PATH). HP Vertica does not provide instructions for installing and configuring these third party binaries. See the respective websites for the driver managers for installation and configuration information:

- UnixODBC: <http://www.unixodbc.org/> <http://www.unixodbc.org/>
- iODBC: <http://www.iodbc.org> <http://www.iodbc.org/dataspace/iodbc/wiki/iODBC/>

Installing ODBC Drivers on Linux, Solaris, AIX, and HP-UX

Note: For additional details about supported platforms, see the [Vertica Supported Platforms](#) document.

Read [Driver Prerequisites](#) (page [15](#)) before you proceed.

For Red Hat Enterprise Linux and SUSE Linux Enterprise Server, you can download and install a client RPM that installs both the ODBC and JDBC driver as well as the vsql client. See [Installing the Client RPM on Red Hat and SUSE](#) (page [21](#)).

Note: The ODBC and JDBC client drivers are installed by the server .rpm files. If you have installed HP Vertica Analytics Platform on your Linux system for development or testing purposes, you do not need to download and install the client drivers on it—you just need to configure the drivers. To use ODBC, you need to create a DSN (see [Creating an ODBC DSN for Linux, Solaris, AIX, and HP-UX](#) (page [29](#))). To use JDBC, you need to add the JDBC client driver to the Java CLASSPATH (see [Modifying the Java CLASSPATH](#) (page [26](#))).

On the **myVertica portal** <http://my.vertica.com/>, the ODBC driver installation packages are broken down by client platform. The package's filename is named based on its operating system and architecture (for example, `vertica_6.1.x.xx_odbc_x86_64_linux.tar.gz`)

Installation Procedure

- 1 Open a Web browser and log in to **myVertica portal** <http://my.vertica.com/>.
- 2 Click the Download tab and locate and download the driver package that corresponds to your client system.
- 3 If you did not directly download to the client system, transfer the downloaded file to it.
- 4 Log in to the client system as root.
- 5 If the directory `/opt/vertica/` does not exist, create it:
`# mkdir -p /opt/vertica/`
- 6 Copy the downloaded file to the `/opt/vertica/` directory. For example:
`# cp vertica_6.1.x.xx_odbc_x86_64_linux.tar.gz /opt/vertica/`
- 7 Change to the `/opt/vertica/` directory:

```
# cd /opt/vertica/
```

8 Uncompress the file you downloaded. For example:

```
$ tar vxzf vertica_6.1.x.XX_odbc_x86_64_linux.tar.gz
```

Two folders are created: one for the include file, and one for the library files. The path of the library file depends on the processor architecture: `lib` for 32-bit libraries, and `lib64` for 64-bit libraries. So, a 64-bit driver client download creates the directories:

- `/opt/vertica/include`, which contains the header file
- `/opt/vertica/lib64`, which contains the library file

Post Driver Installation Configuration

You must configure the ODBC driver before you can use it. There are two required configuration files:

- The `odbc.ini` configuration file defines the Data Source Names (DSNs) that tell the ODBC how to access your HP Vertica databases. See ***Creating an ODBC Data Source Name*** (page [29](#)) for instructions to create this file.
- The `vertica.ini` configuration file defines some HP Vertica-specific settings required by the drivers. See ***Additional ODBC Driver Configuration Settings*** (page [49](#)) for instructions to create this file.

Note: If you are upgrading your ODBC driver, you must either update your DSNs to point to the newly-installed driver or create new DSNs. If your `odbc.ini` file references drivers defined in an `odbcinst.ini` file, you just need to update the `odbcinst.ini` file. See ***Creating an ODBC Data Source Name (DSN)*** (page [29](#)) for details.

Installing the Client RPM on Red Hat and SUSE

For Red Hat Enterprise Linux and SUSE Linux Enterprise Server, you can download and install a client driver RPM that installs both the ODBC and JDBC driver libraries and the `vsq1` client.

To install the client driver RPM package:

- 1 Open a Web browser and log in to the ***myVertica portal*** <http://my.vertica.com/>.
 - 2 Click the Download tab and download the client RPM file that matches your client platform's architecture.
- Note:** The 64-bit client driver RPM installs both the 64-bit and 32-bit ODBC driver libraries, so you do not need to install both on your 64-bit client system.
- 3 If you did not directly download the RPM on the client system, transfer the file to the client.
 - 4 Log in to the client system as root.
 - 5 Install the RPM package you downloaded:

```
# rpm -Uvh package_name.rpm
```

Note: You receive one or more conflict error messages if there are existing HP Vertica client driver files on your system. This can happen if you are trying to install the client driver package on a system that has the server package installed, since the server package also includes the client drivers. In this case, you don't need to install the client drivers, and can instead use the drivers installed by the server package. If the conflict arises from an old driver installation or from a server installation for an older version, you can use the rpm command's `--force` switch to force it to overwrite the existing files with the files in the client driver package.

Once you have installed the client package, you need to create a DSN (see ***Creating an ODBC DSN for Linux, Solaris, AIX, and HP-UX*** (page [29](#))) and set some additional configuration parameters (see ***Additional ODBC Driver Configuration Settings*** (page [49](#))) to use ODBC. To use JDBC, you need to modify your class path (see ***Modifying the Java CLASSPATH*** (page [26](#))) before you can use JDBC.

You may also want to add the vsql client to your PATH environment variable so that you do not need to enter its full path to run it. You add it to your path by adding the following to the `.profile` file in your home directory or the global `/etc/profile` file:

```
export PATH=$PATH:/opt/vertica/bin
```

Installing JDBC Driver on Linux, Solaris, AIX, and HPUX

Note: The ODBC and JDBC client drivers are installed by the server `.rpm` files. If you have installed HP Vertica Analytics Platform on your Linux system for development or testing purposes, you do not need to download and install the client drivers on it—you just need to configure the drivers. To use ODBC, you need to create a DSN (see ***Creating an ODBC DSN for Linux, Solaris, AIX, and HP-UX*** (page [29](#))). To use JDBC, you need to add the JDBC client driver to the Java CLASSPATH (see ***Modifying the Java CLASSPATH*** (page [26](#))).

Note: For additional details about supported platforms, see the Vertica Supported Platforms document.

The JDBC driver is available for download from ***myVertica portal*** <http://my.vertica.com/>. There is a single `.jar` file that works on all platforms and architectures. To download and install the file:

- 1 Open a Web browser and log in to ***myVertica portal*** <http://my.vertica.com/>.
- 2 Click the Download tab and locate and download the JDBC driver.
- 3 You need to copy the `.jar` file you downloaded file to a directory in your Java ***CLASSPATH*** http://en.wikipedia.org/wiki/Classpath_%28Java%29 on every client system with which you want to access HP Vertica. You can either:
 - Copy the `.jar` file to its own directory (such as `/opt/vertica/java/lib`) and then add that directory to your CLASSPATH (recommended). See ***Modifying the Java CLASSPATH*** (page [26](#)) for details.
 - Copy the `.jar` file to directory that is already in your CLASSPATH (for example, a directory where you have placed other `.jar` files on which your application depends).

Note: In the directory where you copied the .jar file, you should create a symbolic link named `vertica_jdk_5.jar` to the .jar file. You can reference this symbolic link anywhere you need to use the name of the JDBC library without having to worry any future upgrade invalidating the file name. This symbolic link is automatically created on server installs. On clients, you need to create and manually maintain this symbolic link yourself if you installed the driver manually. The ***Installing the Client RPM on Red Hat and SUSE*** (page [21](#)) create this link when they install the JDBC library.

Installing ODBC/JDBC Client Drivers and vsql Client on Windows

This topic details how to download and install the HP Vertica ODBC/JDBC client drivers and vsql client for Windows systems. The installer can be run as a regular windows installer or silently. The Windows client drivers (ODBC, JDBC, etc.) are all installed using a single installer. There are 32-bit and 64-bit installers available. The 32-bit installer provides a 32-bit driver. The 64-bit installer provides both 32-bit and 64-bit drivers.

Read ***Driver Prerequisites*** (page [15](#)) before you proceed.

Note: If you are uninstalling a previous release of the HP Vertica ODBC/JDBC drivers, delete any DSNs associated with those drivers before you uninstall. Windows requires that the driver files be present when a DSN is removed. If you uninstall the driver first, then the DSN cannot be removed. For releases after 5.1 you do not need to uninstall the drivers, as the installation program upgrades the existing 5.1+ drivers in place.

To download the Windows client-drivers:

- 1 Open a Web browser and log in to ***myVertica portal*** <http://my.vertica.com/>.
- 2 Click the Download tab and select the ODBC/JDBC Windows installer that you want to install (32-bit or 64-bit) and follow the on-screen prompts to download the installer.

To install the Windows client-drivers and vsql client:

- 1 As a Windows Administrator, double-click the installer to start the install process.
- 2 The introduction screen appears. Click Next to begin the installation.
- 3 Read the license agreement and check the appropriate radio box. Click Next to continue.
- 4 Optionally change the installation directory and click Next. The default directory is C:\Program Files (x86)\Vertica Systems\.
- 5 Select the components to install and click Next. By default all components are selected.
- 6 Click Install to install the options you selected.
- 7 Click Finish.

To silent-install the Windows client-drivers and vsql client:

- 1 As a Windows Administrator, open a command-line session and change directory to the folder that contains the installer.
- 2 Run the command `vertica_client_drivers_[VERSION].exe /S /v/qn`

- 3 The drivers are silently installed in C:\Program Files\Vertica Systems\. If you install the 32-bit drivers on a 64-bit system, then those drivers are installed to C:\Program Files (x86)\Vertica Systems\. The driver appears in the list of installed programs and is now available in the ODBC control panel.

After you install:

- The client drivers are available in the ODBC and JDBC folders of the installation directory.
- There is no shortcut for the vsql client. vsql is added to the windows PATH environment variable. Start a command window and type vsql -? at the command prompt to start vsql and show the help list. See **vsql Notes for Windows Users** for important details about using vsql in a Windows console.

You must perform an additional step for some of the client drivers before you use them:

- For ODBC, **create a new Data Source Name** (page [29](#)) (DSN).
- For JDBC, **Modifying the Java CLASSPATH** (page [26](#)).

Installing the Microsoft Connectivity Pack and ADO.NET Driver on Windows

This topic details how to download and install the HP Vertica the Microsoft Connectivity Pack and ADO.NET client driver for Windows systems. The installer can be run as a regular windows installer or silently. There are 32-bit and 64-bit installers available. Use the correct installer for your operating system, i.e. 32-bit systems must use the 32-bit installer.

Read **Microsoft Connectivity Pack/DO.NET Prerequisites** (page [16](#)) before you proceed.

For more details about the Microsoft Connectivity Pack, see **Microsoft Connectivity Pack** in the Programming ADO.NET Applications section of this document.

NOTE: If you are upgrading the driver from a version prior to 6.0, then you must first uninstall the current driver before installing the new driver. The installer does not upgrade old versions of the driver. For example, if you have the 5.1 ADO.NET client driver installed, and you want to install the 5.1.5 Microsoft Connectivity Pack/ADO.NET driver, then you must first use the Windows uninstall utility in control panel to uninstall the existing 5.1 ADO.NET driver.

NOTE: If you are installing the SSAS, SSIS, or SSRS components and the server contains more than one installation of SQL Server, then the installer installs the components on the first installation of SQL Server based on the order provided in the Windows registry.

To download the Microsoft Connectivity Pack/ADO.NET client-driver:

- 1 Open a Web browser and log in to the **myVertica portal** <http://my.vertica.com/>.
- 2 Click the Download tab and select the ADO.NET Windows installer that you want to install (32-bit or 64-bit) and follow the on-screen prompts to download the installer. Use the 64-bit version on 64-bit Windows machines and the 32-bit installer on 32-bit Windows machines.

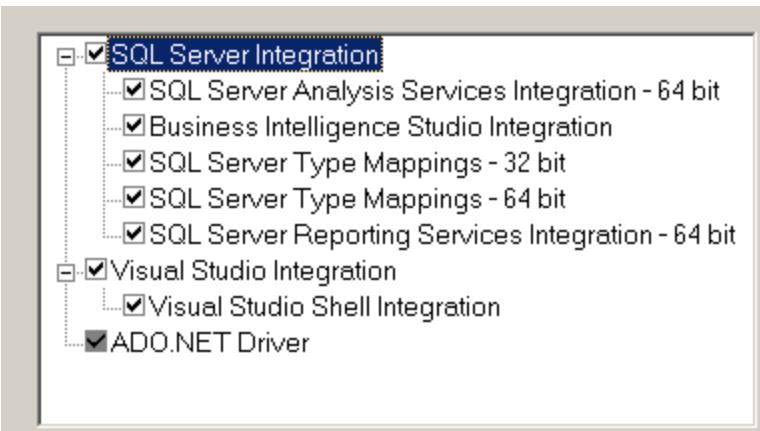
To install the Microsoft Connectivity Pack/ADO.NET client-driver:

- 1 As a Windows Administrator, double-click the installer to start the install process.
- 2 The introduction screen appears. Click **Next** to begin the installation.

- 3 Optionally change the installation directory and click **Next**. The default directory is C:\Program Files\Vertica Systems\.

Note: The driver is also installed into the Windows Global Assembly Cache (GAC).

- 4 Select the components to install and click **Next**. By default all components are selected. In Version 6.0.0.1+, additional components can be selected for installation depending on which Microsoft components are already installed on the server. If the prerequisites software is not installed, then the additional components are not shown. See **Microsoft Connectivity Pack/ADO.NET Prerequisites** (page 16) for details on optional prerequisites for the ADO.NET client driver. The image below details all of the components that can be installed using the 64-bit installer:



- 5 Click **Install** to install the options you selected.
- 6 Click **Finish**.

To silent-install the Windows client-drivers:

- 1 As a Windows Administrator, open a command-line session and change directory to the folder that contains the installer.
- 2 Run the command `[ADO.NET_INSTALLER_FILENAME].exe /S /v/qn`
- 3 The drivers are silently installed in C:\Program Files\Vertica Systems\ and also in the Global Assembly Cache.

After you install:

The drivers are available in the ADO.NET folder of the installation directory.

See Also

HP Vertica - Microsoft Integration

Modifying the Java CLASSPATH

The CLASSPATH environment variable contains the list of directories where the Java run time looks for library class files. For your Java client code to access HP Vertica, you need to add the directory where the HP Vertica JDBC .jar file is located.

Note: In your CLASSPATH, use the symbolic link `vertica_jdk_5.jar` that points to the JDBC library .jar file, rather than the .jar file itself. Using the symbolic link ensures that any updates to the JDBC library .jar file (which will use a different filename) will not invalidate your CLASSPATH setting, since the symbolic link's filename will remain the same. You just need to update the symbolic link to point at the new .jar file.

Linux, Solaris, AIX, HP-UX, and OS X

If you are using the Bash shell, use the `export` command to define the CLASSPATH variable:

```
# export CLASSPATH=/opt/vertica/java/lib/vertica_jdk_5.jar
```

If environment variable CLASSPATH is already defined, use the following command to prevent it from being overwritten:

```
# export CLASSPATH=$CLASSPATH:/opt/vertica/java/lib/vertica_jdk_5.jar
```

If you are using a shell other than Bash, consult its documentation to learn how to set environment variables.

You need to either set the CLASSPATH environment variable for every login session, or insert the command to set the variable into one of your startup scripts (such as `~/.profile` or `/etc/profile`).

Windows

Provide the class paths to the .jar, .zip, or .class files.

```
C:> SET CLASSPATH=classpath1;classpath2...
```

For example:

```
C:> SET CLASSPATH=C:\java\MyClasses\vertica_jdk_5.jar
```

As with the Linux/UNIX settings, this setting only lasts for the current session. To set the CLASSPATH permanently, set an environment variable:

- 1 On the Windows Control Panel, click **System**.
- 2 Click **Advanced** or **Advanced Systems Settings**.
- 3 Click **Environment Variables**.
- 4 Under User variables, click **New**.
- 5 In the Variable name box, type **CLASSPATH**.
- 6 In the Variable value box, type the path to the HP Vertica JDBC .jar file on your system (for example, `C:\Program Files (x86)\HP Systems\JDBC\vertica_jdk_5.jar`)

Specifying the Library Directory in the Java Command

There is an alternative way to tell the Java run time where to find the HP Vertica JDBC driver other than changing the CLASSPATH environment variable: explicitly add the directory containing the .jar file to the java command line using either the -cp or -classpath argument. For example, on Linux, start your client application using:

```
# java -classpath /opt/vertica/java/lib/vertica_jdk_5.jar myapplication.class
```

Your Java IDE may also let you add directories to your CLASSPATH, or let you import the HP Vertica JDBC driver into your project. See your IDE documentation for details.

Installing the JDBC Driver on Macintosh OS X

To install the HP Vertica JDBC driver on your Macintosh OS X client system, download the cross-platform JDBC driver .jar file to your system and ensure OS X's Java installation can find it.

Downloading the JDBC Driver

To download the HP Vertica JDBC driver on Macintosh OS X:

- 1 On your Macintosh client system, open a browser and log into the **myVertica portal** <http://my.vertica.com/>.
- 2 Navigate to the Downloads page, scroll to the Client Software download section, and click the download link for the JDBC driver.
- 3 Accept the license agreement and wait for the download to complete.

Ensuring Java Can Find the JDBC Driver

In order for your Java client application to use the HP Vertica JDBC driver, the Java interpreter needs to be able to find its library file. Choose one of these methods to tell the Java interpreter where to look for the library:

- Copy the JDBC .jar file you downloaded to either the system-wide Java Extensions folder (/Library/Java/Extensions) or your user Java Extensions folder (/Users/username/Library/Java/Extensions).
- Add the directory containing the JDBC .jar file to the CLASSPATH environment variable (see **Modifying the Java CLASSPATH** (page [26](#))).
- Specify the directory containing the JDBC .jar using the -cp argument in the Java command line you use to start your Java command line.

Installing the ODBC Driver on Macintosh OS X

The HP Vertica ODBC driver for Macintosh OS X is packaged as a gzipped tar archive (.tar.gz). This driver works with both 32-bit and 64-bit applications. You need to extract the library files from this archive onto your system.

Download the Driver

Follow these steps to download the HP Vertica ODBC driver for Macintosh:

- 1 On your Macintosh client system, open a browser and log into the the ***myVertica portal*** <http://my.vertica.com/>.
- 2 Navigate to the Downloads tab, scroll to the Client Software section, then click the download link for the Macintosh OS X ODBC driver package.
- 3 Accept the license agreement, and wait for the download to complete.

Decide where to Install the Driver

Where you decide to install the driver depends on which users on the client Macintosh need to use the HP Vertica ODBC driver:

- If multiple users need to use the driver, install it in /Library/ODBC/vertica. You need to be logged into an administrator account to install the driver in this location.
- If just a single user needs to use the driver (or you do not have administrative privileges on the client OS X system), install the driver here: /Users/username/Library/ODBC/vertica.

Unpack the Driver

To unpack the driver:

- 1 Log into the client Macintosh either with an administrator account (if installing the driver for system-wide use) or as the user who needs to use the HP Vertica ODBC driver.
- 2 Open a Terminal window (in the Finder, click Applications > Utilities > Terminal).
- 3 Enter one of the following commands to create the target directory for the driver files:
 - To install system-wide: mkdir -p /Library/ODBC/vertica
 - To install for the current user: mkdir -p ~/Library/ODBC/vertica
- 4 Change to the directory you just created:
 - For system-wide installs: cd /Library/ODBC/vertica
 - For current user installs: cd ~/Library/ODBC/vertica
- 5 Unpack the .tar.gz file containing the ODBC driver using the command:
`tar -xzf ~/Downloads/vertica_6.1.x.x_odbc_mac_tar.gz`

Note: If you downloaded the driver .tar.gz file to a directory other than your Downloads directory, or you downloaded it using another user account, change the path in the above tar command to the path of the downloaded file.

After installing the ODBC driver, must create a DSN to be able to connect to your HP Vertica database. See ***Creating an ODBC DSN for Macintosh OS X Clients*** (page [41](#)).

Upgrading the HP Vertica Client Drivers

The HP Vertica client driver are usually updated for each new release of the HP Vertica server. The client driver installation packages include the version number of the corresponding HP Vertica server release. Usually, the drivers are forward-compatible with the next release, so your client applications are still be able to connect using the older drivers after you upgrade to the next version of HP Vertica Analytics Platform server. See ***Client Driver and Server Version Compatibility*** (page [13](#)) for details on which client driver versions work with each version of HP Vertica server.

You should upgrade your clients as soon as possible after upgrading your server, to take advantage of new features and to maintain maximum compatibility with the server.

To upgrade your drivers, follow the same procedure you used to install them in the first place. The new installation will overwrite the old. See the specific instructions for installing the drivers on your client platform for any special instructions regarding upgrades.

Note: Installing new ODBC drivers does not alter existing DSN settings. You may need to change the driver settings in either the DSN or in the `odbcinst.ini` file, if your client system uses one. See ***Creating an ODBC Data Source Name*** (page 29) for details.

Using Legacy Drivers

The HP Vertica server supports connections from the previous version of the client drivers. For example, the HP Vertica version 5.1 server works with the 4.1 client drivers, since they were the drivers distributed with the previous version of the server. This backwards compatibility lets you upgrade your HP Vertica database first, then later upgrade your clients.

If you have not yet updated your code to work with the new version of the HP Vertica client drivers, you can continue to use the older drivers until you do. If you need to install your client application on a new client system, you can download and install the older drivers. See ***myVertica portal*** <http://my.vertica.com/> to download the installers; find installation documentation at <http://www.vertica.com/documentation> (<http://www.vertica.com/documentation>).

For detailed information on which the compatibility of different versions of the HP Vertica server and HP Vertica client, see ***Client Driver and Server Version Compatibility*** (page 13).

Note: The support for a previous version of the drivers is usually eliminated in the next release of HP Vertica. For example, the HP Vertica version 5.1 server does not support the version 4.0 drivers. You should update your client application to work with the new client drivers as soon as possible.

Creating an ODBC Data Source Name (DSN)

A Data Source Name (DSN) is the logical name that is used by Open Database Connectivity (ODBC) to refer to the driver and other information that is required to access data from a data source. Whether you are developing your own ODBC client code or you are using a third-party tool that needs to access HP Vertica using ODBC, you need to configure and test a DSN. The method you use depends upon the client operating system you are using.

Creating an ODBC DSN for Linux, Solaris, AIX, and HP-UX

DSNs are defined on Linux, Solaris, and other UNIX-like platforms in a text file. Your client's driver manager reads this file to determine how to connect to your HP Vertica database. The driver manager usually looks for the DSN definitions in two places:

- `/etc/odbc.ini`

- `~/.odbc.ini` (a file named `.odbc.ini` in the user's home directory)

The structure of these files is the same, only their location differs. If both files are present, the `~/.odbc.ini` file usually overrides the system-wide `/etc/odbc.ini` file.

Note: See your ODBC driver manager's documentation for details on where these files should be located and any other requirements.

odbc.ini file Structure

The `odbc.ini` is a text file that contains two types of lines:

- Section definitions, which are text strings enclosed in square brackets.
- Parameter definitions, which contain a parameter name, an equal sign, and then the parameter's value.

The first section of the file is always named [ODBC Data Sources], and contains a list of all the DSNs that the `odbc.ini` file defines. The parameters in this section are the names of the DSNs, which appear as section definitions later in the file. The value is a text description of the DSN, and has no function. For example, an `odbc.ini` file that defines a single DSN named HP VerticaDSN could have this ODBC Data Sources section:

```
[ODBC Data Sources]
HPVerticaDSN = "vmartdb"
```

After the ODBC data sources section are sections that define each DSN. The name of a DSN section must match one of the names defined in the ODBC Data Sources section.

Configuring the odbc.ini file:

To create or edit the DSN definition file:

- 1 Using the text editor of your choice, open `odbc.ini` or `~/.odbc.ini`.
- 2 Create an ODBC Data Sources section and define a parameter whose name is the name of the DSN you want to create and whose value is a description of the DSN. For example, to create a DSN named VMart, you would enter:

```
[ODBC Data Sources]
VMart = "VMart database on HP Vertica"
```

- 3 Create a section whose name matches the DSN name you defined in step 2. In this section, you add parameters that define the DSN's settings. The most commonly-defined parameters are:

- **Description** – Additional information about the data source.
- **Driver** – The location and designation of the HP Vertica ODBC driver, or the name of a driver defined in the `odbcinst.ini` file (see below). For future compatibility, you should use the name of the symbolic link in the library directory (`/opt/vertica/lib` on 32-bit clients, and `/opt/vertica/lib64` on 64-bit clients), rather than the library file. For example, the symbolic link for the 64-bit ODBC driver library is:

```
/opt/vertica/lib64/libverticaodbc.so
```

The symbolic link always points to the most up-to-date version of the HP Vertica client ODBC library. Using the link ensures that you do not need to update all of your DSNs when you update your client drivers.

- **Database** – The name of the database running on the server. This example uses vmartdb for the vmartdb.
- **ServerName** — The name of the server where HP Vertica is installed. Use localhost if HP Vertica is installed on the same machine.
- **UID** – Either the database superuser (same name as database administrator account) or a user that the superuser has created and granted privileges. This example uses the user name dbadmin.
- **PWD** – The password for the specified user name. This example leaves the password field blank.
- **Port** – The port number on which HP Vertica listens for ODBC connections. For example, 5433.
- **ConnSettings** – Can contain SQL commands separated by a semicolon. These commands can be run immediately after connecting to the server.
- **SSLKeyFile** – The file path and name of the client's private key. This file can reside anywhere on the system.
- **SSLCertFile** – The file path and name of the client's public certificate. This file can reside anywhere on the system.
- **Locale** – The default locale used for the session. By default, the locale for the database is en_US@collation=binary (English as in the United States of America). Specify the locale as an ICU Locale. See the ICU User Guide (<http://userguide.icu-project.org/locale>) for a complete list of parameters that can be used to specify a locale.

For example:

```
[VMart]
Description = Vmart Database
Driver = /opt/vertica/lib64/libverticaodbc.so
Database = vmartdb
Servername = host01
UID = dbadmin
PWD =
Port = 5433
ConnSettings =
SSLKeyFile = /home/dbadmin/client.key
SSLCertFile = /home/dbadmin/client.crt
Locale = en_GB
```

See **DSN parameters** (page 43) for a complete list of parameters including HP Vertica-specific ones.

Using an odbcinst.ini File

Instead of giving the path of the ODBC driver library in your DSN definitions, you can use the name of a driver defined in the `odbcinst.ini` file. This is a useful method if you have many DSNs and often need to update them to point to new driver libraries. It also allows you to set some additional ODBC parameters, such as the threading model.

Just as in the `odbc.ini` file, `odbcinst.ini` has sections. Each section defines an ODBC driver that can be referenced in the `odbc.ini` files.

In a section, you can define the following parameters:

- **Description** — Additional information about the data source.
- **Driver** — The location and designation of the HP Vertica ODBC driver. For example:
/opt/vertica/lib64/libverticaodbc.so

For example:

```
[HPVertica]
Description = HP Vertica ODBC Driver
Driver = /opt/vertica/lib64/libverticaodbc.so
```

Then in your `odbc.ini` file, you use the name of the section you created in the `odbcinst.ini` file that describes the driver you want to use. For example:

```
[VMart]
Description = HP Vertica Vmart database
Driver = HPVertica
```

If you are using the unixODBC driver manager, you should also add an ODBC section to override its standard threading settings. By default, unixODBC will serialize all SQL calls through ODBC, which prevents multiple parallel loads. To change this default behavior, add the following to your `odbcinst.ini` file:

```
[ODBC]
Threading = 1
```

Configuring Additional ODBC Settings

On Linux and UNIX systems, you need to configure some additional driver settings before you can use your DSN. See **Additional ODBC Driver Configuration Settings** (page [49](#)) for details.

Testing a DSN Using isql

The unixODBC driver manager includes a utility named `isql`, which is a simple ODBC command-line client. It lets you to connect to a DSN to send commands and receive results, similarly to `vsql`.

To use `isql` to test a DSN connection:

- 1 Run the following command:

```
$ isql -v DSNname
SQL>
```

Where `DSNname` is the name of the DSN you created.

A connection message and a SQL prompt display. If they do not, you could have a configuration problem or you could be using the wrong user name or password.

- 2 Try a simple SQL statement. For example:

```
SQL> SELECT table_name FROM tables;
```

The `isql` tool returns the results of your SQL statement.

Note: If you have not set the `ErrorMessagesPath` in the additional driver configuration settings, any errors during testing will trigger a missing error message file ("The error message `NoSQLGetPrivateProfileString` could not be found in the en-US locale"). See **Additional ODBC Driver Configuration Settings** (page [49](#)) for more information.

Creating an ODBC DSN for Windows Clients

Creating a DSN for Microsoft Windows clients consists of:

- **Setting up a DSN** (page [33](#))
- Testing the DSN using **Excel 2007** (page [38](#))

Setting Up a DSN

A Data Source Name (DSN) is the logical name that is used by Open Database Connectivity (ODBC) to refer to the drive and other information that is required to access data. The name is used by Internet Information Services (IIS) for a connection to an ODBC data source.

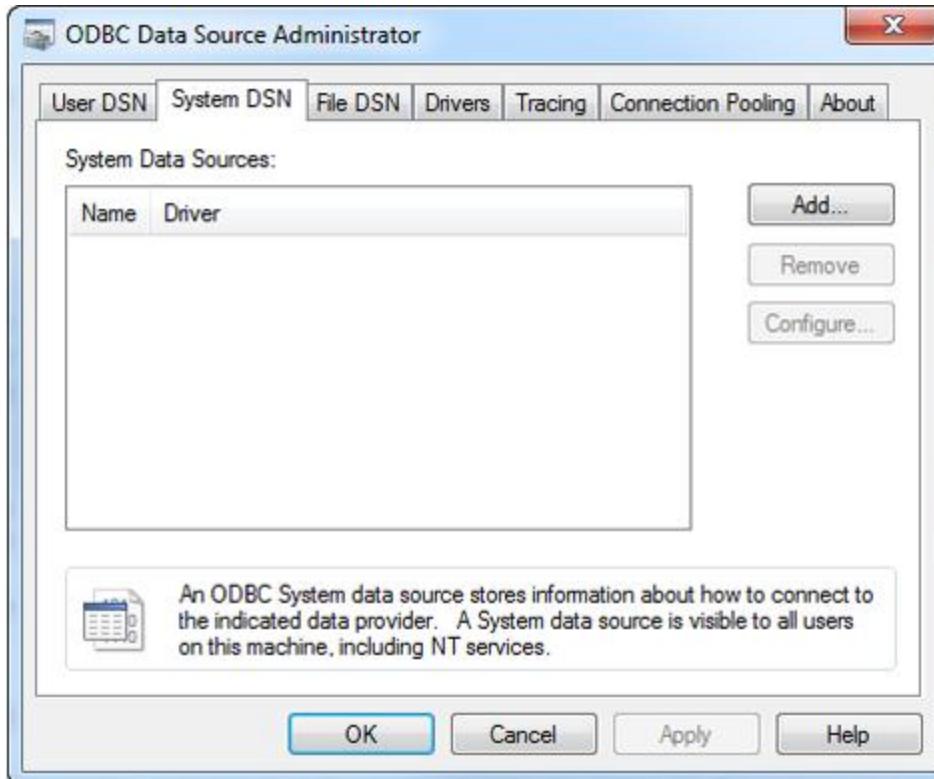
This section describes how to use the HP Vertica ODBC Driver to set up an ODBC DSN. This topic assumes that the driver is already installed, as described in **Installing Client Drivers on Windows** (page [23](#)).

To set up a DSN:

- 1 Open the ODBC Administrator (For example, Start > Control Panel > Administrative Tools > Data Sources (ODBC)).

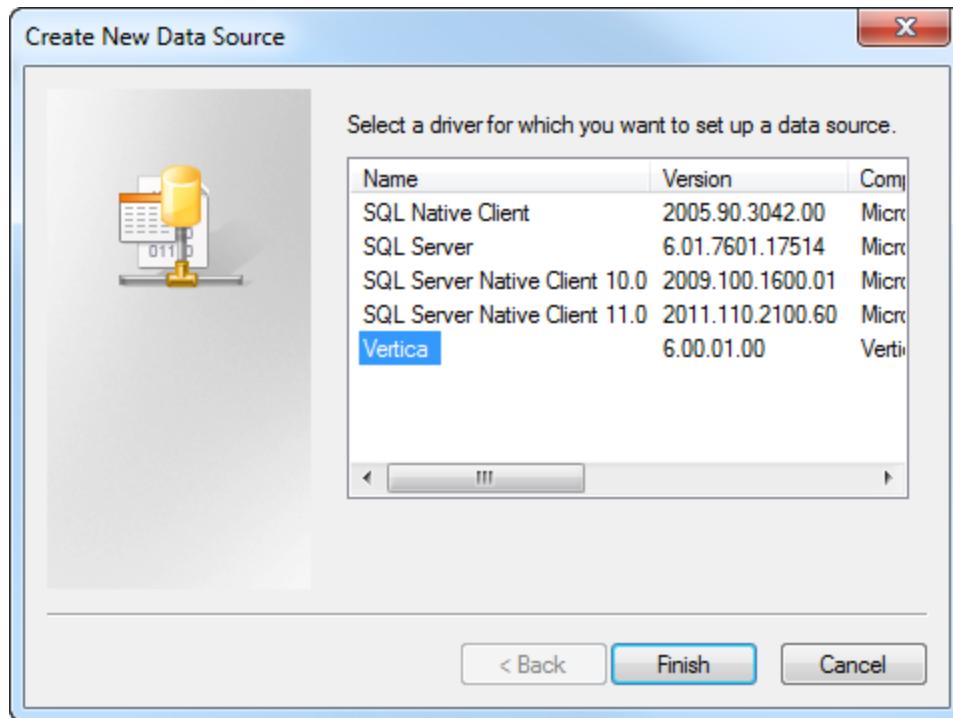
Note: The method you use depends on the version of Windows you are using. Differences between Windows versions and Start Menu customizations could require a different action to open the ODBC Administrator

- 2 If you want all users on your client system to be able to access to the DSN for the HP Vertica database, click the **System DSN** tab.



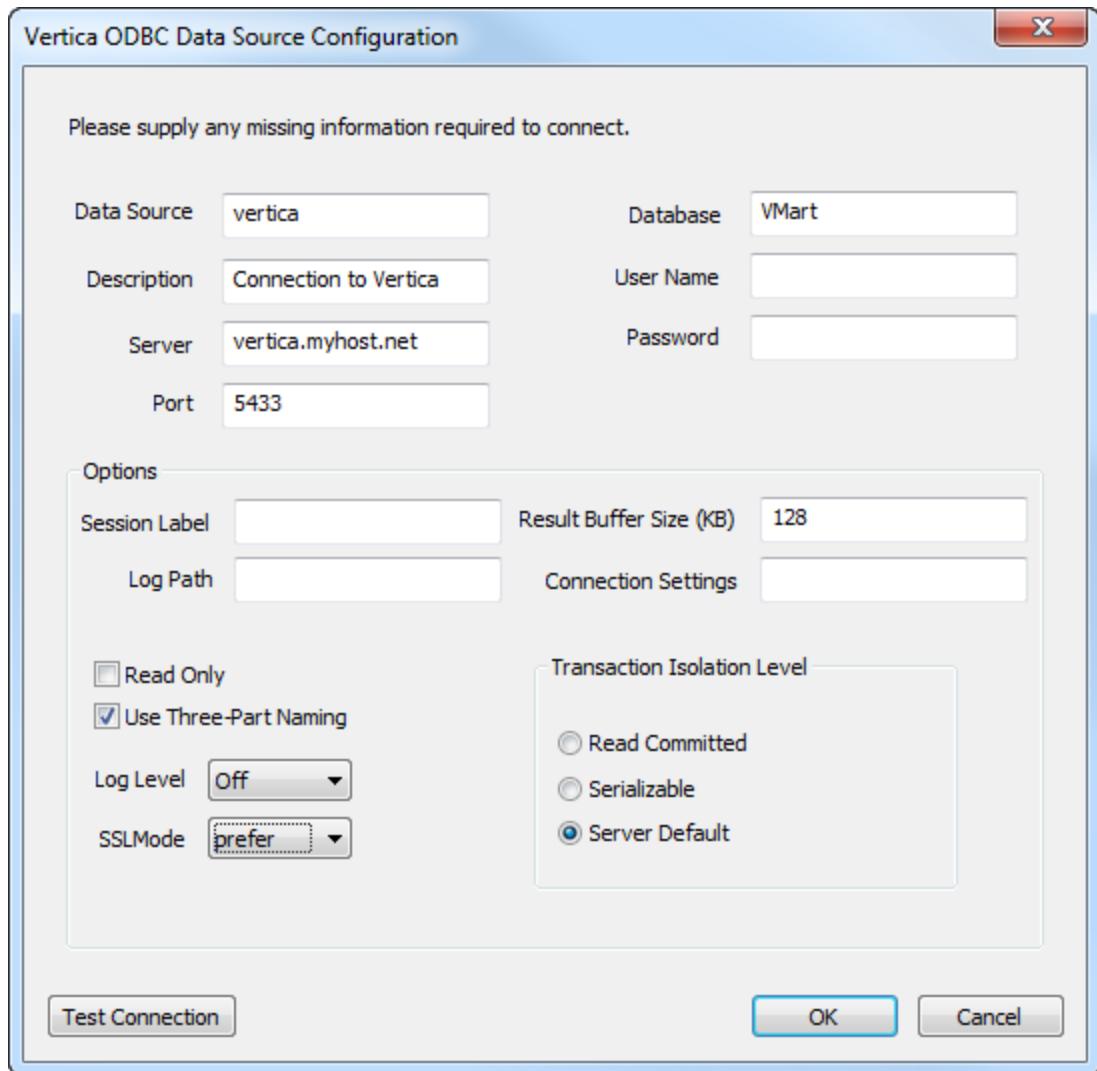
Otherwise, click the User DSN tab to create a DSN that is only usable by your Windows user account.

- 3 Click **Add** to create a new DSN to connect to the HP Vertica database.
4 Scroll through the list of drivers in the Create a New Data Source dialog to locate the HP Vertica driver. Select the driver, and then click **Finish**.



Note: If you have installed more than one version of the HP Vertica client drivers on your Windows client system, you may see multiple versions of the driver in this list. Choose the version that you know is compatible with your client application. When in doubt, use the latest version.

5 Enter your data source information in the HP Vertica ODBC Driver Setup dialog.



The following list describes all the fields in the HP Vertica ODBC Driver Setup dialog:

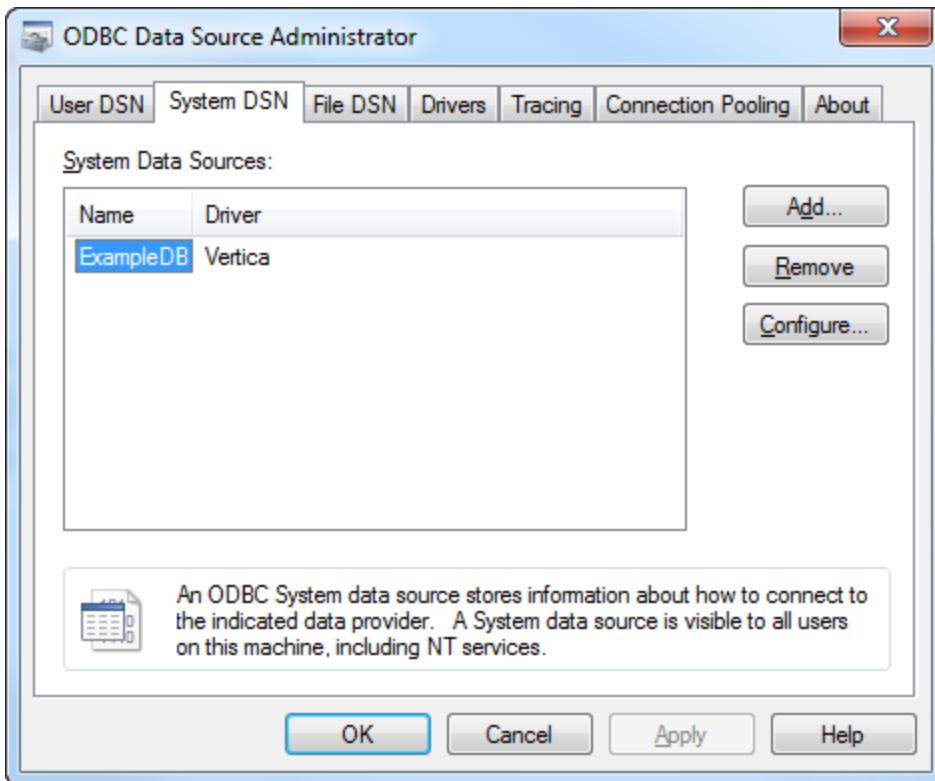
- **Data Source** — The name for the DSN. Clients will use this name to identify the DSN to which they want to connect.
 - **Description** — Additional information that helps identify the data source.
 - **Server** — The hostname or IP address of any active node within an HP Vertica database.
 - **Port** — The port number on which HP Vertica listens for ODBC connections (5433, by default).
 - **Database** — The name of the HP Vertica database.
 - **User Name** — The name of the user account to use when connecting to the database. This account name is used to log into the database if the application does not supply its own user name when connecting to the DSN.
 - **Password** — The password for the account entered in the User Name field.
- Note:** Storing a password in the DSN is very insecure. You should only use this field to temporarily enter a password to test the DSN.

- **Session Label** — Sets a label for the connection on the server. This value appears in the session_id column of the V_MONITOR.SESSIONS system table.
- **Log Path** — The absolute path to the log file.
- **Result Buffer Size (KB)** — Size of memory buffer for the large result sets in streaming mode.
- **Connection Settings** — A string containing SQL commands that the driver should execute immediately after connecting to the server. This parameter is often used to configure the connection in some manner, such as setting a schema search path.
Note: In the connection string ';' is a reserved symbol. If you need to set multiple parameters as part of the Connection Settings parameter, then use '%3B' in place of ';' and use '+' for spaces.
- **Read Only** — When selected, prevents users of this data source from writing to the database.
- **Use Three-Part Naming** — This setting controls how the database metadata APIs reports the catalog name. When checked, the database name is returned as the catalog name in the database metadata. When not checked, NULL is returned as the catalog name. Enable this option if your client software expects to be able to get the catalog name from the database metadata and use it as part of a three-part name reference.
- **Log Level** — The sort of messages between the client application and HP Vertica are saved in a log. The default value is Off, meaning no messages are ever logged. The options are listed in decreasing order of severity: **Fatal** (messages that indicate the connection has failed) through **Trace** (all messages passed between the client and server are logged).
- **SSLMode** — Can be set to *prefer* (try to connect using SSL first, then try to connect without SSL), *disable* (do not use SSL), *accept* (try to connect using a non-SSL connection first, then try to connect with SSL), or *require* (only use SSL).
- **Transaction Isolation Level** — Sets the transaction isolation level for the connection. See Transactions in the Concepts Guide for an explanation of the different transaction isolations.

The DSN and Database fields are required to be able to save the DSN.

- 6 If you want to test the connection, be sure to enter a valid **User Name** and **Password**, then click **Test Connection**.

- 7 When you have finished editing and testing the DSN, click **Save**. The Vertica ODBC Driver Setup window closes, and your new DSN is listed in the ODBC Data Source Administrator window.



- 8 Click **OK** to close the ODBC Data Source Administrator.

After creating the DSN, you can test it using **Microsoft Excel 2007** (page [38](#)).

Setting up a 32-Bit DSN on 64-Bit Versions of Windows

On 64-bit versions of Windows, the default ODBC Data Source Administrator creates and edits DSNs that are tied to the 64-bit HP Vertica ODBC library. Attempting to use these 64-bit DSNs with a 32-bit client application results in an architecture mismatch error. You need to create a specific 32-bit DSN for 32-bit clients by running the 32-bit ODBC Administrator usually located at:

```
c:\Windows\SysWOW64\odbcad32.exe
```

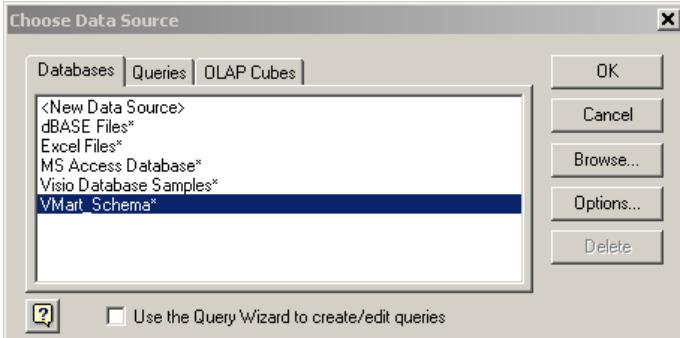
This administrator window edits a set of DSNs that are tied to the 32-bit ODBC library. You can then use your 32-bit client applications with the DSNs you create with this version of the ODBC administrator.

Testing a DSN Using Excel 2007

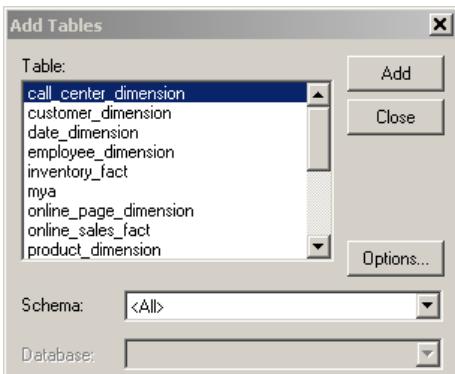
This section uses Microsoft Excel 2007 to verify that an application can connect to an ODBC data source. You can accomplish the same thing with any ODBC application.

- 1 Open Excel.

- 2 From the menu, select **Data > Get External Data > From Other Sources > From Microsoft Query.**
- 3 Select VMart_Schema*, make sure the "Use the Query Wizard" check box is deselected and click **OK**.



- 4 When the Add Tables window loads, click **Close**.

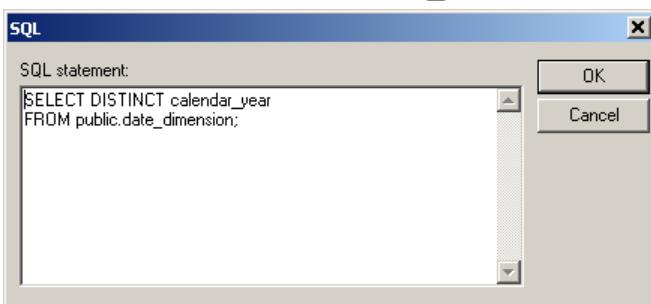


- 5 The Microsoft Query window opens; click the **SQL** button.



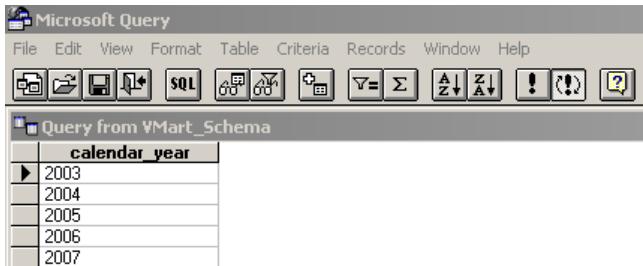
- 6 In the SQL window write any simple query to test your connection. This example uses the following query:

```
SELECT DISTINCT calendar_year FROM date_dimension;
```



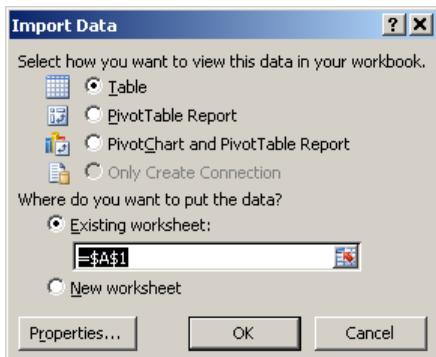
- 7 If you see the caution, "SQL Query can't be represented graphically. Continue anyway?" click **OK**.

The data values 2003, 2004, 2005, 2006, 2007 indicate that you successfully connected to and ran a query through ODBC.

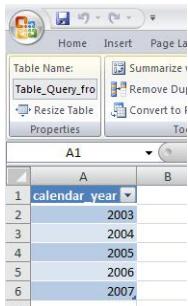


8 Click File > Return Data to Microsoft Office Excel.

9 In the Import Data dialog, click OK.



The data is now available for use in an Excel worksheet.



Editing DSN Entries

The HP Vertica ODBC user interface lets you set the most important parameters in your DSN. To view and change DSN parameters:

- 1 Open the ODBC Data Source Administrator (Control Panel > Administrative Tools > Data Sources (ODBC)).
- 2 Select the DSN you want to view or edit on the User DSN or System DSN tab.
- 3 Click **Configure**.
- 4 Make the changes you want to the DSN, then click **OK**.

Editing DSN Parameters Directly in the Windows Registry

There are some less-common DSN parameters that are not available through the user interface of the HP Vertica ODBC client driver for Windows, such as Locale. You can add entries for these parameters directly to the DSN's definition within the Window's registry.

To add a new entry to a DSN:

- 1 Click the Windows Start menu, click Run.
- 2 In the Run window, type regedit in the Open box.
- 3 Navigate to the the DSN you want to edit:
 - System DSNs are located in `HKEY_LOCAL_MACHINE\Software\ODBC\ODBC.INI`
 - User DSNs are located in `HKEY_CURRENT_USER\Software\ODBC\ODBC.INI`
- 4 Right-click in the right pane of the Registry Window, and select New > String Value.
- 5 Enter the name of the DSN parameter you want to enter.
- 6 Double-click the entry you just created, and enter a value for the parameter.

Creating an ODBC DSN for Macintosh OS X Clients

DSNs are defined on OS X in a text file named `odbc.ini`. The ODBC driver manager in OS X reads this file to determine how to connect to your HP Vertica database. The driver manager looks for the `odbc.ini` file in two locations:

- System DSNs (those available for all users on the OS X client) are defined in `/Library/ODBC/odbc.ini`
- User DSNs (defined for just a single user) are defined in `/Users/username/ODBC/odbc.ini`

The structure of these files is the same, only their location differs. If both files are present, the entries in the user DSN usually override those in the system DSN.

odbc.ini file Structure

The `odbc.ini` is a text file that contains two types of lines:

- Section definitions, which are text strings enclosed in square brackets.
- Parameter definitions, which contain a parameter name, an equal sign, and then the value for the parameter.

The first section of the file is always named [ODBC Data Sources], and contains a list of all the DSNs that the `odbc.ini` file defines. The parameters in this section are the names of the DSNs, which appear as section definitions later in the file. The value is a text description of the DSN, and has no function. For example, an `odbc.ini` file that defines a single DSN named HP VerticaDSN could have this ODBC Data Sources section:

```
[ODBC Data Sources]
HPVerticaDSN = VMart Database
```

Following the ODBC Data Sources section are sections that define each DSN. The name of a DSN section must match one of the parameter names defined in the ODBC Data Sources section.

Configuring the odbc.ini file:

To create or edit the DSN definition file:

- 1 Using the text editor of your choice, open `/Library/ODBC/odbc.ini` (to create a system DSN entry) or `/Users/username/ODBC/odbc.ini` to create a user DSN entry).

Note: You must be a system administrator in order to define a system DSN.

- 2 Create an ODBC Data Sources section and create an entry for the DSN you want to create (for example, HPVerticaDSN). This entry establishes the name by which the new data source is referred. The value you assign to the DSN entry is just a comment that describes the DSN. For example:

```
[ODBC Data Sources]
HPVerticaDSN = "vmartdb connection"
```

- 3 Create a section for the DSN, and add values that define the settings needed to connect to your database. The following are the most commonly-defined parameters:

- **Description** – Additional information about the data source.
- **Driver** – The path to the HP Vertica ODBC driver library, or the name of a driver defined in the `odbcinst.ini` file (see below). The location of the driver depends on whether it was installed system-wide use, or just for an individual user:

If you installed the ODBC driver for system-wide use, its path should be
`/Library/ODBC/vertica/lib/libverticaodbc.dylib`

If you installed the ODBC driver for just the current user, its path should be
`/Users/username/Library/ODBC/vertica/lib/libverticaodbc.dylib`

The file name `libverticaodbc.dylib` is a symbolic link that always points to the most up-to-date version of the HP Vertica client ODBC library. Using this link ensures that you do not need to update all of your DSNs when you update your client drivers.

- **Database** – The name of the database running on the server.
- **ServerName** — The name of the server where HP Vertica is installed.
- **UID** – The HP Vertica user account to use when connecting.
- **PWD** – The password for the user given in the UID.
- **Port** – The port number on which HP Vertica listens for connections. This is usually 5433.
- **Locale** – The default locale used for the session. By default, the locale for the database is `en_US@collation=binary` (English as in the United States of America). Specify the locale as an ICU Locale. See the **ICU User Guide** <http://userguide.icu-project.org/locale> for a complete list of parameters that can be used to specify a locale.

For example:

```
[VMart]
Description = Vmart Database
Driver = /Library/ODBC/vertica/lib/libverticaodbc.dylib
Database = vmartdb
Servername = host01
UID = dbadmin
PWD = password
Port = 5433
Locale = en_GB
```

See **DSN parameters** (page [43](#)) for a complete list of parameters including HP Vertica-specific ones.

Note: Instead of editing the `odbc.ini` and `odbcinst.ini` files in a text editor, you can install and use Apple's **ODBC Administrator Tool** <http://support.apple.com/kb/DL895>.

Using an `odbcinst.ini` File

Instead of giving the path of the ODBC driver library in your DSN definitions, you can use the name of a driver defined in the `odbcinst.ini` file. This is a useful method if you have many DSNs, and often need to update them to point to new driver libraries. It also allows you to set some additional ODBC parameters.

Just as in the `odbc.ini` file, `odbcinst.ini` has sections. Each section defines an ODBC driver that can be referenced in the `odbc.ini` files.

In a section, you can define the following parameters:

- **Description** — Additional information about the database driver.
- **Driver** — The location of the HP Vertica ODBC driver library. For example:
`/Library/ODBC/vertica/lib/libverticaodbc.dylib`

For example:

```
[HPVerticaDriver]
Description = HP Vertica ODBC Driver
Driver = /Library/ODBC/vertica/lib/libverticaodbc.dylib
```

Then in your `odbc.ini` file, you use the name of the section you created in the `odbcinst.ini` file that describes the driver you want to use. For example:

```
[VMart]
Description = HP Vertica Vmart database
Driver = HPVerticaDriver
```

Configuring Additional ODBC Settings

In addition to configuring the `odbc.ini` file, you need to configure some additional driver settings before you can use your DSN. See **Additional ODBC Driver Configuration Settings** (page [49](#)) for details.

DSN Parameters

The following tables list the connection properties you can set in the DSNs for use with HP Vertica's ODBC driver.

Required Connection Parameters

These connection parameters are the minimum required to create a connection to the database. If any parameters are missing from the DSN, they must be supplied by the function call or connection string in order for the connection to HP Vertica to succeed.

Parameters	Description	Default Value	Standard/HP Vertica
Driver	The file path and name of the driver used.	none	Standard
Database	The name of the database running on the server.	none	Standard
Servername	The hostname or IP address of any active node within an HP Vertica database; for example, host01. Note: you can also use the aliases "server" and "host" for this parameter.	none	Standard
Port	The port number on which HP Vertica listens for ODBC connections.	5433	Standard
Username	Either the database superuser (same name as the database administrator account) or a user that the superuser has created and granted privileges.	none	Standard
Password	The password for the specified user name. You may insert an empty string to leave this parameter blank.	none	Standard

Advanced Settings

Parameters	Description	Default	Standard/HP Vertica
AutoCommit	A Boolean value that controls whether the driver automatically commits transactions after executing a DML statement.	true	Standard

Parameters	Description	Default	Standard/HP Vertica
ConnSettings	A string containing SQL commands that the driver should execute immediately after connecting to the server. This parameter is often used to configure the connection in some manner, such as setting a schema search path. Note: In the connection string ';' is a reserved symbol. If you need to set multiple parameters as part of ConnSettings parameter use '%3B' in place of '. Also use '+' for spaces.	none	HP Vertica
DirectBatchInsert	A Boolean that controls where data inserted through the connection is stored. When set to true, HP Vertica directly inserts data into ROS containers. Otherwise, it stores data using AUTO mode.	false	HP Vertica
DriverStringConversions	Controls whether the ODBC driver performs type conversions on strings sent between the ODBC driver and the database. Possible values are: <ul style="list-style-type: none"> ▪ NONE—no conversion in either direction. this results in the highest performance. ▪ INPUT—strings sent from the client to the server are converted, but strings sent from the server to the client are not. ▪ OUTPUT—strings sent by the server to the client are converted, but strings sent from the client to the server are not. ▪ BOTH—strings are converted in both directions. 	OUTPUT	HP Vertica

Parameters	Description	Default	Standard/HP Vertica
Locale	The locale used for the session. Specify the locale as an ICU Locale. See the ICU User Guide (http://userguide.icu-project.org/locale) for a complete list of parameters that can be used to specify a locale.	en_US@collation=binary (English as in the United States of America)	HP Vertica
ReadOnly	A true/false value that controls whether the connection can only read data from HP Vertica.	false	HP Vertica
ResultBufferSize	Size of memory buffer for the large result sets in streaming mode. Note: This parameter was previously called MaxMemoryCache	131072 (128KB)	HP Vertica
TransactionIsolation	Sets the transaction isolation for the connection. Valid values are: <ul style="list-style-type: none">▪ Read Committed▪ Serializable▪ Server Default See Changing Transaction Isolation Levels in the Administrator's Guide for an explanation of transaction isolation.	Server Default	HP Vertica

Identification

Parameters	Description	Default	Standard/HP Vertica
Description	An optional description for the DSN entry. Insert an empty string to leave the description empty.	none	Standard
Label / SessionLabel	Sets a label for the connection on the server. This value appears in the session_id column of the V_MONITOR.SESSIONS system table. Note: Label and SessionLabel are synonyms. They can be used interchangeably.	none	HP Vertica

Encryption

Parameters	Description	Default	Standard/HP Vertica
SSLMode	<p>Controls whether the connection to the database uses SSL encryption. Valid values are:</p> <ul style="list-style-type: none"> ▪ require—Requires the server to use SSL. If the server cannot provide an encrypted channel, the connection fails. ▪ prefer—Prefers the server to use SSL. If the server does not offer an encrypted channel, the client requests one. Note that the first connection attempt to the database tries to use SSL. If that fails, a second connection is attempted over a clear channel. ▪ allow—Makes a connection to the server whether the server uses SSL or not. Note that the first connection attempt to the database is attempted over a clear channel. If that fails, a second connection is attempted over SSL. ▪ disable—Never connects to the server using SSL. This setting is typically used for troubleshooting 	prefer	HP Vertica
SSLKeyFile	The absolute path to the client's private key file. This file can reside anywhere on the system.	none	HP Vertica
SSLCertFile	The absolute path of the client's public certificate file. This file can reside anywhere on the system.	none	HP Vertica

Third-Party Compatibility

Parameters	Description	Default	Standard/HP Vertica
ColumnsAsChar	How character column types are reported when the driver is in Unicode mode. When set to false, the ODBC	false	HP Vertica

	driver reports the data type of character columns as WCHAR. If you set ColumnsAsChar to true, the driver identifies character column as CHAR. This setting is normally used for compatibility with some third-party clients such as Informatica.		
ThreePartNaming	A Boolean that controls how the database metadata APIs reports the catalog name. When set to true, the database name is returned as the catalog name in the database metadata. When set to false, NULL is returned as the catalog name. Enable this option of your client software expects to be able to get the catalog name from the database metadata and use it as part of a three-part name reference.	false on Unix clients true on Windows clients	HP Vertica

See Also

- *Additional ODBC Driver Configuration Settings* (page [49](#))

Setting DSN Parameters

The parameters in the following tables are common for all user and system DSN entries. The examples provided are for Windows clients.

To edit DSN parameters:

- On UNIX and Linux client platforms, you can edit the `odbc.ini` file. (See *Creating an ODBC DSN for Linux, Solaris, AIX, and HP-UX* (page [29](#)).) The location of this file is specific to the driver manager.
- On Windows client platforms, you can edit some DSN parameters using the HP Vertica ODBC client driver interface. See *Creating an ODBC DSN for Windows Clients* (page [33](#)).

You can also edit the DSN parameters directly by opening the DSN entry in the Windows registry (for example, at `HKEY_LOCAL_MACHINE\SOFTWARE\ODBC\ODBC.INI\DSNname`). Directly editing the registry can be risky, so you should only use this method for parameters cannot be set through the ODBC driver's user interface, or via your client code.

- You can set parameters in the connection string when opening a connection using the `SQLDriverConnect()` function:

```
sqlRet = SQLDriverConnect(sql_hDBC, 0,
    (SQLCHAR*)"DSN=DSNName;Locale=en_GB",
    SQL_NTS, szDNS, 1024,&nSize, SQL_DRIVER_NOPROMPT);
```

Note: In the connection string ';' is a reserved symbol. If you need to set multiple parameters as part of ConnSettings parameter use '%3B' in place of ';'. Also use '+' instead of spaces.

For Example:

```
sqlRet = SQLDriverConnect(sql_hDBC, 0, (SQLCHAR*)"DSN=HP VerticaSQL;ConnSettings=
set+search_path+a,b,c%3Bset+locale=ch;SSLMode=prefer", SQL_NTS,
szDNS, 1024,&nSize, SQL_DRIVER_NOPROMPT);
```

- Your client code can retrieve DSN parameter values after a connection has been made to HP Vertica using the `SQLGetConnectAttr()` and `SQLGetStmtAttr()` API calls. Some parameters can be set and using `SQLSetConnectAttr()` and `SQLSetStmtAttr()`. For details of the list of HP Vertica-specific parameters see ***HP Vertica-specific ODBC Header File*** (page [58](#)).

Additional ODBC Driver Configuration Settings

On Linux and UNIX platforms, in addition to the DSN settings, you need to provide some additional settings to configure the HP Vertica ODBC client driver. These settings control the following:

- The text encoding used by the driver manager (for example, UTF-8 or UTF-16).
- The location of the directory containing the HP Vertica ODBC driver's error message files.
- Whether and how the ODBC driver logs messages.

Note: The additional driver configuration settings are available on Windows platforms, but are not necessary. You must supply the additional configuration settings on Linux/UNIX systems before the ODBC drivers can function properly.

The topics in this section describe these settings in greater detail.

Location of the Additional Driver Settings

Where the additional driver settings are stored depends on your client platform:

- On Linux and UNIX platforms, the settings are contained in a text file named `vertica.ini` (although you can choose a different filename). You tell the HP Vertica ODBC driver where to find this file using an environment variable named `VERTICAINI`.
- On Windows platforms, the additional settings are set using the ODBC Data Source Configuration window. The values for the settings are stored in the Windows registry under the path `HKEY_LOCAL_MACHINE\SOFTWARE\Vertica\Driver`.

Creating a `vertica.ini` File

There is no standard location for the `vertica.ini` file—you can store the file anywhere that it is convenient for you on your client system. One possible location is in the `/etc` directory if you have multiple users on your client system that need to access it, or have a `vertica.ini` file in each user's home directory so users can alter their own settings. Wherever you store it, be sure users have read access to the file.

The format of the `vertica.ini` file is similar to the `odbc.ini` file, with a section followed by parameter definitions. Unlike the `odbc.ini` file, `vertica.ini` contains a single section named Driver:

```
[Driver]
```

Following the section definition, you add setting definitions, one per line. A setting definition consists of the setting name, followed by an equal sign (=), followed by the value. The value does not need quotes. For example, to set the `ODBCInstLib` setting, you add a line like this:

```
ODBCInstLib=/usr/lib64/libodbcinst.so
```

See **Additional Parameter Settings** (page [51](#)) for a list of the additional settings.

Required Settings

You must configure two settings in order for the ODBC driver to work correctly:

- `ErrorMessagesPath`
- `ODBCInstLib` (unless the driver manager's installation library is in a directory listed in the `LD_LIBRARY_PATH` or `LIB_PATH` environment variables).

Also, if your driver manager does not use UTF-8 encoding, you need to set `DriverManagerEncoding` to the proper encoding.

Setting the VERTICAINI Environment Variable

You must set an environment variable named `VERTICAINI` to the absolute path of the `vertica.ini` file. The HP Vertica ODBC driver uses this variable to find the settings.

Where you set this variable depends on whether users on your client system need to have separate `vertica.ini` files. If you want to have a single, system-wide `vertica.ini` file, you can add a command to set `VERTICAINI` in `/etc/profile` or some other system-wide environment file. For example:

```
export VERTICAINI=/etc/vertica.ini
```

If users need individual `vertica.ini` files, set `VERTICAINI` in their `~/.profile` or similar configuration file. For example:

```
export VERTICAINI=~/vertica.ini
```

On Macintosh OS X client systems, you can set the `VERTICAINI` environment variable in each user's `~/MacOSX/environment.plist` file. See the **Environment Variables** <http://developer.apple.com/library/mac/#documentation/MacOSX/Conceptual/BPRuntimeConfig/Articles/EnvironmentVars.html> entry in the Apple's Developer's Library for more information.

Example `vertica.ini` File

The following example `vertica.ini` file configures the ODBC driver to:

- use the 64-bit UnixODBC driver manager.
- get its error messages from the standard HP Vertica 64-bit ODBC driver installation directory.
- log all warnings and more severe messages to log files stored in the temporary directory.

```
[Driver]
DriverManagerEncoding=UTF-16
ODBCInstLib=/usr/lib64/libodbcinst.so
ErrorMessagesPath=/opt/vertica/lib64
LogLevel=4
LogPath=/tmp
```

Additional Parameter Settings

The following parameters can be set for the HP Vertica client drivers.

Logging Settings

These parameters control how messages between the client and server are logged. None of these settings are required. If they are not set, then the client library does not log any messages. They apply to both ADO.NET and ODBC.

- **LogLevel**—The severity of messages that are logged between the client and the server. The valid values are:
 - 0—No logging
 - 1—Fatal errors
 - 2—Errors
 - 3—Warnings
 - 4—Info
 - 5—Debug
 - 6—Trace (all messages)

The value you specify for this setting sets the minimum severity for a message to be logged. For example, setting LogLevel to 3 means that the client driver logs all warnings, errors, and fatal errors.

- **LogPath**—The absolute path of a directory to store log files . For example:
/var/log/verticaodbc
- **LogNamespace**—Limits logging to messages generated by certain objects in the client driver.

Note: These settings are also available for the HP Vertica JDBC driver through connection properties. See **Connection Properties** (page [117](#)) for details.

ODBC-specific Settings

The following settings are used only by the HP Vertica ODBC client driver.

- **DriverManagerEncoding**—The UTF encoding standard that the driver manager uses. This setting needs to match the encoding the driver manager expects. The available values for this setting are:
 - UTF-8
 - UTF-16 (usually used by unixODBC)
 - UTF-32 (usually used by iODBC)

See the documentation for your driver manager to find the correct value for this setting.

Note: While both UTF-16 and UTF-8 are valid settings for DataDirect, Vertica recommends that you set the DataDirect driver manager encoding to UTF-16.

If you do not set this parameter, the ODBC driver defaults to the value shown in the following table. If your driver manager uses a different encoding, you must set this value for the ODBC driver to be able to work.

Client Platform	Default Encoding
AIX 32-bit	UTF-16
AIX 64-bit	UTF-32
HPUX 32-bit	UTF-32
HPUX 64-bit	UTF-32
Linux x86 32-bit	UTF-32
Linux x86 64-bit	UTF-32
Linux Itanium 64-bit	UTF-32
OS X	UTF-32
Solaris x86 32-bit	UTF-32
Solaris x86 64-bit	UTF-32
Solaris SPARC 32-bit	UTF-32
Solaris SPARC 64-bit	UTF-32
Windows 32-bit	UTF-16
Windows 64-bit	UTF-16

- **ErrorMessagesPath**—The absolute path to the parent directory that contains the HP Vertica client driver's localized error message files. These files are usually stored in the same directory as the HP Vertica ODBC driver files.

Note: This setting is required. If you do not set it, then any error the ODBC driver encounters will result in an error message about a missing `ODBCMessages.xml` file.

- **ODBCInstLib**—The absolute path to the file containing the ODBC installer library (ODBCInst). This setting is required if the directory containing this library is not set in the `LD_LIBRARY_PATH` or `LIB_PATH` environment variables. The library files for the major driver manager are:
 - UnixODBC: `libodbcinst.so`
 - iODBC: `libiodbcinst.so` (`libiodbcinst.2.dylib` on OS X)
 - DataDirect: `libodbcinst.so`

Note: On AIX platforms, you need give the path to the library archive, followed by the name of the library enclosed in parenthesis. For example:

`ODBCInstLib=/usr/lib64/libodbcinst.a(libodbcinst.so.1)`

ADO.NET-specific Settings

This setting applies only to the ADO.NET client driver:

C#PreloadLogging—Tells the HP Vertica ADO.NET driver to begin logging as soon as possible, before the driver has fully loaded itself. Normally, logging only starts after the driver has fully loaded. Valid values for this setting are:

- 0—Do not start logging before the driver has loaded.
- 1—Start logging as soon as possible.

Programming ODBC Client Applications

HP Vertica provides an Open Database Connectivity (ODBC) driver that allows applications to connect to the HP Vertica database. This driver can be used by custom-written client applications that use the ODBC API to interact with HP Vertica. ODBC is also used by many third-party applications to connect to HP Vertica, including business intelligence applications and extract, transform, and load (ETL) applications.

This section details the process for configuring the HP Vertica ODBC driver. It also explains how to use the ODBC API to connect to HP Vertica in your own client applications.

This section assumes that you have already installed the ODBC libraries on your client system. If you have not, see ***Client Driver Install Procedures*** (page [19](#)).

ODBC Architecture

The ODBC architecture has four layers:

- **Client Application**
Is an application that opens a data source through a Data Source Name (DSN). It then sends requests to the data source, and receives the results of those requests. Requests are made in the form of calls to ODBC functions.
- **Driver Manager**
Is a library on the client system that acts as an intermediary between a client application and one or more drivers. The driver manager:
 - Resolves the DSN provided by the client application.
 - Loads the driver required to access the specific database defined within the DSN.
 - Processes ODBC function calls from the client or passing them to the driver.
 - Retrieves results from the driver.
 - Unloads drivers when they are no longer needed.
- **Driver**
A library on the client system that provides access to a specific database. It translates requests into the format expected by the database, and translates results back into the format required by the client application.
- **Database**
The database processes requests initiated at the client application and returns results.

ODBC Feature Support

The ODBC driver for HP Vertica supports the most of the features defined in the Microsoft ODBC 3.5 specifications. The following features are *not* supported:

- Updatable result sets
- Backwards scrolling cursors
- Cursor attributes
- More than one open statement per connection. For example you cannot execute a new statement while another statement has a result set open. If you need to execute multiple statements at once, open multiple database connections.
- Keysets
- Bookmarks

The HP Vertica ODBC driver accurately reports its capabilities. If you need to determine whether it complies with a specific feature, you should query the driver's capabilities directly using the `SQLGetInfo()` function.

Updating ODBC Client Code from Previous Driver Versions

In HP Vertica Version 5.1, the client drivers were rewritten to improve standards compliance and reliability. As a result, some HP Vertica-specific features and past incompatibilities have been eliminated. You must update any client code written for versions of the HP Vertica ODBC driver earlier than 5.1 to work with the newer drivers. The following topics give you an overview of the necessary code changes.

DSN Parameter Changes

A number of HP Vertica-specific DSN parameters have been eliminated or changed.

Removed DSN Parameters

The following parameters are no longer available in the 5.1 ODBC driver.

Parameter	Description
BatchInsertEnforceLength	Batch inserts now behave the same way all other inserts behave. If a piece of data is too wide for its column, the row will be rejected. To avoid having rows rejected, either truncate the data yourself or use the COPY statement directly, which defaults to truncating data.
BinaryDataTransfer	All data is now transferred using NATIVE VARCHAR.
BoolAsChar	Boolean columns can no longer be bound to SQL_CHAR values. Use SQL_BIT values

	instead.
Debug	Use the LogLevel parameter instead.
LRSPath and RSSStreaming	The ODBC driver now always streams data. It does not cache data on the local disk.
SupressWarnings	Removed to prevent clients from ignoring warnings.
WideCharSizeIn and WideCharSizeOut	These options are now set using the DriverManagerEncoding option in the <code>vertica.ini</code> file.

Changed DSN Parameters

The following DSN parameters have changed since the previous version of the ODBC driver.

Parameter	Description
MaxMemoryCache	This parameter is now named ResultBufferSize to make its name consistent across all HP Vertica client drivers.

New DSN Parameter

The following DSN parameters are new in the version 5.1 ODBC driver.

Parameter	Description
DriverStringConversionS	Determines whether strings sent between the server and the ODBC client are converted.
ThreePartNaming	Controls whether the database metadata uses the database name as the catalog name. This parameter is only used for backwards compatibility with some client software that expects a non-null catalog name.

New DSN Parameter Alias

Parameter	Description
Password	An alias for PWD.
SessionLabel	This is a new alias for the existing Label parameter that lets you assign a label to an ODBC connection.
UserName	An alias for UID.

Function Changes

The following functions have changed their behavior in the version 5.1 drivers.

- `SQLGetInfo()` now returns the file name of the ODBC library file when queried for the `SQL_DRIVER_NAME`. Previous versions would return the brand name of the driver, which is not part of the ODBC specifications.
- In previous versions of the ODBC driver, passing the `SQLGetInfo` function `SQL_PARAM_ARRAY_SELECTS` returned `SQL_PAS_BATCH`, indicating that the driver returns a batch for each set of parameters in a `SELECT` statement. This return value was incorrect. The driver now correctly returns `SQL_PAS_NO_SELECT`, which indicates that the driver does not support `SELECT` queries using arrays of parameters.
- For better compatibility with the ODBC standards, the time data type in the ODBC driver no longer contain fractions of a second. In the new driver, functions that convert time values to strings (for example, a `SQLBindCol()` call to bind a `SQL_TYPE_TIME` to a `SQL_C_CHAR` value) no longer add fractional second values to the string. Earlier versions of the driver would return the fractions of a second that the HP Vertica database stores.
- `SQLBindParameter()` now requires that its column-size argument for variable-width columns (such as `SQL_CHAR`, `SQL_VARCHAR`, `SQL_VARBINARY`) be non-zero as specified in the ODBC standards. The implementation of this function in previous versions of the driver allowed a non-standard zero value to indicate the column width was a default width value.
- The driver is now more strict about converting from character data types to numerical data types. In previous drivers, any portion of the character string that could not be converted to a numeric value was ignored. The new driver returns an error if any portion of the string cannot be converted. For example, asking the previous driver to insert the character string "3 days" to an integer column resulted in the value 3 being stored in the column. Now, the driver returns an error when attempting to store this character value in an integer column.
- Functions that return result sets containing catalog metadata now return `SQL_WVARCHAR` columns instead of `SQL_VARCHAR` columns. This is standard behavior for ODBC 3.52 drivers that are Unicode capable.

Removed Functions

The `LCOPY` function has been removed from the version 5.1 driver. You should instead use the `LOCAL` option of the `COPY SQL` statement to copy data from the client system to the server. See ***Streaming Data from the Client Using COPY LOCAL*** (page [103](#)).

Interval and TimeStamp Changes

When you call the `SQLBindParameter()` function to bind a `SQL_C_INTERVAL` value (for example, `SQL_INTERVAL_STRUCT`) to an `INTERVAL` column after calling `SQLPrepare()`, the interval leading precision is now reset to the default value of 2. Earlier versions of the driver did not reset the leading precision as called for in the ODBC standards. If you want your interval value to have a greater leading precision, your client application can take either of the following steps:

- Call `SQLBindParameter()` to bind the value to the INTERVAL column before calling `SQLPrepare()`. The interval precision is not reset unless you call `SQLBindParameter()` after you have called `SQLPrepare()`.
- Reset the leading precision by using the `SQLSetDescField()` function to set `SQL_DESC_DATETIME_INTERVAL_PRECISION` to whatever value you want.

`SQLDescribeCol()` now returns a new width for interval data types. For example, when passed `SQL_INTERVAL_SECOND`, the previous driver would return 21 bytes. The new driver returns 16.

In general, the new drivers are more strict regarding interval values, and throw errors when the old drivers silently truncated values. If your application throws an exception when dealing with an interval, your first debugging step is to make sure the values you are inserting are the correct width and type.

Note: The units interval style is not supported. Do not use the `SET INTERVALSTYLE` statement to change the interval style in your client applications.

`SQLBindParameter()` is more strict about the number of digits you supply in fractions of a second in a timestamp. For example, the following call generates an error:

```
SQL_TIMESTAMP_STRUCT ts;
ts.fraction = 123456; //represents the fraction 0.000123456
SQLBindParameter(hstmt, 1, SQL_PARAM_INPUT, SQL_C_TIMESTAMP, SQL_TYPE_TIMESTAMP,
0, 6, (SQLPOINTER)&ts, 0, NULL);
SQLExecute(hstmt);
```

The error occurs because the fractional value represents more than six digits. Instead you would need to change the `SQLBindParameter` call to allow 9 digits in the fraction:

```
SQLBindParameter(hstmt, 1, SQL_PARAM_INPUT, SQL_C_TIMESTAMP, SQL_TYPE_TIMESTAMP,
0, 9, (SQLPOINTER)&ts, 0, NULL);
```

Note that the fraction will be truncated to 0.000123, since timestamps do not have nanosecond precision. But you still need to allow for all of the fractional digits to be inserted into the timestamp.

New Additional Driver Information

The new HP Vertica version 5.1 ODBC driver has some additional configuration settings not covered by the standard ODBC.INI file. use a configuration file named `vertica.ini` on Linux, AIX, Solaris, and HP-UX. It controls several features of the ODBC driver. For more information, see [Additional ODBC Driver Configuration Settings](#) (page 49).

HP Vertica-specific ODBC Header File

The HP Vertica ODBC driver provides a C header file named `verticaodbc.h` that defines several useful constants that you can use in your applications. These constants let you access and alter HP Vertica-specific settings.

This file's location depends on your client operating system:

- /opt/vertica/include on Linux and UNIX systems.
- C:\Program Files (x86) \HP Systems\ODBC\include on Windows systems.

The constants defined in this file are listed below.

Parameter	Description	Associated Function
SQL_ATTR_VERTICA_RESULT_BUFFER_SIZE	Sets the size of the buffer used when retrieving results from the server.	SQLSetConnectAttr() SQLGetConnectAttr()
SQL_ATTR_VERTICA_DIRECT_BATCH_INSERT	Determines whether a batch is inserted directly into the ROS (1) or using AUTO mode (0). By default batches are inserted using AUTO.	SQLSetConnectAttr() SQLSetStmtAttr() SQLGetConnectAttr() SQLGetStmtAttr()
SQL_ATTR_VERTICA_LOCALE	Changes the locale from en_US@collation=binary to the ICU locale specified. See <i>Setting the Locale for ODBC Sessions</i> (page 64) for an example of using this parameter.	SQLSetConnectAttr() SQLGetConnectAttr()

Connecting to HP Vertica

The first step in any ODBC application is to connect to the database. When you create the connection to a data source using ODBC, you use the name of the DSN that contains the details of the driver to use, the database host, and other basic information about connecting to the data source.

There are 4 steps your application needs to take to connect to a database:

- 1 Call `SQLAllocHandle()` to allocate a handle for the ODBC environment. This handle is used to create connection objects and to set application-wide settings.
- 2 Use the environment handle to set the version of ODBC that your application wants to use. This ensures that the data source knows which API your application will use to interact with it.
- 3 Allocate a database connection handle by calling `SQLAllocHandle()`. This handle represents a connection to a specific data source.
- 4 Use the `SQLConnect()` or `SQLDriverConnect()` functions to open the connection to the database.

Note: If you specify a locale either in the connection string or in the DSN, the call to the connection function returns `SQL_SUCCESS_WITH_INFO` on a successful connection, with messages about the state of the locale.

When creating the connection to the database, use `SQLConnect()` when the only options you need to set at connection time is the username and password. Use `SQLDriverConnect()` when you want to change connection options, such as the locale.

The following example demonstrates connecting to a database using a DSN named ExampleDB. After it creates the connection successfully, this example simply closes it.

```
// Demonstrate connecting to Vertica using ODBC.

// Standard i/o library
#include <stdio.h>
#include <stdlib.h>
// Only needed for Windows clients
// #include <windows.h>

// SQL include files that define data types and ODBC API
// functions
#include <sql.h>
#include <sqlext.h>
#include <sqltypes.h>

int main()
{
    SQLRETURN ret;      // Stores return value from ODBC API calls
    SQLHENV hdlEnv;   // Handle for the SQL environment object

    // Allocate an a SQL environment object
    ret = SQLAllocHandle(SQL_HANDLE_ENV, SQL_NULL_HANDLE, &hdlEnv);
    if(!SQL_SUCCEEDED(ret)) {
        printf("Could not allocate a handle.\n");
        exit(EXIT_FAILURE);
    } else {
        printf("Allocated an environment handle.\n");
    }

    // Set the ODBC version we are going to use to
    // 3.
    ret = SQLSetEnvAttr(hdlEnv, SQL_ATTR_ODBC_VERSION,
                        (SQLPOINTER) SQL_OV_ODBC3, SQL_IS_UINTEGER);
    if(!SQL_SUCCEEDED(ret)) {
        printf("Could not set application version to ODBC 3.\n");
        exit(EXIT_FAILURE);
    } else {
        printf("Set application version to ODBC 3.\n");
    }

    // Allocate a database handle.
    SQLHDBC hdlDbc;
    ret = SQLAllocHandle(SQL_HANDLE_DBC, hdlEnv, &hdlDbc);
    if(!SQL_SUCCEEDED(ret)) {
        printf("Could not allocate database handle.\n");
        exit(EXIT_FAILURE);
    } else {
        printf("Allocated Database handle.\n");
    }
}
```

```
// Connect to the database using
// SQL Connect
printf("Connecting to database.\n");
const char *dsName = "ExampleDB";
const char* userID = "ExampleUser";
const char* passwd = "password123";
ret = SQLConnect(hdlDbc, (SQLCHAR*)dsName,
    SQL_NTS, (SQLCHAR*)userID, SQL_NTS,
    (SQLCHAR*)passwd, SQL_NTS);

if(!SQL_SUCCEEDED(ret)) {
    printf("Could not connect to database.\n");
    exit(EXIT_FAILURE);
} else {
    printf("Connected to database.\n");
}

// We're connected. You can do real
// work here

// When done, free all of the handles to close them
// in an orderly fashion.
printf("Disconnecting and freeing handles.\n");
ret = SQLDisconnect( hdlDbc );
if(!SQL_SUCCEEDED(ret)) {
    printf("Error disconnecting from database. Transaction still open?\n");
    exit(EXIT_FAILURE);
}

SQLFreeHandle(SQL_HANDLE_DBC, hdlDbc);
SQLFreeHandle(SQL_HANDLE_ENV, hdlEnv);
exit(EXIT_SUCCESS);
}
```

Running the above code prints the following:

```
Allocated an environment handle.
Set application version to ODBC 3.
Allocated Database handle.
Connecting to database.
Connected to database.
Disconnecting and freeing handles.
```

See **Setting the Locale for ODBC Sessions** (page [64](#)) for an example of using SQLDriverConnect to connect to the database.

Notes

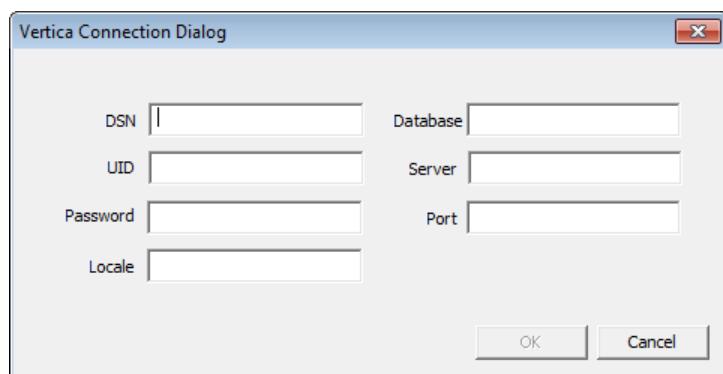
- If you use the DataDirect® driver manager, you should always use the SQL_DRIVER_NOPROMPT value for the SQLDriverConnect function's DriverCompletion parameter (the final parameter in the function call) when connecting to HP Vertica. HP Vertica's ODBC driver on Linux and UNIX platforms does not contain a UI, and therefore cannot prompt users for a password.
- On Windows client platforms, if your connection string doesn't include a DSN and also lacks either or both a database or server parameter, the HP Vertica ODBC Driver will open a dialog box to prompt the user for the missing information. See **Prompting Windows Users for Missing Connection Parameters** (page [63](#)) for more information.
- If your database is not in compliance with the terms your license agreement (for example, it is larger than the data allowance in your license), HP Vertica sends a message about the non-compliance to your client application in the return value of the SQLConnect() function. Your application should always test this return value to see if it is SQL_SUCCESS_WITH_INFO. If it is, your application should extract and display the message to the user.

Prompting Windows Users for Missing Connection Parameters

The HP Vertica Windows ODBC driver can prompt the user for connection information if required information is missing. The driver displays the HP Vertica Connection Dialog if the client application calls SQLDriverConnect to connect to HP Vertica and either of the following is true:

- the DriverCompletion parameter is set to SQL_DRIVER_PROMPT.
- the DriverCompletion parameter is set to SQL_DRIVER_COMPLETE or SQL_DRIVER_COMPLETE_REQUIRED and the connection string or DSN being used to connect is missing the server, database, or port information.

If either of the above conditions are true, the driver displays an HP Vertica Connection Dialog to the user to prompt for connection information.



Any parameters supplied in the connection string or DSN filled in on the dialog.

Note: Your connection string at least needs to specify Vertica as the driver, otherwise Windows will not know to use the Vertica ODBC driver to try to open the connection.

The required fields on the connection dialog are Database, UID, Server, and Port. Once these are filled in, the form enables the **OK** button.

If the user clicks **Cancel** on the dialog, the `SQLDriverConnect` function call returns `SQL_NO_DATA` immediately, without attempting to connect to HP Vertica. If the user supplies incomplete or incorrect information for the connection, the connection function returns `SQL_ERROR` after the connection attempt fails.

Note: If the `DriverCompletion` parameter of the `SQLDriverConnect` function call is `SQL_DRIVER_NOPROMPT`, the ODBC driver immediately returns a `SQL_ERROR` indicating that it cannot connect because not enough information has been supplied and the driver is not allowed to prompt the user for the missing information.

Setting the Locale for ODBC Sessions

HP Vertica provides three ways to set the locale for an ODBC session:

- Specify the locale for all connections made using the DSN:
 - On Linux and other UNIX-like platforms: *Creating an ODBC DSN for Linux, Solaris, AIX, and HP-UX* (page [29](#))
 - On Windows platforms, you need to directly add the locale DSN parameter to the ODBC definition in the Windows registry. See *Editing DSN Entries* (page [40](#)).
- Set the `Locale` connection parameter in the connection string in `SQLDriverConnect()` function.

For example:

```
SQLDriverConnect(conn, NULL, (SQLCHAR*)"DSN=Vertica;Locale=en_GB",
SQL_NTS, szConnOut, sizeof(szConnOut), &iAvailable,
SQL_DRIVER_NOPROMPT)
```

- Use the `SQLSetConnectAttr()` method with the `SQL_ATTR_VERTICA_LOCALE` constant and specify the ICU string as the attribute value. See the example below.

Notes

- Having the client system use a non-Unicode locale (such as setting `LANG=C` on Linux platforms) and using a Unicode locale for the connection to HP Vertica can result in errors such as "(10170) String data right truncation on data from data source." If data received from HP Vertica isn't in UTF-8 format. The driver allocates string memory based on the system's locale setting, and non-UTF-8 data can trigger an overrun. You can avoid these errors by always using a Unicode locale on the client system.
- If you specify a locale either in the connection string or in the DSN, the call to the connection function returns `SQL_SUCCESS_WITH_INFO` on a successful connection, with messages about the state of the locale.
- ODBC applications can be in either ANSI or Unicode mode:
 - If Unicode, the encoding used by ODBC is UCS-2.
 - If ANSI, the data must be in single-byte ASCII, which is compatible with UTF-8 on the database server.

The ODBC driver converts UCS-2 to UTF-8 when passing to the HP Vertica server and converts data sent by the HP Vertica server from UTF-8 to UCS-2.

- If the end-user application is not already in UCS-2, the application is responsible for converting the input data to UCS-2, or unexpected results could occur. For example:
 - On non-UCS-2 data passed to ODBC APIs, when it is interpreted as UCS-2, it could result in an invalid UCS-2 symbol being passed to the APIs, resulting in errors.
 - Or the symbol provided in the alternate encoding could be a valid UCS-2 symbol; in this case, incorrect data is inserted into the database.

ODBC applications should set the correct server session locale using `SQLSetConnectAttr` (if different from database-wide setting) in order to set the proper collation and string functions behavior on server.

The following example code demonstrates setting the locale using both the connection string and through the `SQLSetConnectAttr()` function.

```
// Standard i/o library
#include <stdio.h>
#include <stdlib.h>
// Only needed for Windows clients
// #include <windows.h>

// SQL include files that define data types and ODBC API
// functions
#include <sql.h>
#include <sqlext.h>
#include <sqltypes.h>

// Vertica-specific definitions. This include file is located as
// /opt/vertica/include on database hosts.
#include <verticaodbc.h>

int main()
{
    SQLRETURN ret;      // Stores return value from ODBC API calls
    SQLHENV hdlEnv;   // Handle for the SQL environment object

    // Allocate an a SQL environment object
    ret = SQLAllocHandle(SQL_HANDLE_ENV, SQL_NULL_HANDLE, &hdlEnv);
    if(!SQL_SUCCEEDED(ret)) {
        printf("Could not allocate a handle.\n");
        exit(EXIT_FAILURE);
    } else {
        printf("Allocated an environment handle.\n");
    }

    // Set the ODBC version we are going to use to 3.
    ret = SQLSetEnvAttr(hdlEnv, SQL_ATTR_ODBC_VERSION,
                        (SQLPOINTER) SQL_OV_ODBC3, SQL_IS_UINTEGER);
    if(!SQL_SUCCEEDED(ret)) {
        printf("Could not set application version to ODBC 3.\n");
        exit(EXIT_FAILURE);
    } else {
        printf("Set application version to ODBC 3.\n");
    }

    // Allocate a database handle.
    SQLHDBC hdlDbc;
    ret = SQLAllocHandle(SQL_HANDLE_DBC, hdlEnv, &hdlDbc);
    if(!SQL_SUCCEEDED(ret)) {
        printf("Could not allocate database handle.\n");
        exit(EXIT_FAILURE);
    } else {
        printf("Allocated Database handle.\n");
    }
}
```

```

// Connect to the database using SQLDriverConnect
printf("Connecting to database.\n");
// Set the locale to English in Great Britain.
const char *connStr = "DSN=ExampleDB;locale=en_GB;" 
                      "UID=dbadmin;PWD=password123";
ret = SQLDriverConnect(hdlDbc, NULL, (SQLCHAR*)connStr, SQL_NTS,
                      NULL, 0, NULL, SQL_DRIVER_NOPROMPT );
if(!SQL_SUCCEEDED(ret)) {
    printf("Could not connect to database.\n");
    exit(EXIT_FAILURE);
} else {
    printf("Connected to database.\n");
}

// Get the Locale
char locale[256];
SQLGetConnectAttr(hdlDbc, SQL_ATTR_VERTICA_LOCALE, locale, sizeof(locale),
                  0);
printf("Locale is set to: %s\n", locale);

// Set the locale to a new value
const char* newLocale = "en_GB";
SQLSetConnectAttr(hdlDbc, SQL_ATTR_VERTICA_LOCALE, (SQLCHAR*)newLocale,
                  SQL_NTS);

// Get the Locale again
SQLGetConnectAttr(hdlDbc, SQL_ATTR_VERTICA_LOCALE, locale, sizeof(locale),
                  0);
printf("Locale is now set to: %s\n", locale);

// When done, free all of the handles to close them
// in an orderly fashion.
printf("Disconnecting and freeing handles.\n");
ret = SQLDisconnect( hdlDbc );
if(!SQL_SUCCEEDED(ret)) {
    printf("Error disconnecting from database. Transaction still open?\n");
    exit(EXIT_FAILURE);
}
SQLFreeHandle(SQL_HANDLE_DBC, hdlDbc);
SQLFreeHandle(SQL_HANDLE_ENV, hdlEnv);
exit(EXIT_SUCCESS);
}

```

AUTOCOMMIT and ODBC Transactions

The AUTOCOMMIT connection attribute controls whether INSERT, ALTER, COPY and other data-manipulation statements are automatically committed after they complete. By default, AUTOCOMMIT is enabled—all statements are committed after they execute. This is often not the best setting to use, since it is less efficient. Also, you often want to control whether a set of statements are committed as a whole, rather than have each individual statement committed. For example, you may only want to commit a series of inserts if all of the inserts succeed. With AUTOCOMMIT disabled, you can roll back the transaction if one of the statements fail.

If AUTOCOMMIT is on, the results of statements are committed immediately after they are executed. You cannot roll back a statement executed in AUTOCOMMIT mode.

For example, when AUTOCOMMIT is on, the following single INSERT statement is automatically committed:

```
ret = SQLExecDirect(hd1Stmt, (SQLCHAR*)"INSERT INTO customers VALUES(500, "
    "'Smith, Sam', '123-456-789');", SQL_NTS);
```

If AUTOCOMMIT is off, you need to manually commit the transaction after executing a statement. For example:

```
ret = SQLExecDirect(hd1Stmt, (SQLCHAR*)"INSERT INTO customers VALUES(500, "
    "'Smith, Sam', '123-456-789');", SQL_NTS);

// Other inserts and data manipulations

// Commit the statements(s)
ret = SQLEndTran(SQL_HANDLE_DBC, hd1Dbc, SQL_COMMIT);
```

The inserted row is only committed when you call `SQLEndTran()`. You can roll back the INSERT and other statements at any point before committing the transaction.

Note: Prepared statements cache the AUTOCOMMIT setting when you create them using `SQLPrepare()`. Later changing the connection's AUTOCOMMIT setting has no effect on the AUTOCOMMIT settings of previously created prepared statements. See [Using Prepared Statements](#) (page 81) for details.

The following example demonstrates turning off AUTOCOMMIT, executing an insert, then manually committing the transaction.

```

// Some standard headers
#include <stdio.h>
#include <stdlib.h>

// Only needed for Windows clients
// #include <windows.h>

// Standard ODBC headers
#include <sql.h>
#include <sqltypes.h>
#include <sqlext.h>

int main()
{
    // Set up the ODBC environment
    SQLRETURN ret;
    SQLHENV hdlEnv;
    ret = SQLAllocHandle(SQL_HANDLE_ENV, SQL_NULL_HANDLE, &hdlEnv);
    if(!SQL_SUCCEEDED(ret)) {
        printf("Could not allocate a handle.\n");
        exit(EXIT_FAILURE);
    } else {
        printf("Allocated an environment handle.\n");
    }

    // Tell ODBC that the application uses ODBC 3.
    ret = SQLSetEnvAttr(hdlEnv, SQL_ATTR_ODBC_VERSION,
        (SQLPOINTER) SQL_OV_ODBC3, SQL_IS_UINTEGER);
    if(!SQL_SUCCEEDED(ret)) {
        printf("Could not set application version to ODBC3.\n");
        exit(EXIT_FAILURE);
    } else {
        printf("Set application to ODBC 3.\n");
    }

    // Allocate a database handle.
    SQLHDBC hdlDbc;
    ret = SQLAllocHandle(SQL_HANDLE_DBC, hdlEnv, &hdlDbc);
    if(!SQL_SUCCEEDED(ret)) {
        printf("Could not allocate database handle.\n");
        exit(EXIT_FAILURE);
    } else {
        printf("Allocated Database handle.\n");
    }

    // Connect to the database
    printf("Connecting to database.\n");
    const char *dsName = "ExampleDB";
    const char* userID = "dbadmin";
}

```

```
const char* passwd = "password123";
ret = SQLConnect(hdlDbc, (SQLCHAR*)dsnName,
    SQL_NTS, (SQLCHAR*)userID,SQL_NTS,
    (SQLCHAR*)passwd, SQL_NTS);
if(!SQL_SUCCEEDED(ret)) {
    printf("Could not connect to database.\n");
    exit(EXIT_FAILURE);
} else {
    printf("Connected to database.\n");
}

// Get the AUTOCOMMIT state
SQLINTEGER autoCommitState;
SQLGetConnectAttr(hdlDbc, SQL_ATTR_AUTOCOMMIT, &autoCommitState, 0, NULL);
printf("Autocommit is set to: %d\n", autoCommitState);

// Disable AUTOCOMMIT
printf("Disabling autocommit.\n");
ret = SQLSetConnectAttr(hdlDbc, SQL_ATTR_AUTOCOMMIT, SQL_AUTOCOMMIT_OFF,
    SQL_NTS);
if(!SQL_SUCCEEDED(ret)) {
    printf("Could not disable autocommit.\n");
    exit(EXIT_FAILURE);
}

// Get the AUTOCOMMIT state again
SQLGetConnectAttr(hdlDbc, SQL_ATTR_AUTOCOMMIT, &autoCommitState, 0, NULL);
printf("Autocommit is set to: %d\n", autoCommitState);

// Set up a statement handle
SQLHSTMT hdlStmt;
SQLAllocHandle(SQL_HANDLE_STMT, hdlDbc, &hdlStmt);

// Create a table to hold the data
SQLExecDirect(hdlStmt, (SQLCHAR*)"DROP TABLE IF EXISTS customers",
    SQL_NTS);
SQLExecDirect(hdlStmt, (SQLCHAR*)"CREATE TABLE customers "
    "(CustID int, CustName varchar(100), Phone_Number char(15));",
    SQL_NTS);

// Insert a single row.
ret = SQLExecDirect(hdlStmt, (SQLCHAR*)"INSERT INTO customers VALUES(500,"
    "'Smith, Sam', '123-456-789');", SQL_NTS);
if(!SQL_SUCCEEDED(ret)) {
    printf("Could not perform single insert.\n");
} else {
    printf("Performed single insert.\n");
}
```

```

// Need to commit the transaction before closing, since autocommit is
// disabled. Otherwise SQLDisconnect returns an error.
printf("Committing transaction.\n");
ret = SQLEndTran(SQL_HANDLE_DBC, hdlDbc, SQL_COMMIT);
if(!SQL_SUCCEEDED(ret)) {
    printf("Error committing transaction.\n");
    exit(EXIT_FAILURE);
}

// Clean up
printf("Free handles.\n");
ret = SQLDisconnect(hdlDbc);
if(!SQL_SUCCEEDED(ret)) {
    printf("Error disconnecting from database. Transaction still open?\n");
    exit(EXIT_FAILURE);
}
SQLFreeHandle(SQL_HANDLE_STMT, hdlStmt);
SQLFreeHandle(SQL_HANDLE_DBC, hdlDbc);
SQLFreeHandle(SQL_HANDLE_ENV, hdlEnv);
exit(EXIT_SUCCESS);
}

```

Running the above code results in the following output:

```

Allocated an environment handle.
Set application to ODBC 3.
Allocated Database handle.
Connecting to database.
Connected to database.
Autocommit is set to: 1
Disabling autocommit.
Autocommit is set to: 0
Performed single insert.
Committing transaction.
Free handles.

```

Note: You can also disable AUTOCOMMIT in the ODBC connection string. See **Setting DSN Parameters** (page [48](#)) for more information.

Retrieving Data through ODBC

To retrieve data through ODBC, you execute a query that returns a result set (SELECT, for example), then retrieve the results using one of two methods:

- Use the `SQLFetch()` function to retrieve a row of the result set, then access column values in the row by calling `SQLGetData()`.

- Use the `SQLBindColumn()` function to bind a variable or array to a column in the result set, then call `SQLExtendedFetch()` or `SQLFetchScroll()` to read a row of the result set and insert its values into the variable or array.

In both methods you loop through the result set until you either reach the end (signaled by the `SQL_NO_DATA` return status) or encounter an error.

Note: HP Vertica supports one cursor per connection. Attempting to use more than one cursor per connection will result in an error. For example, you receive an error if you execute a statement while another statement has a result set open.

The following code example demonstrates retrieving data from HP Vertica by:

- 1 Connecting to the database.
- 2 Executing a `SELECT` statement that returns the IDs and names of all tables.
- 3 Binds two variables to the two columns in the result set.
- 4 Loops through the result set, printing the ids and name values.

```

// Demonstrate running a query and getting results by querying the tables
// system table for a list of all tables in the current schema.

// Some standard headers
#include <stdlib.h>
#include <sstream>
#include <iostream>
#include <assert.h>

// Standard ODBC headers
#include <sql.h>
#include <sqltypes.h>
#include <sqlext.h>

// Use std namespace to make output easier
using namespace std;

// Helper function to print SQL error messages.
template <typename HandleT>
void reportError(int handleTypeEnum, HandleT hdl)
{
    // Get the status records.
    SQLSMALLINT i, MsgLen;
    SQLRETURN ret2;
    SQLCHAR SqlState[6], Msg[SQL_MAX_MESSAGE_LENGTH];
    SQLINTEGER NativeError;
    i = 1;
    cout << endl;
    while ((ret2 = SQLGetDiagRec(handleTypeEnum, hdl, i, SqlState, &NativeError,
        Msg, sizeof(Msg), &MsgLen)) != SQL_NO_DATA) {
        cout << "error record #" << i++ << endl;
        cout << "sqlstate: " << SqlState << endl;
        cout << "detailed msg: " << Msg << endl;
        cout << "native error code: " << NativeError << endl;
    }
}

int main()
{
    // Set up the ODBC environment
    SQLRETURN ret;
    SQLHENV hdlEnv;
    ret = SQLAllocHandle(SQL_HANDLE_ENV, SQL_NULL_HANDLE, &hdlEnv);
    assert(SQL_SUCCEEDED(ret));

    // Tell ODBC that the application uses ODBC 3.
    ret = SQLSetEnvAttr(hdlEnv, SQL_ATTR_ODBC_VERSION,

```

```
(SQLPOINTER) SQL_OV_ODBC3, SQL_IS_UINTEGER);
assert(SQL_SUCCEEDED(ret));

// Allocate a database handle.
SQLHDBC hdlDbc;
ret = SQLAllocHandle(SQL_HANDLE_DBC, hdlEnv, &hdlDbc);
assert(SQL_SUCCEEDED(ret));

// Connect to the database
cout << "Connecting to database." << endl;
const char* dsnName = "ExampleDB";
const char* userID = "dbadmin";
const char* passwd = "password123";
ret = SQLConnect(hdlDbc, (SQLCHAR*)dsnName,
    SQL_NTS, (SQLCHAR*)userID, SQL_NTS,
    (SQLCHAR*)passwd, SQL_NTS);
if (!SQL_SUCCEEDED(ret)) {
    cout << "Could not connect to database" << endl;
    reportError<SQLHDBC>(SQL_HANDLE_DBC, hdlDbc);
    exit(EXIT_FAILURE);
} else {
    cout << "Connected to database." << endl;
}

// Set up a statement handle
SQLHSTMT hdlStmt;
SQLAllocHandle(SQL_HANDLE_STMT, hdlDbc, &hdlStmt);
assert(SQL_SUCCEEDED(ret));

// Execute a query to get the names and IDs of all tables in the schema
// search p[ath (usually public).
ret = SQLExecDirect( hdlStmt, (SQLCHAR*)"SELECT table_id, table_name "
    "FROM tables ORDER BY table_name", SQL_NTS );

if (!SQL_SUCCEEDED(ret)) {
    // Report error and go no further if statement failed.
    cout << "Error executing statement." << endl;
    reportError<SQLHDBC>(SQL_HANDLE_STMT, hdlStmt);
    exit(EXIT_FAILURE);
} else {

    // Query succeeded, so bind two variables to the two columns in the
    // result set,
    cout << "Fetching results..." << endl;
    SQLBIGINT table_id;          // Holds the ID of the table.
    SQLTCHAR table_name[256];    // buffer to hold name of table
    ret = SQLBindCol(hdlStmt, 1, SQL_C_SBIGINT, (SQLPOINTER)&table_id,
        sizeof(table_id), NULL);
```

```

    ret = SQLBindCol(hdlStmt, 2, SQL_C_TCHAR, (SQLPOINTER)table_name,
                     sizeof(table_name), NULL);

    // Loop through the results,
    while( SQL_SUCCEEDED(ret = SQLFetchScroll(hdlStmt, SQL_FETCH_NEXT,1))) {
        // Print the bound variables, which now contain the values from the
        // fetched row.
        cout << table_id << " | " << table_name << endl;
    }

    // See if loop exited for reasons other than running out of data
    if (ret != SQL_NO_DATA) {
        // Exited for a reason other than no more data... report the error.
        reportError<SQLHDBC>( SQL_HANDLE_STMT, hdlStmt );
    }
}

// Clean up by shutting down the connection
cout << "Free handles." << endl;
ret = SQLDisconnect( hdlDbc );
if(!SQL_SUCCEEDED(ret)) {
    cout << "Error disconnecting. Transaction still open?" << endl;
    exit(EXIT_FAILURE);
}
SQLFreeHandle(SQL_HANDLE_STMT, hdlStmt);
SQLFreeHandle(SQL_HANDLE_DBC, hdlDbc);
SQLFreeHandle(SQL_HANDLE_ENV, hdlEnv);
exit(EXIT_SUCCESS);
}

```

Running the example code in the vmart database produces output similar to this:

```

Connecting to database.
Connected to database.
Fetching results...
45035996273970908 | call_center_dimension
45035996273970836 | customer_dimension
45035996273972958 | customers
45035996273970848 | date_dimension
45035996273970856 | employee_dimension
45035996273970868 | inventory_fact
45035996273970904 | online_page_dimension
45035996273970912 | online_sales_fact
45035996273970840 | product_dimension
45035996273970844 | promotion_dimension
45035996273970860 | shipping_dimension
45035996273970876 | store_dimension
45035996273970894 | store_orders_fact
45035996273970880 | store_sales_fact
45035996273972806 | t

```

```
45035996273970852 | vendor_dimension  
45035996273970864 | warehouse_dimension  
Free handles.
```

Handling NULL Values in ODBC

When inserting data into and reading data from HP Vertica, your ODBC client program needs to handle NULL values in a special way. There is no value that represents NULL for any of HP Vertica's data types. Instead, a column's value is NULL when the width of the data in the column equals the `SQL_NULL_DATA` constant.

When reading data from a result set returned by HP Vertica, you should always check the width of the values you are reading to for NULL values if the column can contain NULLs. You do this by passing the address of a `SQLLEN` variable as the last parameter of the `SQLBindCol` function call. You then see if the value of this length variable is equal to `SQL_NULL_DATA`. If it is, the value in the variable bound to the column in the result set is not valid. Your application will produce inaccurate results if you use this value.

Similarly, when inserting data into HP Vertica, the last parameter of `SQLBindParameter` function call is the address of a `SQLLEN` variable that indicates the width of the data in the parameter. When you need to insert a null value into a column, set the parameter width variable to `SQL_NULL_DATA` to mark the value as NULL. The actual value of the variable that is bound to the parameter is irrelevant—the ODBC driver ignores it when sending data to HP Vertica, since the value's width indicates it is a NULL value.

The following example code demonstrates inserting two rows of data, then reading them back. The second row of data has a NULL value.

```

// Some standard headers
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

// Only needed for Windows clients
// #include <windows.h>

// Standard ODBC headers
#include <sql.h>
#include <sqltypes.h>
#include <sqlext.h>

int main()
{
    // Set up the ODBC environment
    SQLRETURN ret;
    SQLHENV hdlEnv;
    ret = SQLAllocHandle(SQL_HANDLE_ENV, SQL_NULL_HANDLE, &hdlEnv);
    if(!SQL_SUCCEEDED(ret)) {
        printf("Could not allocate a handle.\n");
        exit(EXIT_FAILURE);
    }

    // Tell ODBC that the application uses ODBC 3.
    ret = SQLSetEnvAttr(hdlEnv, SQL_ATTR_ODBC_VERSION,
                        (SQLPOINTER) SQL_OV_ODBC3, SQL_IS_UINTEGER);
    if(!SQL_SUCCEEDED(ret)) {
        printf("Could not set application version to ODBC3.\n");
        exit(EXIT_FAILURE);
    }

    // Allocate a database handle.
    SQLHDBC hdlDbc;
    ret = SQLAllocHandle(SQL_HANDLE_DBC, hdlEnv, &hdlDbc);

    // Connect to the database
    printf("Connecting to database.\n");
    const char* dsnName = "verticaDSN";
    const char* userID = "ExampleUser";
    const char* passwd = "password123";
    ret = SQLConnect(hdlDbc, (SQLCHAR*)dsnName,
                     SQL_NTS, (SQLCHAR*)userID, SQL_NTS,
                     (SQLCHAR*)passwd, SQL_NTS);
    if(!SQL_SUCCEEDED(ret)) {
        printf("Could not connect to database.\n");
        exit(EXIT_FAILURE);
    } else {
        printf("Connected to database.\n");
    }

    // Disable AUTOCOMMIT
    printf("Disabling autocommit.\n");
}

```

```
ret = SQLSetConnectAttr(hdlDbc, SQL_ATTR_AUTOCOMMIT, SQL_AUTOCOMMIT_OFF,
    0);

// Set up a statement handle
SQLHSTMT hdlStmt;
SQLAllocHandle(SQL_HANDLE_STMT, hdlDbc, &hdlStmt);
SQLExecDirect(hdlStmt, (SQLCHAR*)"DROP TABLE IF EXISTS customers",
    SQL_NTS);
SQLExecDirect(hdlStmt, (SQLCHAR*)"CREATE TABLE customers "
    "(CustID int NOT NULL, CustName varchar(100) NOT NULL, "
    "Phone_Number char(15));",
    SQL_NTS);

// Create the prepared statement. This will insert data into the
// table we created above.
printf("Creating prepared statement\n");
ret = SQLPrepare (hdlStmt, (SQLTCHAR*)"INSERT INTO customers (CustID, "
    "CustName, Phone_Number) VALUES(?, ?, ?)", SQL_NTS) ;

// Set up a bunch of variables to be bound to the statement
// parameters.

SQLINTEGER custID = 1234;                                // Integer for the ID
SQLLEN custIDLen = sizeof(custID);                         // The size of the custID
SQLVARCHAR custName[100] = "Adams, Alan"; // a varchar for customer name

// Use SQL_NTS to have the driver calculate the size of the null-terminated
// string value. This is ratehr lazy. It is better to supply the size
// yourself to avoid forcing additional overhead on the driver.
SQLLEN custNameLen = SQL_NTS;

// CHAR value for the phone number. Use strlen to supply an actual numeric
// value for the size. Need to cast to C++ char for strlen to work.
SQLCHAR phoneNum[15] = "555-123-6789";
SQLLEN phoneNumLen = strlen((char *)phoneNum);

// Bind the data arrays to the parameters in the prepared SQL
// statement
SQLBindParameter(hdlStmt, 1, SQL_PARAM_INPUT, SQL_C_DEFAULT, SQL_INTEGER,
    0, 0, &custID, 0, &custIDLen);

// Bind CustNames
SQLBindParameter(hdlStmt, 2, SQL_PARAM_INPUT, SQL_C_DEFAULT, SQL_VARCHAR,
    50, 0, (SQLPOINTER)custName, 0, &custNameLen);

// Bind phoneNums
SQLBindParameter(hdlStmt, 3, SQL_PARAM_INPUT, SQL_C_DEFAULT, SQL_CHAR,
    15, 0, (SQLPOINTER)phoneNum, 0, &phoneNumLen);

// Execute the prepared statement.
printf("Inserting row #1...");
ret = SQLExecute(hdlStmt);
if(!SQL_SUCCEEDED(ret)) {
    printf("not successful!\n");
```

```

} else {
    printf("successful.\n");
}

// Change the bound values to insert another row.
custID++;
strcpy((char *)custName, "Billings, Bob");

// Insert a NULL value for the Phone # of the second row.

// Technically, the actual value of phoneNum doesn't matter, since the
// data isn't used when the column length indicates it is NULL. This
// example sets it to a dummy value. Remember, an empty string is not the
// same as a NULL value!
strcpy((char *)phoneNum, "NULL VALUE");

// To actually set the NULL value, set the length of the value
// to the SQL_NULL_DATA constant. This marks the column as NULL.
phoneNumLen = SQL_NULL_DATA;

// Execute the prepared statement again to insert values in new row.
printf("Inserting row #2...");
ret = SQLExecute(hdlStmt);
if(!SQL_SUCCEEDED(ret)) {
    printf("not successful!\n");
} else {
    printf("successful.\n");
}

// Done with inserts, commit the transaction
printf("Committing transaction\n");
ret = SQLEndTran(SQL_HANDLE_DBC, hdlDbc, SQL_COMMIT);
if(!SQL_SUCCEEDED(ret)) {
    printf("Could not commit transaction\n");
} else {
    printf("Committed transaction\n");
}

// Re-enable autocommit so we don't get nagged about uncommitted
// transactions after querying database
printf("Enabling autocommit.\n");
ret = SQLSetConnectAttr(hdlDbc, SQL_ATTR_AUTOCOMMIT, (void *)
    SQL_AUTOCOMMIT_ON, 0);

// Now read the data back.

// Free and reallocate statetment handle
SQLFreeHandle(SQL_HANDLE_STMT, hdlStmt);
ret = SQLAllocHandle(SQL_HANDLE_STMT, hdlDbc, &hdlStmt);

// Query the Customers table
ret = SQLExecDirect( hdlStmt, (SQLCHAR*)"SELECT * FROM Customers "
    "ORDER BY CustID", SQL_NTS );

```

```
if(!SQL_SUCCEEDED(ret)) {
    printf("Error executing query statement.\n");
    exit(EXIT_FAILURE);
}

// Query succeeded, so bind variables to result set, Reuse the previously
// defined variables that we used to insert data.
printf("Fetching results...\n");
ret = SQLBindCol(hdlStmt, 1, SQL_C_ULONG, &custID,
    sizeof(custID), &custIDLen);
ret = SQLBindCol(hdlStmt, 2, SQL_C_CHAR, custName,
    sizeof(custName), &custNameLen);
ret = SQLBindCol(hdlStmt, 3, SQL_C_CHAR, phoneNum,
    sizeof(phoneNum), &phoneNumLen);

// Print header for table
printf (" CustID | Name                                | Phone\n");
printf (" ======\n");
// Loop through the results, printing them in a table.
while( SQL_SUCCEEDED(ret = SQLFetchScroll(hdlStmt, SQL_FETCH_NEXT,1))) {
    // Print the bound variables, which now contain the values from the
    // fetched row. Do not need to check custID or custName for nulls, since
    // the columns are defined as NOT NULL.
    printf(" %6d | %-30s | ",custID, custName);

    // Check the phoneNum column for NULL values by comparing the length of
    // the value to the SQL_NULL_DATA constant. If they match, the column
    // value is NULL. The value that is stored in phoneNum is not correct.
    // using it without checking for null values results in incorrect
    // results.
    if (phoneNumLen == SQL_NULL_DATA) {
        // NULL value. Handle by just printing the string "NULL"
        printf("%-15s","NULL");
    } else {
        // Value is not null. You can retrieve the value safely.
        printf("%-15s",phoneNum);
    }
    printf("\n");
}

// Clean up
printf("Free handles.\n");
ret = SQLDisconnect( hdlDbc );
if(!SQL_SUCCEEDED(ret)) {
    printf("Error disconnecting. Transaction still open?\n");
    // reportError<SQLHDBC>( SQL_HANDLE_DBC, hdlDbc );
    exit(EXIT_FAILURE);
}
SQLFreeHandle(SQL_HANDLE_STMT, hdlStmt);
SQLFreeHandle(SQL_HANDLE_DBC, hdlDbc);
SQLFreeHandle(SQL_HANDLE_ENV, hdlEnv);

exit(EXIT_SUCCESS);
}
```

The example produces the following output when run:

```
Connecting to database.  
Connected to database.  
Disabling autocommit.  
Creating prepared statement  
Inserting row #1...successful.  
Inserting row #2...successful.  
Committing transaction  
Committed transaction  
Enabling autocommit.  
Fetching results...  
CustID | Name | Phone  
===== | ===== | =====  
1234 | Adams, Alan | 555-123-6789  
1235 | Billings, Bob | NULL  
Free handles.
```

Loading Data through ODBC

A primary task for many client applications is loading data into the HP Vertica database. There are several different ways to insert data using ODBC, which are covered by the topics in this section.

Using a Single Row Insert

The easiest way to load data into HP Vertica is to run an INSERT SQL statement using the SQLExecDirect function. However this method is limited to inserting a single row of data.

```
ret = SQLExecDirect(hstmt, (SQLTCHAR*)"INSERT into Customers values"  
    "(1,'abcd', 'efgh', '1')", SQL_NTS);
```

Using Prepared Statements

HP Vertica supports using server-side prepared statements with both ODBC and JDBC. Prepared statements let you define a statement once, and then run it many times with different parameters. The statement you want to execute contains placeholders instead of parameters. When you execute the statement, you supply values for each placeholder.

Placeholders are represented by question marks (?) as in the following example query:

```
SELECT * FROM public.inventory_fact WHERE product_key = ?
```

Server-side prepared statements are useful for:

- Optimizing queries. HP Vertica only needs to parse the statement once.

- Preventing SQL injection attacks. A SQL injection attack occurs when user input is either incorrectly filtered for string literal escape characters embedded in SQL statements or user input is not strongly typed and thereby unexpectedly run. Since a prepared statement is parsed separately from the input data, there is no chance the data can be accidentally executed by the database.
- Binding direct variables to return columns. By pointing to data structures, the code doesn't have to perform extra transformations.

The following example demonstrates a using a prepared statement for a single insert.

```
// Some standard headers
#include <stdio.h>
#include <stdlib.h>

// Only needed for Windows clients
// #include <windows.h>

// Standard ODBC headers
#include <sql.h>
#include <sqltypes.h>
#include <sqlext.h>

// Some constants for the size of the data to be inserted.
#define CUST_NAME_LEN 50
#define PHONE_NUM_LEN 15
#define NUM_ENTRIES 4

int main()
{
    // Set up the ODBC environment
    SQLRETURN ret;
    SQLHENV hdlEnv;
    ret = SQLAllocHandle(SQL_HANDLE_ENV, SQL_NULL_HANDLE, &hdlEnv);
    if(!SQL_SUCCEEDED(ret)) {
        printf("Could not allocate a handle.\n");
        exit(EXIT_FAILURE);
    } else {
        printf("Allocated an environment handle.\n");
    }

    // Tell ODBC that the application uses ODBC 3.
    ret = SQLSetEnvAttr(hdlEnv, SQL_ATTR_ODBC_VERSION,
        (SQLPOINTER) SQL_OV_ODBC3, SQL_IS_UINTEGER);
    if(!SQL_SUCCEEDED(ret)) {
        printf("Could not set application version to ODBC3.\n");
        exit(EXIT_FAILURE);
    } else {
        printf("Set application to ODBC 3.\n");
    }

    // Allocate a database handle.
    SQLHDBC hdlDbc;
    ret = SQLAllocHandle(SQL_HANDLE_DBC, hdlEnv, &hdlDbc);

    // Connect to the database
    printf("Connecting to database.\n");
    const char *dsnName = "ExampleDB";
```

```
const char* userID = "dbadmin";
const char* passwd = "password123";
ret = SQLConnect(hdlDbc, (SQLCHAR*)dsnName,
    SQL_NTS, (SQLCHAR*)userID, SQL_NTS,
    (SQLCHAR*)passwd, SQL_NTS);
if(!SQL_SUCCEEDED(ret)) {
    printf("Could not connect to database.\n");
    exit(EXIT_FAILURE);
} else {
    printf("Connected to database.\n");
}

// Disable AUTOCOMMIT
printf("Disabling autocommit.\n");
ret = SQLSetConnectAttr(hdlDbc, SQL_ATTR_AUTOCOMMIT, SQL_AUTOCOMMIT_OFF,
    SQL_NTS);
if(!SQL_SUCCEEDED(ret)) {
    printf("Could not disable autocommit.\n");
    exit(EXIT_FAILURE);
}

// Set up a statement handle
SQLHSTMT hdlStmt;
SQLAllocHandle(SQL_HANDLE_STMT, hdlDbc, &hdlStmt);
SQLExecDirect(hdlStmt, (SQLCHAR*)"DROP TABLE IF EXISTS customers",
    SQL_NTS);
SQLExecDirect(hdlStmt, (SQLCHAR*)"CREATE TABLE customers "
    "(CustID int, CustName varchar(100), Phone_Number char(15));",
    SQL_NTS);

// Set up a bunch of variables to be bound to the statement
// parameters.

// Create the prepared statement. This will insert data into the
// table we created above.
printf("Creating prepared statement\n");
ret = SQLPrepare (hdlStmt, (SQLTCHAR*)"INSERT INTO customers (CustID, "
    "CustName, Phone_Number) VALUES(?, ?, ?)", SQL_NTS) ;
if(!SQL_SUCCEEDED(ret)) {
    printf("Could not create prepared statement\n");
    SQLFreeHandle(SQL_HANDLE_STMT, hdlStmt);
    SQLFreeHandle(SQL_HANDLE_DBC, hdlDbc);
    SQLFreeHandle(SQL_HANDLE_ENV, hdlEnv);
    exit(EXIT_FAILURE);
} else {
    printf("Created prepared statement.\n");
}

SQLINTEGER custID = 1234;
SQLCHAR custName[100] = "Fein, Fredrick";
SQLVARCHAR phoneNum[15] = "555-123-6789";
```

```

SQLLEN strFieldLen = SQL_NTS;
SQLLEN custIDLen = 0;

// Bind the data arrays to the parameters in the prepared SQL
// statement
ret = SQLBindParameter(hdlStmt, 1, SQL_PARAM_INPUT, SQL_C_LONG, SQL_INTEGER,
    0, 0, &custID, 0, &custIDLen);
if(!SQL_SUCCEEDED(ret)) {
    printf("Could not bind custID array\n");
    SQLFreeHandle(SQL_HANDLE_STMT, hdlStmt);
    SQLFreeHandle(SQL_HANDLE_DBC, hdlDbc);
    SQLFreeHandle(SQL_HANDLE_ENV, hdlEnv);
    exit(EXIT_FAILURE);
} else {
    printf("Bound custID to prepared statement\n");
}

// Bind CustNames
SQLBindParameter(hdlStmt, 2, SQL_PARAM_INPUT, SQL_C_CHAR, SQL_VARCHAR,
    50, 0, (SQLPOINTER)custName, 0, &strFieldLen);
if(!SQL_SUCCEEDED(ret)) {
    printf("Could not bind custNames\n");
    SQLFreeHandle(SQL_HANDLE_STMT, hdlStmt);
    SQLFreeHandle(SQL_HANDLE_DBC, hdlDbc);
    SQLFreeHandle(SQL_HANDLE_ENV, hdlEnv);
    exit(EXIT_FAILURE);
} else {
    printf("Bound custName to prepared statement\n");
}

// Bind phoneNums
SQLBindParameter(hdlStmt, 3, SQL_PARAM_INPUT, SQL_C_CHAR, SQL_CHAR,
    15, 0, (SQLPOINTER)phoneNum, 0, &strFieldLen);
if(!SQL_SUCCEEDED(ret)) {
    printf("Could not bind phoneNums\n");
    SQLFreeHandle(SQL_HANDLE_STMT, hdlStmt);
    SQLFreeHandle(SQL_HANDLE_DBC, hdlDbc);
    SQLFreeHandle(SQL_HANDLE_ENV, hdlEnv);
    exit(EXIT_FAILURE);
} else {
    printf("Bound phoneNum to prepared statement\n");
}

// Execute the prepared statement.
printf("Running prepared statement...");
ret = SQLExecute(hdlStmt);
if(!SQL_SUCCEEDED(ret)) {
    printf("not successful!\n");
} else {
    printf("successful.\n");
}

```

```
// Done with batches, commit the transaction
printf("Committing transaction\n");
ret = SQLEndTran(SQL_HANDLE_DBC, hdlDbc, SQL_COMMIT);
if(!SQL_SUCCEEDED(ret)) {
    printf("Could not commit transaction\n");
} else {
    printf("Committed transaction\n");
}

// Clean up
printf("Free handles.\n");
ret = SQLDisconnect( hdlDbc );
if(!SQL_SUCCEEDED(ret)) {
    printf("Error disconnecting. Transaction still open?\n");
    exit(EXIT_FAILURE);
}
SQLFreeHandle(SQL_HANDLE_STMT, hdlStmt);
SQLFreeHandle(SQL_HANDLE_DBC, hdlDbc);
SQLFreeHandle(SQL_HANDLE_ENV, hdlEnv);

exit(EXIT_SUCCESS);
}
```

Using Batch Inserts

You use batch inserts to insert chunks of data into the database. By breaking the data into batches, you can monitor the progress of the load by receiving information about any rejected rows after each batch is loaded. To perform a batch load through ODBC, you typically use a prepared statement with the parameters bound to arrays that contain the data to be loaded. For each batch, you load a new set of data into the arrays then execute the prepared statement.

When you perform a batch load, HP Vertica uses a COPY statement to load the data. Each additional batch you load uses the same COPY statement. The statement remains open until you end the transaction, close the cursor for the statement, or execute a non-INSERT statement.

Using a single COPY statement for multiple batches improves batch loading efficiency by:

- reducing the overhead of inserting individual batches
- combining individual batches into larger ROS containers

Note: If the database connection has AUTOCOMMIT enabled, then the transaction is automatically committed after each batch insert statement which closes the COPY statement. Leaving AUTOCOMMIT enabled makes your batch load much less efficient, and can cause added overhead in your database as all of the smaller loads are consolidated.

Even though HP Vertica uses a single COPY statement to insert multiple batches within a transaction, you can locate which (if any) rows were rejected due to invalid row formats or data type issues after each batch is loaded. See **Tracking Load Status** (page [92](#)) for details.

Note: While you can find rejected rows during the batch load transaction, other types of errors (such as running out of disk space or a node shutdown that makes the database unsafe) are only reported when the COPY statement ends.

Since the batch loads share a COPY statement, errors in one batch can cause earlier batches in the same transaction to be rolled back.

Batch Insert Steps

The steps your application needs to take in order to perform an ODBC Batch Insert are:

- 1 Connect to the database.
- 2 Disable autocommit for the connection.
- 3 Create a prepared statement that inserts the data you want to load.
- 4 Bind the parameters of the prepared statement to arrays that will contain the data you want to load.
- 5 Populate the arrays with the data for your batches.
- 6 Execute the prepared statement.
- 7 Optionally, check the results of the batch load to find rejected rows.
- 8 Repeat the previous three steps until all of the data you want to load is loaded.
- 9 Commit the transaction.
- 10 Optionally, check the results of the entire batch transaction.

The following example code demonstrates a simplified version of the above steps.

```
// Some standard headers
#include <stdio.h>
#include <stdlib.h>

// Only needed for Windows clients
// #include <windows.h>

// Standard ODBC headers
#include <sql.h>
#include <sqltypes.h>
#include <sqlext.h>

int main()
{
    // Number of data rows to insert
    const int NUM_ENTRIES = 4;

    // Set up the ODBC environment
    SQLRETURN ret;
    SQLHENV hdlEnv;
    ret = SQLAllocHandle(SQL_HANDLE_ENV, SQL_NULL_HANDLE, &hdlEnv);
    if(!SQL_SUCCEEDED(ret)) {
        printf("Could not allocate a handle.\n");
        exit(EXIT_FAILURE);
    } else {
        printf("Allocated an environment handle.\n");
    }

    // Tell ODBC that the application uses ODBC 3.
    ret = SQLSetEnvAttr(hdlEnv, SQL_ATTR_ODBC_VERSION,
        (SQLPOINTER) SQL_OV_ODBC3, SQL_IS_UINTEGER);
    if(!SQL_SUCCEEDED(ret)) {
        printf("Could not set application version to ODBC3.\n");
        exit(EXIT_FAILURE);
    } else {
        printf("Set application to ODBC 3.\n");
    }

    // Allocate a database handle.
    SQLHDBC hdlDbc;
    ret = SQLAllocHandle(SQL_HANDLE_DBC, hdlEnv, &hdlDbc);
    if(!SQL_SUCCEEDED(ret)) {
        printf("Could not allocate database handle.\n");
        exit(EXIT_FAILURE);
    } else {
        printf("Allocated Database handle.\n");
    }
}
```

```

// Connect to the database
printf("Connecting to database.\n");
const char *dsnName = "ExampleDB";
const char* userID = "dbadmin";
const char* passwd = "password123";
ret = SQLConnect(hdlDbc, (SQLCHAR*) dsnName,
                 SQL_NTS, (SQLCHAR*) userID, SQL_NTS,
                 (SQLCHAR*) passwd, SQL_NTS);
if(!SQL_SUCCEEDED(ret)) {
    printf("Could not connect to database.\n");
    exit(EXIT_FAILURE);
} else {
    printf("Connected to database.\n");
}

// Disable AUTOCOMMIT
printf("Disabling autocommit.\n");
ret = SQLSetConnectAttr(hdlDbc, SQL_ATTR_AUTOCOMMIT, SQL_AUTOCOMMIT_OFF,
                       SQL_NTS);
if(!SQL_SUCCEEDED(ret)) {
    printf("Could not disable autocommit.\n");
    exit(EXIT_FAILURE);
}

// Set up a statement handle
SQLHSTMT hdlStmt;
SQLAllocHandle(SQL_HANDLE_STMT, hdlDbc, &hdlStmt);

// Create a table to hold the data
SQLExecDirect(hdlStmt, (SQLCHAR*)"DROP TABLE IF EXISTS customers",
              SQL_NTS);
SQLExecDirect(hdlStmt, (SQLCHAR*)"CREATE TABLE customers "
              "(CustID int, CustName varchar(100), Phone_Number char(15));",
              SQL_NTS);

// Create the prepared statement. This will insert data into the
// table we created above.
printf("Creating prepared statement\n");
ret = SQLPrepare (hdlStmt, (SQLTCHAR*)"INSERT INTO customers (CustID,
              "CustName, Phone_Number) VALUES(?, ?, ?)", SQL_NTS) ;
if(!SQL_SUCCEEDED(ret)) {
    printf("Could not create prepared statement\n");
    exit(EXIT_FAILURE);
} else {
    printf("Created prepared statement.\n");
}

// This is the data to be inserted into the database.

```

```
SQLCHAR custNames[] [50] = { "Allen, Anna", "Brown, Bill", "Chu, Cindy",
    "Dodd, Don" };
SQLINTEGER custIDs[] = { 100, 101, 102, 103};
SQLCHAR phoneNums[] [15] = {"1-617-555-1234", "1-781-555-1212",
    "1-508-555-4321", "1-617-555-4444"};
```

```
// Bind the data arrays to the parameters in the prepared SQL
// statement. First is the custID.
ret = SQLBindParameter(hdlStmt, 1, SQL_PARAM_INPUT, SQL_C_LONG, SQL_INTEGER,
    0, 0, (SQLPOINTER)custIDs, sizeof(SQLINTEGER), NULL);
if(!SQL_SUCCEEDED(ret)) {
    printf("Could not bind custID array\n");
    exit(EXIT_FAILURE);
} else {
    printf("Bound CustIDs array to prepared statement\n");
}
```

```
// Bind CustNames
ret = SQLBindParameter(hdlStmt, 2, SQL_PARAM_INPUT, SQL_C_CHAR, SQL_VARCHAR,
    50, 0, (SQLPOINTER)custNames, 50, NULL);
if(!SQL_SUCCEEDED(ret)) {
    printf("Could not bind custNames\n");
    exit(EXIT_FAILURE);
} else {
    printf("Bound CustNames array to prepared statement\n");
}
```

```
// Bind phoneNums
ret = SQLBindParameter(hdlStmt, 3, SQL_PARAM_INPUT, SQL_C_CHAR, SQL_CHAR,
    15, 0, (SQLPOINTER)phoneNums, 15, NULL);
if(!SQL_SUCCEEDED(ret)) {
    printf("Could not bind phoneNums\n");
    exit(EXIT_FAILURE);
} else {
    printf("Bound phoneNums array to prepared statement\n");
}
```

```
// Tell the ODBC driver how many rows we have in the
// array.
ret = SQLSetStmtAttr( hdlStmt, SQL_ATTR_PARAMSET_SIZE,
    (SQLPOINTER)NUM_ENTRIES, 0 );
if(!SQL_SUCCEEDED(ret)) {
    printf("Could not bind set parameter size\n");
    exit(EXIT_FAILURE);
} else {
    printf("Bound phoneNums array to prepared statement\n");
}
```

```
// Add multiple batches to the database. This just adds the same
```

```

// batch of data four times for simplicity's sake. Each call adds
// the 4 rows into the database.
for (int batchLoop=1; batchLoop<=5; batchLoop++) {
    // Execute the prepared statement, loading all of the data
    // in the arrays.
    printf("Adding Batch #%d...", batchLoop);
    ret = SQLExecute(hdlStmt);
    if(!SQL_SUCCEEDED(ret)) {
        printf("not successful!\n");
    } else {
        printf("successful.\n");
    }
}

// Done with batches, commit the transaction
printf("Committing transaction\n");
ret = SQLEndTran(SQL_HANDLE_DBC, hdlDbc, SQL_COMMIT);
if(!SQL_SUCCEEDED(ret)) {
    printf("Could not commit transaction\n");
} else {
    printf("Committed transaction\n");
}

// Clean up
printf("Free handles.\n");
ret = SQLDisconnect( hdlDbc );
if(!SQL_SUCCEEDED(ret)) {
    printf("Error disconnecting. Transaction still open?\n");
    exit(EXIT_FAILURE);
}
SQLFreeHandle(SQL_HANDLE_STMT, hdlStmt);
SQLFreeHandle(SQL_HANDLE_DBC, hdlDbc);
SQLFreeHandle(SQL_HANDLE_ENV, hdlEnv);
exit(EXIT_SUCCESS);
}

```

The result of running the above code is shown below.

```

Allocated an environment handle.
Set application to ODBC 3.
Allocated Database handle.
Connecting to database.
Connected to database.
Creating prepared statement
Created prepared statement.
Bound CustIDs array to prepared statement
Bound CustNames array to prepared statement
Bound phoneNums array to prepared statement
Adding Batch #1...successful.
Adding Batch #2...successful.
Adding Batch #3...successful.

```

```
Adding Batch #4...successful.  
Adding Batch #5...successful.  
Committing transaction  
Committed transaction  
Free handles.
```

The resulting table looks like this:

```
=> SELECT * FROM customers;  
CustID | CustName      | Phone_Number  
-----+-----+-----  
100  | Allen, Anna    | 1-617-555-1234  
101  | Brown, Bill    | 1-781-555-1212  
102  | Chu, Cindy     | 1-508-555-4321  
103  | Dodd, Don      | 1-617-555-4444  
100  | Allen, Anna    | 1-617-555-1234  
101  | Brown, Bill    | 1-781-555-1212  
102  | Chu, Cindy     | 1-508-555-4321  
103  | Dodd, Don      | 1-617-555-4444  
100  | Allen, Anna    | 1-617-555-1234  
101  | Brown, Bill    | 1-781-555-1212  
102  | Chu, Cindy     | 1-508-555-4321  
103  | Dodd, Don      | 1-617-555-4444  
100  | Allen, Anna    | 1-617-555-1234  
101  | Brown, Bill    | 1-781-555-1212  
102  | Chu, Cindy     | 1-508-555-4321  
103  | Dodd, Don      | 1-617-555-4444  
100  | Allen, Anna    | 1-617-555-1234  
101  | Brown, Bill    | 1-781-555-1212  
102  | Chu, Cindy     | 1-508-555-4321  
103  | Dodd, Don      | 1-617-555-4444  
(20 rows)
```

Note: An input parameter bound with the SQL_C_NUMERIC data type uses the default numeric precision (37) and the default scale (0) instead of the precision and scale set by the SQL_NUMERIC_STRUCT input value. This behavior adheres to the ODBC standard. If you do not want to use the default precision and scale, use SQLSetDescField() or SQLSetDescRec() to change them in the statement's attributes.

Tracking Load Status

After loading a batch of data, your client application can get the number of rows that were processed and find out whether each row was accepted or rejected.

Finding the Number of Accepted Rows

To get the number of rows processed by a batch, you add an attribute named SQL_ATTR_PARAMS_PROCESSED_PTR to the statement object that points to a variable to receive the number rows:

```
SQLULEN rowsProcessed;
SQLSetStmtAttr(hdlStmt, SQL_ATTR_PARAMS_PROCESSED_PTR, &rowsProcessed, 0);
```

When your application calls `SQLExecute()` to insert the batch, the HP Vertica ODBC driver saves the number of rows that it processed (which is not necessarily the number of rows that were successfully inserted) in the variable you specified in the `SQL_ATTR_PARAMS_PROCESSED_PTR` statement attribute.

Finding the Accepted and Rejected Rows

Your application can also set a statement attribute named `SQL_ATTR_PARAM_STATUS_PTR` that points to an array where the ODBC driver can store the result of inserting each row:

```
SQLUSMALLINT rowResults[ NUM_ENTRIES ];
SQLSetStmtAttr(hdlStmt, SQL_ATTR_PARAM_STATUS_PTR, rowResults, 0);
```

This array must be at least as large as the number of rows being inserted in each batch.

When your application calls `SQLExecute` to insert a batch, the ODBC driver populates the array with values indicating whether each row was successfully inserted (`SQL_PARAM_SUCCESS` or `SQL_PARAM_SUCCESS_WITH_INFO`) or encountered an error (`SQL_PARAM_ERROR`).

The following example expands on the example shown in [Using Batch Inserts](#) (page 86) to include reporting the number of rows processed and the status of each row inserted.

```
// Some standard headers
#include <stdio.h>
#include <stdlib.h>

// Only needed for Windows clients
// #include <windows.h>

// Standard ODBC headers
#include <sql.h>
#include <sqltypes.h>
#include <sqlext.h>

// Helper function to print SQL error messages.
template <typename HandleT>
void reportError(int handleTypeEnum, HandleT hdl)
{
    // Get the status records.
    SQLSMALLINT    i, MsgLen;
    SQLRETURN ret2;
    SQLCHAR        SqlState[6], Msg[SQL_MAX_MESSAGE_LENGTH];
    SQLINTEGER      NativeError;
    i = 1;
    printf("\n");
    while ((ret2 = SQLGetDiagRec(handleTypeEnum, hdl, i, SqlState, &NativeError,
        Msg, sizeof(Msg), &MsgLen)) != SQL_NO_DATA) {
        printf("error record %d\n", i);
        printf("sqlstate: %s\n", SqlState);
        printf("detailed msg: %s\n", Msg);
        printf("native error code: %d\n\n", NativeError);
        i++;
    }
}

int main()
{
    // Number of data rows to insert
    const int NUM_ENTRIES = 4;

    SQLRETURN ret;
    SQLHENV hdlEnv;
    ret = SQLAllocHandle(SQL_HANDLE_ENV, SQL_NULL_HANDLE, &hdlEnv);
    if(!SQL_SUCCEEDED(ret)) {
        printf("Could not allocate a handle.\n");
        exit(EXIT_FAILURE);
    } else {
        printf("Allocated an environment handle.\n");
    }

    ret = SQLSetEnvAttr(hdlEnv, SQL_ATTR_ODBC_VERSION,
```

```

        (SQLPOINTER) SQL_OV_ODBC3, SQL_IS_UINTEGER);
if(!SQL_SUCCEEDED(ret)) {
    printf("Could not set application version to ODBC3.\n");
    exit(EXIT_FAILURE);
} else {
    printf("Set application to ODBC 3.\n");
}

SQLHDBC hdlDbc;
ret = SQLAllocHandle(SQL_HANDLE_DBC, hdlEnv, &hdlDbc);
if(!SQL_SUCCEEDED(ret)) {
    printf("Could not allocate database handle.\n");
    exit(EXIT_FAILURE);
} else {
    printf("Allocated Database handle.\n");
}

// Connect to the database
printf("Connecting to database.\n");
const char *dsName = "ExampleDB";
const char* userID = "dbadmin";
const char* passwd = "password123";
ret = SQLConnect(hdlDbc, (SQLCHAR*)dsName,
                 SQL_NTS, (SQLCHAR*)userID, SQL_NTS,
                 (SQLCHAR*)passwd, SQL_NTS);
if(!SQL_SUCCEEDED(ret)) {
    printf("Could not connect to database.\n");
    reportError<SQLHDBC>(SQL_HANDLE_DBC, hdlDbc);
    exit(EXIT_FAILURE);
} else {
    printf("Connected to database.\n");
}

// Set up a statement handle
SQLHSTMT hdlStmt;
SQLAllocHandle(SQL_HANDLE_STMT, hdlDbc, &hdlStmt);
SQLEexecDirect(hdlStmt, (SQLCHAR*)"DROP TABLE IF EXISTS customers",
               SQL_NTS);

// Create a table into which we can store data
printf("Creating table.\n");
ret = SQLEexecDirect(hdlStmt, (SQLCHAR*)"CREATE TABLE customers "
                     "(CustID int, CustName varchar(50), Phone_Number char(15));",
                     SQL_NTS);
if(!SQL_SUCCEEDED(ret)) {
    reportError<SQLHDBC>( SQL_HANDLE_STMT, hdlStmt );
    exit(EXIT_FAILURE);
} else {
    printf("Created table.\n");
}

```

```
// Create the prepared statement. This will insert data into the
// table we created above.
printf("Creating prepared statement\n");
ret = SQLPrepare (hdlStmt, (SQLTCHAR*)"INSERT INTO customers (CustID,
    "CustName, Phone_Number) VALUES(?, ?, ?)", SQL_NTS) ;
if(!SQL_SUCCEEDED(ret)) {
    reportError<SQLHDBC>( SQL_HANDLE_STMT, hdlStmt );
    exit(EXIT_FAILURE);
} else {
    printf("Created prepared statement.\n");
}

// This is the data to be inserted into the database.
char custNames[][50] = { "Allen, Anna", "Brown, Bill", "Chu, Cindy",
    "Dodd, Don" };
SQLINTEGER custIDs[] = { 100, 101, 102, 103};
char phoneNums[][15] = {"1-617-555-1234", "1-781-555-1212",
    "1-508-555-4321", "1-617-555-4444"};

// Bind the data arrays to the parameters in the prepared SQL
// statement
ret = SQLBindParameter(hdlStmt, 1, SQL_PARAM_INPUT, SQL_C_LONG, SQL_INTEGER,
    0, 0, (SQLPOINTER)custIDs, sizeof(SQLINTEGER) , NULL);
if(!SQL_SUCCEEDED(ret)) {
    reportError<SQLHDBC>( SQL_HANDLE_STMT, hdlStmt );
    exit(EXIT_FAILURE);
} else {
    printf("Bound CustIDs array to prepared statement\n");
}

// Bind CustNames
SQLBindParameter(hdlStmt, 2, SQL_PARAM_INPUT, SQL_C_CHAR, SQL_VARCHAR,
    50, 0, (SQLPOINTER)custNames, 50, NULL);
if(!SQL_SUCCEEDED(ret)) {
    reportError<SQLHDBC>( SQL_HANDLE_STMT, hdlStmt );
    exit(EXIT_FAILURE);
} else {
    printf("Bound CustNames array to prepared statement\n");
}

// Bind phoneNums
SQLBindParameter(hdlStmt, 3, SQL_PARAM_INPUT, SQL_C_CHAR, SQL_CHAR,
    15, 0, (SQLPOINTER)phoneNums, 15, NULL);
if(!SQL_SUCCEEDED(ret)) {
    reportError<SQLHDBC>( SQL_HANDLE_STMT, hdlStmt );
    exit(EXIT_FAILURE);
} else {
    printf("Bound phoneNums array to prepared statement\n");
```

```

}

// Set up a variable to receive number of parameters processed.
SQLULEN rowsProcessed;
// Set a statement attribute to point to the variable
SQLSetStmtAttr(hdlStmt, SQL_ATTR_PARAMS_PROCESSED_PTR, &rowsProcessed, 0);

// Set up an array to hold the result of each row insert
SQLUSMALLINT    rowResults[ NUM_ENTRIES ];
// Set a statement attribute to point to the array
SQLSetStmtAttr(hdlStmt, SQL_ATTR_PARAM_STATUS_PTR, rowResults, 0);

// Tell the ODBC driver how many rows we have in the
// array.
SQLSetStmtAttr(hdlStmt, SQL_ATTR_PARAMSET_SIZE, (SQLPOINTER)NUM_ENTRIES,
0);

// Add multiple batches to the database. This just adds the same
// batch of data over and over again for simplicity's sake.
for (int batchLoop=1; batchLoop<=5; batchLoop++) {
    // Execute the prepared statement, loading all of the data
    // in the arrays.
    printf("Adding Batch #%d...", batchLoop);
    ret = SQLExecute(hdlStmt);
    if(!SQL_SUCCEEDED(ret)) {
        reportError<SQLHDBC>( SQL_HANDLE_STMT, hdlStmt );
        exit(EXIT_FAILURE);
    }

    // Number of rows processed is in rowsProcessed
    printf("Params processed: %d\n", rowsProcessed);
    printf("Results of inserting each row:\n");
    int i;
    for (i = 0; i<NUM_ENTRIES; i++) {
        SQLUSMALLINT result = rowResults[i];
        switch(rowResults[i]) {
            case SQL_PARAM_SUCCESS:
            case SQL_PARAM_SUCCESS_WITH_INFO:
                printf(" Row %d inserted successfully\n", i+1);
                break;
            case SQL_PARAM_ERROR:
                printf(" Row %d was not inserted due to an error.", i+1);
                break;
            default:
                printf(" Row %d had some issue with it: %d\n", i+1, result);
        }
    }
}

```

```
// Done with batches, commit the transaction
printf("Commit Transaction\n");
ret = SQLEndTran(SQL_HANDLE_DBC, hdlDbc, SQL_COMMIT);
if(!SQL_SUCCEEDED(ret)) {
    reportError<SQLHDBC>( SQL_HANDLE_STMT, hdlStmt );
}

// Clean up
printf("Free handles.\n");
ret = SQLDisconnect( hdlDbc );
if(!SQL_SUCCEEDED(ret)) {
    printf("Error disconnecting. Transaction still open?\n");
    exit(EXIT_FAILURE);
}
SQLFreeHandle(SQL_HANDLE_STMT, hdlStmt);
SQLFreeHandle(SQL_HANDLE_DBC, hdlDbc);
SQLFreeHandle(SQL_HANDLE_ENV, hdlEnv);
exit(EXIT_SUCCESS);
}
```

Running the example code produces the following output:

```
Allocated an environment handle.
Set application to ODBC 3.
Allocated Database handle.
Connecting to database.
Connected to database.
Creating table.
Created table.
Creating prepared statement
Created prepared statement.
Bound CustIDs array to prepared statement
Bound CustNames array to prepared statement
Bound phoneNums array to prepared statement
Adding Batch #1...Params processed: 4
Results of inserting each row:
    Row 1 inserted successfully
    Row 2 inserted successfully
    Row 3 inserted successfully
    Row 4 inserted successfully
Adding Batch #2...Params processed: 4
Results of inserting each row:
    Row 1 inserted successfully
    Row 2 inserted successfully
    Row 3 inserted successfully
    Row 4 inserted successfully
Adding Batch #3...Params processed: 4
Results of inserting each row:
    Row 1 inserted successfully
    Row 2 inserted successfully
    Row 3 inserted successfully
```

```
Row 4 inserted successfully
Adding Batch #4...Params processed: 4
Results of inserting each row:
  Row 1 inserted successfully
  Row 2 inserted successfully
  Row 3 inserted successfully
  Row 4 inserted successfully
Adding Batch #5...Params processed: 4
Results of inserting each row:
  Row 1 inserted successfully
  Row 2 inserted successfully
  Row 3 inserted successfully
  Row 4 inserted successfully
Commit Transaction
Free handles.
```

Error Handling During Batch Loads

When loading individual batches, you can find information on how many rows were accepted and what rows were rejected (see [Tracking Load Status](#) (page 92) for details). Other errors, such as disk space errors, do not occur while inserting individual batches. This behavior is caused by having a single COPY statement perform the loading of multiple consecutive batches. Using the single COPY statement makes the batch load process perform much faster. It is only when the COPY statement closes that the batched data is committed and HP Vertica reports other types of errors.

Your bulk loading application should check for errors when the COPY statement closes. Normally, you force the COPY statement to close by calling the SQLEndTran() function to end the transaction. You can also force the COPY statement to close by closing the cursor using the SQLCloseCursor() function, or by setting the database connection's AutoCommit property to true before inserting the last batch in the load.

Note: The COPY statement also closes if you execute any non-insert statement. However having to deal with errors from the COPY statement in what might be an otherwise-unrelated query is not intuitive, and can lead to confusion and a harder to maintain application. You should explicitly end the COPY statement at the end of your batch load and handle any errors at that time.

Using the COPY Statement

The COPY statement lets you bulk load data from a file stored on a database node into the HP Vertica database. This method is the most efficient way to load data into HP Vertica because the file resides on the database server. One drawback is that only a database superuser can use COPY, since it requires privilege in order to access the filesystem of the database node.

One drawback of using COPY instead of performing batch loads is that you can only get results of the load (the number of accepted and rejected rows) when the COPY statement has finished. With batch loads, you can monitor the progress as batches are inserted. The ability to monitor the progress of a load can be a useful feature if you want to stop loading if a large portion of the data is being rejected.

A primary concern when bulk loading data using COPY is deciding whether the data should be loaded directly into ROS using the DIRECT option, or by using the AUTO method (loading into WOS until it fills, then loading into ROS). You should load directly into the ROS when your transaction will load a large (more than 100MB of data or so) amount of data.

Note: The exceptions/rejections files are created on the client machine when the exceptions and rejected data modifiers are specified on the COPY command. Specify a local path and filename for these modifiers when executing a COPY query from the driver.

The following example loads data into the WOS (Write Optimized Store) until it fills, then stores additional data directly in ROS (Read Optimized Store).

```
ret=SQLExecDirect(hdlStmt, (SQLCHAR*)"COPY customers "
    "FROM '/data/customers.txt' AUTO",SQL_NTS);
```

The following example loads data into the ROS (Read Optimized Store).

```
ret=SQLExecDirect(hdlStmt, (SQLCHAR*)"COPY customers "
    "FROM '/data/customers.txt' DIRECT",SQL_NTS);
```

See the COPY statement in the SQL Reference Manual for more information about its syntax and use.

The following example demonstrates using the COPY command.

```
// Some standard headers
#include <stdio.h>
#include <stdlib.h>

// Only needed for Windows clients
// #include <windows.h>

// Standard ODBC headers
#include <sql.h>
#include <sqltypes.h>
#include <sqlext.h>

// Helper function to determine if an ODBC function call returned
// successfully.
bool notSuccess(SQLRETURN ret) {
    return (ret != SQL_SUCCESS && ret != SQL_SUCCESS_WITH_INFO);
}

int main()
{
    // Set up the ODBC environment
    SQLRETURN ret;
    SQLHENV hdlEnv;
    ret = SQLAllocHandle(SQL_HANDLE_ENV, SQL_NULL_HANDLE, &hdlEnv);
    if(notSuccess(ret)) {
        printf("Could not allocate a handle.\n");
        exit(EXIT_FAILURE);
    } else {
        printf("Allocated an environment handle.\n");
    }

    // Tell ODBC that the application uses ODBC 3.
    ret = SQLSetEnvAttr(hdlEnv, SQL_ATTR_ODBC_VERSION,
        (SQLPOINTER) SQL_OV_ODBC3, SQL_IS_UINTEGER);
    if(notSuccess(ret)) {
        printf("Could not set application version to ODBC3.\n");
        exit(EXIT_FAILURE);
    } else {
        printf("Set application to ODBC 3.\n");
    }

    // Allocate a database handle.
    SQLHDBC hdlDbc;
    ret = SQLAllocHandle(SQL_HANDLE_DBC, hdlEnv, &hdlDbc);

    // Connect to the database
```

```
printf("Connecting to database.\n");
const char *dsnName = "ExampleDB";

// Note: User MUST be a database superuser to be able to access files on the
// filesystem of the node.
const char* userID = "dbadmin";
const char* passwd = "password123";
ret = SQLConnect(hdlDbc, (SQLCHAR*)dsnName,
                 SQL_NTS, (SQLCHAR*)userID, SQL_NTS,
                 (SQLCHAR*)passwd, SQL_NTS);
if(notSuccess(ret)) {
    printf("Could not connect to database.\n");
    exit(EXIT_FAILURE);
} else {
    printf("Connected to database.\n");
}

// Disable AUTOCOMMIT
printf("Disabling autocommit.\n");
ret = SQLSetConnectAttr(hdlDbc, SQL_ATTR_AUTOCOMMIT, SQL_AUTOCOMMIT_OFF,
SQL_NTS);
if(notSuccess(ret)) {
    printf("Could not disable autocommit.\n");
    exit(EXIT_FAILURE);
}

// Set up a statement handle
SQLHSTMT hdlStmt;
SQLAllocHandle(SQL_HANDLE_STMT, hdlDbc, &hdlStmt);

// Create table to hold the data
SQLExecDirect(hdlStmt, (SQLCHAR*)"DROP TABLE IF EXISTS customers",
              SQL_NTS);
SQLExecDirect(hdlStmt, (SQLCHAR*)"CREATE TABLE customers"
              "(Last_Name char(50) NOT NULL, First_Name char(50), Email char(50), "
              "Phone_Number char(15));",
              SQL_NTS);

// Run the copy command to load data into ROS.
ret=SQLExecDirect(hdlStmt, (SQLCHAR*)"COPY customers "
                  "FROM '/data/customers.txt' DIRECT",
                  SQL_NTS);
if(notSuccess(ret)) {
    printf("Data was not successfully loaded.\n");
    exit(EXIT_FAILURE);
} else {
    // Get number of rows added.
    SQLLEN numRows;
    ret=SQLRowCount(hdlStmt, &numRows);
```

```
    printf("Successfully inserted %d rows.\n", numRows);

}

// Done with batches, commit the transaction
printf("Committing transaction\n");
ret = SQLEndTran(SQL_HANDLE_DBC, hdlDbc, SQL_COMMIT);
if(notSuccess(ret)) {
    printf("Could not commit transaction\n");
} else {
    printf("Committed transaction\n");
}

// Clean up
printf("Free handles.\n");
SQLFreeHandle(SQL_HANDLE_STMT, hdlStmt);
SQLFreeHandle(SQL_HANDLE_DBC, hdlDbc);
SQLFreeHandle(SQL_HANDLE_ENV, hdlEnv);
exit(EXIT_SUCCESS);
}
```

The example prints the following when run:

```
Allocated an environment handle.
Set application to ODBC 3.
Connecting to database.
Connected to database.
Disabling autocommit.
Successfully inserted 10001 rows.
Committing transaction
Committed transaction
Free handles.
```

Streaming Data from the Client Using COPY LOCAL

The LOCAL option of the SQL COPY statement lets you stream data from a file on a client system to your HP Vertica database. This statement works through the ODBC driver, making the task of transferring data files from the client to the server much easier.

The LOCAL option of COPY works transparently through the ODBC driver. Just have your client application execute a statement containing a COPY LOCAL statement, and the ODBC driver will read and stream the data file from the client to the server. For example:

```
// Some standard headers
#include <stdio.h>
#include <stdlib.h>

// Only needed for Windows clients
// #include <windows.h>

// Standard ODBC headers
#include <sql.h>
#include <sqltypes.h>
#include <sqlext.h>

int main()
{
    // Set up the ODBC environment
    SQLRETURN ret;
    SQLHENV hdlEnv;
    ret = SQLAllocHandle(SQL_HANDLE_ENV, SQL_NULL_HANDLE, &hdlEnv);
    if(!SQL_SUCCEEDED(ret)) {
        printf("Could not allocate a handle.\n");
        exit(EXIT_FAILURE);
    } else {
        printf("Allocated an environment handle.\n");
    }

    // Tell ODBC that the application uses ODBC 3.
    ret = SQLSetEnvAttr(hdlEnv, SQL_ATTR_ODBC_VERSION,
                        (SQLPOINTER) SQL_OV_ODBC3, SQL_IS_UINTEGER);
    if(!SQL_SUCCEEDED(ret)) {
        printf("Could not set application version to ODBC3.\n");
        exit(EXIT_FAILURE);
    } else {
        printf("Set application to ODBC 3.\n");
    }

    // Allocate a database handle.
    SQLHDBC hdlDbc;
    ret = SQLAllocHandle(SQL_HANDLE_DBC, hdlEnv, &hdlDbc);
    if(!SQL_SUCCEEDED(ret)) {
        printf("Could not aalocate a database handle.\n");
        exit(EXIT_FAILURE);
    } else {
        printf("Set application to ODBC 3.\n");
    }

    // Connect to the database
    printf("Connecting to database.\n");
    const char *dsnName = "ExampleDB";
```

```

const char* userID = "dbadmin";
const char* passwd = "password123";
ret = SQLConnect(hdlDbc, (SQLCHAR*)dsnName,
    SQL_NTS, (SQLCHAR*)userID,SQL_NTS,
    (SQLCHAR*)passwd, SQL_NTS);
if(!SQL_SUCCEEDED(ret)) {
    printf("Could not connect to database.\n");
    exit(EXIT_FAILURE);
} else {
    printf("Connected to database.\n");
}

// Set up a statement handle
SQLHSTMT hdlStmt;
SQLAllocHandle(SQL_HANDLE_STMT, hdlDbc, &hdlStmt);

// Create table to hold the data
SQLExecDirect(hdlStmt, (SQLCHAR*)"DROP TABLE IF EXISTS customers",
    SQL_NTS);
SQLExecDirect(hdlStmt, (SQLCHAR*)"CREATE TABLE customers"
    "(Last_Name char(50) NOT NULL, First_Name char(50),Email char(50), "
    "Phone_Number char(15));",
    SQL_NTS);

// Run the copy command to load data into ROS.
ret=SQLExecDirect(hdlStmt, (SQLCHAR*)"COPY customers "
    "FROM LOCAL '/home/dbadmin/customers.txt' DIRECT",
    SQL_NTS);
if(!SQL_SUCCEEDED(ret)) {
    printf("Data was not successfully loaded.\n");
    exit(EXIT_FAILURE);
} else {
    // Get number of rows added.
    SQLLEN numRows;
    ret=SQLRowCount(hdlStmt, &numRows);
    printf("Successfully inserted %d rows.\n", numRows);
}

// COPY commits automatically, unless it is told not to, so
// there is no need to commit the transaction.

// Clean up
printf("Free handles.\n");
ret = SQLDisconnect( hdlDbc );
if(!SQL_SUCCEEDED(ret)) {
    printf("Error disconnecting. Transaction still open?\n");
    exit(EXIT_FAILURE);
}
SQLFreeHandle(SQL_HANDLE_STMT, hdlStmt);
SQLFreeHandle(SQL_HANDLE_DBC, hdlDbc);

```

```
SQLFreeHandle(SQL_HANDLE_ENV, hdlEnv);
exit(EXIT_SUCCESS);
}
```

This example is essentially the same as the example shown in [Using the COPY Statement](#) (page 99), except it uses the COPY statement's LOCAL option to load data from the client system rather than from the filesystem of the database node.

Note: On Windows clients, the path you supply for the COPY LOCAL file is limited to 216 characters due to limitations in the Windows API.

See Also

- [COPY LOCAL \(SQL Reference Manual\)](#).

Programming JDBC Client Applications

The HP Vertica JDBC driver provides you with a standard JDBC API. If you have accessed other databases using JDBC, you should find accessing HP Vertica familiar. This section explains how to use the JDBC to connect your Java application to HP Vertica.

You must first install the JDBC client driver on all client systems that will be accessing the HP Vertica database. For installation instructions, see ***Installing the HP Vertica Client Drivers*** (page [15](#)).

For more information about JDBC:

- JDBC Driver JavaDoc (HP Vertica extensions)
- ***An Introduction to JDBC, Part 1***
(http://www.onjava.com/pub/a/onjava/excerpt/javaentnut_2/index1.html)

JDBC Feature Support

The HP Vertica JDBC driver complies with the JDBC 3 standards, and supports most of its features. You can use the `DatabaseMetaData` class to determine if the a particular feature you want to use is supported. Also, note the following about the features supported by the HP Vertica JDBC driver:

- Cursors are forward only and are not scrollable. Result sets cannot be updated.
- A connection supports a single statement executing at any time. If you want to execute multiple statements simultaneously, open multiple connections.
- Because HP Vertica does not have stored procedures, `CallableStatement` is not supported. The `DatabaseMetaData.getProcedures()` and `.getProcedureColumns()` methods return information about SQL functions (including UDFs) instead of stored procedures.

Multiple SQL Statement Support

The HP Vertica JDBC driver supports executing strings containing multiple statements. For example:

```
stmt.executeUpdate("CREATE TABLE t(a INT);INSERT INTO t VALUES(10);");
```

Only the `Statement` interface supports executing strings containing multiple SQL statements. You cannot use multiple statement strings with `PreparedStatement`. COPY statements that copy a file from a host file system work in a multiple statement string. However, client COPY statements (COPY FROM STDIN) do not work.

Multiple Batch Conversion to COPY Statements

When you turn off your connection's AutoCommit property, the HP Vertica JDBC driver converts all sequential batch insertions into a single COPY statement. This conversion can improve load performance.

Updating JDBC Client Code from Previous Driver Versions

The HP Vertica version 5.1 client drivers have been rewritten to improve standards compliance and reliability. As a result, some HP Vertica-specific features and past incompatibilities have been eliminated. You must update any client code written for the prior versions of the JDBC driver to work with the version 5.1 driver and beyond. The following topics explain these updates.

Driver Package and Interface Name Changes

The name of the HP Vertica client driver package has changed. Previously, the HP Vertica JDBC driver classes were located in `com.vertica`. They are now in `com.vertica.jdbc`.

Loading the 4.1 Driver	Loading the 5.1 Driver
<code>Class.forName ("com.vertica.Driver");</code>	<code>Class.forName ("com.vertica.jdbc.Driver");</code>

Interface Name Changes

The following table lists the interfaces in the HP Vertica JDBC client library whose names have changed.

4.1 Interface Name	5.1 Interface Name
<code>PGConnection</code>	<code>VerticaConnection</code>
<code>PGStatement</code>	<code>VerticaStatement</code>

Normally, you reference these interfaces only when casting a `Connection` or `Statement` object to access HP Vertica-specific methods or properties. Many of the HP Vertica-specific methods and properties have been removed from the version 5.1 client drivers in favor of JDBC-standard methods and properties. Therefore, you should not need to cast to these interfaces as often when using the new client drivers. See [Converting from PGConnection to VerticaConnection](#) (page 109) and [Converting from PGStatement to VerticaStatement](#) (page 110) for more information.

Removed Classes

The HP Vertica version 5.1 JDBC driver has removed several legacy classes.

Previously, many HP Vertica-specific methods would throw a `PSQLEException` when encountering an error. This class has been removed. Instead, all methods now throw a standard `SQLException`.

The `PGInterval` class has been replaced with a pair of HP Vertica interval classes:

`VerticaDayTimeInterval` (which represents all ten types of day/time intervals) and

`VerticaYearMonthInterval` (which represents all three types of year/month intervals). See [Using Intervals with JDBC](#) (page 131) for details.

The `PGMoney` class has been removed from the driver.

Converting from PGConnection to VerticaConnection

The VerticaConnection interface replaces the PGConnection interface in the version 5.1 JDBC driver. The PGConnection interface contained HP Vertica-specific extensions to the standard JDBC Connection interface. VerticaConnection does not implement some of PGConnection's methods to make it more compliant with the JDBC standards.

Property Setters and Getters

The PGConnection interface had several specific setters and getters for some connection properties. These have been removed from VerticaConnection and replaced with properties, as described in the following table:

4.1 Methods	5.1 Property Name	Description
getBatchDirectInsert() setBatchDirectInsert()	DirectBatchInsert	Controls whether data is inserted directly into ROS, or into WOS.
getMaxLRSMemory() setMaxLRSMemory()	ResultBufferSize	Controls the size of the memory buffer the client uses when retrieving a result set stream.

Instead of these non-standard methods, use the VerticaConnection.getProperty() and VerticaConnection.setProperty() methods to access these properties, or set them when creating the database connection. See [Connection Properties](#) (page 117) and [Setting and Getting Connection Property Values](#) (page 120) for more information.

Deprecated Methods

The following methods of the PGConnection class were deprecated in the version 4.1 drivers, and are not implemented by VerticaConnection:

Removed Methods	Reason
getBatchInsertEnforceLength() setBatchInsertEnforceLength()	In the HP Vertica version 5.1 drivers, batch inserts always enforce column-width limitations. This makes batch inserts consistent with non-batch inserts, which always enforce width limitations. If you do not want to batch load errors to occur due to data being too wide for the column, you can either: <ul style="list-style-type: none"> ▪ Truncate the data to the column's width before attempting to insert it ▪ Use the <code>VerticaCopyStream</code> class to execute a COPY FROM STDIN statement, without an ENFORCELENGTH parameter.

Removed Methods	Reason
getBinaryBatchInsert() setBinaryBatchInsert()	The new JDBC driver now uses a single batch insert protocol rather than having separate binary and text modes to insert data.
getLocale() setLocale()	These methods are not implemented by VerticalConnection. Instead, you set the connection's locale using the SET LOCALE SQL statement. See Setting the Locale for JDBC Sessions (page 123) for details.
getStreamingLRS() setStreamingLRS()	The new JDBC driver always uses streaming result sets rather than optionally caching the results on the client.
getEncoding() setEncoding() getFastPathAPI() getLargeObjectAPI() getManagedBatchInsert() setManagedBatchInsert() getObject() getPGType() getPrepareThreshold() setPrepareThreshold() getSQLType() getUse35CopyFormat() setUse35CopyFormat() getUse35CopyParameters() setUser35CopyParameters() addDataType()	All of these methods were previously deprecated and have been removed from the version 5.1 JDBC driver.

Savepoint Support

The version 5.1 JDBC driver implements the `Savepoint` interface, allowing you to use savepoints to segment your transactions and later roll back a portion of the transaction.

Updatable Result Set Changes

The `createStatement()` method in the 4.1 and earlier JDBC drivers accepted the `ResultSet.CONCUR_UPDATABLE` flag to create an updatable result set. However, the driver's support of this feature was limited. The 5.1 JDBC driver does not support updatable result sets. The `createStatement()` method now accepts just `ResultSet.TYPE_FORWARD_ONLY` and `ResultSet.CONCUR_READ_ONLY` flags. It throws an exception if you pass it other flags.

Converting from PGStatement to VerticalStatement

The `VerticalStatement` interface contains the HP Vertica-specific extensions of the standard JDBC Statement interface. In previous versions of the HP Vertica JDBC driver, this interface was named `PGStatement`. In addition to the name change, a some methods have been removed from this interface.

Deprecated Methods

VerticaStatement does not implement the following PGStatement methods because they are obsolete:

- executeCopyIn()
- executeCopyOut()
- finishLoad()
- getLastOID()

Bulk Loading Method Changes

VerticaStatement does not implement the following PGStatement bulk loading methods:

- addStreamtoCopyIn()
- startCopyIn()
- finishCopyIn()

Instead, the new VerticaCopyStream class implements a stream copying feature. See **Streaming Data via JDBC** (page [152](#)).

Connection Property Setters and Getters

In previous versions of the drivers, many of the connection property setters and getters on the PGConnection interface were also implemented in the PGStatement interface. These methods allowed you to change some of the connection parameters for the statement, letting you override their settings on the PGConnection object used to create the statement. VerticaStatement does not implement these setters and getters helping to prevent potential confusion and difficult-to-debug issues caused by having different statements on the same connection having their own connection properties.

VerticaStatement objects cache two properties independently: DirectBatchInsert and ResultBufferSize. Once a VerticaStatement object is instantiated, it stores the values of these properties that were set on the VerticaConnection object you used to create them. The object retains these values even if you later change the property on the VerticaConnection object.

For example, in the following code:

```
// Set the DirectBatchInsert property
((VerticaConnection) conn).setProperty("DirectBatchInsert", true );
// Create a statement object
Statement stmtA = conn.createStatement();
// Change the direct batch insert setting and create another
// statement.
((VerticaConnection) conn).setProperty("DirectBatchInsert", false );
Statement stmtB = conn.createStatement();
```

The stmtA object has its DirectBatchInsert property set to true, since that was the property's value on the VerticaConnection used to instantiate it. Since this property is specific to the statement, stmtA's DirectBatchInsert property remains unchanged when the connection's DirectBatchInsert property changes to false later.

Note: The `VerticaStatement` interface does not cache any of the other connection properties. If you change another property (such as `Locale`) on a `VerticaConnection` object, the change affects all of the `VerticaStatement` objects instantiated using that connection object.

Multiple Statement Support

The previous JDBC driver's implementation of the `Statement` interface did not support executing SQL strings containing multiple statements. The new driver's implementation does support multiple statements. For example:

```
stmt.executeUpdate("CREATE TABLE t(a INT);INSERT INTO t VALUES(10);");
```

Only the `Statement` interface supports executing strings containing multiple SQL statements. You cannot use multiple statement strings with `PreparedStatement`. `COPY` statements that copy a file from a host file system work in a multiple statement string. However, client `COPY` statements (`COPY FROM STDIN`) do not work.

Connection Property Changes

JDBC connection properties let you control the behavior of your application's connection to the database. The HP Vertica version 5.1 JDBC driver has removed some old properties, renamed several others, and added some new properties.

New Connection Properties

The following properties have been added to the HP Vertica version 5.1 JDBC driver.

Property	Description
<code>ConnSettings</code>	Contains SQL commands to be executed when the database connection is established.
<code>LogLevel</code>	Sets the types of messages that the client writes to a log file.
<code>LogNameSpace</code>	Limits the messages written to the log to only those generated by classes in the given namespace.
<code>LogPath</code>	Sets the path where the log file is written.
<code>TransactionIsolation</code>	Previously could only be accessed using a getter and setter method on the <code>PGConnection</code> object. It can now be set using the same methods as other connection properties.

Property	Description
ThreePartNaming	Controls whether the database metadata uses the database name as the catalog name. This property is only used for backwards compatibility with some client software.

See [Connection Properties](#) (page 117) for more information about these new properties.

Renamed Properties

Several properties have been renamed to make connection properties more consistent across the different client libraries:

4.1 Property Name	5.1 Name	Description
defaultAutoCommit	Autocommit	Sets whether statements automatically commit themselves.
SessionLabel	Label	Identifies the connection on the server.
maxLRSMemory	ResultBufferSize	Sets the buffer size the driver uses when retrieving a result set from the server. In addition, the default value has been changed from 8MB to 8KB.

Removed Connection Properties

The following table lists the connection properties have been removed from the HP Vertica version 5.1 JDBC driver:

Parameter	Description
batchInsertEnforceLength	Controlled whether inserting data that is too wide for its column would cause an error. Removed to make batch inserts consistent with other types of data inserts. Attempting to insert data that is too wide for a column always results in an error.
batchInsertRecordTerminator	Set the record terminator for a batch insert. This property was deprecated and was only available for backwards compatibility.

Parameter	Description
binaryBatchInsert	Controlled whether batched data inserts were transmitted as binary data or converted to string. Removed because the driver now uses NATIVE VARCHAR transfer for all data types.
BinaryDataTransfer	Controlled whether data was transmitted between the server and the client in binary format. Removed because the driver now uses NATIVE VARCHAR to transfer data
KeepAlive	Caused the network connection to send keepalive packets to ensure the connection remained open during idle periods. The new JDBC driver always sends keepalive packets.
Locale	Set the locale for the connection. Instead of a property, use a query to set the locale. You can include a SQL statement in the ConnSettings property to set the locale as soon as the JDBC driver connects to the database. See Setting the Locale for JDBC Sessions (page 123).
prepareThreshold	Controlled how many times a statement would be executed before the server would automatically convert it to a server-side prepared statement. Removed since this functionality was deprecated.
streamingLRS	Controlled whether results were streamed to the client as it requested data, or if all data in a result set was sent to the client, which cached it in a local file. Removed since the new driver always uses streaming mode.

Creating and Configuring a Connection

Before your Java application can interact with HP Vertica, it must create a connection. Connecting to HP Vertica via JDBC is similar to connecting to most other databases.

Importing SQL Packages and Loading the Driver

Before creating a connection, you must import the Java SQL packages. The easiest way to do this is to import the entire package using a wildcard:

```
import java.sql.*;
```

You may also want to import the `Properties` class. You can use an instance of this class to pass connection properties when instantiating a connection, rather than encoding everything within the connection string:

```
import java.util.Properties;
```

Finally, you'll need to load the HP Vertica JDBC driver using the `Class.forName()` method:

```
try {
    Class.forName("com.vertica.jdbc.Driver");
} catch (ClassNotFoundException e) {
    // Could not find the driver class. Likely an issue
    // with finding the .jar file.
    System.err.println("Could not find the JDBC driver class.");
    e.printStackTrace();
    return; // Exit. Cannot do anything further.
}
```

Opening the Connection

With SQL packages imported and the driver loaded, you are ready to create your connection by calling the `DriverManager.getConnection()` method. You supply this method with at least the following information:

- The name of a host in the database cluster
- The port number for the database
- The name of the database
- The username of a user who has access to the database
- The password of the user

The first three parameters are always supplied as part of the connection string (a URL that tells the JDBC driver where to find the database). The format of the connection string is:

```
"jdbc:vertica://VerticalHost:portNumber/databaseName"
```

The first portion of the connection string selects the specific JDBC driver to use, followed by the location of the database.

The last two parameters, username and password, can be given to the JDBC driver in one of three ways:

- as part of the connection string. The parameters are encoded similarly to URL parameters:
`"jdbc:vertica://VerticalHost:portNumber/databaseName?user=username&password=password"`
- passed as separate parameters to `DriverManager.getConnection()`:

```
Connection conn = DriverManager.getConnection(
    "jdbc:vertica://VerticalHost:portNumber/databaseName",
    "username", "password");
```
- passed in a `Properties` object:

```
Properties myProp = new Properties();
myProp.put("user", "username");
myProp.put("password", "password");
Connection conn = DriverManager.getConnection(
    "jdbc:vertica://VerticaHost:portNumber/databaseName", myProp);
```

You usually want to use the `Properties` object, because it makes passing additional connection properties to the `getconnection()` method easy. See [Connection Properties](#) (page 117) and [Setting and Getting Connection Property Values](#) (page 120) for more information about the additional connection properties.

The `getconnection()` method throws a `SQLException` if there is any problem establishing a connection to the database, so you want to enclose it within a try-catch block, as shown in the following complete example of establishing a connection:

```
import java.sql.*;
import java.util.Properties;

public class ConnectionExample {
    public static void main(String[] args) {
        // Load JDBC driver
        try {
            Class.forName("com.vertica.jdbc.Driver");
        } catch (ClassNotFoundException e) {
            // Could not find the driver class. Likely an issue
            // with finding the .jar file.
            System.err.println("Could not find the JDBC driver class.");
            e.printStackTrace();
            return; // Bail out. We cannot do anything further.
        }

        // Create property object to hold username & password
        Properties myProp = new Properties();
        myProp.put("user", "ExampleUser");
        myProp.put("password", "password123");
        Connection conn;
        try {
            conn = DriverManager.getConnection(
                "jdbc:vertica://VerticaHost:5433/ExampleDB", myProp);
        } catch (SQLException e) {
            // Could not connect to database.
            System.err.println("Could not connect to database.");
            e.printStackTrace();
            return;
        }

        // Connection is established, do something with it here or
        // return it to a calling method
    }
}
```

Notes:

- When you disconnect a user session, any uncommitted transactions are automatically rolled back.
- If your database is not compliant with your HP Vertica license terms, HP Vertica issues a SQLWarning when you establish the connection to the database. You can retrieve this warning using the `Connection.getWarnings()` method.

JDBC Connection Properties

You use connection properties to configure the connection between your JDBC client application and your HP Vertica database. The properties provide the basic information about the connections, such as the server name and port number to use to connect to your database. They also let you tune the performance of your connection and enable logging.

There are three ways to set a connection property:

- Including the property name and value as part of the connection string you pass to the `DriverManager.getConnection()` method.
- Setting the properties in a `Properties` object, then passing it to the `DriverManager.getConnection()` method.
- Using the `VerticaConnection.setProperty()` method. Only the connection properties that can be changed after the connection has been established can be changed using the `setProperty()` method.

In addition, some of the standard JDBC connection properties have getters and setters on the `Connection` interface (such as `Connection.setAutocommit()`).

The following tables list the properties supported by the HP Vertica JDBC driver, and explain which are required in order for the connection to be established.

Connection Properties

The properties in the following table can only be set before you open the connection to the database. Two of them are required for every connection.

Property	Description	Required?	Default Value
ConnSettings	A string containing SQL statements that the JDBC driver automatically runs after it connects to the database. This property is useful to set the locale, set the schema search path, or perform other configuration that the connection requires.	No	none
Label	Sets a label for the connection on the server. This value appears in the <code>session_id</code> column of the <code>V_MONITOR.SESSIONS</code> system table.	No	<code>jdbc-driver_version-random_number</code>

Property	Description	Required?	Default Value
LoginTimeout	The number of seconds HP Vertica waits for a connection to be established to the database before throwing a <code>SQLException</code> . When set to 0 (the default) there is no TCP timeout.	No	0
SSL	When set to true, uses SSL to encrypt the connection to the server. HP Vertica needs to be configured to handle SSL connections before you can establish an SSL-encrypted connection to it. See Implementing SSL in the Administrator's Guide.	No	false
Password	The password to use to log into the database.	Yes	none
User	The database username to use to connection to the database.	Yes	none

General Properties

The following properties can be set after the connection is established. None of these properties are required.

Property	Description	Set After Connection	Default Value
AutoCommit	Controls whether the connection automatically commits transactions. Set this parameter to false to prevent the connection from automatically committing its transactions. You often want to do this when you are bulk loading multiple batches of data and you want the ability to roll back all of the loads if an error occurs. Note: This property was called <code>defaultAutoCommit</code> in previous versions of the HP Vertica JDBC driver.	<code>Connection.setAutoCommit()</code>	true
DirectBatchInsert	Determines whether a batch insert stored data directly into ROS (true) or using AUTO mode (false).	<code>VerticaConnection.setProperty()</code>	false

Property	Description	Set After Connection	Default Value
ReadOnly	When set to true, makes the data connection read-only. Any queries attempting to update the database using a read-only connection cause a <code>SQLException</code> .	<code>Connection.setReadOnly()</code>	false
ResultBufferSize	Sets the size of the buffer the HP Vertica JDBC driver uses to temporarily store result sets. Note: This property was named <code>maxLRSMemory</code> in previous versions of the HP Vertica JDBC driver.	<code>VerticaConnection.setProperty()</code>	8912 (8KB)
SearchPath	Sets the schema search path for the connection. The value for this property is a string containing a comma-separated list of schema names. See Setting Search Paths in the Administrator's Guide for more information on the schema search path.	<code>VerticaConnection.setProperty()</code>	"\$user", public, v_catalog, v_monitor, v_internal
ThreePartNaming	A Boolean that controls how <code>DatabaseMetaData</code> reports the catalog name. When set to true, the database name is returned as the catalog name in the database metadata. When set to false, <code>NULL</code> is returned as the catalog name. Enable this option if your client software expects to be able to get the catalog name from the database metadata and use it as part of a three-part name reference.	<code>VerticaConnection.setProperty()</code>	true
TransactionIsolation	Sets the isolation level of the transactions that use the connection. See Changing the Transaction Isolation Level (page 125) for details. Note: In previous versions of the HP Vertica JDBC driver, this property was only available using a getter and setter on the <code>PGConnection</code> object. It can now be set like other connection properties.	<code>Connection.setTransactionIsolation()</code>	TRANSACTION_READ_COMMITTED

Logging Properties

The properties that control client logging must be set before the connection is opened. None of these properties are required, and none can be changed after the `Connection` object has been instantiated.

Property	Description	Default Value
LogLevel	Sets the type of information logged by the JDBC driver. The value is set to one of the following values: <ul style="list-style-type: none"> ▪ "DEBUG" ▪ "ERROR" ▪ "TRACE" ▪ "WARNING" ▪ "INFO" ▪ "OFF" 	"OFF"
LogNameSpace	Restricts logging to just messages generated by a specific packages. Valid values are: <ul style="list-style-type: none"> ▪ <code>com.vertica</code> (all messages generated by the JDBC driver) ▪ <code>com.vertica.jdbc</code> (messages generated by the top-level JDBC API layer) ▪ <code>com.vertica.jdbc.core</code> (connection and statement settings) ▪ <code>com.vertica.jdbc.io</code> (client/server protocol messages) ▪ <code>com.vertica.jdbc.util</code> (miscellaneous utilities) ▪ <code>com.vertica.jdbc.dataengine</code> (query execution and result set iteration). 	none
LogPath	Sets the path where the log file is written.	The current working directory

Note: The `VerticaConnection.setProperty()` method can also be used to set properties that have standard JDBC Connection setters, such as `AutoCommit`.

For information about manipulating these attributes, see ***Setting and Getting Connection Property Values*** (page [120](#)).

Setting and Getting Connection Property Values

There are three ways to set a connection property:

- Including the property name and value as part of the connection string you pass to the `DriverManager.getConnection()` method.

- Setting the properties in a `Properties` object, then passing it to the `DriverManager.getConnection()` method.
- Using the `VerticaConnection.setProperty()` method. Only the connection properties that can be changed after the connection has been established can be changed using the `setProperty()` method.

In addition, some of the standard JDBC connection properties have getters and setters on the `Connection` interface (such as `Connection.setAutocommit()`).

Setting Properties when Connecting

There are two ways you can set connection properties when creating a connection to HP Vertica:

- In the connection string, using the same URL parameter format that you can use to set the username and password. The following example sets the SSL connection parameter to true:
`"jdbc:vertica://VerticalHost:5433/db?user=UserName&password=Password&ssl=true"`
- In a `Properties` object that you pass to the `getConnection()` call. You will need to import the `java.util.Properties` class in order to instantiate a `Properties` object. Then you use the `put()` method to add the property name and value to the object:

```
Properties myProp = new Properties();
myProp.put("user", "ExampleUser");
myProp.put("password", "password123");
myProp.put("LoginTimeout", "35");
Connection conn;
try {
    conn = DriverManager.getConnection(
        "jdbc:vertica://VerticalHost:5433/ExampleDB", myProp);
} catch (SQLException e) {
    e.printStackTrace();
}
```

Note: The data type of all of the values you set in the `Properties` object are strings, even if the property value's data type is integer or Boolean.

Getting and Setting Properties after Connecting

The `VerticaConnection.getProperty()` method lets you get the value of some connection properties. You can use `VerticaConnection.setProperty()` method to change the value for properties that can be set after the database connection has been established. Since these methods are HP Vertica-specific, you must cast your `Connection` object to the `VerticaConnection` interface to be able to use them. To cast to `VerticaConnection`, you must either import it into your client application or use a fully-qualified reference (`com.vertica.jdbc.VerticaConnection`). The following example demonstrates getting and setting the value of the `DirectBatchInsert` property.

```
import java.sql.*;
import java.util.Properties;
import com.vertica.jdbc.*;

public class SetConnectionProperties {
    public static void main(String[] args) {
        // Note: If your application needs to run under Java 5, you need to
        // load the JDBC driver using Class.forName() here.
        Properties myProp = new Properties();

        myProp.put("user", "ExampleUser");
        myProp.put("password", "password123");
        // Set DirectBatchInsert to true initially
        myProp.put("DirectBatchInsert", "true");

        Connection conn;
        try {
            conn = DriverManager.getConnection(
                "jdbc:vertica://VerticaHost:5433/ExampleDB",
                myProp);

            // Show state of the DirectBatchInsert property. This was set at the
            // time the connection was created.
            System.out.println("DirectBatchInsert state: "
                + ((VerticaConnection) conn).getProperty(
                    "DirectBatchInsert"));

            // Change it and show it again
            ((VerticaConnection) conn).setProperty("DirectBatchInsert", false);
            System.out.println("DirectBatchInsert state is now: " +
                ((VerticaConnection) conn).getProperty(
                    "DirectBatchInsert"));

            conn.close();
        } catch (SQLException e) {
            e.printStackTrace();
        }
    }
}
```

When run, the example prints the following on the standard output:

```
DirectBatchInsert state: true
DirectBatchInsert state is now: false
```

Setting the Locale for JDBC Sessions

You set the locale for a connection while opening it by including a SET LOCALE statement in the ConnSettings property, or by executing a SET LOCALE statement at any time after opening the connection. Changing the locale of a `Connection` object affects all of the `Statement` objects you instantiated using it.

You can get the locale by executing a SHOW LOCALE query. The following example demonstrates setting the locale using ConnSettings and executing a statement, as well as getting the locale:

```
import java.sql.*;
import java.util.Properties;

public class GetAndSetLocale {
    public static void main(String[] args) {
        try {
            Class.forName("com.vertica.jdbc.Driver");
        } catch (ClassNotFoundException e) {
            System.err.println("Could not find the JDBC driver class.");
            e.printStackTrace();
            return;
        }
        Properties myProp = new Properties();
        myProp.put("user", "ExampleUser");
        myProp.put("password", "password123");

        // Set Locale to true en_GB on connection. After the connection
        // is established, the JDBC driver runs the statements in the
        // ConnSettings property.
        myProp.put("ConnSettings", "SET LOCALE TO en_GB");
        Connection conn;
        try {
            conn = DriverManager.getConnection(
                "jdbc:vertica://VerticaHost:5433/ExampleDB",
                myProp);

            // Execute a query to get the locale. The results should
            // show "en_GB" as the locale, since it was set by the
            // conn settings property.
            Statement stmt = conn.createStatement();
            ResultSet rs = null;
            rs = stmt.executeQuery("SHOW LOCALE");
            System.out.print("Query reports that Locale is set to: ");
            while (rs.next()) {
                System.out.println(rs.getString(2).trim());
            }

            // Now execute a query to set locale.
            stmt.execute("SET LOCALE TO en_US");

            // Run query again to get locale.
            rs = stmt.executeQuery("SHOW LOCALE");
            System.out.print("Query now reports that Locale is set to: ");
            while (rs.next()) {
                System.out.println(rs.getString(2).trim());
            }

            // Clean up
            conn.close();
        }
    }
}
```

```

        } catch (SQLException e) {
            e.printStackTrace();
        }
    }
}

```

Running the above example displays the following on the system console:

```
Query reports that Locale is set to: en_GB (LEN)
```

```
Query now reports that Locale is set to: en_US (LEN)
```

Notes:

- JDBC applications use a UTF-16 character set encoding and are responsible for converting any non-UTF-16 encoded data to UTF-16. Failing to convert the data can result in errors or the data being stored incorrectly.
- The JDBC driver converts UTF-16 data to UTF-8 when passing to the HP Vertica server and converts data sent by HP Vertica server from UTF-8 to UTF-16 .

Changing the Transaction Isolation Level

Changing the transaction isolation level lets you choose how transactions prevent interference from other transactions. By default, the JDBC driver matches the transaction isolation level of the HP Vertica server. The HP Vertica default transaction isolation level is `READ COMMITTED`, which means any changes made by a transaction cannot be read by any other transaction until after they are committed. This prevents a transaction from reading data inserted by another transaction that is later rolled back.

HP Vertica also supports the `SERIALIZABLE` transaction isolation level. This level locks tables to prevent queries from having the results of their `WHERE` clauses changed by other transactions. Locking tables can have a performance impact, since only one transaction is able to access the table at a time.

A transaction retains its isolation level until it completes, even if the session's transaction isolation level changes mid-transaction. HP Vertica internal processes (such as the Tuple Mover and refresh operations) and DDL operations are always run at `SERIALIZABLE` isolation level to ensure consistency.

You can change the transaction isolation level connection property after the connection has been established using the `Connection` object's setter (`setTransactionIsolation()`) and getter (`getTransactionIsolation()`). The value for transaction isolation property is an integer. The `Connection` interface defines constants to help you set the value in a more intuitive manner:

Constant	Value
<code>Connection.TRANSACTION_READ_COMMITTED</code>	2
<code>Connection.TRANSACTION_SERIALIZABLE</code>	8

Note: The Connection interface also defines several other transaction isolation constants (READ_UNCOMMITTED and REPEATABLE_READ). Since HP Vertica does not support these isolation levels, they are converted to READ_COMMITTED and SERIALIZABLE, respectively.

The following example demonstrates setting the transaction isolation level to SERIALIZABLE.

```
import java.sql.*;
import java.util.Properties;

public class SetTransactionIsolation {
    public static void main(String[] args) {
        try {
            Class.forName("com.vertica.jdbc.Driver");
        } catch (ClassNotFoundException e) {
            System.err.println("Could not find the JDBC driver class.");
            e.printStackTrace();
            return;
        }
        Properties myProp = new Properties();
        myProp.put("user", "ExampleUser");
        myProp.put("password", "password123");

        Connection conn;
        try {
            conn = DriverManager.getConnection(
                "jdbc:vertica://VerticaHost:5433/ExampleDB",
                myProp);

            // Get default transaction isolation
            System.out.println("Transaction Isolation Level: "
                + conn.getTransactionIsolation());

            // Set transaction isolation to SERIALIZABLE
            conn.setTransactionIsolation(Connection.TRANSACTION_SERIALIZABLE);

            // Get the transaction isolation again
            System.out.println("Transaction Isolation Level: "
                + conn.getTransactionIsolation());

            conn.close();
        } catch (SQLException e) {
            e.printStackTrace();
        }
    }
}
```

Running the example results in the following being printed out to the console:

```
Transaction Isolation Level: 2
Transaction Isolation Level: 8
```

Using a Pooling Data Source

A pooling data source uses pool of connections in order to reduce the overhead of network connections between the client and server. Opening a new connection for each request is more costly to both the server and the client than keeping a small pool of connections open constantly, ready to be used by new requests. When a request comes in, one of the pre-existing connections in the pool is assigned to it. Only if there are no free connections in the pool is a new connection created. Once the request is complete, the connection returns to the pool and waits to service another request.

The HP Vertica JDBC driver supports connection pooling as defined in the JDBC 3.0 standard. If you are using a J2EE-based application server in conjunction with HP Vertica, it should already have a built-in data pooling feature. All that is required is that the application server work with the `PooledConnection` interface implemented by HP Vertica's JDBC driver. An application server's pooling feature is usually well-tuned for the works loads that the server is designed to handle. See your application server's documentation for details on how to work with pooled connections. Normally, using pooled connections should be transparent in your code—you will just open connections and the application server will worry about the details of pooling them.

If you are not using an application server, or your application server does not offer connection pooling that is compatible with HP Vertica, you can use a third-party pooling library, such as the open-source c3p0 library, to implement connection pooling.

JDBC Data Types

The JDBC driver transparently converts most HP Vertica data types to the appropriate Java data type. In a few cases, an HP Vertica data type cannot be directly translated to a Java data type; these are explained in this section.

HP Vertica Numeric Data Alias Conversion

The HP Vertica server supports data type aliases for INTEGER, FLOAT, and NUMERIC types (see SQL Data Types in the SQL Reference Manual). The JDBC driver reports these as its basic data types (Integer, Float, and Numeric), as follows:

HP Vertica Server Types and Aliases	HP Vertica JDBC Type
INTEGER	Integer
INT	
INT8	
BIGINT	
SMALLINT	
TINYINT	

HP Vertica Server Types and Aliases	HP Vertica JDBC Type
DOUBLE PRECISION FLOAT5 FLOAT8 REAL	Float
DECIMAL NUMERIC NUMBER MONEY	Numeric

If a client application retrieves the values into smaller data types, HP Vertica JDBC driver does not check for overflows. The following example demonstrates the results of this overflow.

```

import java.sql.*;
import java.util.Properties;

public class JDBCDataTypes {
    public static void main(String[] args) {
        // If running under a Java 5 JVM, use you need to load the JDBC driver
        // using Class.forName here

        Properties myProp = new Properties();
        myProp.put("user", "ExampleUser");
        myProp.put("password", "password123");

        Connection conn;
        try {
            conn = DriverManager.getConnection(
                "jdbc:vertica://VerticaHost:5433/VMart",
                myProp);

            Statement statement = conn.createStatement();

            // Create a table that will hold a row of different types of
            // numeric data.
            statement.executeUpdate(
                "DROP TABLE IF EXISTS test_all_types cascade");

            statement.executeUpdate("CREATE TABLE test_all_types (
                + "c0 INTEGER, c1 TINYINT, c2 DECIMAL,
                + "c3 MONEY, c4 DOUBLE PRECISION, c5 REAL)");

            // Add a row of values to it.
            statement.executeUpdate("INSERT INTO test_all_types VALUES(
                + "111111111111, 444, 5555555555.5555,
                + "77777777.77, 88888888888888.88,
                + "10101010.10101010101010)");

            // Query the new table to get the row back as a result set.
            ResultSet rs = statement
                .executeQuery("SELECT * FROM test_all_types");

            // Get the metadata about the row, including its data type.
            ResultSetMetaData md = rs.getMetaData();

            // Loop should only run once...
            while (rs.next()) {
                // Print out the data type used to defined the column, followed
                // by the values retrieved using several different retrieval
                // methods.

                String[] vertTypes = new String[] {"INTEGER", "TINYINT",
                    "DECIMAL", "MONEY", "DOUBLE PRECISION", "REAL"};

                for (int x=1; x<7; x++) {
                    System.out.println("\n\nColumn " + x + " (" +
vertTypes[x-1]

```

```
        + ")");
    System.out.println("\tgetColumnType() \t\t"
        + md.getColumnType(x));
    System.out.println("\tgetColumnName() \t"
        + md.getColumnName(x));
    System.out.println("\tgetShort() \t\t"
        + rs.getShort(x));
    System.out.println("\tgetLong() \t\t" + rs.getLong(x));
    System.out.println("\tgetInt() \t\t" + rs.getInt(x));

    System.out.println("\tgetByte() \t\t" + rs.getByte(x));
}
}

rs.close();
statement.executeUpdate("drop table test_all_types cascade");
statement.close();

} catch (SQLException e) {
    e.printStackTrace();
}
}
}
```

The above example prints the following on the console when run:

```
Column 1 (INTEGER)
getColumnType()          -5
getColumnName()          Integer
getShort()               455
getLong()                111111111111
getInt()                 -558038585
getByte()                -57
```

```
Column 2 (TINYINT)
getColumnType()          -5
getColumnName()          Integer
getShort()               444
getLong()                444
getInt()                 444
getByte()                -68
```

```
Column 3 (DECIMAL)
getColumnType()          2
getColumnName()          Numeric
getShort()               -1
getLong()                555555555555
getInt()                 2147483647
getByte()                -1
```

```
Column 4 (MONEY)
getColumnType()          2
```

```

getColumnTypeName()      Numeric
getShort()              -13455
getLong()               77777777
getInt()                77777777
getByte()               113

Column 5 (DOUBLE PRECISION)
getColumnType()          8
getColumnTypeName()       Float
getShort()               -1
getLong()                8888888888888900
getInt()                 2147483647
getByte()               -1

Column 6 (REAL)
getColumnType()          8
getColumnTypeName()       Float
getShort()               8466
getLong()                10101010
getInt()                 10101010
getByte()               18

```

Using Intervals with JDBC

The JDBC standard does not contain a data type for intervals (the duration between two points in time). To handle HP Vertica's INTERVAL data type, you must use JDBC's database-specific object type.

When reading an interval value from a result set, use the `ResultSet.getObject()` method to retrieve the value, and then cast it to one of the HP Vertica interval classes:

`VerticaDayTimeInterval` (which represents all ten types of day/time intervals) or
`VerticaYearMonthInterval` (which represents all three types of year/month intervals).

Note: The units interval style is not supported. Do not use the `SET INTERVALSTYLE` statement to change the interval style in your client applications.

Using Intervals in Batch Inserts

When inserting batches into tables that contain interval data, you must create instances of the `VerticaDayTimeInterval` or `VerticaYearMonthInterval` classes to hold the data you want to insert. You set values either when calling the class's constructor, or afterwards using setters. You then insert your interval values using the `PreparedStatement.setObject()` method. You can also use the `.setString()` method, passing it a string in "`DD HH:MM:SS`" or "`YY-MM`" format.

The following example demonstrates inserting data into a table containing a day/time interval and a year/month interval:

```
import java.sql.*;
import java.util.Properties;

// Need to import the Vertica JDBC classes to be able to instantiate
// the interval classes.
import com.vertica.jdbc.*;

public class IntervalDemo {
    public static void main(String[] args) {
        // If running under a Java 5 JVM, use you need to load the JDBC driver
        // using Class.forName here

        Properties myProp = new Properties();
        myProp.put("user", "ExampleUser");
        myProp.put("password", "password123");

        Connection conn;
        try {
            conn = DriverManager.getConnection(
                "jdbc:vertica://VerticaHost:5433/VMart", myProp);

            // Create table for interval values
            Statement stmt = conn.createStatement();
            stmt.execute("DROP TABLE IF EXISTS interval_demo");
            stmt.executeUpdate("CREATE TABLE interval_demo("
                + "DayInt INTERVAL DAY TO SECOND, "
                + "MonthInt INTERVAL YEAR TO MONTH)");

            // Insert data into interval columns using
            // VerticaDayTimeInterval and VerticaYearMonthInterval
            // classes.
            PreparedStatement pstmt = conn.prepareStatement(
                "INSERT INTO interval_demo VALUES(?,?)");

            // Create instances of the Vertica classes that represent
            // intervals.
            VerticaDayTimeInterval dayInt = new VerticaDayTimeInterval(10, 0,
                5, 40, 0, 0, false);
            VerticaYearMonthInterval monthInt = new VerticaYearMonthInterval(
                10, 6, false);

            // These objects can also be manipulated using setters.
            dayInt.setHour(7);

            // Add the interval values to the batch
            ((VerticaPreparedStatement) pstmt).setObject(1, dayInt);
            ((VerticaPreparedStatement) pstmt).setObject(2, monthInt);
            pstmt.addBatch();

            // Set another row from strings.
            // Set day interval in "days HH:MM:SS" format
            pstmt.setString(1, "10 10:10:10");
            // Set year to month value in "MM-YY" format
            pstmt.setString(2, "12-09");
        }
    }
}
```

```
pstmt.addBatch();  
  
// Execute the batch to insert the values.  
try {  
    pstmt.executeBatch();  
} catch (SQLException e) {  
    System.out.println("Error message: " + e.getMessage());  
}
```

Reading Interval Values

You read an interval value from a result set using the `ResultSet.getObject()` method, and cast the object to the appropriate HP Vertica object class: `VerticaDayTimeInterval` for day/time intervals or `VerticaYearMonthInterval` for year/month intervals. This is easy to do if you know that the column contains an interval, and you know what type of interval it is. If your application cannot assume the structure of the data in the result set it reads in, you can test whether a column contains a database-specific object type, and if so, determine whether the object belongs to either the `VerticaDayTimeInterval` or `VerticaYearMonthInterval` classes.

```

// Retrieve the interval values inserted by previous demo.
// Query the table to get the row back as a result set.
ResultSet rs = stmt.executeQuery("SELECT * FROM interval_demo");

// If you do not know the types of data contained in the result set,
// you can read its metadata to determine the type, and use
// additional information to determine the interval type.
ResultSetMetaData md = rs.getMetaData();
while (rs.next()) {
    for (int x = 1; x <= md.getColumnCount(); x++) {
        // Get data type from metadata
        int colDataType = md.getColumnType(x);

        // You can get the type in a string:
        System.out.println("Column " + x + " is a "
                           + md.getColumnTypeName(x));

        // Normally, you'd have a switch statement here to
        // handle all sorts of column types, but this example is
        // simplified to just handle database-specific types
        if (colDataType == Types.OTHER) {
            // Column contains a database-specific type. Determine
            // what type of interval it is. Assuming it is an
            // interval...
            Object columnVal = rs.getObject(x);
            if (columnVal instanceof VerticaDayTimeInterval) {
                // We know it is a date time interval
                VerticaDayTimeInterval interval =
                    (VerticaDayTimeInterval) columnVal;
                // You can use the getters to access the interval's
                // data
                System.out.print("Column " + x + "'s value is ");
                System.out.print(interval.getDay() + " Days ");
                System.out.print(interval.getHour() + " Hours ");
                System.out.println(interval.getMinute()
                                   + " Minutes");
            } else if (columnVal instanceof
VerticaYearMonthInterval) {
                VerticaYearMonthInterval interval =
                    (VerticaYearMonthInterval) columnVal;
                System.out.print("Column " + x + "'s value is ");
                System.out.print(interval.getYear() + " Years ");
                System.out.println(interval.getMonth() + "
Months");
            } else {
                System.out.println("Not an interval.");
            }
        }
    }
}

} catch (SQLException e) {
    e.printStackTrace();
}

```

```
    }  
}
```

The example prints the following to the console:

```
Column 1 is a INTERVAL DAY TO SECOND  
Column 1's value is 10 Days 7 Hours 5 Minutes  
Column 2 is a INTERVAL YEAR TO MONTH  
Column 2's value is 10 Years 6 Months  
Column 1 is a INTERVAL DAY TO SECOND  
Column 1's value is 10 Days 10 Hours 10 Minutes  
Column 2 is a INTERVAL YEAR TO MONTH  
Column 2's value is 12 Years 9 Months
```

Another option is to use database metadata to find columns that contain intervals.

```
// Determine the interval data types by examining the database
// metadata.
DatabaseMetaData dbmd = conn.getMetaData();
ResultSet dbMeta = dbmd.getColumns(null, null, "interval_demo", null);
int colcount = 0;
while (dbMeta.next()) {

    // Get the metadata type for a column.
    int javaType = dbMeta.getInt("DATA_TYPE");

    System.out.println("Column " + ++colcount + " Type name is " +
                       dbMeta.getString("TYPE_NAME"));

    if(javaType == Types.OTHER) {
        // The SQL_DATETIME_SUB column in the metadata tells you
        // Specifically which subtype of interval you have.
        // The VerticalDayTimeInterval.isDayTimeInterval()
        // methods tells you if that value is a day time.
        //
        int intervalType = dbMeta.getInt("SQL_DATETIME_SUB");
        if(VerticalDayTimeInterval.isDayTimeInterval(intervalType)) {
            // Now you know it is one of the 10 day/time interval types.
            // When you select this column you can cast to
            // VerticalDayTimeInterval.
            // You can get more specific by checking intervalType
            // against each of the 10 constants directly, but
            // they all are represented by the same object.
            System.out.println("column " + colcount + " is a " +
                               "VerticalDayTimeInterval intervalType = "
                               + intervalType);
        } else if(VerticalYearMonthInterval.isYearMonthInterval(
                  intervalType)) {
            //now you know it is one of the 3 year/month intervals,
            //and you can select the column and cast to
            // VerticalYearMonthInterval
            System.out.println("column " + colcount + " is a " +
                               "VerticalDayTimeInterval intervalType = "
                               + intervalType);
        } else {
            System.out.println("Not an interval type.");
        }
    }
}
```

Executing Queries Through JDBC

To run a query through JDBC:

- 1 Connect with the HP Vertica database. See ***Creating and Configuring a Connection*** (page [114](#)).
- 2 Run the query.

The method you use to run the query depends on the type of query you want to run:

- a DDL query that does not return a result set.
- a DDL query that returns a result set.
- a DML query

Executing DDL (Data Definition Language) Queries

To run DDL queries, such as `CREATE TABLE` and `COPY`, use the `Statement.execute()` method. You get an instance of this class by calling the `createStatement` method of your connection object.

The following example creates an instance of the `Statement` class and uses it to execute a `CREATE TABLE` and a `COPY` query:

```
Statement stmt = conn.createStatement();
stmt.execute("CREATE TABLE address_book (Last_Name char(50) default ''," +
    "First_Name char(50),Email char(50),Phone_Number char(50))");
stmt.execute("COPY address_book FROM 'address.dat' DELIMITER ',' NULL 'null'");
```

Executing Queries that Return Result Sets

Use the `Statement` class's `executeQuery` method to execute queries that return a result set, such as `SELECT`. To get the data from the result set, use methods such as `getInt`, `getString`, and `getDouble` to access column values depending upon the data types of columns in the result set. Use `ResultSet.next` to advance to the next row of the data set.

```
ResultSet rs = null;
rs = stmt.executeQuery("SELECT First_Name, Last_Name FROM address_book");
int x = 1;
while(rs.next()){
    System.out.println(x + ". " + rs.getString(1).trim() + " " +
        + rs.getString(2).trim());
    x++;
}
```

Note: The HP Vertica JDBC driver does not support scrollable cursors. You can only read forwards through the result set.

Executing DML (Data Manipulation Language) Queries Using `executeUpdate`

Use the `executeUpdate` method for DML SQL queries that change data in the database, such as `INSERT`, `UPDATE` and `DELETE` which do not return a result set.

```
stmt.executeUpdate("INSERT INTO address_book " +
                   "VALUES ('Ben-Shachar', 'Tamar', 'tamarow@example.com', " +
                   "'555-380-6466')");
stmt.executeUpdate("INSERT INTO address_book (First_Name, Email) " +
                   "VALUES ('Pete', 'pete@example.com')");
```

Note: The HP Vertica JDBC driver's `Statement` class supports executing multiple statements in the SQL string you pass to the `execute` method. The `PreparedStatement` class does not support using multiple statements in a single execution.

Loading Data Through JDBC

You can use any of the following methods to load data via the JDBC interface:

- Executing a SQL INSERT statement to insert a single row directly.
- Batch loading data using a prepared statement.
- Bulk loading data from files or streams using COPY.

When loading data into HP Vertica, you need to decide whether to write data to the Write Optimized Store (WOS) or the Read Optimized Store (ROS). By default, most data loading methods insert data into the WOS until it fills up, then insert any additional data directly into ROS containers (called AUTO mode). This is the best method to use when frequently loading small amounts of data (often referred to as trickle-loading). When performing less frequent large data loads (any loads over 100MB of data at once), you should change this behavior to insert data directly into the ROS.

The following sections explain in detail how you load data using JDBC.

Using a Single Row Insert

The simplest way to insert data into a table is to use the SQL INSERT statement. You can use this statement by instantiating a member of the `Statement` class, and use its `executeUpdate()` method to run your SQL statement.

The following code fragment demonstrates how you can create a `Statement` object and use it to insert data into a table named `address_book`:

```
Statement stmt = conn.createStatement();
stmt.executeUpdate("INSERT INTO address_book " +
                   "VALUES ('Smith', 'John', 'jsmith@example.com', " +
                   "'555-123-4567')");
```

This method has a few drawbacks: you need convert your data to string and escape any special characters in your data. A better way to insert data is to use prepared statements. See **[Batch Inserts Using JDBC Prepared Statements](#)** (page [139](#)).

Batch Inserts Using JDBC Prepared Statements

You can load batches of data into HP Vertica using prepared INSERT statements—server-side statements that you set up once, and then call repeatedly. You instantiate a member of the `PreparedStatement` class with a SQL statement that contains question mark placeholders for data. For example:

```
PreparedStatement pstmt = conn.prepareStatement(  
    "INSERT INTO customers(last, first, id) VALUES(?, ?, ?)");
```

You then set the parameters using data-type-specific methods on the `PreparedStatement` object, such as `setString()` and `setInt()`. Once your parameters are set, call the `addBatch()` method to add the row to the batch. When you have a complete batch of data ready, call the `executeBatch()` method to execute the insert batch.

Behind the scenes, the batch insert is converted into a COPY statement. When the connection's AutoCommit parameter is disabled, HP Vertica keeps the COPY statement open and uses it to load sequential batches until the transaction is committed, the cursor is closed, or your application executes a non-insert SQL statement (or executes any statement using another `Statement` or `PreparedStatement` object). Using a single COPY statement for multiple batch inserts makes loading data more efficient. If you are loading multiple batches, you should disable the AutoCommit property of the database to take advantage of this increased efficiency.

The following example demonstrates using a prepared statement to batch insert data.

```
import java.sql.*;
import java.util.Properties;

public class BatchInsertExample {
    public static void main(String[] args) {
        try {
            Class.forName("com.vertica.jdbc.Driver");
        } catch (ClassNotFoundException e) {
            System.err.println("Could not find the JDBC driver class.");
            e.printStackTrace();
            return;
        }
        Properties myProp = new Properties();
        myProp.put("user", "ExampleUser");
        myProp.put("password", "password123");
        Connection conn;
        try {
            conn = DriverManager.getConnection(
                "jdbc:vertica://VerticaHost:5433/ExampleDB",
                myProp);
            // establish connection and make a table for the data.
            Statement stmt = conn.createStatement();

            // Set AutoCommit to false to allow Vertica to reuse the same
            // COPY statement
            conn.setAutoCommit(false);

            // Drop table and recreate.
            stmt.execute("DROP TABLE IF EXISTS customers CASCADE");
            stmt.execute("CREATE TABLE customers (CustID int, Last_Name"
                + " char(50), First_Name char(50), Email char(50), "
                + "Phone_Number char(12))");

            // Some dummy data to insert.
            String[] firstNames = new String[] { "Anna", "Bill", "Cindy",
                "Don", "Eric" };
            String[] lastNames = new String[] { "Allen", "Brown", "Chu",
                "Dodd", "Estavez" };
            String[] emails = new String[] { "aang@example.com",
                "b.brown@example.com", "cindy@example.com",
                "d.d@example.com", "e.estavez@example.com" };
            String[] phoneNumbers = new String[] { "123-456-7890",
                "555-444-3333", "555-867-5309",
                "555-555-1212", "781-555-0000" };

            // Create the prepared statement
            PreparedStatement pstmt = conn.prepareStatement(
                "INSERT INTO customers (CustID, Last_Name, " +
                "First_Name, Email, Phone_Number) " +
                "VALUES (?, ?, ?, ?, ?)");
            // Add rows to a batch in a loop. Each iteration adds a
```

```

// new row.
for (int i = 0; i < firstNames.length; i++) {
    // Add each parameter to the row.
    pstmt.setInt(1, i + 1);
    pstmt.setString(2, lastNames[i]);
    pstmt.setString(3, firstNames[i]);
    pstmt.setString(4, emails[i]);
    pstmt.setString(5, phoneNumbers[i]);
    // Add row to the batch.
    pstmt.addBatch();
}

try {
    // Batch is ready, execute it to insert the data
    pstmt.executeBatch();
} catch (SQLException e) {
    System.out.println("Error message: " + e.getMessage());
    return; // Exit if there was an error
}

// Commit the transaction to close the COPY command
conn.commit();

// Print the resulting table.
ResultSet rs = null;
rs = stmt.executeQuery("SELECT CustID, First_Name, "
        + "Last_Name FROM customers ORDER BY CustID");
while (rs.next()) {
    System.out.println(rs.getInt(1) + " - "
            + rs.getString(2).trim() + " "
            + rs.getString(3).trim());
}

// Cleanup
conn.close();
} catch (SQLException e) {
    e.printStackTrace();
}
}
}

```

The result of running the example code is:

1 - Anna Allen
2 - Bill Brown
4 - Don Dodd
5 - Eric Estavez

Notes

- Using the `PreparedStatement.setFloat()` method can cause rounding errors. If precision is important, use the `.setDouble()` method instead.
- The `PreparedStatement` object caches the connection's `AutoCommit` property when the statement is prepared. Later changes to the `AutoCommit` property has no effect on the prepared statement.
- In previous versions of the HP Vertica JDBC driver, the `PreparedStatement.addBatch()` method would execute the batch immediately. In version 5.1 and later, the batch is only executed when you call `PreparedStatement.executeBatch()`.
- Always check batch insert returns values for SQL warnings. Warnings can occur for issues such as the truncation of a fractional portion of a numeric value.

Loading Batches Directly into ROS

When loading large batches of data (more than 100MB or so), you should load the data directly into ROS containers. Inserting directly into ROS is more efficient for large loads than AUTO mode, since it avoids overflowing the WOS and spilling the remainder of the batch to ROS. Otherwise, the Tuple Mover has to perform a moveout on the data in the WOS, while subsequent data is directly written into ROS containers causing your data to be segmented across storage containers.

To directly load batches into ROS, set the `directBatchInsert` connection property to true. See **Setting and Getting Connection Property Values** (page [120](#)) for an explanation of how to set connection properties. When this property is set to true, all batch inserts bypass the WOS and load directly into a ROS container.

If all of batches being inserted using a connection should be inserted into the ROS, you should set the `DirectBatchInsert` connection property to true in the `Properties` object you use to create the connection:

```
Properties myProp = new Properties();
myProp.put("user", "ExampleUser");
myProp.put("password", "password123");
// Enable directBatchInsert for this connection
myProp.put("DirectBatchInsert", "true");
Connection conn;
try {
    conn = DriverManager.getConnection(
        "jdbc:vertica://VerticaHost:5433/ExampleDB", myProp);
. . .
```

If you will be using the connection for inserting both large and small batches (or you do not know the size batches you will be inserting when you create the `Connection` object), you can set the `DirectBatchInsert` property after the connection has been established using the `VerticaConnection.setProperty` method:

```
((VerticaConnection)conn).setProperty("DirectBatchInsert", true);
```

See **Setting and Getting Connection Property Values** (page [120](#)) for a full example of setting `DirectBatchInsert`.

Error Handling During Batch Loads

When loading individual batches, you can find how many rows were accepted and what rows were rejected (see **Identifying Accepted and Rejected Rows** (page [143](#)) for details). If you have disabled the AutoCommit connection setting, other errors (such as disk space errors, for example) do not occur while inserting individual batches. This behavior is caused by having a single SQL COPY statement perform the loading of multiple consecutive batches (which makes the load process more efficient). It is only when the COPY statement closes that the batched data is committed and HP Vertica reports other types of errors.

Therefore, your bulk loading application should be prepared to check for errors when the COPY statement closes. You can trigger the COPY statement to close by:

- ending the batch load transaction by calling `Connection.commit()`
- closing the statement using `Statement.close()`
- setting the connection's AutoCommit property to true before inserting the last batch in the load

Note: The COPY statement also closes if you execute any non-insert statement or execute any statement using a different Statement or PreparedStatement object. Ending the COPY statement using either of these methods can lead to confusion and a harder-to-maintain application, since you would need to handle batch load errors in a non-batch load statement. You should explicitly end the COPY statement at the end of your batch load and handle any errors at that time.

Identifying Accepted and Rejected Rows

The return value of `PreparedStatement.executeBatch` is an integer array containing the success or failure status of inserting each row. A value 1 means the row was accepted and a value of -3 means that the row was rejected. In the case where an exception occurred during the batch execution, you can also get the array using `BatchUpdateException.getUpdateCounts()`.

The following example extends the example shown in **Batch Inserts Using JDBC Prepared Statements** (page [139](#)) to retrieve this array and display the results the batch load.

```
import java.sql.*;
import java.util.Arrays;
import java.util.Properties;

public class BatchInsertErrorHandlerExample {
    public static void main(String[] args) {
        try {
            Class.forName("com.vertica.jdbc.Driver");
        } catch (ClassNotFoundException e) {
            System.err.println("Could not find the JDBC driver class.");
            e.printStackTrace();
            return;
        }
        Properties myProp = new Properties();
        myProp.put("user", "ExampleUser");
        myProp.put("password", "password123");
        Connection conn;

        // establish connection and make a table for the data.
        try {
            conn = DriverManager.getConnection(
                "jdbc:vertica://VerticaHost:5433/ExampleDB",
                myProp);

            // Disable auto commit
            conn.setAutoCommit(false);

            // Create a statement
            Statement stmt = conn.createStatement();
            // Drop table and recreate.
            stmt.execute("DROP TABLE IF EXISTS customers CASCADE");
            stmt.execute("CREATE TABLE customers (CustID int, Last_Name"
                + " char(50), First_Name char(50), Email char(50), "
                + "Phone_Number char(12))");

            // Some dummy data to insert. The one row won't insert because
            // the phone number is too long for the phone column.
            String[] firstNames = new String[] { "Anna", "Bill", "Cindy",
                "Don", "Eric" };
            String[] lastNames = new String[] { "Allen", "Brown", "Chu",
                "Dodd", "Estavez" };
            String[] emails = new String[] { "aang@example.com",
                "b.brown@example.com", "cindy@example.com",
                "d.d@example.com", "e.estavez@example.com" };
            String[] phoneNumbers = new String[] { "123-456-789",
                "555-444-3333", "555-867-53093453453",
                "555-555-1212", "781-555-0000" };

            // Create the prepared statement
            PreparedStatement pstmt = conn.prepareStatement(
                "INSERT INTO customers (CustID, Last_Name, " +
```

```

        "First_Name, Email, Phone_Number)" +
        " VALUES(?, ?, ?, ?, ?)");

// Add rows to a batch in a loop. Each iteration adds a
// new row.
for (int i = 0; i < firstNames.length; i++) {
    // Add each parameter to the row.
    pstmt.setInt(1, i + 1);
    pstmt.setString(2, lastNames[i]);
    pstmt.setString(3, firstNames[i]);
    pstmt.setString(4, emails[i]);
    pstmt.setString(5, phoneNumbers[i]);
    // Add row to the batch.
    pstmt.addBatch();
}

// Integer array to hold the results of inserting
// the batch. Will contain an entry for each row,
// indicating success or failure.
int[] batchResults = null;

try {
    // Batch is ready, execute it to insert the data
    batchResults = pstmt.executeBatch();
} catch (BatchUpdateException e) {
    // We expect an exception here, since one of the
    // inserted phone numbers is too wide for its column. All of the
    // rest of the rows will be inserted.
    System.out.println("Error message: " + e.getMessage());

    // Batch results isn't set due to exception, but you
    // can get it from the exception object.
    //
    // In your own code, you shouldn't assume that a batch
    // exception occurred, since exceptions can be thrown
    // by the server for a variety of reasons.
    batchResults = e.getUpdateCounts();
}
// You should also be prepared to catch SQLExceptions in your own
// application code, to handle dropped connections and other general
// problems.

// Commit the transaction
conn.commit();

// Print the array holding the results of the batch insertions.
System.out.println("Return value from inserting batch: "
    + Arrays.toString(batchResults));

```

```
// Print the resulting table.  
ResultSet rs = null;  
rs = stmt.executeQuery("SELECT CustID, First_Name, "  
+ "Last_Name FROM customers ORDER BY CustID");  
while (rs.next()) {  
    System.out.println(rs.getInt(1) + " - "  
+ rs.getString(2).trim() + " "  
+ rs.getString(3).trim());  
}  
  
// Cleanup  
conn.close();  
} catch (SQLException e) {  
    e.printStackTrace();  
}  
}  
}  
}
```

Running the above example produces the following output on the console:

```
Error message: [Vertica] [VJDBC] (100172) One or more rows were rejected by the  
server.  
Return value from inserting batch: [1, 1, -3, 1, 1]  
1 - Anna Allen  
2 - Bill Brown  
4 - Don Dodd  
5 - Eric Estavez
```

Notice that the third row failed to insert because its phone number is too long for the `Phone_Number` column. All of the rest of the rows in the batch (including those after the error) were correctly inserted.

Note: It is more efficient for you to ensure that the data you are inserting is the correct data type and width for the table column you are inserting it into than to handle exceptions after the fact.

Rolling Back Batch Loads on the Server

Batch loads always insert all of their data, even if one or more rows is rejected. Only the rows that caused errors in a batch are not loaded. When the database connection's `AutoCommit` property is true, batches automatically commit their transactions when they complete, so once the batch finishes loading, the data is committed.

In some cases, you may want all of the data in a batch to be successfully inserted—none of the data should be committed if an error occurs. The best way to accomplish this is to turn off the database connection's `AutoCommit` property to prevent batches from automatically committing themselves. Then, if a batch encounters an error, you can roll back the transaction after catching the `BatchUpdateException` caused by the insertion error.

The following example demonstrates performing a rollback if any error occurs when loading a batch.

```

import java.sql.*;
import java.util.Arrays;
import java.util.Properties;

public class RollbackBatchOnError {
    public static void main(String[] args) {
        try {
            Class.forName("com.vertica.jdbc.Driver");
        } catch (ClassNotFoundException e) {
            System.err.println("Could not find the JDBC driver class.");
            e.printStackTrace();
            return;
        }
        Properties myProp = new Properties();
        myProp.put("user", "ExampleUser");
        myProp.put("password", "password123");
        Connection conn;
        try {
            conn = DriverManager.getConnection(
                "jdbc:vertica://VerticaHost:5433/ExampleDB",
                myProp);

            // Disable auto-commit. This will allow you to roll back a
            // a batch load if there is an error.
            conn.setAutoCommit(false);

            // establish connection and make a table for the data.
            Statement stmt = conn.createStatement();
            // Drop table and recreate.
            stmt.execute("DROP TABLE IF EXISTS customers CASCADE");
            stmt.execute("CREATE TABLE customers (CustID int, Last_Name"
                + " char(50), First_Name char(50), Email char(50), "
                + "Phone_Number char(12))");

            // Some dummy data to insert. The one row won't insert because
            // the phone number is too long for the phone column.
            String[] firstNames = new String[] { "Anna", "Bill", "Cindy",
                "Don", "Eric" };
            String[] lastNames = new String[] { "Allen", "Brown", "Chu",
                "Dodd", "Estavez" };
            String[] emails = new String[] { "aang@example.com",
                "b.brown@example.com", "cindy@example.com",
                "d.d@example.com", "e.estavez@example.com" };
            String[] phoneNumbers = new String[] { "123-456-789",
                "555-444-3333", "555-867-53094535", "555-555-1212",
                "781-555-0000" };

            // Create the prepared statement
            PreparedStatement pstmt = conn.prepareStatement(
                "INSERT INTO customers (CustID, Last_Name, " +
                "First_Name, Email, Phone_Number) " +
                "VALUES(?, ?, ?, ?, ?)");

```

```
// Add rows to a batch in a loop. Each iteration adds a
// new row.
for (int i = 0; i < firstNames.length; i++) {
    // Add each parameter to the row.
    pstmt.setInt(1, i + 1);
    pstmt.setString(2, lastNames[i]);
    pstmt.setString(3, firstNames[i]);
    pstmt.setString(4, emails[i]);
    pstmt.setString(5, phoneNumbers[i]);
    // Add row to the batch.
    pstmt.addBatch();
}

// Integer array to hold the results of inserting
// the batch. Will contain an entry for each row,
// indicating success or failure.
int[] batchResults = null;

try {
    // Batch is ready, execute it to insert the data
    batchResults = pstmt.executeBatch();

    // If we reach here, we inserted the batch without errors.
    // Commit it.
    System.out.println("Batch insert successful. Committing.");
    conn.commit();
} catch (BatchUpdateException e) {
    System.out.println("Error message: " + e.getMessage());
    // Batch results isn't set due to exception, but you
    // can get it from the exception object.
    batchResults = e.getUpdateCounts();
    // Roll back the batch transaction.
    System.out.println("Rolling back batch insertion");
    conn.rollback();
}
catch (SQLException e) {
    // General SQL errors, such as connection issues, throw
    // SQLExceptions. Your application should do something more
    // than just print a stack trace,
    e.printStackTrace();
}

System.out.println("Return value from inserting batch: "
    + Arrays.toString(batchResults));
System.out.println("Customers table contains:");

// Print the resulting table.
ResultSet rs = null;
rs = stmt.executeQuery("SELECT CustID, First_Name, "
    + "Last_Name FROM customers ORDER BY CustID");
while (rs.next()) {
    System.out.println(rs.getInt(1) + " - "
```

```
        + rs.getString(2).trim() + " "
        + rs.getString(3).trim());
    }

    // Cleanup
    conn.close();
} catch (SQLException e) {
    e.printStackTrace();
}
}
```

Running the above example prints the following on the system console:

```
Error message: [Vertica] [VJDBC] (100172) One or more rows were rejected by the server.  
Rolling back batch insertion  
Return value from inserting batch: [1, 1, -3, 1, 1]  
Customers table contains:
```

The return values indicate whether each row was successfully inserted. The value 1 means the row inserted without any issues, and a -3 indicates the row failed to insert.

The customers table is empty since the batch insert was rolled back due to the error caused by the third column.

Bulk Loading Using the COPY Statement

One of the fastest ways to load large amounts of data into HP Vertica at once (bulk loading) is to use the COPY statement. This statement loads data from a file stored on an HP Vertica host (or in a data stream) into a table in the database. You can pass the COPY statement parameters that define the format of the data in the file, how the data is to be transformed as it is loaded, how to handle errors, and how the data should be loaded. See the COPY documentation in the SQL Reference Manual for details.

One parameter that is particularly important is the DIRECT option, which tells COPY to load the data directly into ROS rather than going through the WOS. You should use this option when you are loading large files (over 100MB) into the database. Without this option, your load may fill the WOS and overflow into ROS, requiring the Tuple Mover to perform a Moveout on the data in the WOS. It is more efficient to directly load into ROS and avoid forcing a moveout.

Only a superuser can use the COPY statement to copy a file stored on a host, so you must connect to the database using a superuser account. If you want to have a non-superuser user bulk-load data, you can use COPY to load from a stream on the host (such as STDIN) rather than a file or stream data from the client (see *Streaming Data via JDBC* (page [152](#))). You can also perform a standard ***batch insert using a prepared statement*** (page [139](#)), which uses the COPY statement in the background to load the data.

The following example demonstrates using the COPY statement through the JDBC to load a file name `customers.txt` into a new database table. This file must be stored on the database host to which your application connects (in this example, a host named `VerticaHost`). Since the `customers.txt` file used in the example is very large, this example uses the DIRECT option to bypass WOS and load directly into ROS.

```

import java.sql.*;
import java.util.Properties;
import com.vertica.jdbc.*;

public class COPYFromFile {
    public static void main(String[] args) {
        try {
            Class.forName("com.vertica.jdbc.Driver");
        } catch (ClassNotFoundException e) {
            System.err.println("Could not find the JDBC driver class.");
            e.printStackTrace();
            return;
        }
        Properties myProp = new Properties();
        myProp.put("user", "ExampleAdmin"); // Must be superuser
        myProp.put("password", "password123");
        Connection conn;
        try {
            conn = DriverManager.getConnection(
                "jdbc:vertica://VerticaHost:5433/ExampleDB", myProp);
            // Disable AutoCommit
            conn.setAutoCommit(false);
            Statement stmt = conn.createStatement();
            // Create a table to hold data.
            stmt.execute("DROP TABLE IF EXISTS customers;");
            stmt.execute("CREATE TABLE IF NOT EXISTS customers (Last_Name
char(50) "
                        + "NOT NULL, First_Name char(50), Email char(50), "
                        + "Phone_Number char(15));");

            // Use the COPY command to load data. Load directly into ROS, since
            // this load could be over 100MB. Use ENFORCELENGTH to reject
            // strings too wide for their columns.
            boolean result = stmt.execute("COPY customers FROM "
                + "'/data/customers.txt' DIRECT ENFORCELENGTH");

            // Determine if execution returned a count value, or a full result
            // set.
            if (result) {
                System.out.println("Got result set");
            } else {
                // Count will usually return the count of rows inserted.
                System.out.println("Got count");
                int rowCount = stmt.getUpdateCount();
                System.out.println("Number of accepted rows = " + rowCount);
            }
        }

        // Commit the data load
        conn.commit();
    } catch (SQLException e) {
        System.out.print("Error: ");
    }
}

```

```
        System.out.println(e.toString());
    }
}
}
```

The example prints the following out to the system console when run (assuming that the `customers.txt` file contained two million valid rows):

```
Number of accepted rows = 2000000
```

Streaming Data via JDBC

There are two options to stream data from a file on the client to your HP Vertica database:

- Use the `VerticaCopyStream` class to stream data in an object-oriented manner
- Execute a `COPY LOCAL` SQL statement to stream the data

The topics in this section explain how to use these options.

Using `VerticaCopyStream`

The `VerticaCopyStream` class lets you stream data from the client system to an HP Vertica database. It lets you use the SQL `COPY` statement directly without having to copy the data to a host in the database cluster first. Using the `COPY` command to load data from the host requires superuser privileges to be able to access the host's filesystem. The `COPY` statement used to load data from a stream does not require superuser privileges so your client can connect using any user account that has `INSERT` privileges on the table that will receive the data.

To copy streams into the database:

- 1 Disable the database connections `AutoCommit` connection parameter.
- 2 Instantiate a `VerticaCopyStreamObject`, passing it at least the database connection objects and a string containing a `COPY` statement to load the data. This statement **must** copy data from the `STDIN` into your table. You can use whatever parameters are appropriate for your data load.
Note: The `VerticaCopyStreamObject` constructor optionally takes a single `InputStream` object, or a `List` of `InputStream` objects. This option lets you pre-populate the list of streams to be copied into the database.
- 3 Call `VerticaCopyStreamObject.start()` to start the `COPY` statement and begin streaming the data in any streams you have already added to the `VerticaCopyStreamObject`.
- 4 Call `VerticaCopyStreamObject.addStream()` to add additional streams to the list of streams to send to the database. You can then call `VerticaCopyStreamObject.execute()` to stream them to the server.

- 5 Optionally, call `VerticaCopyStreamObject.getRejects()` to get a list of rejected rows from the last `.execute()` call. The list of rejects is reset by each call to `.execute()` or `.finish()`.

Note: If you used either the REJECTED DATA or EXCEPTIONS options in the COPY statement you passed to `VerticaCopyStreamObject` the object in step 2, `.getRejects()` returns an empty list. You can only use one method of tracking the rejected rows at a time.

- 6 When you are finished adding streams, call `VerticaCopyStreamObject.finish()` to send any remaining streams to the database and close the COPY statement.
- 7 Call `Connection.commit()` to commit the loaded data.

Getting Rejected Rows

The `VerticaCopyStreamObject.getRejects()` method returns a List containing the row numbers of rows that were rejected after the previous `.execute()` method call. Each call to `.execute()` clears the list of rejected rows, so you need to call `.getRejects()` after each call to `.execute()`. Since `.start()` and `.finish()` also call `.execute()` to send any pending streams to the server, you should also call `.getRejects()` after these methods as well.

The following example demonstrates loading the content of five text files stored on the client system into a table.

```
import java.io.File;
import java.io.FileInputStream;
import java.sql.Connection;
import java.sql.DriverManager;
import java.sql.Statement;
import java.util.Iterator;
import java.util.List;
import java.util.Properties;

import com.vertica.jdbc.VerticaConnection;
import com.vertica.jdbc.VerticaCopyStream;

public class CopyMultipleStreamsExample {
    public static void main(String[] args) {
        try {
            Class.forName("com.vertica.jdbc.Driver");
        } catch (ClassNotFoundException e) {
            System.err.println("Could not find the JDBC driver class.");
            e.printStackTrace();
            return;
        }

        // Set up the properties of the connection
        Properties myProp = new Properties();
        myProp.put("user", "ExampleUser"); // Must be superuser
        myProp.put("password", "password123");
        // When performing bulk loads, you should always disable the
        // connection's AutoCommit property to ensure the loads happen as
        // efficiently as possible by reusing the same COPY command and
        // transaction.
        myProp.put("AutoCommit", "false");
        Connection conn;
        try {
            conn = DriverManager.getConnection(
                "jdbc:vertica://VerticaHost:5433/ExampleDB",
                myProp);
            Statement stmt = conn.createStatement();

            // Create a table to receive the data
            stmt.execute("DROP TABLE IF EXISTS customers");
            stmt.execute("CREATE TABLE customers (Last_Name char(50), "
                + "First_Name char(50), Email char(50), "
                + "Phone_Number char(15))");

            // Prepare the query to insert from a stream. This query must use
            // the COPY statement to load data from STDIN. Unlike copying from
            // a file on the host, you do not need superuser privileges to
            // copy a stream. All your user account needs is INSERT privileges
            // on the target table.
            String copyQuery = "COPY customers FROM STDIN "
                + "DELIMITER '|' DIRECT ENFORCELENGTH";
```

```
// Create an instance of the stream class. Pass in the
// connection and the query string.
VerticaCopyStream stream = new VerticaCopyStream(
    (VerticaConnection) conn, copyQuery);

// Keep running count of the number of rejects
int totalRejects = 0;

// start() starts the stream process, and opens the COPY command.
stream.start();

// If you added streams to VerticaCopyStream before calling start(),
// You should check for rejects here (see below). The start() method
// calls execute() to send any pre-queued streams to the server
// once the COPY statement has been created.

// Simple for loop to load 5 text files named customers-1.txt to
// customers-5.txt
for (int loadNum = 1; loadNum <= 5; loadNum++) {
    // Prepare the input file stream. Read from a local file.
    String filename = "C:\\\\Data\\\\customers-" + loadNum + ".txt";
    System.out.println("\n\nLoading file: " + filename);
    File inputFile = new File(filename);
    FileInputStream inputStream = new FileInputStream(inputFile);

    // Add stream to the VerticaCopyStream
    stream.addStream(inputStream);

    // call execute() to load the newly added stream. You could
    // add many streams and call execute once to load them all.
    // Which method you choose depends mainly on whether you want
    // the ability to check the number of rejections as the load
    // progresses so you can stop if the number of rejects gets too
    // high. Also, high numbers of InputStreams could create a
    // resource issue on your client system.
    stream.execute();

    // Show any rejects from this execution of the stream load
    // getRejects() returns a List containing the
    // row numbers of rejected rows.
    List<Long> rejects = stream.getRejects();

    // The size of the list gives you the number of rejected rows.
    int numRejects = rejects.size();
```

```

        totalRejects += numRejects;
        System.out.println("Number of rows rejected in load #"
                           + loadNum + ": " + numRejects);

        // List all of the rows that were rejected.
        Iterator<Long> rejIt = rejects.iterator();
        long linecount = 0;
        while (rejIt.hasNext()) {
            System.out.print("Rejected row #" + ++linecount);
            System.out.println(" is row " + rejIt.next());
        }
    }

    // Finish closes the COPY command. It returns the number of
    // rows inserted.
    long results = stream.finish();
    System.out.println("Finish returned " + results);

    // If you added any streams that hadn't been executed(),
    // you should also check for rejects here, since finish()
    // calls execute() to

    // You can also get the number of rows inserted using
    // getRowCount().
    System.out.println("Number of rows accepted: "
                       + stream.getRowCount());
    System.out.println("Total number of rows rejected: " + totalRejects);

    // Commit the loaded data
    conn.commit();

} catch (Exception e) {
    e.printStackTrace();
}
}
}

```

Running the above example on some sample data results in the following output:

```
Loading file: C:\Data\customers-1.txt
Number of rows rejected in load #1: 3
Rejected row #1 is row 3
Rejected row #2 is row 7
Rejected row #3 is row 51
```

```
Loading file: C:\Data\customers-2.txt  
Number of rows rejected in load #2: 5  
Rejected row #1 is row 4143
```

```
Rejected row #2 is row 6132
Rejected row #3 is row 9998
Rejected row #4 is row 10000
Rejected row #5 is row 10050
```

```
Loading file: C:\Data\customers-3.txt
Number of rows rejected in load #3: 9
Rejected row #1 is row 14142
Rejected row #2 is row 16131
Rejected row #3 is row 19999
Rejected row #4 is row 20001
Rejected row #5 is row 20005
Rejected row #6 is row 20049
Rejected row #7 is row 20056
Rejected row #8 is row 20144
Rejected row #9 is row 20236
```

```
Loading file: C:\Data\customers-4.txt
Number of rows rejected in load #4: 8
Rejected row #1 is row 23774
Rejected row #2 is row 24141
Rejected row #3 is row 25906
Rejected row #4 is row 26130
Rejected row #5 is row 27317
Rejected row #6 is row 28121
Rejected row #7 is row 29321
Rejected row #8 is row 29998
```

```
Loading file: C:\Data\customers-5.txt
Number of rows rejected in load #5: 1
Rejected row #1 is row 39997
Finish returned 39995
Number of rows accepted: 39995
Total number of rows rejected: 26
```

Note: The above example shows a simple load process that targets one node in the HP Vertica cluster. It is more efficient to simultaneously load multiple streams to multiple database nodes. Doing so greatly improves performance, because it spreads the processing for the load across the cluster.

Using COPY LOCAL with JDBC

To use COPY LOCAL with JDBC, just execute a COPY LOCAL statement with the path to the source file on the client system. This method is simpler than using the `VerticaCopyStream` class. However, you may prefer using `VerticaCopyStream` if you have many files to copy to the database or if your data comes from a source other than a file (streamed over a network connection, for example).

The following example code demonstrates using COPY LOCAL to copy a file from the client to the database. It is the same as the code shown in **Bulk Loading Using the COPY Statement** (page [149](#)), except for the use of the LOCAL option in the COPY statement, and the path to the data file is on the client system, rather than on the server.

Note: The exceptions/rejections files are created on the client machine when the exceptions and rejected data modifiers are specified on the copy local command. Specify a local path and filename for these modifiers when executing a COPY LOCAL query from the driver.

```

import java.sql.*;
import java.util.Properties;

public class COPYLocal {
    public static void main(String[] args) {
        try {
            Class.forName("com.vertica.jdbc.Driver");
        } catch (ClassNotFoundException e) {
            System.err.println("Could not find the JDBC driver class.");
            e.printStackTrace();
            return;
        }
        Properties myProp = new Properties();
        myProp.put("user", "ExampleUser"); // Do not need to superuser
        myProp.put("password", "password123");
        Connection conn;
        try {
            conn = DriverManager.getConnection(
                "jdbc:vertica://VerticalHost:5433/ExampleDB", myProp);
            // Disable AutoCommit
            conn.setAutoCommit(false);
            Statement stmt = conn.createStatement();
            // Create a table to hold data.
            stmt.execute("DROP TABLE IF EXISTS customers;");
            stmt.execute("CREATE TABLE IF NOT EXISTS customers (Last_Name
char(50) "
                        + "NOT NULL, First_Name char(50), Email char(50), "
                        + "Phone_Number char(15))");

            // Use the COPY command to load data. Load directly into ROS, since
            // this load could be over 100MB. Use ENFORCELENGTH to reject
            // strings too wide for their columns.
            boolean result = stmt.execute("COPY customers FROM LOCAL "
                + " 'C:\\\\Data\\\\customers.txt' DIRECT
ENFORCELENGTH");
            // Determine if execution returned a count value, or a full result
            // set.
            if (result) {
                System.out.println("Got result set");
            } else {
                // Count will usually return the count of rows inserted.
                System.out.println("Got count");
                int rowCount = stmt.getUpdateCount();
                System.out.println("Number of accepted rows = " + rowCount);
            }
            conn.close();
        } catch (SQLException e) {
            System.out.print("Error: ");
            System.out.println(e.toString());
        }
    }
}

```

```
    }  
}
```

The result of running this code appears below. In this case, the customers.txt file contains 10000 rows, seven of which get rejected because they contain data too wide to fit into their database columns.

```
Got count  
Number of accepted rows = 9993
```

Programming ADO.NET Applications

The HP Vertica driver for the Microsoft Connectivity Pack and ADO.NET allows applications written in C# to read data from, update, and load data into HP Vertica databases. It provides a data adapter (**HP Vertica Data Adapter**) that facilitates reading data from a database into a data set, and then writing changed data from the data set back to the database. It also provides a data reader (HP VerticaDataReader) for reading data. The driver requires the .NET framework version 3.5+.

For more information about ADO.NET, see:

- **Overview of ADO.NET** ([http://msdn.microsoft.com/en-us/library/h43ks021\(vs.85\).aspx](http://msdn.microsoft.com/en-us/library/h43ks021(vs.85).aspx))
- **ADO.NET .NET Framework Developer's Guide**

Note: All of the examples provided in this section are in C#.

Updating ADO.NET Client Code from Previous Driver Versions

Starting in release 5.1.1, the HP Vertica client drivers have been updated to improve standards compliance, performance, and reliability. As a result, some HP Vertica-specific features and past incompatibilities have been eliminated. You must update any client code written for the prior versions of the ADO.NET driver to work with the version 5.1.1 driver and beyond.

Auto Commit Change

- All queries are now Auto Committed. The only exception is that queries run using a Transaction are not committed until the Commit(); method is called.

Performance Improvements

- Prepared INSERT statements now run significantly faster than in previous driver versions. For the best performance, prepared statements should be executed as part of a transaction.

Namespace Change

- The namespace has changed from vertica to Vertical.Data.VerticalClient

Connection Properties

- DSN is no longer a valid connection string keyword. You cannot connect to HP Vertica using ADO.net with a DSN.
- The RowBufferSize connection property has been renamed to ResultBufferSize.
- Getters on the VerticalConnection to get various connection string options (CacheDirectoryPooling, MinPoolSize, MaxPoolSize, SyncNotification, Timeout, Enlist, UseExtendedTypes, Password, Pooling, MinPoolSize, MaxPoolSize) have been removed.
- There is no longer a locale connection string keyword and you cannot set the locale through the connection string. To change the locale, run the query "set locale to..."
- The connection property to enable or disable auto commit has been removed. All queries outside of transactions are auto-committed.

Result Buffering

- The driver now buffers all results, and always uses streaming. Because of this, the following functionality has changed:
 - `VerticaCommandBehavior` enum has been removed. This enum extended the ADO.NET `CommandBehavior` enum to add support for buffering results. Results are now buffered in HP Vertica 5.1.x.
 - The `VerticaCommand.ExecuteReader(CommandBehavior, bool)` argument has been removed.
 - `CacheDirectory` or `PreloadReader` connection string options have been removed.

Logging Changes

- Log properties are no longer configured on the connection string. Log properties are now configured through the ***VerticaLogProperties*** class.

Data Type Changes

The following data types have changed:

Old Datatype Name	New Datatype Name
<code>verticaType.Integer</code>	<code>VerticaType.BigInt</code>
<code>verticaType.Bigint</code>	<code>VerticaType.BigInt</code>
<code>verticaType.Timestamp</code>	<code>VerticaType.DateTime</code>
<code>verticaType.Interval</code>	Changed to specific type of interval, for example: <ul style="list-style-type: none">▪ <code>VerticaType.IntervalDay</code>▪ <code>VerticaType.IntervalDayToHour</code>▪ <code>VerticaType.IntervalDayToMinute</code>▪ etc.
<code>verticaType.Real</code>	<code>VerticaType.Double</code>
<code>verticaType.Text</code>	<code>VerticaType.VarChar</code>
<code>verticaType.Smallint</code>	<code>VerticaType.BigInt</code>
<code>verticaType.Varbinary</code>	<code>VerticaType.VarBinary</code>

Multiple Commands Now Supported

Multiple commands in a single statement are now supported, provided that parameters are not used in any of the commands in the statement. The exception is COPY commands. You cannot issue multiple COPY commands in the same statement.

Setting the Locale for ADO.NET Sessions

- ADO.NET applications use a UTF-16 character set encoding and are responsible for converting any non-UTF-16 encoded data to UTF-16. The same cautions as for ODBC apply if this encoding is violated.
- The ADO.NET driver converts UTF-16 data to UTF-8 when passing to the HP Vertica server and converts data sent by HP Vertica server from UTF-8 to UTF-16
- ADO.NET applications should set the correct server session locale by executing the SET LOCALE TO command in order to get expected collation and string functions behavior on the server.
- If there is no default session locale at the database level, ADO.NET applications need to set the correct server session locale by executing the SET LOCALE TO command in order to get expected collation and string functions behavior on the server. See the SET LOCALE command in the SQL Reference Manual

Connecting to the Database

This section describes:

- ***Using SSL: Installing SSL Certificates on Windows*** (page [163](#))
- ***Opening and Closing the Database Connection (ADO.NET)*** (page [164](#))
- ***ADO.NET Connection Properties*** (page [166](#))
- ***Configuring Log Properties***

Using SSL: Installing Certificates on Windows

You can optionally secure communication between your ADO.NET application and HP Vertica using SSL. The HP Vertica ADO.NET driver uses the default Windows key store when looking for SSL certificates. This is the same key store that Internet Explorer uses.

Before you can use SSL on the client side, you must implement SSL on the server. See Implementing SSL in the Administrator's Guide, perform those steps, then return to this topic to install the SSL certificate on Windows.

To use SSL for ADO.NET connections to HP Vertica:

- Import the server and client certificates into the Windows Key Store.
- If required by your certificates, import the public certificate of your Certifying Authority.

Import the server and client certificates into the Windows key store:

- 1 Copy the server.crt file you generated when you enabled SSL on the server to your Windows Machine.
- 2 Double-click the certificate.
- 3 Let Windows determine the key type, and click **Install**.

Import the public certificate of your CA:

You must establish a chain of trust for the certificates. You may need to import the public certificate for your Certifying Authority (CA) (especially if it is a self-signed certificate).

- 1 using the same certificate as above, double-click the certificate.
- 2 Select **Place all certificates in the following store**.
- 3 Click **Browse**, select **Trusted Root Certification Authorities** and click **Next**.
- 4 Click **Install**.

Enable SSL in your ADO.NET Applications

In your connection string, be sure to enable SSL by setting the `SSL` property in `VerticaConnectionStringBuilder` to true, for example:

```
//configure connection properties
VerticaConnectionStringBuilder builder = new
VerticaConnectionStringBuilder();
    builder.Host = "192.168.17.10";
    builder.Database = "VMart";
    builder.User = "dbadmin";
    builder.SSL = true;
//open the connection
VerticaConnection _conn = new VerticaConnection(builder.ToString());
_conn.Open();
```

Opening and Closing the Database Connection (ADO.NET)

Before you can access data in HP Vertica through ADO.NET, you must create a connection to the database using the `VerticaConnection` class which is an implementation of `System.Data.DbConnection`. The `VerticaConnection` class takes a single argument that contains the connection properties as a string. You can manually create a string of property keywords to use as the argument, or you can use the `VerticaConnectionStringBuilder` class to build a connection string for you.

This topic details the following:

- Manually building a connection string and connecting to HP Vertica
- Using `VerticaConnectionStringBuilder` to create the connection string and connecting to HP Vertica
- Closing the connection

To manually create a connection string:

See **ADO.NET Connection Properties** (page [166](#)) for a list of available properties to use in your connection string. At a minimum, you need to specify the Host, Database, and User.

- 1 For each property, provide a value and append the properties and values one after the other, separated by a semicolon. Assign this string to a variable. For example:

```

String connectString = "DATABASE=VMart;HOST=node01;USER=dbadmin";
2 Build an HP Vertica connection object that specifies your connection string.
VerticaConnection _conn = new VerticaConnection(connectString)
3 Open the connection.
_conn.Open();
4 Create a command object and associate it with a connection. All VerticaCommand objects
must be associated with a connection.
VerticaCommand command = _conn.CreateCommand();

```

To use the VerticaConnectionStringBuilder class to create a connection string and open a connection:

- 1 Create a new object of the VerticaConnectionStringBuilder class.

```
VerticaConnectionStringBuilder builder = new
VerticaConnectionStringBuilder();
```

- 2 Update your VerticaConnectionStringBuilder object with property values. See **ADO.NET Connection Properties** (page [166](#)) for a list of available properties to use in your connection string. At a minimum, you need to specify the Host, Database, and User.

```
builder.Host = "node01";
builder.Database = "VMart";
builder.User = "dbadmin";
```

- 3 Build an HP Vertica connection object that specifies your connection VerticaConnectionStringBuilder object as a string.

```
VerticaConnection _conn = new VerticaConnection(builder.ToString());
```

- 4 Open the connection.

```
_conn.Open();
```

- 5 Create a command object and associate it with a connection. All VerticaCommand objects must be associated with a connection.

```
VerticaCommand command = _conn.CreateCommand();
```

Note: If your database is not in compliance with your HP Vertica license, the call to `VerticaConnection.open()` returns a warning message to the console and the log. See [Managing Your License Key](#) in the Administrator's Guide for more information.

To close the connection:

When you're finished with the database, close the connection. Failure to close the connection can deteriorate the performance and scalability of your application. It can also prevent other clients from obtaining locks.

```
_conn.Close();
```

Example Usage:

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;
using System.Data;
using Verticala.Data.VerticalaClient;

namespace ConsoleApplication
{
    class Program
    {
        static void Main(string[] args)
        {
            VerticalaConnectionStringBuilder builder = new
VerticalaConnectionStringBuilder();
            builder.Host = "192.168.1.10";
            builder.Database = "VMart";
            builder.User = "dbadmin";

            VerticalaConnection _conn = new VerticalaConnection(builder.ToString());
            _conn.Open();

            //Perform some operations

            _conn.Close();
        }
    }
}
```

ADO.NET Connection Properties

You use connection properties to configure the connection between your ADO.NET client application and your HP Vertica database. The properties provide the basic information about the connections, such as the server name and port number to use to connect to your database.

You can set a connection property in two ways:

- Including the property name and value as part of the the connection string you pass to a VerticalaConnection.
- Setting the properties in a VerticalaConnectionStringBuilder object, then passing the object as a string to a VerticalaConnection.

Property	Description	Default Value
Database	Name of the HP Vertica database to connect to. For example, if you installed the example VMart database, the database is "VMart"	string.Empty
User	Name of the user to log into HP Vertica/	string.Empty
Port	Port on which HP Vertica is running.	5433
Host	The hostname or IP address of the server on which HP Vertica is running.	string.Empty
Password	The password associated with the user connecting to the server.	string.Empty
ConnSettings	SQL commands to run upon connection. Uses %3B for semicolons.	string.Empty
IsolationLevel	Sets the transaction isolation level for HP Vertica. See Transactions for a description of the different transaction levels. This value is either Serializable, ReadCommitted, or Unspecified. See Setting the Transaction Isolation Level (page 179) for an example of setting the isolation level using this keyword. Note: By default, this value is set to IsolationLevel.Unspecified, which means the connection uses the server's default transaction isolation level. HP Vertica's default isolation level is IsolationLevel.ReadCommitted.	System.Data.IsolationLevel.Unspecified
Label	A string to identify the session on the server.	string
DirectBatchInsert	A boolean value, whether to Bulk insert to ROS (true) or WOS (false).	false
ResultBufferSize	The size of the buffer to use when streaming results.	8192
ConnectionTimeout	Number seconds to wait for a connection. A value of 0 means no timeout.	0
ReadOnly	Boolean, if true, throw an exception on write attempts.	false
Pooling	A boolean value, whether to enable connection pooling. Connection pooling is useful for server applications because it allows the server to reuse connections. This saves resources and enhances the performance of executing commands on the database. It also reduces the amount of time a user must wait to establish a connection to the database	false

MinPoolSize	An integer that defines the minimum number of connections to pool. Cannot be greater than the number of connections that the server is configured to allow or an exception is thrown when that threshold is exceeded. The default number of connections allowed is 55.	1
MaxPoolSize	An integer that defines the maximum number of connections to pool. Cannot be greater than the number of connections that the server is configured to allow or an exception is thrown when that threshold is exceeded.	20
LoadBalanceTimeout	The amount of time, in seconds, to timeout/remove pooled connections if the connections are unused. Set to 0 to disable this parameter and have no timeouts occur. If you are using a cluster environment to load-balance the work, then pool is restricted to the servers in the cluster when the pool was created. If additional servers are added to the cluster, and the pool is not removed, then the new servers will never be added to the connection pool unless LoadBalanceTimeout is set and exceeded or <code>VerticaConnection.ClearAllPools()</code> is manually called from an application. If you are using loadbalancing then set this to a value that takes into account when new servers are added to the cluster. However, do not set it so low that pools are frequently removed and rebuilt, as this defeats the purpose of using pooling in the first place.	0 (no timeout)
SSL	A boolean value, whether to use SSL for the connection.	false

Configuring Log Properties (ADO.Net)

Log properties for ADO.Net are configured differently than they are other client drivers. On the other client drivers, log properties can be configured as one of the connection properties. The ADO.Net driver user the `VerticaLogProperties` class to configure the properties.

VerticaLogProperties

`VerticaLogProperties` is a static class that allows you to set and get the log settings for the ADO.net driver. You can control the log level, log path, and log namespace using this class.

The log is created when the first connection is opened. Once the connection is opened, you cannot change the log path. It must be set prior to opening the connection. You can change the log level and log namespace at any time.

Setting Log Properties

Setting the log properties is done using the three methods in the VerticalLogProperties class. The three methods are:

- SetLogPath(String path, bool persist)
- SetLogNamespace(String lognamespace, bool persist)
- SetLogLevel(VerticalLogLevel loglevel, bool persist)

Each of the methods requires a boolean persist argument. When set to true, the persist argument causes the setting to be written to the client's Windows Registry, where it is used for all subsequent connections. If set to false, then the log property only applies to the current session.

SetLogPath

The SetLogPath method takes as its arguments a string containing the path to the log file and the persist argument. If the path string contains only a directory path, then the log file is created with the name vdp-driver-MM-dd_HH.mm.ss.log (where MM-dd_HH.mm.ss is the date and time the log was created). If the path ends in a filename, such as log.txt or log.log, then the log is created with that filename.

If SetLogPath is called with an empty string for the path argument, then the client executable's current directory is used as the log path.

If SetLogPath is not called and no registry entry exists for the log path, and you have called any of the other VerticalLogProperties methods, then the client executable's current directory is used as the log path.

When the persist argument is set to true, the path specified is copied to the registry verbatim. If no filename was specified, then the filename is not saved to the registry.

Note: The path must exist on the client system prior to calling this method. The method does not create directories.

Example Usage:

```
//set the log path
string path = "C:\\log";
VerticalLogProperties.SetLogPath(path, false);
```

SetLogNamespace

The SetLogNamespace method takes as its arguments a string containing the namespace to log and the persist argument. The namespace string to log can be one of the following:

- Vertica
- Vertica.Data.VerticaClient
- Vertica.Data.Internal.IO
- Vertica.Data.Internal.DataEngine
- Vertica.Data.Internal.Core

Namespaces can be truncated to include multiple child namespaces. For example, you can specify "Vertica.Data.Internal" to log for all of the Vertica.Data.Internal namespaces.

If a log namespace is not set, and no value is stored in the registry, then the "Vertica" namespace is used for logging.

Example Usage:

```
//set namespace to log
string lognamespace = "Vertica.Data.VerticaClient";
VerticalogProperties.SetLogNamespace(lognamespace, false);
```

SetLogLevel

The SetLogLevel method takes as its arguments a VerticalogLevel type and the persist argument. The VerticalogLevel argument can be one of:

- VerticalogLevel.None
- VerticalogLevel.Fatal
- VerticalogLevel.Error
- VerticalogLevel.Warning
- VerticalogLevel.Info
- VerticalogLevel.Debug
- VerticalogLevel.Trace

If a log level is not set, and no value is stored in the registry, then VerticalogLevel.None is used.

Example Usage:

```
//set log level
VerticalogLevel level = VerticalogLevel.Debug;
VerticalogProperties.SetLogLevel(level, false);
```

Getting Log Properties

You can get the log property values using the getters included in the VerticalogProperties class. The properties are:

- LogPath
- LogNamespace
- LogLevel

Example Usage:

```
//get current log settings
string logpath = VerticalLogProperties.LogPath;
VerticalLogLevel loglevel = VerticalLogProperties.LogLevel;
string logns = VerticalLogProperties.LogNamespace;

Console.WriteLine("Current Log Settings:");
Console.WriteLine("Log Path: " + logpath);
Console.WriteLine("Log Level: " + loglevel);
Console.WriteLine("Log Namespace: " + logns);
```

Setting and Getting Log Properties Example

This complete example shows how to set and get log properties:

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;
using System.Data;
using Vertical.Data.VerticalClient;

namespace ConsoleApplication
{
    class Program
    {
        static void Main(string[] args)
        {

            //configure connection properties

            VerticalConnectionStringBuilder builder = new
            VerticalConnectionStringBuilder();
            builder.Host = "192.168.1.10";
            builder.Database = "VMart";
            builder.User = "dbadmin";

            //get current log settings

            string logpath = VerticalLogProperties.LogPath;
            VerticalLogLevel loglevel = VerticalLogProperties.LogLevel;
            string logns = VerticalLogProperties.LogNamespace;

            Console.WriteLine("\nOld Log Settings:");
            Console.WriteLine("Log Path: " + logpath);
            Console.WriteLine("Log Level: " + loglevel);
            Console.WriteLine("Log Namespace: " + logns);

            //set the log path
```

```
        string path = "C:\\log";
        VerticalLogProperties.SetLogPath(path, false);

//set log level
        VerticalLogLevel level = VerticalLogLevel.Debug;
        VerticalLogProperties.SetLogLevel(level, false);

//set namespace to log
        string lognamespace = "Vertica";
        VerticalLogProperties.SetLogNamespace(lognamespace, false);

//open the connection
        VerticalConnection _conn = new VerticalConnection(builder.ToString());
        _conn.Open();

//get new log settings
        logpath = VerticalLogProperties.LogPath;
        loglevel = VerticalLogProperties.LogLevel;
        logns = VerticalLogProperties.LogNamespace;

        Console.WriteLine("\nNew Log Settings:");
        Console.WriteLine("Log Path: " + logpath);
        Console.WriteLine("Log Level: " + loglevel);
        Console.WriteLine("Log Namespace: " + logns);

//close the connection
        _conn.Close();
    }
}
```

The example produces the following output:

```
Old Log Settings:
Log Path:
Log Level: None
Log Namespace:
```

New Log Settings:
 Log Path: C:\log
 Log Level: Debug
 Log Namespace: Vertica

Querying the Database using ADO.NET

This section describes how to create queries to do the following:

- ***Inserting data into the database*** (page [173](#))
- ***Read data from the database*** (page [182](#))
- ***Load data into the database*** (page [194](#))

Note: The ExecuteNonQuery() method used to query the database returns an int32 with the number of rows affected by the query. The maximum size of an int32 type is a constant and is defined to be 2,147,483,547. If your query returns more results than the int32 max, then ADO.NET throws an exception because of the overflow of the int32 type. However the query is still processed by HP Vertica even when the reporting of the return value fails. This is a limitation in .NET, as ExecuteNonQuery() is part of the standard ADO.NET interface.

Inserting Data (ADO.NET)

Inserting data can done using the VerticalCommand class. VerticalCommand is an implementation of DbCommand. It allows you to create and send an SQL statement to the database. Use the CommandText method to assign an SQL statement to the command and then execute the SQL by calling the ExecuteNonQuery method. The ExecuteNonQuery method is used for executing statements that do not return result sets.

To insert a single row of data:

- 1 ***Create a connection to the database*** (page [164](#)).
- 2 Create a command object using the connection.

```
VerticalCommand command = _conn.CreateCommand();
```

- 3 Insert data using an INSERT statement. The following is an example of a simple insert. Note that it does not contain a COMMIT statement because the HP Vertica ADO.NET driver operates in autocommit mode.

```
command.CommandText =
    "INSERT into test values(2, 'username', 'email', 'password');
```

- 4 Execute the query. The rowsAdded variable contains the number of rows added by the insert statement.

```
Int32 rowsAdded = command.ExecuteNonQuery();
```

The ExecuteNonQuery() method returns the number of rows affected by the command for UPDATE, INSERT, and DELETE statements. For all other types of statements it returns -1. If a rollback occurs then it is also set to -1.

Example Usage:

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;
using System.Data;
using Vertical.Data.VerticalClient;

namespace ConsoleApplication
{
    class Program
    {
        static void Main(string[] args)
        {
            VerticalConnectionStringBuilder builder = new
VerticalConnectionStringBuilder();
            builder.Host = "192.168.1.10";
            builder.Database = "VMart";
            builder.User = "dbadmin";

            VerticalConnection _conn = new VerticalConnection(builder.ToString());
            _conn.Open();

            VerticalCommand command = _conn.CreateCommand();
            command.CommandText =
                "INSERT into test values(2, 'username', 'email', 'password')";
            Int32 rowsAdded = command.ExecuteNonQuery();
            Console.WriteLine( rowsAdded + " rows added!");
            _conn.Close();
        }
    }
}
```

Using Parameters

You can use parameters to execute similar SQL statements repeatedly and efficiently.

Using Parameters

VerticalParameters are an extension of the System.Data.DbParameter base class in ADO.NET and are used to set parameters in commands sent to the server. Use Parameters in all queries (SELECT/INSERT/UPDATE/DELETE) for which the values in the WHERE clause are not static; that is for all queries that have a known set of columns, but whose filter criteria is set dynamically by an application or end user. Using parameters in this way greatly decreases the chances of an SQL injection issue that can occur when simply creating a SQL query from a number of variables.

Parameters require that a valid DbType, VerticaDbType, or System type be assigned to the parameter. See SQL Data Types and **ADO.NET Data Types** for a mapping of System, Vertica, and DbTypes.

To create a parameter placeholder, place either the at sign (@) or a colon (:) character in front of the parameter name in the actual query string. Do not insert any spaces between the placeholder indicator (@ or :) and the placeholder.

Note: The @ character is the preferred way to identify parameters. The colon (:) character is supported for backward compatibility.

For example, the following typical query uses the string 'MA' as a filter.

```
SELECT customer_name, customer_address, customer_city, customer_state
FROM customer_dimension WHERE customer_state = 'MA';
```

Instead, the query can be written to use a parameter. In the following example, the string MA is replaced by the parameter placeholder @STATE.

```
SELECT customer_name, customer_address, customer_city, customer_state
FROM customer_dimension WHERE customer_state = @STATE;
```

For example, the ADO.net code for the prior example would be written as:

```
VerticaCommand command = new VerticaCommand();
command.Text = "SELECT customer_name, customer_address, customer_city,
customer_state
    FROM customer_dimension WHERE customer_state = @STATE", _conn );
command.Parameters.Add(new VerticaParameter("STATE", VerticaType.VarChar));
command.Parameters["STATE"] = 'MA';
```

Note: Although the VerticaCommand class supports a Prepare() method, you do not need to call the Prepare() method for parameterized statements because HP Vertica automatically prepares the statement for you.

Creating and Rolling Back Transactions

Creating Transactions

Transactions in HP Vertica are atomic, consistent, isolated, and durable. When you connect to a database using the Vertica ADO.NET Driver, the connection is in autocommit mode and each individual query is committed upon execution. You can collect multiple statements into a single transaction and commit them at the same time by using a transaction. You can also choose to rollback a transaction before it is committed if your code determines that a transaction should not commit.

Transactions use the VerticaTransaction object, which is an implementation of DbTransaction. You must associate the transaction with the VerticaCommand object.

The following code uses an explicit transaction to insert one row each into to tables of the VMart schema.

To create a transaction in HP Vertica using the ADO.NET driver:

1 *Create a connection to the database* (page [164](#)).

2 Create a command object using the connection.

```
VerticaCommand command = _conn.CreateCommand();
```

3 Start an explicit transaction, and associate the command with it.

```
VerticaTransaction txn = _conn.BeginTransaction();
command.Connection = _conn;
command.Transaction = txn;
```

4 Execute the individual SQL statements to add rows.

```
command.CommandText =
    "insert into product_dimension values( ... )";
command.ExecuteNonQuery();
command.CommandText =
    "insert into store_orders_fact values( ... )";
```

5 Commit the transaction.

```
txn.Commit();
```

Rolling Back Transactions

If your code checks for errors, then you can catch the error and rollback the entire transaction.

```
VerticaTransaction txn = _conn.BeginTransaction();
VerticaCommand command = new VerticaCommand("insert into product_dimension
values( 838929, 5, 'New item 5' )", _conn);

// execute the insert
command.ExecuteNonQuery();
command.CommandText = "insert into product_dimension values( 838929, 6, 'New item
6' )";

// try insert and catch any errors
bool error = false;
try
{
    command.ExecuteNonQuery();
}
catch (Exception e)
{
    Console.WriteLine(e.Message);
    error = true;
}
if (error)
{
    txn.Rollback();
    Console.WriteLine("Errors. Rolling Back.");
}
else
{
    txn.Commit();
    Console.WriteLine("Queries Successful. Committing.");
}
```

Commit and Rollback Example

This example details how you can commit or rollback queries during a transaction.

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;
using System.Data;
using Vertical.Data.VerticalClient;

namespace ConsoleApplication
{
    class Program
    {
        static void Main(string[] args)
        {
            VerticalConnectionStringBuilder builder = new
VerticalConnectionStringBuilder();
            builder.Host = "192.168.1.10";
            builder.Database = "VMart";
            builder.User = "dbadmin";

            VerticalConnection _conn = new VerticalConnection(builder.ToString());
            _conn.Open();
            bool error = false;
            VerticalCommand command = _conn.CreateCommand();
            VerticalCommand command2 = _conn.CreateCommand();
            VerticalTransaction txn = _conn.BeginTransaction();
            command.Connection = _conn;
            command.Transaction = txn;
            command.CommandText =
                "insert into test values(1, 'test', 'test', 'test' )";
            Console.WriteLine(command.CommandText);
            try
            {
                command.ExecuteNonQuery();
            }
            catch (Exception e)
            {
                Console.WriteLine(e.Message);
                error = true;
            }
            command.CommandText =
                "insert into test values(2, 'ear', 'eye', 'nose', 'extra' )";
            Console.WriteLine(command.CommandText);
            try
            {
                command.ExecuteNonQuery();
            }
            catch (Exception e)
            {
                Console.WriteLine(e.Message);
                error = true;
            }
            if (error)
            {
                txn.Rollback();
            }
        }
    }
}
```

```
                Console.WriteLine("Errors. Rolling Back.");
            }
        else
        {
            txn.Commit();
            Console.WriteLine("Queries Successful. Committing.");
        }
        _conn.Close();
    }
}
```

The example displays the following output on the console:

```
insert into test values(1, 'test', 'test', 'test' )
insert into test values(2, 'ear', 'eye', 'nose', 'extra' )
[42601]ERROR: INSERT has more expressions than target columns
Errors. Rolling Back.
```

See Also

Setting the Transaction Isolation Level (page [179](#))

Setting the Transaction Isolation Level

You can set the transaction isolation level on a per-connection and per-transaction basis. See Transaction for an overview of the transaction isolation levels supported in HP Vertica. To set the default transaction isolation level for a connection, use the `IsolationLevel` keyword in the `VerticaConnectionStringBuilder` string (see **Connection String Keywords** (page 166) for details). To set the isolation level for an individual transaction, pass the isolation level to the `VerticaConnection.BeginTransaction()` method call to start the transaction.

To set the Isolation Level on a connection-basis:

- 1 Use the `VerticaConnectionStringBuilder` to build the connection string.
 - 2 Provide a value for the `IsolationLevel` builder string. It can take one of two values: `IsolationLevel.ReadCommitted` (default) or `IsolationLevel.Serializable`. For example:

```
VerticaConnectionStringBuilder builder = new  
VerticaConnectionStringBuilder();  
    builder.Host = "192.168.1.100";  
    builder.Database = "VMart";  
    builder.User = "dbadmin";  
builder.IsolationLevel = System.Data.IsolationLevel.Serializable  
    VerticaConnection _conn1 = new  
    VerticaConnection(builder.ToString());  
    conn1.Open();
```

To set the Isolation Level on a transaction basis:

- 1 Set the IsolationLevel on the BeginTransaction method, for example

```
VerticaTransaction txn =  
_conn.BeginTransaction(IsolationLevel.Serializable);
```

Example usage:

The following example demonstrates:

- getting the connection's transaction isolation level.
- setting the connection's isolation level using connection property.
- setting the transaction isolation level for a new transaction.

```

using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;
using System.Data;
using Verticala.Data.VerticalaClient;

namespace ConsoleApplication
{
    class Program
    {
        static void Main(string[] args)
        {
            VerticalaConnectionStringBuilder builder = new
VerticalaConnectionStringBuilder();
            builder.Host = "192.168.1.10";
            builder.Database = "VMart";
            builder.User = "dbadmin";

            VerticalaConnection _conn1 = new
VerticalaConnection(builder.ToString());
            _conn1.Open();
            VerticalaTransaction txn1 = _conn1.BeginTransaction();
            Console.WriteLine("\n Transaction 1 Transaction Isolation Level: " +
                txn1.IsolationLevel.ToString());
            txn1.Rollback();
            VerticalaTransaction txn2 =
_conn1.BeginTransaction(IsolationLevel.Serializable);
            Console.WriteLine("\n Transaction 2 Transaction Isolation Level: " +
                txn2.IsolationLevel.ToString());
            txn2.Rollback();
            VerticalaTransaction txn3 =
_conn1.BeginTransaction(IsolationLevel.ReadCommitted);
            Console.WriteLine("\n Transaction 3 Transaction Isolation Level: " +
                txn3.IsolationLevel.ToString());
            _conn1.Close();

        }
    }
}

```

When run, the example code prints the following to the system console:

```

Transaction 1 Transaction Isolation Level: ReadCommitted
Transaction 2 Transaction Isolation Level: Serializable
Transaction 3 Transaction Isolation Level: ReadCommitted

```

Reading Data (ADO.Net)

To read data from the database use VerticalDataReader, an implementation of DbDataReader. This implementation is useful for moving large volumes of data quickly off the server where it can be run through analytic applications.

Note: that the VerticalDataReader.HasRows property returns true if the result generated any rows. In versions of HP Vertica prior to 5.1, HasRows returned rows if there were more rows to be read.

Note: A VerticalCommand cannot execute anything else while it has an open VerticalDataReader associated with it. To execute something else, close the data reader or use a different VerticalCommand object.

To read data from the database using VerticalDataReader:

- 1 *Create a connection to the database* (page [164](#)).
- 2 Create a command object using the connection.

```
VerticalCommand command = _conn.CreateCommand();
```

- 3 Create a query. This query works with the example VMart database.

```
command.CommandText =  
    "SELECT fat_content, product_description " +  
    "FROM (SELECT DISTINCT fat_content, product_description" +  
    "        FROM product_dimension " +  
    "        WHERE department_description " +           "      IN  
('Dairy') " +  
    "            ORDER BY fat_content) AS food " +  
    "LIMIT 10;";
```

- 4 Execute the reader to return the results from the query. The following command calls the ExecuteReader method of the VerticalCommand object to obtain the VerticalDataReader object.

```
VerticalDataReader dr = command.ExecuteReader();
```

- 5 Read the data. The data reader returns results in a sequential stream. Therefore, you must read data from tables row-by-row. The following example uses a while loop to accomplish this:

```
Console.WriteLine("\n\n Fat Content\t Product Description");  
Console.WriteLine("-----\t -----");  
int rows = 0;  
while (dr.Read())  
{  
    Console.WriteLine("      " + dr[0] + "      \t " + dr[1]);  
    ++rows;
```

```
    }
    Console.WriteLine("-----\n  (" + rows + " rows)\n");
```

6 When you're finished, close the data reader to free up resources.

```
dr.Close();
```

Example Usage:

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;
using System.Data;
using Verticala.Data.VerticalaClient;

namespace ConsoleApplication
{
    class Program
    {
        static void Main(string[] args)
        {
            VerticalaConnectionStringBuilder builder = new
VerticalaConnectionStringBuilder();
            builder.Host = "192.168.1.10";
            builder.Database = "VMart";
            builder.User = "dbadmin";

            VerticalaConnection _conn = new VerticalaConnection(builder.ToString());
            _conn.Open();
            VerticalaCommand command = _conn.CreateCommand();
            command.CommandText =
                "SELECT fat_content, product_description " +
                "FROM (SELECT DISTINCT fat_content, product_description" +
                "      FROM product_dimension " +
                "      WHERE department_description " +
                "      IN ('Dairy') " +
                "      ORDER BY fat_content) AS food " +
                "LIMIT 10;";

            VerticalaDataReader dr = command.ExecuteReader();

            Console.WriteLine("\n\n Fat Content\t Product Description");
            Console.WriteLine("-----\t -----");
            int rows = 0;
            while (dr.Read())
            {
                Console.WriteLine("      " + dr[0] + "      \t " + dr[1]);
                ++rows;
            }
            Console.WriteLine("-----\n (" + rows + " rows)\n");
            dr.Close();
            _conn.Close();
        }
    }
}
```

Loading Data Through ADO.Net

This section details the different ways that you can load data in HP Vertica using the ADO.NET client driver:

- ***Using the HP Vertica Data Adapter*** "[Using the HP Vertica Data Adapter](#)"
- ***Using Batch Inserts and Prepared Statements*** "[Using Batch Inserts and Prepared Statements](#)"
- ***Streaming Data via ADO.NET*** "[Streaming Data via ADO.NET](#)"

Using the HP Vertica Data Adapter

The HP Vertica data adapter (VerticalDataAdapter) enables a client to exchange data between a data set and an HP Vertica database. It is an implementation of DbDataAdapter. You can use VerticalDataAdapter to simply read data, or, for example, read data from a database into a data set, and then write changed data from the data set back to the database.

Batching Updates

When using the Update() method to update a dataset, you can optionally use the UpdateBatchSize() method prior to calling Update() to reduce the number of times the client communicates with the server to perform the update. The default value of UpdateBatchSize is 1. If you have multiple rows.Add() commands for a data set, then you can change the batch size to an optimal size to speed up the operations your client must perform to complete the update.

Reading data from HP Vertica using the data adapter:

The following example details how to perform a select query on the VMart schema and load the result into a DataTable, then output the contents of the DataTable to the console.

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;
using System.Data;
using System.Data.SqlClient;
using Verticala.Data.VerticalaClient;

namespace ConsoleApplication
{
    class Program
    {
        static void Main(string[] args)
        {
            VerticalaConnectionStringBuilder builder = new
VerticalaConnectionStringBuilder();
            builder.Host = "192.168.1.10";
            builder.Database = "VMart";
            builder.User = "dbadmin";

            VerticalaConnection _conn = new VerticalaConnection(builder.ToString());
            _conn.Open();

            // Try/Catch any exceptions

            try
            {
                using (_conn)
                {

                    // Create the command

                    VerticalaCommand command = _conn.CreateCommand();
                    command.CommandText = "select product_key,
product_description " +
                        "from product_dimension where product_key < 10";

                    // Associate the command with the connection

                    command.Connection = _conn;

                    // Create the DataAdapter

                    VerticalaDataAdapter adapter = new VerticalaDataAdapter();
                    adapter.SelectCommand = command;

                    // Fill the DataTable
```

```
DataTable table = new DataTable();
adapter.Fill(table);

// Display each row and column value.

int i = 1;
foreach (DataRow row in table.Rows)
{
    foreach (DataColumn column in table.Columns)
    {
        Console.Write(row[column] + "\t");
    }
    Console.WriteLine();
    i++;
}
Console.WriteLine(i + " rows returned.");
}

catch (Exception e)
{
    Console.WriteLine(e.Message);
}
_conn.Close();
}

}
```

Reading Data from HP Vertica into a data set and changing data:

The following example shows how to use a data adapter to read from and insert into a dimension table of the VMart schema.

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;
using System.Data;
using System.Data.SqlClient;
using Vertica.Data.VerticaClient

namespace ConsoleApplication
{
    class Program
    {
        static void Main(string[] args)
        {
            VerticalConnectionStringBuilder builder = new
VerticalConnectionStringBuilder();
            builder.Host = "192.168.1.10";
            builder.Database = "VMart";
            builder.User = "dbadmin";

            VerticalConnection _conn = new VerticalConnection(builder.ToString());
            _conn.Open();

            // Try/Catch any exceptions

            try
            {
                using (_conn)
                {

                    //Create a data adapter object using the connection

                    VerticalDataAdapter da = new VerticalDataAdapter();

                    //Create a select statement that retrieves data from the table

                    da.SelectCommand = new VerticalCommand("select * from
product_dimension where product_key < 10", _conn);

                    //Set up the insert command for the data adapter, and bind variables for some
of the columns
```

```

        da.InsertCommand = new VerticalCommand("insert into
product_dimension values( :key, :version, :desc )", _conn);
        da.InsertCommand.Parameters.Add(new
VerticalParameter("key", VerticalType.BigInt));
        da.InsertCommand.Parameters.Add(new
VerticalParameter("version", VerticalType.BigInt));
        da.InsertCommand.Parameters.Add(new
VerticalParameter("desc", VerticalType.VarChar));
        da.InsertCommand.Parameters[0].SourceColumn =
"product_key";
        da.InsertCommand.Parameters[1].SourceColumn =
"product_version";
        da.InsertCommand.Parameters[2].SourceColumn =
"product_description";
        da.TableMappings.Add("product_key", "product_key");
        da.TableMappings.Add("product_version",
"product_version");
        da.TableMappings.Add("product_description",
"product_description");
    
```

//Create and fill a Data set for this dimension table, and get the resulting
DataTable.

```

DataSet ds = new DataSet();
da.Fill(ds, 0, 0, "product_dimension");
DataTable dt = ds.Tables[0];
    
```

//Bind parameters and add two rows to the table.

```

DataRow dr = dt.NewRow();
dr["product_key"] = 838929;
dr["product_version"] = 5;
dr["product_description"] = "New item 5";
dt.Rows.Add(dr);
dr = dt.NewRow();
dr["product_key"] = 838929;
dr["product_version"] = 6;
dr["product_description"] = "New item 6";
dt.Rows.Add(dr);
    
```

//Extract the changes for the added rows.

```

DataSet ds2 = ds.GetChanges();
    
```

//Send the modifications to the server.

```
    int updateCount = da.Update(ds2, "product_dimension");

    //Merge the changes into the original Data set, and mark it up to date.

        ds.Merge(ds2);
        ds.AcceptChanges();
        Console.WriteLine(updateCount + " updates made!");
    }

    catch (Exception e)
    {
        Console.WriteLine(e.Message);
    }
    _conn.Close();
}

}
```

Using Batch Inserts and Prepared Statements

You can load data in batches using a prepared statement with parameters. You can also use transactions to rollback the batch load if any errors are encountered.

If you are loading large batches of data (more than 100MB), then consider using a **direct batch insert**.

The following example details using data contained in arrays, parameters, and a transaction to batch load data.

The test table used in the example is created with the command: `create table test (id INT, username VARCHAR(24), email VARCHAR(64), password VARCHAR(8));`

Example Batch Insert Using Parameters and Transactions

```

using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;
using System.Data;
using Verticala.Data.VerticalaClient;

namespace ConsoleApplication
{
    class Program
    {
        static void Main(string[] args)
        {
            VerticalaConnectionStringBuilder builder = new
VerticalaConnectionStringBuilder();
            builder.Host = "192.168.1.10";
            builder.Database = "VMart";
            builder.User = "dbadmin";

            VerticalaConnection _conn = new VerticalaConnection(builder.ToString());
            _conn.Open();

            // create arrays for column data

            int[] ids = {1, 2, 3, 4};
            string[] usernames = {"user1", "user2", "user3", "user4"};
            string[] emails = { "user1@example.com",
"user2@example.com", "user3@example.com", "user4@example.com" };
            string[] passwords = { "pass1", "pass2", "pass3", "pass4" };

            // create counters for accepted and rejected rows

            int rows = 0;
            int rejRows = 0;
            bool error = false;

            // create the transaction

            VerticalaTransaction txn = _conn.BeginTransaction();

            // create the parametrized query and assign parameter types

```

```
    VerticalCommand command = _conn.CreateCommand();
    command.CommandText = "insert into TEST values (@id, @username,
@email, @password)";
    command.Parameters.Add(new VerticalParameter("id",
VerticalType.BigInt));
    command.Parameters.Add(new VerticalParameter("username",
VerticalType.VarChar));
    command.Parameters.Add(new VerticalParameter("email",
VerticalType.VarChar));
    command.Parameters.Add(new VerticalParameter("password",
VerticalType.VarChar));

// prepare the statement
command.Prepare();

// loop through the column arrays and insert the data
for (int i = 0; i < ids.Length; i++)
{
    command.Parameters["id"].Value = ids[i];
    command.Parameters["username"].Value = usernames[i];
    command.Parameters["email"].Value = emails[i];
    command.Parameters["password"].Value = passwords[i];
    try
    {
        rows += command.ExecuteNonQuery();
    }
    catch (Exception e)
    {
        Console.WriteLine("\nInsert failed - \n" + e.Message +
"\n");
        ++rejRows;
        error = true;
    }
}
if (error)
{

//roll back if errors

Console.WriteLine("Errors. Rolling Back Transaction.");
Console.WriteLine(rejRows + " rows rejected.");
txn.Rollback();
}
else
{

//commit if no errors
}
```

```
        Console.WriteLine("No Errors. Committing Transaction.");
        txn.Commit();
        Console.WriteLine("Inserted " + rows + " rows. ");
    }
    _conn.Close();
}
}
```

Loading Batches Directly into ROS

When loading large batches of data (more than 100MB or so), you should load the data directly into ROS containers. Inserting directly into ROS is more efficient for large loads than AUTO mode, since it avoids overflowing the WOS and spilling the remainder of the batch to ROS. Otherwise, the Tuple Mover has to perform a moveout on the data in the WOS, while subsequent data is directly written into ROS containers. This results in the data from your batch being segmented across containers.

To directly load batches into ROS, set the DirectBatchInsert connection property to true. See ***Opening and Closing the Database Connection*** (page [164](#)) for details on all of the connection properties. When the DirectBatchInsert property is set to true, all batch inserts bypass the WOS and load directly into a ROS container.

Example usage:

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;
using System.Data;
using Verticala.Data.VerticalaClient;

namespace ConsoleApplication
{
    class Program
    {
        static void Main(string[] args)
        {
            VerticalaConnectionStringBuilder builder = new
VerticalaConnectionStringBuilder();
            builder.Host = "192.168.1.10";
            builder.Database = "VMart";
            builder.User = "dbadmin";
            builder.DirectBatchInsert = true;

            VerticalaConnection _conn = new VerticalaConnection(builder.ToString());
            _conn.Open();

            //Perform some operations
            _conn.Close();
        }
    }
}
```

Streaming Data via ADO.NET

There are two options to stream data from a file on the client to your HP Vertica database through ADO.NET:

- Use the `VerticalaCopyStream` ADO.NET class to stream data in an object-oriented manner
- Execute a COPY SQL statement to stream the data

The topics in this section explain how to use these options.

Streaming from the Client via VerticalaCopyStream

The `VerticalaCopyStream` class lets you stream data from the client system to an HP Vertica database. It lets you use the SQL COPY statement directly without having to copy the data to a host in the database cluster first by substituting one or more data stream(s) for STDIN.

Notes:

- Use Transactions and disable auto commit on the copy command for better performance.

- Disable auto commit using the copy command with the 'no commit' modifier. You must explicitly disable commits. Enabling transactions does not disable autocommit when using VerticalCopyStream.
- The copy command used with VerticalCopyStream uses copy syntax.
- VerticalCopyStream.rejects is zeroed every time execute is called. If you want to capture the number of rejects, assign the value of VerticalCopyStream.rejects to another variable before calling execute again.
- You can add multiple streams using multiple AddStream() calls.

Example usage:

The following example demonstrates using VerticalCopyStream to copy a file stream into HP Vertica.

```

using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;
using System.Data;
using System.IO;
using Verticala.Data.VerticalClient;

namespace ConsoleApplication
{
    class Program
    {
        static void Main(string[] args)
        {

            //configure connection properties

            VerticalConnectionStringBuilder builder = new
VerticalConnectionStringBuilder();
            builder.Host = "192.168.1.10";
            builder.Database = "VMart";
            builder.User = "dbadmin";

            //open the connection
            VerticalConnection _conn = new VerticalConnection(builder.ToString());
            _conn.Open();

            try
            {
                using (_conn)
                {

                    //start a transaction

```

```
VerticaTransaction txn = _conn.BeginTransaction();

//create a table for this example
VerticaCommand command = new VerticaCommand("DROP TABLE IF
EXISTS copy_table", _conn);
command.ExecuteNonQuery();
command.CommandText = "CREATE TABLE copy_table (Last_Name
char(50), "
+ "First_Name char(50),Email char(50), "
+ "Phone_Number char(15))";
command.ExecuteNonQuery();

//create a new filestream from the data file
string filename = "C:/customers.txt";
Console.WriteLine("\n\nLoading File: " + filename);
FileStream inputfile = File.OpenRead(filename);

//define the copy command
string copy = "copy copy_table from stdin record terminator
E'\n' delimiter '|'
+ " enforcelength "
+ " no commit";

//create a new copy stream instance with the connection and copy statement
VerticaCopyStream vcs = new VerticaCopyStream(_conn, copy);

//start the VerticaCopyStream process
vcs.Start();

//add the file stream
vcs.AddStream(inputfile, false);

//execute the copy
vcs.Execute();

//finish stream and write out the list of inserted and rejected rows
```

```

        long rowsInserted = vcs.Finish();
        IList<long> rowsRejected = vcs.Rejects; // does not work when
rejected or exceptions defined
        Console.WriteLine("Number of Rows inserted: " +
rowsInserted);
        Console.WriteLine("Number of Rows rejected: " +
rowsRejected.Count);
        if (rowsRejected.Count > 0)
        {
            for (int i = 0; i < rowsRejected.Count; i++)
            {
                Console.WriteLine("Rejected row #{0} is row {1}", i,
rowsRejected[i]);
            }
        }
    }

    //commit the changes
    txn.Commit();
}
}
catch (Exception e)
{
    Console.WriteLine(e.Message);
}

//close the connection
_conn.Close();
}
}
}

```

Using Copy with ADO.NET

To use COPY with ADO.NET, just execute a COPY statement and the path to the source file on the client system. This method is simpler than using the VerticalCopyStream class. However, you may prefer using VerticalCopyStream if you have many files to copy to the database or if your data comes from a source other than a local file (streamed over a network connection, for example).

The following example code demonstrates using COPY to copy a file from the client to the database. It is the same as the code shown in Bulk Loading Using the COPY Statement and the path to the data file is on the client system, rather than on the server.

To load data that is stored on a database node, use a VerticalCommand object to create a COPY command:

- 1 **Create a connection to the database** (page [164](#)) through the node on which the data file is stored.
- 2 Create a command object using the connection.

```
VerticaCommand command = _conn.CreateCommand();
```

- 3 Copy data. The following is an example of using the COPY command to load data. It uses the LOCAL modifier to copy a file local to the client issuing the command.

```
command.CommandText = "copy lcopy_table from LOCAL 'c://customers.txt'"  
    + " record terminator E'\n' delimiter '|'"  
    + " enforceLength ";  
  
Int32 insertedRows = command.ExecuteNonQuery();  
Console.WriteLine(insertedRows + " inserted.");
```

Example Usage:

```
using System;  
using System.Collections.Generic;  
using System.Linq;  
using System.Text;  
using System.Data;  
using System.IO;  
using Vertica.Data.VerticaClient;  
  
namespace ConsoleApplication  
{  
    class Program  
    {  
        static void Main(string[] args)  
        {  
  
            //configure connection properties  
  
            VerticalConnectionStringBuilder builder = new  
VerticalConnectionStringBuilder();  
            builder.Host = "192.168.1.10";  
            builder.Database = "VMart";  
            builder.User = "dbadmin";  
  
            //open the connection
```

```

VerticalConnection _conn = new VerticalConnection(builder.ToString());
_conn.Open();

try
{
    using (_conn)
    {

        //start a transaction

        VerticalTransaction txn = _conn.BeginTransaction();

        //create a table for this example

        VerticalCommand command = new VerticalCommand("DROP TABLE IF
EXISTS lcopy_table", _conn);
        command.ExecuteNonQuery();
        command.CommandText = "CREATE TABLE IF NOT EXISTS lcopy_table
>Last_Name char(50), "
                           + "First_Name char(50),Email char(50), "
                           + "Phone_Number char(15))";
        command.ExecuteNonQuery();

        //define the copy command

        command.CommandText = "copy lcopy_table from LOCAL
'c://customers.txt'"
                           + " record terminator E'\n' delimiter '|'"
                           + " enforcelength "
                           + " no commit";

        //execute the copy

        Int32 insertedRows = command.ExecuteNonQuery();
        Console.WriteLine(insertedRows + " inserted.");

        //commit the changes

        txn.Commit();
    }
}
catch (Exception e)
{
    Console.WriteLine("Exception: " + e.Message);
}

//close the connection

```

```
        _conn.Close();
    }
}
```

Handling Messages (ADO.NET)

You can capture info and warning messages that HP Vertica provides to the ADO.NET driver by using the InfoMessage event on the VerticalConnection delegate class. This class captures messages that are not severe enough to force an exception to be triggered, but might still provide information that can benefit your application.

To use the **VerticalInfoMessageEventHandler** class:

- 1 Create a method to handle the message sent from the even handler:

```
static void conn_InfoMessage(object sender,
VerticalInfoMessageEventArgs e)
{
    Console.WriteLine(e.SqlState + ": " + e.Message);
}
```

- 2 Create a **connection** (page [164](#)) and register a new VerticalInfoMessageHandler delegate for the InfoMessage event:

```
_conn.InfoMessage += new
VerticalInfoMessageEventHandler(conn_InfoMessage);
```

- 3 Execute your queries. If a message is generated, then the event handle function is run.

- 4 You can unsubscribe from the event with the following command:

```
_conn.InfoMessage -= new
VerticalInfoMessageEventHandler(conn_InfoMessage);
```

Example usage:

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;
using System.Data;
using Verticala.Data.VerticalaClient;

namespace ConsoleApplication
{
    class Program
    {

        // define message handler to deal with messages
        static void conn_InfoMessage(object sender, VerticalaInfoMessageEventArgs e)
        {
            Console.WriteLine(e.SqlState + ":" + e.Message);
        }

        static void Main(string[] args)
        {

            //configure connection properties
            VerticalaConnectionStringBuilder builder = new
            VerticalaConnectionStringBuilder();
            builder.Host = "192.168.1.10";
            builder.Database = "VMart";
            builder.User = "dbadmin";

            //open the connection
            VerticalaConnection _conn = new VerticalaConnection(builder.ToString());
            _conn.Open();

            //create message handler instance by subscribing it to the InfoMessage event of the
            connection
            _conn.InfoMessage += new
            VerticalaInfoMessageEventHandler(conn_InfoMessage);

            //create and execute the command
        }
    }
}
```

```
    VerticalCommand cmd = _conn.CreateCommand();
    cmd.CommandText = "drop table if exists fakeTable";
    cmd.ExecuteNonQuery();

    //close the connection
    _conn.Close();
}
}
```

This examples displays the following when run:

```
00000: Nothing was dropped
```

Getting Table Metadata (ADO.Net)

You can get the table metadata by using the GetSchema() method on a connection and loading the metadata into a DataTable:

```
DataTable table = _conn.GetSchema("Tables", new string[] { database_name,
schema_name, table_name, table_type });
```

For example:

```
DataTable table = _conn.GetSchema("Tables", new string[] { null, null, null, "SYSTEM TABLE" });
```

database_name, schema_name, table_name can be set to *null*, be a specific name, or use a LIKE pattern.

table_type can be one of:

- "SYSTEM TABLE"
- "TABLE"
- "GLOBAL TEMPORARY"
- "LOCAL TEMPORARY"
- "VIEW"
- null

If *table_type* is set to null, then the metadata for all metadata tables is returned.

Example Usage:

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;
using System.Data;
using Verticala.Data.VerticalaClient;

namespace ConsoleApplication
{
    class Program
    {

        static void Main(string[] args)
        {

            //configure connection properties

            VerticalaConnectionStringBuilder builder = new
            VerticalaConnectionStringBuilder();
            builder.Host = "192.168.1.10";
            builder.Database = "VMart";
            builder.User = "dbadmin";


            //open the connection

            VerticalaConnection _conn = new VerticalaConnection(builder.ToString());
            _conn.Open();


            //create a new data table containing the schema

            //the last argument can be "SYSTEM TABLE", "TABLE", "GLOBAL
            TEMPORARY",
            // "LOCAL TEMPORARY", "VIEW", or null for all types
            DataTable table = _conn.GetSchema("Tables", new string[] { null, null,
            null, "SYSTEM TABLE" });




            //print out the schema
```

```

        foreach (DataRow row in table.Rows)
    {
        foreach (DataColumn col in table.Columns)
        {
            Console.WriteLine("{0} = {1}", col.ColumnName, row[col]);
        }
        Console.WriteLine("=====");
    }

    //close the connection
    _conn.Close();
}
}
}

```

ADO.NET Data Types

This table details the mapping between HP Vertica data type's and .NET and ADO.NET data types.

.NET Framework Type	ADO.NET DbType	VerticaType	HP Vertica Data Type	VerticaDataReader getter
Boolean	Boolean	Bit	Boolean	GetBoolean()
byte[]	Binary	Binary VarBinary	Binary VarBinary	GetBytes()
Datetime	DateTime	Date Time TimeStamp	Date Time TimeStamp	GetDateTime() Note: The Time portion of the DateTime object for vertica dates is set to DateTime.MinValue. Previously, VerticaType.DateTime was used for all date/time types. VerticaType.DateTime still exists for backwards compatibility, but now there are more specific VerticaTypes for each type.
DateOffset	DateTimeOffset	TimestampTZ TimeTZ	TimestampTZ TimeTZ	GetDateTimeOffset() Note: The Date portion of the DateTime is set to DateTime.MinValue

Decimal	Decimal	Numeric	Numeric	GetDecimal()
Double	Double	Double	Double Precision	GetDouble()
Int64	Int64	BigInt	Integer	GetInt64()
TimeSpan	Object	13 Interval Types	13 Interval Types	GetInterval() Note: There are 13 VerticaType values for the 13 types of intervals. The specific VerticaType used determines the conversion rules that the driver applies. Year/Month intervals represented as 365/30 days
String	String	Varchar	Varchar	GetString()
String	StringFixedLength	Char	Char	GetString()
Object	Object	N/A	N/A	GetValue()

Microsoft Connectivity Pack

The 6.0.0.1 and later versions of the Microsoft Connectivity Pack/ADO.NET client driver provide additional components for integration with Visual Studio and Microsoft SQL Server. This enhanced HP Vertica .NET data provider package provides integration with the following:

- Microsoft Business Intelligence Development Studio (BIDS) plugin and Visual Studio Shell Integration
- SQL Server Analysis Services (SSAS)
- SQL Server Integration Services (SSIS) - which provides SQL Server Type Mappings to map data types between HP Vertica and SQL Server.
- SQL Server Reporting Services (SSRS)

See ***Microsoft Connectivity Pack/ADO.NET Prerequisites*** (page [16](#)) for details on which Microsoft components must be installed to use this integration.

Microsoft Business Intelligence Development Studio (BIDS) plugin and Visual Studio Shell Integration

Business Intelligence Development Studio (BIDS) is Microsoft Visual Studio 2008 with additional project types that are specific to SQL Server business intelligence. BIDS is the primary environment that you use to develop business solutions that include Analysis Services, Integration Services, and Reporting Services projects.

The HP Vertica Microsoft Business Intelligence Development Studio (BIDS) plugin lets you view a list of tables and data in your HP Vertica database from within Visual Studio's Server Explorer and from within C# application when Visual Studio is used in BIDS mode.

Visual Studio Shell Integration allows you to browse an HP Vertica database from within Visual Studio's server explorer outside of BIDS development.

Notes:

- Business Intelligence Development Studio and the the 32-bit development environment for Analysis Services, Integration Services, and Reporting Services projects are not designed to run on the Itanium 64-bit architecture and is not installed on Itanium servers.
- Microsoft Visual Studio 2010 does not support Business Intelligence Development Studio Integration Services, Report Services and Analysis Services projects for SQL Server 2008 and SQL Server 2008 R2. To work around this issue, install Visual Studio 2008 alongside Visual Studio 2010 on the same workstation and open your Business Intelligence Development Studio projects in Visual Studio 2008.

Microsoft SSAS, SSIS, and SSRS Components

Both client and server side components are necessary in order to develop and implement the Microsoft Business Intelligence capabilities. This section describes the offerings provided by HP Vertica.

SQL Server Analysis Services (SSAS) Support

Business Intelligence Development Studio includes the Analysis Services project for developing online analytical processing (OLAP) for business intelligence applications. This project type includes the templates for cubes, dimensions, data sources, and data source views, and provides the tools for working with these objects.

Support for using HP Vertica as a data source and target is now available from both SSIS and the import/export wizard. HP Vertica specific mapping files must be installed on the Integration Server and BIDS workstation in order to enable this capability. The ADO.NET client driver installs these mapping files as the "SQL Server Type Mappings" component(s) (both 32-bit and 64-bit versions).

SQL Server Integration Services (SSIS) Support

Business Intelligence Development Studio includes the Integration Services project for developing ETL solutions. This project type includes the templates for packages, data sources, and data source views, and provides the tools for working with these objects.

Integration Services Limitations.

- 1 The .NET data provider for ODBC DDL SQL generation for target source generates a syntax error:

When using HP Vertica as a target data source using the .net data provider for ODBC, the following error occurs when you expect SSIS to generate valid SQL for HP Vertica:

ERROR [42601] ERROR 4856: Syntax error at or near "(" at character 60

This error occurs because, when using the ODBC bridge, SSIS does not know the flavor of SQL required to create a new table, so it defaults to SQL Server syntax. To use the ODBC bridge and create a new table with SSIS, you must manually edit the SQL in the CREATE statement to conform to valid HP Vertica syntax.

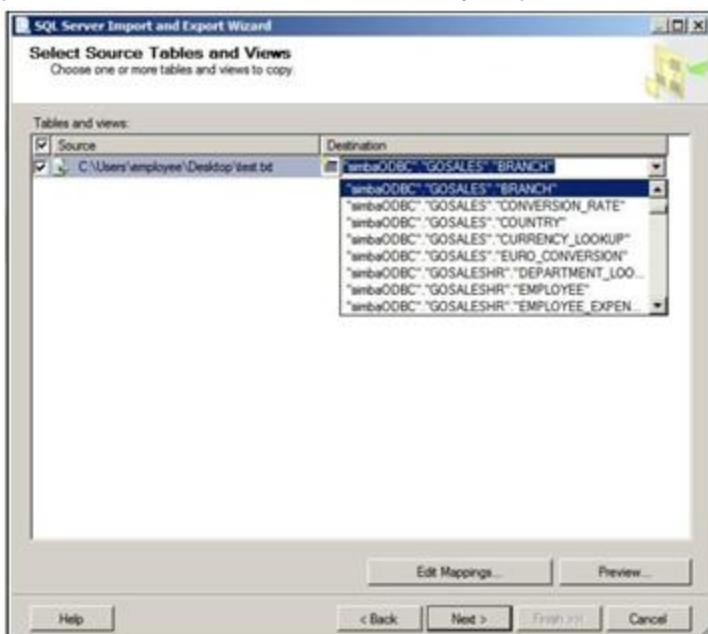
2 SSIS Package Upgrades:

When HP Vertica provides a new version of the ADO.NET data provider and the version number changes, any SSIS packages created must have the version number modified. Currently this is a manual process. Listed below is an example of a SSIS package XML tag with the version number.

```
<DTS:Property
DTS:Name="CreationName">ADO.NET:Vertica.Data.VerticaClient.VerticaCo
nnection, Vertica.Data, Version=6.0.1.0, Culture=neutral,
PublicKeyToken=725728a8837b3bd5</DTS:Property><DTS:PropertyExpression
n
DTS:Name="ConnectionString">@ [User:::SrcConnectionString]</DTS:Proper
tyExpression><DTS:ObjectData><DTS:ConnectionManager>
```

3 Schema Name Not provided when Mapping HP Vertica Destination:

Currently when mapping an HP Vertica destination, the schema name is not automatically provided. You must enter it manually or pick it from the drop-down menu as follows.



4 Null values when using the ODBC bridge data provider:

Essentially, the existence of null values in the source data can cause the batched insert to fail or partially fail. For example, the null value stops the insertion mid-update. All the rows that do not have null values that came before the null row are returned, but none after. For example, if transferring 5 rows with SSIS using the bridge for a destination and the data returned by the provider in this order:

A

- B
- C (contains null)
- D
- E

After the package executes, the destination has only A, B, and C in it.

SQL Server Reporting Services (SSRS) Support

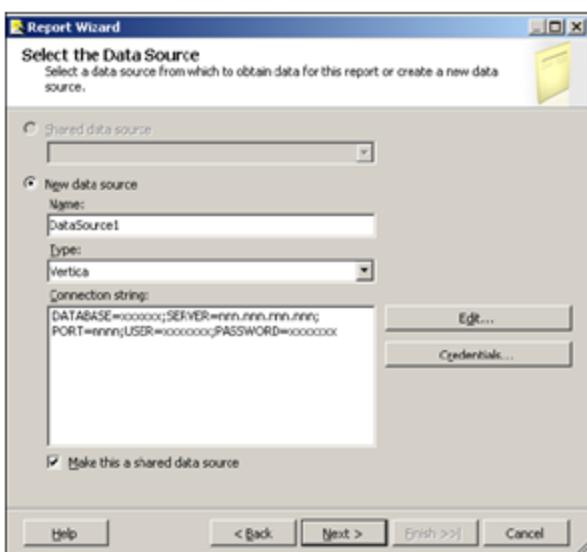
Business Intelligence Development Studio includes the Report projects for developing reporting solutions.

Support for using HP Vertica as a data source is now available for Reporting Service. The installer implements various configuration file modifications to enable this capability on both the BIDS workstation and the Reporting Services server.

Reporting Services Limitations:

1 Data Connection Wizard

The Report Wizard provides a data connection wizard. When selecting the wizard and entering all the connection information, it is not possible to click the OK button. Because of this, it is not possible to save your work and continue. The workaround is not to use the wizard and to use the following panel instead as follows shown:



2 Report Wizard - Query Designer

The HP Vertica Data Provider uses the Generic Query Designer. Other data sources use a Graphical Query Designer that supports visually building queries. The Graphical Query Designer is a part of a package call Visual Data Tools (VDT). The Graphical Query Designer only works with Generic OLEDB providers and the built-in providers; it cannot be used with the HP Vertica Data Provider.

1 Report Builder

Report Builder is a web-based report design tool. It does not support creating reports using custom data extensions, so it cannot be used with the HP Vertica Data Provider. When creating a report using Report Builder, existing HP Vertica data sources appear in the list of available data sources, but choosing an HP Vertica data source causes an error.

Data Type Limitations in SSIS

Consider the following data type limitations when using SQL Server Integration Services (SSIS):

DATE and DATETIME

The range for DATE and DATETIME, in order to function without errors, falls between 0001-01-01 00:00:00.0000000 and 9999-12-31 23:59:59.999999.

In SSIS, the DATETIME type (DT_TIMESTAMP) only supports a scale up to three decimal places for the seconds. Any decimal places after that are automatically discarded. Derived column transformations can only be performed on DATETIME values between January 1, 1753 through December 31, 9999.

Numeric

The maximum and minimum decimal allowed is:

- Max: +79,228,162,514,264,337,593,543,950,335
- Min: -79,228,162,514,264,337,593,543,950,335

For example, if the scale is 16, the range of values is:

+/- 7,922,816,251,426.4337593543950335

The valid scale range is any number that is smaller than 29 and greater than 38. Using a scale between 29 and 38 generates an error.

See : <http://msdn.microsoft.com/en-us/library/system.decimal.maxvalue.aspx>
<http://msdn.microsoft.com/en-us/library/system.decimal.maxvalue.aspx>

Character

The CHAR and VARCHAR data type used in SSIS is DT_WSTR; it has a maximum length of 4000 characters.

In SSIS, HP Vertica strings are converted to Unicode strings in SSIS to handle multi-lingual data. The strings can be converted to ASCII using a Data Conversion Task.

Floating point

SQL Server does not support the values NaN, Infinity, or –Infinity. These values work when you use SSIS to transfer between HP Vertica instances, but they do not work with a SQL Server Destination.

Scale

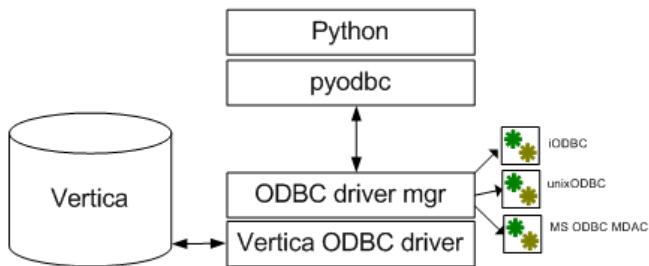
Whenever a scale greater than 38 is used, SSIS replaces it with a value of 4.

Interval

SSIS does not support interval types. It converts them to TIME and strips off the day component. Any package that has interval types greater than a day fails with truncation.

Programming Python Client Applications

HP Vertica provides an ODBC driver so applications can connect to the HP Vertica database.



In order to use Python with HP Vertica, you must install the pyodbc module and an HP Vertica ODBC driver on the machine where Python is installed. See [Python Prerequisites](#) (page 17).

Python on Linux

Most Linux distributions come with Python preinstalled. If you want a more recent version, you can download and build it from the source code, though sometimes RPMs are also available. See the the [Python Web site](http://www.python.org/download/) <http://www.python.org/download/> and click an individual release for details. See also [Python documentation](http://www.python.org/doc/) <http://www.python.org/doc/>.

To determine the Python version on your Linux operating systems, type the following at a command prompt:

```
# python -v
```

The system returns the version; for example:

```
Python 2.5.2
```

Python on Windows

Python is not required to run natively on Windows operating systems, so it is not preinstalled. The ActiveState Web site distributes a free Windows installer for Python called **ActivePython** <http://www.activestate.com/activepython/>.

If you need installation instructions for Windows, see [Using Python on Windows](http://docs.python.org/using/windows.html) <http://docs.python.org/using/windows.html> at python.org. [Python on Windows](http://diveintopython.org/installing_python/windows.html) http://diveintopython.org/installing_python/windows.html at diveintopython.org provides installation instructions for both the ActivePython and python.org packages.

The Python Driver Module (pyodbc)

The native python driver is not supported.

Before you can connect to HP Vertica using Python, you need the pyodbc module, which communicates with iODBC/unixODBC driver on UNIX operating systems and the ODBC Driver Manager for Windows operating systems.

The pyodbc module is an open source , MIT-licensed Python module that implements the Python Database API Specification v2.0, letting you use ODBC to connect to almost any database from Windows, Linux, Mac OS/X, and other operating systems.

HP Vertica supports pyodbc version 2.1.6, which requires Python 2.4 or greater, up to 2.6. HP Vertica does not support Python version 3.x. See **Python Prerequisites** (page 17) for additional details.

Download the source distribution from the **pyodbc Web site**

<http://code.google.com/p/pyodbc/>, unpack it and build it. See the **pyodbc wiki** <http://code.google.com/p/pyodbc/w/list> for instructions.

Note: Links to external Web sites could change between HP Vertica releases.

External Resources

Python Database API Specification v2.0 <http://www.python.org/dev/peps/pep-0249/>

Python documentation <http://www.python.org/doc/>

Configuring the ODBC Run-time Environment on Linux

To configure the ODBC run-time environment on Linux:

- 1 Create the `odbc.ini` file if it does not already exist.
- 2 Add the ODBC driver directory to the `LD_LIBRARY_PATH` system environment variable:

```
export LD_LIBRARY_PATH=/path-to-vertica-odbc-driver:$LD_LIBRARY_PATH
```

IMPORTANT! If you skip Step 2, the ODBC manager cannot find the driver in order to load it.

These steps are relevant only for unixODBC and iODBC. See their respective documentation for details on `odbc.ini`.

See Also

unixODBC Web site <http://www.unixodbc.org/>

iODBC Web site <http://www.idbc.org/dataspace/idbc/wiki/iODBC/>

Querying the Database Using Python

The example session below uses pyodbc with the HP Vertica ODBC driver to connect Python to the HP Vertica database.

iODBC Users:

SQLFetchScroll and SQLFetch functions cannot be mixed together in iODBC code.

When using pyodbc with the iODBC driver manager, skip cannot be used with the fetchall, fetchone, and fetchmany functions.

1 Open a database connection, create a table called TEST:

```
cnxn = pyodbc.connect(connection_string, ansi=True) cursor =
cnxn.cursor()
# create table
cursor.execute("CREATE TABLE TEST(
    "C_ID INT,
    "C_FP FLOAT,
    "C_VARCHAR VARCHAR(100),
    "C_DATE DATE, C_TIME TIME,
    "C_TS TIMESTAMP,
    "C_BOOL BOOL)")
```

2 Insert records into table TEST:

```
cursor.execute("INSERT into test
values(1,1.1,'abcdefg1234567890','1901-01-01','23:12:34','1901-01-01
09:00:09','t')")
```

3 Insert records using bind values:

```
values =
(2,2.28,'abcdefg1234567890','1901-01-01','23:12:34','1901-01-01
09:00:09','t')
cursor.execute("INSERT into test values(?, ?, ?, ?, ?, ?, ?)",
values[0], values[1], values[2], values[3], values[4],
values[5], values[6])
```

4 Select data from the TEST table:

```
cursor.execute("SELECT * FROM TEST")
rows = cursor.fetchall()
for row in rows:
    print row
```

The following is the example output:

```
(1L, 1.1000000000000001, 'abcdefg1234567890', datetime.date(1901, 1,
1), datetime.time(23, 12, 34), datetime.datetime(1901, 1, 1, 9, 0, 9),
'1') (2L, 2.2799999999999998, 'abcdefg1234567890', datetime.date(1901,
1, 1), datetime.time(23, 12, 34), datetime.datetime(1901, 1, 1, 9, 0,
9), '1')
```

5 Drop the TEST table and its associated projections and close the database connection:

```
cursor.execute("DROP TABLE TEST CASCADE")
cursor.close()
cnxn.close()
```

Notes

SQLPrimaryKeys returns the table name in the primary (`pk_name`) column for unnamed primary constraints. For example:

- Unnamed primary key:

```
CREATE TABLE schema.test(c INT PRIMARY KEY);
SQLPrimaryKeys
"TABLE_CAT", "TABLE_SCHEMA", "TABLE_NAME", "COLUMN_NAME", "KEY_SEQ",
"PK_NAME" <Null>, "SCHEMA", "TEST", "C", 1, "TEST"
```

- Named primary key:

```
CREATE TABLE schema.test(c INT CONSTRAINT pk_1 PRIMARY KEY);
SQLPrimaryKeys
"TABLE_CAT", "TABLE_SCHEMA", "TABLE_NAME", "COLUMN_NAME", "KEY_SEQ",
"PK_NAME" <Null>, "SCHEMA", "TEST", "C", 1, "PK_1"
HP recommends that you name your constraints.
```

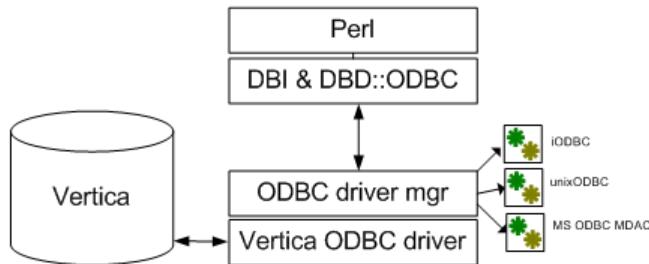
See Also

Loading Data Through ODBC (page [81](#))

Programming Perl Client Applications

The Perl programming language has a Database Interface module (DBI) that creates a standard interface for Perl scripts to interact with databases. The interface module relies on Database Driver modules (DBDs) to handle all of the database-specific communication tasks. The result is an interface that provides a consistent way for Perl scripts to interact with many different types of databases.

Your Perl script can interact with HP Vertica using the Perl DBI module along with the DBD::ODBC database driver to interface to HP Vertica's ODBC driver. See the CPAN pages for Perl's **DBI** <http://search.cpan.org/dist/DBI/DBI.pm> and **DBD::ODBC** <http://search.cpan.org/~mjevans/DBD-ODBC-1.43/ODBC.pm> modules for detailed documentation.



The topics in this chapter explain how to:

- Configure Perl to access HP Vertica
- Connect to HP Vertica
- Query data stored in HP Vertica
- Insert data into HP Vertica

Perl Client Prerequisites

In order run a Perl client script that connects to HP Vertica, your client system must have:

- The HP Vertica ODBC drivers installed and configured. See **Installing the HP Vertica Client Drivers** (page [15](#)) for details.
- A Data Source Name (DSN) containing the connection parameters for your HP Vertica. See **Creating an ODBC Data Source Name** (page [29](#)). (Optionally, your Perl script can connect to HP Vertica without using a DSN as described in **Connecting from Perl Without a DSN** (page [221](#))).
- A supported version of Perl installed
- The DBI and DBD::ODBC Perl modules (see below)

Supported Perl Versions

HP Vertica supports Perl versions 5.8 and 5.10. Versions later than 5.10 may also work.

Perl on Linux

Most Linux distributions come with Perl preinstalled. See your Linux distribution's documentation for details of installing and configuring its Perl package if it is not already installed.

To determine the Perl version on your Linux operating systems, type the following at a command prompt:

```
# perl -v
```

The system returns the version; for example:

```
This is perl, v5.10.0 built for x86_64-linux-thread-multi
```

Perl on Windows

Perl is not installed by default on Windows platforms. There are several different Perl packages you can download and install on your Windows system:

- **ActivePerl** <http://www.activestate.com/activeperl/> by ActiveState is a commercially-supported version of Perl for Windows platforms.
- **Strawberry Perl** <http://strawberryperl.com/> is an open-source port of Perl for Windows.

The Perl Driver Modules (DBI and DBD::ODBC)

Before you can connect to HP Vertica using Perl, your Perl installation needs to have the Perl Database Interface module (DBI) and the Database Driver for ODBC (DBD::ODBC). These modules communicate with iODBC/unixODBC driver on UNIX operating systems or the ODBC Driver Manager for Windows operating systems.

HP Vertica supports the following Perl modules:

- DBI version 1.609 (`DBI-1.609.tar.gz`)
- DBD::ODBC version 1.22 (`DBD-ODBC-1.22.tar.gz`)

Later versions of DBI and DBD::ODBC may also work.

DBI is installed by default with many Perl installations. You can test whether it is installed by executing the following command on the Linux or Windows command line:

```
# perl -e "use DBI;"
```

If the command exits without printing anything, then DBI is installed. If it prints an error, such as:

```
Can't locate DBI.pm in @INC (@INC contains: /usr/local/lib64/perl5  
/usr/local/share/perl5 /usr/lib64/perl5/vendor_perl  
/usr/share/perl5/vendor_perl  
/usr/lib64/perl5 /usr/share/perl5 .) at -e line 1.  
BEGIN failed--compilation aborted at -e line 1.
```

then DBI is not installed.

Similarly, you can see if DBD::ODBC is installed by executing the command:

```
# perl -e "use DBD::ODBC;"
```

You can also run the following Perl script to determine if DBI and DBD::ODBC are installed. If they are, the script lists any available DSNs.

```

#!/usr/bin/perl

use strict;
# Attempt to load the DBI module in an eval using require. Prevents
# script from erroring out if DBI is not installed.
eval
{
    require DBI;
    DBI->import();
};

if ($@) {
    # The eval failed, so DBI must not be installed
    print "DBI module is not installed\n";
} else {
    # Eval was successful, so DBI is installed
    print "DBI Module is installed\n";
    # List the drivers that DBI knows about.
    my @drivers = DBI->available_drivers;
    print "Available Drivers: \n";
    foreach my $driver (@drivers) {
        print "\t$driver\n";
    }

    # See if DBD::ODBC is installed by searching driver array.
    if (grep {/ODBC/i} @drivers) {
        print "\nDBD::ODBC is installed.\n";
        # List the ODBC data sources (DSNs) defined on the system
        print "Defined ODBC Data Sources:\n";
        my @dsns = DBI->data_sources('ODBC');
        foreach my $dsn (@dsns) {
            print "\t$dsn\n";
        }
    } else {
        print "DBD::ODBC is not installed\n";
    }
}

```

The exact output of the above code will depend on the configuration of your system. The following is an example of running the code on a Windows computer:

```

DBI Module is installed
Available Drivers:
    ADO
    DBM
    ExampleP
    File
    Gofer
    ODBC
    Pg
    Proxy
    SQLite
    Sponge
    mysql

```

```
DBD::ODBC is installed.  
Defined ODBC Data Sources:  
    dbi:ODBC:dBASE Files  
    dbi:ODBC:Excel Files  
    dbi:ODBC:MS Access Database  
    dbi:ODBC:VerticaDSN
```

Installing Missing Perl Modules

If Perl's DBI or DBD::ODBC modules are not installed on your client system, you must install them before your Perl scripts can connect to HP Vertica. How you install modules depends on your Perl configuration:

- For most Perl installations, you use the `cpan` command to install modules. If the `cpan` command alias isn't installed on your system, you can try to start CPAN by using the command:
`perl -MCPAN -e shell`
- Some Linux distributions provide Perl modules as packages that can be installed with the system package manager (such as yum or apt). See your Linux distribution's documentation for details.
- On ActiveState Perl for Windows, you use the Perl Package Manager (PPM) program to install Perl modules. See the ***Activestate's PPM documentation*** <http://docs.activestate.com/activeperl/5.16/faq/ActivePerl-faq2.html> for details.

Note: Installing Perl modules usually requires administrator or root privileges. If you do not have these permissions on your client system, you need to ask your system administrator to install these modules for you.

Connecting to HP Vertica Using Perl

You use the Perl DBI module's `connect` function to connect to HP Vertica. This function takes a required data source string argument and optional arguments for the username, password, and connection attributes.

The data source string must start with "dbi:ODBC:", which tells the DBI module to use the DBD::ODBC driver to connect to HP Vertica. The remainder of the string is interpreted by the DBD::ODBC driver. It usually contains the name of a DSN that contains the connection information needed to connect to your HP Vertica database. For example, to tell the DBD::ODBC driver to use the DSN named VerticaDSN, you use the data source string:

```
"dbi:ODBC:VerticaDSN"
```

The username and password parameters are optional. However, if you do not supply them (or just the username for a passwordless account) and they are not set in the DSN, attempting to connect always fails.

The `connect` function returns a database handle if it connects to HP Vertica. If it does not, it returns `undef`. In that case, you can access the DBI module's error string property (`$DBI::errstr`) to get the error message.

Note: By default, the DBI module prints an error message to STDERR whenever it encounters an error. If you prefer to display your own error messages or handle errors in some other manner, you may want to disable these automatic messages by setting DBI's PrintError connection attribute to false. See **Setting Perl DBI Connection Attributes** (page 220) for details. Otherwise, users may see two error messages: the one that DBI prints automatically, and the one that your script prints on its own.

The following example demonstrates connecting to HP Vertica using a DSN named VerticalDSN. The call to connect supplies a username and password. After connecting, it calls the database handle's disconnect function, which closes the connection.

```
#!/usr/bin/perl -w
use strict;
use DBI;

# Open a connection using a DSN. Supply the username and password.
my $dbh = DBI->connect("dbi:ODBC:VerticalDSN", "ExampleUser", "password123");
unless (defined $dbh) {
    # Connection failed.
    die "Failed to connect: $DBI::errstr";
}
print "Connected!\n";
$dbh->disconnect();
```

Setting ODBC Connection Parameters in Perl

To set ODBC connection parameters, replace the DSN name with a semicolon delimited list of parameter name and value pairs in the source data string. Use the DSN parameter to tell DBD::ODBC which DSN to use, then add in other the other ODBC parameters you want to set. For example, the following code connects using a DSN named VerticalDSN and sets the connection's locale to en_GB.

```
#!/usr/bin/perl -w
use strict;
use DBI;

# Instead of just using the DSN name, use name and value pairs.
my $dbh =
DBI->connect("dbi:ODBC:DSN=VerticaDSN;Locale=en_GB", "ExampleUser", "password123
");
unless (defined $dbh) {
    # Connection failed.
    die "Failed to connect: $DBI::errstr";
}
print "Connected!\n";
$dbh->disconnect();
```

See **DSN Parameters** (page 43) for a list of the connection parameters you can set in the source data string.

Setting Perl DBI Connection Attributes

The Perl DBI module has attributes that you can use to control the behavior of its database connection. These attributes are similar to the ODBC connection parameters (in several cases, they duplicate each other's functionality). The DBI connection attributes are a cross-platform way of controlling the behavior of the database connection.

You can set the DBI connection attributes when establishing a connection by passing the DBI `connect` function a hash containing attribute and value pairs. For example, to set the DBI connection attribute `AutoCommit` to false, you would use:

```
# Create a hash that holds attributes for the connection
my $attr = {AutoCommit => 0};

# Open a connection using a DSN. Supply the username and password.
my $dbh = DBI->connect("dbi:ODBC:VerticaDSN", "ExampleUser", "password123",
    $attr);
```

See the DBI documentation's **Database Handle Attributes** http://search.cpan.org/~timb/DBI/DBI.pm#ATTRIBUTES_COMMON_TO_ALL_HANDLES section for a full description of the attributes you can set on the database connection.

After your script has connected, it can access and modify the connection attributes through the database handle by using it as a hash reference. For example:

```
print "The AutoCommit attribute is: " . $dbh->{AutoCommit} . "\n";
```

The following example demonstrates setting two connection attributes:

- `RaiseError` controls whether the DBI driver generates a Perl error if it encounters a database error. Usually, you set this to true (1) if you want your Perl script to exit if there is a database error.

- AutoCommit controls whether statements automatically commit their transactions when they complete. DBI defaults to HP Vertica's default AutoCommit value of true. Always set AutoCommit to false (0) when bulk loading data to increase database efficiency.

```
#!/usr/bin/perl
use strict;
use DBI;

# Create a hash that holds attributes for the connection
my $attr = {
    RaiseError => 1, # Make database errors fatal to script
    AutoCommit => 0, # Prevent statements from committing
                     # their transactions.
};

# Open a connection using a DSN. Supply the username and password.
my $dbh = DBI->connect("dbi:ODBC:VerticaDSN", "ExampleUser", "password123",
    $attr);

if (defined $dbh->err) {
    # Connection failed.
    die "Failed to connect: $DBI::errstr";
}
print "Connected!\n";

# The database handle lets you access the connection attributes directly:
print "The AutoCommit attribute is: " . $dbh->{AutoCommit} . "\n";
print "The RaiseError attribute is: " . $dbh->{RaiseError} . "\n";
# And you can change values, too...
$dbh->{AutoCommit} = 1;
print "The AutoCommit attribute is now: " . $dbh->{AutoCommit} . "\n";

$dbh->disconnect();
```

The example outputs the following when run:

```
Connected!
The AutoCommit attribute is: 0
The RaiseError attribute is: 1
The AutoCommit attribute is now: 1
```

Connecting from Perl Without a DSN

If you do not want to set up a Data Source Name (DSN) for your database, you can supply all of the information Perl's DBD::ODBC driver requires to connect to your HP Vertica database in the data source string. This source string must the `DRIVER=` parameter that tells DBD::ODBC which driver library to use in order to connect. The value for this parameter is the name assigned to the driver by the client system's driver manager:

- On Windows, the name assigned to the HP Vertica ODBC driver by the driver manager is Vertica.

- On Linux and other UNIX-like operating systems, the HP Vertica ODBC driver's name is assigned in the system's `odbcinst.ini` file. For example, if your `/etc/odbcinst.ini` contains the following:

```
[HPVertica]
Description = HP Vertica ODBC Driver
Driver = /opt/vertica/lib64/libverticaodbc.so
```

you would use the name `HPVertica`. See ***Creating an ODBC DSN for Linux, Solaris, AIX, and HP-UX*** (page [29](#)) for more information about the `odbcinst.ini` file.

You can take advantage of Perl's variable expansion within strings to use variables for most of the connection properties, as the following example demonstrates.

```
#!/usr/bin/perl
use strict;
use DBI;

my $server='VerticaHost';
my $port = '5433';
my $database = 'VMart';
my $user = 'ExampleUser';
my $password = 'password123';

# Connect without a DSN by supplying all of the information for the connection.
# The DRIVER value on UNIX platforms depends on the entry in the odbcinst.ini
# file.
my $dbh = DBI->connect ("dbi:ODBC:DRIVER={Vertica};Server=$server;" .
                           "Port=$port;Database=$database;UID=$user;PWD=$password")
      or die "Could not connect to database: " . DBI::errstr;

print "Connected!\n";

$dbh->disconnect();
```

Note: Surrounding the driver name with braces ({ and }) in the source string is optional.

Executing Statements Using Perl

Once your Perl script has connected to HP Vertica (see ***Connecting to HP Vertica Using Perl*** (page [218](#))), it can execute simple statements that return a value rather than a result set by using the Perl DBI module's `do` function. You usually use this function to execute DDL statements or data loading statements such as `COPY` (see ***Using COPYLOCAL to Load Data in Perl*** (page [226](#))).

```

#!/usr/bin/perl
use strict;
use DBI;

# Disable autocommit
my $attr = {AutoCommit => 0};

# Open a connection using a DSN.
my $dbh = DBI->connect("dbi:ODBC:VerticaDSN", "ExampleUser", "password123",
    $attr);
unless (defined $dbh) {
    # Connection failed.
    die "Failed to connect: $DBI::errstr";
}

# You can use the do function to perform DDL commands.
# Drop any existing table.
$dbh->do ("DROP TABLE IF EXISTS TEST CASCADE;");

# Create a table to hold data.
$dbh->do ("CREATE TABLE TEST( \
            C_ID INT, \
            C_FP FLOAT, \
            C_VARCHAR VARCHAR(100), \
            C_DATE DATE, C_TIME TIME, \
            C_TS TIMESTAMP, \
            C_BOOL BOOL)");

```

Commit changes and exit.

```

$dbh->commit();
$dbh->disconnect();

```

Note: The `do` function returns the number of rows that were affected by the statement (or -1 if the count of rows doesn't apply or is unavailable). Usually, the only time you need to consult this value is after you deleted a number of rows or if you used a bulk load command such as `COPY`. You use other DBI functions instead of `do` to perform batch inserts and selects (see **Batch Loading Data Using Perl** (page [223](#)) and **Querying HP Vertica Using Perl** (page [229](#)) for details).

Batch Loading Data Using Perl

To load large batches of data into HP Vertica using Perl:

- 1 Set DBI's AutoCommit connection attribute to false to improve the batch load speed. See **Setting Perl DBI Connection Attributes** (page [220](#)) for an example of disabling AutoCommit.
- 2 Call the database handle's `prepare` function to prepare a SQL `INSERT` statement that contains placeholders for the data values you want to insert. For example:

```

# Prepare an INSERT statement for the test table
$sth = $dbh->prepare("INSERT into test values (?,?,?,?,?,?)");

```

The `prepare` function returns a statement handle that you will use to insert the data.

- 3 Assign data to the placeholders. There are several ways to do this. The easiest is to populate an array with a value for each placeholder in your INSERT statement.
- 4 Call the statement handle's `execute` function to insert a row of data into HP Vertica. The return value of this function call lets you know whether HP Vertica accepted or rejected the row.
- 5 Repeat steps 3 and 4 until you have loaded all of the data you need to load.
- 6 Call the database handle's `commit` function to commit the data you inserted.

The following example demonstrates inserting a small batch of data by populating an array of arrays with data, then looping through it and inserting each row.

```

#!/usr/bin/perl
use strict;
use DBI;

# Create a hash reference that holds a hash of parameters for the
# connection.
my $attr = {AutoCommit => 0, # Turn off autocommit
            PrintError => 0    # Turn off automatic error printing.
                                # This is handled manually.
            };

# Open a connection using a DSN. Supply the username and password.
my $dbh = DBI->connect("dbi:ODBC:VerticaDSN","ExampleUser","password123",
                        $attr);
if (defined DBI::err) {
    # Connection failed.
    die "Failed to connect: $DBI::errstr";
}

print "Connection AutoCommit state is: " . $dbh->{AutoCommit} . "\n";

# Create table to hold inserted data
$dbh->do ("DROP TABLE IF EXISTS TEST CASCADE;" or die "Could not drop table";
$dbh->do ("CREATE TABLE TEST( \
            C_ID INT, \
            C_FP FLOAT, \
            C_VARCHAR VARCHAR(100), \
            C_DATE DATE, C_TIME TIME, \
            C_TS TIMESTAMP, \
            C_BOOL BOOL)" or die "Could not create table";

# Populate an array of arrays with values. One of these rows contains
# data that will not be successfully inserted. Another contains an
# undef value, which gets inserted into the database as a NULL.
my @data = (
    [1,1.111,'Hello World!', '2001-01-01', '01:01:01'
     , '2001-01-01 01:01:01', 't'],
    [2,2.2222,'How are you?', '2002-02-02', '02:02:02'
     , '2002-02-02 02:02:02', 'f'],
    ['bad value',2.22222,'How are you?', '2002-02-02', '02:02:02'
     , '2002-02-02 02:02:02', 'f'],
    [4,4.2222,undef,'2002-02-02', '02:02:02'
     , '2002-02-02 02:02:02', 'f'],
);
# Create a prepared statement to use parameters for inserting values.
my $sth = $dbh->prepare_cached("INSERT into test values(?, ?, ?, ?, ?, ?, ?)");

my $rowcount = 0; # Count # of rows

# Loop through the arrays to insert values
foreach my $tuple (@data) {
    $rowcount++;
    # Insert the row
}

```

```
my $retval = $sth->execute(@$tuple);

# See if the row was successfully inserted.
if ($retval == 1) {
    # Value of 1 means the row was inserted (1 row was affected by insert)
    print "Row $rowcount successfully inserted\n";
} else {
    print "Inserting row $rowcount failed";
    # Error message is not set on some platforms/versions of DBUI. Check to
    # ensure a message exists to avoid getting an uninitialized var warning.
    if ($sth->err()) {
        print ": " . $sth->errstr();
    }
    print "\n";
}
}

# Commit changes. With AutoCommit off, you need to use commit for batched
# data to actually be committed into the database. If your Perl script exits
# without committing its data, HP Vertica rolls back the transaction and the
# data is not committed.
$dbh->commit();
$dbh->disconnect();
```

The previous example displays the following when successfully run:

```
Connection AutoCommit state is: 0
Row 1 successfully inserted
Row 2 successfully inserted
Inserting row 3 failed with error 01000 [Vertica][VerticaDSII] (20) An
error occurred during query execution: Row rejected by server; see
server log for details (SQL-01000)
Row 4 successfully inserted
```

Note that one of the rows was not inserted because it contained a string value that could not be stored in an integer column. See ***Conversions between Perl and HP Vertica Data Types*** (page [232](#)) for details of data type handling in Perl scripts that communicate with HP Vertica.

Using COPY LOCAL to Load Data in Perl

If you have delimited files (for example, a file with comma-separated values) on your client system that you want to load into HP Vertica, you can use the COPY LOCAL statement to directly load the file's contents into HP Vertica instead of using Perl to read, parse, and then batch insert the data. You execute a COPY LOCAL statement to load the file from the local filesystem. The result of executing the statement is the number of rows that were successfully inserted.

The following example code demonstrates loading a file named data.txt and located in the same directory as the Perl file into HP Vertica using a COPY LOCAL statement.

```

#!/usr/bin/perl
use strict;
use DBI;
# Filesystem path handling module
use File::Spec;

# Create a hash reference that holds a hash of parameters for the
# connection.
my $attr = {AutoCommit => 0}; # Turn off AutoCommit

# Open a connection using a DSN. Supply the username and password.
my $dbh = DBI->connect("dbi:ODBC:VerticaDSN", "ExampleUser", "password123",
    $attr) or die "Failed to connect: $DBI::errstr";
print "Connected!\n";

# Drop any existing table.
$dbh->do("DROP TABLE IF EXISTS Customers CASCADE;");

# Create a table to hold data.
$dbh->do("CREATE TABLE Customers( \
    ID INT, \
    FirstName VARCHAR(100), \
    LastName VARCHAR(100), \
    Email VARCHAR(100), \
    Birthday DATE)");

# Find the absolute path to the data file located in the current working
# directory and named data.txt
my $currDir = File::Spec->rel2abs(File::Spec->curdir());
my $dataFile = File::Spec->catfile($currDir, 'data.txt');

print "Loading file $dataFile\n";

# Load local file using copy local. Return value is the # of rows affected
# which equates to the number of rows inserted.
my $rows = $dbh->do("COPY Customers FROM LOCAL '$dataFile' DIRECT")
    or die $dbh->errstr;
print "Copied $rows rows into database.\n";
$dbh->commit();

# Prepare a query to get the first 15 rows of the results
my $sth = $dbh->prepare("SELECT * FROM Customers WHERE ID < 15 \
    ORDER BY ID");

$sth->execute() or die "Error querying table: " . $dbh->errstr;
my @row; # Pre-declare variable to hold result row used in format statement.

# Use Perl formats to pretty print the output. Declare the heading for the
# form.
format STDOUT_TOP =
ID First           Last          EMail           Birthday
--  ----           ----          -----           -----

```

```

# The Perl write statement will output a formatted line with values from the
# @row array. See http://perldoc.perl.org/perlform.html for details.
format STDOUT =
@>  @<<<<<<<<<  @<<<<<<<<  @<<<<<<<<<<<<<<<<  @<<<<<<<
@row
.

# Loop through result rows while we have them
while (@row = $sth->fetchrow_array()) {
    write; # Format command does the work of extracting the columns from
          # the @row array and writing them out to STDOUT.
}

# Call commit to prevent Perl from complaining about uncommitted transactions
# when disconnecting
$dbh->commit();
$dbh->disconnect();

```

The data.txt file is a text file containing a row of data on each line. The columns are delimited by pipe (|) characters. This is the default format that the COPY command accepts, which makes the COPY LOCAL statement in the example code simple. See the COPY statement entry in the SQL Reference Manual for handling data files that are in different formats. Here is an example of the content in this file:

```

1|Georgia|Gomez|Rhiannon@magna.us|1937-10-03
2|Abdul|Alexander|Kathleen@ipsum.gov|1941-03-10
3|Nigel|Contreras|Tanner@et.com|1955-06-01
4|Gray|Holt|Thomas@Integer.us|1945-12-06
5|Candace|Bullock|Scott@vitae.gov|1932-05-27
6|Matthew|Dotson|Keith@Cras.com|1956-09-30
7|Haviva|Hopper|Morgan@porttitor.edu|1975-05-10
8|Stewart|Sweeney|Rhonda@lectus.us|2003-06-20
9|Allen|Rogers|Alexander@enim.gov|2006-06-17
10|Trevor|Dillon|Eagan@id.org|1988-11-27
11|Leroy|Ashley|Carter@turpis.edu|1958-07-25
12|Elmo|Malone|Carla@enim.edu|1978-08-29
13|Laurel|Ball|Zelenia@Integer.us|1989-09-20
14|Zeus|Phillips|Branden@blandit.gov|1996-08-08
15|Alexis|Mclean|Flavia@Suspendisse.org|2008-01-07

```

The example code produces the following output when run on a large sample file:

```

Connected!
Loading file /home/dbadmin/Perl/data.txt
Copied 1000000 rows into database.

ID First           Last            EMail                Birthday
==  =====          =====          =====                ======
1   Georgia        Gomez          Rhiannon@magna.us  1937-10-03
2   Abdul          Alexander      Kathleen@ipsum.gov 1941-03-10
3   Nigel          Contreras     Tanner@et.com       1955-06-01
4   Gray           Holt          Thomas@Integer.us  1945-12-06
5   Candace        Bullock       Scott@vitae.gov    1932-05-27
6   Matthew         Dotson       Keith@Cras.com    1956-09-30
7   Haviva          Hopper       Morgan@porttitor.edu 1975-05-10
8   Stewart         Sweeney      Rhonda@lectus.us  2003-06-20
9   Allen           Rogers       Alexander@enim.gov 2006-06-17

```

10	Trevor	Dillon	Eagan@id.org	1988-11-27
11	Leroy	Ashley	Carter@turpis.edu	1958-07-25
12	Elmo	Malone	Carla@enim.edu	1978-08-29
13	Laurel	Ball	Zelenia@Integer.us	1989-09-20
14	Zeus	Phillips	Branden@blandit.gov	1996-08-08

Note: Loading a single, large data file into HP Vertica through a single data connection is less efficient than loading a number of smaller files onto multiple nodes in parallel. Loading onto multiple nodes prevents any one node from becoming a bottleneck.

Querying HP Vertica Using Perl

To query HP Vertica using Perl:

- 1 Prepare a query statement using the Perl DBI module's `prepare` function. This function returns a statement handle that you use to execute the query and get the result set.
- 2 Execute the prepared statement by calling the `execute` function on the statement handle.
- 3 Retrieve the results of the query from the statement handle using one of several methods, such as calling the statement handle's `fetchrow_array` function to retrieve a row of data, or `fetchall_array` to get an array of arrays containing the entire result set (not a good idea if your result set may be very large!).

The following example demonstrates querying the table created by the example shown in ***Batch Loading Data Using Perl*** (page [223](#)). It executes a query to retrieve all of the content of the table, then repeatedly calls the statement handle's `fetchrow_array` function to get rows of data in an array. It repeats this process until `fetchrow_array` returns `undef`, which means that there are no more rows to be read.

```
#!/usr/bin/perl
use strict;
use DBI;

my $attr = {RaiseError => 1 }; # Make errors fatal to the Perl script.

# Open a connection using a DSN. Supply the username and password.
my $dbh = DBI->connect("dbi:ODBC:VerticaDSN","ExampleUser","password123",
                        $attr);

# Prepare a query to get the content of the table
my $sth = $dbh->prepare("SELECT * FROM TEST ORDER BY C_ID ASC");
# Execute the query by calling execute on the statement handle
$sth->execute();

# Loop through result rows while we have them, getting each row as an array
while (my @row = $sth->fetchrow_array()) {
    # The @row array contains the column values for this row of data
    # Loop through the column values
    foreach my $column (@row) {
        if (!defined $column) {
            # NULLs are signaled by undefs. Set to NULL for clarity
            $column = "NULL";
        }
        print "$column\t"; # Output the column separated by a tab
    }
    print "\n";
}

$dbh->disconnect();
```

The example prints the following when run:

```
1      1.111  Hello World!  2001-01-01    01:01:01      2001-01-01 01:01:01   1
2      2.22222 How are you? 2002-02-02    02:02:02      2002-02-02 02:02:02   0
4      4.22222 NULL       2002-02-02    02:02:02      2002-02-02 02:02:02   0
```

Binding Variables to Column Values

Another method of retrieving the query results is to bind variables to columns in the result set using the statement handle's `bind_columns` function. You may find this method convenient if you need to perform extensive processing on the returned data, since your code can use variables rather than array references to access the data. The following example demonstrates binding variables to the result set, rather than looping through the row and column values.

```

#!/usr/bin/perl
use strict;
use DBI;

my $attr = {RaiseError => 1 }; # Make SQL errors fatal to the Perl script.

# Open a connection using a DSN. Supply the username and password.
my $dbh = DBI->connect("dbi:ODBC:VerticaDSN32", "ExampleUser", "password123",
                        $attr);

# Prepare a query to get the content of the table
my $sth = $dbh->prepare("SELECT * FROM TEST ORDER BY C_ID ASC");
$sth->execute();

# Create a set of variables to bind to the column values.
my ($C_ID, $C_FP, $C_VARCHAR, $C_DATE, $C_TIME, $C_TS, $C_BOOL);

# Bind the variable references to the columns in the result set.
$sth->bind_columns(\$C_ID, \$C_FP, \$C_VARCHAR, \$C_DATE, \$C_TIME,
                     \$C_TS, \$C_BOOL);

# Now, calling fetch() to get a row of data updates the values of the bound
# variables. Continue calling fetch until it returns undefined.
while ($sth->fetch()) {
    # Note, you should always check that values are defined before using them,
    # since NULL values are translated into Perl as undefined. For this
    # example, just check the VARCHAR column for undefined values.
    if (!defined $C_VARCHAR) {
        $C_VARCHAR = "NULL";
    }
    # Just print values separated by tabs.
    print "$C_ID\t$C_FP\t$C_VARCHAR\t$C_DATE\t$C_TIME\t$C_TS\t$C_BOOL\n";
}

$dbh->disconnect();

```

The output of this example is identical to the output of the previous example.

Preparing, Querying, and Returning a Single Row

If you expect a single row as the result of a query (for example, when you execute a COUNT (*) query), you can use the DBI module's `selectrow_array` function to combine executing a statement and retrieving an array as a result.

The following example shows using `selectrow_array` to execute and get the results of the SHOW LOCALE statement. It also demonstrates changing the locale using the `do` function.

```
#!/usr/bin/perl
use strict;
use DBI;

my $attr = {RaiseError => 1 }; # Make SQL errors fatal to the Perl script.

# Open a connection using a DSN. Supply the username and password.
my $dbh = DBI->connect("dbi:ODBC:VerticaDSN","ExampleUser","password123",
                        $attr);

# Demonstrate setting/getting locale.

# Use selectrow_array to combine preparing a statement, executing it, and
# getting an array as a result.
my @localerv = $dbh->selectrow_array("SHOW LOCALE;");
# The locale name is the 2nd column (array index 1) in the result set.
print "Locale: $localerv[1]\n";

# Use do() to execute a SQL statement to set the locale.
$dbh->do("SET LOCALE TO en_GB");

# Get the locale again.
@localerv = $dbh->selectrow_array("SHOW LOCALE;");
print "Locale is now: $localerv[1]\n";

$dbh->disconnect();
```

The result of running the example is:

```
Locale: en_US@collation=binary (LEN_KBINARY)
Locale is now: en_GB (LEN)
```

Conversions between Perl and HP Vertica Data Types

Perl is a loosely-typed programming language that does not assign specific data types to values. It converts between string and numeric values based on the operations being performed on the values. For this reason, Perl has little problem extracting most string and numeric data types from HP Vertica. All interval data types (DATE, TIMESTAMP, etc.) are converted to strings. You can use several different date and time handling Perl modules to manipulate these values in your scripts.

HP Vertica NULL values translate to Perl's undefined (`undef`) value. When reading data from columns that can contain NULL values, you should always test whether a value is defined before using it.

When inserting data into HP Vertica, Perl's DBI module attempts to coerce the data into the correct format. By default, it assumes column values are VARCHAR unless it can determine that they are some other data type. If given a string value to insert into a column that has an integer or numeric data type, DBI attempts to convert the string's contents to the correct data type. If the entire string can be converted to a value of the appropriate data type, it inserts the value into the column. If not, inserting the row of data fails.

DBI transparently converts integer values into numeric or float values when inserting into column of FLOAT, NUMERIC, or similar data types. It converts numeric or floating values to integers only when there would be no loss of precision (the value to the right of the decimal point is 0). For example, it can insert the value 3.0 into an INTEGER column since there is no loss of precision when converting the value to an integer. It cannot insert 3.1 into an INTEGER column, since that would result in a loss of precision. It returns an error instead of truncating the value to 3.

The following example demonstrates some of the conversions that the DBI module performs when inserting data into HP Vertica.

```

#!/usr/bin/perl
use strict;
use DBI;

# Create a hash reference that holds a hash of parameters for the
# connection.
my $attr = {AutoCommit => 0, # Turn off autocommit
            PrintError => 0    # Turn off print error. Manually handled
            };

# Open a connection using a DSN. Supply the username and password.
my $dbh = DBI->connect("dbi:ODBC:VerticaDSN", "ExampleUser", "password123",
                        $attr);
if (defined DBI::err) {
    # Connection failed.
    die "Failed to connect: $DBI::errstr";
}

print "Connection AutoCommit state is: " . $dbh->{AutoCommit} . "\n";

# Create table to hold inserted data
$dbh->do("DROP TABLE IF EXISTS TEST CASCADE;");
$dbh->do("CREATE TABLE TEST( \
            C_ID INT, \
            C_FP FLOAT, \
            C_VARCHAR VARCHAR(100), \
            C_DATE DATE, C_TIME TIME, \
            C_TS TIMESTAMP, \
            C_BOOL BOOL)");

# Populate an array of arrays with values.
my @data = (
            # Start with matching data types
            [1,1.111,'Matching datatypes','2001-01-01','01:01:01'
             , '2001-01-01 01:01:01','t'],
            # Force floats -> int and int -> float.
            [2.0,2,"Ints <-> floats",'2002-02-02','02:02:02'
             , '2002-02-02 02:02:02',1],
            # Float -> int *only* works when there is no loss of precision.
            # this row will fail to insert:
            [3.1,3,"float -> int with trunc?",'2003-03-03','03:03:03'
             , '2003-03-03 03:03:03',1],
            # String values are converted into numbers
            ["4","4.4","Strings -> numbers", '2004-04-04','04:04:04',
             , '2004-04-04 04:04:04',0],
            # String -> numbers only works if the entire string can be
            # converted into a number
            ["5 and a half","5.5","Strings -> numbers", '2005-05-05',
             , '05:05:05', , '2005-05-05 05:05:05',0],
            # Number are converted into string values automatically,
            # assuming they fit into the column width.
            [6,6.6,3.14159, '2006-06-06','06:06:06',
             , '2006-06-06 06:06:06',0],

```

```

        # There are some variations in the accepted date strings
        [7,7.7,'Date/time formats', '07/07/2007','07:07:07',
         , '07-07-2007 07:07:07',1],
    );
# Create a prepared statement to use parameters for inserting values.
my $sth = $dbh->prepare_cached("INSERT into test values(?, ?, ?, ?, ?, ?, ?)");

my $rowcount = 0; # Count # of rows

# Loop through the arrays to insert values
foreach my $tuple (@data) {
    $rowcount++;
    # Insert the row
    my $retval = $sth->execute(@$tuple);

    # See if the row was successfully inserted.
    if ($retval == 1) {
        # Value of 1 means the row was inserted (1 row was affected by insert)
        print "Row $rowcount successfully inserted\n";
    } else {
        print "Inserting row $rowcount failed with error ".
              $sth->state . " " . $sth->errstr . "\n";
    }
}

# Commit the data
$dbh->commit();

# Prepare a query to get the content of the table
$sth = $dbh->prepare("SELECT * FROM TEST ORDER BY C_ID ASC");
$sth->execute() or die "Error: " . $dbh->errstr;
my @row; # Need to pre-declare to use in the format statement.

# Use Perl formats to pretty print the output.
format STDOUT_TOP =
Int      Float          VarChar          Date       Time       Timestamp      Bool
====  =====  =====  =====  =====  =====  =====  =====
.

format STDOUT =
@>>  @<<<<  @<<<<<<<<<<<  @<<<<<<<  @<<<<<<<<<<<  @<<<<
@row
.

# Loop through result rows while we have them
while (@row = $sth->fetchrow_array()) {
    write; # Format command does the work of extracting the columns from
           # the array.
}

# Commit to stop Perl complaining about in-progress transactions.
$dbh->commit();
$dbh->disconnect();

```

The example produces the following output when run:

```
Connection AutoCommit state is: 0
Row 1 successfully inserted
Row 2 successfully inserted
Inserting row 3 failed with error 01000 [Vertica][VerticaDSII] (20) An error
occurred during query execution: Row rejected by server; see server log for details
(SQL-01000)
Row 4 successfully inserted
Inserting row 5 failed with error 01000 [Vertica][VerticaDSII] (20) An error
occurred during query execution: Row rejected by server; see server log for details
(SQL-01000)
Row 6 successfully inserted
Row 7 successfully inserted
Int   Float          VarChar        Date      Time      Timestamp     Bool
====  =====  =====
 1    1.111  Matching datatypes  2001-01-01 01:01:01 2001-01-01 01:01 1
 2    2       Ints <-> floats   2002-02-02 02:02:02 2002-02-02 02:02 1
 4    4.4    Strings -> numbers  2004-04-04 04:04:04 2004-04-04 04:04 0
 6    6.6    3.14159            2006-06-06 06:06:06 2006-06-06 06:06 0
 7    7.7    Date/time formats  2007-07-07 07:07:07 2007-07-07 07:07 1
```

Perl Unicode Support

Perl supports Unicode data with some caveats. See the [*perlunicode*](#)

<http://perldoc.perl.org/perlunicode.html> and the [*perlunitut*](#)

<http://perldoc.perl.org/perlunitut.html> (Perl Unicode tutorial) manual pages for details. (Be sure to see the copies of these manual pages included with the version of Perl installed on your client system, as the support for Unicode has changed in recent versions of Perl.) Perl DBI and DBD::ODBC also support Unicode, however DBD::ODBC must be compiled with Unicode support. See the [**DBD::ODBC**](#) <http://search.cpan.org/~mjevans/DBD-ODBC-1.43/ODBC.pm> documentation for details. You can check the DBD::ODBC-specific connection attribute named `odbc_has_unicode` to see if Unicode support is enabled in the driver.

The following example Perl script demonstrates directly inserting UTF-8 strings into HP Vertica and then reading them back. The example writes a text file with the output, since there are may problems displaying Unicode characters in terminal windows or consoles.

```

#!/usr/bin/perl
use strict;
use DBI;

# Open a connection using a DSN.
my $dbh = DBI->connect("dbi:ODBC:VerticaDSN","ExampleUser","password123");
unless (defined $dbh) {
    # Connection failed.
    die "Failed to connect: $DBI::errstr";
}

# Output to a file. Displaying Unicode characters to a console or terminal
# window has many problems. This outputs a UTF-8 text file that can
# be handled by many Unicode-aware text editors:
open OUTFILE, '>:utf8', "unicodeout.txt";

# See if the DBD::ODBC driver was compiled with Unicode support. If this returns
# 1, your Perl script will get strings from the driver with the UTF-8
# flag set on them, ensuring that Perl handles them correctly.
print OUTFILE "Was DBD::ODBC compiled with Unicode support? " .
    $dbh->{odbc_has_unicode} . "\n";

# Create a table to hold VARCHARs
$dbh->do ("DROP TABLE IF EXISTS TEST CASCADE");

# Create a table to hold data. Remember that the width of the VARCHAR column
# is the number of bytes set aside to store strings, which often does not equal
# the number of characters it can hold when it comes to Unicode!
$dbh->do ("CREATE TABLE test( C_VARCHAR VARCHAR(100) )");

print OUTFILE "Inserting data...\n";
# Use Do to perform simple inserts
$dbh->do ("INSERT INTO test VALUES('Hello')");
# This string contains several non-latin accented characters and symbols, encoded
# with Unicode escape notation. They are converted by Perl into UTF-8 characters
$dbh->do ("INSERT INTO test VALUES('My favorite band is " .
    "\N{U+00DC}ml\N{U+00E4}\N{U+00FC}t \N{U+00D6}v\N{U+00EB}rk\N{U+00EF}ll" .
    "\N{U+263A}')");
# Some Chinese (Simplified) characters. This again uses escape sequence
# that Perl translates into UTF-8 characters.
$dbh->do ("INSERT INTO test VALUES('\x{4F60}\x{597D}')");

print OUTFILE "Getting data...\n";
# Prepare a query to get the content of the table
my $sth = $dbh->prepare_cached("SELECT * FROM test");
# Execute the query by calling execute on the statement handle
$sth->execute();

# Loop through result rows while we have them
while (my @row = $sth->fetchrow_array()) {
    # Loop through the column values
    foreach my $column (@row) {
        print OUTFILE "$column\t";
    }
}

```

```
    print OUTFILE "\n";
}

close OUTFILE;
$dbh->disconnect();
```

Viewing the unicodeout.txt file in a UTF-8-capable text editor or viewer displays:

```
Was DBD::ODBC compiled with Unicode support? 1
Inserting data...
Getting data...
My favorite band is Ümläüt Övärkïll ☺
你好
Hello
```

Note: Terminal windows and consoles often have problems properly displaying Unicode characters. That is why the example writes the output to a text file. With some text editors, you may need to manually set the encoding of the text file to UTF-8 in order for the characters to properly appear (and the font used to display text must have a full Unicode character set). If the character still do not show up, it may be that your version of DBD::ODBC was not compiled with UTF-8 support.

See Also

- Unicode Character Encoding in the Concepts Guide.
- ***Additional ODBC Driver Configuration Settings*** (page [49](#))

Programming PHP Client Applications

You can connect to HP Vertica through PHP-ODBC using the *Unix ODBC* <http://www.unixodbc.org/> or *iODBC* <http://www.iodbc.org/dataspace/iodbc/wiki/iODBC/> library.

In order to use PHP with HP Vertica, you must install the following packages (and their dependencies):

- php
- php-odbc
- php-pdo
- UnixODBC (if you are using the Unix ODBC driver)
- libiodbc (if you are using the iODBC driver)

PHP on Linux

PHP is available with most Linux operating systems as a module for the Apache web server. Check your particular Linux repository for PHP RPMs or Debian packages. You can also build PHP from source. See the PHP web site for documentation and source downloads.

PHP on Windows

PHP is available for windows for both the Apache and IIS web servers. You can download PHP for Windows and view installation instructions at the PHP web site.

The PHP ODBC Drivers

PHP supports both the *UnixODBC* <http://www.unixodbc.org/> drivers and *iODBC* <http://www.iodbc.org/dataspace/iodbc/wiki/iODBC/> drivers. Both drivers use PHP's ODBC database abstraction layer.

Setup

You must read **Programming ODBC Client Applications** (page 54) before connecting to HP Vertica through PHP. The following example ODBC configuration entries detail the typical settings required for PHP ODBC connections. The driver location assumes you have copied the HP Vertica drivers to /usr/lib64.

Example odbc.ini

```
[ODBC Data Sources]
VerticaDSNunixodbc = exampledb
VerticaDSNiodbc = exampledb2
[VerticaDSNunixodbc]
Description = VerticaDSN Unix ODBC driver
Driver = /usr/lib64/libverticaodbc.so
Database = Telecom
Servername = localhost
UserName = dbadmin
Password =
Port = 5433
[VerticaDSNiodbc]
```

```
Description = VerticaDSN iODBC driver
Driver = /usr/lib64/libverticaodbc.so
Database = Telecom
Servername = localhost
UserName = dbadmin
Password =
Port = 5433
```

Example odbcinst.ini

```
# Vertica
[VerticaDSNunixodbc]
Description = VerticaDSN Unix ODBC driver
Driver = /usr/lib64/libverticaodbc.so
[VerticaDNSiodbc]
Description = VerticaDSN iODBC driver
Driver = /usr/lib64/libverticaodbc.so
[ODBC]
Threading = 1
```

Verify the HP Vertica UnixODBC or iODBC Library

Verify the HP Vertica UnixODBC library can load all dependant libraries with the following command (assuming you have copies the libraries to /usr/lib64):

For example:

```
ldd /usr/lib64/libverticaodbc.so
```

You must resolve any "not found" libraries before continuing.

Test your ODBC connection

Test your ODBC connection with the following.

```
isql -v VerticaDSN
```

PHP Unicode Support

PHP does not offer native Unicode support. PHP only supports a 256-character set. However, PHP provides the UTF-8 functions `utf8_encode()` and `utf8_decode()`

<http://www.php.net/manual/en/function.utf8-decode.php> to provide some basic Unicode functionality.

See the PHP manual for **strings** <http://php.net/manual/en/language.types.string.php> for more details about PHP and Unicode.

Querying the Database Using PHP

The example script below details the use of PHP ODBC functions to connect to the HP Vertica Analytics Platform.

```
<?php
# Turn on error reporting
error_reporting(E_ERROR | E_WARNING | E_PARSE | E_NOTICE);

# A simple function to trap errors from queries
function errortrap_odbc($conn, $sql) {
    if(!$rs = odbc_exec($conn,$sql)) {
        echo "<br/>Failed to execute SQL: $sql<br/>" . odbc_errormsg($conn);
    } else {
        echo "<br/>Success: " . $sql;
    }
    return $rs;
}

# Connect to the Database
$dsn = "VerticaDSNunixodbc";
$conn = odbc_connect($dsn,'','') or die ("<br/>CONNECTION ERROR");
echo "<p>Connected with DSN: $dsn</p>";

# Create a table
$sql = "CREATE TABLE TEST(
    C_ID INT,
    C_FP FLOAT,
    C_VARCHAR VARCHAR(100),
    C_DATE DATE, C_TIME TIME,
    C_TS TIMESTAMP,
    C_BOOL BOOL)";
$result = errortrap_odbc($conn, $sql);

# Insert data into the table with a standard SQL statement
$sql = "INSERT into test values(1,1.1,'abcdefg1234567890','1901-01-01','23:12:34
','1901-01-01 09:00:09','t')";
$result = errortrap_odbc($conn, $sql);

# Insert data into the table with odbc_prepare and odbc_execute
$values = array(2,2.28,'abcdefg1234567890','1901-01-01','23:12:34','1901-01-01
0
9:00:09','t');
$statement = odbc_prepare($conn,"INSERT into test values(?, ?, ?, ?, ?, ?, ?)");
if(!$result = odbc_execute($statement, $values)) {
    echo "<br/>odbc_execute Failed!";
} else {
    echo "<br/>Success: odbc_execute.";
}

# Get the data from the table and display it
$sql = "SELECT * FROM TEST";
if($result = errortrap_odbc($conn, $sql)) {
    echo "<pre>";
    while($row = odbc_fetch_array($result) ) {


```

```

        print_r($row);
    }
    echo "</pre>";
}

# Drop the table and projection
$sql = "DROP TABLE TEST CASCADE";
$result = errortrap_odbc($conn, $sql);

# Close the ODBC connection
odbc_close($conn);
?>

```

Example Output

The following is the example output from the script.

```

Success: CREATE TABLE TEST( C_ID INT, C_FP FLOAT, C_VARCHAR VARCHAR(100), C_DATE
DATE, C_TIME TIME, C_TS TIMESTAMP, C_BOOL BOOL)
Success: INSERT into test
values(1,1.1,'abcdefg1234567890','1901-01-01','23:12:34 ','1901-01-01
09:00:09','t')
Success: odbc_execute.
Success: SELECT * FROM TEST

Array
(
    [C_ID] => 1
    [C_FP] => 1.1
    [C_VARCHAR] => abcdefg1234567890
    [C_DATE] => 1901-01-01
    [C_TIME] => 23:12:34
    [C_TS] => 1901-01-01 09:00:09
    [C_BOOL] => 1
)
Array
(
    [C_ID] => 2
    [C_FP] => 2.28
    [C_VARCHAR] => abcdefg1234567890
    [C_DATE] => 1901-01-01
    [C_TIME] => 23:12:34
    [C_TS] => 1901-01-01 23:12:34
    [C_BOOL] => 1
)

Success: DROP TABLE TEST CASCADE

```

Using vsq

vsq is a character-based, interactive, front-end utility that lets you type SQL statements and see the results. It also provides a number of meta-commands and various shell-like features that facilitate writing scripts and automating a variety of tasks.

If you are using the vsq client installed on the server, then you can connect from the:

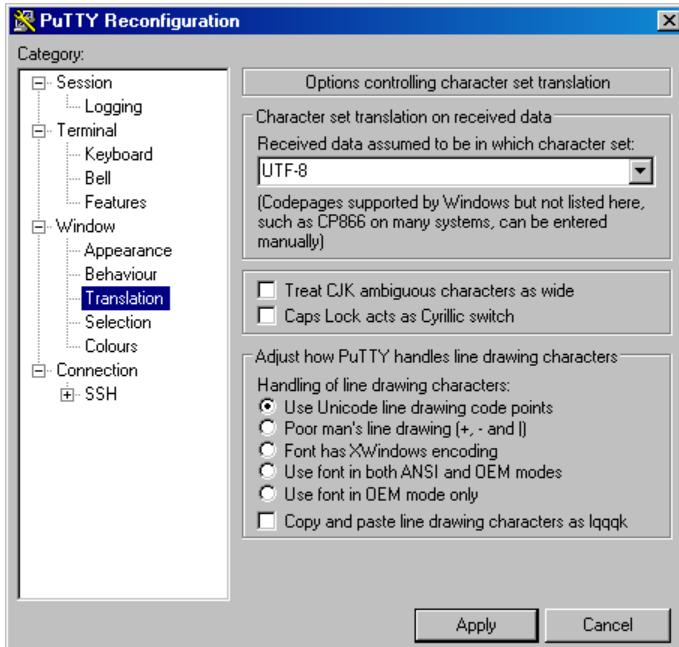
- **Administration Tools** (page [246](#))
- **Linux command line** (page [247](#))

You can also *install the vsq client* for other supported platforms.

A man page is available for vsq. If you are running as the dbadmin user, simply type: `man vsq`. If you are running as a different user, type: `man -M /opt/vertica/man vsq`.

General Notes

- SQL statements can be spread over several lines for clarity.
- vsq can handle input and output in UTF-8 encoding. Note that the terminal emulator running vsq must be set up to display the UTF-8 characters correctly. Follow the documentation of your terminal emulator. The following example shows the settings in PuTTY from the Change Settings > Window > Translation option:



See also Best Practices for Working with Locales.

- Cancel SQL statements by typing `Ctrl+C`.
- Traverse command history by typing `Ctrl+R`.
- When you disconnect a user session, any transactions in progress are automatically rolled back.
- To view wide result sets, use the Linux `less` utility to truncate long lines.

1. Before connecting to the database, specify that you want to use `less` for query output:

```
$ export PAGER=less
```
 2. Connect to the database.
 3. Query a wide table:

```
=> select * from wide_table;
```
 4. At the `less` prompt, type:
`-S`
- If a shell running vsqI fails (crashes or freezes), the vsqI processes continue to run even if you stop the database. In that case, log in as root on the machine on which the shell was running and manually kill the vsqI process. For example:
- ```
ps -ef | grep vertica
:
fred 2401 1 0 06:02 pts/1 00:00:00 /opt/vertica/bin/vsqI -p
5433 -h test01_site01 quick_start_single
:
kill -9 2401
```

## Installing the vsqI Client

The vsqI client is installed as part of the HP Vertica server rpm, but it is also available as a download for other Unix-based systems such as HP-UX, AIX, and Mac OSX.

### How to install vsqI on Unix-based systems:

- 1 Use a web browser to log in to the ***myVertica portal*** <http://my.vertica.com/>.
- 2 Click the Download tab, scroll down to the CLIENT PACKAGES section and download the appropriate vsqI client from the HP Vertica downloads page. Note that there are both 32-bit and 64-bit versions for most platforms.
- 3 Extract the tarball. The tarball is organized to extract into /opt/vertica if you extract it at the root (/) of the drive.
- 4 Optionally add the directory where the vsqI client resides to your path.
- 5 Verify mode on the vsqI file is executable. For example: `chmod ugo+x vsqI_VERSION`
- 6 Set your shell locale to a locale supported by vsqI. For example, in your .profile, add, `export LANG=en_US.UTF-8`

### Installing vsqI on Windows:

vsqI on Windows is installed as part of the Windows Client Driver package. To install vsqI on windows see the instructions for ***installing the Windows Client Driver*** package.

See ***vsqI Notes for Windows Users*** for details on using vsqI in a windows console.

## vsqI Notes for Windows Users

### Font

Set the console font to "Lucida Console", because the raster font does not work well with the ANSI code page.

### Console Encoding

vsqI is built as a "console application." The Windows console windows use a different encoding than the rest of the system, so take care when you use 8-bit characters within vsqI. If vsqI detects a problematic console code page, it warns you at startup. To change the console code page, two things are necessary:

- Set the code page by entering cmd.exe /c chcp 1252.  
1252 is a code page that is appropriate for European languages; replace it with your preferred locale code page.

### Running Under Cygwin

Verify that your cygwin.bat file does not include the "tty" flag. If the "tty" flag is included in your cygwin.bat file, then banners and prompts are not displayed in vsqI.

For example, change:

```
set CYGWIN=binmode tty ntsec
```

to:

```
set CYGWIN=binmode ntsec
```

Additionally, when running under Cygwin, vsqI uses Cygwin shell conventions as opposed to Windows console conventions.

### Tab Completion

Tab completion is a function of the shell, not vsqI. Because of this, tab completion does not work the same way in Windows vsqI as it does on Linux versions of vsqI.

On Windows, instead of using tab-completion. Press F7 to pop-up a history window of commands, or press F8 after typing a few letters of a command to cycle through commands in the history buffer starting with the same letters.

## Connecting From the Administration Tools

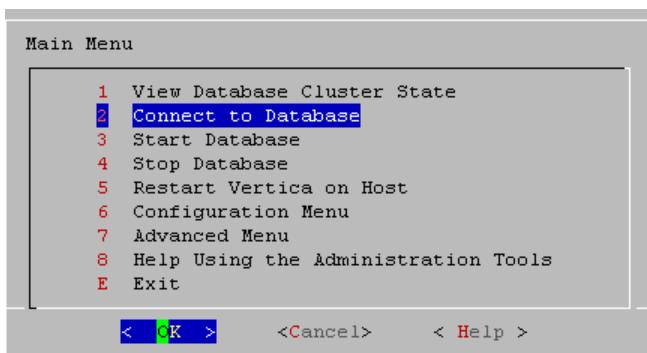
You can use the Administration Tools to connect to a database using vsqI on any node in the cluster.

1 Log in as any user that does not have root privileges. (HP Vertica does not allow users with root privileges to connect to a database for security reasons).

2 Run the Administration Tools.

```
/opt/vertica/bin/admintools
```

3 On the Main Menu, select Connect to Database.



4 Supply the database password if asked:

Password:

When you create a new user with the CREATE USER command, you can configure the password or leave it empty. You cannot bypass the password if the user was created with a password configured. You can change a user's password using the ALTER USER command.

5 The Administration Tools connect to the database and transfer control to vsqI.

Welcome to vsqI, the Vertica Analytic Database interactive terminal.

Type: \h or \? for help with vsqI commands  
 \g or terminate with semicolon to execute query  
 \q to quit

=>

**Note:** See **Meta-Commands** (page [252](#)) for the various commands you can run while connected to the database through the Administration Tools.

## Connecting from the Command Line

You can use vsqI from the command line to connect to a database from any Linux machine, including those not part of the cluster. Copy /opt/vertica/bin/vsqI to your machine.

### Syntax

```
/opt/vertica/bin/vsqI [option...] [dbname [username]]
```

### Parameters

|               |                                                                                 |
|---------------|---------------------------------------------------------------------------------|
| <i>option</i> | One or more of the vsqI <b>command line options</b> (page <a href="#">248</a> ) |
| <i>dbname</i> | The name of the target database                                                 |

|          |                                    |
|----------|------------------------------------|
| username | The name of the user to connect as |
|----------|------------------------------------|

## Notes

- If the database is password protected, you must specify the `-w` or `--password` command line option.
- The default dbname and username is your Linux user name.
- If the connection cannot be made for any reason (for example, insufficient privileges, server is not running on the targeted host, etc.), vsql returns an error and terminates.
- vsql returns the following informational messages:
  - 0 to the shell if it finished normally
  - 1 if a fatal error of its own (out of memory, file not found) occurs
  - 2 if the connection to the server went bad and the session was not interactive
  - 3 if an error occurred in a script and the variable `ON_ERROR_STOP` was set
- Unrecognized words in the command line might be interpreted as database or user names.

## Example

The following example redirects vsql output and error messages into an output file called `retail_queries.out` and captures any error messages:

```
$ vsql --echo-all < retail_queries.sql > retail_queries.out 2>&1
```

## Command Line Options

This section contains the command-line options for vsql:

- ? --help displays help about vsql command line arguments and exits.
- a --echo-all prints all input lines to standard output as they are read. This is more useful for script processing than interactive mode. It is equivalent to setting the variable `ECHO` (page [274](#)) to all.
- A --no-align switches to unaligned output mode. (The default output mode is aligned.)
- c command --command command runs one command and exits. This is useful in shell scripts. The command must be either a command string that can be completely parsed by the server (it contains no vsql specific features), or a single meta-command. In other words, you cannot mix SQL and vsql meta-commands. To achieve that, you can pipe the string into vsql like this:

```
echo "\\\ntiming\\\\\\select * from t" | ../Linux64/bin/vsql
Timing is on.
i | c | v
----+---+
(0 rows)
```

**Note:** If you use double quotes with echo, you must double the backslashes.

- d dbname --dbname dbname specifies the name of the database to connect to. This is equivalent to specifying `dbname` as the first non-option argument on the command line.

**-e --echo-queries** copies all SQL commands sent to the server to standard output as well. This is equivalent to setting the variable ECHO (page [274](#)) to queries.

**-E** displays queries generated by internal commands.

**-f filename --file filename** uses the file *filename* as the source of commands instead of reading commands interactively. After the file is processed, vsq terminates. This is in many ways equivalent to the internal command \i (see "i FILE" on page [265](#)).

If *filename* is – (hyphen), the standard input is read.

Using this option is subtly different from writing `vsq < filename`. In general, both do what you expect, but using **-f** enables some nice features such as error messages with line numbers. There is also a slight chance that using this option reduces the start-up overhead. On the other hand, the variant using the shell's input redirection is (in theory) guaranteed to yield exactly the same output that you would have gotten had you entered everything by hand.

### Using f filename to Read Data Piped into vsq

To read data piped into vsq from a data file:

1. Create the following:

- A named pipe. For example, to create a named pipe called pipe1: `mkfifo pipe1`
  - A data file. The data file in this example is called *data\_file*.
  - The command file that selects the table into which you want to copy data, copies the data from the pipe file (pipe1), and removes the pipe file. The command file in this example is called *command\_line*.
1. From the command line, run a command that pipes the data file (*data\_file*) into the appropriate table through vsq. The following example pipes the data file into `public.shipping_dimension` in the VMart database.

```
cat data_file > pipe1 | vsq -f 'command_line'
```

Example *data\_file*:

```
110|EXPRESS|SEA|FEDEX
111|EXPRESS|HAND CARRY|MSC
112|OVERNIGHT|COURIER|USPS
```

Example *command\_line* file:

```
SELECT * FROM public.shipping_dimension;

\set dir `pwd`/
\set file '":dir"pipe1'

COPY public.shipping_dimension FROM :file delimiter '|';

SELECT * FROM public.shipping_dimension;

--Remove the pipe1
\! rm pipe1
```

`-F separator --field-separator separator` specifies the field separator for unaligned output (default: "|") (`-P fieldsep=`). (See `-A --no-align`.) This is equivalent to `\pset` (page [267](#)) `fieldsep` or `\f (see "f [ string ]" on page 263)`.

`-h hostname --host hostname` specifies the host name of the machine on which the server is running.

**Notes:**

- If you are using client authentication with a connection method of either "gss" or "krb5" (Kerberos), you are required to specify `-h hostname`.
- If you are using client authentication with a "local" connection type specified, avoid using `-h hostname` if you want to match the client authentication entry.

`-H --html` turns on HTML tabular output. This is equivalent to `\pset` (page [267](#)) `format html` or the `\H (see "H" on page 264)` command.

`-l --list` returns all available databases, then exits. Other non-connection options are ignored. This command is similar to the internal command `\list`.

`-n` disables command line editing.

`-o filename --output filename` writes all query output into file *filename*. This is equivalent to the command `\o (page 266)`.

`-p port --port port` specifies the TCP port or the local socket file extension on which the server is listening for connections. Defaults to port 5433.

`-P assignment --pset assignment` lets you specify printing options in the style of `\pset` (page [267](#)) on the command line. Note that you have to separate name and value with an equal sign instead of a space. Thus to set the output format to LaTeX, you could write `-P format=latex`.

`-q --quiet` specifies that vsql do its work quietly. By default, it prints welcome messages and various informational output. If this option is used, none of this appears. This is useful with the `-c` option. Within vsql you can also set the `QUIET` (page [276](#)) variable to achieve the same effect.

`-R separator --record-separator separator` uses *separator* as the record separator. This is equivalent to the `\pset` (page [267](#)) `recordsep` command.

`-s --single-step` runs in single-step mode for debugging scripts. Forces vsql to prompt before each statement is sent to the database and allows you to cancel execution.

`-S --single-line` runs in single-line mode where a newline terminates a SQL command, like the semicolon does.

**Note:** This mode is provided for those who insist on it, but you are not necessarily encouraged to use it, particularly if you mix SQL and meta-commands on a line. The order of execution might not always be clear to the inexperienced user.

`-t --tuples-only` disables printing of column names, result row count footers, and so on. This is equivalent to the `\t (see "t" on page 271)` command.

`-T table_options --table-attr table_options` allows you to specify options to be placed within the HTML table tag. See [\pset \(page 267\)](#) for details.

`-U username --username username` connects to the database as the user *username* instead of the default.

`-v assignment --set assignment --variable assignment` performs a variable assignment, like the `\set` (see "set [ NAME [ VALUE [ ... ] ] ]" on page [270](#)) internal command.

**Note:** You must separate name and value, if any, by an equal sign on the command line.

To unset a variable, omit the equal sign. To set a variable without a value, use the equal sign but omit the value. These assignments are done during a very early stage of start-up, so variables reserved for internal purposes can get overwritten later.

`-V --version` prints the vsq version and exits.

`-w password` specifies the password for a database user.

**Note:** Using this command line option displays the database password in plain text on the screen. Use it with care, particularly if you are connecting as the database administrator.

`-W --password` forces vsq to prompt for a password before connecting to a database.

The password is not displayed on the screen. This option remains set for the entire session, even if you change the database connection with the meta-command `\connect` (see "c (or \connect) [ dbname [ username ] ]" on page [254](#)).

`-x --expanded` enables extended table formatting mode. This is equivalent to the command `\ x` (see "x" on page [272](#)).

`-X, --no-vsqlirc` prevents the start-up file from being read (the system-wide `vsqlirc` file or the user's `~/.vsqlirc` file).

## Connecting From a Non-Cluster Host

You can use the HP Vertica vsq executable image on a non-cluster Linux host to connect to an HP Vertica database.

- On Red Hat 5.0 64-bit and SUSE 10/11 64-bit, you can install the client driver RPM, which includes the vsq executable. See **Installing the Client RPM on Red Hat and SUSE** (page [21](#)) for details.
- If the non-cluster host is running the same version of Linux as the cluster, copy the image file to the remote system. For example:
 

```
$ scp host01:/opt/vertica/bin/vsq .
$./vsq
```

- If the non-cluster host is running a different version of Linux than your cluster hosts, and that operating system is not Red Hat version 5 64-bit or SUSE 10/11 64-bit, you must install the HP Vertica server RPM in order to get vsq1. Download the appropriate rpm package from the Download tab of the **myVertica portal** <http://my.vertica.com/> then log into the non-cluster host as root and install the rpm package using the command:

```
rpm -Uvh filename
```

In the above command, *filename* is package you downloaded. Note that you do not have to run the `install_HP_Vertica` script on the non-cluster host in order to use vsq1.

## Notes

- Use the same **command line options** (page [248](#)) that you would on a cluster host.
- You cannot run vsq1 on a Cygwin bash shell (Windows). Use ssh to connect to a cluster host, then run vsq1.

## Meta-Commands

Anything you enter in vsq1 that begins with an unquoted backslash is a vsq1 meta-command that is processed by vsq1 itself. These commands help make vsq1 more useful for administration or scripting. Meta-commands are more commonly called slash or backslash commands.

The format of a vsq1 command is the backslash, followed immediately by a command verb, then any arguments. The arguments are separated from the command verb and each other by any number of whitespace characters.

To include whitespace into an argument you can quote it with a single quote. To include a single quote into such an argument, precede it by a backslash. Anything contained in single quotes is furthermore subject to C-like substitutions for `\n` (new line), `\t` (tab), `\digits`, `\0digits`, and `\0xdigits` (the character with the given decimal, octal, or hexadecimal code).

If an unquoted argument begins with a colon (:), it is taken as a vsq1 variable and the value of the variable is used as the argument instead.

Arguments that are enclosed in backquotes (`) are taken as a command line that is passed to the shell. The output of the command (with any trailing newline removed) is taken as the argument value. The above escape sequences also apply in backquotes.

Some commands take a SQL identifier (such as a table name) as argument. These arguments follow the syntax rules of SQL: Unquoted letters are forced to lowercase, while double quotes ("") protect letters from case conversion and allow incorporation of whitespace into the identifier. Within double quotes, paired double quotes reduce to a single double quote in the resulting name. For example, FOO"BAR"BAZ is interpreted as fooBARbaz, and "A weird"" name" becomes A weird" name.

Parsing for arguments stops when another unquoted backslash occurs. This is taken as the beginning of a new meta-command. The special sequence `\\"` (two backslashes) marks the end of arguments and continues parsing SQL commands, if any. That way SQL and vsq1 commands can be freely mixed on a line. But in any case, the arguments of a meta-command cannot continue beyond the end of the line.

**! [ COMMAND ]**

**\! [ COMMAND ]** executes a command in a Linux shell (passing arguments as entered) or starts an interactive shell.

**?**

**\?** displays help information about the meta-commands. Works the same as **\h** (see "**h Help**" on page [264](#)).

=> \?

**General**

```
\c[onnect] [DBNAME| - [USER]] connect to new database (currently "VMart")
\cd [DIR] change the current working directory
\q quit vsql
\set [NAME [VALUE]] set internal variable, or list all if no parameters
\timing toggle timing of commands (currently off)
\unset NAME unset (delete) internal variable
\! [COMMAND] execute command in shell or start interactive shell
\password [USER] change user's password
```

**Query Buffer**

```
\e [FILE] edit the query buffer (or file) with external editor
\g send query buffer to server
\g FILE send query buffer to server and results to file
\g | COMMAND send query buffer to server and pipe results to command
\p show the contents of the query buffer
\reset (clear) the query buffer
\s [FILE] display history or save it to file
\w FILE write query buffer to file
```

**Input/Output**

```
\echo [STRING] write string to standard output
\i FILE execute commands from file
\o FILE send all query results to file
\o | COMMAND pipe all query results to command
\o close query-results file or pipe
\qecho [STRING] write string to query output stream (see \o)
```

**Informational**

```
\d [PATTERN] describe tables (list tables if no argument is supplied)
```

```
\df [PATTERN] list functions
\dj [PATTERN] list projections
\dn [PATTERN] list schemas
\dp [PATTERN] list table access privileges
\ds [PATTERN] list sequences
\ds [PATTERN] list system tables
\dt [PATTERN] list tables
\dtv [PATTERN] list tables and views
\dT [PATTERN] list data types
\du [PATTERN] list users
\dv [PATTERN] list views
\l list all databases
\z [PATTERN] list table access privileges (same as \dp)
```

#### Formatting

```
\a toggle between unaligned and aligned output mode
\b toggle beep on command completion
\c [STRING] set table title, or unset if none
\f [STRING] show or set field separator for unaligned query output
\H toggle HTML output mode (currently off)
\pset NAME [VALUE]
 set table output option
 (NAME := {format|border|expanded|fieldsep|footer|null|
 recordsep|tuples_only|title|tableattr|pager})
\t show only rows (currently off)
\T [STRING] set HTML <table> tag attributes, or unset if none
\x toggle expanded output (currently off)
```

## a

\a toggles output format alignment. This command is kept for backwards compatibility. See [\pset](#) (page [267](#)) for a more general solution.

\a is similar to the command line option -A --no-align, which only disables alignment.

## b

\b toggles beep on command completion.

## c (or \connect) [ dbname [ username ] ]

\c (or \connect) [ dbname [ username ] ] establishes a connection to a new database and/or under a user name. The previous connection is closed. If dbname is - the current database name is assumed.

If username is omitted the current user name is assumed.

As a special rule, `\connect` without any arguments connects to the default database as the default user (as you would have gotten by starting vsql without any arguments).

If the connection attempt fails (wrong user name, access denied, etc.), the previous connection is kept if and only if vsql is in interactive mode. When executing a non-interactive script, processing immediately stops with an error. This distinction that avoids typos and a prevent scripts from accidentally acting on the wrong database.

## C [ STRING ]

`\C [ STRING ]` sets the title of any tables being printed as the result of a query or unsets any such title. This command is equivalent to `\pset title title`. (The name of this command derives from "caption", as it was previously only used to set the caption in an HTML table.)

## cd [ DIR ]

`\cd [ DIR ]` changes the current working directory to *directory*. Without argument, changes to the current user's home directory.

To print your current working directory, use `!pwd` (see "`! [ COMMAND ]`" on page [253](#)) for example:

```
=> \!pwd
/home/dbadmin
```

## The \d [ PATTERN ] meta-commands

This section describes the various `\d` meta-commands

All `\d` meta-commands take an optional pattern (asterisk [ \* ] or question mark [ ? ]) and return only the records that match that pattern.

The ? argument is useful if you can't remember if a table name uses an underscore or a dash:

```
=> \dn v?internal
 List of schemas
 Name | Owner
-----+-----
 v_internal | dbadmin
(1 row)
```

The output from the `\d` metacommands places double quotes around non-alphanumeric table names and table names that are keywords, such as in the following example.

```
=> CREATE TABLE my_keywords.precision(x numeric (4,2));
CREATE TABLE
=> \d
 List of tables
 Schema | Name | Kind | Owner
-----+-----+-----+-----
```

```
my_keywords | "precision" | table | dbadmin
```

Double quotes are optional when you use a `\d` command with pattern matching.

## d [ PATTERN ]

The `\d [ PATTERN ]` meta-command lists all tables in the database and returns their schema, table name, kind (e.g., table), and owner. For example, the following is the result of `\d` in the vmart schema.

```
vmartdb=> \d
```

| List of tables |                       |       |         |  |
|----------------|-----------------------|-------|---------|--|
| Schema         | Name                  | Kind  | Owner   |  |
| online_sales   | call_center_dimension | table | dbadmin |  |
| online_sales   | online_page_dimension | table | dbadmin |  |
| online_sales   | online_sales_fact     | table | dbadmin |  |
| public         | customer_dimension    | table | dbadmin |  |
| public         | date_dimension        | table | dbadmin |  |
| public         | employee_dimension    | table | dbadmin |  |
| public         | inventory_fact        | table | dbadmin |  |
| public         | product_dimension     | table | dbadmin |  |
| public         | promotion_dimension   | table | dbadmin |  |
| public         | shipping_dimension    | table | dbadmin |  |
| public         | vendor_dimension      | table | dbadmin |  |
| public         | warehouse_dimension   | table | dbadmin |  |
| store          | store_dimension       | table | dbadmin |  |
| store          | store_orders_fact     | table | dbadmin |  |
| store          | store_sales_fact      | table | dbadmin |  |

(15 rows)

If you provide the table name as an argument, the result shows the schema name, table name, column name, column data type, data type size, default value, whether it is Nullable or has a NOT NULL constraint, and whether there is a primary key or foreign key constraint.

```
vmartdb=> \d inventory_fact
```

| List of Fields by Tables |                     |                   |      |      |         |          |             |             |
|--------------------------|---------------------|-------------------|------|------|---------|----------|-------------|-------------|
| Schema                   | Table               | Column            | Type | Size | Default | Not Null | Primary Key | Foreign Key |
| public                   | inventory_fact      | date_key          | int  | 8    |         | t        | f           |             |
| public                   | date_dimension      | (date_key)        |      |      |         |          |             |             |
| public                   | inventory_fact      | product_key       | int  | 8    |         | t        | f           |             |
| public                   | product_dimension   | (product_key)     |      |      |         |          |             |             |
| public                   | inventory_fact      | product_version   | int  | 8    |         | t        | f           |             |
| public                   | product_dimension   | (product_version) |      |      |         |          |             |             |
| public                   | inventory_fact      | warehouse_key     | int  | 8    |         | t        | f           |             |
| public                   | warehouse_dimension | (warehouse_key)   |      |      |         |          |             |             |
| public                   | inventory_fact      | qty_in_stock      | int  | 8    |         | f        | f           |             |

(5 rows)

You can also use the question mark [ ? ] argument to replace a single character. For example, the ? argument replaces the last character in the SubQ1 and SubQ2 tables, so the command returns information about both:

```
=> \d SubQ?
```

```
List of Fields by Tables
```

| Schema | Table | Column | Type | Size | Default | Not Null | Primary Key | Foreign Key |
|--------|-------|--------|------|------|---------|----------|-------------|-------------|
| public | SubQ1 | a      | int  | 8    |         | f        | f           |             |
| public | SubQ1 | b      | int  | 8    |         | f        | f           |             |
| public | SubQ1 | c      | int  | 8    |         | f        | f           |             |
| public | SubQ2 | x      | int  | 8    |         | f        | f           |             |
| public | SubQ2 | y      | int  | 8    |         | f        | f           |             |
| public | SubQ2 | z      | int  | 8    |         | f        | f           |             |

(6 rows)

## df [ PATTERN ]

The `\df [ PATTERN ]` meta-command returns all function names, the function return data type, and the function argument data type. Also returns the procedure names and arguments for all procedures that are available to the user.

```
vmartdb=> \df
 List of functions
procedure_name | procedure_return_type | procedure_argument_types
-----+-----+-----+
abs | Float | Float
abs | Integer | Integer
abs | Interval | Interval
abs | Interval | Interval
abs | Numeric | Numeric
acos | Float | Float
add_location | Varchar | Varchar
add_location | Varchar | Varchar, Varchar, Varchar
...
width_bucket | Integer | Float, Float, Float, Integer
width_bucket | Integer | Interval, Interval, Interval, Integer
width_bucket | Integer | Interval, Interval, Interval, Integer
width_bucket | Integer | Timestamp, Timestamp, Timestamp,
Integer
...
```

The following example uses the wildcard character to search for all functions that begin with as:

```
vmartdb=> \df as*
 List of functions
procedure_name | procedure_return_type | procedure_argument_types
-----+-----+-----+
ascii | Integer | Varchar
asin | Float | Float
(2 rows)
```

## dj [ PATTERN ]

The `\dj [ PATTERN ]` meta-command returns all projections showing the schema, projection name, owner, and node:

```
vmartdb=> \dj
 List of projections
```

```

Schema | Name | Owner | Node
-----+-----+-----+-----+
public | product_dimension_node0001 | dbadmin | v_wmartdb_node0001
public | product_dimension_node0002 | dbadmin | v_wmartdb_node0002
public | product_dimension_node0003 | dbadmin | v_wmartdb_node0003
online_sales | call_center_dimension_node0001 | dbadmin | v_wmartdb_node0001
online_sales | call_center_dimension_node0002 | dbadmin | v_wmartdb_node0002
online_sales | call_center_dimension_node0003 | dbadmin | v_wmartdb_node0003
...

```

If you supply a projection name as an argument, the system returns fewer records:

```

vmartdb=> \dj call_center_dimension_n*
 List of projections
Schema | Name | Owner | Node
-----+-----+-----+-----+
online_sales | call_center_dimension_node0001 | dbadmin | v_wmartdb_node0001
online_sales | call_center_dimension_node0002 | dbadmin | v_wmartdb_node0002
online_sales | call_center_dimension_node0003 | dbadmin | v_wmartdb_node0003
(3 rows)

```

## dn [ PATTERN ]

The `\dn [ PATTERN ]` meta-command returns the schema names and schema owner.

```

vmartdb=> \dn
 List of schemas
Name | Owner
-----+-----
v_internal | dbadmin
v_catalog | dbadmin
v_monitor | dbadmin
public | dbadmin
store | dbadmin
online_sales | dbadmin
(6 rows)

```

The following command returns all schemas that begin with the letter v:

```

=> \dn v*
 List of schemas
Name | Owner
-----+-----
v_internal | dbadmin
v_catalog | dbadmin
v_monitor | dbadmin
(3 rows)

```

## dp [ PATTERN ]

The `\dp [ PATTERN ]` meta-command returns the grantee, grantor, privileges, schema, and name for all table access privileges in each schema:

```
vmartdb=> \dp
 Access privileges for database "vmartdb"
 Grantee | Grantor | Privileges | Schema | Name
-----+-----+-----+-----+-----+
 | dbadmin | USAGE | | public
 | dbadmin | USAGE | | v_internal
 | dbadmin | USAGE | | v_catalog
 | dbadmin | USAGE | | v_monitor
(4 rows)
```

**Note:** `\dp` is the same as `\z` (see "`z`" on page [272](#)).

## ds [ PATTERN ]

The `\ds [ PATTERN ]` meta-command (lowercase s) returns a list of sequences and their parameters.

The following series of commands creates a sequence called `my_seq` and uses the `vsql` command to display its parameters:

```
=> CREATE SEQUENCE my_seq MAXVALUE 5000 START 150;
CREATE SEQUENCE

=> \ds
 List of Sequences
 Schema | Sequence | CurrentValue | IncrementBy | Minimum | Maximum | AllowCycle
-----+-----+-----+-----+-----+-----+-----+

 public | my_seq | 149 | 1 | 1 | 5000 | f
(1 row)
```

**Note:** You can return additional information about sequences by issuing `SELECT * FROM V_CATALOGSEQUENCES`, as described in the SQL Reference Manual.

## dS [ PATTERN ]

The `\dS [ PATTERN ]` meta-command (uppercase S) returns all system table (monitoring API) names. You can get identical results issuing `SELECT * FROM system_tables;`

```
vmartdb=> \dS
 List of tables
 Schema | Name | Kind | Description
-----+-----+-----+-----+
```

```

v_catalog | columns | system | Table column information
v_catalog | dual | system | Oracle(TM) compatibility DUAL table
v_catalog | foreign_keys | system | Foreign key information
v_catalog | grants | system | Grant information
v_catalog | passwords | system | User password history and password reuse
policy
v_catalog | primary_keys | system | Primary key information
v_catalog | profile_parameters | system | Profile Parameters information
v_catalog | profiles | system | Profile information
v_catalog | projection_columns | system | Projection columns information
v_catalog | projections | system | Projection information
...
v_monitor | host_resources | system | Per host profiling information
v_monitor | load_streams | system | Load metrics for each load stream on
each node
v_monitor | locks | system | Lock grants and requests for all nodes
v_monitor | node_resources | system | Per node profiling information
...

```

## dt [ PATTERN ]

The `\dt [ PATTERN ]` meta-command (lowercase t) is identical to `\d` and returns all tables in the database—unless a table name is specified—in which case the command lists only the schema, name, kind and owner for the specified table (or tables if wildcards used).

```

vmartdb=> \dt inventory_fact
 List of tables
 Schema | Name | Kind | Owner
-----+-----+-----+-----
 public | inventory_fact | table | dbadmin
(1 row)

```

The following command returns all table names that begin with "st":

```

vmartdb=> \dt st*
 List of tables
 Schema | Name | Kind | Owner
-----+-----+-----+-----
 store | store_dimension | table | dbadmin
 store | store_orders_fact | table | dbadmin
 store | store_sales_fact | table | dbadmin
(3 rows)

```

## dT [ PATTERN ]

The `\dT [ PATTERN ]` meta-command (uppercase T) lists all supported data types.

```

vmartdb=> \dT
List of data types
 type_name

 Binary

```

```

Boolean
Char
Date
Float
Integer
Interval Day
Interval Day to Hour
Interval Day to Minute
Interval Day to Second
Interval Hour
Interval Hour to Minute
Interval Hour to Second
Interval Minute
Interval Minute to Second
Interval Month
Interval Second
Interval Year
Interval Year to Month
Numeric
Time
TimeTz
Timestamp
TimestampTz
Varbinary
Varchar
(26 rows)

```

## **dtv [ PATTERN ]**

The `\dtv [ PATTERN ]` meta-command lists all tables and views, returning the schema, table or view name, kind (table or view), and owner.

```

vmartdb=> \dtv
 List of tables
 Schema | Name | Kind | Owner
-----+-----+-----+-----+
online_sales | call_center_dimension | table | release
online_sales | online_page_dimension | table | release
online_sales | online_sales_fact | table | release
public | customer_dimension | table | release
public | date_dimension | table | release
public | employee_dimension | table | release
public | inventory_fact | table | release
public | product_dimension | table | release
public | promotion_dimension | table | release
public | shipping_dimension | table | release
public | vendor_dimension | table | release
public | warehouse_dimension | table | release
store | store_dimension | table | release
store | store_orders_fact | table | release
store | store_sales_fact | table | release
(15 rows)

```

## du [ PATTERN ]

The `\du [ PATTERN ]` meta-command returns all database users and attributes, such as if user is a superuser.

```
vmartdb=> \du
 List of users
 User name | Is Superuser
-----+-----
 dbadmin | t
(1 row)
```

## dv [ PATTERN ]

The `\dv [ PATTERN ]` meta-command returns the schema name, view name, and view owner.

The following example defines a view using the SEQUENCES system table:

```
vmartdb=> CREATE VIEW my_seqview AS (SELECT * FROM sequences);
CREATE VIEW
```

```
vmartdb=> \dv
 List of views
 Schema | Name | Owner
-----+-----+-----
 public | my_seqview | dbadmin
(1 row)
```

If a view name is provided as an argument, the result shows the schema, view name, and the following for all columns within the view's result set: schema name, view name, column name, column data type, and data type size.

```
vmartdb=> \dv my_seqview
 List of View Fields
 Schema | View | Column | Type | Size
-----+-----+-----+-----+-----+
 public | my_seqview | sequence_schema | varchar(128) | 128
 public | my_seqview | sequence_name | varchar(128) | 128
 public | my_seqview | owner_name | varchar(128) | 128
 public | my_seqview | identity_table_name | varchar(128) | 128
 public | my_seqview | session_cache_count | int | 8
 public | my_seqview | allow_cycle | boolean | 1
 public | my_seqview | output_ordered | boolean | 1
 public | my_seqview | increment_by | int | 8
 public | my_seqview | minimum | int | 8
 public | my_seqview | maximum | int | 8
 public | my_seqview | current_value | int | 8
 public | my_seqview | sequence_schema_id | int | 8
 public | my_seqview | sequence_id | int | 8
```

```
public | my_seqview | owner_id | int | 8
public | my_seqview | identity_table_id | int | 8
(15 rows)
```

## e \edit [ FILE ]

\e \edit [ FILE ] edits the query buffer (or specified file) with an external editor. When the editor exits, its content is copied back to the query buffer. If no argument is given, the current query buffer is copied to a temporary file which is then edited in the same fashion.

The new query buffer is then re-parsed according to the normal rules of vsqL, where the whole buffer up to the first semicolon is treated as a single line. (Thus you cannot make scripts this way. Use \i (see "i FILE" on page [265](#)) for that.) If there is no semicolon, vsqL waits for one to be entered (it does not execute the query buffer).

**Tip:** vsqL searches the environment variables VSQL\_EDITOR, EDITOR, and VISUAL (in that order) for an editor to use. If all of them are unset, vi is used on Linux systems, notepad.exe on Windows systems.

## echo [ STRING ]

\echo [ STRING ] writes the string to standard output

**Tip:** If you use the \o (page [266](#)) command to redirect your query output you might want to use \qecho (page [269](#)) instead of this command.

## f [ string ]

\f [ string ] sets the field separator for unaligned query output. The default is the vertical bar (|). See also \pset (page [267](#)) for a generic way of setting output options.

## g

The \g meta-command sends the query in the input buffer (see \p (see "p" on page [267](#)) to the server. With no arguments, it displays the results in the standard way.

\g FILE sends the query input buffer to the server, and writes the results to FILE.

\g | COMMAND sends the query buffer to the server, and pipes the results to a shell COMMAND.

## See Also

**\o** *meta-command* (see "o" on page [266](#))

## H

\H toggles HTML query output format. This command is for compatibility and convenience, but see \pset (page [267](#)) about setting other output options.

## h \help

\h \help displays help information about the meta-commands. Works the same as !? (see "?" on page [253](#)).

```
=> \h

General
 \c[onnect] [DBNAME| - [USER]] connect to new database (currently "VMart")
 \cd [DIR] change the current working directory
 \q quit vsql
 \set [NAME [VALUE]] set internal variable, or list all if no parameters
 \timing toggle timing of commands (currently off)
 \unset NAME unset (delete) internal variable
 \! [COMMAND] execute command in shell or start interactive shell
 \password [USER] change user's password

Query Buffer
 \e [FILE] edit the query buffer (or file) with external editor
 \g send query buffer to server
 \g FILE send query buffer to server and results to file
 \g | COMMAND send query buffer to server and pipe results to command
 \p show the contents of the query buffer
 \r reset (clear) the query buffer
 \s [FILE] display history or save it to file
 \w FILE write query buffer to file

Input/Output
 \echo [STRING] write string to standard output
 \i FILE execute commands from file
 \o FILE send all query results to file
 \o | COMMAND pipe all query results to command
 \o close query-results file or pipe
 \qecho [STRING] write string to query output stream (see \o)

Informational
 \d [PATTERN] describe tables (list tables if no argument is supplied)
 \df [PATTERN] list functions
 \dj [PATTERN] list projections
```

---

```
\dn [PATTERN] list schemas
\dp [PATTERN] list table access privileges
\ds [PATTERN] list sequences
\ds [PATTERN] list system tables
\dt [PATTERN] list tables
\dtv [PATTERN] list tables and views
\dT [PATTERN] list data types
\du [PATTERN] list users
\dv [PATTERN] list views
\l list all databases
\z [PATTERN] list table access privileges (same as \dp)
```

**Formatting**

|                    |                                                                                                                                    |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------|
| \a                 | toggle between unaligned and aligned output mode                                                                                   |
| \b                 | toggle beep on command completion                                                                                                  |
| \C [STRING]        | set table title, or unset if none                                                                                                  |
| \f [STRING]        | show or set field separator for unaligned query output                                                                             |
| \H                 | toggle HTML output mode (currently off)                                                                                            |
| \pset NAME [VALUE] | set table output option<br>(NAME := {format border expanded fieldsep footer null <br>recordsep tuples_only title tableattr pager}) |
| \t                 | show only rows (currently off)                                                                                                     |
| \T [STRING]        | set HTML <table> tag attributes, or unset if none                                                                                  |
| \x                 | toggle expanded output (currently off)                                                                                             |

**i FILE**

**\i filename** command reads input from the file *filename* and executes it as though it had been typed on the keyboard.

**Note:** To see the lines on the screen as they are read, set the variable **ECHO** (page [274](#)) to all.

**I**

**\l** provides a list of databases and their owners.

```
vmartdb=> \l
```

```
List of databases
 name | user_name
-----+-----
 vmartdb | dbadmin
(1 row)
```

**locale**

The **vsqL \locale** command displays the current locale setting or lets you set a new locale for the session.

This command does not alter the default locale for all database sessions. To change the default for all sessions, set the `DefaultSessionLocale` configuration parameter.

### **Viewing the Current Locale Setting**

To view the current locale setting, use the `vsq1` command `\locale`, as follows:

```
=> \locale
en_US@collation=binary
```

### **Overriding the Default Local for a Session**

To override the default local for a specific session, use the `vsq1` command `\locale <ICU-locale-identifier>`. The session locale setting applies to any subsequent commands issued in the session.

For example:

```
\locale en_GB
INFO: Locale: 'en_GB'
INFO: English (United Kingdom)
INFO: Short form: 'LEN'
```

You can also use the short form of an ICU locale identifier:

```
\locale LEN
INFO: Locale: 'en'
INFO: English
INFO: Short form: 'LEN'
```

### **Notes**

The server locale settings impact only the collation behavior for server-side query processing. The client application is responsible for ensuring that the correct locale is set in order to display the characters correctly. Below are the best practices recommended by HP to ensure predictable results:

- The locale setting in the terminal emulator for `vsq1` (POSIX) should be set to be equivalent to session locale setting on server side (ICU) so data is collated correctly on the server and displayed correctly on the client.
- The `vsq1` locale should be set using the POSIX `LANG` environment variable in terminal emulator. Refer to the documentation of your terminal emulator for how to set locale.
- Server session locale should be set using the set as described in Specify the Default Locale for the Database.
- Note that all input data for `vsq1` should be in UTF-8 and all output data is encoded in UTF-8
- Non UTF-8 encodings and associated locale values are not supported.

## **O**

The `\o` meta-command is used to control where `vsq1` directs its query output. The output can be written to a file, piped to a shell command, or sent to the standard output.

- \o FILE sends all subsequent query output to FILE.
- \o | COMMAND pipes all subsequent query output to a shell COMMAND.
- \o with no argument closes any open file or pipe, and switches back to normal query result output.

### Notes

- Query results includes all tables, command responses, and notices obtained from the database server.
- To intersperse text output with query results, use **\qecho** (page [269](#)).

### See Also

**\g** *meta-command* (page [263](#))

## p

\p prints the current query buffer to the standard output. For example:

```
=> \p
CREATE VIEW my_seqview AS (SELECT * FROM sequences);
```

## password [ USER ]

\password starts the password change process. Users can only change their own passwords. The command prompts the user for the old password, a new password, and then the new password again to confirm.

A superuser can change the password of another user by supplying the username. A superuser is not prompted for the old password, either when changing his or her own password, or when changing another user's password.

**Note:** If you want to cancel the password change process, press ENTER until you return the to vsql prompt.

## pset NAME [ VALUE ]

\pset NAME [ VALUE ] sets options affecting the output of query result tables. NAME describes which option to set, as illustrated in the following table. The parameters of VALUE depend thereon.

It is an error to call \pset without arguments

Adjustable printing options are:

---

|        |                                                                                                                              |
|--------|------------------------------------------------------------------------------------------------------------------------------|
| format | Sets the output format to one of <code>unaligned</code> , <code>aligned</code> , <code>html</code> , or <code>latex</code> . |
|--------|------------------------------------------------------------------------------------------------------------------------------|

---

|                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                              | Unique abbreviations are allowed. (That would mean one letter is enough.) "Unaligned" writes all columns of a row on a line, separated by the currently active field separator. This is intended to create output that might be intended to be read in by other programs (tab-separated, comma-separated). "Aligned" mode is the standard, human-readable, nicely formatted text output that is default. The "HTML" and "LaTeX" modes put out tables that are intended to be included in documents using the respective mark-up language. They are not complete documents! (This might not be so dramatic in HTML, but in LaTeX you must have a complete document wrapper.) |
| border                       | The second argument must be a number. In general, the higher the number the more borders and lines the tables have, but this depends on the particular format. In HTML mode, this translates directly into the <code>border=...</code> attribute, in the others only values 0 (no border), 1 (internal dividing lines), and 2 (table frame) make sense.                                                                                                                                                                                                                                                                                                                     |
| expanded                     | Toggles between regular and expanded format. When expanded format is enabled, all output has two columns with the column name on the left and the data on the right. This mode is useful if the data wouldn't fit on the screen in the normal "horizontal" mode.<br>Expanded mode is supported by all four output formats.<br><code>\x</code> is the same as <code>\pset expanded</code> .                                                                                                                                                                                                                                                                                  |
| fieldsep                     | Specifies the field separator to be used in unaligned output mode. That way one can create, for example, tab- or comma-separated output, which other programs might prefer. To set a tab as field separator, type <code>\pset fieldsep '\t'</code> . The default field separator is ' '(a vertical bar).                                                                                                                                                                                                                                                                                                                                                                    |
| footer                       | Toggles the display of the default footer ( <code>x rows</code> ).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| null                         | The second argument is a string that is printed whenever a column is null. The default is not to print anything, which can easily be mistaken for, say, an empty string. Thus, one might choose to write <code>\pset null '(null)'</code> .                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| recordsep                    | Specifies the record (line) separator to use in unaligned output mode. The default is a newline character.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| tuples_only (or t)           | Toggles between tuples only and full display. Full display might show extra information such as column headers, titles, and various footers. In tuples only mode, only actual table data is shown.                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| title [ text ]               | Sets the table title for any subsequently printed tables. This can be used to give your output descriptive tags. If no argument is given, the title is unset.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| tableattr (or T)<br>[ text ] | Allows you to specify any attributes to be placed inside the HTML <code>table</code> tag. This could for example be <code>cellpadding</code> or <code>bgcolor</code> . Note that you probably don't want to specify <code>border</code> here, as that is already taken care of by <code>\pset border</code> .                                                                                                                                                                                                                                                                                                                                                               |
| pager                        | Controls use of a pager for query and vsql help output. If the environment variable <code>PAGER</code> is set, the output is piped to the specified program. Otherwise a platform-dependent default (such as <code>more</code> ) is used.<br>When the pager is off, the pager is not used. When the pager is on, the pager is used only when appropriate; that is, the output is to a terminal and does not fit on the screen. (vsql does not do a perfect job of estimating when                                                                                                                                                                                           |

---

to use the pager.) `\pset pager` turns the pager on and off. Pager can also be set to `always`, which causes the pager to be always used.

---

See illustrations on how these different formats look in the ***Examples*** (page [283](#)) section.

**Tip:** There are various shortcut commands for `\pset`. See `\a` (see "`a`" on page [254](#)), `\C` (see "`C[STRING]`" on page [255](#)), `\H` (see "`H`" on page [264](#)), `\t` (see "`t`" on page [271](#)), `\T` (see "`T[STRING]`" on page [271](#)), and `\x` (see "`x`" on page [272](#)).

## q

`\q` quits the vsqI program.

## qecho [ STRING ]

`\qecho [ STRING ]` is identical to `\echo [ STRING ]` (see "`echo [ STRING ]`" on page [263](#)) except that the output is written to the query output stream, as set by `\o` (see "`o`" on page [266](#)).

## r

`\r` resets (clears) the query buffer.

For example, run the `\p` (see "`p`" on page [267](#)) meta-command to see what is in the query buffer:

```
=> \p
CREATE VIEW my_seqview AS (SELECT * FROM sequences);
```

Now reset the query buffer:

```
=> \r
Query buffer reset (cleared).
```

If you reissue the command to see what's in the query buffer, you can see it is now empty:

```
=> \p
Query buffer is empty.
```

## s [ FILE ]

`\s [ FILE ]` prints or saves the command line history to *filename*. If a filename is not specified, `\s` writes the history to the standard output. This option is only available if vsqI is configured to use the GNU Readline library.

## set [ NAME [ VALUE [ ... ] ] ]

\set [ name [ value [ ... ] ] ] sets the internal variable *name* to *value* or, if more than one value is given, to the concatenation of all of values. If no second argument is given, the variable is set with no value.

If no argument is provided, \set lists all internal variables; for example:

```
=> \set
VERSION = 'Vertica Analytic Database v6.0.0-0'
AUTOCOMMIT = 'off'
VERBOSITY = 'default'
PROMPT1 = '%/%R%# '
PROMPT2 = '%/%R%# '
PROMPT3 = '>> '
ROWS_AT_A_TIME = '1000'
DBNAME = 'VMartDB'
USER = 'dbadmin'
HOST = '<host_ip_address>'
PORT = '5433'
LOCALE = 'en_US@collation=binary'
HISTSIZE = '500'
```

### Notes

- Valid variable names are case sensitive and can contain characters, digits, and underscores. vsq1 treats several variables as special, which are described in [Variables](#) (page 272).
- The \set parameter ROWS\_AT\_A\_TIME defaults to 1000. It retrieves results as blocks of rows of that size. The column formatting for the first block is used for all blocks, so in later blocks some entries could overflow. See [\timing](#) (page 271) for examples.
- When formatting results, HP Vertica buffers ROWS\_AT\_A\_TIME rows in memory to calculate the maximum column widths. It is possible that rows after this initial fetch are not properly aligned if any of the field values are longer than those seen in the first ROWS\_AT\_A\_TIME rows. ROWS\_AT\_A\_TIME can be [\unset](#) (see "[\unset \[ NAME \]](#)" on page 271) to guarantee perfect alignment, but this requires re-buffering the entire result set in memory and may cause vsq1 to fail if the result set is too big.
- To unset a variable, use the [\unset](#) (page 271) command.

### Using Backquotes to Read System Variables

In vsq1, the contents of backquotes are passed to the system shell to be interpreted (the same behavior as many UNIX shells). This is particularly useful in setting internal vsq1 variables, since you may want to access UNIX system variables (such as HOME or TMPDIR) rather than hard-code values.

For example, if you want to set an internal variable to the full path for a file in your UNIX user directory, you could use backquotes to get the content of the system HOME variable, which is the full path to your user directory:

```
=> \set inputfile `echo $HOME`/myinput.txt
=> \echo :inputfile
```

```
/home/dbadmin/myinput.txt
```

The contents of the backquotes are replaced with the results of running the contents in a system shell interpreter. In this case, the `echo $HOME` command returns the contents of the `HOME` system variable.

## t

`\t` toggles the display of output column name headings and row count footer. This command is equivalent to `\pset tuples_only` and is provided for convenience.

## T [ STRING ]

`\T [ STRING ]` specifies attributes to be placed within the `table` tag in HTML tabular output mode. This command is equivalent to `\pset tableattr table_options`.

## timing

`\timing` toggles the timing of commands (currently off). The meta-command displays how long each SQL statement takes, in milliseconds, and reports both the time required to fetch the first block of rows from the server and the total until the last block is formatted.

### Example

```
=> \o /dev/null
=> SELECT * FROM fact LIMIT 100000;
Time: First fetch (1000 rows): 22.054 ms. All rows formatted: 235.056 ms
```

Note that the database retrieved the first 1000 rows in 22 ms and completed retrieving and formatting all rows in 235 ms.

### See Also

`\iset` (page [270](#))

## unset [ NAME ]

`\unset [ NAME ]` unsets (deletes) the internal variable `name` that was set using the `\iset` (page [270](#)) meta-command.

## w [ FILE ]

\w [ FILE ] outputs the current query buffer to the file *filename*.

## x

\x toggles extended table formatting mode. Is equivalent to \pset (page [267](#)) expanded.

**Note:** There is no space between the backslash and the x.

## z

\z lists table access privileges (grantee, grantor, privilege, and name) for all table access privileges in each schema. Is the same as \dp (see "**dp [ PATTERN ]**" on page [259](#))

## Variables

vsq provides variable substitution features similar to common Linux command shells. Variables are simply name/value pairs, where the value can be any string of any length. To set variables, use the vsq meta-command \set (see "set [ NAME [ VALUE [ ... ] ] ]" on page [270](#)):

```
=> \set fact dim
```

sets the variable `fact` to the value `dim`. To retrieve the content of the variable, precede the name with a colon and use it as the argument of any slash command:

```
=> \echo :fact
dim
```

**Note:** The arguments of \set are subject to the same substitution rules as with other commands. For example, \set dim :fact is a valid way to copy a variable.

If you call \set without a second argument, the variable is set, with an empty string as value. To unset (or delete) a variable, use the command \unset (see "unset [ NAME ]" on page [271](#)).

vsq's internal variable names can consist of letters, numbers, and underscores in any order and any number. Some of these variables are treated specially by vsq. They indicate certain option settings that can be changed at run time by altering the value of the variable or represent some state of the application. Although you can use these variables for any other purpose, this is not recommended. By convention, all specially treated variables consist of all upper-case letters (and possibly numbers and underscores). To ensure maximum compatibility in the future, avoid using such variable names for your own purposes.

## SQL Interpolation

An additional useful feature of vsq variables is that you can substitute ("interpolate") them into regular SQL statements. The syntax for this is again to prepend the variable name with a colon ( : ).

```
testdb=> \set fact 'my_table'
testdb=> SELECT * FROM :fact;
```

would then query the table `my_table`. The value of the variable is copied literally (except for backquoted strings, see below), so it can even contain unbalanced quotes or backslash commands. Make sure that it makes sense where you put it. Variable interpolation is not performed into quoted SQL entities.

**Note:** The one exception to variable values being copied literally is strings in backquotes (`). The contents of backquoted strings are passed to a system shell, and replaced with the shell's output. See the [set](#) (page 270) metacommand topic for details.

## AUTOCOMMIT

When AUTOCOMMIT is set 'on', each SQL command is automatically committed upon successful completion; for example:

```
\set (see "set [NAME [VALUE [...]]]" on page 270) AUTOCOMMIT on
```

To postpone COMMIT in this mode, set the value as off.

```
\set AUTOCOMMIT off
```

If AUTOCOMMIT is empty or defined as off, SQL commands are not committed unless you explicitly issue COMMIT.

### Notes

- AUTOCOMMIT is off by default.
- AUTOCOMMIT must be in uppercase, but the values, on or off, are case insensitive.
- In autocommit-off mode, you must explicitly abandon any failed transaction by entering ABORT or ROLLBACK.
- If you exit the session without committing, your work is rolled back.
- Validation on vsqL variables is done when they are run, not when they are set.
- The COPY statement, by default, commits on completion, so it does not matter which AUTOCOMMIT mode you use, unless you issue COPY NO COMMIT.
- To tell if AUTOCOMMIT is on or off, issue the set command:

```
$ \set
...
AUTOCOMMIT = 'off'
...
```

- AUTOCOMMIT is off if a `SELECT * FROM LOCKS` shows locks from the statement you just ran.

```
$ \set AUTOCOMMIT off
$ \set
...
AUTOCOMMIT = 'off'
...
SELECT COUNT(*) FROM customer_dimension;
count

```

```
50000
(1 row)
SELECT node_names, object_name, lock_mode, lock_scope
FROM LOCKS;
+-----+-----+-----+-----+
| node_names | object_name | lock_mode | lock_scope |
+-----+-----+-----+-----+
| site01 | Table:customer_dimension | S | TRANSACTION
+-----+-----+-----+-----+
(1 row)
```

## DBNAME

The name of the database to which you are currently connected. DBNAME is set every time you connect to a database (including program startup), but it can be unset.

## ECHO

If set to `all`, all lines entered from the keyboard or from a script are written to the standard output before they are parsed or run.

To select this behavior on program start-up, use the switch `-a`. If set to `queries`, vsql merely prints all queries as they are sent to the server. The switch for this is `-e`.

## ECHO\_HIDDEN

When this variable is set and a backslash command queries the database, the query is first shown. This way you can study the HP Vertica internals and provide similar functionality in your own programs. (To select this behavior on program start-up, use the switch `-E`.)

If you set the variable to the value `noexec`, the queries are just shown but are not actually sent to the server and run.

## ENCODING

The current client character set encoding.

## HISTCONTROL

If this variable is set to `ignorespace`, lines that begin with a space are not entered into the history list. If set to a value of `ignoredups`, lines matching the previous history line are not entered. A value of `ignoreboth` combines the two options. If unset, or if set to any other value than those previously mentioned, all lines read in interactive mode are saved on the history list.

**Source:** Bash.

## HISTSIZE

The number of commands to store in the command history. The default value is 500.

**Source:** Bash.

## HOST

The database server host you are currently connected to. This is set every time you connect to a database (including program startup), but can be unset.

## IGNOREEOF

If unset, sending an EOF character (usually Control+D) to an interactive session of vsqL terminates the application. If set to a numeric value, that many EOF characters are ignored before the application terminates. If the variable is set but has no numeric value, the default is 10.

**Source:** Bash.

## ON\_ERROR\_STOP

By default, if a script command results in an error, for example, because of a malformed command or invalid data format, processing continues. If you set ON\_ERROR\_STOP to 'on' in a script and an error occurs during processing, the script terminates immediately.

If you set ON\_ERROR\_STOP to 'on' in a script, run the script from Linux using `vsqL -f <filename>`, and an error occurs, vsqL returns an error code 3 to Linux to indicate that the error occurred in a script.

To enable ON\_ERROR\_STOP:

```
=> \set ON_ERROR_STOP on
```

To disable ON\_ERROR\_STOP:

```
=> \set ON_ERROR_STOP off
```

## PORT

The database server port to which you are currently connected. This is set every time you connect to a database (including program start-up), but can be unset.

## PROMPT1 PROMPT2 PROMPT3

These specify what the prompts vsql issues look like. See *Prompting* (page [277](#)) for details.

## QUIET

This variable is equivalent to the command line option `-q`. It is probably not too useful in interactive mode.

## SINGLELINE

This variable is equivalent to the command line option `-s`.

## SINGLESTEP

This variable is equivalent to the command line option `-s`.

## USER

The database user you are currently connected as. This is set every time you connect to a database (including program startup), but can be unset.

## VERBOSITY

This variable can be set to the values `default`, `verbose`, or `terse` to control the verbosity of error reports.

## VSQL\_HOME

By default, the vsq1 program reads configuration files from the user's home directory. In cases where this is not desirable, the configuration file location can be overridden by setting the `VSQL_HOME` environment variable in a way that does not require modifying a shared resource.

In the following example, vsq1 reads configuration information out of `/tmp/jsmith` rather than out of `~`.

```
Make an alternate configuration file in /tmp/jsmith
mkdir -p /tmp/jsmith
echo "\echo Using VSQLRC in tmp/jsmith" > /tmp/jsmith/.vsqlrc
Note that nothing is echoed when invoked normally
vsq1
```

---

```
Note that the .vsqLrc is read and the following is
displayed before the vsqL prompt
#
Using VSQLRc in tmp/jsmith
VSQL_HOME=/tmp/jsmith vsqL
```

## Prompting

The prompts vsqL issues can be customized to your preference. The three variables `PROMPT1`, `PROMPT2`, and `PROMPT3` contain strings and special escape sequences that describe the appearance of the prompt. Prompt 1 is the normal prompt that is issued when vsqL requests a new command. Prompt 2 is issued when more input is expected during command input because the command was not terminated with a semicolon or a quote was not closed. Prompt 3 is issued when you run a SQL `COPY` command and you are expected to type in the row values on the terminal.

The value of the selected prompt variable is printed literally, except where a percent sign (%) is encountered. Depending on the next character, certain other text is substituted instead. Defined substitutions are:

|                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>%M</code>      | The full host name (with domain name) of the database server, or [local] if the connection is over a socket, or [local:/dir/name], if the socket is not at the compiled in default location.                                                                                                                                                                                                                                                                                                           |
| <code>%m</code>      | The host name of the database server, truncated at the first dot, or [local].                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <code>%&gt;</code>   | The port number at which the database server is listening.                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <code>%n</code>      | The database session user name.                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <code>%/</code>      | The name of the current database.                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <code>%~</code>      | Like %/, but the output is ~ (tilde) if the database is your default database.                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <code>%#</code>      | If the session user is a database superuser, then a #, otherwise a >. (The expansion of this value might change during a database session as the result of the command <code>SET SESSION AUTHORIZATION</code> .)                                                                                                                                                                                                                                                                                       |
| <code>%R</code>      | In prompt 1 normally =, but ^ if in single-line mode, and ! if the session is disconnected from the database (which can happen if \connect fails). In prompt 2 the sequence is replaced by -, *, a single quote, a double quote, or a dollar sign, depending on whether vsqL expects more input because the command wasn't terminated yet, because you are inside a /* ... */ comment, or because you are inside a quoted or dollar-escaped string. In prompt 3 the sequence doesn't produce anything. |
| <code>%x</code>      | Transaction status: an empty string when not in a transaction block, or * when in a transaction block, or ! when in a failed transaction block, or ? when the transaction state is indeterminate (for example, because there is no connection).                                                                                                                                                                                                                                                        |
| <code>%digits</code> | The character with the indicated numeric code is substituted. If digits starts with 0x the rest of the characters are interpreted as hexadecimal; otherwise if the first digit is 0 the digits are interpreted as octal; otherwise the digits are read as a decimal number.                                                                                                                                                                                                                            |

|            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| %:name:    | The value of the vsqI variable name. See the section Variables for details.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| %`command` | The output of command, similar to ordinary "back-tick" substitution.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| %[ ... %]  | Prompts may contain terminal control characters which, for example, change the color, background, or style of the prompt text, or change the title of the terminal window. In order for the line editing features of Readline to work properly, these non-printing control characters must be designated as invisible by surrounding them with %[ and %]. Multiple pairs of these may occur within the prompt. The following example results in a boldfaced (1;) yellow-on-black (33;40) prompt on VT100-compatible, color-capable terminals:<br><pre>testdb=&gt; \set PROMPT1 '%[%033[1;33;40m%]n@%/%R%#%[%033[0m%]'</pre> To insert a percent sign into your prompt, write %. The default prompts are '%/%R%#%' for prompts 1 and 2, and '>>' for prompt 3.<br><b>Note:</b> See the <i>specification for terminal control sequences</i> <a href="http://www.xfree86.org/current/ctlseqs.html">http://www.xfree86.org/current/ctlseqs.html</a> (applicable to gnome-terminal and xterm). |

## Command Line Editing

vsqI supports the tecla library for convenient line editing and retrieval.

The command history is automatically saved when vsqI exits and is reloaded when vsqI starts up. Tab-completion is also supported, although the completion logic makes no claim to be a SQL parser. If for some reason you do not like the tab completion, you can turn it off by putting this in a file named .teclarC in your home directory:

```
bind ^I
```

Read the tecla documentation for further details.

### Notes

The vsqI implementation of the tecla library deviates from the tecla documentation as follows:

- Recalling Previously Typed Lines  
Under pure tecla, all new lines are appended to a list of historical input lines maintained within the GetLine resource object. In vsqI, only different, non-empty lines are appended to the list of historical input lines.
- History Files  
tecla has no standard name for the history file. In vsqI, the file name is called ~/.vsqI\_hist.
- International Character Sets (Meta keys and locales)  
In vsqI, 8-bit meta characters are no longer supported. Make sure that meta characters send an escape by setting their EightBitInput X resource to False. You can do this in one of the following ways:
  - Edit the ~/.Xdefaults file by adding the following line:  

```
XTerm*EightBitInput: False
```

- Start an xterm with an -xrm '\*EightBitInput: False' command-line argument.
- Key Bindings:
- The following key bindings are specific to vsqI:
  - *Insert* switches between insert mode (the default) and overwrite mode.
  - *Delete* deletes the character to the right of the cursor.
  - *Home* moves the cursor to the front of the line.
  - *End* moves the cursor to the end of the line.
  - *^R* Performs a history backwards search.

## vsqI Environment Variables

The following environment variables can be set to automatically use the defined properties each time you start vsqI:

- **PAGER** - If the query results do not fit on the screen, they are piped through this command. Typical values are `more` or `less`. The default is platform-dependent. The use of the pager can be disabled by using the `!pset` (see "`pset NAME [ VALUE ]`" on page [267](#)) command.
- **VSQL\_DATABASE** - Database to connect to. For example, `VMart`.
- **VSQL\_HOST** - Host name or IP address of the HP Vertica node.
- **VSQL\_PORT** - Port to use for the connection.
- **VSQL\_USER** - Username to use for the connection.
- **VSQL\_PASSWORD** - Password to use for the connection.
- **VSQL\_EDITOR, EDITOR and VISUAL** - Editor used by the `\e` command. The variables are examined in the order listed; the first that is set is used.
- **SHELL** - Command run by the `! [ COMMAND ]` (see "`! [ COMMAND ]`" on page [253](#)) command.
- **TMPDIR** - Directory for storing temporary files. The default is platform-dependant. On Unix-like systems the default is `/tmp`.

## Locales

The default terminal emulator under Linux is gnome-terminal, although xterm can also be used.

HP recommends that you use gnome-terminal with vsqI in UTF-8 mode, which is its default.

### To change settings on Linux

- 1 From the tabs at the top of the vsqI screen, select Terminal.
- 2 Click **Set Character Encoding**.
- 3 Select **Unicode (UTF-8)**.

**Note:** This works well for standard keyboards. xterm has a similar UTF-8 option.

### To change settings on Windows using PuTTY

- 1 Right click the vsqI screen title bar and select **Change Settings**.

- 2 Click **Window** and click **Translation**.
- 3 Select **UTF-8** in the drop-down menu on the right.

### Notes

- vsql has no way of knowing how you have set your terminal emulator options.
- The tecla library is prepared to do POSIX-type translations from a local encoding to UTF-8 on interactive input, using the POSIX LANG, etc., environment variables. This could be useful to international users who have a non-UTF-8 keyboard. See the tecla documentation for details.  
HP recommends the following (or whatever other .UTF-8 locale setting you find appropriate):  
`export LANG=en_US.UTF-8`
- The vsql **Vocale** (see "**locale**" on page [265](#)) command invokes and tracks the server SET LOCALE TO command, described in the SQL Reference Manual. vsql itself currently does nothing with this locale setting, but rather treats its input (from files or from tecla), all its output, and all its interactions with the server as UTF-8. vsql ignores the POSIX locale variables, except for any "automatic" uses in `printf`, and so on.

## Files

Before starting up, vsql attempts to read and execute commands from the system-wide `vsqlrc` file and the user's `~/.vsqlrc` file. The command-line history is stored in the file `~/.vsql_history`.

**Tip:** If you want to save your old history file, open another terminal window and save a copy to a different file name.

## Exporting Data Using vsql

You can use vsql for simple data exports tasks by changing its output format options so the output is suitable for importing into other systems (tab delimited or comma-separated files, for example). These options can be set either from within an interactive vsql session, or through command-line arguments to the vsql command (making the export process suitable for automation through scripting). After you have set vsql's options so it outputs the data in a format your target system can read, you run a query and capture the result in a text file.

The following table lists the meta-commands and command-line options that are useful for changing the format of vsql's output.

| Description                                 | Meta-command                                | Command-line Option |
|---------------------------------------------|---------------------------------------------|---------------------|
| Disable padding used to align output.       | <code>\a</code> (page <a href="#">254</a> ) | -A or --no-align    |
| Show only tuples, disabling column headings | <code>\t</code> (page <a href="#">271</a> ) | -t or --tuples-only |

|                                     |                                                      |                         |
|-------------------------------------|------------------------------------------------------|-------------------------|
| and row counts.                     |                                                      |                         |
| Set the field separator character.  | <b>\pset</b> (page <a href="#">267</a> )<br>fieldsep | -F or --field-separator |
| Send output to a file.              | <b>\o</b> (page <a href="#">266</a> )                | -o or --output          |
| Specify a SQL statement to execute. | N/A                                                  | -c or --command         |

The following example demonstrates disabling padding and column headers in the output, and setting a field separator to dump a table to a tab-separated text file within an interactive session.

```
=> SELECT * FROM my_table;
a | b | c
---+-----+---
a | one | 1
b | two | 2
c | three | 3
d | four | 4
e | five | 5
(5 rows)

=> \a
Output format is unaligned.
=> \t
Showing only tuples.
=> \pset fieldsep '\t'
Field separator is " ".
=> \o dumpfile.txt
=> select * from my_table;
=> \o
=> \! cat dumpfile.txt
a one 1
b two 2
c three 3
d four 4
e five 5
```

**Note:** You could encounter issues with empty strings being converted to NULLs or the reverse using this technique. You can prevent any confusion by explicitly setting null values to output a unique string such as NULLNULLNULL (for example, **\pset null 'NULLNULLNULL'**). Then, on the import end, convert the unique string back to a null value. For example, if you are copying the file back into an HP Vertica database, you would give the argument **NULL 'NULLNULLNULL'** to the **COPY** statement.

When logged into one of the database nodes, you can create the same output file directly from the command line by passing the right parameters to vsqI:

```
> vsqI -U username -F $'\t' -At -o dumpfile.txt -c "SELECT * FROM my_table;"
Password:
> cat dumpfile.txt
a one 1
b two 2
c three 3
d four 4
```

e        five        5

**Note:** `$' . . . '` is a BASH-specific string format that interprets backslash escapes, so it will pass a literal tab character to the vsql command as the argument for the `-F` parameter. Shells other than BASH may have other string literal syntax.

If you want to convert null values to a unique string as mentioned earlier, you can add the argument `-P null='NULLNULLNULL'` (or whatever unique string you choose).

By adding the `-w` vsql command-line option to the example command line, you could use the command within a batch script to automate the data export. However, the script would contain the database password as plain text. If you take this approach, you should prevent unauthorized access to the batch script, and also have the script use a database user account that has limited access.

## Copying Data Using vsql

You can use vsql to copy data between two HP Vertica databases. This technique is similar to the technique explained in **Exporting Data Using vsql** (page 280), except instead of having vsql save data to a file for export, you pipe one vsql's output to the input of another vsql command that runs a COPY statement from STDIN. This technique can also work for other databases or applications that accept data from an input stream.

**Note:** The following technique only works for individual tables. To copy an entire database to another cluster, see Copying a Database to Another Cluster in the Administrator's Guide.

The easiest way to copy using vsql is to log in to a node of the target database, then issue a vsql command that connects to the source HP Vertica database to dump the data you want. For example, the following command copies the store.store\_sales\_fact table from the vmart database on node testdb01 to the vmart database on the node you are logged into:

```
vsq1 -U username -w passwd -h testdb01 -d vmart -At -c "SELECT * from store.store_sales_fact" \
| vsq1 -U username -w passwd -d vmart -c "COPY store.store_sales_fact FROM STDIN DELIMITER '|';"
```

**Note:** The above example copies the data only, not the table design. The target table for the data copy must already exist in the target database. You can export the design of the table using EXPORT\_OBJECTS or EXPORT\_CATALOG.

## Monitoring Progress (optional)

You may want some way of monitoring progress when copying large amounts of data between HP Vertica databases. One way of monitoring the progress of the copy operation is to use a utility such as **Pipe Viewer** (<http://www.ivarch.com/programs/pv.shtml>) that pipes its input directly to its output while displaying the amount and speed of data it passes along. Pipe Viewer can even display a progress bar if you give it the total number of bytes or lines you expect to be processed. You can get the number of lines to be processed by running a separate vsql command that executes a SELECT COUNT query.

**Note:** Pipe Viewer isn't a standard Linux or Solaris command, so you will need download and install it yourself. See the [Pipe Viewer \(<http://www.ivarch.com/programs/pv.shtml>\)](http://www.ivarch.com/programs/pv.shtml) page for download packages and instructions. HP does not support Pipe Viewer. Install and use it at your own risk.

The following command demonstrates how you can use Pipe Viewer to monitor the progress of the copy shown in the prior example. The command is complicated by the need to get the number of rows that will be copied, which is done using a separate vsql command within a BASH backquote string, which executes the strings contents and inserts the output of the command into the command line. This vsql command just counts the number of rows in the store.store\_sales\_fact table.

```
vsql -U username -w passwd -h testdb01 -d vmart -At -c "SELECT * from store.store_sales_fact" \
| pv -lptr -s `vsql -U username -w passwd -h testdb01 -d vmart -At -c "SELECT COUNT (*) FROM
store.store_sales_fact;"` \
| vsql -U username -w passwd -d vmart -c "COPY store.store_sales_fact FROM STDIN DELIMITER '|';"
```

While running, the above command displays a progress bar that looks like this:

```
0:00:39 [12.6M/s] [=====>] 50% ETA 00:00:40
```

## Output Formatting Examples

The first example shows how to spread a command over several lines of input. Notice the changing prompt:

```
testdb=> CREATE TABLE my_table (
testdb(> first integer not null default 0,
testdb(> second char(10));
CREATE TABLE
```

Assume you have filled the table with data and want to take a look at it:

```
testdb=> SELECT * FROM my_table;
 first | second
-----+-----
 1 | one
 2 | two
 3 | three
 4 | four
(4 rows)
```

You can display tables in different ways by using the \pset command:

```
testdb=> \pset border 2
Border style is 2.
testdb=> SELECT * FROM my_table;
-----+-----+
| first | second |
-----+-----+
| 1 | one |
| 2 | two |
```

```
| 3 | three |
| 4 | four |
+-----+-----+
(4 rows)

testdb=> \pset border 0
Border style is 0.
testdb=> SELECT * FROM my_table;
first second
----- -----
 1 one
 2 two
 3 three
 4 four
(4 rows)

testdb=> \pset border 1
Border style is 1.
testdb=> \pset format unaligned
Output format is unaligned.
testdb=> \pset fieldsep ','
Field separator is ",".
testdb=> \pset tuples_only
Showing only tuples.
testdb=> SELECT second, first FROM my_table;
one,1
two,2
three,3
four,4
```

**Alternatively, use the short commands:**

```
testdb=> \a \t \ x
Output format is aligned.
Tuples only is off.
Expanded display is on.
testdb=> SELECT * FROM my_table;
first | 1
second | one
-----+-----
first | 2
second | two
-----+-----
first | 3
second | three
-----+-----
first | 4
second | four
```

# Writing Queries

---

Queries are database operations that retrieve data from one or more tables or views. In HP Vertica, the top-level `SELECT` statement is the query, and a query nested within another SQL statement is called a subquery.

HP Vertica is designed to run the same SQL standard queries that run on other databases. However, there are some differences between HP Vertica queries and queries used in other relational database management systems.

The HP Vertica transaction model is different from the SQL standard in a way that has a profound effect on query performance. You can:

- Run a query on a static snapshot of the database from any specific date and time. Doing so avoids holding locks or blocking other database operations.
- Use a subset of the standard SQL isolation levels and access modes (read/write or read-only) for a user session.

In HP Vertica, the primary structure of a SQL query is its statement. Each statement ends with a semicolon, and you can write multiple queries separated by semicolons; for example:

```
=> CREATE TABLE t1(..., date_col DATE NOT NULL, ...);
=> CREATE TABLE t2(..., state VARCHAR NOT NULL, ...);
```

## Multiple Instances of Dimension Tables in the FROM Clause

The same dimension table can appear multiple times in a query's `FROM` clause, using different aliases. For example:

```
SELECT *
FROM fact, dimension d1, dimension d2
WHERE fact.fk = d1.pk
 AND
 fact.name = d2.name;
```

# Historical (Snapshot) Queries

HP Vertica supports querying historical data for individual `SELECT` statements.

## Syntax

```
[AT EPOCH LATEST] | [AT TIME 'timestamp'] SELECT ...
```

## Parameters

|                 |                                                                                         |
|-----------------|-----------------------------------------------------------------------------------------|
| AT EPOCH LATEST | Queries all committed data in the database up to, but not including, the current epoch. |
|-----------------|-----------------------------------------------------------------------------------------|

|                     |                                                                                                                                                                        |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| AT TIME 'timestamp' | Queries all committed data in the database up to the time stamp specified. AT TIME 'timestamp' queries are resolved to the next epoch boundary before being evaluated. |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Historical queries, also known as snapshot queries, are useful because they access data in past epochs only. Historical queries do not need to hold table locks or block write operations because they do not return the absolute latest data.

Historical queries behave in the same manner regardless of transaction isolation level. Historical queries observe only committed data, even excluding updates made by the current transaction, unless those updates are to a temporary table.

**Note:** You do not need to use historical queries for temporary tables because temp tables do not require locks. Their content is private to the transaction and valid only for the length of the transaction.

Be aware that there is only one snapshot of the logical schema. This means that any changes you make to the schema are reflected across all epochs. If, for example, you add a new column to a table and you specify a default value for the column, all historical epochs display the new column and its default value.

#### See Also

Transactions in the Concepts Guide

## Temporary Tables

You can use the `CREATE TEMPORARY TABLE` statement to implement certain queries using multiple steps:

- 1 Create one or more temporary tables.
- 2 Execute queries and store the result sets in the temporary tables.
- 3 Execute the main query using the temporary tables as if they were a normal part of the logical schema.

See `CREATE TEMPORARY TABLE` in the SQL Reference Manual for details.

## SQL Queries

All DML (Data Manipulation Language) statements can contain queries. This section introduces some of the query types in HP Vertica, with additional details in later sections.

**Note:** Many of the examples in this chapter use the VMart schema. For information about other HP Vertica-supplied queries, see the Getting Started Guide.

## Simple Queries

Simple queries contain a query against one table. Minimal effort is required to process the following query, which looks for product keys and SKU numbers in the product table:

```
=> SELECT product_key, sku_number FROM public.product_dimension;

product_key | sku_number
-----+-----
43 | SKU-#129
87 | SKU-#250
42 | SKU-#125
49 | SKU-#154
37 | SKU-#107
36 | SKU-#106
86 | SKU-#248
41 | SKU-#121
88 | SKU-#257
40 | SKU-#120
(10 rows)
```

## Joins

Joins use a relational operator that combines information from two or more tables. The query's `ON` clause specifies how tables are combined, such as by matching foreign keys to primary keys. In the following example, the query requests the names of stores with transactions greater than 70 by joining the store key ID from the store schema's sales fact and sales tables:

```
=> SELECT store_name, COUNT(*) FROM store.store_sales_fact
 JOIN store.store_dimension ON store.store_sales_fact.store_key = store.store_dimension.store_key
 GROUP BY store_name HAVING COUNT(*) > 70 ORDER BY store_name;

store_name | count
-----+-----
Store49 | 72
Store83 | 78
(2 rows)
```

For more detailed information, see [Joins](#) (page 315). See also the Multicolumn subqueries section in [Subquery Examples](#).

## Cross Joins

Also known as the Cartesian product, a cross join is the result of joining every record in one table with every record in another table. A cross join occurs when there is no join key between tables to restrict records. The following query, for example, returns all instances of vendor and store names in the vendor and store tables:

```
=> SELECT vendor_name, store_name FROM public.vendor_dimension
 CROSS JOIN store.store_dimension;
vendor_name | store_name
-----+-----
Deal Warehouse | Store41
Deal Warehouse | Store12
Deal Warehouse | Store46
Deal Warehouse | Store50
```

```
Deal Warehouse | Store15
Deal Warehouse | Store48
Deal Warehouse | Store39
Sundry Wholesale | Store41
Sundry Wholesale | Store12
Sundry Wholesale | Store46
Sundry Wholesale | Store50
Sundry Wholesale | Store15
Sundry Wholesale | Store48
Sundry Wholesale | Store39
Market Discounters | Store41
Market Discounters | Store12
Market Discounters | Store46
Market Discounters | Store50
Market Discounters | Store15
Market Discounters | Store48
Market Discounters | Store39
Market Suppliers | Store41
Market Suppliers | Store12
Market Suppliers | Store46
Market Suppliers | Store50
Market Suppliers | Store15
Market Suppliers | Store48
Market Suppliers | Store39
...
(4000 rows)
```

This example's output is truncated because this particular cross join returned several thousand rows. See also [Cross Joins](#) (page 321).

## Subqueries

A subquery is a query nested within another query. In the following example, we want a list of all products containing the highest fat content. The inner query (subquery) returns the product containing the highest fat content among all food products to the outer query block (containing query). The outer query then uses that information to return the names of the products containing the highest fat content.

```
=> SELECT product_description, fat_content FROM public.product_dimension
 WHERE fat_content IN
 (SELECT MAX(fat_content) FROM public.product_dimension
 WHERE category_description = 'Food' AND department_description = 'Bakery')
 LIMIT 10;
```

| product_description                 |  | fat_content |
|-------------------------------------|--|-------------|
| Brand #59110 hotdog buns            |  | 90          |
| Brand #58107 english muffins        |  | 90          |
| Brand #57135 english muffins        |  | 90          |
| Brand #54870 cinnamon buns          |  | 90          |
| Brand #53690 english muffins        |  | 90          |
| Brand #53096 bagels                 |  | 90          |
| Brand #50678 chocolate chip cookies |  | 90          |
| Brand #49269 wheat bread            |  | 90          |
| Brand #47156 coffee cake            |  | 90          |

---

|                                        |  |    |
|----------------------------------------|--|----|
| Brand #43844 corn muffins<br>(10 rows) |  | 90 |
|----------------------------------------|--|----|

For more information, see **Subqueries** (page [290](#)).

## Sorting Queries

Use the `ORDER BY` clause to order the rows that a query returns.

### Special Note About Query Results

You could get different results running certain queries on one machine or another for the following reasons:

- Partitioning on a `FLOAT` type could return nondeterministic results because of the precision, especially when the numbers are close to one another, such as results from the `RADIANS()` function, which has a very small range of output.

To get deterministic results, use `NUMERIC` if you must partition by data that is not an `INTEGER` type.

- Most analytics (with analytic aggregations, such as `MIN()` / `MAX()` / `SUM()` / `COUNT()` / `AVG()` as exceptions) rely on a unique order of input data to get deterministic result. If the analytic **window-order** (page [336](#)) clause cannot resolve ties in the data, results could be different each time you run the query.

For example, in the following query, the analytic `ORDER BY` does not include the first column in the query, `promotion_key`. So for a tie of `AVG(RADIANS(cost_dollar_amount))`, `product_version`, the same `promotion_key` could have different positions within the analytic partition, resulting in a different `NTILE()` number. Thus, `DISTINCT` could also have a different result:

```
=> SELECT COUNT(*) FROM
 (SELECT DISTINCT
 SIN(FLOOR(MAX(store.store_sales_fact.promotion_key))), ,
 NTILE(79) OVER(PARTITION BY AVG(RADIANS
 (store.store_sales_fact.cost_dollar_amount)))
 ORDER BY store.store_sales_fact.product_version)
 FROM store.store_sales_fact
 GROUP BY store.store_sales_fact.product_version,
 store.store_sales_fact.sales_dollar_amount) AS store;
count

 1425
(1 row)
```

If you add `MAX(promotion_key)` to analytic `ORDER BY`, the results are the same on any machine:

```
=> SELECT COUNT(*) FROM (SELECT DISTINCT
 MAX(store.store_sales_fact.promotion_key),
 NTILE(79) OVER(PARTITION BY
 MAX(store.store_sales_fact.cost_dollar_amount)
 ORDER BY store.store_sales_fact.product_version,
 MAX(store.store_sales_fact.promotion_key))
```

```
FROM store.store_sales_fact
GROUP BY store.store_sales_fact.product_version,
 store.store_sales_fact.sales_dollar_amount) AS store;
```

## Subqueries

Subqueries provide a great deal of flexibility to SQL statements by letting you perform in one step what, otherwise, would require several steps. For example, instead of having to write separate queries to answer multiple-part questions, you can write a subquery.

A subquery is a SELECT statement within another SELECT statement. The inner statement is the subquery, and the outer statement is the containing statement (often referred to in HP Vertica as the outer query block).

Like any query, a subquery returns records from a table that could consist of a single column and record, a single column with multiple records, or multiple columns and records. Queries can be **noncorrelated** or **correlated** (page [303](#)). You can even use them to **update** or **delete** (page [305](#)) records in a table based on values that are stored in other database tables.

### Notes

- Many examples in this section use the VMart example database.
- Be sure to read **Subquery Restrictions** (page [314](#)).

## Subqueries Used in Search Conditions

Subqueries are used as search conditions in order to filter results. They specify the conditions for the rows returned from the containing query's select-list, a query expression, or the subquery itself. The operation evaluates to TRUE, FALSE, or UNKNOWN (NULL).

### Syntax

```
< search_condition > {
 [{ AND | OR [NOT] } { < predicate > | (< search_condition >) }]
 } [,...]
< predicate >
 { expression comparison-operator expression
 ... | string-expression [NOT] { LIKE | ILIKE | LIKEB | ILIKEB }
string-expression
 ... | expression IS [NOT] NULL
 ... | expression [NOT] IN (subquery | expression [,...n])
 ... | expression comparison-operator [ANY | SOME] (subquery)
 ... | expression comparison-operator ALL (subquery)
 ... | expression OR (subquery)
 ... | [NOT] EXISTS (subquery)
 ... | [NOT] IN (subquery)
}
```

### Parameters

|                    |                                                                        |
|--------------------|------------------------------------------------------------------------|
| <search-condition> | Specifies the search conditions for the rows returned from one of the: |
|--------------------|------------------------------------------------------------------------|

|                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                              | <ul style="list-style-type: none"> <li>▪ containing query's select-list</li> <li>▪ a query expression</li> <li>▪ a subquery</li> </ul> <p>If the subquery is used with an UPDATE or DELETE statement, UPDATE specifies the rows to update and DELETE specifies the rows to delete.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| { AND   OR   NOT }                           | <p>Keywords that specify the logical operators that combine conditions, or in the case of NOT, negate conditions.</p> <ul style="list-style-type: none"> <li>▪ AND — Combines two conditions and evaluates to TRUE when both of the conditions are TRUE.</li> <li>▪ OR — Combines two conditions and evaluates to TRUE when either condition is TRUE.</li> <li>▪ NOT — Negates the Boolean expression specified by the predicate.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                            |
| <predicate>                                  | Is an expression that returns TRUE, FALSE, or UNKNOWN (NULL).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <i>expression</i>                            | Can be a column name, a constant, a function, a scalar subquery, or a combination of column names, constants, and functions connected by operators or subqueries.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| comparison-operator                          | <p>Test conditions between expressions:</p> <ul style="list-style-type: none"> <li>▪ &lt; tests the condition of one expression being less than the other.</li> <li>▪ &gt; tests the condition of one expression being greater than the other.</li> <li>▪ &lt;= tests the condition of one expression being less than or equal to the other expression.</li> <li>▪ &gt;= tests the condition of one expression being greater than or equal to the other expression.</li> <li>▪ = tests the equality between two expressions.</li> <li>▪ &lt;=&gt; tests equality like the = operator, but it returns TRUE instead of UNKNOWN if both operands are UNKNOWN and FALSE instead of UNKNOWN if one operand is UNKNOWN.</li> <li>▪ &lt;&gt; and != test the condition of two expressions not equal to one another.</li> </ul> |
| <i>string_expression</i>                     | Is a character string with optional wildcard (*) characters.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| [ NOT ] { LIKE   ILIKE  <br>LIKEB   ILIKEB } | Indicates that the character string following the predicate is to be used (or not used) for pattern matching.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| IS [ NOT ] NULL                              | Searches for values that are null or are not null.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| ALL                                          | Is used with a comparison operator and a subquery. Returns TRUE for the lefthand predicate if all values returned by the subquery satisfy the comparison operation, or FALSE if not all values satisfy the comparison or if the subquery returns no rows to the outer query block.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

|                |                                                                                                                                                                                                                                                                                                                                                                            |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ANY   SOME     | ANY and SOME are synonyms and are used with a comparison operator and a subquery. Either returns TRUE for the lefthand predicate if any value returned by the subquery satisfies the comparison operation, or FALSE if no values in the subquery satisfy the comparison or if the subquery returns no rows to the outer query block. Otherwise, the expression is UNKNOWN. |
| [ NOT ] EXISTS | Used with a subquery to test for the existence of records that the subquery returns.                                                                                                                                                                                                                                                                                       |
| [ NOT ] IN     | Searches for an expression on the basis of an expression's exclusion or inclusion from a list. The list of values is enclosed in parentheses and can be a subquery or a set of constants.                                                                                                                                                                                  |

## Logical Operators AND and OR

The AND and OR logical operators combine two conditions. AND evaluates to TRUE when both of the conditions joined by the AND keyword are matched, and OR evaluates to TRUE when either condition joined by OR is matched.

### OR subqueries (complex expressions)

HP Vertica supports subqueries in more complex expressions using OR; for example:

- More than one subquery in the conjunct expression:  

$$(SELECT MAX(b) FROM t1) + SELECT (MAX FROM t2)$$

$$a \text{ IN } (SELECT a FROM t1) \text{ OR } b \text{ IN } (SELECT x FROM t2)$$
- An OR clause in the conjunct expression involves at least one subquery:  

$$a \text{ IN } (SELECT a FROM t1) \text{ OR } b \text{ IN } (SELECT x FROM t2)$$

$$a \text{ IN } (SELECT a from t1) \text{ OR } b = 5$$

$$a = (SELECT MAX FROM t2) \text{ OR } b = 5$$
- One subquery is present but it is part of another expression:  

$$x \text{ IN } (SELECT a FROM t1) = (x = (SELECT MAX FROM t2))$$

$$(x \text{ IN } (SELECT a FROM t1)) \text{ IS NULL}$$

### How AND queries are evaluated

HP Vertica treats expressions separated by AND (conjunctive) operators individually. For example if the WHERE clause were:

```
WHERE (a IN (SELECT a FROM t1) OR b IN (SELECT x FROM t2)) AND (c IN (SELECT a FROM t1))
```

the query would be interpreted as two conjunct expressions:

- 1 (a IN (SELECT a FROM t1) OR b IN (SELECT x FROM t2))
- 2 (c IN (SELECT a FROM t1))

The first expression is considered a complex subquery, whereas the second expression is not.

### Examples

The following list shows some of the ways you can filter complex conditions in the WHERE clause:

- OR expression between a subquery and a non-subquery condition:  

$$\Rightarrow \text{SELECT } x \text{ FROM } t \text{ WHERE } x > (\text{SELECT SUM(DISTINCT } x) \text{ FROM } t \text{ GROUP BY } y) \text{ OR } x < 9;$$
- OR expression between two subqueries:  

$$\Rightarrow \text{SELECT } * \text{ FROM } t \text{ WHERE } x = (\text{SELECT } x \text{ FROM } t) \text{ OR EXISTS } (\text{SELECT } x \text{ FROM } tt);$$
- Subquery expression:  

$$\Rightarrow \text{SELECT } * \text{ FROM } t \text{ WHERE } x = (\text{SELECT } x \text{ FROM } t) + 1 \text{ OR } x < (\text{SELECT } x \text{ FROM } t) + 1;$$
- OR expression with [NOT] IN subqueries:  

$$\Rightarrow \text{SELECT } * \text{ FROM } t \text{ WHERE NOT } (\text{EXISTS } (\text{SELECT } x \text{ FROM } t)) \text{ OR } x > 9;$$
- OR expression with IS [NOT] NULL subqueries:  

$$\Rightarrow \text{SELECT } * \text{ FROM } t \text{ WHERE } (\text{SELECT } * \text{ FROM } t) \text{ IS NULL OR } (\text{SELECT } * \text{ FROM } tt) \text{ IS NULL};$$
- OR expression with boolean column and subquery that returns Boolean data type:  

$$\Rightarrow \text{SELECT } * \text{ FROM } t2 \text{ WHERE } x = (\text{SELECT } x \text{ FROM } t2) \text{ OR } x;$$

**Note:** To return TRUE, the argument of OR must be a Boolean data type.
- OR expression in the CASE statement:  

$$\Rightarrow \text{SELECT } * \text{ FROM } t \text{ WHERE CASE WHEN } x=1 \text{ THEN } x > (\text{SELECT } * \text{ FROM } t) \text{ OR } x < (\text{SELECT } * \text{ FROM } t2) \text{ END ;}$$
- Analytic function, NULL-handling function, string function, math function, and so on:  

$$\Rightarrow \text{SELECT } x \text{ FROM } t \text{ WHERE } x > (\text{SELECT COALESCE } (x,y) \text{ FROM } t \text{ GROUP BY } x,y) \text{ OR } x < 9;$$
- In user-defined functions (assuming  $f()$  is one):  

$$\Rightarrow \text{SELECT } * \text{ FROM } t \text{ WHERE } x > 5 \text{ OR } x = (\text{SELECT } f(x) \text{ FROM } t);$$
- Use of parentheses at different places to restructure the queries:  

$$\Rightarrow \text{SELECT } x \text{ FROM } t \text{ WHERE } (x = (\text{SELECT } x \text{ FROM } t) \text{ AND } y = (\text{SELECT } y \text{ FROM } t)) \text{ OR } (\text{SELECT } x \text{ FROM } t) = 1;$$
- Multicolumn subqueries:  

$$\Rightarrow \text{SELECT } * \text{ FROM } t \text{ WHERE } (x,y) = (\text{SELECT } x,y \text{ FROM } t) \text{ OR } x > 5;$$
- Constant/NULL on lefthand side of subquery:  

$$\Rightarrow \text{SELECT } * \text{ FROM } t \text{ WHERE } x > 5 \text{ OR } 5 = (\text{SELECT } x \text{ FROM } t);$$

## See Also

[Subquery Restrictions](#) (page 314)

## In Place of an Expression

Subqueries that return a single value (unlike a list of values returned by IN subqueries) can be used just about anywhere an expression is allowed in SQL. It can be a column name, a constant, a function, a scalar subquery, or a combination of column names, constants, and functions connected by operators or subqueries.

For example:

```
=> SELECT c1 FROM t1 WHERE c1 = ANY (SELECT c1 FROM t2) ORDER BY c1;
=> SELECT c1 FROM t1 WHERE COALESCE((t1.c1 > ANY (SELECT c1 FROM t2)), TRUE);
=> SELECT c1 FROM t1 GROUP BY c1 HAVING
 COALESCE((t1.c1 <> ALL (SELECT c1 FROM t2)), TRUE);
```

Multi-column expressions are also supported:

```
=> SELECT c1 FROM t1 WHERE (t1.c1, t1.c2) = ALL (SELECT c1, c2 FROM t2);
=> SELECT c1 FROM t1 WHERE (t1.c1, t1.c2) <> ANY (SELECT c1, c2 FROM t2);
```

HP Vertica returns an error on queries where more than one row would be returned by any subquery used as an expression:

```
=> SELECT c1 FROM t1 WHERE c1 = (SELECT c1 FROM t2) ORDER BY c1;
 ERROR: more than one row returned by a subquery used as an expression
```

## See Also

**Subquery Restrictions** (page [314](#))

## Comparison Operators

HP Vertica supports Boolean subquery expressions in the WHERE clause with any of the following operators: (>, <, >=, <=, =, <>, <=>).

WHERE clause subqueries filter results and take the following form:

```
SELECT <column, ...>
FROM <table>
WHERE <condition> (SELECT <column, ...> FROM <table> WHERE <condition>);
```

These conditions are available for all data types where comparison makes sense. All comparison operators are binary operators that return values of TRUE, FALSE, or UNKNOWN (NULL).

Expressions that correlate to just one outer table in the outer query block are supported, and these correlated expressions can be comparison operators.

The following subquery scenarios are supported:

```
SELECT * FROM T1 WHERE T1.x = (SELECT MAX(c1) FROM T2);
SELECT * FROM T1 WHERE T1.x >= (SELECT MAX(c1) FROM T2 WHERE T1.y = T2.c2);
SELECT * FROM T1 WHERE T1.x <= (SELECT MAX(c1) FROM T2 WHERE T1.y = T2.c2);
```

## See Also

**Subquery Restrictions** (page [314](#))

## LIKE Pattern Matching

HP Vertica supports LIKE pattern-matching conditions in subqueries and take the following form:

*string-expression* [ NOT ] { LIKE | ILIKE | LIKEB | ILIKEB } *string-expression*

The following command searches for customers whose company name starts with "Ev" and returns the total count:

```
=> SELECT COUNT(*) FROM customer_dimension WHERE customer_name LIKE
 (SELECT 'Ev%' FROM customer_dimension LIMIT 1);
count

 153
(1 row)
```

HP Vertica also supports single-row subqueries as the pattern argument for LIKEB and ILIKEB predicates; for example:

```
=> SELECT * FROM t1 WHERE t1.x LIKEB (SELECT t2.x FROM t2);
```

The following symbols are substitutes for the LIKE keywords:

|      |            |
|------|------------|
| ~~   | LIKE       |
| ~#   | LIKEB      |
| ~~*  | ILIKE      |
| ~#*  | ILIKEB     |
| !~~  | NOT LIKE   |
| !~#  | NOT LIKEB  |
| !~~* | NOT ILIKE  |
| !~#* | NOT ILIKEB |

**Note:** The `ESCAPE` keyword is not valid for the above symbols.

See `LIKE`-predicate in the SQL Reference Manual for additional examples.

## ANY (SOME) and ALL

Normally, you use operators like equal and greater-than only on subqueries that return one row. With ANY and ALL, however, comparisons can be made on subqueries that return multiple rows. The ANY and ALL keywords let you specify whether *any* or *all* of the subquery values, respectively, match the specified condition.

These subqueries take the following form:

```
expression comparison-operator { ANY | SOME } (subquery)
expression comparison-operator ALL (subquery)
```

### Notes

- The keyword `SOME` is an alias for `ANY`.
- `IN` is equivalent to `= ANY`.
- `NOT IN` is equivalent to `<> ALL`.

### ANY subqueries

Subqueries that use the ANY keyword yield a Boolean result when *any* value retrieved in the subquery matches the value of the lefthand expression.

| Expression                      | Returns                                                                                            |
|---------------------------------|----------------------------------------------------------------------------------------------------|
| <code>&gt; ANY(1,10,100)</code> | Returns TRUE for any value > 1 (greater than at least one value or greater than the minimum value) |

|                 |                                                                                                |
|-----------------|------------------------------------------------------------------------------------------------|
| < ANY(1,10,100) | Returns TRUE for any value < 100 (less than at least one value or less than the maximum value) |
| = ANY(1,10,100) | Returns TRUE for any value = 1 or 10 or 100 (equals <i>any</i> of the values)                  |

### ANY subquery examples

- An ANY subquery within an expression. Note that the second statement uses the SOME keyword:  

$$\Rightarrow \text{SELECT c1 FROM t1 WHERE COALESCE((t1.c1 > ANY (SELECT c1 FROM t2)), \text{TRUE});}$$

$$\Rightarrow \text{SELECT c1 FROM t1 WHERE COALESCE((t1.c1 > SOME (SELECT c1 FROM t2)), \text{TRUE});}$$
- ANY noncorrelated subqueries without aggregates:  

$$\Rightarrow \text{SELECT c1 FROM t1 WHERE c1 = ANY (SELECT c1 FROM t2) ORDER BY c1;}$$

Note that omitting the ANY keyword returns an error because more than one row would be returned by the subquery used as an expression:

$$\Rightarrow \text{SELECT c1 FROM t1 WHERE c1 = (SELECT c1 FROM t2) ORDER BY c1;}$$
- ANY noncorrelated subqueries with aggregates:  

$$\Rightarrow \text{SELECT c1 FROM t1 WHERE c1 <> ANY (SELECT MAX(c1) FROM t2) ORDER BY c1;}$$

$$\Rightarrow \text{SELECT c1 FROM t1 GROUP BY c1 HAVING c1 <> ANY (SELECT MAX(c1) FROM t2) ORDER BY c1;}$$
- ANY noncorrelated subqueries with aggregates and a GROUP BY clause:  

$$\Rightarrow \text{SELECT c1 FROM t1 WHERE c1 <> ANY (SELECT MAX(c1) FROM t2 GROUP BY c2) ORDER BY c1;}$$
- ANY noncorrelated subqueries with a GROUP BY clause:  

$$\Rightarrow \text{SELECT c1 FROM t1 WHERE c1 <= ANY (SELECT c1 FROM t2 GROUP BY c1) ORDER BY c1;}$$
- ANY correlated subqueries with no aggregates or GROUP BY clause:  

$$\Rightarrow \text{SELECT c1 FROM t1 WHERE c1 >= ANY (SELECT c1 FROM t2 WHERE t2.c2 = t1.c2) ORDER BY c1;}$$

### ALL subqueries

Subqueries that use the ALL keyword yield a Boolean result when *all* values retrieved in the subquery match the specified condition of the lefthand expression.

| Expression      | Returns                                                             |
|-----------------|---------------------------------------------------------------------|
| > ALL(1,10,100) | Returns the expression value > 100 (greater than the maximum value) |
| < ALL(1,10,100) | Returns the expression value < 1 (less than the minimum value)      |

## ALL subquery examples

Following are some examples of ALL (subquery):

- ALL noncorrelated subqueries without aggregates:  
 $=> \text{SELECT } c1 \text{ FROM } t1 \text{ WHERE } c1 \geq \text{ALL} (\text{SELECT } c1 \text{ FROM } t2) \text{ ORDER BY } c1;$
- ALL noncorrelated subqueries with aggregates:  
 $=> \text{SELECT } c1 \text{ FROM } t1 \text{ WHERE } c1 = \text{ALL} (\text{SELECT MAX}(c1) \text{ FROM } t2) \text{ ORDER BY } c1;$   
 $=> \text{SELECT } c1 \text{ FROM } t1 \text{ GROUP BY } c1 \text{ HAVING } c1 <> \text{ALL} (\text{SELECT MAX}(c1) \text{ FROM } t2)$   
 $\text{ORDER BY } c1;$
- ALL noncorrelated subqueries with aggregates and a GROUP BY clause:  
 $=> \text{SELECT } c1 \text{ FROM } t1 \text{ WHERE } c1 \leq \text{ALL} (\text{SELECT MAX}(c1) \text{ FROM } t2 \text{ GROUP BY } c2)$   
 $\text{ORDER BY } c1;$
- ALL noncorrelated subqueries with a GROUP BY clause:  
 $=> \text{SELECT } c1 \text{ FROM } t1 \text{ WHERE } c1 <> \text{ALL} (\text{SELECT } c1 \text{ FROM } t2 \text{ GROUP BY } c1)$   
 $\text{ORDER BY } c1;$

### See Also

**Subquery Restrictions** (page [314](#))

## EXISTS and NOT EXISTS

The EXISTS predicate is one of the most common predicates used to build conditions that use noncorrelated and correlated subqueries. Use EXISTS to identify the existence of a relationship without regard for the quantity. For example, EXISTS returns true if the subquery returns any rows, and NOT EXISTS returns true if the subquery returns no rows.

[NOT] EXISTS subqueries take the following form:

```
expression [NOT] EXISTS (subquery)
```

The EXISTS condition is considered to be met if the subquery returns at least one row. Since the result depends only on whether any records are returned, and not on the contents of those records, the output list of the subquery is normally uninteresting. A common coding convention is to write all EXISTS tests as follows:

```
EXISTS (SELECT 1 WHERE ...)
```

In the above fragment, SELECT 1 returns the value 1 for every record in the query. If the query returns, for example, five records, it returns 5 ones. The system doesn't care about the real values in those records; it just wants to know if a row is returned.

Alternatively, a subquery's select list that uses EXISTS might consist of the asterisk (\*). You do not need to specify column names, because the query tests for the existence or nonexistence of records that meet the conditions specified in the subquery.

```
EXISTS (SELECT * WHERE ...)
```

## Notes

- If EXISTS (subquery) returns at least 1 row, the result is TRUE.
- If EXISTS (subquery) returns no rows, the result is FALSE.
- If NOT EXISTS (subquery) returns at least 1 row, the result is FALSE.
- If NOT EXISTS (subquery) returns no rows, the result is TRUE.

## Examples

The following query retrieves the list of all the customers who purchased anything from any of the stores amounting to more than 550 dollars:

```
=> SELECT customer_key, customer_name, customer_state
 FROM public.customer_dimension WHERE EXISTS
 (SELECT 1 FROM store.store_sales_fact
 WHERE customer_key = public.customer_dimension.customer_key
 AND sales_dollar_amount > 550)
 AND customer_state = 'MA' ORDER BY customer_key;
```

| customer_key | customer_name      | customer_state |
|--------------|--------------------|----------------|
| 14818        | William X. Nielson | MA             |
| 18705        | James J. Goldberg  | MA             |
| 30231        | Sarah N. McCabe    | MA             |
| 48353        | Mark L. Brown      | MA             |

(4 rows)

Whether you use EXISTS or IN subqueries depends on which predicates you select in outer and inner query blocks. For example, to get a list of all the orders placed by all stores on January 2, 2003 for vendors with records in the vendor table:

```
=> SELECT store_key, order_number, date_ordered
 FROM store.store_orders_fact WHERE EXISTS
 (SELECT 1 FROM public.vendor_dimension
 WHERE public.vendor_dimension.vendor_key =
store.store_orders_fact.vendor_key)
 AND date_ordered = '2003-01-02';
```

| store_key | order_number | date_ordered |
|-----------|--------------|--------------|
| 37        | 2559         | 2003-01-02   |
| 16        | 552          | 2003-01-02   |
| 35        | 1156         | 2003-01-02   |
| 13        | 3885         | 2003-01-02   |
| 25        | 554          | 2003-01-02   |
| 21        | 2687         | 2003-01-02   |
| 49        | 3251         | 2003-01-02   |
| 19        | 2922         | 2003-01-02   |
| 26        | 1329         | 2003-01-02   |
| 40        | 1183         | 2003-01-02   |

(10 rows)

The above query looks for existence of the vendor and date ordered. To return a particular value, rather than simple existence, the query looks for orders placed by the vendor who got the best deal on January 4, 2004:

```
=> SELECT store_key, order_number, date_ordered
 FROM store.store_orders_fact ord, public.vendor_dimension vd
 WHERE ord.vendor_key = vd.vendor_key AND vd.deal_size IN
 (SELECT MAX(deal_size) FROM public.vendor_dimension)
 AND date_ordered = '2004-01-04';

store_key | order_number | date_ordered
-----+-----+-----
 166 | 36008 | 2004-01-04
 113 | 66017 | 2004-01-04
 198 | 75716 | 2004-01-04
 27 | 150241 | 2004-01-04
 148 | 182207 | 2004-01-04
 9 | 188567 | 2004-01-04
 45 | 202416 | 2004-01-04
 24 | 250295 | 2004-01-04
 121 | 251417 | 2004-01-04
(9 rows)
```

## See Also

**Subquery Restrictions** (page [314](#))

## IN and NOT IN

While you cannot equate a single value to a set of values, you can check to see if a single value is found within that set of values. Use the `IN` clause for multiple-record, single-column subqueries. After the subquery returns results introduced by `IN` or `NOT IN`, the outer query uses them to return the final result.

[NOT] IN subqueries take the following form:

```
{ expression [NOT] IN (subquery)
| expression [NOT] IN (expression) }
```

There is no limit to the number of parameters passed to the `IN` clause of the `SELECT` statement; for example:

```
=> SELECT * FROM tablename WHERE column IN (a, b, c, d, e, ...);
```

HP Vertica also supports queries where two or more outer expressions refer to different inner expressions:

```
=> SELECT * FROM A WHERE (A.x,A.x) IN (SELECT B.x, B.y FROM B);
```

## Examples

The following query uses the Vmart schema to illustrate the use of outer expressions referring to different inner expressions:

```
=> SELECT product_description, product_price FROM product_dimension
```

```
WHERE (product_dimension.product_key, product_dimension.product_key) IN
 (SELECT store.store_orders_fact.order_number,
 store.store_orders_fact.quantity_ordered
 FROM store.store_orders_fact);

product_description | product_price
-----+-----
Brand #72 box of candy | 326
Brand #71 vanilla ice cream | 270
(2 rows)
```

To find all products supplied by stores in MA, first create the inner query and run it to ensure that it works as desired. The following query returns all stores located in MA:

```
=> SELECT store_key FROM store.store_dimension WHERE store_state = 'MA';
store_key

13
31
(2 rows)
```

Then create the outer or main query that specifies all distinct products that were sold in stores located in MA. This statement combines the inner and outer queries using the IN predicate:

```
=> SELECT DISTINCT s.product_key, p.product_description
 FROM store.store_sales_fact s, public.product_dimension p
 WHERE s.product_key = p.product_key
 AND s.product_version = p.product_version
 AND s.store_key IN
 (SELECT store_key
 FROM store.store_dimension
 WHERE store_state = 'MA')
 ORDER BY s.product_key;
```

```
product_key | product_description
-----+-----
1 | Brand #1 white bread
1 | Brand #4 vegetable soup
3 | Brand #9 wheelchair
5 | Brand #15 cheddar cheese
5 | Brand #19 bleach
7 | Brand #22 canned green beans
7 | Brand #23 canned tomatoes
8 | Brand #24 champagne
8 | Brand #25 chicken nuggets
11 | Brand #32 sausage
...
(281 rows)
```

When using NOT IN, the subquery returns a list of zero or more values in the outer query where the comparison column does not match any of the values returned from the subquery. Using the previous example, NOT IN returns all the products that are not supplied from MA.

## Notes

HP Vertica supports multicolumn NOT IN subqueries in which the columns are not marked NOT NULL. Previously, marking the columns NOT NULL was a requirement; now, if one of the columns is found to contain a a NULL value during query execution, HP Vertica returns a run-time error.

Similarly, IN subqueries nested within another expression are not supported if any of the column values are NULL. For example, if in the following statement column x from either table contained a NULL value, Vertica would return a run-time error:

```
=> SELECT * FROM t1 WHERE (x IN (SELECT x FROM t2)) IS FALSE;
 ERROR: NULL value found in a column used by a subquery
```

## See Also

**Subquery Restrictions** (page [314](#))

IN-predicate in the SQL Reference Manual

## Subqueries in the SELECT List

Subqueries can occur in the select list of the containing query. The results from the following statement are ordered by the first column (customer\_name). You could also write ORDER BY 2 and specify that the results be ordered by the select-list subquery.

```
=> SELECT c.customer_name, (SELECT AVG(annual_income) FROM customer_dimension
 WHERE deal_size = c.deal_size) AVG_SAL DEAL FROM customer_dimension c
 ORDER BY 1;
```

| customer_name | AVG_SAL DEAL |
|---------------|--------------|
| Goldstar      | 603429       |
| Metatech      | 628086       |
| Metadata      | 666728       |
| Foodstar      | 695962       |
| Verihope      | 715683       |
| Veridata      | 868252       |
| Bettercare    | 879156       |
| Foodgen       | 958954       |
| Virtacom      | 991551       |
| Inicorp       | 1098835      |
| ...           |              |

## Notes

- Scalar subqueries in the select-list return a single row/column value. These subqueries use Boolean comparison operators: =, >, <, <>, <=, >=.
- If the query is correlated, it returns NULL if the correlation results in 0 rows. If the query returns more than one row, the query errors out at run time and HP Vertica displays an error message that the scalar subquery must only return 1 row.

- Subquery expressions such as [NOT] IN, [NOT] EXISTS, ANY/SOME, or ALL always return a single Boolean value that evaluates to TRUE, FALSE, or UNKNOWN; the subquery itself can have many rows. Most of these queries can be correlated or noncorrelated.  
**Note:** ALL subqueries cannot be correlated.
- Subqueries in the ORDER BY and GROUP BY clauses are supported; for example, the following statement says to order by the first column, which is the select-list subquery:  
SELECT (SELECT MAX(x) FROM t2 WHERE y=t1.b) FROM t1 ORDER BY 1;

## See Also

**Subquery Restrictions** (page [314](#))

## WITH Clauses in SELECT

While not strictly subqueries, WITH clauses are concomitant queries within a larger, primary query. HP Vertica evaluates each WITH clause only once while executing the primary query. You can reference the results of any evaluated WITH clause during the primary query transaction, as if the results existed in a temporary table using the WITH query name. Each WITH clause query must have a unique name. Attempting to use same-name aliases for WITH clause query names causes an error.

You can also use the results of a previously evaluated WITH clause in any subsequent WITH clause or select statement. Combining WITH clause results in another WITH query lets you successively use the results of evaluated WITH clauses (the limit of evaluated WITH clauses is undefined). WITH clauses do not support INSERT, DELETE, and UPDATE statements, and you cannot use them recursively.

### Using WITH Clauses

This example illustrates the use of two WITH clauses evaluated before the primary query, `regional_sales` and `top_regions`. Following are the evaluation and usage steps:

- The `regional_sales` clause evaluates its select statement from table `orders`. After evaluation, each of the columns selected in this WITH clause can be queried or used as part of a later WITH clause.
- The `top_regions` clause is evaluated using values from results obtained in the `regional_sales` clause.
- The primary query is then evaluated using the results obtained in the `top_regions` clause, and accessed as if `top_regions` is a temporary table.

```
-- Begin WITH clauses,

-- First WITH clause, regional_sales
WITH
 regional_sales AS (
 SELECT region, SUM(amount) AS total_sales
 FROM orders
```

```

 GROUP BY region),

-- Second WITH clause top_regions
top_regions AS (
 SELECT region
 FROM regional_sales
 WHERE total_sales > (SELECT SUM (total_sales)/10 FROM regional_sales))

-- End defining WITH clause statement

-- Begin main primary query
SELECT region,
 product,
 SUM(quantity) AS product_units,
 SUM(amount) AS product_sales
FROM orders
WHERE region IN (SELECT region FROM top_regions)
GROUP BY region, product;

```

## See Also

**Subquery Restrictions** (page [314](#))

WITH Clause in the SQL Reference Manual

## Noncorrelated and Correlated Subqueries

A class of queries is evaluated by running the subquery once and then substituting the resulting value or values into the `WHERE` clause of the outer query. These self-contained queries are called **noncorrelated** (simple) subqueries; you can run them by themselves and inspect the results independent of their containing statements. A **correlated** subquery, however, is dependent on its containing statement, from which it references one or more columns.

See the following table for examples of the two subquery types:

| Noncorrelated (simple)                                                                                                                                       | Correlated                                                                                                                                                                                                                                 |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <pre> SELECT name, street, city, state FROM addresses as ADD WHERE state IN     (SELECT state FROM states); </pre>                                           | <pre> SELECT name, street, city, state FROM addresses as ADD WHERE EXISTS     (SELECT * FROM states as ST      WHERE ST.state = ADD.state); </pre>                                                                                         |
| The subquery (SELECT state FROM states) is independent from the containing query. It is evaluated first and its results are passed to the outer query block. | The subquery needs values from the state column in containing query, and results are then passed to the outer query block. The subquery is evaluated for every record of the outer block because the column is being used in the subquery. |

The difference between noncorrelated (simple) subqueries and correlated subqueries is that in simple subqueries, the containing (outer) query only has to take action on the results from the subquery (inner query). In a correlated subquery, the outer query block provides values for subquery to use in its evaluation.

### Notes

- You can use an outer join to obtain the same effect as a correlated subquery.
- Arbitrary uncorrelated queries are permitted in the WHERE clause as single-row expressions; for example:  
=> SELECT COUNT(\*) FROM SubQ1 WHERE SubQ1.a = (SELECT y from SubQ2);
- Noncorrelated queries in the HAVING clause as single-row expressions are permitted; for example:  
=> SELECT COUNT(\*) FROM SubQ1 GROUP BY SubQ1.a  
      HAVING SubQ1.a = (SubQ1.a & (SELECT y from SubQ2));

### See Also

**Subquery Restrictions** (page [314](#))

## Flattening FROM Clause Subqueries and Views

FROM clause subquery are always evaluated before their containing query. For example, in the following statement, the HP Vertica optimizer must evaluate all records in table t1 before it can evaluate the records in table t0:

```
=> SELECT * FROM (SELECT a, MAX(a) AS max FROM (SELECT * FROM t1) AS t0 GROUP BY a);
```

In an optimization called subquery flattening, some FROM clause subqueries are *flattened* into the containing query, improving the performance of subquery-containing queries.

Using the above query, HP Vertica can internally flatten it as follows:

```
=> SELECT * FROM (SELECT a, MAX(a) FROM t1 GROUP BY a) AS t0;
```

Both queries return the same results, but the flattened query runs more quickly.

The optimizer will choose the flattening plan if the subquery or view does not contain the following:

- Aggregates
- Analytics
- An outer join (left, right or full)
- GROUP BY, ORDER BY, or HAVING clause
- DISTINCT keyword
- LIMIT or OFFSET clause
- UNION, EXCEPT, or INTERSECT clause
- EXISTS subquery

To see if a FROM clause subquery has been flattened, inspect the query plan, as described in EXPLAIN in the SQL Reference Manual. Typically, the number of value expression nodes (ValExpNode) decreases after flattening.

### Flattening views

When you specify a view in a FROM clause query, HP Vertica first replaces the view name with the view definition query, creating further opportunities for subquery flattening. This process is called view flattening and works the same way as subquery flattening. See Implementing Views in the Administrator's Guide for additional details about views.

### Examples

If you have a predicate that applies to a view or subquery, the flattening operation can allow for optimizations by evaluating the predicates before the flattening takes place. In this example, without flattening, HP Vertica must first evaluate the subquery, and only then can the predicate WHERE  $x > 10$  be applied. In the flattened subquery, HP Vertica applies the predicate before evaluating the subquery, thus reducing the amount of work for the optimizer because it returns only the records WHERE  $x > 10$  to the containing query.

Assume that view v1 is defined as follows:

```
=> CREATE VIEW v1 AS SELECT * FROM a;
```

You enter the following query:

```
=> SELECT * FROM v1 JOIN b ON x=y WHERE x > 10;
```

HP Vertica internally transforms the above query as follows:

```
=> SELECT * FROM (SELECT * FROM a) AS t1 JOIN b ON x=y WHERE x > 10;
```

And the flattening mechanism gives you the following:

```
=> SELECT * FROM a JOIN b ON x=y WHERE x > 10;
```

The following example is how HP Vertica transforms FROM clause subqueries within a WHERE clause IN subquery:

- Original query: `SELECT * FROM a WHERE b IN (SELECT b FROM (SELECT * FROM t2) AS D WHERE x=1);`
- Flattened query: `SELECT * FROM a WHERE b IN (SELECT b FROM t2) AS D WHERE x=1;`

### See Also

**Subquery Restrictions** (page [314](#))

## Subqueries in UPDATE and DELETE Statements

You can nest subqueries within UPDATE and DELETE statements.

## UPDATE subqueries

If you want to update records in a table based on values that are stored in other database tables, you can nest a subquery within an `UPDATE` statement. See also `UPDATE` in the SQL Reference Manual.

### Syntax

```
UPDATE [[db-name.]schema.]table
SET column = { expression | DEFAULT } [, ...]
[FROM from-list]
[WHERE Clause]
```

|           |                                                                                                                                                                                                                                                                     |
|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Semantics | <code>UPDATE</code> changes the values of the specified columns in all rows that satisfy the condition. Only the columns to be modified need to be specified in the <code>SET</code> clause. Columns that are not explicitly modified retain their previous values. |
| Outputs   | On successful completion, an update operation returns a count, which represents the number of rows updated. A count of 0 is not an error; it means that no rows matched the condition.                                                                              |

### Performance tip

To be eligible for `DELETE` optimization, all target table columns referenced in a `DELETE` or `UPDATE` statement's `WHERE` clause must be in the projection definition.

For example, the following simple schema has two tables and three projections:

```
CREATE TABLE tb1 (a INT, b INT, c INT, d INT);
CREATE TABLE tb2 (g INT, h INT, i INT, j INT);
```

The first projection references all columns in `tb1` and sorts on column `a`:

```
CREATE PROJECTION tb1_p AS SELECT a, b, c, d FROM tb1 ORDER BY a;
```

The buddy projection references and sorts on column `a` in `tb1`:

```
CREATE PROJECTION tb1_p_2 AS SELECT a FROM tb1 ORDER BY a;
```

This projection references all columns in `tb2` and sorts on column `i`:

```
CREATE PROJECTION tb2_p AS SELECT g, h, i, j FROM tb2 ORDER BY i;
```

Consider the following DML statement, which references `tb1.a` in its `WHERE` clause. Since both projections on `tb1` contain column `a`, both are eligible for the optimized `DELETE`:

```
DELETE FROM tb1 WHERE tb1.a IN (SELECT tb2.i FROM tb2);
```

### Restrictions

Optimized `DELETEs` are not supported under the following conditions:

- With pre-join projections on nodes that are down
- With replicated and pre-join projections if subqueries reference the target table. For example, the following syntax is not supported:

```
DELETE FROM tb1 WHERE tb1.a IN (SELECT e FROM tb2, tb2 WHERE tb2.e = tb1.e);
```

- With subqueries that do not return multiple rows. For example, the following syntax is not supported:

```
DELETE FROM tb1 WHERE tb1.a = (SELECT k from tb2);
```

### Notes and restrictions

- The table specified in the UPDATE list cannot also appear in the FROM list (no self joins); for example, the following is not allowed:
 

```
=> BEGIN;
=> UPDATE result_table
 SET address='new' || r2.address
 FROM result_table r2
 WHERE r2.cust_id = result_table.cust_id + 10;
ERROR: Self joins in UPDATE statements are not allowed
DETAIL: Target relation result_table also appears in the FROM list
```
- If more than one row in a table to be updated matches the WHERE predicate, HP Vertica returns an error specifying which row had more than one match.

### UPDATE example

The following series of commands illustrate the use of subqueries in UPDATE statements; they all use the following simple schema:

```
=> CREATE TABLE result_table(
 cust_id INTEGER,
 address VARCHAR(2000));
```

Enter some customer data:

```
=> COPY result_table FROM stdin delimiter ',' DIRECT;
20, Lincoln Street
30, Booth Hill Road
30, Beach Avenue
40, Mt. Vernon Street
50, Hillside Avenue
\.
```

Query the table you just created:

```
=> SELECT * FROM result_table;
cust_id | address
-----+-----
20 | Lincoln Street
30 | Beach Avenue
30 | Booth Hill Road
40 | Mt. Vernon Street
50 | Hillside Avenue
(5 rows)
```

Create a second table called new\_addresses:

```
=> CREATE TABLE new_addresses (
 new_cust_id integer,
 new_address VARCHAR(200));
```

Enter some customer data.

**Note:** The following `COPY` statement creates an entry for a customer ID with a value of 60, which does not have a matching value in the `result_table` table:

```
=> COPY new_addresses FROM stdin delimiter ',' DIRECT;
 20, Infinite Loop
 30, Loop Infinite
 60, New Addresses
 \.
```

Query the `new_addresses` table:

```
=> SELECT * FROM new_addresses;
 new_cust_id | new_address
-----+-----
 20 | Infinite Loop
 30 | Loop Infinite
 60 | New Addresses
(3 rows)
```

Commit the changes:

```
=> COMMIT;
```

In the following example, a **noncorrelated subquery** (page [303](#)) is used to change the address record in `results_table` to 'New Address' when the query finds a customer ID match in both tables:

```
=> UPDATE result_table
 SET address='New Address'
 WHERE cust_id IN (SELECT new_cust_id FROM new_addresses);
```

The output returns the expected count indicating that three rows were updated:

```
OUTPUT

 3
(1 row)
```

Now query the `result_table` table to see the changes for matching customer ID 20 and 30. Addresses for customer ID 40 and 50 are not updated:

```
=> SELECT * FROM result_table;
 cust_id | address
-----+-----
 20 | New Address
 30 | New Address
 30 | New Address
 40 | Mt. Vernon Street
 50 | Hillside Avenue
(5 rows)
```

To preserve your original data, issue the `ROLLBACK` command:

```
=> ROLLBACK;
```

In the following example, a correlated subquery is used to replace all `address` records in the `results_table` with the `new_address` record from the `new_addresses` table when the query finds match on the customer ID in both tables:

```
=> UPDATE result_table
 SET address=new_addresses.new_address
 FROM new_addresses
 WHERE cust_id = new_addresses.new_cust_id;
```

Again, the output returns the expected count indicating that three rows were updated:

```
OUTPUT

 3
(1 row)
```

Now query the `result_table` table to see the changes for customer ID 20 and 30. Addresses for customer ID 40 and 50 are not updated, and customer ID 60 is omitted because there is no match:

```
=> SELECT * FROM result_table;
 cust_id | address
-----+-----
 20 | Infinite Loop
 30 | Loop Infinite
 30 | Loop Infinite
 40 | Mt. Vernon Street
 50 | Hillside Avenue
(5 rows)
```

## **DELETE subqueries**

If you want to delete records in a table based on values that are stored in other database tables, you can nest a subquery within a `DELETE` statement. See also `DELETE` in the SQL Reference Manual.

### **Syntax**

```
DELETE FROM [[db-name.] schema.] table
WHERE Clause
```

|           |                                                                                                                                                                                                                                                                     |
|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Semantics | The <code>DELETE</code> operation deletes rows that satisfy the <code>WHERE</code> clause from the specified table. If the <code>WHERE</code> clause is absent, all table rows are deleted. The result is a valid, even though the statement leaves an empty table. |
| Outputs   | On successful completion, a <code>DELETE</code> operation returns a count, which represents the number of rows deleted. A count of 0 is not an error; it means that no rows matched the condition.                                                                  |

## **DELETE example**

The following series of commands illustrate the use of subqueries in `DELETE` statements; they all use the following simple schema:

```
=> CREATE TABLE t (a INTEGER);
=> CREATE TABLE t2 (a INTEGER);
=> INSERT INTO t VALUES (1);
=> INSERT INTO t VALUES (2);
=> INSERT INTO t2 VALUES (1);
=> COMMIT;
```

The following command deletes the expected row from table t:

```
=> DELETE FROM t WHERE t.a IN (SELECT t2.a FROM t2);
 OUTPUT

 1
(1 row)
```

Notice that table t now has only one row, instead of two:

```
=> SELECT * FROM t;
 a

 2
(1 row)
```

To preserve the data for this example, issue the rollback command:

```
=> ROLLBACK;
```

The following command deletes the expected two rows:

```
=> DELETE FROM t WHERE EXISTS (SELECT * FROM t2);
 OUTPUT

 2
(1 row)
```

Now table t contains no rows:

```
=> SELECT * FROM t;
 a

(0 rows)
```

Roll back to the previous state and verify that you still have two rows:

```
=> ROLLBACK;
SELECT * FROM t;
 a

 1
 2
(2 rows)
```

The following command uses a correlated subquery to delete all rows in table t where t.a matches a value of t2.a.

```
=> DELETE FROM t WHERE EXISTS (SELECT * FROM t2 WHERE t.a = t2.a);
 OUTPUT

 1
(1 row)
```

Query the table to verify the row was deleted:

```
=> SELECT * FROM t;
 a

```

```
2
(1 row)
```

Roll back to the previous state and query the table again:

```
=> ROLLBACK;
=> SELECT * FROM t;
a

1
2
(2 rows)
```

## See Also

**Subquery Restrictions** (page [314](#))

## Subquery Examples

This topic illustrates some of the subqueries you can write. The examples use the Vmart example database.

### Single-row subqueries

Single-row subqueries are used with single-row comparison operators (=, >=, <=, <>, and <=>) and return exactly one row.

For example, the following query retrieves the name and hire date of the oldest employee in the Vmart database:

```
=> SELECT employee_key, employee_first_name, employee_last_name, hire_date
 FROM employee_dimension
 WHERE hire_date = (SELECT MIN(hire_date) FROM employee_dimension);

employee_key | employee_first_name | employee_last_name | hire_date
-----+-----+-----+-----+
 2292 | Mary | Bauer | 1956-01-11
(1 row)
```

### Multiple-row subqueries

Multiple-row subqueries return multiple records.

For example, the following IN clause subquery returns the names of the employees making the highest salary in each of the six regions:

```
=> SELECT employee_first_name, employee_last_name, annual_salary,
 employee_region
 FROM employee_dimension WHERE annual_salary IN
 (SELECT MAX(annual_salary) FROM employee_dimension GROUP BY employee_region)
 ORDER BY annual_salary DESC;

employee_first_name | employee_last_name | annual_salary | employee_region
-----+-----+-----+-----+
 Alexandra | Sanchez | 992363 | West
```

---

|          |          |        |           |
|----------|----------|--------|-----------|
| Mark     | Vogel    | 983634 | South     |
| Tiffany  | Vu       | 977716 | SouthWest |
| Barbara  | Lewis    | 957949 | MidWest   |
| Sally    | Gauthier | 927335 | East      |
| Wendy    | Nielson  | 777037 | NorthWest |
| (6 rows) |          |        |           |

## Multicolumn subqueries

Multicolumn subqueries return one or more columns. Sometimes a subquery's result set is evaluated in the containing query in column-to-column and row-to-row comparisons.

**Note:** Multicolumn subqueries can use the `<>`, `!=`, and `=` operators but not the `<`, `>`, `<=`, `>=` operators.

You can substitute some multicolumn subqueries with a join, with the reverse being true as well. For example, the following two queries ask for the sales transactions of all products sold online to customers located in Massachusetts and return the same result set. The only difference is the first query is written as a join and the second is written as a subquery.

| Join query:                                                                                                                                        | Subquery:                                                                                                                                                              |
|----------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| => SELECT *<br>FROM online_sales.online_sales_fact<br>INNER JOIN public.customer_dimension<br>USING (customer_key)<br>WHERE customer_state = 'MA'; | => SELECT *<br>FROM online_sales.online_sales_fact<br>WHERE customer_key IN<br>(SELECT customer_key<br>FROM public.customer_dimension<br>WHERE customer_state = 'MA'); |

The following query returns all employees in each region whose salary is above the average:

```
=> SELECT e.employee_first_name, e.employee_last_name, e.annual_salary,
 e.employee_region, s.average
 FROM employee_dimension e,
 (SELECT employee_region, AVG(annual_salary) AS average
 FROM employee_dimension GROUP BY employee_region) AS s
 WHERE e.employee_region = s.employee_region AND e.annual_salary > s.average
 ORDER BY annual_salary DESC;
```

| employee_first_name | employee_last_name | annual_salary | employee_region | average          |
|---------------------|--------------------|---------------|-----------------|------------------|
| Doug                | Overstreet         | 995533        | East            | 61192.786013986  |
| Matt                | Gauthier           | 988807        | South           | 57337.8638902996 |
| Lauren              | Nguyen             | 968625        | West            | 56848.4274914089 |
| Jack                | Campbell           | 963914        | West            | 56848.4274914089 |
| William             | Martin             | 943477        | NorthWest       | 58928.2276119403 |
| Luigi               | Campbell           | 939255        | MidWest         | 59614.9170454545 |
| Sarah               | Brown              | 901619        | South           | 57337.8638902996 |
| Craig               | Goldberg           | 895836        | East            | 61192.786013986  |
| Sam                 | Vu                 | 889841        | MidWest         | 59614.9170454545 |
| Luigi               | Sanchez            | 885078        | MidWest         | 59614.9170454545 |
| Michael             | Weaver             | 882685        | South           | 57337.8638902996 |
| Doug                | Pavlov             | 881443        | SouthWest       | 57187.2510548523 |
| Ruth                | McNulty            | 874897        | East            | 61192.786013986  |
| Luigi               | Dobisz             | 868213        | West            | 56848.4274914089 |
| Laura               | Lang               | 865829        | East            | 61192.786013986  |
| ...                 |                    |               |                 |                  |

You can also use the EXCEPT, INTERSECT, and UNION [ALL] keywords in FROM, WHERE, and HAVING clauses.

The following subquery returns information about all Connecticut-based customers who bought items through either stores or online sales channel and whose purchases amounted to more than 500 dollars:

```
=> SELECT DISTINCT customer_key, customer_name FROM public.customer_dimension
 WHERE customer_key IN (SELECT customer_key FROM store.store_sales_fact
 WHERE sales_dollar_amount > 500
 UNION ALL
 SELECT customer_key FROM online_sales.online_sales_fact
 WHERE sales_dollar_amount > 500)
 AND customer_state = 'CT';

customer_key | customer_name
-----+-----
 200 | Carla Y. Kramer
 733 | Mary Z. Vogel
 931 | Lauren X. Roy
 1533 | James C. Vu
 2948 | Infocare
 4909 | Matt Z. Winkler
 5311 | John Z. Goldberg
 5520 | Laura M. Martin
 5623 | Daniel R. Kramer
 6759 | Daniel Q. Nguyen
...
...
```

### HAVING clause subqueries

A HAVING clause is used in conjunction with the GROUP BY clause to filter the select-list records that a GROUP BY returns. HAVING clause subqueries must use Boolean comparison operators: =, >, <, <>, <=, >= and take the following form:

```
SELECT <column, ...>
FROM <table>
GROUP BY <expression>
HAVING <expression>
 (SELECT <column, ...>
 FROM <table>
 HAVING <expression>);
```

For example, the following statement uses the VMart database and returns the number of customers who purchased lowfat products. Note that the GROUP BY clause is required because the query uses an aggregate (COUNT).

```
=> SELECT s.product_key, COUNT(s.customer_key) FROM store.store_sales_fact s
 GROUP BY s.product_key HAVING s.product_key IN
 (SELECT product_key FROM product_dimension WHERE diet_type = 'Low Fat');
```

The subquery first returns the product keys for all low-fat products, and the outer query then counts the total number of customers who purchased those products.

```
product_key | count
-----+-----
 15 | 2
 41 | 1
 66 | 1
```

```
106 | 1
```

```
118 | 1
```

```
169 | 1
```

```
181 | 2
```

```
184 | 2
```

```
186 | 2
```

```
211 | 1
```

```
229 | 1
```

```
267 | 1
```

```
289 | 1
```

```
334 | 2
```

```
336 | 1
```

(15 rows)

## Subquery Restrictions

The following list summarizes subquery restrictions in HP Vertica.

- Subqueries are not allowed in the defining query of a CREATE PROJECTION statement.
- Subqueries can be used in the select-list, but GROUP BY or aggregate functions are not allowed in the query if the subquery is not part of the GROUP BY clause in the containing query; for example, the following two statement returns an error message:

```
=> SELECT y, (SELECT MAX(a) FROM t1) FROM t2 GROUP BY y;
 ERROR: subqueries in the SELECT or ORDER BY are not supported if the
 subquery is not part of the GROUP BY
=> SELECT MAX(y), (SELECT MAX(a) FROM t1) FROM t2;
 ERROR: subqueries in the SELECT or ORDER BY are not supported if the
 query has aggregates and the subquery is not part of the GROUP BY
```
- Subqueries are supported within UPDATE statements with the following exceptions:
  - You cannot use SET column = {expression} to specify a subquery.
  - The table specified in the UPDATE list cannot also appear in the FROM list (no self joins).
- FROM clause subqueries require an alias but tables do not. If the table has no alias, the query must refer to columns inside it as <table>.<column>; however, if the column names are uniquely identified among all tables used by the query, then preceding the column with a table name is not enforced.
- If the ORDER BY clause is inside a FROM clause subquery, rather than in the containing query, the query could return unexpected sort results. This is because HP Vertica data comes from multiple nodes, so sort order cannot be guaranteed unless an ORDER BY clause is specified in the outer query block. This behavior is compliant with the SQL standard but it might differ from other databases.
- Multicolumn subqueries cannot use the <, >, <=, >= comparison operators. They can use <>, !=, and = operators.
- WHERE and HAVING clause subqueries must use Boolean comparison operators: =, >, <, >=, <=, >. Those subqueries can be noncorrelated and correlated.
- [NOT] IN and ANY subqueries nested within another expression are not supported if any of the column values are NULL. In the following statement, for example, if column x from either table t1 or t2 contains a NULL value, HP Vertica returns a run-time error:

- => SELECT \* FROM t1 WHERE (x IN (SELECT x FROM t2)) IS FALSE;  
 ERROR: NULL value found in a column used by a subquery
- HP Vertica returns an error message during subquery run time on scalar subqueries that return more than one row.
  - Aggregates and GROUP BY clauses are allowed in subqueries, as long as those subqueries are not correlated.
  - Correlated expressions under ALL and [NOT] IN are not supported.
  - Correlated expressions under OR are not supported.
  - Multiple correlations are allowed only for subqueries that are joined with an equality predicate (<, >, <=, =, <>, <=>) but IN/NOT IN, EXISTS/NOT EXISTS predicates within correlated subqueries are not allowed:  
 => SELECT t2.x, t2.y, t2.z FROM t2 WHERE t2.z NOT IN  
   (SELECT t1.z FROM t1 WHERE t1.x = **t2.x**);  
 ERROR: Correlated subquery with NOT IN is not supported
  - Up to one level of correlated subqueries is allowed in the WHERE clause if the subquery references columns in the immediate outer query block. For example, the following query is not supported because the **t2.x = t3.x** subquery can only refer to table **t1** in the outer query, making it a correlated expression because **t3.x** is two levels out:  
 => SELECT t3.x, t3.y, t3.z FROM t3 WHERE t3.z IN (  
   SELECT t1.z FROM t1 WHERE EXISTS (  
     SELECT 'x' FROM t2 WHERE **t2.x = t3.x**) AND t1.x = t3.x);  
 ERROR: More than one level correlated subqueries are not supported  
 The query is supported if it is rewritten as follows:  
 => SELECT t3.x, t3.y, t3.z FROM t3 WHERE t3.z IN  
   (SELECT t1.z FROM t1 WHERE EXISTS  
     (SELECT 'x' FROM t2 WHERE t2.x = **t1.x**)  
   AND t1.x = t3.x);

## Joins

Queries can combine records from multiple tables, or multiple instances of the same table. A query that combines records from one or more tables is called a join. Joins are allowed in a SELECT statement, as well as inside a subquery.

HP Vertica supports the following join types:

- Inner (including natural, cross) joins
- Left, right, and full outer joins
- Optimizations for equality and range joins predicates
- Hash, merge and sort-merge join algorithms.

There are three basic algorithms that perform a join operation: hash, merge, and nested loop:

- A hash join is used to join large data sets. The smaller joined table is used to build a hash table in memory on the join column. The HP Vertica optimizer then scans the larger table and probes the hash table to look for matches. The optimizer chooses a hash join when projections are not sorted on the join columns.

- If both inputs are pre-sorted, the optimizer can skip a sort operation and choose a merge join. The term sort-merge join refers to the case when one or both inputs must be sorted before the merge join. In this case, HP Vertica sorts the inner input but only if the outer input is already sorted on the join keys.
- HP Vertica does not support nested loop joins.

## The ANSI Join Syntax

Before the ANSI SQL-92 standard introduced the new join syntax, relations (tables, views, etc.) were named in the `FROM` clause, separated by commas. Join conditions were specified in the `WHERE` clause:

```
=> SELECT * FROM T1, T2 WHERE T1.id = T2.id;
```

The ANSI SQL-92 standard provided more specific join syntax, with join conditions named in the `ON` clause:

```
=> SELECT * FROM T1
 [INNER | LEFT OUTER | RIGHT OUTER | FULL OUTER | NATURAL | CROSS] JOIN T2
 ON T1.id = T2.id
```

See SQL-99 ANSI syntax at ***BNF Grammar for SQL-99***  
(<http://savage.net.au/SQL/sql-99.bnf.html>) for additional details.

Although some users continue to use the older join syntax, HP encourages you to use the SQL-92 join syntax whenever possible because of its many advantages:

- SQL-92 outer join syntax is portable across databases; the older syntax was not consistent between databases. (HP Vertica does not support proprietary outer join syntax such as '+' that can be used in some databases.)
- SQL-92 syntax provides greater control over whether predicates are to be evaluated during or after outer joins. This was also not consistent between databases when using the older syntax. See "Join Conditions vs. Filter Conditions" below.
- SQL-92 syntax eliminates ambiguity in the order of evaluating the joins, in cases where more than two tables are joined with outer joins.
- Union joins can be expressed using the SQL-92 syntax, but not in the older syntax.

**Note:** HP Vertica does not currently support union joins.

## Join Conditions vs. Filter Conditions

If you do not use the SQL-92 syntax, join conditions (predicates that are evaluated during the join) are difficult to distinguish from filter conditions (predicates that are evaluated after the join), and in some cases cannot be expressed at all. With SQL-92, join conditions and filter conditions are separated into two different clauses, the `ON` clause and the `WHERE` clause, respectively, making queries easier to understand.

- **The ON clause** contains relational operators (for example, <, <=, >, >=, <>, =, <=>) or other predicates that specify which records from the left and right input relations to combine, such as by matching foreign keys to primary keys. `ON` can be used with inner, left outer, right outer, and full outer joins. Cross joins and union joins do not use an `ON` clause.

Inner joins return all pairings of rows from the left and right relations for which the `ON` clause evaluates to TRUE. In a left join, all rows from the left relation in the join are present in the result; any row of the left relation that does not match any rows in the right relation is still present in the result but with nulls in any columns taken from the right relation. Similarly, a right join preserves all rows from the right relation, and a full join retains all rows from both relations.

- **The WHERE clause** is evaluated after the join is performed. It filters records returned by the `FROM` clause, eliminating any records that do not satisfy the `WHERE` clause condition.

HP Vertica automatically converts outer joins to inner joins in cases where it is correct to do so, allowing the optimizer to choose among a wider set of query plans and leading to better performance.

## Inner Joins

An inner join combines records from two tables based on a join predicate and requires that each record in the first table has a matching record in the second table. Inner joins, thus, return only those records from both joined tables that satisfy the join condition. Records that contain no matches are not preserved.

Inner joins take the following form:

```
SELECT <column list>
FROM <left joined table>
[INNER] JOIN <right joined table>
ON <join condition>
```

### Notes

- Inner joins are commutative and associative, which means you can specify the tables in any order you want, and the results do not change.
- If you omit the `INNER` keyword, the join is still an inner join, the most commonly used type of join.
- Join conditions that follow the `ON` keyword generally can contain many predicates connected with Boolean `AND`, `OR`, or `NOT` predicates.
- For best performance, do not join on any `LONG VARBINARY` and `LONG VARCHAR` columns.
- You can also use inner join syntax to specify joins for pre-join projections. See ***Pre-join Projections and Join Predicates*** (page [326](#)). Some SQL-related books and online tutorials refer to a left-joined table as the outer table and a right-joined table as the inner table. The HP documentation often uses the left/right table concept.

## Example

In the following example, an inner join produces only the set of records that matches in both T1 and T2 when T1 and T2 have the same data type; all other data is excluded.

```
=> SELECT * FROM T1 INNER JOIN T2 ON (T1.id = T2.id);
```

If a company, for example, wants to know the dates vendors in Utah sold inventory:

```
=> SELECT v.vendor_name, d.date FROM vendor_dimension v
INNER JOIN date_dimension d ON v.vendor_key = d.date_key
WHERE vendor_state = 'UT';
```

| vendor_name      | date       |
|------------------|------------|
| Frozen Warehouse | 2003-01-07 |
| Delicious Farm   | 2003-01-26 |

(2 rows)

To clarify, if the vendor dimension table contained a third row that has no corresponding date when a vendor sold inventory, then that row would not be included in the result set. Similarly, if on some date there was no inventory sold by any vendor, those rows would be left out of the result set. If you want to include all rows from one table or the other regardless of whether a match exists, you can specify an **outer join** (page [322](#)).

## See Also

**Joins Notes and Restrictions** (page [327](#))

## Equi-joins and Non Equi-Joins

HP Vertica supports any arbitrary join expression with both matching and non-matching column values; for example:

```
SELECT * FROM fact JOIN dim ON fact.x = dim.x;
SELECT * FROM fact JOIN dim ON fact.x > dim.y;
SELECT * FROM fact JOIN dim ON fact.x <= dim.y;
SELECT * FROM fact JOIN dim ON fact.x <> dim.y;
SELECT * FROM fact JOIN dim ON fact.x <=> dim.y;
```

**Note:** The = and <=> operators generally run the fastest.

Equi-joins are based on equality (matching column values). This equality is indicated with an equal sign (=), which functions as the comparison operator in the **ON** clause using SQL-92 syntax or the **WHERE** clause using older join syntax.

The first example below uses SQL-92 syntax and the **ON** clause to join the online sales table with the call center table using the call center key; the query then returns the sale date key that equals the value 156:

```
=> SELECT sale_date_key, cc_open_date FROM online_sales.online_sales_fact
INNER JOIN online_sales.call_center_dimension
ON (online_sales.online_sales_fact.call_center_key =
online_sales.call_center_dimension.call_center_key
AND sale_date_key = 156);
```

```

sale_date_key | cc_open_date
-----+-----
 156 | 2005-08-12
(1 row)

```

The second example uses older join syntax and the `WHERE` clause to join the same tables to get the same results:

```

=> SELECT sale_date_key, cc_open_date
 FROM online_sales.online_sales_fact, online_sales.call_center_dimension
 WHERE online_sales.online_sales_fact.call_center_key =
 online_sales.call_center_dimension.call_center_key
 AND sale_date_key = 156;

sale_date_key | cc_open_date
-----+-----
 156 | 2005-08-12
(1 row)

```

HP Vertica also permits tables with compound (multiple-column) primary and foreign keys. For example, to create a pair of tables with multi-column keys:

```

=> CREATE TABLE dimension(pk1 INTEGER NOT NULL, pk2 INTEGER NOT NULL);
=> ALTER TABLE dimension ADD PRIMARY KEY (pk1, pk2);
=> CREATE TABLE fact (fk1 INTEGER NOT NULL, fk2 INTEGER NOT NULL);
=> ALTER TABLE fact ADD FOREIGN KEY (fk1, fk2) REFERENCES dimension (pk1, pk2);

```

To join tables using compound keys, you must connect two join predicates with a Boolean `AND` operator. For example:

```
=> SELECT * FROM fact f JOIN dimension d ON f.fk1 = d.pk1 AND f.fk2 = d.pk2;
```

You can write queries with expressions that contain the `<=>` operator for `NULL=NULL` joins.

```
=> SELECT * FROM fact JOIN dim ON fact.x <=> dim.y;
```

The `<=>` operator performs an equality comparison like the `=` operator, but it returns true, instead of `NULL`, if both operands are `NULL`, and false, instead of `NULL`, if one operand is `NULL`.

```

=> SELECT 1 <=> 1, NULL <=> NULL, 1 <=> NULL;
?column? | ?column? | ?column?
-----+-----+-----
 t | t | f
(1 row)

```

Compare the `<=>` operator to the `=` operator:

```

=> SELECT 1 = 1, NULL = NULL, 1 = NULL;
?column? | ?column? | ?column?
-----+-----+-----
 t | |
(1 row)

```

**Note:** Writing `NULL=NULL` joins on primary key/foreign key combinations is not an optimal choice because PK/FK columns are usually defined as `NOT NULL`.

When composing joins, it helps to know in advance which columns contain null values. An employee's hire date, for example, would not be a good choice because it is unlikely hire date would be omitted. An hourly rate column, however, might work if some employees are paid hourly and some are salaried. If you are unsure about the value of columns in a given table and want to check, type the command:

```
=> SELECT COUNT(*) FROM tablename WHERE columnname IS NULL;
```

## Natural Joins

A natural join is just a join with an implicit join predicate. Natural joins can be inner, left outer, right outer, or full outer joins and take the following form:

```
SELECT <column list> FROM <left-joined table>
NATURAL [INNER | LEFT OUTER | RIGHT OUTER | FULL OUTER] JOIN <right-joined table>
```

Natural joins are, by default, natural *inner* joins; however, there can also be natural (left/right) outer joins. The primary difference between an inner and natural join is that inner joins have an explicit join condition, whereas the natural join's conditions are formed by matching all pairs of columns in the tables that have the same name and compatible data types, making natural joins equi-joins because join condition are equal between common columns. (If the data types are incompatible, HP Vertica returns an error.)

**Note:** The data type coercion chart lists the data types that can be cast to other data types. If one data type can be cast to the other, those two data types are compatible.

The following query is a simple natural join between tables T1 and T2 when the T2 column `val` is greater than 5:

```
=> SELECT * FROM T1 NATURAL JOIN T2 WHERE T2.val > 5;
```

The following example shows a natural join between the `store_sales_fact` table and the `product_dimension` table with columns of the same name, `product_key` and `product_version`:

```
=> SELECT product_description, store.store_sales_fact.*
 FROM store.store_sales_fact, public.product_dimension
 WHERE store.store_sales_fact.product_key =
public.product_dimension.product_key
 AND store.store_sales_fact.product_version =
public.product_dimension.product_version;
```

The following three queries return the same result expressed as a basic query, an inner join, and a natural join. At the table expressions are equivalent only if the common attribute in the `store_sales_fact` table and the `store_dimension` table is `store_key`. If both tables have a column named `store_key`, then the natural join would also have a `store_sales_fact.store_key = store_dimension.store_key` join condition. Since the results are the same in all three instances, they are shown in the first (basic) query only:

```
=> SELECT store_name FROM store.store_sales_fact, store.store_dimension
 WHERE store.store_sales_fact.store_key = store.store_dimension.store_key
 AND store.store_dimension.store_state = 'MA' ORDER BY store_name;
```

store\_name

```

Store11
Store128
Store178
Store66
Store8
Store90
(6 rows)
```

The query written as an inner join:

```
=> SELECT store_name FROM store.store_sales_fact
 INNER JOIN store.store_dimension
 ON (store.store_sales_fact.store_key = store.store_dimension.store_key)
 WHERE store.store_dimension.store_state = 'MA' ORDER BY store_name;
```

In the case of the natural join, the join predicate appears implicitly by comparing all of the columns in both tables that are joined by the same column name. The result set contains only one column representing the pair of equally-named columns.

```
=> SELECT store_name FROM store.store_sales_fact
 NATURAL JOIN store.store_dimension
 WHERE store.store_dimension.store_state = 'MA' ORDER BY store_name;
```

## Cross Joins

Cross joins are the simplest joins to write, but they are not usually the fastest to run because they consist of all possible combinations of two tables' records. Cross joins contain no join condition and return what is known as a Cartesian product, where the number of rows in the result set is equal to the number of rows in the first table multiplied by the number of rows in the second table.

The following query returns all possible combinations from the promotion table and the store sales table:

```
=> SELECT * FROM promotion_dimension CROSS JOIN store.store_sales_fact;
```

Since this example returns over 600 million records, many cross join results can be extremely large and difficult to manage. Cross joins can be useful, however, such as when you want to return a single-row result set.

---

**Tip:** Filter out unwanted records in a cross with `WHERE` clause join predicates:

```
=> SELECT * FROM promotion_dimension p
 CROSS JOIN store.store_sales_fact f
 WHERE p.promotion_key LIKE f.promotion_key;
```

For details on what qualifies as a join predicate, see [Pre-join Projections and Join Predicates](#) (page [326](#)).

---

HP recommends that you do not write implicit cross joins (comma-separated tables in the `FROM` clause). These queries could imply accidental omission of a join predicate.

The following statement is an example of an implicit cross join:

```
=> SELECT * FROM promotion_dimension , store.store_sales_fact;
```

If you intend is to run a cross join, write an explicit cross join query using CROSS JOIN keywords, such as in the following statement:

```
=> SELECT * FROM promotion_dimension CROSS JOIN store.store_sales_fact;
```

## Examples

The following example creates two small tables and their superprojections and then runs a cross join on the tables:

```
=> CREATE TABLE employee(employee_id INT, employee_fname VARCHAR(50));
=> CREATE TABLE department(dept_id INT, dept_name VARCHAR(50));
=> INSERT INTO employee VALUES (1, 'Andrew');
=> INSERT INTO employee VALUES (2, 'Priya');
=> INSERT INTO employee VALUES (3, 'Michelle');
=> INSERT INTO department VALUES (1, 'Engineering');
=> INSERT INTO department VALUES (2, 'QA');
=> SELECT * FROM employee CROSS JOIN department;
```

In the result set, the cross join retrieves records from the first table and then creates a new row for every row in the 2nd table. It then does the same for the next record in the first table, and so on.

| employee_id | employee_name | dept_id | dept_name   |
|-------------|---------------|---------|-------------|
| 1           | Andrew        | 1       | Engineering |
| 2           | Priya         | 1       | Engineering |
| 3           | Michelle      | 1       | Engineering |
| 1           | Andrew        | 2       | QA          |
| 2           | Priya         | 2       | QA          |
| 3           | Michelle      | 2       | QA          |

(6 rows)

## Outer Joins

Outer joins extend the functionality of inner joins by letting you preserve rows of one or both tables that do not have matching rows in the non-preserved table. Outer joins take the following form:

```
SELECT <column list>
FROM <left-joined table>
[LEFT | RIGHT | FULL] OUTER JOIN <right-joined table>
ON <join condition>
```

**Note:** Omitting the keyword OUTER from your statements does not affect results of left and right joins. LEFT OUTER JOIN and LEFT JOIN perform the same operation and return the same results.

### Left Outer Joins

A left outer join returns a complete set of records from the left-joined (preserved) table T1, with matched records, where available, in the right-joined (non-preserved) table T2. Where HP Vertica finds no match, it extends the right side column (T2) with null values.

```
=> SELECT * FROM T1 LEFT OUTER JOIN T2 ON T1.x = T2.x;
```

To exclude the non-matched values from T2, write the same left outer join, but filter out the records you don't want from the right side by using a `WHERE` clause:

```
=> SELECT * FROM T1 LEFT OUTER JOIN T2
 ON T1.x = T2.x WHERE T2.x IS NOT NULL;
```

The following example uses a left outer join to enrich telephone call detail records with an incomplete numbers dimension. It then filters out results that are known not to be from Massachusetts:

```
=> SELECT COUNT(*) FROM calls LEFT OUTER JOIN numbers
 ON calls.to_phone = numbers.phone WHERE NVL(numbers.state, '') <> 'MA';
```

## Right Outer Joins

A right outer join returns a complete set of records from the right-joined (preserved) table, as well as matched values from the left-joined (non-preserved) table. If HP Vertica finds no matching records from the left-joined table (T1), NULL values appears in the T1 column for any records with no matching values in T1. A right join is, therefore, similar to a left join, except that the treatment of the tables is reversed.

```
=> SELECT * FROM T1 RIGHT OUTER JOIN T2 ON T1.x = T2.x;
```

The above query is equivalent to the following query, where `T1 RIGHT OUTER JOIN T2 = T2 LEFT OUTER JOIN T1`.

```
=> SELECT * FROM T2 LEFT OUTER JOIN T1 ON T2.x = T1.x;
```

The following example identifies customers who have *not* placed an order:

```
=> SELECT customers.customer_id FROM orders RIGHT OUTER JOIN customers
 ON orders.customer_id = customers.customer_id
 GROUP BY customers.customer_id HAVING COUNT(orders.customer_id) = 0;
```

## Full Outer Joins

A full outer join returns results for both left and right outer joins. The joined table contains all records from both tables, including nulls (missing matches) from either side of the join. This is useful if you want to see, for example, each employee who is assigned to a particular department and each department that has an employee, but you also want to see all the employees who are not assigned to a particular department, as well as any department that has no employees:

```
=> SELECT employee_last_name, hire_date FROM employee_dimension emp
 FULL OUTER JOIN department dept ON emp.employee_key = dept.department_key;
```

## Notes

HP Vertica also supports joins where the outer (preserved) table or subquery is replicated on more than one node and the inner (non-preserved) table or subquery is segmented across more than one node. For example, in the following query, the fact table, which is almost always segmented, appears on the non-preserved side of the join, and it is allowed:

```
=> SELECT sales_dollar_amount, transaction_type, customer_name
 FROM store.store_sales_fact f RIGHT JOIN customer_dimension d
 ON f.customer_key = d.customer_key;
```

```
sales_dollar_amount | transaction_type | customer_name
-----+-----+-----
 252 | purchase | Inistar
 363 | purchase | Inistar
 510 | purchase | Inistar
 -276 | return | Foodcorp
 252 | purchase | Foodcorp
 195 | purchase | Foodcorp
 290 | purchase | Foodcorp
 222 | purchase | Foodcorp
 |
 | | Foodgen
 | | Goldcare
(10 rows
```

## Range Joins

HP Vertica provides performance optimizations for <, <=, >, >=, and BETWEEN predicates in join ON clauses. These optimizations are particularly useful when a column from one table is restricted to be in a range specified by two columns of another table.

### Key Ranges

Multiple, consecutive key values can map to the same dimension values. Consider, for example, a table of IPv4 addresses and their owners. Because large subnets (ranges) of IP addresses could belong to the same owner, this dimension can be represented as:

```
=> CREATE TABLE ip_owners(
 ip_start INTEGER,
 ip_end INTEGER,
 owner_id INTEGER);

=> CREATE TABLE clicks(
 ip_owners INTEGER,
 dest_ip INTEGER);
```

A query that associates a click stream with its destination can use a join similar to the following, which takes advantage of the range optimization:

```
=> SELECT owner_id, COUNT(*) FROM clicks JOIN ip_owners
 ON clicks.dest_ip BETWEEN ip_start AND ip_end
 GROUP BY owner_id;
```

### Slowly-changing Dimensions

Sometimes there are multiple dimension ranges, each relevant over a different time period. For example, stocks might undergo splits (and reverse splits), and the price or volume of two trades might not be directly comparable without taking this into account. A “split factor” can be defined, which accounts for these events through time:

```
=> CREATE TABLE splits(
 symbol VARCHAR(10),
 start DATE,
 "end" DATE,
```

```
 split_factor FLOAT);
```

A join with an optimized range predicate can then be used to match each trade with the effective split factor:

```
=> SELECT trades.symbol, SUM(trades.volume * splits.split_factor)
 FROM trades JOIN splits
 ON trades.symbol = splits.symbol AND trades.tdate between splits.start AND
splits.end
 GROUP BY trades.symbol;
```

## Notes

- Operators <, <=, >, >=, or BETWEEN must appear as top-level conjunctive predicates for range join optimization to be effective, as shown in the following examples:

The following example query is optimized because BETWEEN is the only predicate:

```
=> SELECT COUNT(*) FROM fact JOIN dim
 ON fact.point BETWEEN dim.start AND dim.end;
```

This next example uses comparison operators as top-level predicates (within AND):

```
=> SELECT COUNT(*) FROM fact JOIN dim
 ON fact.point > dim.start AND fact.point < dim.end;
```

The following is optimized because BETWEEN is a top-level predicate (within AND):

```
=> SELECT COUNT(*) FROM fact JOIN dim
 ON (fact.point BETWEEN dim.start AND dim.end) AND fact.c <> dim.c;
```

The following query is not optimized because OR is the top-level predicate (disjunctive):

```
=> SELECT COUNT(*) FROM fact JOIN dim
 ON (fact.point BETWEEN dim.start AND dim.end) OR dim.end IS NULL;
```

- Expressions are optimized in range join queries in many cases.
- If range columns can have NULL values indicating that they are open-ended, it is possible to use range join optimizations by replacing nulls with very large or very small values:

```
=> SELECT COUNT(*) FROM fact JOIN dim
 ON fact.point BETWEEN NVL(dim.start, -1) AND NVL(dim.end,
1000000000000);
```

- If there is more than one set of ranging predicates in the same ON clause, the order in which the predicates are specified might impact the effectiveness of the optimization:

```
=> SELECT COUNT(*) FROM fact JOIN dim
 ON fact.point1 BETWEEN dim.start1 AND dim.end1
 AND fact.point2 BETWEEN dim.start2 AND dim.end2;
```

The optimizer chooses the first range to optimize, so write your queries so that the range you most want optimized appears first in the statement.

- The use of the range join optimization is not directly affected by any characteristics of the physical schema; no schema tuning is required to benefit from the optimization.
- The range join optimization can be applied to joins without any other predicates, and to HASH or MERGE joins.
- To determine if an optimization is in use, search for RANGE in the EXPLAIN plan. For example:

```
=> EXPLAIN SELECT owner_id, COUNT(*) FROM clicks JOIN ip_owners
```

```
ON clicks.dest_ip BETWEEN ip_start AND ip_end GROUP BY owner_id;
```

Join: Hash-Join:  
(ip\_owners x clicks) using subquery and subquery  
[RANGE JOIN]

Unc: Integer(8)  
Unc: Integer(8)  
Unc: Integer(8)  
Unc: Integer(8)

## Pre-join Projections and Join Predicates

HP Vertica can use pre-join projections when queries contain equi-joins between tables that contain all foreign key-primary key (FK-PK) columns in the equality predicates.

If you use pre-join projections in queries, the join in the input query becomes an inner join due to FK-PK constraints, so the second predicate in the example that follows (AND f.id2 = d.id2) is just extra. HP Vertica runs queries using pre-join projections only if the query contains a superset of the join predicates in the pre-join projection. In the following example, as long as the pre-join projection contains f.id = d.id, the pre-join can be used, even with the presence of f.id2 = d.id2.

```
=> SELECT * FROM fact f JOIN dim d ON f.id = d.id AND f.id2 = d.id2;
```

**Note:** HP Vertica uses a maximum of one pre-join projection per query. More than one pre-join projection might appear in a query plan, but at most, one will have been used to replace the join that would be computed with the precomputed pre-join. Any other pre-join projections are used as regular projections to supply records from a particular table.

### Examples

The following is an example of a pre-join projection schema with a single-column constraint called `customer_key`. The first sequence of statements creates a customer table in the `public` schema and a `store_sales` table in the `store` schema. The dimension table has one primary key, and the fact table has a foreign key that references the dimension table's primary key.

```
=> CREATE TABLE public.customer_dimension (
 customer_key integer,
 annual_income integer,
 largest_bill_amount integer);
=> CREATE TABLE store.store_sales_fact (
 customer_key integer,
 sales_quantity integer,
 sales_dollar_amount integer);
=> ALTER TABLE public.customer_dimension
 ADD CONSTRAINT pk_customer_dimension PRIMARY KEY (customer_key);
=> ALTER TABLE store.store_sales_fact
 ADD CONSTRAINT fk_store_sales_fact FOREIGN KEY (customer_key)
 REFERENCES public.customer_dimension (customer_key);
=> CREATE PROJECTION p1 (
 customer_key,
```

```

 annual_income,
 largest_bill_amount)
AS SELECT * FROM public.customer_dimension UNSEGMENTED ALL NODES;
=> CREATE PROJECTION p2 (
 customer_key,
 sales_quantity,
 sales_dollar_amount)
AS SELECT * FROM store.store_sales_fact UNSEGMENTED ALL NODES;
```

The following command creates the pre-join projection:

```

=> CREATE PROJECTION pp (
 cust_customer_key,
 cust_annual_income,
 cust_largest_bill_amount,
 fact_customer_key,
 fact_sales_quantity,
 fact_sales_dollar_amount)
AS SELECT * FROM public.customer_dimension cust, store.store_sales_fact fact
WHERE cust.customer_key = fact.customer_key ORDER BY cust.customer_key;
```

The pre-join projection contains columns from both tables and has a join predicate between `customer_dimension` and `store_sales_fact` along the FK-PK (primary key-foreign key) constraints defined on the tables.

The following query uses a pre-join projection because the join predicates match the pre-join projection's predicates exactly:

```

=> SELECT COUNT(*) FROM public.customer_dimension INNER JOIN
store.store_sales_fact
 ON public.customer_dimension.customer_key =
store.store_sales_fact.customer_key;
count

10000
(1 row)
```

## Join Notes and Restrictions

The following list summarizes the notes and restrictions for joins in HP Vertica:

- Inner joins are commutative and associative, which means you can specify the tables in any order you want, and the results do not change.
- If you omit the `INNER` keyword, the join is still an inner join, the most commonly used type of join.
- Join conditions that follow the `ON` keyword generally can contain many predicates connected with Boolean `AND`, `OR`, or `NOT` predicates.
- For best performance, do not join on any `LONG VARBINARY` and `LONG VARCHAR` columns.
- You can also use inner join syntax to specify joins for pre-join projections. See ***Pre-join Projections and Join Predicates*** (page [326](#)).
- HP Vertica supports any arbitrary join expression with both matching and non-matching column values; for example:

```
=> SELECT * FROM fact JOIN dim ON fact.x = dim.x;
=> SELECT * FROM fact JOIN dim ON fact.x > dim.y;
=> SELECT * FROM fact JOIN dim ON fact.x <= dim.y;
=> SELECT * FROM fact JOIN dim ON fact.x <> dim.y;
=> SELECT * FROM fact JOIN dim ON fact.x <=> dim.y;
```

- HP Vertica permits joins between tables with compound (multiple-column) primary and foreign keys, as long as you connect the two join predicates with a Boolean AND operator.
- You can write queries with expressions that contain the `<=>` operator for NULL=NULL joins.  
`=> SELECT * FROM fact JOIN dim ON fact.x <=> dim.y;`  
The `<=>` operator performs an equality comparison like the `=` operator, but it returns true, instead of NULL, if both operands are NULL, and false, instead of NULL, if one operand is NULL.
- HP recommends that you do not write implicit cross joins (such as tables named in the `FROM` clause separated by commas). Such queries could imply accidental omission of a join predicate. If your intent is to run a cross join, write explicit `CROSS JOIN` syntax.
- HP Vertica supports joins where the outer (preserved) table or subquery is replicated on more than one node and the inner (non-preserved) table or subquery is segmented across more than one node.
- HP Vertica uses a maximum of one pre-join projection per query. More than one pre-join projection might appear in a query plan, but at most, one will have been used to replace the join that would be computed with the precomputed pre-join. Any other pre-join projections are used as regular projections to supply records from a particular table.

# Using SQL Analytics

---

HP Vertica analytics are SQL functions based on the ANSI 99 standard. These functions handle complex analysis and reporting tasks such as:

- Rank the longest-standing customers in a particular state
- Calculate the moving average of retail volume over a specified time
- Find the highest score among all students in the same grade
- Compare the current sales bonus each salesperson received against his or her previous bonus

Analytic functions return aggregate results but they do not group the result set. They return the group value multiple times, once per record.

You can sort these group values, or partitions, using a window ORDER BY clause, but the order affects only the function result set, not the entire query result set. This ordering concept is described more fully later.

## Notes

HP Vertica supports a full list of analytic functions, including:

- FIRST\_VALUE(*arguments*): Allows the selection of the first value of a table or partition without having to use a self-join
- MEDIAN(*arguments*): Returns the middle value from a set of values
- NTILE(*value*): Equally divides the data set into a {value} number of subsets (buckets)
- RANK(): Assigns a rank to each row returned from the query with respect to the other ordered rows
- STDDEV(*arguments*): Computes the statistical sample standard deviation of the current row with respect to a group of rows
- AVG(*arguments*): Computes an average of an expression in a group of rows

For additional details, see Analytic Functions in the SQL Reference Manual.

## How Analytic Functions Work

Analytic functions take the following form:

```
analytic_function (arguments) OVER(analytic_clause)
```

### Evaluation order

Analytic functions conform to the following phases of execution:

- 1 Take the input rows.

Analytic functions are computed after WHERE, GROUP BY, HAVING clause operations, and joins are performed on the query.

## 2 Group input rows according to the PARTITION BY clause.

The analytic PARTITION BY clause (called the `window_partition_clause`) is different from table partition expressions. See Partitioning Tables in the Administrator's Guide for details.

## 3 Order rows within groups (partitions) according to ORDER BY clause.

The analytic ORDER BY clause (called the `window_order_clause` (page [336](#))) is different from the SQL ORDER BY clause. If the query has a final ORDER BY clause (outside the OVER() clause), the final results are ordered according by the SQL ORDER BY clause, not the window\_order\_clause. See **NULL Placement by Analytic Functions** (page [406](#)) and **Designing Tables to Minimize Run-Time Sorting of NULL Values in Analytic Functions** (page [407](#)) in the Programmer's Guide for additional information about sort computation.

## 4 Compute some function for each row.

Analytic functions:

- Require the OVER() clause. However, depending on the function, the `window_frame_clause` and `window_order_clause` might not apply. For example, when used with analytic aggregate functions like `SUM(x)`, you can use the `OVER()` clause without supplying any of the windowing clauses; in this case, the aggregate returns the same aggregated value for each row of the result set.
- Are allowed only in the SELECT and ORDER BY clauses.
- Can be used in a subquery or in the parent query but *cannot* be nested; for example, the following query is not allowed:  
`=> SELECT MEDIAN(RANK() OVER(ORDER BY sal) OVER()) .`
- WHERE, GROUP BY and HAVING operators are technically not part of the analytic function; however, they determine on which rows the analytic functions operate.

**Note:** Several examples throughout this section refer back to this example's `allsales` table schema.

### Example: Calculation of Median Value

A median is a numerical value that separates the higher half of a sample from the lower half. For example, you can retrieve the median of a finite list of numbers by arranging all observations from lowest value to highest value and then picking the middle one.

If there is an even number of observations, then there is no single middle value; the median is then defined to be the mean (average) of the two middle values

### allsales table schema

```
CREATE TABLE allsales(state VARCHAR(20), name VARCHAR(20), sales INT);
INSERT INTO allsales VALUES('MA', 'A', 60);
INSERT INTO allsales VALUES('NY', 'B', 20);
INSERT INTO allsales VALUES('NY', 'C', 15);
INSERT INTO allsales VALUES('MA', 'D', 20);
INSERT INTO allsales VALUES('MA', 'E', 50);
INSERT INTO allsales VALUES('NY', 'F', 40);
```

```
INSERT INTO allsales VALUES('MA', 'G', 10);
COMMIT;
```

The following analytic query returns the median value from the allsales table. Note that the median value is reported for every row in the result set:

```
=> SELECT name, sales, MEDIAN(sales) OVER () AS
 MEDIAN FROM allsales;
 name | sales | median
-----+-----+-----
 G | 10 | 20
 C | 15 | 20
 D | 20 | 20
 B | 20 | 20
 F | 40 | 20
 E | 50 | 20
 A | 60 | 20
(7 rows)
```

Additional MEDIAN() examples are in [Window Partitioning](#) (page [334](#)).

## See Also

Analytic Functions in the SQL Reference Manual

## Analytic Functions versus Aggregate Functions

Like aggregate functions, analytic functions return aggregate results, but analytics do not group the result set. Instead, they return the group value multiple times with each record, allowing further analysis. Analytic queries also generally run faster and use fewer resources than aggregate queries.

| Analytic functions                                                                                                    | Aggregate functions                                                                               |
|-----------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| Return the same number of rows as the input                                                                           | Return a single summary value                                                                     |
| The groups of rows on which an analytic function operates are defined by window partitioning and window frame clauses | The groups of rows on which an aggregate function operates are defined by the SQL GROUP BY clause |

## Example

This examples illustrate the difference between aggregate functions and their analytic counterpart using table employees defined in the below sample schema:

```
CREATE TABLE employees(emp_no INT, dept_no INT);
INSERT INTO employees VALUES(1, 10);
INSERT INTO employees VALUES(2, 30);
INSERT INTO employees VALUES(3, 30);
INSERT INTO employees VALUES(4, 10);
INSERT INTO employees VALUES(5, 30);
INSERT INTO employees VALUES(6, 20);
INSERT INTO employees VALUES(7, 20);
INSERT INTO employees VALUES(8, 20);
INSERT INTO employees VALUES(9, 20);
INSERT INTO employees VALUES(10, 20);
INSERT INTO employees VALUES(11, 20);
COMMIT;
```

**Table employees:**

```
SELECT * FROM employees ORDER BY emp_no;
emp_no | dept_no
-----+-----
 1 | 10
 2 | 30
 3 | 30
 4 | 10
 5 | 30
 6 | 20
 7 | 20
 8 | 20
 9 | 20
 10 | 20
 11 | 20
(11 rows)
```

Both queries below ask for the number of employees are in each department:

---

**Aggregate query/result**

```
SELECT dept_no, COUNT(*)
 AS emp_count
 FROM employees
 GROUP BY dept_no ORDER BY 1;
```

---

**Analytics query/result**

```
SELECT emp_no, dept_no, COUNT(*)
OVER(PARTITION BY dept_no
 ORDER BY emp_no)
AS emp_count FROM employees;
```

| dept_no | emp_count |
|---------|-----------|
| 10      | 2         |
| 20      | 6         |
| 30      | 3         |

(3 rows)

Aggregate function COUNT() returns one row per department for the number of employees in that department.

| emp_no | dept_no | emp_count |
|--------|---------|-----------|
| 1      | 10      | 1         |
| 4      | 10      | 2         |
| 6      | 20      | 1         |
| 7      | 20      | 2         |
| 8      | 20      | 3         |
| 9      | 20      | 4         |
| 10     | 20      | 5         |
| 11     | 20      | 6         |
| 2      | 30      | 1         |
| 3      | 30      | 2         |
| 5      | 30      | 3         |

(11 rows)

The analytic function COUNT() returns a count of the number of employees in each department, as well as which employee is in each department. Within each partition, the results are sorted on the emp\_no column, which is specified in the OVER order by clause.

If you wanted to add the employee number to the above aggregate query, you would add the emp\_no column to the GROUP BY clause. For results, you would get emp\_count=1 for each row—unless the data contained employees with the same emp\_no value. For example:

```
SELECT dept_no, emp_no, COUNT(*)
AS emp_count
FROM employees
GROUP BY dept_no, emp_no ORDER BY 1, 2;
```

| dept_no | emp_no | emp_count |
|---------|--------|-----------|
| 10      | 1      | 1         |
| 10      | 4      | 1         |
| 20      | 6      | 1         |
| 20      | 7      | 1         |
| 20      | 8      | 1         |
| 20      | 9      | 1         |
| 20      | 10     | 1         |
| 20      | 11     | 1         |
| 30      | 2      | 1         |
| 30      | 3      | 1         |
| 30      | 5      | 1         |

(11 rows)

## See Also

[Analytic Query Examples](#) (page 354)

## The Window OVER() Clause

The OVER() clause contains what is called a window. The window defines partitioning, ordering, and framing for an analytic function—important elements that determine what data the analytic function takes as input with respect to the current row. The analytic function then operates on a query result set, which are the rows that are returned after the FROM, WHERE, GROUP BY, and HAVING clauses have been evaluated.

You can also use the OVER() clause with certain analytic functions to define a moving window of data for every row within a partition.

When used with analytic aggregate functions, OVER() does not require any of the windowing clauses; in this case, the aggregate returns the same aggregated value for each row of the result set.

The OVER () clause must follow the analytic function, as in the following syntax:

```
ANALYTIC_FUNCTION (arguments)
 OVER(window_partition_clause
 window_order_clause
 window_frame_clause)
```

## Window Partitioning

Window partitioning is optional. When specified, the window\_partition\_clause divides the rows in the input based on user-provided expressions, such as aggregation functions like SUM(x).

Window partitioning is similar to the GROUP BY clause except that it returns only one result row per input row. If you omit the window\_partition\_clause, all input rows are treated as a single partition.

The analytic function is computed per partition and starts over again (resets) at the beginning of each subsequent partition. The window\_partition\_clause is specified within the OVER () clause.

### Syntax

```
OVER(window_partition_clause
 window_order_clause
 window_frame_clause)
```

### Examples

The examples in this topic use the allsales schema defined in **How Analytic Functions Work** (page [329](#)).

## Median of sales within each state

The following query uses the analytic window\_partition\_clause to calculate the median of sales within each state. The analytic function is computed per partition and starts over again at the beginning of the next partition.

```
=> SELECT state, name, sales, MEDIAN(sales)
 OVER (PARTITION BY state) AS median from allsales;
```

Results are grouped into partitions for MA (35) and NY (20) under the median column.

| state | name | sales | median |
|-------|------|-------|--------|
| NY    | C    | 15    | 20     |
| NY    | B    | 20    | 20     |
| NY    | F    | 40    | 20     |
| <hr/> |      |       |        |
| MA    | G    | 10    | 35     |
| MA    | D    | 20    | 35     |
| MA    | E    | 50    | 35     |
| MA    | A    | 60    | 35     |

(7 rows)

## Median of sales among all states

This query calculates the median of total sales among states. When you use OVER() with no parameters, there is one partition, the entire input:

```
=> SELECT state, sum(sales), median(SUM(sales))
 OVER () AS median FROM allsales GROUP BY state;
```

| state | sum | median |
|-------|-----|--------|
| NY    | 75  | 107.5  |
| MA    | 140 | 107.5  |

(2 rows)

## Sales larger than median (evaluation order)

Remember that analytic functions are evaluated *after* all other clauses except the query's final SQL ORDER BY clause. So if you were to write a query like the following, which asks for all rows with sales larger than the median, HP Vertica would return an error because the WHERE clause is applied before the analytic function and m does not yet exist

```
=> SELECT name, sales, MEDIAN(sales) OVER () AS m
 FROM allsales WHERE sales > m;
ERROR 2624: Column "m" does not exist
```

You can work around this by having the 'WHERE sales > m' predicate complete in a subquery:

```
=> SELECT * FROM
 (SELECT name, sales, MEDIAN(sales) OVER () AS m FROM allsales) sq
 WHERE sales > m;
```

| name | sales | m |
|------|-------|---|
|------|-------|---|

```

F | 40 | 20
E | 50 | 20
A | 60 | 20
(3 rows)

```

For additional examples, see [Analytic Query Examples](#) (page 354).

## Window Ordering

Window ordering sorts the rows specified by the OVER() clause and specifies whether data is sorted in ascending or descending order as well as the placement of null values; for example: ORDER BY expr\_list [ ASC | DESC ] [ NULLS { FIRST | LAST | AUTO } ]. The ordering of the data affects the results.

Using ORDER BY in an OVER clause changes the default window to RANGE UNBOUNDED PRECEDING AND CURRENT ROW, which is described in [Window Framing](#) (page 337).

The following table shows the default null placement, with bold clauses to indicate what is implicit:

| Ordering              | Null placement                     |
|-----------------------|------------------------------------|
| ORDER BY column1      | ORDER BY a <b>ASC NULLS LAST</b>   |
| ORDER BY column1 ASC  | ORDER BY a <b>ASC NULLS LAST</b>   |
| ORDER BY column1 DESC | ORDER BY a <b>DESC NULLS FIRST</b> |

Because the window\_order\_clause is different from a query's final ORDER BY clause, window ordering might not guarantee the final result order; it specifies only the order within a window result set, supplying the ordered set of rows to the window\_frame\_clause (if present), to the analytic function, or to both. Use the SQL ORDER BY clause to guarantee ordering of the final result set. (See also [NULL Placement by Analytic Functions](#) (page 406) and [Designing Tables to Minimize Run-Time Sorting of NULL Values in Analytic Functions](#) (page 407).)

### Syntax

```

OVER(window_partition_clause
 window_order_clause
 window_frame_clause)

```

### Examples

The below examples use the the allsales table schema, defined in [How Analytic Functions Work](#) (page 329).

#### Example 1

In this example, the query orders the sales inside each sales partition:

#### Example 2

In this example, the final ORDER BY clause sorts the results by name:

```
SELECT state, sales, name, RANK()
OVER (PARTITION BY state
 ORDER BY sales) AS RANK
FROM allsales;
```

| state | sales | name | RANK |
|-------|-------|------|------|
| MA    | 10    | G    | 1    |
| MA    | 20    | D    | 2    |
| MA    | 50    | E    | 3    |
| MA    | 60    | A    | 4    |
| NY    | 15    | C    | 1    |
| NY    | 20    | B    | 2    |
| NY    | 40    | F    | 3    |

(7 rows)

```
SELECT state, sales, name, RANK()
OVER (PARTITION BY state
 ORDER BY sales) AS RANK
FROM allsales ORDER BY name;
```

| state | sales | name | RANK |
|-------|-------|------|------|
| MA    | 60    | A    | 4    |
| NY    | 20    | B    | 2    |
| NY    | 15    | C    | 1    |
| MA    | 20    | D    | 2    |
| MA    | 50    | E    | 3    |
| NY    | 40    | F    | 3    |
| MA    | 10    | G    | 1    |

(7 rows)

## Window Framing

Window framing represents a unique construct, called a moving window. It defines which values in the partition are evaluated relative to the current row. You specify a window frame type by using the **RANGE** (page 341) or **ROWS** (page 338) keywords, described in the next topics. Both RANGE and ROWS are respective to the CURRENT ROW, which is the next row for which the analytic function computes results. As the current row advances, the window boundaries are recomputed (move) along with it, determining which rows fall into the current window.

An analytic function with a window frame specification is computed for each row based on the rows that fall into the window relative to that row. If you omit the `window_frame_clause`, the default window is RANGE UNBOUNDED PRECEDING AND CURRENT ROW.

### Syntax

```
OVER(window_partition_clause
 window_order_clause
 window_frame_clause)
```

See `window_frame_clause` in the SQL Reference Manual for more detailed syntax.

### Schema for examples

The window framing examples that follow use the following `emp` table schema:

```
CREATE TABLE emp(deptno INT, sal INT, empno INT);

INSERT INTO emp VALUES(10,101,1);
INSERT INTO emp VALUES(10,104,4);
INSERT INTO emp VALUES(20,100,11);
INSERT INTO emp VALUES(20,109,7);
INSERT INTO emp VALUES(20,109,6);
INSERT INTO emp VALUES(20,109,8);
INSERT INTO emp VALUES(20,110,10);
INSERT INTO emp VALUES(20,110,9);
INSERT INTO emp VALUES(30,102,2);
INSERT INTO emp VALUES(30,103,3);
INSERT INTO emp VALUES(30,105,5);

COMMIT;
```

## Windows with a Physical Offset (ROWS)

ROWS specifies the window as a physical offset. Using ROWS, defines a start and end point of a window by the number of rows before or after the current row. The value can be INTEGER data type only.

**Note:** The value returned by an analytic function with a physical offset could produce nondeterministic results unless the ordering expression results in a unique ordering. You might have to specify multiple columns in the window\_order\_clause to achieve this unique ordering.

### Examples

The examples on this page use the emp table schema defined in *Window Framing* (page [337](#)):

- The red line represents the partition
- The blue box represents the current row
- The green box represents the analytic window relative to the current row.

The following example uses the ROWS-based window for the COUNT() analytic function to return the department number, salary, and employee number with a count. The

window\_frame\_clause specifies the rows between the current row and two preceding. Using ROWS in the window\_frame\_clause specifies the window as a physical offset and defines the start- and end-point of a window by the number of rows before and after the current row.

```
SELECT deptno, sal, empno, COUNT(*)
OVER (PARTITION BY deptno ORDER BY sal
 ROWS BETWEEN 2 PRECEDING AND CURRENT ROW)
AS count FROM emp;
```

Notice that the partition includes department 20, and the current row and window are the same because there are no rows that precede the current row within that partition, even though the query specifies 2 preceding. The value in the count column (1) represents the number of rows in the current window.

| deptno | sal | empno | count |
|--------|-----|-------|-------|
| 10     | 101 | 1     | 1     |
| 10     | 104 | 4     | 2     |
| 20     | 100 | 11    | 1     |
| 20     | 109 | 7     |       |
| 20     | 109 | 6     |       |
| 20     | 109 | 8     |       |
| 20     | 110 | 10    |       |
| 20     | 110 | 9     |       |
| 30     | 102 | 2     | 1     |
| 30     | 103 | 3     | 2     |
| 30     | 105 | 5     | 3     |

As the current row moves, the window spans from 1 preceding to the current row, which is as far as it can go within the constraints of the `window_frame_clause`. `COUNT()` returns the number of rows in the window, even if 2 preceding is specified. In the count column, (2) includes the current row and the row above, which is the maximum the statement of 2 preceding allows within the current partition.

| deptno | sal | empno | count |
|--------|-----|-------|-------|
| 10     | 101 | 1     | 1     |
| 10     | 104 | 4     | 2     |
| 20     | 100 | 11    | 1     |
| 20     | 109 | 7     | 2     |
| 20     | 109 | 6     |       |
| 20     | 109 | 8     |       |
| 20     | 110 | 10    |       |
| 20     | 110 | 9     |       |
| 30     | 102 | 2     | 1     |
| 30     | 103 | 3     | 2     |
| 30     | 105 | 5     | 3     |

The current row moves again, and the window can now span 2 preceding the current row within the partition. The count (3) includes the number of rows in the partition (2 above + current), which is the maximum the statement of 2 preceding allows within the current partition.

| deptno | sal | empno | count |
|--------|-----|-------|-------|
| 10     | 101 | 1     | 1     |
| 10     | 104 | 4     | 2     |
| 20     | 100 | 11    | 1     |
| 20     | 109 | 7     | 2     |
| 20     | 109 | 6     | 3     |
| 20     | 109 | 8     |       |
| 20     | 110 | 10    |       |
| 20     | 110 | 9     |       |
| 30     | 102 | 2     | 1     |
| 30     | 103 | 3     | 2     |
| 30     | 105 | 5     | 3     |

When the current row moves, the window also moves to maintain 2 preceding and current row. The count of 3 repeats because it represents the number of rows in the window, which has not changed:

| deptno | sal | empno | count |
|--------|-----|-------|-------|
| 10     | 101 | 1     | 1     |
| 10     | 104 | 4     | 2     |
| 20     | 100 | 11    | 1     |
| 20     | 109 | 7     | 2     |
| 20     | 109 | 6     | 3     |
| 20     | 109 | 8     | 3     |
| 20     | 110 | 10    |       |
| 20     | 110 | 9     |       |
| 30     | 102 | 2     | 1     |
| 30     | 103 | 3     | 2     |
| 30     | 105 | 5     | 3     |

The current row advances again, and the window is defined by the same window, so the count does not change.

| deptno | sal | empno | count |
|--------|-----|-------|-------|
| 10     | 101 | 1     | 1     |
| 10     | 104 | 4     | 2     |
| 20     | 100 | 11    | 1     |
| 20     | 109 | 7     | 2     |
| 20     | 109 | 6     | 3     |
| 20     | 109 | 8     | 3     |
| 20     | 110 | 10    | 3     |
| 20     | 110 | 9     |       |
| 30     | 102 | 2     | 1     |
| 30     | 103 | 3     | 2     |
| 30     | 105 | 5     | 3     |

In this example, the current row advances once more. Notice the current row has reached the end of the `deptno` partition.

| deptno | sal | empno | count |
|--------|-----|-------|-------|
| 10     | 101 | 1     | 1     |
| 10     | 104 | 4     | 2     |
| 20     | 100 | 11    | 1     |
| 20     | 109 | 7     | 2     |
| 20     | 109 | 6     | 3     |
| 20     | 109 | 8     | 3     |
| 20     | 110 | 10    | 3     |
| 20     | 110 | 9     | 3     |
| 30     | 102 | 2     | 1     |
| 30     | 103 | 3     | 2     |
| 30     | 105 | 5     | 3     |

## Windows with a Logical Offset (RANGE)

The RANGE keyword specifies the window as a logical offset, such as time. The range value must match the `window_order_clause` data type, which can be NUMERIC, DATE/TIME, FLOAT or INTEGER.

**Note:** The value returned by an analytic function with a logical offset is always deterministic, which means that the function returns the same result every time it is called if given the same input value.

During the analytical computation, rows are excluded or included based on the logical offset, or value (RANGE), relative to the current row, which is always the reference point.

The ORDER BY column (`window_order_clause`) is the column whose value is used to compute the window span.

Only one `window_order_clause` column is allowed, and the data type must be NUMERIC, DATE/TIME, FLOAT or INTEGER, unless the window specifies one of following frames:

- RANGE BETWEEN UNBOUNDED PRECEDING AND CURRENT ROW
- RANGE BETWEEN CURRENT ROW AND UNBOUNDED FOLLOWING
- RANGE BETWEEN UNBOUNDED PRECEDING AND UNBOUNDED FOLLOWING

INTERVAL Year to Month can be used in an analytic RANGE window when the ORDER BY column type is TIMESTAMP/TIMESTAMP WITH TIMEZONE, or DATE. TIME/TIME WITH TIMEZONE are not supported.

INTERVAL Day to Second can be used when the ORDER BY column type is TIMESTAMP/TIMESTAMP WITH TIMEZONE, DATE, and TIME/TIME WITH TIMEZONE.

## Examples

The examples on this page use the emp table schema defined in [Window Framing \(page 337\)](#):

- The red line represents the partition
- The blue box represents the current row
- The green box represents the analytic window relative to the current row.

In the following query, RANGE specifies the window as a logical offset (value-based). The ORDER BY column is the column on which the range is applied.

```
SELECT deptno, sal, empno, COUNT(*)
OVER (PARTITION BY deptno ORDER BY sal
 RANGE BETWEEN 2 PRECEDING AND CURRENT ROW)
AS COUNT FROM emp;
```

The partition includes department 20, and the current row and window are the same because there are no rows that precede the current row within that partition:

| deptno | sal | empno | count |
|--------|-----|-------|-------|
| 10     | 101 | 1     | 1     |
| 10     | 104 | 4     | 2     |
| 20     | 100 | 11    | 1     |
| 20     | 109 | 7     |       |
| 20     | 109 | 6     |       |
| 20     | 109 | 8     |       |
| 20     | 110 | 10    |       |
| 20     | 110 | 9     | 1     |
| 30     | 102 | 2     | 1     |
| 30     | 103 | 3     | 2     |
| 30     | 105 | 5     | 3     |

In the next example, the ORDER BY column value is 109, so  $109 - 2 = 107$ . The window would include all rows whose ORDER BY column values are between 107 and 109 inclusively.

| deptno | sal | empno | count |
|--------|-----|-------|-------|
| 10     | 101 | 1     | 1     |
| 10     | 104 | 4     | 2     |
| 20     | 100 | 11    | 1     |
| 20     | 109 | 7     | 3     |
| 20     | 109 | 6     |       |
| 20     | 109 | 8     |       |
| 20     | 110 | 10    |       |
| 20     | 110 | 9     | 1     |
| 30     | 102 | 2     | 1     |
| 30     | 103 | 3     | 2     |
| 30     | 105 | 5     | 3     |

Here, the current row advances, and 107-109 are still inclusive.

| deptno | sal | empno | count |
|--------|-----|-------|-------|
| 10     | 101 | 1     | 1     |
| 10     | 104 | 4     | 2     |
| 20     | 100 | 11    | 1     |
| 20     | 109 | 7     | 3     |
| 20     | 109 | 6     | 3     |
| 20     | 109 | 8     | 3     |
| 20     | 110 | 10    |       |
| 20     | 110 | 9     |       |
| 30     | 102 | 2     | 1     |
| 30     | 103 | 3     | 2     |
| 30     | 105 | 5     | 3     |

Though the current row advances again, the window is the same.

| deptno | sal | empno | count |
|--------|-----|-------|-------|
| 10     | 101 | 1     | 1     |
| 10     | 104 | 4     | 2     |
| 20     | 100 | 11    | 1     |
| 20     | 109 | 7     | 3     |
| 20     | 109 | 6     | 3     |
| 20     | 109 | 8     | 3     |
| 20     | 110 | 10    |       |
| 20     | 110 | 9     |       |
| 30     | 102 | 2     | 1     |
| 30     | 103 | 3     | 2     |
| 30     | 105 | 5     | 3     |

The current row advances so that the ORDER BY column value becomes 110 (before it was 109). Now the window would include all rows whose ORDER BY column values were between 108 and 110, inclusive, because  $110 - 2 = 108$ .

| deptno | sal | empno | count |
|--------|-----|-------|-------|
| 10     | 101 | 1     | 1     |
| 10     | 104 | 4     | 2     |
| 20     | 100 | 11    | 1     |
| 20     | 109 | 7     | 3     |
| 20     | 109 | 6     | 3     |
| 20     | 109 | 8     | 3     |
| 20     | 110 | 10    | 5     |
| 20     | 110 | 9     |       |
| 30     | 102 | 2     | 1     |
| 30     | 103 | 3     | 2     |
| 30     | 105 | 5     | 3     |

As the current row advances, the window still includes rows for 108-110, inclusive.

| deptno | sal | empno | count |
|--------|-----|-------|-------|
| 10     | 101 | 1     | 1     |
| 10     | 104 | 4     | 2     |
| 20     | 100 | 11    | 1     |
| 20     | 109 | 7     | 3     |
| 20     | 109 | 6     | 3     |
| 20     | 109 | 8     | 3     |
| 20     | 110 | 10    | 5     |
| 20     | 110 | 9     | 5     |
| 30     | 102 | 2     | 1     |
| 30     | 103 | 3     | 2     |
| 30     | 105 | 5     | 3     |

Remember that a window frame can also be time based, such as the following query:

```
SELECT ts, bid, avg(bid) OVER
 (ORDER BY ts RANGE BETWEEN '40 SECONDS' PRECEDING AND CURRENT ROW)
 FROM ticks WHERE stock = 'VERT'
 GROUP BY bid, ts ORDER BY ts;
```

## Reporting Aggregates

Some of the analytic functions that take the window\_frame\_clause are the reporting aggregates. These functions let you compare a partition's aggregate values with detail rows, taking the place of correlated subqueries or joins.

- AVG()
- COUNT()
- MAX() and MIN()
- SUM()
- STDDEV(), STDDEV\_POP(), and STDDEV\_SAMP()
- VARIANCE(), VAR\_POP(), and VAR\_SAMP()

If you use a window aggregate with an empty OVER() clause, the analytic function is used as a reporting function, where the entire input is treated as a single partition.

### About standard deviation and variance functions

With standard deviation functions, a low standard deviation indicates that the data points tend to be very close to the mean, whereas high standard deviation indicates that the data points are spread out over a large range of values.

Standard deviation is often graphed and a distributed standard deviation creates the classic bell curve.

Variance functions measure how far a set of numbers is spread out.

### Examples

Think of the window for reporting aggregates as a window defined as UNBOUNDED PRECEDING and UNBOUNDED FOLLOWING. The omission of a window\_order\_clause makes all rows in the partition also the window (reporting aggregates).

```
SELECT deptno, sal, empno, COUNT(sal)
OVER (PARTITION BY deptno) AS COUNT FROM emp;
```

| deptno | sal | empno | count |
|--------|-----|-------|-------|
| 10     | 101 | 1     | 2     |
| 10     | 104 | 4     | 2     |
| 20     | 110 | 10    | 6     |
| 20     | 110 | 9     | 6     |
| 20     | 109 | 7     | 6     |
| 20     | 109 | 6     | 6     |
| 20     | 109 | 8     | 6     |
| 20     | 100 | 11    | 6     |
| 30     | 105 | 5     | 3     |
| 30     | 103 | 3     | 3     |
| 30     | 102 | 2     | 3     |

(11 rows)

If the OVER() clause in the above query contained a `window_order_clause` (for example, `ORDER BY sal`), it would become a moving window (window aggregate) query with a default window of `RANGE BETWEEN UNBOUNDED PRECEDING AND CURRENT ROW`:

```
SELECT deptno, sal, empno, COUNT(sal)
OVER (PARTITION BY deptno ORDER BY sal) AS COUNT FROM emp;
```

| deptno | sal | empno | count |
|--------|-----|-------|-------|
| 10     | 101 | 1     | 1     |
| 10     | 104 | 4     | 2     |
| 20     | 100 | 11    | 1     |
| 20     | 109 | 7     | 4     |
| 20     | 109 | 6     | 4     |
| 20     | 109 | 8     | 4     |
| 20     | 110 | 10    | 6     |
| 20     | 110 | 9     | 6     |
| 30     | 102 | 2     | 1     |
| 30     | 103 | 3     | 2     |
| 30     | 105 | 5     | 3     |

(11 rows)

### What about LAST\_VALUE()?

You might wonder why you couldn't just use the `LAST_VALUE()` analytic function. For example, for each employee, get the highest salary in the department:

```
SELECT deptno, sal, empno,
LAST_VALUE(empno) OVER (PARTITION BY deptno ORDER BY sal) AS lv FROM emp;
```

| deptno | sal | empno | lv |
|--------|-----|-------|----|
| 10     | 101 | 1     | 1  |
| 10     | 104 | 4     | 4  |
| 20     | 100 | 11    | 11 |
| 20     | 109 | 7     | 7  |
| 20     | 109 | 6     | 7  |
| 20     | 109 | 8     | 7  |
| 20     | 110 | 10    | 10 |
| 20     | 110 | 9     | 10 |
| 30     | 102 | 2     | 2  |
| 30     | 103 | 3     | 3  |
| 30     | 105 | 5     | 5  |

Due to default window semantics, LAST\_VALUE does not always return the last value of a partition. If you omit the window\_frame\_clause from the analytic clause, LAST\_VALUE operates on this default window. Results, therefore, can seem non-intuitive because the function does not return the bottom of the current partition. It returns the bottom of the window, which continues to change along with the current input row being processed.

Remember the default window:

```
OVER (PARTITION BY deptno ORDER BY sal)
```

is the same as:

```
OVER(PARTITION BY deptno ORDER BY sal
ROWS BETWEEN UNBOUNDED PRECEDING AND CURRENT ROW)
```

| deptno | sal | empno | lv |
|--------|-----|-------|----|
| 10     | 101 | 1     | 1  |
| 10     | 104 | 4     | 4  |
| 20     | 100 | 11    | 11 |
| 20     | 109 | 7     |    |
| 20     | 109 | 6     |    |
| 20     | 109 | 8     |    |
| 20     | 110 | 10    |    |
| 20     | 110 | 9     |    |
| 30     | 102 | 2     | 2  |
| 30     | 103 | 3     | 3  |
| 30     | 105 | 5     | 5  |

| deptno | sal | empno | lv |
|--------|-----|-------|----|
| 10     | 101 | 1     | 1  |
| 10     | 104 | 4     | 4  |
| 20     | 100 | 11    | 11 |
| 20     | 109 | 7     | 7  |
| 20     | 109 | 6     |    |
| 20     | 109 | 8     |    |
| 20     | 110 | 10    |    |
| 20     | 110 | 9     |    |
| 30     | 102 | 2     | 2  |
| 30     | 103 | 3     | 3  |
| 30     | 105 | 5     | 5  |

| deptno | sal | empno | lv |  |
|--------|-----|-------|----|--|
| 10     | 101 | 1     | 1  |  |
| 10     | 104 | 4     | 4  |  |
| 20     | 100 | 11    | 11 |  |
| 20     | 109 | 7     | 7  |  |
| 20     | 109 | 6     | 7  |  |
| 20     | 109 | 8     |    |  |
| 20     | 110 | 10    |    |  |
| 20     | 110 | 9     |    |  |
| 30     | 102 | 2     | 2  |  |
| 30     | 103 | 3     | 3  |  |
| 30     | 105 | 5     | 5  |  |

| deptno | sal | empno | lv |  |
|--------|-----|-------|----|--|
| 10     | 101 | 1     | 1  |  |
| 10     | 104 | 4     | 4  |  |
| 20     | 100 | 11    | 11 |  |
| 20     | 109 | 7     | 7  |  |
| 20     | 109 | 6     | 7  |  |
| 20     | 109 | 8     | 7  |  |
| 20     | 110 | 10    |    |  |
| 20     | 110 | 9     |    |  |
| 30     | 102 | 2     | 2  |  |
| 30     | 103 | 3     | 3  |  |
| 30     | 105 | 5     | 5  |  |

| deptno | sal | empno | lv |
|--------|-----|-------|----|
| 10     | 101 | 1     | 1  |
| 10     | 104 | 4     | 4  |
| 20     | 100 | 11    | 11 |
| 20     | 109 | 7     | 7  |
| 20     | 109 | 6     | 7  |
| 20     | 109 | 8     | 7  |
| 20     | 110 | 10    | 10 |
| 20     | 110 | 9     | 10 |
| 30     | 102 | 2     | 2  |
| 30     | 103 | 3     | 3  |
| 30     | 105 | 5     | 5  |

| deptno | sal | empno | lv |
|--------|-----|-------|----|
| 10     | 101 | 1     | 1  |
| 10     | 104 | 4     | 4  |
| 20     | 100 | 11    | 11 |
| 20     | 109 | 7     | 7  |
| 20     | 109 | 6     | 7  |
| 20     | 109 | 8     | 7  |
| 20     | 110 | 10    | 10 |
| 20     | 110 | 9     | 10 |
| 30     | 102 | 2     | 2  |
| 30     | 103 | 3     | 3  |
| 30     | 105 | 5     | 5  |

If you want to return the last value of a partition, use UNBOUNDED PRECEDING AND UNBOUNDED FOLLOWING.

```
SELECT deptno, sal, empno, LAST_VALUE(empno)
OVER (PARTITION BY deptno ORDER BY sal
ROWS BETWEEN UNBOUNDED PRECEDING AND UNBOUNDED FOLLOWING) AS lv
```

```
FROM emp;

deptno | sal | empno | lv
-----+----+----+---
 10 | 101 | 1 | 4
 10 | 104 | 4 | 4
 20 | 100 | 11 | 9
 20 | 109 | 7 | 9
 20 | 109 | 6 | 9
 20 | 109 | 8 | 9
 20 | 110 | 10 | 9
 20 | 110 | 9 | 9
 30 | 102 | 2 | 5
 30 | 103 | 3 | 5
 30 | 105 | 5 | 5
```

Vertica recommends that you use LAST\_VALUE with the window\_order\_clause to produce deterministic results.

In the following example, empno 6, 7, and 8 have the same salary, so they are in adjacent rows. empno 8 appears first in this case but the order is not guaranteed.

```
deptno | sal | empno | lv
-----+----+----+---
 10 | 101 | 1 | 4
 10 | 104 | 4 | 4
 20 | 100 | 11 | 7
 20 | 109 | 8 | 7
 20 | 109 | 6 | 7
 20 | 109 | 7 | 7
 30 | 102 | 2 | 5
 30 | 103 | 3 | 5
 30 | 105 | 5 | 5
```

Notice in the output above, the last value is 7, which is the last row from the partition deptno = 20. If the rows have a different order, then the function returns a different value:

| deptno | sal | empno | lv |
|--------|-----|-------|----|
| 10     | 101 | 1     | 4  |
| 10     | 104 | 4     | 4  |
| 20     | 100 | 11    | 6  |
| 20     | 109 | 8     | 6  |
| 20     | 109 | 7     | 6  |
| 20     | 109 | 6     | 6  |
| 30     | 102 | 2     | 5  |
| 30     | 103 | 3     | 5  |
| 30     | 105 | 5     | 5  |

Now the last value is 6, which is the last row from the partition deptno = 20. The solution is to add a unique key to the sort order. Even if the order of the query changes, the result will always be the same, and so deterministic.

```
SELECT deptno, sal, empno,
LAST_VALUE(empno) OVER (PARTITION BY deptno ORDER BY sal, empno
ROWS BETWEEN UNBOUNDED PRECEDING AND UNBOUNDED FOLLOWING) as lv
FROM emp;
```

| deptno | sal | empno | lv |
|--------|-----|-------|----|
| 10     | 101 | 1     | 4  |
| 10     | 104 | 4     | 4  |
| 20     | 100 | 11    | 8  |
| 20     | 109 | 6     | 8  |
| 20     | 109 | 7     | 8  |
| 20     | 109 | 8     | 8  |
| 30     | 102 | 2     | 5  |
| 30     | 103 | 3     | 5  |
| 30     | 105 | 5     | 5  |

Notice how the rows are now ordered by `empno`, the last value stays at 8, and it does not matter the order of the query.

## Naming Windows

You can use the WINDOW clause to name one or more windows and avoid typing long OVER() clause syntax. The WINDOW clause takes the following form:

```
WINDOW window_name AS (window_definition_clause);
```

The window\_definition\_clause is described in detail in the SQL Reference Manual.

### Example

In the following example, RANK() and DENSE\_RANK() use the partitioning and ordering specifications in the window definition for a window named w:

```
=> SELECT RANK() OVER w , DENSE_RANK() OVER w
 FROM employee_dimension
 WINDOW w AS (PARTITION BY employee_region ORDER by annual_salary);
```

Though analytic functions can reference a named window to inherit the window\_partition\_clause, you can define your own window\_order\_clause; for example:

```
=> SELECT RANK() OVER(w ORDER BY annual_salary ASC) ,
 DENSE_RANK() OVER(w ORDER BY annual_salary DESC)
 FROM employee_dimension
 WINDOW w AS (PARTITION BY employee_region);
```

### Notes:

- Each window defined in the window\_definition\_clause must have a unique name.
- The window\_partition\_clause is defined in the named window specification, not in the OVER() clause.
- The OVER() clause can specify its own window\_order\_clause only if the window\_definition\_clause did not already define it. For example, if the second example above is rewritten as follows, the system returns an error:

```
=> SELECT RANK() OVER(w ORDER BY annual_salary ASC) ,
 DENSE_RANK() OVER(w ORDER BY annual_salary DESC)
 FROM employee_dimension
 WINDOW w AS (PARTITION BY employee_region ORDER BY annual_salary);
 ERROR: cannot override ORDER BY clause of window "w"
```

- A window definition cannot contain a window\_frame\_clause.
- Each window defined in the window\_definition\_clause must have a unique name. You can reference window names within their scope only. For example, because named window w1 below is defined before w2, w2 is within the scope of w1:

```
=> SELECT RANK() OVER(w1 ORDER BY sal DESC),
 RANK() OVER w2
 FROM EMP
 WINDOW w1 AS (PARTITION BY deptno), w2 AS (w1 ORDER BY sal);
```

## Analytic Query Examples

### Calculating a Median Value

A median is described as the numerical value separating the higher half of a sample from the lower half. The median of a finite list of numbers can be found by arranging all the observations from lowest value to highest value and picking the middle one.

If there is an even number of observations, then there is no single middle value. The median is then defined to be the mean (average) of the two middle values.

The examples that follow use the `allsales` table schema, defined in [\*\*How Analytic Functions Work\*\*](#) (page [329](#)).

Table `allsales`:

```
=> SELECT * FROM allsales;
 state | name | sales
-----+-----+-----
 MA | A | 60
 NY | B | 20
 NY | C | 15
 MA | D | 20
 MA | E | 50
 NY | F | 40
 MA | G | 10
(7 rows)
```

The following query calculates the median of sales from the `allsales` table. Note that when you use `OVER()` with no parameters, the query returns the same aggregated value for each row of the result set:

```
=> SELECT name, sales, MEDIAN(sales) OVER() AS median FROM allsales;

 name | sales | median
-----+-----+-----
 G | 10 | 20
 C | 15 | 20
 D | 20 | 20
 B | 20 | 20
 F | 40 | 20
 E | 50 | 20
 A | 60 | 20
(7 rows)
```

Without analytics, you'd have to write an overly complex query to get the median sales, but performance will suffer, and the query returns only one row:

```
=> SELECT sales MEDIAN FROM
```

```

(
 SELECT a1.name, a1.sales, COUNT(a1.sales) Rank
 FROM allsales a1, allsales a2
 WHERE a1.sales < a2.sales OR
 (a1.sales=a2.sales AND a1.name <= a2.name)
 GROUP BY a1.name, a1.sales
 ORDER BY a1.sales desc
) a3
WHERE Rank =
(SELECT (COUNT(*)+1) / 2 FROM allsales);

MEDIAN

 20
(1 row)

```

## Getting Price Differential for Two Stocks

The following subquery selects out two stocks of interest. The outer query uses the LAST\_VALUE() and OVER() components of analytics, with IGNORE NULLS.

### Schema

```

DROP TABLE ticks CASCADE;

CREATE TABLE ticks (ts TIMESTAMP, stock varchar(10), bid float);

INSERT INTO ticks VALUES('2011-07-12 10:23:54', 'abc', 10.12);
INSERT INTO ticks VALUES('2011-07-12 10:23:58', 'abc', 10.34);
INSERT INTO ticks VALUES('2011-07-12 10:23:59', 'abc', 10.75);
INSERT INTO ticks VALUES('2011-07-12 10:25:15', 'abc', 11.98);
INSERT INTO ticks VALUES('2011-07-12 10:25:16', 'abc');
INSERT INTO ticks VALUES('2011-07-12 10:25:22', 'xyz', 45.16);
INSERT INTO ticks VALUES('2011-07-12 10:25:27', 'xyz', 49.33);
INSERT INTO ticks VALUES('2011-07-12 10:31:12', 'xyz', 65.25);
INSERT INTO ticks VALUES('2011-07-12 10:31:15', 'xyz');

COMMIT;

```

### ticks table

```

SELECT * FROM ticks;
 ts | stock | bid
-----+-----+-----
2011-07-12 10:23:59 | abc | 10.75
2011-07-12 10:25:22 | xyz | 45.16
2011-07-12 10:23:58 | abc | 10.34
2011-07-12 10:25:27 | xyz | 49.33
2011-07-12 10:23:54 | abc | 10.12

```

```
2011-07-12 10:31:15 | xyz |
2011-07-12 10:25:15 | abc | 11.98
2011-07-12 10:25:16 | abc |
2011-07-12 10:31:12 | xyz | 65.25
(9 rows)
```

## Query

```
SELECT ts, stock, bid, last_value(price1 IGNORE NULLS)
 OVER(ORDER BY ts) - last_value(price2 IGNORE NULLS)
 OVER(ORDER BY ts) as price_diff
FROM
 (SELECT ts, stock, bid,
 CASE WHEN stock = 'abc' THEN bid ELSE NULL END AS price1,
 CASE WHEN stock = 'xyz' then bid ELSE NULL END AS price2
 FROM ticks
 WHERE stock IN ('abc','xyz')
) v1
ORDER BY ts;
```

| ts                  | stock | bid   | price_diff |
|---------------------|-------|-------|------------|
| 2011-07-12 10:23:54 | abc   | 10.12 |            |
| 2011-07-12 10:23:58 | abc   | 10.34 |            |
| 2011-07-12 10:23:59 | abc   | 10.75 |            |
| 2011-07-12 10:25:15 | abc   | 11.98 |            |
| 2011-07-12 10:25:16 | abc   |       |            |
| 2011-07-12 10:25:22 | xyz   | 45.16 | -33.18     |
| 2011-07-12 10:25:27 | xyz   | 49.33 | -37.35     |
| 2011-07-12 10:31:12 | xyz   | 65.25 | -53.27     |
| 2011-07-12 10:31:15 | xyz   |       | -53.27     |

```
(9 rows)
```

## Calculating the Moving Average

This example calculates a 40-second moving average of bids for one stock.

**Note:** This examples uses the ticks table schema defined in [Getting Price Differential for Two Stocks](#) (page [355](#)).

## Query

```
SELECT ts, bid, AVG(bid)
OVER(ORDER BY ts
 RANGE BETWEEN INTERVAL '40 seconds'
 PRECEDING AND CURRENT ROW)
FROM ticks
WHERE stock = 'abc'
GROUP BY bid, ts
```

```
ORDER BY ts;
```

| ts                  | bid   | ?column?        |
|---------------------|-------|-----------------|
| 2011-07-12 10:23:54 | 10.12 | 10.12           |
| 2011-07-12 10:23:58 | 10.34 | 10.23           |
| 2011-07-12 10:23:59 | 10.75 | 10.403333333333 |
| 2011-07-12 10:25:15 | 11.98 | 11.98           |
| 2011-07-12 10:25:16 |       | 11.98           |

(5 rows)

## Avoiding GROUPBY HASH with Projection Design

If your query contains a `GROUP BY` clause, HP Vertica computes the result with either the `GROUPBY PIPELINED` or `GROUPBY HASH` algorithm.

Both algorithms compute the same results and have similar performance when the query produces a small number of distinct groups (typically a thousand per node in the cluster). For queries that contain a large number of groups, `GROUPBY PIPELINED` uses less memory and can be faster but is only used when the input data is pre-sorted on the `GROUP BY` columns.

To improve the performance of a query that has a large number of distinct groups that is currently using the `GROUP BY HASH` algorithm, you can enable the use of the `GROUPBY PIPELINED` algorithm, as this section describes.

To determine which algorithm your query is using, run the `EXPLAIN` statement on the query.

The three conditions described in this section refer to the following schema.

```
CREATE TABLE sortopt (
 a INT NOT NULL,
 b INT NOT NULL,
 c INT,
 d INT
);

CREATE PROJECTION sortopt_p (
 a_proj,
 b_proj,
 c_proj,
 d_proj)
AS SELECT * FROM sortopt
ORDER BY a,b,c
UNSEGMENTED ALL NODES;

INSERT INTO sortopt VALUES(5,2,13,84);
INSERT INTO sortopt VALUES(14,22,8,115);
INSERT INTO sortopt VALUES(79,9,401,33);
```

**Condition #1**

All columns in the query's GROUP BY clause must be included in the projection's sort columns. If even one column in the GROUP BY clause is excluded from the projection's ORDER BY clause, HP Vertica uses GROUPBY HASH instead of GROUPBY PIPELINED:

Given a projection sort order ORDER BY a, b, c:

|                                                                                |                                                                                                                     |
|--------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| GROUP BY a<br>GROUP BY a,b<br>GROUP BY b,a<br>GROUP BY a,b,c<br>GROUP BY c,a,b | The query optimizer uses GROUPBY PIPELINED because columns a, b, and c are included in the projection sort columns. |
| GROUP BY a,b,c,d                                                               | The query optimizer uses GROUPBY HASH because column d is not part of the projection sort columns.                  |

**Condition #2**

If the number of columns in the query's GROUP BY clause is less than the number of columns in the projection's ORDER BY clause, columns in the query's GROUP BY clause must occur *first* in the projection's ORDER BY clause.

Given a projection sort order ORDER BY a, b ,c:

|                                                                                |                                                                                                                  |
|--------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|
| GROUP BY a<br>GROUP BY a,b<br>GROUP BY b,a<br>GROUP BY a,b,c<br>GROUP BY c,a,b | The query optimizer uses GROUPBY PIPELINED because columns a, b, c are included in the projection sort columns.  |
| GROUP BY a,c                                                                   | The query optimizer uses GROUPBY HASH because columns a and c do not occur first in the projection sort columns. |

**Condition #3**

If the columns in a query's GROUP BY clause do not appear first in the projection's ORDER BY clause, then any early-appearing projection sort columns that are missing in the query's GROUP BY clause must be present as single-column constant equality predicates in the query's WHERE clause.

Given a projection sort order ORDER BY a, b, c:

|                                                 |                                                                                                                                                 |
|-------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| SELECT a FROM tab WHERE a = 10<br>GROUP BY b    | The query optimizer uses GROUPBY PIPELINED because all columns preceding b in the projection sort order appear as constant equality predicates. |
| SELECT a FROM tab WHERE a = 10<br>GROUP BY a, b | The query optimizer uses GROUPBY PIPELINED even if redundant grouping column a is present.                                                      |

|                                                 |                                                                                                                                                          |
|-------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| SELECT a FROM tab WHERE a = 10<br>GROUP BY b, c | The query optimizer uses GROUPBY PIPELINED because all columns preceding b and c in the projection sort order appear as constant equality predicates.    |
| SELECT a FROM tab WHERE a = 10<br>GROUP BY c, b | The query optimizer uses GROUPBY PIPELINED because all columns preceding b and c in the projection sort order appear as constant equality predicates.    |
| SELECT a FROM tab WHERE a = 10<br>GROUP BY c    | The query optimizer uses GROUPBY HASH because all columns preceding c in the projection sort order do <i>not</i> appear as constant equality predicates. |

## Getting Latest bid and ask Results

The following example query fills in missing (null) values to create a full book order showing latest bid and ask price and size, by vendor id. Original rows have values for (typically) one price and one size, so use `last_value` with "ignore nulls" to find the most recent non-null value for the other pair each time there is an entry for the ID. `Sequenceno` provides a unique total ordering.

### Schema:

```
CREATE TABLE bookorders (
 vendorid VARCHAR(100),
 date TIMESTAMP,
 sequenceno INT,
 askprice FLOAT,
 asksize INT,
 bidprice FLOAT,
 bidsize INT);

INSERT INTO bookorders VALUES('3325XPK','2011-07-12 10:23:54', 1, 10.12, 55, 10.23, 59);
INSERT INTO bookorders VALUES('3345XPZ','2011-07-12 10:23:55', 2, 10.55, 58, 10.75, 57);
INSERT INTO bookorders VALUES('445XPKF','2011-07-12 10:23:56', 3, 10.22, 43, 54);
INSERT INTO bookorders VALUES('445XPKF','2011-07-12 10:23:57', 3, 10.22, 59, 10.25, 61);
INSERT INTO bookorders VALUES('3425XPY','2011-07-12 10:23:58', 4, 11.87, 66, 11.90, 66);
INSERT INTO bookorders VALUES('3727XVK','2011-07-12 10:23:59', 5, 11.66, 51, 11.67, 62);
INSERT INTO bookorders VALUES('5325XYZ','2011-07-12 10:24:01', 6, 15.05, 44, 15.10, 59);
INSERT INTO bookorders VALUES('3675XVS','2011-07-12 10:24:05', 7, 15.43, 47, 58);
INSERT INTO bookorders VALUES('8972VUG','2011-07-12 10:25:15', 8, 14.95, 52, 15.11, 57);

COMMIT;
```

**Query:**

```

SELECT
 sequenceno Seq,
 date "Time",
 vendorid ID,
 LAST_VALUE (bidprice IGNORE NULLS)
 OVER (PARTITION BY vendorid ORDER BY sequenceno
 ROWS BETWEEN UNBOUNDED PRECEDING AND CURRENT ROW)
 AS "Bid Price",
 LAST_VALUE (bidsize IGNORE NULLS)
 OVER (PARTITION BY vendorid ORDER BY sequenceno
 ROWS BETWEEN UNBOUNDED PRECEDING AND CURRENT ROW)
 AS "Bid Size",
 LAST_VALUE (askprice IGNORE NULLS)
 OVER (PARTITION BY vendorid ORDER BY sequenceno
 ROWS BETWEEN UNBOUNDED PRECEDING AND CURRENT ROW)
 AS "Ask Price",
 LAST_VALUE (asksize IGNORE NULLS)
 OVER (PARTITION BY vendorid ORDER BY sequenceno
 ROWS BETWEEN UNBOUNDED PRECEDING AND CURRENT ROW)
 AS "Ask Size"
FROM bookorders
ORDER BY sequenceno;

```

| Seq | Time                | ID      | Bid Price | Bid Size | Ask Price | Ask Size |
|-----|---------------------|---------|-----------|----------|-----------|----------|
| 1   | 2011-07-12 10:23:54 | 3325XPK | 10.23     | 59       | 10.12     | 55       |
| 1   | 2011-07-12 10:23:54 | 3325XPK | 10.23     | 59       | 10.12     | 55       |
| 2   | 2011-07-12 10:23:55 | 3345XPZ | 10.75     | 57       | 10.55     | 58       |
| 2   | 2011-07-12 10:23:55 | 3345XPZ | 10.75     | 57       | 10.55     | 58       |
| 3   | 2011-07-12 10:23:56 | 445XPKF | 54        | 61       | 10.22     | 43       |
| 3   | 2011-07-12 10:23:57 | 445XPKF | 10.25     | 61       | 10.22     | 59       |
| 3   | 2011-07-12 10:23:56 | 445XPKF | 54        | 61       | 10.22     | 43       |
| 3   | 2011-07-12 10:23:57 | 445XPKF | 10.25     | 61       | 10.22     | 59       |
| 4   | 2011-07-12 10:23:58 | 3425XPY | 11.9      | 66       | 11.87     | 66       |
| 4   | 2011-07-12 10:23:58 | 3425XPY | 11.9      | 66       | 11.87     | 66       |
| 5   | 2011-07-12 10:23:59 | 3727XVK | 11.67     | 662      | 11.66     | 51       |
| 5   | 2011-07-12 10:23:59 | 3727XVK | 11.67     | 62       | 11.66     | 51       |
| 6   | 2011-07-12 10:24:01 | 5325XYZ | 15.1      | 59       | 15.05     | 44       |
| 6   | 2011-07-12 10:24:01 | 5325XYZ | 15.1      | 59       | 15.05     | 44       |
| 7   | 2011-07-12 10:24:05 | 3675XVS | 58        |          | 15.43     | 47       |
| 7   | 2011-07-12 10:24:05 | 3675XVS | 58        |          | 15.43     | 47       |
| 8   | 2011-07-12 10:25:15 | 8972VUG | 15.11     | 57       | 14.95     | 52       |
| 8   | 2011-07-12 10:25:15 | 8972VUG | 15.11     | 57       | 14.95     | 52       |

(18 rows)

## Event-based Windows

Event-based windows let you break time series data into windows that border on significant events within the data. This is especially relevant in financial data where analysis often focuses on specific events as triggers to other activity.

There are two event-based window functions in HP Vertica. These functions are an HP Vertica extension and are not part of the SQL-99 standard:

- `CONDITIONAL_CHANGE_EVENT()` assigns an event window number to each row, starting from 0, and increments by 1 when the result of evaluating the argument expression on the current row differs from that on the previous row. This function is similar to the analytic function `ROW_NUMBER`, which assigns a unique number, sequentially, starting from 1, to each row within a partition.
- `CONDITIONAL_TRUE_EVENT()` assigns an event window number to each row, starting from 0, and increments the number by 1 when the result of the boolean argument expression evaluates true.

The `CONDITIONAL_CHANGE_EVENT` and `CONDITIONAL_TRUE_EVENT` functions do not allow **window framing** (page [337](#)).

### Example Schema

The examples in this topic use the following schema:

```
CREATE TABLE TickStore3 (
 ts TIMESTAMP,
 symbol VARCHAR(8),
 bid FLOAT
);
CREATE PROJECTION TickStore3_p (ts, symbol, bid) AS
SELECT * FROM TickStore3
ORDER BY ts, symbol, bid UNSEGMENTED ALL NODES;

INSERT INTO TickStore3 VALUES ('2009-01-01 03:00:00', 'XYZ', 10.0);
INSERT INTO TickStore3 VALUES ('2009-01-01 03:00:03', 'XYZ', 11.0);
INSERT INTO TickStore3 VALUES ('2009-01-01 03:00:06', 'XYZ', 10.5);
INSERT INTO TickStore3 VALUES ('2009-01-01 03:00:09', 'XYZ', 11.0);
COMMIT;
```

### Using the `CONDITIONAL_CHANGE_EVENT` Function

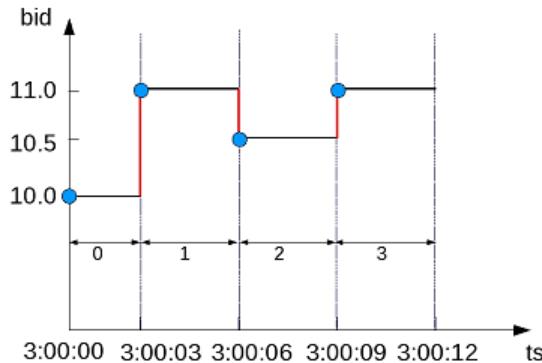
The analytical function `CONDITIONAL_CHANGE_EVENT` returns a sequence of integers indicating event window numbers, starting from 0. The function increments the event window number when the result of evaluating the function expression on the current row differs from the previous value.

In the following example, the first query returns all records from the `TickStore3` table. The second query uses the `CONDITIONAL_CHANGE_EVENT` function on the `bid` column. Since each `bid` row value is different from the previous value, the function increments the window ID from 0 to 3:

```
SELECT ts, symbol, bid
FROM Tickstore3
ORDER BY ts;
-----+-----+-----+
ts | symbol | bid
-----+-----+-----+
2009-01-01 03:00:00 | XYZ | 10
2009-01-01 03:00:03 | XYZ | 11
2009-01-01 03:00:06 | XYZ | 10.5
2009-01-01 03:00:09 | XYZ | 11
(4 rows)
```

```
SELECT CONDITIONAL_CHANGE_EVENT(bid)
OVER (ORDER BY ts)
FROM Tickstore3;
-----+-----+-----+-----+
ts | symbol | bid | cce
-----+-----+-----+-----+
2009-01-01 03:00:00 | XYZ | 10 | 0
2009-01-01 03:00:03 | XYZ | 11 | 1
2009-01-01 03:00:06 | XYZ | 10.5 | 2
2009-01-01 03:00:09 | XYZ | 11 | 3
(4 rows)
```

The following figure is a graphical illustration of the change in the bid price. Each value is different from its previous one, so the window ID increments for each time slice:



So the window ID starts at 0 and increments at every change in from the previous value.

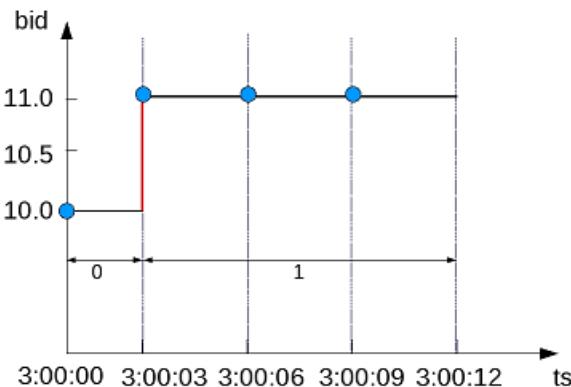
In this example, the bid price changes from \$10 to \$11 in the second row, but then stays the same. The CONDITIONAL\_CHANGE\_EVENT function increments the event window ID in row 2, but not subsequently:

```
SELECT ts, symbol, bid
FROM Tickstore3
ORDER BY ts;
-----+-----+
ts | symbol | bid
-----+-----+
2009-01-01 03:00:00 | XYZ | 10
2009-01-01 03:00:03 | XYZ | 11
2009-01-01 03:00:06 | XYZ | 11
2009-01-01 03:00:09 | XYZ | 11
```

```
SELECT CONDITIONAL_CHANGE_EVENT(bid)
OVER(ORDER BY ts)
FROM Tickstore3;
=====+-----+-----+
ts | symbol | bid | cce
=====+-----+-----+
2009-01-01 03:00:00 | XYZ | 10 | 0
2009-01-01 03:00:03 | XYZ | 11 | 1
2009-01-01 03:00:06 | XYZ | 11 | 1
2009-01-01 03:00:09 | XYZ | 11 | 1
```

==>

The following figure is a graphical illustration of the change in the bid price at 3:00:03 only. The price stays the same at 3:00:06 and 3:00:09, so the window ID remains at 1 for each time slice after the change:



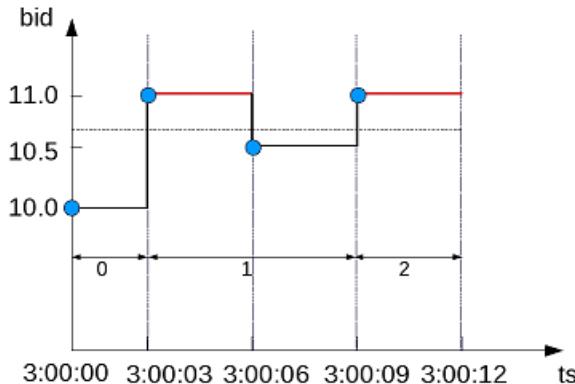
## Using the CONDITIONAL\_TRUE\_EVENT Function

Like CONDITIONAL\_CHANGE\_EVENT, the analytic function CONDITIONAL\_TRUE\_EVENT also returns a sequence of integers indicating event window numbers, starting from 0. The difference between the two functions is that the CONDITIONAL\_TRUE\_EVENT function increments the window ID each time its expression evaluates to true, while CONDITIONAL\_CHANGE\_EVENT increments on a comparison expression with the previous value.

In the following example, the first query returns all records from the TickStore3 table. The second query uses the CONDITIONAL\_TRUE\_EVENT function to test whether the current bid is greater than a given value (10.6). Each time the expression tests true, the function increments the window ID. The first time the function increments the window ID is on row 2, when the value is 11. The expression tests false for the next row (value is not greater than 10.6), so the function does not increment the event window ID. In the final row, the expression is true for the given condition, and the function increments the window:

| <pre>SELECT ts, symbol, bid FROM Tickstore3 ORDER BY ts;</pre>                                                                                                                                                                                                                                                                                                           |        | <pre>SELECT CONDITIONAL_TRUE_EVENT(bid &gt; 10.6) OVER (ORDER BY ts) FROM Tickstore3;</pre> |     |                     |     |    |                     |     |    |                     |     |      |                     |     |    |     |                                                                                                                                                                                                                                                                                                                                                                                                                              |    |        |     |     |                     |     |    |   |                     |     |    |   |                     |     |      |   |                     |     |    |   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|---------------------------------------------------------------------------------------------|-----|---------------------|-----|----|---------------------|-----|----|---------------------|-----|------|---------------------|-----|----|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|--------|-----|-----|---------------------|-----|----|---|---------------------|-----|----|---|---------------------|-----|------|---|---------------------|-----|----|---|
| <table border="1"> <thead> <tr> <th>ts</th><th>symbol</th><th>bid</th></tr> </thead> <tbody> <tr> <td>2009-01-01 03:00:00</td><td>XYZ</td><td>10</td></tr> <tr> <td>2009-01-01 03:00:03</td><td>XYZ</td><td>11</td></tr> <tr> <td>2009-01-01 03:00:06</td><td>XYZ</td><td>10.5</td></tr> <tr> <td>2009-01-01 03:00:09</td><td>XYZ</td><td>11</td></tr> </tbody> </table> | ts     | symbol                                                                                      | bid | 2009-01-01 03:00:00 | XYZ | 10 | 2009-01-01 03:00:03 | XYZ | 11 | 2009-01-01 03:00:06 | XYZ | 10.5 | 2009-01-01 03:00:09 | XYZ | 11 | ==> | <table border="1"> <thead> <tr> <th>ts</th><th>symbol</th><th>bid</th><th>cte</th></tr> </thead> <tbody> <tr> <td>2009-01-01 03:00:00</td><td>XYZ</td><td>10</td><td>0</td></tr> <tr> <td>2009-01-01 03:00:03</td><td>XYZ</td><td>11</td><td>1</td></tr> <tr> <td>2009-01-01 03:00:06</td><td>XYZ</td><td>10.5</td><td>1</td></tr> <tr> <td>2009-01-01 03:00:09</td><td>XYZ</td><td>11</td><td>2</td></tr> </tbody> </table> | ts | symbol | bid | cte | 2009-01-01 03:00:00 | XYZ | 10 | 0 | 2009-01-01 03:00:03 | XYZ | 11 | 1 | 2009-01-01 03:00:06 | XYZ | 10.5 | 1 | 2009-01-01 03:00:09 | XYZ | 11 | 2 |
| ts                                                                                                                                                                                                                                                                                                                                                                       | symbol | bid                                                                                         |     |                     |     |    |                     |     |    |                     |     |      |                     |     |    |     |                                                                                                                                                                                                                                                                                                                                                                                                                              |    |        |     |     |                     |     |    |   |                     |     |    |   |                     |     |      |   |                     |     |    |   |
| 2009-01-01 03:00:00                                                                                                                                                                                                                                                                                                                                                      | XYZ    | 10                                                                                          |     |                     |     |    |                     |     |    |                     |     |      |                     |     |    |     |                                                                                                                                                                                                                                                                                                                                                                                                                              |    |        |     |     |                     |     |    |   |                     |     |    |   |                     |     |      |   |                     |     |    |   |
| 2009-01-01 03:00:03                                                                                                                                                                                                                                                                                                                                                      | XYZ    | 11                                                                                          |     |                     |     |    |                     |     |    |                     |     |      |                     |     |    |     |                                                                                                                                                                                                                                                                                                                                                                                                                              |    |        |     |     |                     |     |    |   |                     |     |    |   |                     |     |      |   |                     |     |    |   |
| 2009-01-01 03:00:06                                                                                                                                                                                                                                                                                                                                                      | XYZ    | 10.5                                                                                        |     |                     |     |    |                     |     |    |                     |     |      |                     |     |    |     |                                                                                                                                                                                                                                                                                                                                                                                                                              |    |        |     |     |                     |     |    |   |                     |     |    |   |                     |     |      |   |                     |     |    |   |
| 2009-01-01 03:00:09                                                                                                                                                                                                                                                                                                                                                      | XYZ    | 11                                                                                          |     |                     |     |    |                     |     |    |                     |     |      |                     |     |    |     |                                                                                                                                                                                                                                                                                                                                                                                                                              |    |        |     |     |                     |     |    |   |                     |     |    |   |                     |     |      |   |                     |     |    |   |
| ts                                                                                                                                                                                                                                                                                                                                                                       | symbol | bid                                                                                         | cte |                     |     |    |                     |     |    |                     |     |      |                     |     |    |     |                                                                                                                                                                                                                                                                                                                                                                                                                              |    |        |     |     |                     |     |    |   |                     |     |    |   |                     |     |      |   |                     |     |    |   |
| 2009-01-01 03:00:00                                                                                                                                                                                                                                                                                                                                                      | XYZ    | 10                                                                                          | 0   |                     |     |    |                     |     |    |                     |     |      |                     |     |    |     |                                                                                                                                                                                                                                                                                                                                                                                                                              |    |        |     |     |                     |     |    |   |                     |     |    |   |                     |     |      |   |                     |     |    |   |
| 2009-01-01 03:00:03                                                                                                                                                                                                                                                                                                                                                      | XYZ    | 11                                                                                          | 1   |                     |     |    |                     |     |    |                     |     |      |                     |     |    |     |                                                                                                                                                                                                                                                                                                                                                                                                                              |    |        |     |     |                     |     |    |   |                     |     |    |   |                     |     |      |   |                     |     |    |   |
| 2009-01-01 03:00:06                                                                                                                                                                                                                                                                                                                                                      | XYZ    | 10.5                                                                                        | 1   |                     |     |    |                     |     |    |                     |     |      |                     |     |    |     |                                                                                                                                                                                                                                                                                                                                                                                                                              |    |        |     |     |                     |     |    |   |                     |     |    |   |                     |     |      |   |                     |     |    |   |
| 2009-01-01 03:00:09                                                                                                                                                                                                                                                                                                                                                      | XYZ    | 11                                                                                          | 2   |                     |     |    |                     |     |    |                     |     |      |                     |     |    |     |                                                                                                                                                                                                                                                                                                                                                                                                                              |    |        |     |     |                     |     |    |   |                     |     |    |   |                     |     |      |   |                     |     |    |   |

The following figure is a graphical illustration that shows the bid values and window ID changes. Because the bid value is greater than \$10.6 on only the second and fourth time slices (3:00:03 and 3:00:09), the window ID returns <0,1,1,2>:

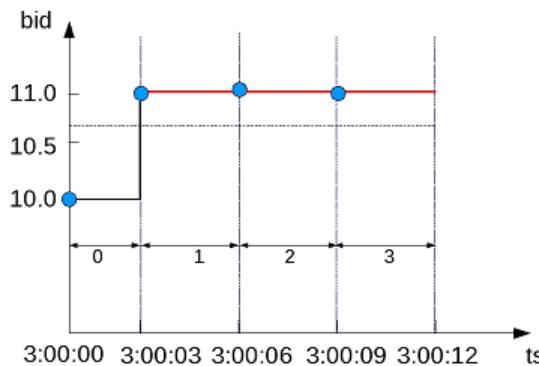


In the following example, the first query returns all records from the TickStore3 table, ordered by the tickstore values (ts). The second query uses the CONDITIONAL\_TRUE\_EVENT function to increment the window ID each time the bid value is greater than 10.6. The first time the function increments the event window ID is on row 2, where the value is 11. The window ID then increments each time after that, because the expression (bid > 10.6) tests true for each time slice:

| <pre>SELECT ts, symbol, bid FROM Tickstore3 ORDER BY ts;</pre>                                                                                                                                                                                                                                                                                                           |        | <pre>SELECT CONDITIONAL_TRUE_EVENT(bid &gt; 10.6) OVER (ORDER BY ts) FROM Tickstore3;</pre> |     |                     |     |    |                     |     |    |                     |     |      |                     |     |    |     |                                                                                                                                                                                                                                                                                                                                                                                                                              |    |        |     |     |                     |     |    |   |                     |     |    |   |                     |     |      |   |                     |     |    |   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|---------------------------------------------------------------------------------------------|-----|---------------------|-----|----|---------------------|-----|----|---------------------|-----|------|---------------------|-----|----|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|--------|-----|-----|---------------------|-----|----|---|---------------------|-----|----|---|---------------------|-----|------|---|---------------------|-----|----|---|
| <table border="1"> <thead> <tr> <th>ts</th><th>symbol</th><th>bid</th></tr> </thead> <tbody> <tr> <td>2009-01-01 03:00:00</td><td>XYZ</td><td>10</td></tr> <tr> <td>2009-01-01 03:00:03</td><td>XYZ</td><td>11</td></tr> <tr> <td>2009-01-01 03:00:06</td><td>XYZ</td><td>10.5</td></tr> <tr> <td>2009-01-01 03:00:09</td><td>XYZ</td><td>11</td></tr> </tbody> </table> | ts     | symbol                                                                                      | bid | 2009-01-01 03:00:00 | XYZ | 10 | 2009-01-01 03:00:03 | XYZ | 11 | 2009-01-01 03:00:06 | XYZ | 10.5 | 2009-01-01 03:00:09 | XYZ | 11 | ==> | <table border="1"> <thead> <tr> <th>ts</th><th>symbol</th><th>bid</th><th>cte</th></tr> </thead> <tbody> <tr> <td>2009-01-01 03:00:00</td><td>XYZ</td><td>10</td><td>0</td></tr> <tr> <td>2009-01-01 03:00:03</td><td>XYZ</td><td>11</td><td>1</td></tr> <tr> <td>2009-01-01 03:00:06</td><td>XYZ</td><td>10.5</td><td>1</td></tr> <tr> <td>2009-01-01 03:00:09</td><td>XYZ</td><td>11</td><td>2</td></tr> </tbody> </table> | ts | symbol | bid | cte | 2009-01-01 03:00:00 | XYZ | 10 | 0 | 2009-01-01 03:00:03 | XYZ | 11 | 1 | 2009-01-01 03:00:06 | XYZ | 10.5 | 1 | 2009-01-01 03:00:09 | XYZ | 11 | 2 |
| ts                                                                                                                                                                                                                                                                                                                                                                       | symbol | bid                                                                                         |     |                     |     |    |                     |     |    |                     |     |      |                     |     |    |     |                                                                                                                                                                                                                                                                                                                                                                                                                              |    |        |     |     |                     |     |    |   |                     |     |    |   |                     |     |      |   |                     |     |    |   |
| 2009-01-01 03:00:00                                                                                                                                                                                                                                                                                                                                                      | XYZ    | 10                                                                                          |     |                     |     |    |                     |     |    |                     |     |      |                     |     |    |     |                                                                                                                                                                                                                                                                                                                                                                                                                              |    |        |     |     |                     |     |    |   |                     |     |    |   |                     |     |      |   |                     |     |    |   |
| 2009-01-01 03:00:03                                                                                                                                                                                                                                                                                                                                                      | XYZ    | 11                                                                                          |     |                     |     |    |                     |     |    |                     |     |      |                     |     |    |     |                                                                                                                                                                                                                                                                                                                                                                                                                              |    |        |     |     |                     |     |    |   |                     |     |    |   |                     |     |      |   |                     |     |    |   |
| 2009-01-01 03:00:06                                                                                                                                                                                                                                                                                                                                                      | XYZ    | 10.5                                                                                        |     |                     |     |    |                     |     |    |                     |     |      |                     |     |    |     |                                                                                                                                                                                                                                                                                                                                                                                                                              |    |        |     |     |                     |     |    |   |                     |     |    |   |                     |     |      |   |                     |     |    |   |
| 2009-01-01 03:00:09                                                                                                                                                                                                                                                                                                                                                      | XYZ    | 11                                                                                          |     |                     |     |    |                     |     |    |                     |     |      |                     |     |    |     |                                                                                                                                                                                                                                                                                                                                                                                                                              |    |        |     |     |                     |     |    |   |                     |     |    |   |                     |     |      |   |                     |     |    |   |
| ts                                                                                                                                                                                                                                                                                                                                                                       | symbol | bid                                                                                         | cte |                     |     |    |                     |     |    |                     |     |      |                     |     |    |     |                                                                                                                                                                                                                                                                                                                                                                                                                              |    |        |     |     |                     |     |    |   |                     |     |    |   |                     |     |      |   |                     |     |    |   |
| 2009-01-01 03:00:00                                                                                                                                                                                                                                                                                                                                                      | XYZ    | 10                                                                                          | 0   |                     |     |    |                     |     |    |                     |     |      |                     |     |    |     |                                                                                                                                                                                                                                                                                                                                                                                                                              |    |        |     |     |                     |     |    |   |                     |     |    |   |                     |     |      |   |                     |     |    |   |
| 2009-01-01 03:00:03                                                                                                                                                                                                                                                                                                                                                      | XYZ    | 11                                                                                          | 1   |                     |     |    |                     |     |    |                     |     |      |                     |     |    |     |                                                                                                                                                                                                                                                                                                                                                                                                                              |    |        |     |     |                     |     |    |   |                     |     |    |   |                     |     |      |   |                     |     |    |   |
| 2009-01-01 03:00:06                                                                                                                                                                                                                                                                                                                                                      | XYZ    | 10.5                                                                                        | 1   |                     |     |    |                     |     |    |                     |     |      |                     |     |    |     |                                                                                                                                                                                                                                                                                                                                                                                                                              |    |        |     |     |                     |     |    |   |                     |     |    |   |                     |     |      |   |                     |     |    |   |
| 2009-01-01 03:00:09                                                                                                                                                                                                                                                                                                                                                      | XYZ    | 11                                                                                          | 2   |                     |     |    |                     |     |    |                     |     |      |                     |     |    |     |                                                                                                                                                                                                                                                                                                                                                                                                                              |    |        |     |     |                     |     |    |   |                     |     |    |   |                     |     |      |   |                     |     |    |   |

|                                |     |                                    |
|--------------------------------|-----|------------------------------------|
| 2009-01-01 03:00:00   XYZ   10 | ==> | 2009-01-01 03:00:00   XYZ   10   0 |
| 2009-01-01 03:00:03   XYZ   11 |     | 2009-01-01 03:00:03   XYZ   11   1 |
| 2009-01-01 03:00:06   XYZ   11 |     | 2009-01-01 03:00:06   XYZ   11   2 |
| 2009-01-01 03:00:09   XYZ   11 |     | 2009-01-01 03:00:09   XYZ   11   3 |

The following figure is a graphical illustration that shows the bid values and window ID changes. The bid value is greater than 10.6 on the second time slice (3:00:03) and remains for the remaining two time slices. The function increments the event window ID each time because the expression tests true:



### Advanced use of event-based windows

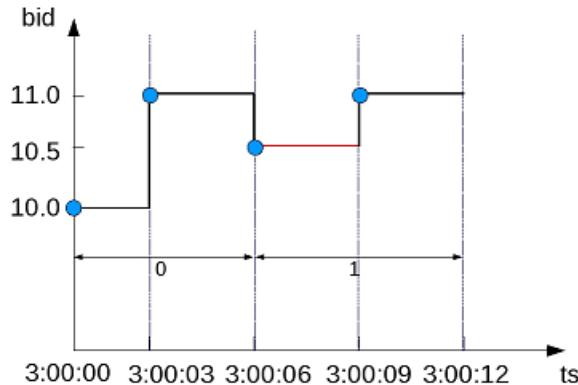
In event-based window functions, the condition expression accesses values from the current row only. To access a previous value, you can use a more powerful event-based window that allows the window event condition to include previous data points. For example, the LAG(x, n) analytic function retrieves the value of column X in the *n*th to last input record. In this case, LAG() shares the OVER() clause specifications of the CONDITIONAL\_CHANGE\_EVENT or CONDITIONAL\_TRUE\_EVENT function expression.

In the following example, the first query returns all records from the TickStore3 table. The second query uses the CONDITIONAL\_TRUE\_EVENT function with the LAG() function in its boolean expression. In this case, the CONDITIONAL\_TRUE\_EVENT function increments the event window ID each time the bid value on the current row is less than the previous value. The first time CONDITIONAL\_TRUE\_EVENT increments the window ID starts on the third time slice, when the expression tests true. The current value (10.5) is less than the previous value. The window ID is not incremented in the last row because the final value is greater than the previous row:

```
SELECT ts, symbol, bid
FROM Tickstore3
ORDER BY ts;
-----+-----+
ts | symbol | bid
-----+-----+
2009-01-01 03:00:00 | XYZ | 10
2009-01-01 03:00:03 | XYZ | 11
2009-01-01 03:00:06 | XYZ | 10.5
2009-01-01 03:00:09 | XYZ | 11
```

```
SELECT CONDITIONAL_TRUE_EVENT(bid <
LAG(bid)) OVER (ORDER BY ts)
FROM Tickstore;
-----+-----+
ts | symbol | bid | cte
-----+-----+
2009-01-01 03:00:00 | XYZ | 10 | 0
2009-01-01 03:00:03 | XYZ | 11 | 0
2009-01-01 03:00:06 | XYZ | 10.5 | 1
2009-01-01 03:00:09 | XYZ | 11 | 1
```

The following figure illustrates the second query above. When the bid price is less than the previous value, the window ID gets incremented, which occurs only in the third time slice (3:00:06):



### See Also

[Sessionization with Event-based Windows](#) (page 365)

[Using Time Series Analytics](#) (page 368)

CONDITIONAL\_CHANGE\_EVENT(), CONDITIONAL\_TRUE\_EVENT() and LAG() in the SQL Reference Manual

## Sessionization with Event-based Windows

Sessionization, a special case of event-based windows, is a feature often used to analyze click streams, such as identifying web browsing sessions from recorded web clicks.

In HP Vertica, given an input clickstream table, where each row records a Web page click made by a particular user (or IP address), the sessionization computation attempts to identify Web browsing sessions from the recorded clicks by grouping the clicks from each user based on the time-intervals between the clicks. If two clicks from the same user are made too far apart in time, as defined by a time-out threshold, the clicks are treated as though they are from two different browsing sessions.

### Example Schema

The examples in this topic use the following WebClicks schema to represent a simple clickstream table:

```
CREATE TABLE WebClicks(userId INT, timestamp TIMESTAMP);
INSERT INTO WebClicks VALUES (1, '2009-12-08 3:00:00 pm');
INSERT INTO WebClicks VALUES (1, '2009-12-08 3:00:25 pm');
INSERT INTO WebClicks VALUES (1, '2009-12-08 3:00:45 pm');
INSERT INTO WebClicks VALUES (1, '2009-12-08 3:01:45 pm');
INSERT INTO WebClicks VALUES (2, '2009-12-08 3:02:45 pm');
INSERT INTO WebClicks VALUES (2, '2009-12-08 3:02:55 pm');
INSERT INTO WebClicks VALUES (2, '2009-12-08 3:03:55 pm');
```

```
COMMIT;
```

The input table `WebClicks` contains the following rows:

```
=> SELECT * FROM WebClicks;
userId | timestamp
-----+-----
1 | 2009-12-08 15:00:00
1 | 2009-12-08 15:00:25
1 | 2009-12-08 15:00:45
1 | 2009-12-08 15:01:45
2 | 2009-12-08 15:02:45
2 | 2009-12-08 15:02:55
2 | 2009-12-08 15:03:55
(7 rows)
```

In the following query, sessionization performs computation on the `SELECT` list columns, showing the difference between the current and previous timestamp value using `LAG()`. It evaluates to true and increments the window ID when the difference is greater than 30 seconds.

```
=> SELECT userId, timestamp,
 CONDITIONAL_TRUE_EVENT(timestamp - LAG(timestamp) > '30 seconds')
 OVER(PARTITION BY userId ORDER BY timestamp) AS session
 FROM WebClicks;
userId | timestamp | session
-----+-----+-----
1 | 2009-12-08 15:00:00 | 0
1 | 2009-12-08 15:00:25 | 0
1 | 2009-12-08 15:00:45 | 0
1 | 2009-12-08 15:01:45 | 1
2 | 2009-12-08 15:02:45 | 0
2 | 2009-12-08 15:02:55 | 0
2 | 2009-12-08 15:03:55 | 1
(7 rows)
```

In the output, the `session` column contains the window ID from the `CONDITIONAL_TRUE_EVENT` function. The window ID evaluates to true on row 4 (timestamp 15:01:45), and the ID that follows row 4 is zero because it is the start of a new partition (for user ID 2), and that row does not evaluate to true until the last line in the output.

You might want to give users different time-out thresholds. For example, one user might have a slower network connection or could be multi-tasking, while another user might have a faster connection and is focused on a single Web site, doing a single task.

To compute an adaptive time-out threshold based on the last 2 clicks, use `CONDITIONAL_TRUE_EVENT` with `LAG` to return the average time between the last 2 clicks with a grace period of 3 seconds:

```
SELECT userId, timestamp,
 CONDITIONAL_TRUE_EVENT(timestamp - LAG(timestamp) >
 (LAG(timestamp, 1) - LAG(timestamp, 3)) / 2 + '3 seconds')
 OVER(PARTITION BY userId ORDER BY timestamp) AS session
 FROM WebClicks;
userId | timestamp | session
-----+-----+-----
2 | 2009-12-08 15:02:45 | 0
```

```
2 | 2009-12-08 15:02:55 | 0
2 | 2009-12-08 15:03:55 | 0
1 | 2009-12-08 15:00:00 | 0
1 | 2009-12-08 15:00:25 | 0
1 | 2009-12-08 15:00:45 | 0
1 | 2009-12-08 15:01:45 | 1
(7 rows)
```

**Note:** You cannot define a moving window in time series data. For example, if the query is evaluating the first row and there's no data, it will be the current row. If you have a lag of 2, no results are returned until the third row.

## See Also

***Event-based Windows*** (page [360](#))

# Using Time Series Analytics

---

Time series analytics evaluate the values of a given set of variables over time and group those values into a window (based on a time interval) for analysis and aggregation.

Common scenarios are changes over time, such as stock market trades and performance, as well as charting trend lines over data.

Because both time and the state of data within a time series are continuous, it can be challenging to evaluate SQL queries over time. Input records usually occur at non-uniform intervals, which means they might have gaps. HP Vertica provides gap-filling functionality—which fills in missing data points, as—and an interpolation scheme, which is a method of constructing new data points within the range of a discrete set of known data points. HP Vertica interpolates the non-time series columns in the data (such as analytic function results computed over time slices) and adds the missing data points to the output. Gap filling and interpolation are described in detail in this section.

You can also use **event-based windows** (page [360](#)) to break time series data into windows that border on significant events within the data. This is especially relevant in financial data where analysis might focus on specific events as triggers to other activity. **Sessionization** (page [365](#)), a special case of event-based windows, is a feature often used to analyze click streams, such as identifying web browsing sessions from recorded web clicks.

HP Vertica provides additional support for time series analytics with the following SQL extensions, which you can read about in the SQL Reference Manual.

- The SELECT..TIMESERIES clause supports gap-filling and interpolation (GFI) computation.
- TS\_FIRST\_VALUE and TS\_LAST\_VALUE are time series aggregate functions that return the value at the start or end of a time slice, respectively, which is determined by the interpolation scheme.
- TIME\_SLICE is a (SQL extension) date/time function that aggregates data by different fixed-time intervals and returns a rounded-up input TIMESTAMP value to a value that corresponds with the start or end of the time slice interval.

## See Also

**Event-based Windows** (page [360](#))

**Sessionization with Event Based Windows** (page [365](#))

## Gap Filling and Interpolation (GFI)

The examples and graphics that explain the concepts in this topic use the following simple schema:

```
CREATE TABLE TickStore (ts TIMESTAMP, symbol VARCHAR(8), bid FLOAT);
INSERT INTO TickStore VALUES ('2009-01-01 03:00:00', 'XYZ', 10.0);
INSERT INTO TickStore VALUES ('2009-01-01 03:00:05', 'XYZ', 10.5);
COMMIT;
```

In HP Vertica, time series data is represented by a sequence of rows that conforms to a particular table schema, where one of the columns stores the time information.

Both time and the state of data within a time series are continuous. This means that evaluating SQL queries over time can be challenging because input records usually occur at non-uniform intervals and could contain gaps. Consider, for example, the following table, which contains two input rows five seconds apart, at 3:00:00 and 3:00:05.

```
=> SELECT * FROM TickStore;
 ts | symbol | bid
-----+-----+-----
2009-01-01 03:00:00 | XYZ | 10
2009-01-01 03:00:05 | XYZ | 10.5
(2 rows)
```

Given those two inputs, how would you determine a bid price that fell between the two points, such as at 3:00:03 PM?

The TIME\_SLICE function, which normalizes timestamps into corresponding time slices, might seem like a logical candidate; however, TIME\_SLICE does not solve the problem of missing inputs (time slices) in the data. Instead, HP Vertica provides gap-filling and interpolation (GFI) functionality to fill in missing data points and add new (missing) data points within a range of known data points to the output using time series aggregate functions and the SQL TIMESERIES clause.

But first, we'll illustrate the components that make up gap filling and interpolation in HP Vertica, starting with ***Constant Interpolation*** (page [370](#)).

The images in the following topics use the following legend:

- The x-axis represents the timestamp (`ts`) column
- The y-axis represents the bid column.
- The vertical blue lines delimit the time slices.
- The red dots represent the input records in the table, \$10.0 and \$10.5.
- The blue stars represent the output values, including interpolated values.

## Constant Interpolation

Given known input timestamps at 03:00:00 and 03:00:05 in the [sample TickStore schema](#) (page 369), how might you determine the bid price at 03:00:03?

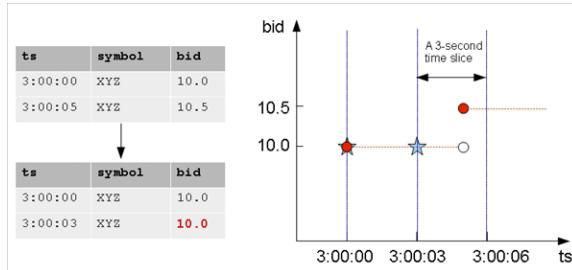
A common interpolation scheme used on financial data is to set the bid price to *the last seen value so far*. This scheme is referred to as **constant interpolation**, in which HP Vertica computes a new value based on the previous input records.

**Note:** Constant is HP Vertica's default interpolation scheme. Another interpolation scheme, [linear](#) (page 372), is discussed in an upcoming topic.

Returning to the problem query, here is the table output, which shows a 5-second lag between bids at 03:00:00 and 03:00:05:

```
=> SELECT * FROM TickStore;
 ts | symbol | bid
-----+-----+-----+
2009-01-01 03:00:00 | XYZ | 10
2009-01-01 03:00:05 | XYZ | 10.5
(2 rows)
```

Using constant interpolation, the interpolated bid price of XYZ remains at \$10.0 at 3:00:03, which falls between the two known data inputs (3:00:00 PM and 3:00:05). At 3:00:05, the value changes to \$10.5. The known data points are represented by a red dot, and the interpolated value at 3:00:03 is represented by the blue star.



In order to write a query that makes the input rows more uniform, you first need to understand the [TIMESERIES clause and time series aggregate functions](#) (page 370).

## The TIMESERIES Clause and Aggregates

The SELECT..TIMESERIES clause and time series aggregates help solve the problem of gaps in input records by normalizing the data into 3-second time slices and interpolating the bid price when it finds gaps.

## The TIMESERIES clause

The TIMESERIES clause is an important component of time series analytics computation. It performs gap filling and interpolation (GFI) to generate time slices missing from the input records. The clause applies to the timestamp columns/expressions in the data, and takes the following form:

```
TIMESERIES slice_time AS 'length_and_time_unit_expression' OVER (
... [window_partition_clause [, ...]]
... ORDER BY time_expression)
... [ORDER BY table_column [, ...]]
```

**Note:** The TIMESERIES clause requires an ORDER BY operation on the timestamp column.

## Time series aggregate (TSA) functions

Timeseries Aggregate (TSA) functions evaluate the values of a given set of variables over time and group those values into a window for analysis and aggregation.

TSA functions process the data that belongs to each time slice. One output row is produced per time slice or per partition per time slice if a partition expression is present.

The following table shows 3-second time slices where

- The first two rows fall within the first time slice, which runs from 3:00:00 to 3:00:02. These are the input rows for the TSA function's output for the time slice starting at 3:00:00.
- The second two rows fall within the second time slice, which runs from 3:00:03 to 3:00:05. These are the input rows for the TSA function's output for the time slice starting at 3:00:03.

The result is the start of each time slice.

| ts      | symbol | bid  | ts      | symbol | bid  |
|---------|--------|------|---------|--------|------|
| 3:00:00 | XYZ    | 10.0 | 3:00:00 | XYZ    | 10.0 |
| 3:00:01 | XYZ    | 10.1 | 3:00:03 | XYZ    | 10.1 |
| 3:00:04 | XYZ    | 10.3 |         |        |      |
| 3:00:05 | XYZ    | 10.5 |         |        |      |

## Example

The following statement uses both the TIMESERIES clause and the TS\_FIRST\_VALUE TSA function to process the data that belongs to each 3-second time slice. The query returns the values of the bid column, as determined by the specified constant interpolation scheme:

```
=> SELECT slice_time, TS_FIRST_VALUE(bid, 'CONST') bid FROM TickStore
 TIMESERIES slice_time AS '3 seconds' OVER(PARTITION by symbol ORDER BY ts);
```

Now the original data inputs (at left) look like the output on the right because HP Vertica interpolated the last known value and filled in the missing data point, returning 10 at 3:00:03:

Original query

| slice_time          |  | bid  |
|---------------------|--|------|
| 2009-01-01 03:00:00 |  | 10   |
| 2009-01-01 03:00:03 |  | 10.5 |
| (2 rows)            |  |      |

Interpolated value

| slice_time          |  | bid       |
|---------------------|--|-----------|
| 2009-01-01 03:00:00 |  | 10        |
| 2009-01-01 03:00:03 |  | <b>10</b> |
| (2 rows)            |  |           |

## Linear Interpolation

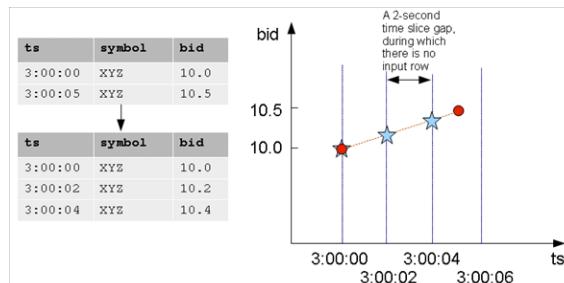
Instead of interpolating data points based on the last seen value (**constant interpolation** (page [370](#))), linear interpolation is where HP Vertica interpolates values in a linear slope based on the specified time slice.

The query that follows uses linear interpolation to place the input records in 2-second time slices and return the first bid value for each symbol/time slice combination (the value at the start of the time slice):

```
=> SELECT slice_time, TS_FIRST_VALUE(bid, 'LINEAR') bid FROM Tickstore
 TIMESERIES slice_time AS '2 seconds' OVER(PARTITION BY symbol ORDER BY ts);

slice_time | bid
-----+-----
2009-01-01 03:00:00 | 10
2009-01-01 03:00:02 | 10.2
2009-01-01 03:00:04 | 10.4
(3 rows)
```

The following figure illustrates the previous query results, showing the 2-second time gaps (3:00:02 and 3:00:04) in which no input record occurs. Note that the interpolated bid price of XYZ changes to 10.2 at 3:00:02 and 10.3 at 3:00:03 and 10.4 at 3:00:04, all of which fall between the two known data inputs (3:00:00 and 3:00:05). At 3:00:05, the value would change to 10.5.

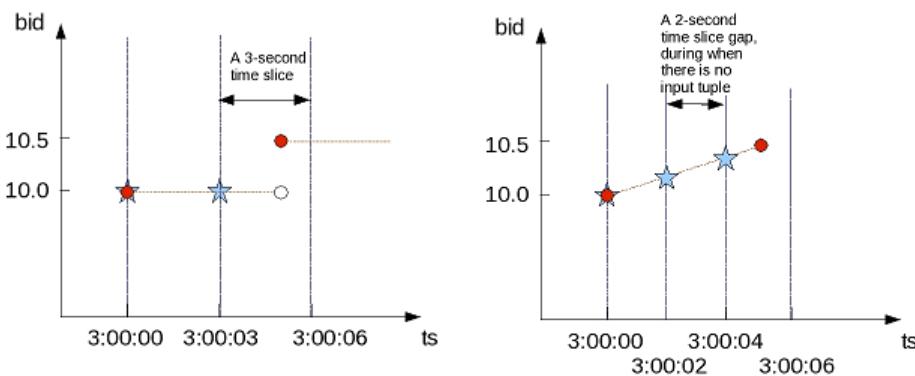


**Note:** The known data points above are represented by a red dot, and the interpolated values are represented by blue stars.

The following is a side-by-side comparison of constant and linear interpolation schemes.

### CONST interpolation

### LINEAR interpolation



## GFI Examples

This topic illustrates some of the queries you can write using the constant and linear interpolation schemes.

### Constant interpolation

The first query uses `TS_FIRST_VALUE()` and the `TIMESERIES` clause to place the input records in 3-second time slices and return the first bid value for each symbol/time slice combination (the value at the start of the time slice).

**Note:** The `TIMESERIES` clause requires an `ORDER BY` operation on the `TIMESTAMP` column.

```
=> SELECT slice_time, symbol, TS_FIRST_VALUE(bid) AS first_bid FROM TickStore
 TIMESERIES slice_time AS '3 seconds' OVER (PARTITION BY symbol ORDER BY ts);
```

Because the bid price of stock XYZ is 10.0 at 3:00:03, the `first_bid` value of the second time slice, which starts at 3:00:03 is till 10.0 (instead of 10.5) because the input value of 10.5 does not occur until 3:00:05. In this case, the interpolated value is inferred from the last value seen on stock XYZ for time 3:00:03:

| slice_time          | symbol | first_bid |
|---------------------|--------|-----------|
| 2009-01-01 03:00:00 | XYZ    | 10        |
| 2009-01-01 03:00:03 | XYZ    | 10        |

(2 rows)

The next example places the input records in 2-second time slices to return the first bid value for each symbol/time slice combination:

```
=> SELECT slice_time, symbol, TS_FIRST_VALUE(bid) AS first_bid FROM TickStore
 TIMESERIES slice_time AS '2 seconds' OVER (PARTITION BY symbol ORDER BY ts);
```

The result now contains three records in 2-second increments, all of which occur between the first input row at 03:00:00 and the second input row at 3:00:05. Note that the second and third output record correspond to a time slice where there is no input record:

```

slice_time | symbol | first_bid
-----+-----+-----
2009-01-01 03:00:00 | XYZ | 10
2009-01-01 03:00:02 | XYZ | 10
2009-01-01 03:00:04 | XYZ | 10
(3 rows)

```

Using the same table schema, the next query uses `TS_LAST_VALUE()`, with the `TIMESERIES` clause to return the last values of each time slice (the values at the end of the time slices).

**Note:** Time series aggregate functions process the data that belongs to each time slice. One output row is produced per time slice or per partition per time slice if a partition expression is present.

```
=> SELECT slice_time, symbol, TS_LAST_VALUE(bid) AS last_bid FROM TickStore
 TIMESERIES slice_time AS '2 seconds' OVER (PARTITION BY symbol ORDER BY ts);
```

Notice that the last value output row is 10.5 because the value 10.5 at time 3:00:05 was the last point inside the 2-second time slice that started at 3:00:04:

```

slice_time | symbol | last_bid
-----+-----+-----
2009-01-01 03:00:00 | XYZ | 10
2009-01-01 03:00:02 | XYZ | 10
2009-01-01 03:00:04 | XYZ | 10.5
(3 rows)

```

Remember that because constant interpolation is the default, the same results are returned if you write the query using the `CONST` parameter as follows:

```
=> SELECT slice_time, symbol, TS_LAST_VALUE(bid, 'CONST') AS last_bid FROM
 TickStore
 TIMESERIES slice_time AS '2 seconds' OVER (PARTITION BY symbol ORDER BY ts);
```

### Linear interpolation

Based on the same input records described in the constant interpolation examples, which specify 2-second time slices, the result of `TS_LAST_VALUE` with linear interpolation is as follows:

```
=> SELECT slice_time, symbol, TS_LAST_VALUE(bid, 'linear') AS last_bid
 FROM TickStore
 TIMESERIES slice_time AS '2 seconds' OVER (PARTITION BY symbol ORDER BY ts);
```

In the results, no `last_bid` value is returned for the last row because the query specified `TS_LAST_VALUE`, and there is no data point after the 3:00:04 time slice to interpolate.

```

slice_time | symbol | last_bid
-----+-----+-----
2009-01-01 03:00:00 | XYZ | 10.2
2009-01-01 03:00:02 | XYZ | 10.4
2009-01-01 03:00:04 | XYZ |
(3 rows)

```

## Using multiple time series aggregate functions

Multiple time series aggregate functions can exist in the same query. They share the same *gap-filling* policy as defined in the TIMESERIES clause; however, each time series aggregate function can specify its own interpolation policy. In the following example, there are two constant and one linear interpolation schemes, but all three functions use a three-second time slice:

```
=> SELECT slice_time, symbol,
 TS_FIRST_VALUE(bid, 'const') fv_c,
 TS_FIRST_VALUE(bid, 'linear') fv_l,
 TS_LAST_VALUE(bid, 'const') lv_c
 FROM TickStore
 TIMESERIES slice_time AS '3 seconds' OVER(PARTITION BY symbol ORDER BY ts);
```

In the following output, the original output is compared to output returned by multiple time series aggregate functions.

| ts       | symbol | bid  |     | slice_time          | symbol | fv_c | fv_l | lv_c |
|----------|--------|------|-----|---------------------|--------|------|------|------|
| 03:00:00 | XYZ    | 10   | ==> | 2009-01-01 03:00:00 | XYZ    | 10   | 10   | 10   |
| 03:00:05 | XYZ    | 10.5 |     | 2009-01-01 03:00:03 | XYZ    | 10   | 10.3 | 10.5 |

(2 rows) (2 rows)

## Using the analytic LAST\_VALUE() function

Here's an example using LAST\_VALUE(), so you can see the difference between it and the GFI syntax.

```
=> SELECT *, LAST_VALUE(bid) OVER(PARTITION by symbol ORDER BY ts)
 AS "last bid" FROM TickStore;
```

There is no gap filling and interpolation to the output values.

| ts                  | symbol | bid  | last bid |
|---------------------|--------|------|----------|
| 2009-01-01 03:00:00 | XYZ    | 10   | 10       |
| 2009-01-01 03:00:05 | XYZ    | 10.5 | 10.5     |

(2 rows)

## Using slice\_time

In a TIMESERIES query, you cannot use the column `slice_time` in the WHERE clause because the WHERE clause is evaluated before the TIMESERIES clause, and the `slice_time` column is not generated until the TIMESERIES clause is evaluated. For example, HP Vertica does not support the following query:

```
=> SELECT symbol, slice_time, TS_FIRST_VALUE(bid IGNORE NULLS) AS fv
 FROM TickStore
 WHERE slice_time = '2009-01-01 03:00:00'
 TIMESERIES slice_time as '2 seconds' OVER (PARTITION BY symbol ORDER BY ts);
```

ERROR: Time Series timestamp alias/Time Series Aggregate Functions not allowed in WHERE clause

Instead, you could write a subquery and put the predicate on `slice_time` in the outer query:

```
=> SELECT * FROM (
 SELECT symbol, slice_time,
```

```
 TS_FIRST_VALUE(bid IGNORE NULLS) AS fv
 FROM TickStore
 TIMESERIES slice_time AS '2 seconds'
 OVER (PARTITION BY symbol ORDER BY ts)) sq
 WHERE slice_time = '2009-01-01 03:00:00';

symbol | slice_time | fv
-----+-----+-----+
XYZ | 2009-01-01 03:00:00 | 10
(1 row)
```

### Creating a dense time series

The TIMESERIES clause provides a convenient way to create a dense time series for use in an outer join with fact data. The results represent every time point, rather than just the time points for which data exists.

The examples that follow use the same TickStore schema described in **Gap Filling and Interpolation (GFI)** (page [369](#)), along with the addition of a new inner table for the purpose of creating a join:

```
=> CREATE TABLE inner_table (
 ts TIMESTAMP,
 bid FLOAT
);
=> CREATE PROJECTION inner_p (ts, bid) as SELECT * FROM inner_table
 ORDER BY ts, bid UNSEGMENTED ALL NODES;

=> INSERT INTO inner_table VALUES ('2009-01-01 03:00:02', 1);
=> INSERT INTO inner_table VALUES ('2009-01-01 03:00:04', 2);
=> COMMIT;
```

You can create a simple union between the start and end range of the timeframe of interest in order to return every time point. This example uses a 1-second time slice:

```
=> SELECT ts FROM (
 SELECT '2009-01-01 03:00:00':::TIMESTAMP AS time FROM TickStore
 UNION
 SELECT '2009-01-01 03:00:05':::TIMESTAMP FROM TickStore) t
 TIMESERIES ts AS '1 seconds' OVER(ORDER BY time);

ts

2009-01-01 03:00:00
2009-01-01 03:00:01
2009-01-01 03:00:02
2009-01-01 03:00:03
2009-01-01 03:00:04
2009-01-01 03:00:05
(6 rows)
```

The next query creates a union between the start and end range of the timeframe using 500-millisecond time slices:

```
=> SELECT ts FROM (
 SELECT '2009-01-01 03:00:00'::TIMESTAMP AS time
 FROM TickStore
 UNION
 SELECT '2009-01-01 03:00:05'::TIMESTAMP FROM TickStore) t
TIMESERIES ts AS '500 milliseconds' OVER(ORDER BY time);

 ts

2009-01-01 03:00:00
2009-01-01 03:00:00.5
2009-01-01 03:00:01
2009-01-01 03:00:01.5
2009-01-01 03:00:02
2009-01-01 03:00:02.5
2009-01-01 03:00:03
2009-01-01 03:00:03.5
2009-01-01 03:00:04
2009-01-01 03:00:04.5
2009-01-01 03:00:05
(11 rows)
```

The following query creates a union between the start- and end-range of the timeframe of interest using 1-second time slices:

```
=> SELECT * FROM (
 SELECT ts FROM (
 SELECT '2009-01-01 03:00:00'::timestamp AS time FROM TickStore
 UNION
 SELECT '2009-01-01 03:00:05'::timestamp FROM TickStore) t
 TIMESERIES ts AS '1 seconds' OVER(ORDER BY time)) AS outer_table
 LEFT OUTER JOIN inner_table ON outer_table.ts = inner_table.ts;
```

The union returns a complete set of records from the left-joined table with the matched records in the right-joined table. Where the query found no match, it extends the right side column with null values:

| ts                  |  | ts                  | bid |
|---------------------|--|---------------------|-----|
| 2009-01-01 03:00:00 |  |                     |     |
| 2009-01-01 03:00:01 |  |                     |     |
| 2009-01-01 03:00:02 |  | 2009-01-01 03:00:02 | 1   |
| 2009-01-01 03:00:03 |  |                     |     |
| 2009-01-01 03:00:04 |  | 2009-01-01 03:00:04 | 2   |
| 2009-01-01 03:00:05 |  |                     |     |

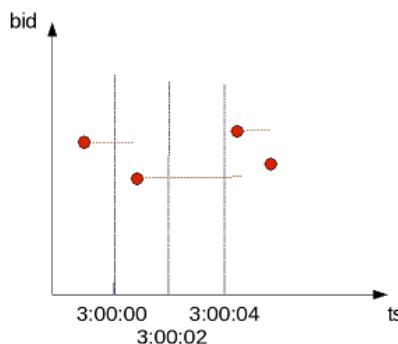
(6 rows)

## When Time Series Data Contains Null Values

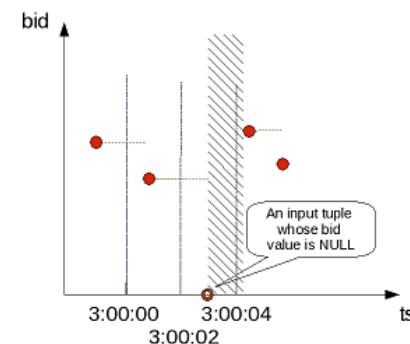
Null values are not common inputs for gap-filling and interpolation (GFI) computation, but if null values do exist, you can use time series aggregate functions (TS\_FIRST\_VALUE/TS\_LAST\_VALUE) with the IGNORE NULLS arguments to affect output of the interpolated values. The TSA functions are treated similarly to their analytic counterparts (FIRST\_VALUE/LAST\_VALUE) in that if the timestamp itself is null HP Vertica filter out those rows before gap filling and interpolation occurs.

The three images below will illustrate the points that follow on how HP Vertica handles time series data that contains null values.

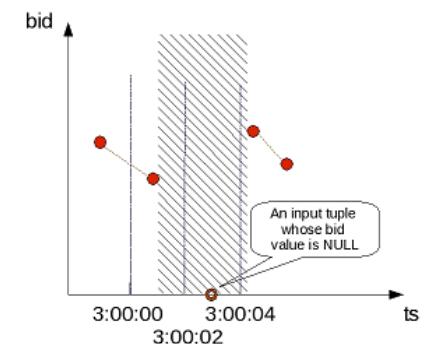
**Figure 1.** Interpolated bid values when the input has no NULLs



**Figure 2.** CONST-interpolated bid values when the input has NULL values



**Figure 3.** LINEAR-interpolated bid values when the input has NULL values



### Constant interpolation with null values

Figure 1 illustrates a default (constant) interpolation result on four input rows where none of the inputs contains a NULL value. Figure 2 shows the same input rows with the addition of another input record whose bid value is NULL, and whose timestamp (ts) value is 3:00:03.

For constant interpolation, the bid value starting at 3:00:03 is null until the next non-null bid value appears in time. In Figure 2, the presence of the null row makes the interpolated bid value null in the time interval denoted by the shaded region. As a result, if `TS_FIRST_VALUE(bid)` is evaluated with constant interpolation on the time slice that begins at 3:00:02, its output is non-null. However, `TS_FIRST_VALUE(bid)` on the next time slice produces null. If the last value of the 3:00:02 time slice is null, the first value for the next time slice (3:00:04) is null. However, if you were to use a TSA function with IGNORE NULLS, then the value at 3:00:04 would be the same value as it was at 3:00:02.

To illustrate, insert a new row into the TickStore table at 03:00:03 with a null bid value, HP Vertica will output a row for the 03:00:02 record with a null value but no row for the 03:00:03 input:

```
=> INSERT INTO tickstore VALUES('2009-01-01 03:00:03', 'XYZ', NULL);

=> SELECT slice_time, symbol, TS_LAST_VALUE(bid) AS last_bid FROM TickStore
-> TIMESERIES slice_time AS '2 seconds' OVER (PARTITION BY symbol ORDER BY ts);
```

```

slice_time | symbol | last_bid
-----+-----+-----
2009-01-01 03:00:00 | XYZ | 10
2009-01-01 03:00:02 | XYZ |
2009-01-01 03:00:04 | XYZ | 10.5
(3 rows)

```

If you specify IGNORE NULLS, HP Vertica fills in the missing data point using a constant interpolation scheme. Here, the bid price at 03:00:02 is interpolated to the last known input record for bid, which was \$10 at 03:00:00:

```

=> SELECT slice_time, symbol, TS_LAST_VALUE(bid IGNORE NULLS) AS last_bid FROM TickStore
-> TIMESERIES slice_time AS '2 seconds' OVER (PARTITION BY symbol ORDER BY ts);
slice_time | symbol | last_bid
-----+-----+-----
2009-01-01 03:00:00 | XYZ | 10
2009-01-01 03:00:02 | XYZ | 10
2009-01-01 03:00:04 | XYZ | 10.5
(3 rows)

```

Now if you were to insert a row where the timestamp column contained a null value, HP Vertica would filter out that row before gap filling and interpolation occurred.

```

=> INSERT INTO tickstore VALUES(NULL, 'XYZ', 11.2);

=> SELECT slice_time, symbol, TS_LAST_VALUE(bid) AS last_bid FROM TickStore
-> TIMESERIES slice_time AS '2 seconds' OVER (PARTITION BY symbol ORDER BY ts);

```

Notice there is no output for the 11.2 bid row:

```

slice_time | symbol | last_bid
-----+-----+-----
2009-01-01 03:00:00 | XYZ | 10
2009-01-01 03:00:02 | XYZ |
2009-01-01 03:00:04 | XYZ | 10.5
(3 rows)

```

## Linear interpolation with null values

For linear interpolation, the interpolated bid value becomes null in the time interval, which is represented by the shaded region in Figure 3. In the presence of an input null value at 3:00:03, HP Vertica cannot linearly interpolate the bid value around that time point.

HP Vertica takes the closest non null value on either side of the time slice and uses that value. For example, if you use a linear interpolation scheme and you do not specify IGNORE NULLS, and your data has one real value and one null, the result is null. If the value on either side is null, the result is null. Therefore, to evaluate TS\_FIRST\_VALUE(bid) with linear interpolation on the time slice that begins at 3:00:02, its output is null. TS\_FIRST\_VALUE(bid) on the next time slice remains null.

```

=> SELECT slice_time, symbol, TS_FIRST_VALUE(bid, 'linear') AS fv_1 FROM TickStore
-> TIMESERIES slice_time AS '2 seconds' OVER (PARTITION BY symbol ORDER BY ts);

```

```
slice_time | symbol | fv_1
-----+-----+-----+
2009-01-01 03:00:00 | XYZ | 10
2009-01-01 03:00:02 | XYZ |
2009-01-01 03:00:04 | XYZ |
(3 rows)
```

## Event Series Joins

---

An event series join is an HP Vertica SQL extension that enables the analysis of two series when their measurement intervals don't align precisely, such as with mismatched timestamps. You can compare values from the two series directly, rather than having to normalize the series to the same measurement interval.

Event series joins are an extension of **outer joins** (page [322](#)), but instead of padding the non-preserved side with NULL values when there is no match, the event series join pads the non-preserved side values that it interpolates from the previous value.

The difference in how you write a regular join versus an event series join is the INTERPOLATE predicate, which is used in the ON clause. For example, the following two statements show the differences, which are shown in greater detail in **Writing Event Series Joins** (page [383](#)).

### Regular full outer join

```
SELECT * FROM hTicks h
FULL OUTER JOIN aTicks a
ON (h.time = a.time);
```

### Event series join

```
SELECT * FROM hTicks h
FULL OUTER JOIN aTicks a
ON (h.time INTERPOLATE PREVIOUS VALUE a.time);
```

Similar to regular joins, an event series join has inner and outer join modes, which are described in the topics that follow.

For full syntax, including notes and restrictions, see **INTERPOLATE** in the SQL Reference Manual

## Sample Schema for Event Series Joins Examples

If you don't plan to run the queries and just want to look at the examples, you can skip this topic and move straight to **Writing Event Series Joins** (page [383](#)).

### Schema of hTicks and aTicks tables

The examples that follow use the following hTicks and aTicks tables schemas:

```

CREATE TABLE hTicks (
 stock VARCHAR(20),
 time TIME,
 price NUMERIC(8,2)
);
CREATE TABLE aTicks (
 stock VARCHAR(20),
 time TIME,
 price NUMERIC(8,2)
);

```

Although **TIMESTAMP** is more commonly used for the event series column, the examples in this topic use **TIME** to keep the output simple.

```

INSERT INTO hTicks VALUES ('HPQ', '12:00', 50.00);
INSERT INTO hTicks VALUES ('HPQ', '12:01', 51.00);
INSERT INTO hTicks VALUES ('HPQ', '12:05', 51.00);
INSERT INTO hTicks VALUES ('HPQ', '12:06', 52.00);
INSERT INTO aTicks VALUES ('ACME', '12:00', 340.00);
INSERT INTO aTicks VALUES ('ACME', '12:03', 340.10);
INSERT INTO aTicks VALUES ('ACME', '12:05', 340.20);
INSERT INTO aTicks VALUES ('ACME', '12:05', 333.80);
COMMIT;

```

Output of the two tables:

#### **hTicks**

```
=> SELECT * FROM hTicks;
```

Notice there are no entry records between 12:02-12:04:

| stock | time     | price |
|-------|----------|-------|
| HPQ   | 12:00:00 | 50.00 |
| HPQ   | 12:01:00 | 51.00 |
| HPQ   | 12:05:00 | 51.00 |
| HPQ   | 12:06:00 | 52.00 |

(4 rows)

#### **aTicks**

```
=> SELECT * FROM aTicks;
```

Notice there are no entry records at 12:01, 12:02 and at 12:04:

| stock | time     | price  |
|-------|----------|--------|
| ACME  | 12:00:00 | 340.00 |
| ACME  | 12:03:00 | 340.10 |
| ACME  | 12:05:00 | 340.20 |
| ACME  | 12:05:00 | 333.80 |

(4 rows)

### **Example query showing gaps**

A full outer join shows the gaps in the timestamps:

```
=> SELECT * FROM hTicks h FULL OUTER JOIN aTicks a ON h.time = a.time;
 stock | time | price | stock | time | price
-----+-----+-----+-----+-----+-----+
 HPQ | 12:00:00 | 50.00 | ACME | 12:00:00 | 340.00
 HPQ | 12:01:00 | 51.00 | | | |
 HPQ | 12:05:00 | 51.00 | ACME | 12:05:00 | 333.80
```

```

HPQ | 12:05:00 | 51.00 | ACME | 12:05:00 | 340.20
HPQ | 12:06:00 | 52.00 | | |
 | | | ACME | 12:03:00 | 340.10
(6 rows)

```

### Schema of bid and asks tables

The examples that follow use the following hTicks and aTicks tables schemas:

```

CREATE TABLE bid(stock VARCHAR(20), time TIME, price NUMERIC(8,2));
CREATE TABLE ask(stock VARCHAR(20), time TIME, price NUMERIC(8,2));
INSERT INTO bid VALUES ('HPQ', '12:00', 100.10);
INSERT INTO bid VALUES ('HPQ', '12:01', 100.00);
INSERT INTO bid VALUES ('ACME', '12:00', 80.00);
INSERT INTO bid VALUES ('ACME', '12:03', 79.80);
INSERT INTO bid VALUES ('ACME', '12:05', 79.90);
INSERT INTO ask VALUES ('HPQ', '12:01', 101.00);
INSERT INTO ask VALUES ('ACME', '12:00', 80.00);
INSERT INTO ask VALUES ('ACME', '12:02', 75.00);
COMMIT;

```

Output of the two tables:

#### bid

```
=> SELECT * FROM bid;
```

Notice there are no entry records for stock ORCL at 12:02 and at 12:04:

```

stock | time | price
-----+-----+-----+
HPQ | 12:00:00 | 100.10
HPQ | 12:01:00 | 100.00
ACME | 12:00:00 | 80.00
ACME | 12:03:00 | 79.80
ACME | 12:05:00 | 79.90
(5 rows)

```

#### ask

```
=> SELECT * FROM ask;
```

Notice there are no entry records for stock IBM at 12:00 and none for ORCL at 12:01:

```

stock | time | price
-----+-----+-----+
HPQ | 12:01:00 | 101.00
ACME | 12:00:00 | 80.00
ACME | 12:02:00 | 75.00
(3 rows)

```

### Example query showing gaps

A full outer join shows the gaps in the timestamps:

```

=> SELECT * FROM bid b FULL OUTER JOIN ask a ON b.time = a.time;
 stock | time | price | stock | time | price
-----+-----+-----+-----+-----+-----+
 HPQ | 12:00:00 | 100.10 | ACME | 12:00:00 | 80.00
 HPQ | 12:01:00 | 100.00 | HPQ | 12:01:00 | 101.00
 ACME | 12:00:00 | 80.00 | ACME | 12:00:00 | 80.00
 ACME | 12:03:00 | 79.80 | | |
 ACME | 12:05:00 | 79.90 | | |
 | | | ACME | 12:02:00 | 75.00

```

---

```
(6 rows)
```

## Writing Event Series Joins

The examples in this topic contains mismatches between timestamps—just as you'd find in real life situations; for example, there could be a period of inactivity on stocks where no trade occurs, which can present challenges when you want to compare two stocks whose timestamps don't match.

### The hTicks and aTicks tables

As described in the ***example ticks schema*** (page [380](#)), tables, hTicks is missing input rows for 12:02, 12:03, and 12:04, and aTicks is missing inputs at 12:01, 12:02, and 12:04.

| hTicks   |                       |       | aTicks   |                       |        |
|----------|-----------------------|-------|----------|-----------------------|--------|
| =>       | SELECT * FROM hTicks; |       | =>       | SELECT * FROM aTicks; |        |
| stock    | time                  | price | stock    | time                  | price  |
| HPQ      | 12:00:00              | 50.00 | ACME     | 12:00:00              | 340.00 |
| HPQ      | 12:01:00              | 51.00 | ACME     | 12:03:00              | 340.10 |
| HPQ      | 12:05:00              | 51.00 | ACME     | 12:05:00              | 340.20 |
| HPQ      | 12:06:00              | 52.00 | ACME     | 12:05:00              | 333.80 |
| (4 rows) |                       |       | (4 rows) |                       |        |

### Querying event series data with full outer joins

Using a traditional full outer join, this query find a match between tables hTicks and aTicks at 12:00 and 12:05 and pads the missing data points with NULL values.

|       |                                                                       |
|-------|-----------------------------------------------------------------------|
| =>    | SELECT * FROM hTicks h FULL OUTER JOIN aTicks a ON (h.time = a.time); |
|       |                                                                       |
| stock | time                                                                  |
| HPQ   | 12:00:00                                                              |
| HPQ   | 12:01:00                                                              |
| HPQ   | 12:05:00                                                              |
| HPQ   | 12:05:00                                                              |
| HPQ   | 12:06:00                                                              |
|       |                                                                       |
| stock | time                                                                  |
| ACME  | 12:00:00                                                              |
|       |                                                                       |
| ACME  | 12:03:00                                                              |
| ACME  | 12:05:00                                                              |
| ACME  | 12:05:00                                                              |
|       |                                                                       |
| stock | time                                                                  |
| ACME  | 12:03:00                                                              |
|       |                                                                       |

To replace the gaps with interpolated values for those missing data points, use the INTERPOLATE predicate to create an event series join. The join condition is restricted to the ON clause, which evaluates the equality predicate on the timestamp columns from the two input tables. In other words, for each row in outer table hTicks, the ON clause predicates are evaluated for each combination of each row in the inner table aTicks.

Simply rewrite the full outer join query to use the INTERPOLATE predicate with the required PREVIOUS VALUE keywords. Note that a full outer join on event series data is the most common scenario for event series data, where you keep all rows from both tables

```
=> SELECT * FROM hTicks h FULL OUTER JOIN aTicks a
 ON (h.time INTERPOLATE PREVIOUS VALUE a.time);
```

HP Vertica interpolates the missing values (which appear as NULL in the full outer join) using that table's previous value:

| stock | time     | price | stock | time     | price  |
|-------|----------|-------|-------|----------|--------|
| HPQ   | 12:00:00 | 50.00 | ACME  | 12:00:00 | 340.00 |
| HPQ   | 12:01:00 | 51.00 | ACME  | 12:00:00 | 340.00 |
| HPQ   | 12:01:00 | 51.00 | ACME  | 12:03:00 | 340.10 |
| HPQ   | 12:05:00 | 51.00 | ACME  | 12:05:00 | 333.80 |
| HPQ   | 12:05:00 | 51.00 | ACME  | 12:05:00 | 340.20 |
| HPQ   | 12:06:00 | 52.00 | ACME  | 12:05:00 | 340.20 |

(6 rows)

**Note:** The output ordering above is different from the regular full outer join because in the event series join, interpolation occurs independently for each stock (hTicks and aTicks), where the data is partitioned and sorted based on the equality predicate. This means that interpolation occurs within, not across, partitions.

If you review the regular full outer join output, you can see that both tables have a match in the time column at 12:00 and 12:05, but at 12:01, there is no entry record for ACME. So the operation interpolates a value for ACME (ACME, 12:00, 340) based on the previous value in the aTicks table.

### Querying event series data with left outer joins

You can also use left and right outer joins. You might, for example, decide you want to preserve only hTicks values. So you'd write a left outer join:

```
=> SELECT * FROM hTicks h LEFT OUTER JOIN aTicks a
 ON (h.time INTERPOLATE PREVIOUS VALUE a.time);
```

| stock | time     | price | stock | time     | price  |
|-------|----------|-------|-------|----------|--------|
| HPQ   | 12:00:00 | 50.00 | ACME  | 12:00:00 | 340.00 |
| HPQ   | 12:01:00 | 51.00 | ACME  | 12:00:00 | 340.00 |
| HPQ   | 12:05:00 | 51.00 | ACME  | 12:05:00 | 333.80 |
| HPQ   | 12:05:00 | 51.00 | ACME  | 12:05:00 | 340.20 |
| HPQ   | 12:06:00 | 52.00 | ACME  | 12:05:00 | 340.20 |

(5 rows)

Here's what the same data looks like using a traditional left outer join:

```
=> SELECT * FROM hTicks h LEFT OUTER JOIN aTicks a ON h.time = a.time;
 stock | time | price | stock | time | price
-----+-----+-----+-----+-----+-----+
 HPQ | 12:00:00 | 50.00 | ACME | 12:00:00 | 340.00
 HPQ | 12:01:00 | 51.00 | | | |
 HPQ | 12:05:00 | 51.00 | ACME | 12:05:00 | 333.80
 HPQ | 12:05:00 | 51.00 | ACME | 12:05:00 | 340.20
 HPQ | 12:06:00 | 52.00 | | | |
(5 rows)
```

Note that a right outer join has the same behavior with the preserved table reversed.

### Querying event series data with inner joins

Note that INNER event series joins behave the same way as normal ANSI SQL-99 joins, where all gaps are omitted. Thus, there is nothing to interpolate, and the following two queries are equivalent and return the same result set:

A regular inner join:

```
=> SELECT * FROM HTicks h JOIN aTicks a
 ON (h.time INTERPOLATE PREVIOUS VALUE a.time);
```

| stock | time     | price | stock | time     | price  |
|-------|----------|-------|-------|----------|--------|
| HPQ   | 12:00:00 | 50.00 | ACME  | 12:00:00 | 340.00 |
| HPQ   | 12:05:00 | 51.00 | ACME  | 12:05:00 | 333.80 |
| HPQ   | 12:05:00 | 51.00 | ACME  | 12:05:00 | 340.20 |

(3 rows)

An event series inner join:

```
=> SELECT * FROM HTicks h INNER JOIN aTicks a ON (h.time = a.time);
```

| stock | time     | price | stock | time     | price  |
|-------|----------|-------|-------|----------|--------|
| HPQ   | 12:00:00 | 50.00 | ACME  | 12:00:00 | 340.00 |
| HPQ   | 12:05:00 | 51.00 | ACME  | 12:05:00 | 333.80 |
| HPQ   | 12:05:00 | 51.00 | ACME  | 12:05:00 | 340.20 |

(3 rows)

### The bid and ask tables

Using the **example schema** (page [380](#)) for the bid and ask tables, write a full outer join to interpolate the missing data points:

```
=> SELECT * FROM bid b FULL OUTER JOIN ask a
 ON (b.stock = a.stock AND b.time INTERPOLATE PREVIOUS VALUE a.time);
```

In the below output, the first row for stock HPQ shows nulls because there is no entry record for HPQ before 12:01.

| stock | time     | price  | stock       | time            | price        |
|-------|----------|--------|-------------|-----------------|--------------|
| ACME  | 12:00:00 | 80.00  | ACME        | 12:00:00        | 80.00        |
| ACME  | 12:00:00 | 80.00  | <b>ACME</b> | <b>12:02:00</b> | <b>75.00</b> |
| ACME  | 12:03:00 | 79.80  | <b>ACME</b> | <b>12:02:00</b> | <b>75.00</b> |
| ACME  | 12:05:00 | 79.90  | <b>ACME</b> | <b>12:02:00</b> | <b>75.00</b> |
| HPQ   | 12:00:00 | 100.10 |             |                 |              |
| HPQ   | 12:01:00 | 100.00 | HPQ         | 12:01:00        | 101.00       |

(6 rows)

Note also that the same row (ACME, 12:02, 75) from the `ask` table appears three times. The first appearance is because no matching rows are present in the `bid` table for the row in `ask`, so Vertica interpolates the missing value using the ACME value at 12:02 (75.00). The second appearance occurs because the row in `bid` (ACME, 12:05, 79.9) has no matches in `ask`. The row from `ask` that contains (ACME, 12:02, 75) is the closest row; thus, it is used to interpolate the values.

If you write a regular full outer join, you can see where the mismatched timestamps occur:

```
=> SELECT * FROM bid b FULL OUTER JOIN ask a ON (b.time = a.time);
 stock | time | price | stock | time | price
-----+-----+-----+-----+-----+-----+
 ACME | 12:00:00 | 80.00 | ACME | 12:00:00 | 80.00
 ACME | 12:03:00 | 79.80 | | | |
 ACME | 12:05:00 | 79.90 | | | |
 HPQ | 12:00:00 | 100.10 | ACME | 12:00:00 | 80.00
 HPQ | 12:01:00 | 100.00 | HPQ | 12:01:00 | 101.00
 | | | ACME | 12:02:00 | 75.00
(6 rows)
```

## Event Series Pattern Matching

---

The SQL MATCH clause syntax (described in the SQL Reference Manual) lets you screen large amounts of historical data in search of event patterns. You specify a pattern as a regular expression and can then search for the pattern within a sequence of input events. MATCH provides subclauses for analytic data partitioning and ordering, and the pattern matching occurs on a contiguous set of rows.

Pattern matching is particularly useful for clickstream analysis where you might want to identify users' actions based on their Web browsing behavior (page clicks). A typical online clickstream funnel is:

Company home page -> product home page -> search -> results -> purchase online

Using the above clickstream funnel, you can search for a match on the user's sequence of web clicks and identify that the user:

- landed on the company home page
- navigated to the product page
- ran a search
- clicked a link from the search results
- made a purchase

### Clickstream funnel schema

The examples in this topic use this clickstream funnel and the following `clickstream_log` table schema:

```

CREATE TABLE clickstream_log (
 uid INT, --user ID
 sid INT, --browsing session ID, produced by previous sessionization computation
 ts TIME, --timestamp that occurred during the user's page visit
 refURL VARCHAR(20), --URL of the page referencing PageURL
 pageURL VARCHAR(20), --URL of the page being visited
 action CHAR(1) --action the user took after visiting the page ('P' = Purchase, 'V' = View)
);
INSERT INTO clickstream_log VALUES (1,100,'12:00','website1.com','website2.com/home', 'V');
INSERT INTO clickstream_log VALUES (1,100,'12:01','website2.com/home','website2.com/floby', 'V');
INSERT INTO clickstream_log VALUES (1,100,'12:02','website2.com/floby','website2.com/shamwow', 'V');
insert into clickstream_log values (1,100,'12:03','website2.com/shamwow','website2.com/buy', 'P');
insert into clickstream_log values (2,100,'12:10','website1.com','website2.com/home', 'V');
insert into clickstream_log values (2,100,'12:11','website2.com/home','website2.com/forks', 'V');
insert into clickstream log values (2,100,'12:13','website2.com/forks','website2.com/buy', 'P');
COMMIT;

```

Here's the clickstream\_log table's output:

```

=> SELECT * FROM clickstream_log;
 uid | sid | ts | refURL | pageURL | action
-----+-----+-----+-----+-----+-----+-----+
 1 | 100 | 12:00:00 | website1.com | website2.com/home | V
 1 | 100 | 12:01:00 | website2.com/home | website2.com/floby | V
 1 | 100 | 12:02:00 | website2.com/floby | website2.com/shamwow | V
 1 | 100 | 12:03:00 | website2.com/shamwow | website2.com/buy | P
 2 | 100 | 12:10:00 | website1.com | website2.com/home | V
 2 | 100 | 12:11:00 | website2.com/home | website2.com/forks | V
 2 | 100 | 12:13:00 | website2.com/forks | website2.com/buy | P
(7 rows)

```

## Example

This example includes the HP Vertica pattern matching functions to analyze users' browsing history over website2.com. It identifies patterns where the user performed the following tasks:

- Landed on website2.com from another web site (Entry)
- Browsed to any number of other pages (Onsite)
- Made a purchase (Purchase)

In the following statement, pattern P (Entry Onsite\* Purchase) consist of three event types: Entry, Onsite, and Purchase. When HP Vertica finds a match in the input table, the associated pattern instance must be an event of type Entry followed by 0 or more events of type Onsite, and an event of type Purchase

```

SELECT uid,
 sid,
 ts,
 refurl,
 pageurl,
 action,
 event_name(),
 pattern_id(),
 match_id()
FROM clickstream_log
MATCH

```

```
(PARTITION BY uid, sid ORDER BY ts
 DEFINE
 Entry AS RefURL NOT ILIKE '%website2.com%' AND PageURL ILIKE
'%website2.com%',
 Onsite AS PageURL ILIKE '%website2.com%' AND Action='V',
 Purchase AS PageURL ILIKE '%website2.com%' AND Action = 'P'
 PATTERN
 P AS (Entry Onsite* Purchase)
 RESULTS ALL ROWS);
```

In the output below, the first four rows represent the pattern for user 1's browsing activity, while the following three rows show user 2's browsing habits.

| uid        | sid | ts       | refurl               | pageurl              | action | event_name |   |
|------------|-----|----------|----------------------|----------------------|--------|------------|---|
| pattern_id |     | match_id |                      |                      |        |            |   |
| 1          | 100 | 12:00:00 | website1.com         | website2.com/home    | V      | Entry      | 1 |
|            | 1   |          |                      |                      |        |            |   |
| 1          | 100 | 12:01:00 | website2.com/home    | website2.com/floby   | V      | Onsite     | 1 |
|            | 2   |          |                      |                      |        |            |   |
| 1          | 100 | 12:02:00 | website2.com/floby   | website2.com/shamwow | V      | Onsite     | 1 |
|            | 3   |          |                      |                      |        |            |   |
| 1          | 100 | 12:03:00 | website2.com/shamwow | website2.com/buy     | P      | Purchase   | 1 |
|            | 4   |          |                      |                      |        |            |   |
| 2          | 100 | 12:10:00 | website1.com         | website2.com/home    | V      | Entry      | 1 |
|            | 1   |          |                      |                      |        |            |   |
| 2          | 100 | 12:11:00 | website2.com/home    | website2.com/forks   | V      | Onsite     | 1 |
|            | 2   |          |                      |                      |        |            |   |
| 2          | 100 | 12:13:00 | website2.com/forks   | website2.com/buy     | P      | Purchase   | 1 |
|            | 3   |          |                      |                      |        |            |   |
| (7 rows)   |     |          |                      |                      |        |            |   |

## See Also

MATCH Clause and Pattern Matching Functions in the SQL Reference Manual

**Perl Regular Expressions Documentation** (<http://perldoc.perl.org/perlre.html>)

# Optimizing Query Performance

---

When you submit a query to HP Vertica for processing, the HP Vertica query optimizer automatically chooses a set of operations to compute the requested result. These operations together are called a *query plan*. The choice of operations can drastically affect the run-time performance and resource consumption needed to compute the query results. Depending on the properties of the projections defined in your database, the query optimizer can choose faster and more efficient operations to compute the query results.

This section describes the different operations that the optimizer uses and how you can get the optimizer to use the most efficient operations to compute the results of your query.

**Note:** Database response time depends on factors such as type and size of the application query, database design, data size and data types stored, available computational power, and network bandwidth. Adding nodes to a database cluster does not necessarily improve the system response time for every query, especially if the response time is already short, e.g., less than 10 seconds, or the response time is not hardware bound.

## First Steps for Improving Query Performance

To improve the performance of your queries, take these steps to ensure that the database is optimized for query performance:

### Run Database Designer

Your first step should always be to run Database Designer. Database Designer creates a physical schema for your database that provides optimal query performance. The first time you run Database Designer, create a comprehensive design and make sure Database Designer has relevant sample queries and data on which to base the design. If you develop performance issues later, consider loading additional queries that you run frequently and rerun Database Designer to create a query-specific design.

For more information about running Database Designer, see Using the Database Designer.

When you run Database Designer, choose the **Update Statistics** option. The HP Vertica query optimizer uses statistics about the data to create a query plan. Statistics help the optimizer determine:

- Multiple eligible projections to answer the query
- The best order in which to perform joins
- Data distribution algorithms, such as broadcast and re-segmentation

If your statistics become out of date, run the ANALYZE\_STATISTICS or ANALYZE\_HISTOGRAM function to update statistics for a given schema, table, or column. For more information, see Collecting Database Statistics.

## Check Query Events Proactively

The QUERY\_EVENTS system table identifies whether there are issues with the planning phase of a query. In particular, the following values in the EVENT\_TYPE column might indicate a problem that needs to be addressed:

- PREDICATE OUTSIDE HISTOGRAM: The optimizer encountered a predicate that was false for the entire histogram created by ANALYZE\_STATISTICS or ANALYZE HISTOGRAM.
- NO HISTOGRAM: The optimizer encountered a predicate on a column for which it does not have a histogram.
- MEMORY LIMIT HIT: The optimizer used all its allocated memory creating the query plan. If you see this value, simplify your query instead of increasing the memory allocation.

The QUERY\_EVENTS table also gives a detailed description of each issue and suggests solutions. For more information about this system table, see [QUERY\\_EVENTS](#).

## Review the Query Plan

A query plan is a sequence of step-like paths that the Vertica query optimizer selects to access or alter information in your Vertica database. There are two ways to get information about the query plan:

- Run the EXPLAIN command. Each step (path) represents a single operation that the optimizer uses for its execution strategy.
- Query the QUERY\_PLAN\_PROFILES system table. This table provides detailed execution status for currently running queries. Output from the QUERY\_PLAN\_PROFILES table shows the real-time flow of data and the time and resources consumed for each path in each query plan.

For more information, see [How to get query plan information](#).

## Optimizing Encoding to Improve Query Performance

You can potentially make queries faster by changing the encoding of the columns. Encoding reduces the on-disk size of your data so that the amount of I/O required for queries is reduced, resulting in faster execution times. Make sure that all columns and projections included in the query are using the correct encoding for the data. To do this, take the following steps:

- 1 Run Database Designer to create a query-specific design. Database Designer implements the optimum encoding and projection design.
- 2 After updating the query-specific design, update statistics using the ANALYZE\_STATISTICS function.
- 3 Run EXPLAIN with one or more of the queries you submitted to the design to make sure it is using the new projections.

Alternatively, run DESIGNER\_DESIGN\_PROJECTION\_ENCODINGS to re-evaluate the current encoding and update it if necessary.

## Improving the Compression of FLOAT Columns

If you are seeing slow performance or a large storage footprint with your FLOAT data, evaluate the data and your business needs to see if it can be contained in a NUMERIC column with a precision of 18 digits or less. Converting a FLOAT column to a NUMERIC column can improve data compression, reduce the on-disk size of your database, and improve the performance of queries on that column.

When you define a NUMERIC data type, you specify the precision and the scale; NUMERIC data are exact representations of data. FLOAT data types represent variable precision and approximate values; they take up more space in the database.

Converting FLOAT columns to NUMERIC columns is most effective when:

- The precision of the NUMERIC column is 18 digits or less. Vertica has finetuned the performance of NUMERIC data for the common case of 18 digits of precision. Vertica does not recommend converting FLOAT columns to NUMERIC columns that require a precision of more than 18 digits.
- The precision of the FLOAT values is bounded, and the values will all fall within a specified precision for a NUMERIC column. One example is monetary values like product prices or financial transaction amounts. For example, a column defined as NUMERIC(11,2) can accommodate prices from 0 to a few million dollars and can store cents, and compresses more efficiently than a FLOAT column.

If you try to load a value into a NUMERIC column that exceeds the specified precision, Vertica gives an error and does not load the data. If you assign a value with more decimal digits than the specified scale, the value is rounded to match the specified scale and stored in that column.

For more information, see Numeric Data Types.

## Using Run Length Encoding (RLE) to Improve Query Performance

If you run Database Designer and choose to optimize for loads, which minimizes database footprint, Database Designer applies the most appropriate encodings, including RLE, to columns in order to maximize query performance.

In an HP Vertica database, run length encoding (RLE) replaces sequences (runs) of identical data values in a column with a set of pairs, where each pair represents the value and number of occurrences. For example, a gender column might have 47 instances of F and 56 instances of M. Using RLE, HP Vertica can save disk space by storing the pairs (47, F) and (56, M).

The advantage of RLE is that it reduces disk I/O and results in a smaller storage footprint for the database. Use RLE for low-cardinality columns, where the average repetition count is less than 10. For example, a gender column with 47 F values and 56 M values can benefit from RLE. A gender column with 6 F values and 10 M values, where the average repetition count is 8, does not benefit from RLE.

## Optimizing Projections for Queries with Predicates

If your query contains one or more predicates, you can modify the projections to improve the query's performance, as described in the following two examples.

### Example 1: Queries that Use Date Ranges

This first example shows how to encode data using RLE and change the projection sort order to improve the performance of a query that retrieves all data within a given date range.

Suppose you have a query that looks like this:

```
=> SELECT * FROM trades
 WHERE trade_date BETWEEN '2007-11-01' AND '2007-12-01';
```

To optimize this query, determine whether all of the projections can perform the SELECT operation in a timely manner. Run `SELECT COUNT(*)` statement for each projection, specifying the date range, and note the response time. For example:

```
=> SELECT COUNT(*) FROM [projection_name]
 WHERE trade_date BETWEEN '2007-11-01' AND '2007-12-01';
```

If one or more of the queries is slow, check the uniqueness of the `trade_date` column and determine if it needs to be in the projection's ORDER BY clause and/or can be encoded using RLE. RLE replaces sequences of the same data values within a column by a pair that represents the value and a count. For best results, order the columns in the projection from lowest cardinality to highest cardinality, and use RLE to encode the data in low-cardinality columns.

**Note:** For an example of using sorting and RLE, see Choosing Sort Orders for Low-Cardinality Predicates.

If the number of unique columns is unsorted, or if the average number of repeated rows is less than 10, `trade_date` is too close to being unique and cannot be encoded using RLE. In this case, add a new column to minimize the search scope.

The following example adds a new column `trade_year`:

- 1 Determine if the new column `trade_year` returns a manageable result set. The following query returns the data grouped by `trade_year`:

```
=> SELECT DATE_TRUNC('trade_year', trade_date), COUNT(*)
 FROM trades
 GROUP BY DATE_TRUNC('trade_year', trade_date);
```

- 2 Assuming that `trade_year = 2007` is near 8k, add a column for `trade_year` to the `trades` table. The `SELECT` statement then becomes:

```
=> SELECT * FROM trades
 WHERE trade_year = 2007
 AND trade_date BETWEEN '2007-11-01' AND '2007-12-01';
```

As a result, you have a projection that is sorted on `trade_year`, which can be encoded using RLE.

## Example 2: Queries for Tables with a High-Cardinality Primary Key

This example demonstrates how you can modify the projection to improve the performance of queries that select data from a table with a high-cardinality primary key.

Suppose you have the following query:

```
=> SELECT FROM [table]
 WHERE pk IN (12345, 12346, 12347, ...);
```

Because the primary key is a high-cardinality column, HP Vertica has to search a large amount of data.

To optimize the schema for this query, create a new column named `buckets` and assign it the value of the primary key divided by 10000. In this example, `buckets=(int) pk/10000`. Use the `buckets` column to limit the search scope as follows:

```
=> SELECT FROM [table]
 WHERE buckets IN (1,...)
 AND pk IN (12345, 12346, 12347, ...);
```

Creating a lower cardinality column and adding it to the query limits the search scope and improves the query performance. In addition, if you create a projection where `buckets` is first in the sort order, the query may run even faster.

## Optimizing GROUP BY Queries

This section explains several ways you can design your projections to optimize the performance of your GROUP BY queries.

### Avoiding GROUPBY HASH with Projection Design

If your query contains a GROUP BY clause, HP Vertica computes the result with either the GROUPBY PIPELINED or GROUPBY HASH algorithm.

Both algorithms compute the same results and have similar performance when the query produces a small number of distinct groups (typically a thousand per node in the cluster). For queries that contain a large number of groups, GROUPBY PIPELINED uses less memory and can be faster but is only used when the input data is pre-sorted on the GROUP BY columns.

To improve the performance of a query that has a large number of distinct groups that is currently using the GROUP BY HASH algorithm, you can enable the use of the GROUPBY PIPELINED algorithm, as this section describes.

To determine which algorithm your query is using, run the EXPLAIN statement on the query.

The three conditions described in this section refer to the following schema.

```
CREATE TABLE sortopt (
 a INT NOT NULL,
 b INT NOT NULL,
 c INT,
 d INT
);

CREATE PROJECTION sortopt_p (
 a_proj,
 b_proj,
 c_proj,
 d_proj)
AS SELECT * FROM sortopt
ORDER BY a,b,c
UNSEGMENTED ALL NODES;

INSERT INTO sortopt VALUES(5,2,13,84);
INSERT INTO sortopt VALUES(14,22,8,115);
INSERT INTO sortopt VALUES(79,9,401,33);
```

#### Condition #1

All columns in the query's GROUP BY clause must be included in the projection's sort columns. If even one column in the GROUP BY clause is excluded from the projection's ORDER BY clause, HP Vertica uses GROUPBY HASH instead of GROUPBY PIPELINED:

Given a projection sort order ORDER BY a, b, c:

|                                                                                |                                                                                                                     |
|--------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| GROUP BY a<br>GROUP BY a,b<br>GROUP BY b,a<br>GROUP BY a,b,c<br>GROUP BY c,a,b | The query optimizer uses GROUPBY PIPELINED because columns a, b, and c are included in the projection sort columns. |
| GROUP BY a,b,c,d                                                               | The query optimizer uses GROUPBY HASH because column d is not part of the projection sort columns.                  |

**Condition #2**

If the number of columns in the query's GROUP BY clause is less than the number of columns in the projection's ORDER BY clause, columns in the query's GROUP BY clause must occur *first* in the projection's ORDER BY clause.

Given a projection sort order ORDER BY a, b ,c:

|                                                                                |                                                                                                                  |
|--------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|
| GROUP BY a<br>GROUP BY a,b<br>GROUP BY b,a<br>GROUP BY a,b,c<br>GROUP BY c,a,b | The query optimizer uses GROUPBY PIPELINED because columns a, b, c are included in the projection sort columns.  |
| GROUP BY a,c                                                                   | The query optimizer uses GROUPBY HASH because columns a and c do not occur first in the projection sort columns. |

**Condition #3**

If the columns in a query's GROUP BY clause do not appear first in the projection's ORDER BY clause, then any early-appearing projection sort columns that are missing in the query's GROUP BY clause must be present as single-column constant equality predicates in the query's WHERE clause.

Given a projection sort order ORDER BY a, b, c:

|                                                 |                                                                                                                                                       |
|-------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| SELECT a FROM tab WHERE a = 10<br>GROUP BY b    | The query optimizer uses GROUPBY PIPELINED because all columns preceding b in the projection sort order appear as constant equality predicates.       |
| SELECT a FROM tab WHERE a = 10<br>GROUP BY a, b | The query optimizer uses GROUPBY PIPELINED even if redundant grouping column a is present.                                                            |
| SELECT a FROM tab WHERE a = 10<br>GROUP BY b, c | The query optimizer uses GROUPBY PIPELINED because all columns preceding b and c in the projection sort order appear as constant equality predicates. |
| SELECT a FROM tab WHERE a = 10<br>GROUP BY c, b | The query optimizer uses GROUPBY PIPELINED because all columns preceding b and c in the projection sort order appear as constant equality predicates. |

|                                              |                                                                                                                                                          |
|----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| SELECT a FROM tab WHERE a = 10<br>GROUP BY c | The query optimizer uses GROUPBY HASH because all columns preceding c in the projection sort order do <i>not</i> appear as constant equality predicates. |
|----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|

## Avoiding Resegmentation During GROUP BY Optimization with Projection Design

To compute the correct result of a query that contains a GROUP BY clause, HP Vertica must ensure that all rows with the same value in the GROUP BY expressions end up at the same node for final computation. If the projection design already guarantees the data is segmented by the GROUP BY columns, no resegmentation is required at run time.

To avoid resegmentation, the GROUP BY clause must contain all the segmentation columns of the projection, but it can also contain other columns.

When your query includes a GROUP BY clause and joins, the joins are performed first. The result of the join operation is the input to the GROUP BY clause. The segmentation of those intermediate results may not be consistent with the GROUP BY clause in your query, resulted in resegmentation at run time.

If your query does not include joins, the GROUP BY clauses are processed using the existing database projections.

### Examples

Assume the following projection:

```
CREATE PROJECTION ... SEGMENTED BY HASH(a,b) ALL NODES
```

The following table explains whether or not resegmentation occurs at run time and why.

|                  |                                                                                                                    |
|------------------|--------------------------------------------------------------------------------------------------------------------|
| GROUP BY a       | Requires resegmentation at run time. The query does not contain all the projection segmentation columns.           |
| GROUP BY a, b    | Does not require resegmentation at run time. The GROUP BY clause contains all the projection segmentation columns. |
| GROUP BY a, b, c | Does not require resegmentation at run time. The GROUP BY clause contains all the projection segmentation columns. |
| GROUP BY a+1, b  | Requires resegmentation at run time because of the expression on column a.                                         |

To determine if resegmentation will occur during your GROUP BY query, look at the EXPLAIN plan.

For example, the following plan uses GROUPBY PIPELINED sort optimization and requires resegmentation to perform the GROUP BY calculation:

```
+--GROUPBY PIPELINED (RESEGMENT GROUPS) [Cost: 194, Rows: 10K (NO STATISTICS)]
(PATH ID: 1)
```

The following plan uses GROUPBY PIPELINED sort optimization, but does not require resegmentation:

```
+--GROUPBY PIPELINED [Cost: 459, Rows: 10K (NO STATISTICS)] (PATH ID: 1)
```

## Optimizing DISTINCT in a SELECT Query List

This section describes how to optimize queries that have the DISTINCT keyword in their SELECT list. The techniques for optimizing DISTINCT queries are similar to the techniques for optimizing GROUP BY queries because when processing queries that use DISTINCT, the HP Vertica optimizer rewrites the query as a GROUP BY query.

The examples in this section use the following table:

```
CREATE TABLE table1 (
 a INT,
 b INT,
 c INT
);
```

### If the query has no aggregates in the SELECT list

If your query has no aggregates in the SELECT list, internally, Vertica treats the query as if it uses GROUP BY instead.

For example, you can rewrite the following query:

```
SELECT DISTINCT a, b, c FROM table1;
```

As:

```
SELECT a, b, c FROM table1 GROUP BY a, b, c;
```

For fastest execution, apply the optimization techniques for GROUP BY queries described in [Optimizing GROUP BY Queries](#) (page 394).

### Optimizing COUNT DISTINCT and Other DISTINCT Aggregates

Computing a DISTINCT aggregate generally requires much more work than other aggregates, so if your query can be expressed without DISTINCT aggregates, the query executes faster.

Similarly, a query that uses a single DISTINCT aggregate requires less time and resources to compute than a query with multiple DISTINCT aggregates. Internally, Vertica handles queries with a single DISTINCT aggregate differently from queries with multiple DISTINCT aggregates.

The examples in this section use the following table:

```
CREATE TABLE table1 (
 a INT,
 b INT,
 c INT
);
```

### If the query has a single DISTINCT aggregate

Vertica computes a DISTINCT aggregate by first removing all duplicate values of the aggregate's argument to find the distinct values. Then it computes the aggregate.

For example, you can rewrite the following query:

```
SELECT a, b, COUNT(DISTINCT c) AS dcnt FROM table1 GROUP BY a, b;
```

As:

```
SELECT a, b, COUNT(dcnt) FROM
 (SELECT a, b, c AS dcnt FROM table1 GROUP BY a, b, c)
GROUP BY a, b;
```

For fastest execution, apply the optimization techniques for GROUP By queries.

### If the query has a multiple DISTINCT aggregates

If your query has multiple DISTINCT aggregates, there is no straightforward SQL rewrite that can compute them. The following query cannot easily be rewritten for improved performance:

```
SELECT a, COUNT(DISTINCT b), COUNT(DISTINCT c) AS dcnt FROM table1 GROUP BY a;
```

For a query with multiple DISTINCT aggregates, there is no projection design that can avoid using GROUPBY HASH and resegmenting the data. To improve performance of this query, make sure that it has large amounts of memory available. For more information about memory allocation for queries, see The Resource Manager.

## Optimizing JOIN Queries

When you run a query that references more than one table, HP Vertica may need to do one or both of the following operations to join the tables together:

- Sort the data
- Resegment the data

The following sections provide recommendations for designing your projections and your queries to reduce query run time and improve the performance of queries that perform joins.

### Hash Joins vs. Merge Joins

When processing a join, the HP Vertica optimizer has two algorithms to choose from:

- **Merge join**—If both inputs are pre-sorted on the join column, the optimizer chooses the faster merge join, which also uses less memory. Vertica can only perform merge joins on queries that have `INSERT` and `SELECT` operations.
- **Hash join**—Using the hash join algorithm, HP Vertica uses the smaller (inner) joined table to build an in-memory hash table on the join column. HP Vertica then scans the outer (larger) table and probes the hash table for matches. A hash join has no sort requirement, but it consumes more memory because a hash table is built with the values in the inner table. The cost of performing a hash join is low if the entire hash table can fit in memory, but the cost rises when the hash table is written to disk. The optimizer chooses a hash join when projections are not sorted on the join columns.

The optimizer automatically chooses the most appropriate algorithm given the query and projections in a system. You can facilitate a merge join by adding a projection that is sorted on the join key.

### Optimizing for Merge Joins

To have HP Vertica perform a merge join, which is usually faster than a hash join, design projections where the join key is the first sorted column. HP Vertica also performs a merge join if the join key is second in the sort order, following the column used in the equality predicate. Otherwise, use a subquery to sort the table on the join key before performing the join.

The following projections are ordered by `join_key`, so the `SELECT` statement executes as a merge join:

```
CREATE TABLE first (
 data INT,
 join_key INT
);
```

```
CREATE TABLE second (
 data INT,
```

```
join_key INT
);

CREATE PROJECTION first_p (data, join_key) AS
 SELECT data, join_key FROM first
 ORDER BY join_key;

CREATE PROJECTION second_p (data, join_key) AS
 SELECT data, join_key FROM second
 ORDER BY join_key;

SELECT first.data, second.data FROM first, second
 WHERE first.join_key = second.join_key;
```

You also get a merge join if your query has an equality predicate in your query and the join key immediately follows the column used in the equality predicate, as in the following example. After applying the predicate, the data is sorted by the `join_key` column:

```
CREATE TABLE first (
 data INT,
 join_key INT
);

CREATE TABLE second (
 data INT,
 join_key INT
);

CREATE PROJECTION first_p (data, join_key)
 AS SELECT data, join_key FROM first
 ORDER BY data, join_key;

CREATE PROJECTION second_p (data, join_key)
 AS SELECT data, join_key FROM second
 ORDER BY join_key;

SELECT first.data, second.data FROM first, second
 WHERE first.join_key = second.join_key AND first.data = 5;
```

## Using Equality Predicates to Optimize Joins

Joins run faster if all the columns on the left side of the equality predicate come from one table and all the columns on the right side of the equality predicate come from another table. For example:

```
=> SELECT * FROM T JOIN X WHERE T.a + T.b = X.x1 - X.x2;
```

The following query requires much more work to compute:

```
=> SELECT * FROM T JOIN X WHERE T.a = X.x1 + T.b
```

## Specifying INNER and OUTER Tables to Optimize Joins

To improve the performance of queries that perform joins, make sure that HP Vertica chooses the larger table as the outer (left hand) input by ensuring that any applicable constraints are defined.

## Avoiding Resegmentation During Joins

To improve query performance when you join multiple tables, create projections that are identically segmented on the join keys. These are called *identically-segmented projections (ISPs)*. Identically-segmented projections allow the joins to occur locally on each node without any data movement across the network during query processing.

To determine if the projections are identically-segmented on the query join keys, create a query plan with EXPLAIN. If the query plan contains RESEGMENT or BROADCAST, the projections are not identically segmented.

The HP Vertica optimizer chooses a projection to supply rows for each table in a query. If two chosen projections to be joined are segmented, the optimizer uses their segmentation expressions and the join expressions in the query to determine if the rows are correctly placed to perform the join without any data movement.

**Note:** Executing queries that join identically-segmented projections is relevant for multi-node databases.

### Join Conditions for Identically Segmented Projections (ISPs)

A projection  $p$  is segmented on join columns if all column references in  $p$ 's segmentation expression are a subset of the columns in the join expression.

The following conditions must be true for two segmented projections  $p_1$  of table  $t_1$  and  $p_2$  of table  $t_2$  to participate in a join of  $t_1$  to  $t_2$ :

- The join condition must have the following form:  

$$t_1.j_1 = t_2.j_1 \text{ AND } t_1.j_2 = t_2.j_2 \text{ AND } \dots \text{ } t_1.j_N = t_2.j_N$$
- The join columns must share the same base data type. For example:
  - If  $t_1.j_1$  is an INTEGER,  $t_2.j_1$  can be an INTEGER but it cannot be a FLOAT.
  - If  $t_1.j_1$  is a CHAR(10),  $t_2.j_1$  can be any CHAR or VARCHAR (for example, CHAR(10), VARCHAR(10), VARCHAR(20)), but  $t_2.j_1$  cannot be an INTEGER.
- If  $p_1$  is segmented by an expression on columns  $\{t_1.s_1, t_1.s_2, \dots, t_1.s_N\}$ , each segmentation column  $t_1.s_X$  must be in the join column set  $\{t_1.j_X\}$ .
- If  $p_2$  is segmented by an expression on columns  $\{t_2.s_1, t_2.s_2, \dots, t_2.s_N\}$ , each segmentation column  $t_2.s_X$  must be in the join column set  $\{t_2.j_X\}$ .
- The segmentation expressions of  $p_1$  and  $p_2$  must be structurally equivalent. For example:
  - If  $p_1$  is SEGMENTED BY hash( $t_1.x$ ) and  $p_2$  is SEGMENTED BY hash( $t_2.x$ ),  $p_1$  and  $p_2$  are identically segmented.
  - If  $p_1$  is SEGMENTED BY hash( $t_1.x$ ) and  $p_2$  is SEGMENTED BY hash( $t_2.x + 1$ ),  $p_1$  and  $p_2$  are not identically segmented.
- $p_1$  and  $p_2$  must have the same segment count.
- The assignment of segments to nodes must match. For example, if  $p_1$  and  $p_2$  use an OFFSET clause, their offsets must match.

- If  $p_1$  and  $p_2$  are range segmented, the ranges must be identical.
- If HP Vertica finds projections for  $t_1$  and  $t_2$  that are not identically segmented, the data is redistributed across the network during query run time, as necessary.
- Tip:** If you are creating custom designs, try to use segmented projections for joins whenever possible. See the following section "Designing Identically Segmented Projections for K-Safety".

The following statements create two tables and specify ISP conditions:

```
CREATE TABLE t1 (id INT, x1 INT, y1 INT) SEGMENTED BY HASH(id) ALL NODES;
CREATE TABLE t2 (id INT, x2 INT, y2 INT) SEGMENTED BY HASH(id) ALL NODES;
```

Corresponding to this design, the following syntax shows ISP-supported join conditions:

```
SELECT * FROM t1 JOIN t2 ON t1.id = t2.id; -- ISP
SELECT * FROM t1 JOIN t2 ON t1.id = t2.id AND t1.x1 = t2.x2; -- ISP
SELECT * FROM t1 JOIN t2 ON t1.x1 = t2.x2; -- NOT ISP
SELECT * FROM t1 JOIN t2 ON t1.id = t2.x2; -- NOT ISP
```

## Designing Identically Segmented Projections for K-Safety

For K-safety, if  $A$  and  $B$  are two identically segmented projections, their buddy projections,  $A_{buddy}$  and  $B_{buddy}$ , should also be identically segmented to each other.

The following syntax illustrates suboptimal buddy projection design because the projections are not identically segmented to each other because their OFFSET values differ:

```
CREATE PROJECTION t1_b1 (id, x1, y1)
AS SELECT * FROM t1
SEGMENTED BY HASH(id)
ALL NODES OFFSET 1; CREATE PROJECTION t2_b1 (id, x2, y2)
 AS SELECT * FROM t2
 SEGMENTED BY HASH(id)
 ALL NODES OFFSET 2;
```

The following syntax is another example of suboptimal buddy projection design. The projections are not identically segmented to each other because their segmentation expressions differ, so the projections do not qualify as buddies:

```
CREATE PROJECTION t1_b2 (id, x1, y1)
AS SELECT * FROM t1
SEGMENTED BY HASH(id, x1)
ALL NODES OFFSET 1; CREATE PROJECTION t2_b2 (id, x2, y2)
 AS SELECT * FROM t2
 SEGMENTED BY HASH(id)
 ALL NODES OFFSET 2;
```

Buddy projections can use different sort orders. For details, see Hash Segmentation in the SQL Reference Manual.

### Notes

- HP Vertica recommends that you use Database Designer to create projections, which uses HASH and ALL NODES syntax.
- HP Vertica recommends that all tables use hash segmentation or be replicated.

### See Also

[Partitioning and Segmenting Data](#)

[CREATE PROJECTION](#) in the the SQL Reference Manual



## Optimizing ORDER BY Queries

You can improve the performance of queries that contain only `ORDER BY` clauses if the columns in a projection's `ORDER BY` clause are the same as the columns in the query.

### Pre-sorting Projections to Optimize ORDER BY Clauses

If you define the projection sort order in the `CREATE PROJECTION` statement, the HP Vertica query optimizer does not have to sort projection data before performing certain `ORDER BY` queries.

The following table, `sortopt`, contains the columns `a`, `b`, `c`, and `d`. Projection `sortopt_p` specifies to order on columns `a`, `b`, and `c`.

```
CREATE TABLE sortopt (
 a INT NOT NULL,
 b INT NOT NULL,
 c INT,
 d INT
);

CREATE PROJECTION sortopt_p (
 a_proj,
 b_proj,
 c_proj,
 d_proj)
AS SELECT * FROM sortopt
ORDER BY a,b,c
UNSEGMENTED ALL NODES;

INSERT INTO sortopt VALUES(5,2,13,84);
INSERT INTO sortopt VALUES(14,22,8,115);
INSERT INTO sortopt VALUES(79,9,401,33);
```

Based on this sort order, if a `SELECT * FROM sortopt` query contains one of the following `ORDER BY` clauses, the query does not have to resort the projection:

- `ORDER BY a`
- `ORDER BY a, b`
- `ORDER BY a, b, c`

For example, HP Vertica does not have to resort the projection in the following query because the sort order includes columns specified in the `CREATE PROJECTION..ORDER BY a, b, c` clause, which mirrors the query's `ORDER BY a, b, c` clause:

```
=> SELECT * FROM sortopt ORDER BY a, b, c;
```

| a  | b  | c  | d   |
|----|----|----|-----|
| 5  | 2  | 13 | 84  |
| 14 | 22 | 8  | 115 |

```
79 | 9 | 401 | 33
(3 rows)
```

If you include column `d` in the query, HP Vertica must re-sort the projection data because column `d` was not defined in the `CREATE PROJECTION..ORDER BY` clause. Therefore, the `ORDER BY d` query won't benefit from any sort optimization.

You cannot specify an ASC or DESC clause in the `CREATE PROJECTION` statement's ORDER BY clause. HP Vertica always uses an ascending sort order in physical storage, so if your query specifies descending order for any of its columns, the query still causes HP Vertica to re-sort the projection data. For example, the following query requires HP Vertica to sort the results:

```
=> SELECT * FROM sortopt ORDER BY a DESC, b, c;
 a | b | c | d
-----+---+---+---+
 79 | 9 | 401 | 33
 14 | 22 | 8 | 115
 5 | 2 | 13 | 84
(3 rows)
```

## See Also

[CREATE PROJECTION](#) in the SQL Reference Manual

## Optimizing SQL-99 Analytic Functions

The following sections describe how to optimizing the SQL-99 analytic functions that HP Vertica supports.

### Avoiding Single-Node Execution by Avoiding Empty OVER() Clauses

The `OVER()` clause does not require a windowing clause. If your query uses an analytic function like `SUM(x)` and you specify an empty `OVER()` clause, the analytic function is used as a reporting function, where the entire input is treated as a single partition; the aggregate returns the same aggregated value for each row of the result set. The query executes on a single node, potentially resulting in poor performance.

If you add a `PARTITION BY` clause to the `OVER()` clause, the query executes on multiple nodes, improving its performance.

### NULL Placement by Analytic Functions

By default, projection column values are stored in ascending order, but the placement of NULLs depends on a column's data type.

The analytic `OVER(window_order_clause)` and the SQL `ORDER BY` clause have slightly different semantics:

| <code>OVER(ORDER BY ...)</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <code>(SQL) ORDER BY</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>The analytic <code>window_order_clause</code> sorts data, based on the results of the analytic function, as either ascending (<code>ASC</code>) or descending (<code>DESC</code>) and specifies where NULL values appear in the sorted result as either <code>NULLS FIRST</code> or <code>NULLS LAST</code>.</p> <p>The following is the analytics default sort order and NULL placement:</p> <ul style="list-style-type: none"> <li>▪ If you order <code>ASC</code>, the null placement is <code>NULLS LAST</code>. NULL values appear at the end of the sorted result.</li> <li>▪ If you order <code>DESC</code>, the null placement is <code>NULLS FIRST</code>. NULL values appear at the beginning of the sorted result.</li> </ul> | <p>The SQL <code>ORDER BY</code> clause specifies only ascending or descending order.</p> <p>In HP Vertica, however, default NULL placement depends on that column's data type:</p> <ul style="list-style-type: none"> <li>▪ NUMERIC, INTEGER, DATE, TIME, TIMESTAMP, and INTERVAL columns: <code>NULLS FIRST</code> (NULL values appear at the beginning of a sorted projection.)</li> <li>▪ FLOAT, STRING, and BOOLEAN columns: <code>NULLS LAST</code> (NULL values appear at the end of a sorted projection.)</li> </ul> |

If you do not care about NULL placement in queries that involve analytic computations, or if you know that columns contain no NULL values, specify `NULLS AUTO`—irrespective of data type. HP Vertica chooses the placement that gives the fastest performance. Otherwise, specify `NULLS FIRST` or `NULLS LAST`.

You can carefully formulate queries so HP Vertica can avoid sorting the data and process the query quicker, as illustrated by the following example. HP Vertica sorts inputs from table `t` on column `x`, as specified in the `OVER (ORDER BY)` clause, and then evaluates `RANK()`:

```
=> CREATE TABLE t (
 x FLOAT,
 y FLOAT);

=> CREATE PROJECTION t_p (x, y) AS SELECT * FROM t
 ORDER BY x, y UNSEGMENTED ALL NODES;

=> SELECT x, RANK() OVER (ORDER BY x) FROM t;
```

In the preceding `SELECT` statement, HP Vertica eliminates the `ORDER BY` clause and runs the query quickly because column `x` is a `FLOAT` data type. As a result, the projection sort order matches the analytic default ordering (`ASC + NULLS LAST`). HP Vertica can also avoid having to sort the data when the underlying projection is already sorted.

However, if column `x` is defined as `INTEGER`, HP Vertica must sort the data because the projection sort order for `INTEGER` data types (`ASC + NULLS FIRST`) does not match the default analytic ordering (`ASC + NULLS LAST`). To help HP Vertica eliminate the sort, specify the placement of `NULLs` to match the default ordering:

```
=> SELECT x, RANK() OVER (ORDER BY x NULLS FIRST) FROM t;
```

If column `x` is a `STRING`, the following query eliminates the sort:

```
=> SELECT x, RANK() OVER (ORDER BY x NULLS LAST) FROM t;
```

If you omit `NULLS LAST` in the preceding query, it eliminates the sort because `ASC + NULLS LAST` is the default sort specification for both the analytic `ORDER BY` clause and for string-related columns in HP Vertica.

If you do not care about `NULL` placement in queries that involve analytic computations, or if you know that columns contain no `NULL` values, specify `NULLS AUTO`. In the following query, HP Vertica chooses the placement that gives the fastest performance:

```
=> SELECT x, RANK() OVER (ORDER BY x NULLS AUTO) FROM t;
```

## See Also

- ***Designing Tables to Minimize Run-Time Sorting of NULL Values in Analytic Functions*** (page [407](#))
- ***Using SQL Analytics*** (page [329](#))

## Designing Tables to Minimize Run-Time Sorting of NULL Values in Analytic Functions

By carefully writing queries or creating your design (or both), you can help the HP Vertica query optimizer skip sorting all columns in a table when performing an analytic function, which can improve query performance.

To minimize HP Vertica's need to sort projections during query execution, redefine the `employee` table and specify that NULL values are not allowed in the sort fields:

```
DROP TABLE employee CASCADE;

CREATE TABLE employee
 (empno INT,
 deptno INT NOT NULL,
 sal INT NOT NULL);

CREATE PROJECTION employee_p AS
 SELECT * FROM employee
 ORDER BY deptno, sal;

INSERT INTO employee VALUES(101,10,50000);
INSERT INTO employee VALUES(103,10,43000);
INSERT INTO employee VALUES(104,10,45000);
INSERT INTO employee VALUES(105,20,97000);
INSERT INTO employee VALUES(108,20,33000);
INSERT INTO employee VALUES(109,20,51000);

=> SELECT * FROM employee;
 empno | deptno | sal
-----+-----+-----
 101 | 10 | 50000
 103 | 10 | 43000
 104 | 10 | 45000
 105 | 20 | 97000
 108 | 20 | 33000
 109 | 20 | 51000
(6 rows)

=> SELECT deptno, sal, empno, RANK() OVER
 (PARTITION BY deptno ORDER BY sal)
 FROM employee;

 deptno | sal | empno | ?column?
-----+-----+-----+-----
 10 | 43000 | 103 | 1
 10 | 45000 | 104 | 2
 10 | 50000 | 101 | 3
 20 | 33000 | 108 | 1
 20 | 51000 | 109 | 2
 20 | 97000 | 105 | 3
(6 rows)
```

**Tip:** If you do not care about NULL placement in queries that involve analytic computations, or if you know that columns contain no NULL values, specify `NULLS AUTO` in your queries . HP Vertica attempts to choose the placement that gives the fastest performance. Otherwise, specify `NULLS FIRST` or `NULLS LAST`.

## Optimizing LIMIT Queries with ROW\_NUMBER Predicates

Queries that use the LIMIT Clause with ORDER BY or the SQL-99 analytic function ROW\_NUMBER() return a specific subset of rows in the query result. HP Vertica processes these queries efficiently using *Top-K Optimization*, which is a database query ranking process. Top-K optimization avoids sorting (and potentially writing to disk) an entire data set to find a small number of rows. This can significantly improve query performance.

For example, in the following query, HP Vertica extracts only the three smallest rows from column x:

```
=> SELECT * FROM t1 ORDER BY x LIMIT 3;
```

If table t1 contains millions of rows, it is time consuming to sort all the x values. Instead, HP Vertica keeps track of the smallest three values in x.

**Note:** If you omit the ORDER BY clause, when using the LIMIT clause, the results can be nondeterministic.

Sort operations that precede a **SQL analytics** (page 329) computation benefit from Top-K optimization if the query contains an OVER (ORDER BY) clause and a predicate on the ROW\_NUMBER function, as in the following example:

```
=> SELECT x FROM
 (SELECT *, ROW_NUMBER() OVER (ORDER BY x) AS row
 FROM t1) t2 WHERE row <= 3;
```

The preceding query has the same behavior as the following query, which uses a LIMIT clause:

```
=> SELECT ROW_NUMBER() OVER (ORDER BY x) AS RANK FROM t1 LIMIT 3;
```

You can use ROW\_NUMBER() with the analytic window\_partition\_clause, something you cannot do if you use LIMIT:

```
=> SELECT x, y FROM
 (SELECT *, ROW_NUMBER() OVER (PARTITION BY x ORDER BY y)
 AS row FROM t1) t2 WHERE row <= 3;
```

**Note:** When the OVER() clause includes the window\_partition\_clause, Top-K optimization occurs only when the analytic sort matches the input's sort, for example, if the projection is sorted on columns x and y in table t1.

If you still want to improve the performance of your query, consider using the optimization techniques described in **Optimizing ORDER BY Queries** (page 404).

## Optimizing INSERT-SELECT Operations

There are several ways to optimize an INSERT-SELECT query that has the following format:

```
INSERT /*+direct*/ INTO destination SELECT * FROM source;
```

### Optimizing INSERT-SELECT Queries for Tables with Pre-join Projections

If you have an INSERT-SELECT query where the SELECT clause includes a join, HP Vertica determines the order for the SELECT part using the rules defined in [Hash Joins vs. Merge Joins](#) (page [399](#)). When inserting into a pre-join projection, a join must be performed during the INSERT-SELECT query. If the incoming data is not already sorted correctly for a merge join, add an ORDER BY clause that matches the sort order of the dimension table's projection to the SELECT clause to facilitate the merge join.

To determine whether your query is using a hash join or a merge join, run the EXPLAIN statement on the query.

The following example generates a hash join instead of a merge join for a FK-PK validation when inserting into a pre-join projection:

```
-- Would like to use a MERGE JOIN for FK-PK validation, but getting a HASH JOIN

DROP TABLE f1 CASCADE;
DROP TABLE d1 CASCADE;
DROP TABLE f1_staging CASCADE;

CREATE TABLE f1(a varchar(10) NOT NULL, b varchar(10) NOT NULL);
CREATE TABLE d1(a varchar(10) NOT NULL, b varchar(10) NOT NULL);
CREATE TABLE f1_staging(a varchar(10) NOT NULL, b varchar(10) NOT NULL);

ALTER TABLE d1 ADD CONSTRAINT d1_pk PRIMARY KEY (a, b);
ALTER TABLE f1 ADD CONSTRAINT f1_fk FOREIGN KEY (a, b) references d1 (a, b);

CREATE PROJECTION f1_super(a, b) AS SELECT * FROM f1 ORDER BY a, b;
CREATE PROJECTION d1_super(a, b) AS SELECT * FROM d1 ORDER BY a, b;
CREATE PROJECTION f1_staging_super(a, b) AS SELECT * FROM f1_staging ORDER BY a, b;

CREATE PROJECTION prejoin(f1_a, f1_b, d1_a, d1_b)
AS SELECT f1.a, f1.b, d1.a, d1.b
FROM f1 join d1 on f1.a=d1.a and f1.b=d1.b
ORDER BY d1.a, d1.b;

COPY d1 FROM stdin delimiter ' ' direct;
one one
two two
```

```
\.

COPY f1 FROM stdin delimiter '' direct;
one one
two two
\.

INSERT INTO f1_staging values('one', 'one');

-- Performing HASH JOIN instead of MERGE JOIN

INSERT INTO f1
SELECT f1s.a, f1s.b
FROM f1_staging f1s join d1
on f1s.a=d1.a and f1s.b=d1.b;

-- Adding an ORDER BY clause to force a MERGE JOIN

INSERT INTO f1
SELECT f1s.a, f1s.b
FROM f1_staging f1s join d1
on f1s.a=d1.a and f1s.b=d1.b ORDER BY f1s.a, f1s.b;
```

## Optimizing INSERT-SELECT Queries by Matching Sort Orders

When performing `INSERT-SELECT` operations, to avoid the sort phase of the `INSERT`, make sure that the sort order for the `SELECT` query matches the projection sort order of the target table.

For example, on a single-node database:

```
=> CREATE TABLE source (col1 INT, col2 INT, col3 INT);
=> CREATE PROJECTION source_p (col1, col2, col3)
 AS SELECT col1, col2, col3 FROM source
 ORDER BY col1, col2, col3
 SEGMENTED BY HASH(col3)
 ALL NODES;
=> CREATE TABLE destination (col1 INT, col2 INT, col3 INT);
=> CREATE PROJECTION destination_p (col1, col2, col3)
 AS SELECT col1, col2, col3 FROM destination
 ORDER BY col1, col2, col3
 SEGMENTED BY HASH(col3)
 ALL NODES;
```

The following `INSERT` does not require a sort because the query result has the column order of the projection:

```
=> INSERT /*+direct*/ INTO destination SELECT * FROM source;
```

The following `INSERT` requires a sort because the order of the columns in the `SELECT` statement does not match the projection order:

```
=> INSERT /*+direct*/ INTO destination SELECT col1, col3, col2 FROM source;
```

The following `INSERT` does not require a sort. The order of the columns doesn't match, but the explicit `ORDER BY` causes the output to be sorted by `c1, c3, c2` in HP Vertica:

```
=> INSERT /*+direct*/ INTO destination SELECT col1, col3, col2 FROM source
 GROUP BY col1, col3, col2
 ORDER BY col1, col2, col3 ;
```

## Avoiding Resegmentation of INSERT-SELECT Queries

When performing an INSERT-SELECT operation from a segmented source table to a segmented destination table, segment both projections on the same column to avoid resegmenting the data, as in the following example:

```
CREATE TABLE source (col1 INT, col2 INT, col3 INT);
CREATE PROJECTION source_p (col1, col2, col3) AS
 SELECT col1, col2, col3 FROM source
 SEGMENTED BY HASH(col3) ALL NODES;
```

```
CREATE TABLE destination (col1 INT, col2 INT, col3 INT);
CREATE PROJECTION destination_p (col1, col2, col3) AS
 SELECT col1, col2, col3 FROM destination
 SEGMENTED BY HASH(col3) ALL NODES;
```

```
INSERT /*+direct*/ INTO destination SELECT * FROM source;
```

## Optimizing DELETE and UPDATE Queries

HP Vertica is optimized for query-intensive workloads, so `DELETE` and `UPDATE` queries might not achieve the same level of performance as other queries. A `DELETE` and `UPDATE` operation has to update all projections, so the operation is as slow as the slowest projection. For additional information, see Using `INSERT`, `UPDATE`, and `DELETE`.

The topics that follow discuss best practices for optimizing `DELETE` and `UPDATE` queries in HP Vertica.

## Performance Considerations for DELETE and UPDATE Queries

To improve the performance of your `DELETE` and `UPDATE` queries, consider the following issues:

- **Query performance after large deletes**—A large number of (unpurged) deleted rows can negatively affect query performance.  
To eliminate rows that have been deleted from the result, a query must do extra processing. If 10% or more of the total rows in a table have been deleted, the performance of a query on the table degrades. However, your experience may vary depending on the size of the table, the table definition, and the query. If a table has a large number of deleted rows, consider purging those rows to improve performance. For more information on purging, see Purging Deleted Data.
- **Recovery performance**—Recovery is the action required for a cluster to restore K-safety after a crash. Large numbers of deleted records can degrade the performance of a recovery. To improve recovery performance, purge the deleted rows. For more information on purging, see Purging Deleted Data.
- **Concurrency**—`DELETE` and `UPDATE` take exclusive locks on the table. Only one `DELETE` or `UPDATE` transaction on a table can be in progress at a time and only when no loads (or `INSERTS`) are in progress. `DELETEs` and `UPDATEs` on different tables can be run concurrently.
- **Pre-join projections**—Avoid pre-joining dimension tables that are frequently updated. `DELETE` and `UPDATE` operations on pre-join projections cascade to the fact table, causing large `DELETE` or `UPDATE` operations.

For detailed tips about improving `DELETE` and `UPDATE` performance, see *Optimizing Deletes and Updates for Performance* (page [414](#)).

**Caution:** HP Vertica does not remove deleted data immediately but keeps it as history for the purposes of historical query. A large amount of history can result in slower query performance. For information about how to configure the appropriate amount of history to retain, see Purging Deleted Data.

## Optimizing DELETES and UPDATES for Performance

The process of optimizing DELETE and UPDATE queries is the same for both operations. Some simple steps can increase the query performance by tens to hundreds of times. The following sections describe several ways to improve projection design and improve DELETE and UPDATE queries to significantly increase DELETE and UPDATE performance.

**Note:** For large bulk deletion, HP Vertica recommends using Partitioned Tables where possible because they provide the best DELETE performance and improve query performance.

### Projection Column Requirements for Optimized Deletes

When all columns required by the DELETE or UPDATE predicate are present in a projection, the projection is optimized for DELETES and UPDATES. DELETE and UPDATE operations on such projections are significantly faster than on non-optimized projections. Both simple and pre-join projections can be optimized.

For example, consider the following table and projections:

```
CREATE TABLE t (a INTEGER, b INTEGER, c INTEGER);
CREATE PROJECTION p1 (a, b, c) AS SELECT * FROM t ORDER BY a;
CREATE PROJECTION p2 (a, c) AS SELECT a, c FROM t ORDER BY c, a;
```

In the following query, both p1 and p2 are eligible for DELETE and UPDATE optimization because column a is available:

```
DELETE from t WHERE a = 1;
```

In the following example, only projection p1 is eligible for DELETE and UPDATE optimization because the b column is not available in p2:

```
DELETE from t WHERE b = 1;
```

### Optimized Deletes in Subqueries

To be eligible for DELETE optimization, all target table columns referenced in a DELETE or UPDATE statement's WHERE clause must be in the projection definition.

For example, the following simple schema has two tables and three projections:

```
CREATE TABLE tb1 (a INT, b INT, c INT, d INT);
CREATE TABLE tb2 (g INT, h INT, i INT, j INT);
```

The first projection references all columns in tb1 and sorts on column a:

```
CREATE PROJECTION tb1_p AS SELECT a, b, c, d FROM tb1 ORDER BY a;
```

The buddy projection references and sorts on column a in tb1:

```
CREATE PROJECTION tb1_p_2 AS SELECT a FROM tb1 ORDER BY a;
```

This projection references all columns in tb2 and sorts on column i:

```
CREATE PROJECTION tb2_p AS SELECT g, h, i, j FROM tb2 ORDER BY i;
```

Consider the following DML statement, which references `tbl1.a` in its WHERE clause. Since both projections on `tbl1` contain column `a`, both are eligible for the optimized DELETE:

```
DELETE FROM tbl1 WHERE tbl1.a IN (SELECT tb2.i FROM tb2);
```

## Restrictions

Optimized Deletes are not supported under the following conditions:

- With pre-join projections on nodes that are down
- With replicated and pre-join projections if subqueries reference the target table. For example, the following syntax is not supported:  

```
DELETE FROM tbl1 WHERE tbl1.a IN (SELECT e FROM tb2, tb2 WHERE tb2.e =
tbl1.e);
```
- With subqueries that do not return multiple rows. For example, the following syntax is not supported:  

```
DELETE FROM tbl1 WHERE tbl1.a = (SELECT k from tb2);
```

## Projection Sort Order for Optimizing Deletes

Design your projections so that frequently-used DELETE or UPDATE predicate columns appear in the sort order of all projections for large Deletes and Updates.

For example, suppose most of the DELETE queries you perform on a projection look like the following:

```
DELETE from t where time_key < '1-1-2007'
```

To optimize the Deletes, make `time_key` appear in the ORDER BY clause of all your projections. This schema design results in better performance of the DELETE operation.

In addition, add additional sort columns to the sort order such that each combination of the sort key values uniquely identifies a row or a small set of rows. For more information, see Choosing Sort Orders for Low Cardinality Predicates. To analyze projections for sort order issues, use the `EVALUATE_DELETE_PERFORMANCE` function.

# **Using External Procedures**

---

An external procedure is a procedure external to HP Vertica that you create, maintain, and store on the server. External procedures are simply executable files such as shell scripts, compiled code, code interpreters, and so on.

## Implementing External Procedures

To implement an external procedure:

- 1 Create an external procedure executable file.  
See **Requirements for External Procedures** (page [418](#)).
- 2 Enable the UID attribute for the file and allow read and execute permission for the group (if the owner is not the database administrator). For example:  
`chmod 4777 helloplanet.sh`
- 3 **Install the external procedure executable file** (page [419](#)).
- 4 **Create the external procedure in HP Vertica** (page [420](#)).

Once a procedure is created in HP Vertica, you can **execute** (page [421](#)) or **drop** (page [422](#)) it, but you cannot alter it.

## Requirements for External Procedures

External procedures have requirements regarding their attributes, where you store them, and how you handle their output. You should also be cognizant of their resource usage.

### Procedure File Attributes

A procedure file must be owned by the database administrator (OS account) or by a user in the same group as the administrator. The procedure file owner cannot be root and must have the set UID attribute enabled and allow read and execute permission for the group if the owner is not the database administrator.

**Note:** The file should end with `exit 0`, and `exit 0` must reside on its own line. This naming convention instructs HP Vertica to return `0` when the script succeeds.

### Handling Procedure Output

HP Vertica does not provide a facility for handling procedure output. Therefore, you must make your own arrangements for handling procedure output, which should include writing error, logging, and program information directly to files that you manage.

### Handling Resource Usage

The HP Vertica resource manager is unaware of resources used by external procedures. Additionally, HP Vertica is intended to be the only major process running on your system. If your external procedure is resource intensive, it could affect the performance and stability of HP Vertica. Consider the types of external procedures you create and when you run them. For example, you might run a resource-intensive procedure during off hours.

### Sample Procedure File

```
#!/bin/bash
echo "hello planet argument: $1" >> /tmp/myprocedure.log
exit 0
```

## Installing External Procedure Executable Files

To install an external procedure, use the Administration Tools from either the graphical user interface or the command line.

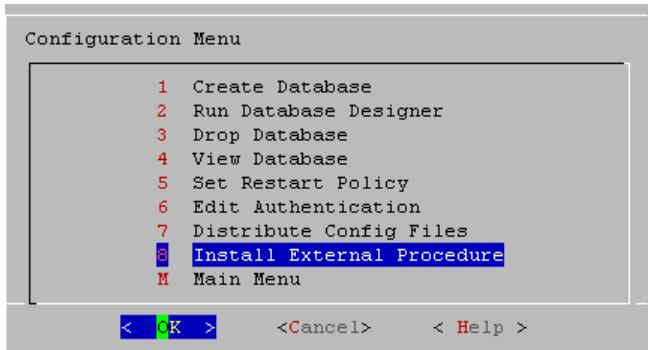
### Graphical User Interface

- 1 Run the Administration Tools.

```
$ /opt/vertica/bin/adminTools
```

- 2 On the AdminTools **Main Menu**, click **Configuration Menu**, and then click **OK**.

- 3 On the **Configuration Menu**, click **Install External Procedure** and then click **OK**.



- 4 Select the database on which you want to install the external procedure.
- 5 Either select the file to install or manually type the complete file path, and then click **OK**.
- 6 If you are not the superuser, you are prompted to enter your password and click **OK**.

The Administration Tools automatically create the

`<database_catalog_path>/procedures` directory on each node in the database and installs the external procedure in these directories for you.

- 7 Click **OK** in the dialog that indicates that the installation was successful.

### Command Line

If you use the command line, be sure to specify the full path to the procedure file and the password of the Linux user who owns the procedure file;

for example:

```
$ admintools -t install_procedure -d vmartdb -f /scratch/helloworld.sh -p
ownerpassword
Installing external procedure...
External procedure installed
```

Once you have installed an external procedure, you need to make HP Vertica aware of it. To do so, use the `CREATE PROCEDURE` statement, but review ***Creating External Procedures*** (page [420](#)) first.

## Creating External Procedures

Once you have installed an external procedure, you need to make HP Vertica aware of it. To do so, use the CREATE PROCEDURE statement.

By default, only a superuser can create and execute a procedure. However, a superuser can grant the right to execute a stored procedure to a user on the operating system. (See GRANT (Procedure).)

Once created, a procedure is listed in the V\_CATALOG.USER\_PROCEDURES system table. Users can see only those procedures that they have been granted the privilege to execute.

### Example

This example creates a procedure named helloplanet for the helloplanet.sh external procedure file. This file accepts one VARCHAR argument. The sample code is provided in **Requirements for External Procedures** (page [418](#)).

```
=> CREATE PROCEDURE helloplanet(arg1 VARCHAR) AS 'helloplanet.sh' LANGUAGE
'external'
 USER 'release';
```

This example creates a procedure named proctest for the copy\_vertica\_database.sh script. This script copies a database from one cluster to another, and it is included in the server RPM located in the /opt/vertica/scripts directory.

```
=> CREATE PROCEDURE proctest(shosts VARCHAR, thosts VARCHAR, dbdir VARCHAR)
 AS 'copy_vertica_database.sh' LANGUAGE 'external' USER 'release';
```

### See Also

CREATE PROCEDURE and GRANT (Procedure) in the SQL Reference Manual

## Executing External Procedures

Once you define a procedure through the `CREATE PROCEDURE` statement, you can use it as a meta command through a simple `SELECT` statement. HP Vertica does not support using procedures in more complex statements or in expressions.

The following example runs a procedure named `helloplanet`:

```
=> SELECT helloplanet('earthlings');
helloplanet

0
(1 row)
```

The following example runs a procedure named `proctest`. This procedure references the `copy_vertica_database.sh` script that copies a database from one cluster to another. It is installed by the server RPM in the `/opt/vertica/scripts` directory.

```
=> SELECT proctest(
 '-s qa01',
 '-t rbench1',
 '-D /scratch_b/qa/PROC_TEST');
```

**Note:** External procedures have no direct access to database data. If available, use ODBC or JDBC for this purpose.

Procedures are executed on the initiating node. HP Vertica runs the procedure by forking and executing the program. Each procedure argument is passed to the executable file as a string. The parent fork process waits until the child process ends.

To stop execution, cancel the process by sending a cancel command (for example, `CTRL+C`) through the client. If the procedure program exits with an error, an error message with the exit status is returned.

### Permissions

To execute an external procedure, the user needs:

- `EXECUTE` privilege on procedure
- `USAGE` privilege on schema that contains the procedure

### See Also

`CREATE PROCEDURE` in the SQL Reference Manual

Procedure Privileges in the Administrator's Guide

## Dropping External Procedures

Only a superuser can drop an external procedure. To drop the definition for an external procedure from HP Vertica, use the DROP PROCEDURE statement. Only the reference to the procedure is removed. The external file remains in the `<database_catalog_path>/procedures` directory on each node in the database.

**Note:** The definition HP Vertica uses for a procedure cannot be altered; it can only be dropped.

### Example

```
=> DROP PROCEDURE helloplanet(arg1 varchar);
```

### See Also

DROP PROCEDURE in the SQL Reference Manual

# Using User-Defined SQL Functions

---

User-Defined SQL Functions let you define and store commonly-used SQL expressions as a function. User-Defined SQL Functions are useful for executing complex queries and combining HP Vertica built-in functions. You simply call the function name you assigned in your query.

A User-Defined SQL Function can be used anywhere in a query where an ordinary SQL expression can be used, except in the table partition clause or the projection segmentation clause.

For syntax and parameters for the commands and system table discussed in this section, see the following topics in the SQL Reference Manual:

- CREATE FUNCTION
- ALTER FUNCTION
- DROP FUNCTION
- GRANT (User Defined Extension)
- REVOKE (User Defined Extension)
- V\_CATALOG.USER\_FUNCTIONS

## Creating User-Defined SQL Functions

A user-defined SQL function can be used anywhere in a query where an ordinary SQL expression can be used, except in the table partition clause or the projection segmentation clause.

To create a SQL function, the user must have CREATE privileges on the schema. To use a SQL function, the user must have USAGE privileges on the schema and EXECUTE privileges on the defined function.

This following statement creates a SQL function called `myzeroifnull` that accepts an `INTEGER` argument and returns an `INTEGER` result.

```
=> CREATE FUNCTION myzeroifnull(x INT) RETURN INT
 AS BEGIN
 RETURN (CASE WHEN (x IS NOT NULL) THEN x ELSE 0 END);
 END;
```

You can use the new SQL function (`myzeroifnull`) anywhere you use an ordinary SQL expression. For example, create a simple table:

```
=> CREATE TABLE tabwnulls(col1 INT);
=> INSERT INTO tabwnulls VALUES(1);
=> INSERT INTO tabwnulls VALUES(NULL);
=> INSERT INTO tabwnulls VALUES(0);

=> SELECT * FROM tabwnulls;
 a

 1
```

```
0
(3 rows)
```

Use the `myzeroifnull` function in a `SELECT` statement, where the function calls `col1` from table `tabwnulls`:

```
=> SELECT myzeroifnull(col1) FROM tabwnulls;
myzeroifnull

 1
 0
 0
(3 rows)
```

Use the `myzeroifnull` function in the `GROUP BY` clause:

```
=> SELECT COUNT(*) FROM tabwnulls GROUP BY myzeroifnull(col1);
count

 2
 1
(2 rows)
```

If you want to change a user-defined SQL function's body, use the `CREATE OR REPLACE` syntax. The following command modifies the `CASE` expression:

```
=> CREATE OR REPLACE FUNCTION myzeroifnull(x INT) RETURN INT
AS BEGIN
 RETURN (CASE WHEN (x IS NULL) THEN 0 ELSE x END);
END;
```

To see how this information is stored in the HP Vertica catalog, see [Viewing Information About SQL Functions](#) (page [426](#)) in this guide.

## See Also

`CREATE FUNCTION` and `USER_FUNCTIONS` in the SQL Reference Manual

## Altering and Dropping User-Defined SQL Functions

HP Vertica allows multiple functions to share the same name with different argument types. Therefore, if you try to alter or drop a SQL function without specifying the argument data type, the system returns an error message to prevent you from dropping the wrong function:

```
=> DROP FUNCTION myzeroifnull();
ROLLBACK: Function with specified name and parameters does not exist:
myzeroifnull
```

**Note:** Only a superuser or owner can alter or drop a SQL Function.

### Altering a user-defined SQL Function

The `ALTER FUNCTION` command lets you assign a new name to a user-defined function, as well as move it to a different schema.

In the previous topic, you created a SQL function called `myzeroifnull`. The following command renames the `myzeroifnull` function to `zerowhennull`:

```
=> ALTER FUNCTION myzeroifnull(x INT) RENAME TO zerowhennull;
ALTER FUNCTION
```

This next command moves the renamed function into a new schema called `macros`:

```
=> ALTER FUNCTION zerowhennull(x INT) SET SCHEMA macros;
ALTER FUNCTION
```

### Dropping a SQL Function

The `DROP FUNCTION` command drops a SQL function from the HP Vertica catalog.

Like with `ALTER FUNCTION`, you must specify the argument data type or the system returns the following error message:

```
=> DROP FUNCTION zerowhennull();
ROLLBACK: Function with specified name and parameters does not exist:
zerowhennull
```

Specify the argument type:

```
=> DROP FUNCTION macros.zerowhennull(x INT);
DROP FUNCTION
```

HP Vertica does not check for dependencies, so if you drop a SQL function where other objects reference it (such as views or other SQL Functions), HP Vertica returns an error when those objects are used, not when the function is dropped.

**Tip:** To view a list of all user-defined SQL functions on which you have `EXECUTE` privileges, (which also returns their argument types), query the `V_CATALOG.USER_FUNCTIONS` system table.

### See Also

`ALTER FUNCTION` and `DROP FUNCTION` in the SQL Reference Manual

## Managing Access to SQL Functions

Before a user can execute a user-defined SQL function, he or she must have `USAGE` privileges on the schema and `EXECUTE` privileges on the defined function. Only the superuser or owner can grant/revoke `EXECUTE` usage on a function.

To grant `EXECUTE` privileges to user Fred on the `myzeroifnull` function:

```
=> GRANT EXECUTE ON FUNCTION myzeroifnull (x INT) TO Fred;
```

To revoke `EXECUTE` privileges from user Fred on the `myzeroifnull` function:

```
=> REVOKE EXECUTE ON FUNCTION myzeroifnull (x INT) FROM Fred;
```

## See Also

GRANT (User Defined Extensions) and REVOKE (User Defined Extensionsn) in the SQL Reference Manual

## Viewing Information About User-Defined SQL Functions

You can access information about any User-Defined SQL Functions on which you have EXECUTE privileges. This information is available in the system table V\_CATALOG.USER\_FUNCTIONS and from the vsql meta-command \df.

To view all of the User-Defined SQL Functions on which you have EXECUTE privileges, query the USER\_FUNCTIONS table:

```
=> SELECT * FROM USER_FUNCTIONS;
-[RECORD 1]-----+-----
schema_name | public
function_name | myzeroifnull
function_return_type | Integer
function_argument_type| x Integer
function_definition | RETURN CASE WHEN (x IS NOT NULL) THEN x ELSE 0 END
volatility | immutable
is_strict | f
```

If you want to change a User-Defined SQL Function's body, use the CREATE OR REPLACE syntax. The following command modifies the CASE expression:

```
=> CREATE OR REPLACE FUNCTION myzeroifnull(x INT) RETURN INT
 AS BEGIN
 RETURN (CASE WHEN (x IS NULL) THEN 0 ELSE x END);
 END;
```

Now when you query the USER\_FUNCTIONS table, you can see the changes in the function\_definition column:

```
=> SELECT * FROM USER_FUNCTIONS;
-[RECORD 1]-----+-----
schema_name | public
function_name | myzeroifnull
function_return_type | Integer
function_argument_type| x Integer
function_definition | RETURN CASE WHEN (x IS NULL) THEN 0 ELSE x END
volatility | immutable
is_strict | f
```

If you use CREATE OR REPLACE syntax to change only the argument name or argument type (or both), the system maintains both versions of the function. For example, the following command tells the function to accept and return a numeric data type instead of an integer for the myzeroifnull function:

```
=> CREATE OR REPLACE FUNCTION myzeroifnull(z NUMERIC) RETURN NUMERIC
 AS BEGIN
 RETURN (CASE WHEN (z IS NULL) THEN 0 ELSE z END);
```

```
END;
```

Now query the `USER_FUNCTIONS` table, and you can see the second instance of `myzeroifnull` in Record 2, as well as the changes in the `function_return_type`, `function_argument_type`, and `function_definition` columns.

**Note:** Record 1 still holds the original definition for the `myzeroifnull` function:

```
=> SELECT * FROM USER_FUNCTIONS;
-[RECORD 1
]-----+
schema_name | public
function_name | myzeroifnull
function_return_type | Integer
function_argument_type | x Integer
function_definition | RETURN CASE WHEN (x IS NULL) THEN 0 ELSE x END
volatility | immutable
is_strict | f
-[RECORD 2
]-----+
schema_name | public
function_name | myzeroifnull
function_return_type | Numeric
function_argument_type | z Numeric
function_definition | RETURN (CASE WHEN (z IS NULL) THEN (0) ELSE z
END)::numeric
volatility | immutable
is_strict | f
```

Because HP Vertica allows functions to share the same name with different argument types, you must specify the argument type when you alter or drop a function. If you do not, the system returns an error message:

```
=> DROP FUNCTION myzeroifnull();
ROLLBACK: Function with specified name and parameters does not exist:
myzeroifnull
```

## See Also

`USER_FUNCTIONS` in the SQL Reference Manual

## Migrating Built-in SQL Functions

If you have built-in SQL functions from another RDBMS that do not map to an HP Vertica-supported function, you can migrate them into your HP Vertica database by using a user-defined SQL function.

The example scripts below show how to create user-defined functions for the following DB2 built-in functions:

- `UCASE()`
- `LCASE()`
- `LOCATE()`

- POSSTR()

### **UCASE()**

This script creates a user-defined SQL function for the UCASE () function:

```
=> CREATE OR REPLACE FUNCTION UCASE (x VARCHAR)
 RETURN VARCHAR
 AS BEGIN
 RETURN UPPER(x);
 END;
```

### **LCASE()**

This script creates a user-defined SQL function for the LCASE () function:

```
=> CREATE OR REPLACE FUNCTION LCASE (x VARCHAR)
 RETURN VARCHAR
 AS BEGIN
 RETURN LOWER(x);
 END;
```

### **LOCATE()**

This script creates a user-defined SQL function for the LOCATE () function:

```
=> CREATE OR REPLACE FUNCTION LOCATE(a VARCHAR, b VARCHAR)
 RETURN INT
 AS BEGIN
 RETURN POSITION(a IN b);
 END;
```

### **POSSTR()**

This script creates a user-defined SQL function for the POSSTR () function:

```
=> CREATE OR REPLACE FUNCTION POSSTR(a VARCHAR, b VARCHAR)
 RETURN INT
 AS BEGIN
 RETURN POSITION(b IN a);
 END;
```

# Developing and Using User Defined Functions

---

User-Defined Functions (UDFs) are functions contained in external shared libraries that you develop in C++, R, or other supported languages, and load into HP Vertica using the CREATE LIBRARY statement. They are best suited for analytic operations that are difficult to perform in SQL, and need to be performed frequently enough that their speed is a major concern.

UDF's primary strengths are:

- They can run almost as fast as HP Vertica's own functions when loaded as a library directly by the HP Vertica server process.
- They can be used much more flexibly than external procedures within SQL statements. Generally, they can be used anywhere an internal function can be used.
- They take full advantage of HP Vertica's distributed computing features. Functions are executed in parallel on each node in the cluster.
- HP Vertica handles the distribution of the UDF library to the individual nodes. You only need to copy the library to the initiator node.
- All of the complicated aspects of developing a distributed piece of analytic code are handled for you by HP Vertica. Your main programming task is to read in data, process it, and then write it out using the HP Vertica SDK APIs.

The only major drawback to UDFs is that when run in "unfenced mode" (directly within the HP Vertica process), poorly-coded UDF's can cause the database to become unstable. Other methods of extending HP Vertica do not carry this risk. External procedures run in a separate process, and are unlikely to cause database stability issues. SQL macros use HP Vertica's own statements and functions and are likewise unlikely to cause stability issues. To avoid causing instability and data loss, you should test your UDF code extensively before deploying it to a production environment.

UDFs also support a limited number of programming languages (C++ and R). External procedures support any programming language that is available on your server hosts.

Since they run on the HP Vertica cluster, you should not use UDF's for highly memory or CPU-intensive tasks. UDFs that do consume lots of computing resources can result in poor database performance. They also should not perform potentially blocking operations (such as network communications), since they would cause the HP Vertica process to block as well.

This chapter explains how to create and use user-defined functions (UDFs).

## How UDFs Work

User Defined Functions are contained in libraries. Multiple functions can be defined in a library, and multiple libraries can be loaded by HP Vertica. You load a library by:

- 1 Copying the library .so file to a location on the initiator node.
- 2 Connecting to the initiator node using vsql.
- 3 Using the CREATE LIBRARY statement, passing it the path where you saved the library file.

The initiator node takes care of distributing the library file to the rest of the nodes in the cluster.

Once the library is loaded, you define individual UDFs using the CREATE FUNCTION SQL statement. This statement assigns SQL function names to the UDF classes in the library. From then on, you are able to use your function within your SQL statements. Whenever you call a UDF, HP Vertica creates an instance of the UDF class on each node in the cluster and passes it data to process.

The CREATE FUNCTION statement adds the UDF to the database catalog. They remain available after a database restart. The database superuser can grant access privileges to the UDFs for users. See GRANT (User Defined Extension) in the SQL Reference Manual for details.

## User Defined Extensions and User Defined Functions

User Defined Extension (UDx) refers to all extensions to HP Vertica developed using the APIs in the HP Vertica SDK. UDxs encompass functions such as User Defined Scalar Functions (UDSFs), and utilities such as the User Defined Load (UDL) feature that let you create custom data load routines.

Thanks to their tight integration with HP Vertica, UDxs usually have better performance than User-defined SQL functions or External Procedures.

User Defined Functions (UDFs) are a specific type of UDx. You use them in SQL statements to process data similarly to HP Vertica's own built-in functions. They give you the power of creating your own functions that run just slightly slower than HP Vertica's own function.

The HP Vertica SDK uses the term UDx extensively, even for APIs that deal exclusively with developing UDFs.

## Types of UDFs

There are five different types of user defined functions:

- User Defined Scalar Functions (UDSFs) take in a single row of data and return a single value. These functions can be used anywhere a native HP Vertica function can be used, except CREATE TABLE BY PARTITION and SEGMENTED BY expressions.
- User Defined Transform Functions (UDTFs) operate on table segments and return zero or more rows of data. The data they return can be an entirely new table, unrelated to the schema of the input table, including having its own ordering and segmentation expressions. They can only be used in the SELECT list of a query. For details see *Using User Defined Transforms* (page [456](#)).
- User Defined Aggregate Functions (UDAf) allow you to create custom aggregate functions specific to your needs. They read one column of data, and return one output column.
- User Defined Analytic Functions (UDAnF) are similar to UDSFs, in that they read a row of data and return a single row. However, the function can read input rows independently of outputting rows, so that the output values can be calculated over several input rows.

- The User Defined Load (UDL) feature allows you to create custom routines to load your data into HP Vertica. You create custom libraries using the HP Vertica SDK to handle various steps in the loading process.

There are many similarities in developing the different types of functions. They can even coexist in the same library. The main difference is the base class you use for your UDF (see **Developing a UDF** (page [434](#)) for details).

## Fenced Mode

User Defined Functions, Transforms, Analytics, Aggregates, etc., (collectively referred to as UDx) can cause issues with HP Vertica if they are not correctly developed. Poorly designed UDx code can result in memory leaks and ultimately bring an HP Vertica node down.

Fenced mode runs UDx code outside of the main HP Vertica process in a separate zygote process. UDx code that crashes while running in fenced mode does not impact the core HP Vertica process. There is a small performance impact when running UDx code in fenced mode. On average, using fenced mode adds about 10% more time to execution compared to unfenced mode.

Fenced mode is currently available for all UDx's with the exception of User Defined Aggregates and User Defined Load.

Using fenced mode does not affect the development of your UDx. Fenced mode is enabled by default for UDx's that support fenced mode. The CREATE FUNCTION command can optionally be issued with the NOT FENCED modifier to disable fenced mode for the function. Also, you can enable or disable fenced mode on any fenced mode-supported C++ UDx by using the ALTER FUNCTION command. **Note:** UDx's created in the R language always run in fenced mode.

### About the Zygote process:

The HP Vertica zygote process starts when HP Vertica starts. Each node has a single zygote process. Side processes are created "on demand". The zygote listens for requests and spawns a UDx side session that runs the UDx in fenced mode when a UDx is called by the user.

### About Fenced Mode Logging:

UDx code that runs in fenced mode is logged in the `UDxZygote.log` and is stored in the `UDxLogs` directory in the catalog directory of HP Vertica. Log entries for the side process are denoted by the UDx language (for example, C++), node, and zygote process ID, and the UdxSideProcess ID.

For example, for the following processes...

```
dbadmin => select * from UDX_FENCED_PROCESSES;
 node_name | process_type | session_id | pid
| port | status
-----+-----+-----+-----+
| v_vmart_node0001 | UDXZygoteProcess | | 27468
| 51900 | UP
| v_vmart_node0001 | UDXSideProcess | localhost.localdoma-27465:0x800b | 5677
| 44123 | UP
```

... the corresponding log file displays:

```
2012-05-16 11:24:43.990 [C++-localhost.localdoma-27465:0x800b-5677]
0x2b3ff17e7fd0 UDx side process started
11:24:43.996 [C++-localhost.localdoma-27465:0x800b-5677] 0x2b3ff17e7fd0
Finished setting up signal handlers.
11:24:43.996 [C++-localhost.localdoma-27465:0x800b-5677] 0x2b3ff17e7fd0 My
port: 44123
11:24:43.996 [C++-localhost.localdoma-27465:0x800b-5677] 0x2b3ff17e7fd0 My
address: 0.0.0.0
11:24:43.996 [C++-localhost.localdoma-27465:0x800b-5677] 0x2b3ff17e7fd0
Vertica port: 51900
11:24:43.996 [C++-localhost.localdoma-27465:0x800b-5677] 0x2b3ff17e7fd0
Vertica address: 127.0.0.1
11:25:19.749 [C++-localhost.localdoma-27465:0x800b-5677] 0x41837940 Setting
memory resource limit to -1
11:30:11.523 [C++-localhost.localdoma-27465:0x800b-5677] 0x41837940 Exiting
UDx side process
```

The last line indicates that the side process was killed. In this case it was killed when the user session (vsq1) closed.

### About Fenced Mode Configuration Parameters:

Fenced mode supports two configuration parameters:

- **FencedUDxMemoryLimitMB** - The maximum memory size, in MB, to use for Fenced Mode processes. The default is -1 (no limit). The side process is killed if this limit is exceeded.
- **ForceUDxFencedMode** - When set to 1, force all UDx's that support fenced mode to run in fenced mode even if their definition specified NOT FENCED. The default is 0 (disabled).

### See also:

- CREATE LIBRARY
- CREATE FUNCTION
- CREATE TRANSFORM FUNCTION
- CREATE ANALYTIC FUNCTION
- ALTER FUNCTION
- UDX\_FENCED\_PROCESSES

## Setting up a UDF Development Environment

You should develop your UDF code on the same Linux platform that you use on your HP Vertica database cluster. This will ensure that your UDF library is compatible with the HP Vertica version deployed on your cluster.

At a minimum, you need to install the following on your development machine:

- **g++** <http://gcc.gnu.org/> and its associated tool chain such as ld. (**Note:** some Linux distributions package g++ separately from gcc.)
- A copy of the HP Vertica SDK. See ***The HP Vertica SDK*** (page [433](#)) for details.

**Note:** The HP Vertica binaries are compiled using the default version of g++ installed on the supported Linux platforms. While other versions of g++ (or even entirely different compilers) may produce compatible libraries, only the platform's default g++ version is supported for compiling UDFs.

While not required, the following additional software packages are highly recommended:

- make, or some other build-management tool.
- gdb or some other debugger.
- Valgrind, or similar tools that detect memory leaks.

You should also have access to a non-production HP Vertica database for testing and debugging. You may want to install a single-node HP Vertica database on your development machine for easier development.

If you want to use any third-party libraries (for example, statistical analysis libraries), you need to install them on your development machine. (If you do not statically link these libraries into your UDF library, you also have to install them on every node in the cluster. See ***Compiling Your UDF*** (page [493](#)) for details.)

## The HP Vertica SDK

The HP Vertica Software Development Kit (SDK) is distributed as part of the server installation. It contains the source and header files you need to create your UDF library, as well as several sample source files that you can use as a basis for your own UDFs.

The SDK files are located in the sdk subdirectory off of the root HP Vertica server directory (usually, /opt/vertica/sdk). This directory contains:

- `include` which contains the headers and source files needed to compile UDF libraries.
- `examples` which contains the source code and sample data for UDF examples.
- `doc` which contains the API documentation for the HP Vertica SDK.

## Running the Examples

See the README file in the examples directory for instructions on compiling and running the examples. Running the examples not only helps you understand how a UDF works, it also helps you ensure your development environment is properly set up to compile UDF libraries.

**Note:** You can copy `/opt/vertica/sdk/examples` to your home directory and run "make" to build the example libraries. You must have a g++ development environment installed. To install a g++ development environment on Red Hat systems, run `yum install gcc gcc-c++ make`.

## Include File Overview

There are two files in the include directory you need when compiling your UDF:

- `Vertica.h` is the main header file for the SDK. Your UDF code needs to include this file in order to find the SDK's definitions.
- `Vertica.cpp` contains support code that needs to be compiled into the UDF library.

Much of the HP Vertica SDK API is defined in the `VerticaUDx.h` header file (which is included by the `Vertica.h` file). If you're curious, you may want to review the contents of this file in addition to reading the API documentation.

## The HP Vertica SDK API Documentation

This documentation only provides a brief overview of the classes and class functions defined by the User Defined Function API. To learn more, see the HP Vertica SDK API. You can find this documentation in two locations:

- In the same directory as the other HP Vertica SDK files: `/opt/vertica/sdk/doc`.
- Included with the full documentation set, available either online or for download. See [Installing HP Vertica Documentation](#) in the Installation Guide.

**Note:** If you are viewing the HTML version of the documentation, you can follow this link to view the SDK API documentation.

## Developing a User Defined Function in C++

To create a User Defined Function (UDF) in C++, you need to create two classes:

- A function class that performs the actual processing you want the UDF to perform.
- A factory class that tells HP Vertica the name of the UDF and its parameters and return values.

The class you use depends on whether you are creating a scalar or transform UDF (see [UDF Types](#) (page 430) for details).

The following sections explain how you develop and compile the code for your UDF.

## HP Vertica C++ SDK Data Types

The HP Vertica SDK has typedefs and classes for representing HP Vertica data types within your UDF code. Using these typedefs ensures data type compatibility between the data your UDF processes and generates and the HP Vertica database. The following table describes some of the typedefs available. Consult *[the HP Vertica SDK API Documentation](#)* (page [434](#)) for a complete list, as well as lists of helper functions to convert and manipulate these data types.

| Type Definition | Description                                                                                                                                                   |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Interval        | An HP Vertica interval                                                                                                                                        |
| IntervalYM      | An HP Vertica year-to-month interval.                                                                                                                         |
| Timestamp       | An HP Vertica timestamp                                                                                                                                       |
| vint            | A standard HP Vertica 64-bit integer                                                                                                                          |
| vint_null       | A null value for integer values                                                                                                                               |
| vbool           | A Boolean value in HP Vertica                                                                                                                                 |
| vbool_null      | A null value for a Boolean data types                                                                                                                         |
| vfloat          | An HP Vertica floating point value                                                                                                                            |
| VString         | String data types (such as varchar and char)<br><b>Note:</b> Do not use a VString object to hold an intermediate result. Use a std::string or char[] instead. |
| VNumeric        | Fixed-point data types from HP Vertica                                                                                                                        |

### Notes

- When making some HP Vertica SDK API calls (such as `VerticaType::getNumericLength`) on objects that have the correct data type. To minimize overhead and improve performance, most of the APIs do not check the data types of the objects on which they are called. Calling a function on an incorrect data type can result in an error.
- A NULL HP Vertica value string data type is converted into an empty C++ string.

## Developing a User Defined Scalar Function

A UDSF function returns a single value for each row of data it reads. It can be used anywhere a built-in HP Vertica function can be used. You usually develop a UDF to perform data manipulations that are too complex or too slow to perform using SQL statements and functions. UDFs also let you use analytic functions provided by third-party libraries within HP Vertica while still maintaining high performance.

The topics in this section guide you through developing a UDSF.

## UDSF Requirements

There are several requirements for your UDSF:

- Your UDSF must return a value for every input row (unless it generates an error, see [Handling Errors](#) (page 514) for details). Failing to return a value for a row will result in incorrect results (and potentially destabilizing the HP Vertica server if not run in **fenced mode**).
- A UDSF cannot have more than 32 arguments.

If you intend your UDSF to run in unfenced mode, it is vital you pay attention to these additional precautions (although fenced-mode UDSFs should follow these guidelines as well).

- Your UDSF must not allow an exception to be passed back to HP Vertica. Doing so could result in a memory leak, as any memory allocated by the exception will not be reclaimed. It is a good practice to use a top-level try-catch block to catch any stray exceptions that may be thrown by your code or any functions or libraries your code calls.
- If your UDSF allocates its own memory, you must make **absolutely sure** it properly frees it. Failing to free even a single byte of allocated memory can have huge consequences if your UDF is called to operate on a multi-million row table. Instead of having your code allocate its own memory, you should use the `vt_alloc` macro, which uses HP Vertica's own memory manager to allocate and track memory. This memory is guaranteed to be properly disposed of when your UDSF completes execution. See [Allocating Resources](#) (page 508) for more information.
- In general, remember that unfenced UDSFs run within the HP Vertica process. Any problems it causes may result in database instability or even data loss.

## UDSF Class Overview

You create your UDSF by subclassing two classes defined by the HP Vertica SDK:

`Vertica::ScalarFunction` and `Vertica::ScalarFunctionFactory`.

The `ScalarFunctionFactory` performs two roles:

- It lists the parameters accepted by the UDSF and the data type of the UDSF's return value. HP Vertica uses this data when you call the CREATE FUNCTION SQL statement to add the function to the database catalog.
- It returns an instance of the UDSF function's `ScalarFunction` subclass that HP Vertica can call to process data.

The `ScalarFunction` class is where you define the `processBlock` function that performs the actual data processing. When a user calls your UDSF function in a SQL statement, HP Vertica bundles together the data from the function parameters and sends it to the `processBlock` statement.

The input and output of the `processBlock` function are supplied by objects of the `Vertica::BlockReader` and `Vertica::BlockWriter` class. They define functions that you use to read the input data and write the output data for your UDSF.

In addition to `processBlock`, the `ScalarFunction` class defines two optional class functions that you can implement to allocate and free resources: `setup` and `destroy`. You should use these class functions to allocate and deallocate resources that you do not allocate through the UDF API (see [Allocating Resources](#) (page 508) for details).

## The ServerInterface Class

All of the class functions that you will define in your UDSF receive an instance of the `ServerInterface` class as a parameter. This object is used by the underlying HP Vertica SDK code to make calls back into the HP Vertica process. For example, the macro you use to instantiate a member of your `ScalarFunction` subclass (`vt_createFuncObj`) needs a pointer to this object to be able to ask HP Vertica to allocate the memory for the new object. You generally will not interact with this object directly, but instead pass it along to HP Vertica SDK function and macro calls.

## Subclassing ScalarFunction

The `ScalarFunction` class is the heart of a UDSF. Your own subclass must contain a single class function named `processBlock` that carries out all of the processing that you want your UDSF to perform.

**Note:** While the name you choose for your `ScalarFunction` subclass does not have to match the name of the SQL function you will later assign to it, HP considers making the names the same a best practice.

The following example shows a very basic subclass of `ScalarFunction` called `Add2ints`. As the name implies it adds two integers together, returning a single integer result. It also demonstrates including the main HP Vertica SDK header file (`HP Vertica.h`) and using the HP Vertica namespace. While not required, using the namespace saves you from having to prefix every HP Vertica SDK class reference with `HP Vertica::`.

```
// Include the top-level Vertica SDK file
#include "Vertica.h"

// Using the Vertica namespace means we don't have to prefix all
// class references with Vertica::
using namespace Vertica;

/*
 * ScalarFunction implementation for a UDSF that adds
 * two numbers together.
 */
```

```
class Add2Ints : public ScalarFunction
{
public:

/*
 * This function does all of the actual processing for the UDF.
 * In this case, it simply reads two integer values and returns
 * their sum.
 *
 * The inputs are retrieved via arg_reader
 * The outputs are returned via arg_writer
 */
virtual void processBlock(ServerInterface &srvInterface,
 BlockReader &arg_reader,
 BlockWriter &res_writer)
{
 // While we have input to process
 do
 {
 // Read the two integer input parameters by calling the
 // BlockReader.getIntRef class function
 const vint a = arg_reader.getIntRef(0);
 const vint b = arg_reader.getIntRef(1);
 // Call BlockWriter.setInt to store the output value, which is the
 // two input values added together
 res_writer.setInt(a+b);
 // Finish writing the row, and advance to the next output row
 res_writer.next();
 // Continue looping until there are no more input rows
 }
 while (arg_reader.next());
}
};
```

The majority of the work in developing a UDSF is creating your `processBlock` class function. This is where all of the processing in your function occurs. Your own UDSF should follow the same basic pattern as this example:

- Read in a set of parameters from the `BlockReader` object using data-type-specific class functions.
- Process the data in some manner.
- Output the resulting value using one of the `BlockWriter` class's data-type-specific class functions.
- Advance to the next row of output and input by calling `BlockWriter.next()` and `BlockReader.next()`.

This process continues until there are no more rows data to be read (`BlockReader.next()` returns false).

## Notes

- You must make sure that `processBlock` reads all of the rows in its input and outputs a single value for each row. Failure to do so can corrupt the data structures that HP Vertica reads to get the output of your UDSF. The only exception to this rule is if your `processBlock` function uses the `vt_report_error` macro to report an error back to HP Vertica (see [Handling Errors](#) (page 514) for more). In that case, HP Vertica does not attempt to read the incomplete result set generated by the UDSF.
- Writing too many output rows can cause HP Vertica an out of bounds error.

## Subclassing ScalarFunctionFactory

The `ScalarFunctionFactory` class tells HP Vertica metadata about your User Defined Scalar Function (UDSF): its number of parameters and their data types, as well as the data type of its return value. It also instantiates a member of the UDSF's `ScalarFunction` subclass for HP Vertica.

After defining your factory class, you need to call the `RegisterFactory` macro. This macro instantiates a member of your factory class, so HP Vertica can interact with it and extract the metadata it contains about your UDSF.

The following example shows the `ScalarFunctionFactory` subclass for the example `ScalarFunction` function subclass shown in [Subclassing ScalarFunction](#) (page 437).

```
/*
* This class provides metadata about the ScalarFunction class, and
* also instantiates a member of that class when needed.
*/
class Add2IntsFactory : public ScalarFunctionFactory
{
 // return an instance of Add2Ints to perform the actual addition.
 virtual ScalarFunction *createScalarFunction(ServerInterface &interface)
 {
 // Calls the vt_createFuncObj to create the new Add2Ints class instance.
 return vt_createFuncObj(interface.allocator, Add2Ints);
 }

 // This function returns the description of the input and outputs of the
 // Add2Ints class's processBlock function. It stores this information in
 // two ColumnTypes objects, one for the input parameters, and one for
 // the return value.
 virtual void getPrototype(ServerInterface &interface,
 ColumnTypes &argTypes,
 ColumnTypes &returnType)
 {
 // Takes two ints as inputs, so add ints to the argTypes object
 argTypes.addInt();
 argTypes.addInt();
 // returns a single int, so add a single int to the returnType object.
 // Note that ScalarFunctions *always* return a single value.
 returnType.addInt();
 }
}
```

```
};
```

There are two required class functions you must implement your `ScalarFunctionFactory` subclass:

- `createScalarFunction` instantiates a member of the UDSF's `ScalarFunction` class. The implementation of this function is simple—you just supply the name of the `ScalarFunction` subclass in a call to the `vt_createFuncObj` macro. This macro takes care of allocating and instantiating the class for you.
- `getPrototype` tells HP Vertica about the parameters and return type for your UDSF. In addition to a `ServerInterface` object, this function gets two `ColumnTypes` objects. All you need to do in this function is to call class functions on these two objects to build the list of parameters and the single return value type.

After you define your `ScalarFunctionFactory` subclass, you need to use the `RegisterFactory` macro to make the factory available to HP Vertica. You just pass this macro the name of your factory class.

### The `getReturnType` Function

If your function returns a sized column (a return data type whose length can vary, such as a `varchar`) or a value that requires precision, you need to implement a class function named `getReturnType`. This function is called by HP Vertica to find the length or precision of the data being returned in each row of the results. The return value of this function depends on the data type your `processBlock` function returns:

- `CHAR` or `VARCHAR` return the maximum length of the string.
- `NUMERIC` types specify the precision and scale.
- `TIME` and `TIMESTAMP` values (with or without timezone) specify precision.
- `INTERVAL YEAR TO MONTH` specifies range.
- `INTERVAL DAY TO SECOND` specifies precision and range.

If your UDSF does not return one of these data types, it does not need a `getReturnType` function.

The input to `getReturnType` function is a `SizedColumnTypes` object that contains the input argument types along with their lengths that will be passed to an instance of your `processBlock` function. Your implementation of `getReturnType` has to extract the data types and lengths from this input and determine the length or precision of the output rows. It then saves this information in another instance of the `SizedColumnTypes` class.

The following demonstration comes from one of the UDSF examples that is included with the HP Vertica SDK. This function determines the length of the `VARCHAR` data being returned by a UDSF that removes all spaces from the input string. It extracts the return value as a `VerticaType` object, then uses the `getVarcharLength` class function to get the length of the string.

```
// Determine the length of the varchar string being returned.
virtual void getReturnType(ServerInterface &srvInterface,
 const SizedColumnTypes &argTypes,
 SizedColumnTypes &returnType)
```

```
{
 const VerticaType &t = argTypes.getColumnType(0);
 returnType.addVarchar(t.getVarcharLength());
}
```

## The RegisterFactory Macro

Once you have completed your `ScalarFunctionFactory` subclass, you need to register it using the `RegisterFactory` macro. This macro instantiates your factory class and makes the metadata it contains available for HP Vertica to access. To call this macro, you just pass it the name of your factory class.

```
// Register the factory with HP Vertica
RegisterFactory(Add2IntsFactory);
```

## Setting Null Input and Volatility Behavior

Normally, HP Vertica calls your UDSF for every row of data in the query. There are two cases where HP Vertica could avoid calling your UDSF code:

- If your function returns `NULL` when any parameter is a `NULL`, HP Vertica can just return `NULL` without having to call the function. This optimization is also helpful since you do not need to handle null input parameters in your UDSF code.
- If your function produces the same output value given the same input parameters, HP Vertica can cache the function's return value. If the UDSF is called with the same set of input parameters again, it can return the cached value, rather than calling your UDSF.

Letting HP Vertica know about these behaviors of your function allows it to optimize queries containing your UDSF.

You indicate the volatility and null handling of your function by setting the `vol` and `strict` fields in your `ScalarFunctionFactory` class's constructor.

### Volatility Settings

To indicate your function's volatility, set the `vol` field to one of the following values:

| Value     | Description                                                                                                                                                      |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| VOLATILE  | Repeated calls to the function with the same input parameters always result in different values. HP Vertica always calls volatile functions for each invocation. |
| IMMUTABLE | Calls to the function with the same input parameters always results in the same output.                                                                          |

|                    |                                                                                                                                                                                                                                                                               |
|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| STABLE             | Repeated calls to the function with the same input <i>within the same statement</i> returns the same output. For example, a function that returns the current user name would be stable since the user cannot change within a statement, but could change between statements. |
| DEFAULT_VOLATILITY | The default volatility. This is the same as VOLATILE.                                                                                                                                                                                                                         |

The following example code shows a version of the Add2ints example factory class that makes the function immutable.

```
class Add2intsImmutableFactory : public Vertica::ScalarFunctionFactory
{
 virtual Vertica::ScalarFunction
*createScalarFunction(Vertica::ServerInterface &srvInterface)
 { return vt_createFuncObj(srvInterface.allocator, Add2ints); }

 virtual void getPrototype(Vertica::ServerInterface &srvInterface,
 Vertica::ColumnTypes &argTypes,
 Vertica::ColumnTypes &returnType)
 {
 argTypes.addInt();
 argTypes.addInt();
 returnType.addInt();
 }

public:
 Add2intsImmutableFactory() { vol = IMMUTABLE; }
};

RegisterFactory(Add2intsImmutableFactory);
```

## Null Input Behavior

To indicate how your function reacts to NULL input, set the `strictness` field to one of the following values.

| Value                     | Description                                                               |
|---------------------------|---------------------------------------------------------------------------|
| CALLED_ON_NULL_INPUT      | The function must be called, even if one or more input values are NULL.   |
| RETURN_NULL_ON_NULL_INPUT | The function always returns a NULL value if any of its inputs are NULL.   |
| STRICT                    | A synonym for RETURN_NULL_ON_NULL_INPUT                                   |
| DEFAULT_STRICTNESS        | The default strictness setting. This is the same as CALLED_ON_NULL_INPUT. |

The following example demonstrates setting the null behavior of Add2ints so HP Vertica does not call the function with NULL values.

```
class Add2intsNullOnNullInputFactory : public Vertical::ScalarFunctionFactory
{
 virtual Vertical::ScalarFunction
*createScalarFunction(Vertical::ServerInterface &srvInterface)
 { return vt_createFuncObj(srvInterface.allocator, Add2ints); }

 virtual void getPrototype(Vertical::ServerInterface &srvInterface,
 Vertical::ColumnTypes &argTypes,
 Vertical::ColumnTypes &returnType)
 {
 argTypes.addInt();
 argTypes.addInt();
 returnType.addInt();
 }

public:
 Add2intsNullOnNullInputFactory() {strict = RETURN_NULL_ON_NULL_INPUT; }
};

RegisterFactory(Add2intsNullOnNullInputFactory);
```

## Deploying and Using UDSFs

To deploy a UDSF on your HP Vertica database:

- 1 Copy the UDF shared library file (.so) that contains your function to a node on your HP Vertica cluster.
- 2 Connect to the node where you copied the library (for example, using vsql).
- 3 Use the CREATE LIBRARY statement to load the UDF library into HP Vertica. You pass this statement the location of the UDF library file you copied to the node earlier. HP Vertica distributes the library to each node in the cluster, and each HP Vertica process loads a copy of the library.
- 4 Use the CREATE FUNCTION statement to add the functions to HP Vertica's catalog. This maps a SQL function name to the name of the UDSF's factory class. If you are not sure of the name of the UDSF's factory class, you can list all of the UDFs in the library (see [Listing the UDFs Contained in a Library](#) (page 542) for details).

The following example demonstrates loading the Add2ints UDSF that is included in the SDK examples directory. It assumes that the ScalarFunctions.so library that contains the function has been copied to the dbadmin user's home directory on the initiator node.

```
=> CREATE LIBRARY ScalarFunctions AS
-> '/home/dbadmin/ScalarFunctions.so';
CREATE LIBRARY

=> CREATE FUNCTION Add2Ints AS LANGUAGE 'C++'
```

```
-> NAME 'Add2IntsFactory' LIBRARY ScalarFunctions;
CREATE FUNCTION
```

After creating the Add2ints UDSF, it can be used almost everywhere a built-in function can be used:

```
=> SELECT Add2Ints(27,15);
Add2ints

 42
(1 row)
=> SELECT * FROM MyTable;
 a | b
-----+-----
 7 | 0
 12 | 2
 12 | 6
 18 | 9
 1 | 1
 58 | 4
 450 | 15
(7 rows)

=> SELECT * FROM MyTable WHERE Add2ints(a, b) > 20;
 a | b
-----+-----
 18 | 9
 58 | 4
 450 | 15
(3 rows)
```

## See Also

CREATE LIBRARY and CREATE FUNCTION in the SQL Reference Manual.

## Developing a User Defined Transform Function in C++

A User Defined Transform Function (UDTF) reads one or more arguments (treated as a row of data), and returns zero or more rows of data consisting of one or more columns. The schema of the output table does not need to correspond to the schema of the input table—they can be totally different. The UDTF can return any number of output rows for each row of input.

UDTFs can only be used in the SELECT list that contains just the UDTF call and a required OVER clause.

Unlike other types of User Defined Functions, UDTFs do not have a limit on the number of arguments that they can accept. Most other types of UDFs have a maximum of 32 arguments..

The topics in this section guide you through developing a UDTF.

## UDTF Requirements

There are several requirements for UDTFs:

- UDTF's are run after 'group by', but before the final 'order by', when used in conjunction with 'group by' and 'order by' in a statement.
- The UDTF can produce as little or as many rows as it wants as output. However, each row it outputs must be complete. Advancing to the next row without having added a value for each column results in incorrect results.
- Your UDTF must not allow an exception to be passed back to Vertica. You should use a top-level try-catch block to catch any stray exceptions that may be thrown by your code or any functions or libraries your code calls.
- If your UDTF allocates its own memory, you must make absolutely sure it properly frees it. Failing to free even a single byte of allocated memory can have huge consequences if your UDF is called to operate on a multi-million row table. Instead of having your code allocate its own memory, you should use the `vt_malloc` macro, which uses Vertica's own memory manager to allocate and track memory. This memory is guaranteed to be properly disposed of when your UDTF finishes executing. See **Allocating Resources** (page [508](#)) for more information.
- If you intend your UDTF to run in unfenced mode, you need to ensure it is error-free. Any errors in an unfenced UDF can result in database instability or even data loss.

## UDTF Class Overview

You create your UDTF by subclassing two classes defined by the HP Vertica SDK:  
`Vertica::TransformFunction` and `Vertica::TransformFunctionFactory`.

The `TransformFunctionFactory` performs two roles:

- It provides the number of parameters and their and data types accepted by the UDTF and the number of output columns and their data types UDTF's output. HP Vertica uses this data when you call the CREATE FUNCTION SQL statement to add the function to the database catalog.
- It returns an instance of the UDTF function's `TransformFunction` subclass that HP Vertica can call to process data.

The `TransformFunction` class is where you define the `processPartition` function, which performs the data processing that you want your UDTF to perform. When a user calls your UDTF function in a SQL SELECT statement, HP Vertica sends a partition of data to the `processPartition` statement.

The input and output of the `processPartition` function are supplied by objects of the `Vertica::PartitionReader` and `Vertica::PartitionWriter` class. They define functions that you use to read the input data and write the output data for your UDTF.

In addition to `processPartition`, the `TransformFunction` class defines two optional class functions that you can implement to allocate and free resources: `setup` and `destroy`. You should use these class functions to allocate and deallocate resources that you do not allocate through the UDF API (see **Allocating Resources** (page [508](#)) for details).

## The ServerInterface Class

All of the class functions that you will define in your UDF receive an instance of the `ServerInterface` class as a parameter. This object is used by the underlying HP Vertica SDK code to make calls back into the HP Vertica process. For example, the macro you use to instantiate a member of your `TransformFunction` subclass (`vt_createFuncObj`) needs a pointer to a class function on this object to be able to ask HP Vertica to allocate the memory for the new object. You generally will not interact with this object directly, but instead pass it along to HP Vertica SDK function and macro calls.

## Subclassing TransformFunction

Your subclass of `Vertica::TransformFunction` is where you define the processing you want your UDTF to perform. The only required function in this class is `processPartition`, which reads the parameters sent to your UDTF via a `Vertica::PartitionReader` object, and writes output values to a `Vertica::PartitionWriter` object.

The following example shows a subclass of `TransformFunction` named `StringTokenizer` that breaks input strings into individual words, returning each on its own row. For example:

```
=> SELECT * FROM t;
 text

 row row row your boat
 gently down the stream
(2 rows)

=> SELECT tokenize(text) OVER (partition by text) FROM t;
 words

 gently
 down
 the
 stream
 row
 row
 row
 your
 boat
(9 rows)
```

Notice that the number of rows in the result table (and the name of the results column) are different than the input table. This is one of the strengths of a UDTF.

The following code defines the `StringTokenizer` class.

```

#include "Vertica.h"
#include <sstream>

// Use the Vertica namespace to make referring
// to SDK classes easier.
using namespace Vertica;
using namespace std;

// The primary class for the StringTokenizer UDTF.
class StringTokenizer : public TransformFunction {
 // Called for each partition in the table. Receives the data from
 // The source table and
 virtual void processPartition(ServerInterface &srvInterface,
 PartitionReader &inputReader,
 PartitionWriter &outputWriter) {
 try {
 // Loop through the input rows
 do {
 // Get a single varchar as input.
 const VString &sentence = inputReader.getStringRef(0);
 // If input string is NULL, then output is NULL as well
 if (sentence.isNull())
 {
 VString &word = outputWriter.getStringRef(0);
 word.setNull();
 outputWriter.next();
 }
 else
 {
 // Otherwise, let's tokenize the string and output the words
 std::string tmp = sentence.str();
 istringstream ss(tmp);

 do
 {
 std::string buffer;
 ss >> buffer;

 // Copy to output
 if (!buffer.empty()) {
 VString &word = outputWriter.getStringRef(0);
 word.copy(buffer);
 outputWriter.next();
 }
 } while (ss);
 }
 } while (inputReader.next()); // Loop until no more input rows
 } catch (exception& e) {
 // Standard exception. Quit.
 vt_report_error(0, "Exception while processing partition: [%s]",
e.what());
 }
 }
};

```

The `processPartition` function in this example follows a pattern that you will follow in your own UDTF: it loops over all rows in the table partition that HP Vertica sends it, processing each row. For UDTF's you do not have to actually process every row. You can exit your function without having read all of the input without any issues. You may choose to do this if your UDTF is performing some sort search or some other operation where it can determine that the rest of the input is unneeded.

## Extracting Parameters

The first task your UDTF function needs to perform in its main loop is to extract its parameters. You call a data-type specific function in the `PartitionReader` object to extract each input parameter. All of these functions take a single parameter: the column number in the input row that you want to read. In this example, `processPartition` extracts the single `VString` `.../SDK/html/class_vertica_1_1_v_string.htm` input parameter from the `PartitionReader` object. The `VString` class represents an HP Vertica string value (VARCHAR or CHAR).

In more complex UDTFs, you may need to extract multiple values. This is done the same way as shown in the example, calling the data-type specific function to extract the value of each column in the input row.

**Note:** In some cases, you may want to determine the number and types of parameters using `PartitionReader`'s `getNumCols` and `getTypeMetaData` functions, instead of just hard-coding the data types of the columns in the input row. This is useful if you want your `TransformFunction` to be able to process input tables with different schemas. You can then use different `TransformFunctionFactory` classes to define multiple function signatures that call the same `TransformFunction` class. See **[Subclassing TransformFunctionFactory](#)** (page 449) for more information.

## Handling Null Values

When developing UDTFs, you often need to handle NULL input values in a special manner. In this example, a NULL input value results in a NULL output value, which is handled as a special case. After writing a NULL to the output, `processPartition` moves on to the next input row.

## Processing Input Values

After handling any NULL values, the `processPartition` shown in the example moves on to performing the actual processing. It breaks the string into individual words and adds each word to its own row in the output.

## Writing Output

After your UDTF has performed its processing, it may need to write output. Unlike a UDSF, outputting data is optional for a UDTF. However, if it does write output, it must supply values for all of the output columns you defined for your UDTF (see **[Subclassing TransformFunctionFactory](#)** (page 449) for details on how you specify the output columns of your UDTF). There are no default values for your output. If you want to output a NULL value in one of the columns, you must explicitly set it.

Similarly to reading input columns, there are function on the `PartitionWriter` object for writing each type of data to the output row. In this case, the example calls the `PartitionWriter` object's `getStringRef` function to allocate a new `VString` object to hold the word it needs to output. Once it has copied the buffer containing the word, the example calls `PartitionWriter.next()` to complete the output row.

### Advancing to the Next Input Row

In most UDTFs, processing will continue until all of the rows of input have been read. You advance to the next row by calling `ProcessReader.next()`. This function returns true if there is another row of input data to process and false if all the data in the partition has been read. Once the input rows are exhausted, your UDTF usually exits so its results are returned back to HP Vertica.

### Subclassing TransformFunctionFactory

Your subclass of the `TransformFunctionFactory` provides metadata about your UDTF to HP Vertica. Included in this information is the function's name, number and data type of parameters, and the number and data types of output columns.

There are three required functions you need to implement in your `TransformFunctionFactory`:

- `getPrototype` returns two `ColumnTypes` objects that describe the columns your UDTF takes as input and returns as output.
- `createTransformFunction` instantiates a member of your `TransformFunction` subclass that HP Vertica can call to process data.
- `getReturnType` tells HP Vertica details about the output values: the width of variable sized data types (such as `VARCHAR`) and the precision of data types that have settable precision (such as `TIMESTAMP`). You can also set the names of the output columns using in this function.

**Note:** The `getReturnType` function is optional for User Defined Scalar Functions since they do not return a table, and therefore do not require column names. It is required for UDTFs.

The following example shows the factory class that corresponds to the `TransformFunction` subclass shown in ***Subclassing TransformFunction*** (page [446](#)).

```
class TokenFactory : public TransformFunctionFactory {
 // Tell Vertica that StringTokenizer reads in a row with 1 string,
 // and returns a row with 1 string
 virtual void getPrototype(ServerInterface &srvInterface, ColumnTypes
 &argTypes, ColumnTypes &returnType) {
 argTypes.addVarchar();
 returnType.addVarchar();
 }
 // Tell Vertica the maximum return string length will be, given the input
 // string length. Also names the output column. This function is only
 // necessary for columns that have a variable size (i.e. strings) or
 // have to report their precision.
 virtual void getReturnType(ServerInterface &srvInterface,
 const SizedColumnTypes &input_types,
 SizedColumnTypes &output_types) {
 int input_len = input_types.getColumnType(0).getStringLength();
 // Output size will never be more than the input size
 // Also sets the name of the output column.
 output_types.addVarchar(input_len, "words");
 }
 virtual TransformFunction *createTransformFunction(ServerInterface
 &srvInterface) {
 return vt_createFuncObj(srvInterface.allocator, StringTokenizer);
 }
};
```

The `getPrototype` function is straightforward. You call functions on the `ColumnTypes` objects to set the data types of the input and output columns for your function. In this example, the UDTF takes a single `VARCHAR` column as input and returns a single `VARCHAR` column as output, so it calls the `addVarchar()` function on both of the `ColumnTypes` objects. See the `ColumnTypes` entry in the HP Vertica API documentation for a full list of the data type functions you can call to set input and output column types.

The `getReturnType` function is similar to `getPrototype`, but instead of returning just the data types of the output columns, this function returns the precision of data types that require it (`INTERVAL`, `INTERVAL YEAR TO MONTH`, `TIMESTAMP`, `TIMESTAMP WITH TIMEZONE`, or `VNumeric`) or the maximum length of variable-width columns (`VARCHAR`). This example just returns the length of the input string, since the output will never be longer than the input string. It also sets the name of the output column to "words."

**Note:** You do not have to supply a name for an output column in this function, since the column name has a default value of "". However, if you do not supply a column name here, the SQL statements that call your UDTF must provide aliases for the unnamed columns or they will fail with an error message. From a usability standpoint, its easier for you to supply the column names here once, rather than to force all of the users of your function to supply their own column names for each call to the UDTF.

`createTransformFunction` is essentially boilerplate code. It just calls the `vt_returnFuncObj` macro with the name of the `TransformFunction` class associated with this factory class. This macro takes care of instantiating a copy of the `TransformFunction` class that HP Vertica can use to process data.

## Registering the UDTF Factory Subclass

The final step in creating your UDTF is to call the `RegisterFactory` macro. This macro ensures that your factory class is instantiated when HP Vertica loads the shared library containing your UDTF. Having your factory class instantiated is the only way that HP Vertica can find your UDTF and determine what its inputs and outputs are.

The `RegisterFactory` macro just takes the name of your factory class:

```
RegisterFactory(TokenFactory);
```

## Creating Multi-phase UDTFs

Multi-phase UDTFs let you break your data processing into multiple steps. Using this feature, your UDTFs can perform processing in a way similar to Hadoop or other MapReduce frameworks. You can use the first phase to break down and gather data, and then use subsequent phases to process the data. For example, the first phase of your UDTF could extract specific types of user interactions from a web server log stored in the column of a table, and subsequent phases could perform analysis on those interactions.

Multi-phase UDTFs also let you decide where processing should occur: locally on each node, or throughout the cluster. If your multi-phase UDTF is like a MapReduce process, you want the first phase of your multi-phase UDTF to process data that is stored locally on the node where the instance of the UDTF is running. This prevents large segments of data from being copied around the HP Vertica cluster. Depending on the type of processing being performed in later phases, you may choose to have the data segmented and distributed across the HP Vertica cluster.

Each phase of the UDTF is the same as a traditional (single-phase) UDTF: it receives a table as input, and generates a table as output. The schema for each phase's output does not have to match its input, and each phase can output as many or as few rows as it wants. You create a subclass of `TransformFunction` to define the processing performed by each stage. If you already have a `TransformFunction` from a single-phase UDTF that performs the processing you want a phase of your multi-phase UDTF to perform, you can easily adapt it to work within the multi-phase UDTF.

What makes a multi-phase UDTF different from a traditional UDTF is the factory class you use. You define a multi-phase UDTF using a subclass of `MultiPhaseTransformFunctionFactory`, rather than the `TransformFunctionFactory`. This factory class acts as a container for all of the phases in your multi-step UDTF. It provides HP Vertica with the input and output requirements of the entire multi-phase UDTF (through the `getPrototype` function), and a list of all the phases in the UDTF.

Within your subclass of the `MultiPhaseTransformFunctionFactory` class, you define one or more subclasses of `TransformFunctionPhase`. These classes fill the same role as `TransformFunctionFactory` class for each phase in your multi-phase UDTF. They define the input and output of each phase and create instances of their associated `TransformFunction` classes to perform the processing for each phase of the UDTF. In addition to these subclasses, your `MultiPhaseTransformFunctionFactory` includes fields that provide a handle to an instance of each of the `TransformFunctionPhase` subclasses.

The following code fragment is from the `InvertedIndex` UDTF example distributed with the HP Vertica SDK. It demonstrates subclassing the `MultiPhaseTransformFunctionFactory` including two `TransformFunctionPhase` subclasses that defines the two phases in this UDTF.

```

class InvertedIndexFactory : public MultiPhaseTransformFunctionFactory
{
public:
 /**
 * Extracts terms from documents.
 */
 class ForwardIndexPhase : public TransformFunctionPhase
 {
 virtual void getReturnType(ServerInterface &srvInterface,
 const SizedColumnTypes &inputTypes,
 SizedColumnTypes &outputTypes)
 {
 // Sanity checks on input we've been given.
 // Expected input: (doc_id INTEGER, text VARCHAR)
 vector<size_t> argCols;
 inputTypes.getArgumentColumns(argCols);

 if (argCols.size() < 2 ||
 !inputTypes.getColumnType(argCols.at(0)).isInt() ||
 !inputTypes.getColumnType(argCols.at(1)).isVarchar())
 vt_report_error(0, "Function only accepts two arguments"
 "(INTEGER, VARCHAR)");

 // Output of this phase is:
 // (term_freq INTEGER) OVER(PBY term VARCHAR OBY doc_id INTEGER)

 // Number of times term appears within a document.
 outputTypes.addInt("term_freq");

 // Add analytic clause columns: (PARTITION BY term ORDER BY doc_id).

 // The length of any term is at most the size of the entire document.
 outputTypes.addVarcharPartitionColumn(
 inputTypes.getColumnType(argCols.at(1)).getStringLength(),
 "term");

 // Add order column on the basis of the document id's data type.
 outputTypes.addOrderColumn(inputTypes.getColumnType(argCols.at(0)),
 "doc_id");
 }

 virtual TransformFunction *createTransformFunction(ServerInterface
 &srvInterface)
 { return vt_createFuncObj(srvInterface.allocator, ForwardIndexBuilder); }
 };

 /**
 * Constructs terms' posting lists.
 */
 class InvertedIndexPhase : public TransformFunctionPhase
 {
 virtual void getReturnType(ServerInterface &srvInterface,
 const SizedColumnTypes &inputTypes,
 SizedColumnTypes &outputTypes)

```

```
{
 // Sanity checks on input we've been given.
 // Expected input:
 // (term_freq INTEGER) OVER(PBY term VARCHAR OBY doc_id INTEGER)
 vector<size_t> argCols;
 inputTypes.getArgumentColumns(argCols);
 vector<size_t> pByCols;
 inputTypes.getPartitionByColumns(pByCols);
 vector<size_t> oByCols;
 inputTypes.getOrderByColumns(oByCols);

 if (argCols.size() != 1 || pByCols.size() != 1 || oByCols.size() != 1
 ||
 !inputTypes.getColumnType(argCols.at(0)).isInt() ||
 !inputTypes.getColumnType(pByCols.at(0)).isVarchar() ||
 !inputTypes.getColumnType(oByCols.at(0)).isInt())
 vt_report_error(0, "Function expects an argument (INTEGER) with "
 "analytic clause OVER(PBY VARCHAR OBY INTEGER)");

 // Output of this phase is:
 // (term VARCHAR, doc_id INTEGER, term_freq INTEGER, corp_freq
 INTEGER).

 outputTypes.addVarchar(inputTypes.getColumnType(
 pByCols.at(0)).getStringLength(), "term");
 outputTypes.addInt("doc_id");

 // Number of times term appears within the document.
 outputTypes.addInt("term_freq");

 // Number of documents where the term appears in.
 outputTypes.addInt("corp_freq");
}

virtual TransformFunction *createTransformFunction(ServerInterface
 &srvInterface)
{ return vt_createFuncObj(srvInterface.allocator, InvertedIndexBuilder);
}
};

ForwardIndexPhase fwardIdxPh;
InvertedIndexPhase invIdxPh;

virtual void getPhases(ServerInterface &srvInterface,
 std::vector<TransformFunctionPhase *> &phases)
{
 fwardIdxPh.setPrepass(); // Process documents wherever they're originally
 stored.
 phases.push_back(&fwardIdxPh);
 phases.push_back(&invIdxPh);
}

virtual void getPrototype(ServerInterface &srvInterface,
 ColumnTypes &argTypes,
```

```

 ColumnTypes &returnType)
{
 // Expected input: (doc_id INTEGER, text VARCHAR).
 argTypes.addInt();
 argTypes.addVarchar();

 // Output is: (term VARCHAR, doc_id INTEGER, term_freq INTEGER, corp_freq
 INTEGER)
 returnType.addVarchar();
 returnType.addInt();
 returnType.addInt();
 returnType.addInt();
}
};

RegisterFactory(InvertedIndexFactory);

```

Most of the code in this example is similar to the the code in a `TransformFunctionFactory` class:

- Both `TransformFunctionPhase` subclasses implement the `getReturnType` function, which describes the output of each stage. This is the similar to the `getPrototype` function from the `TransformFunctionFactory` class. However, this function also lets you control how the data is partitioned and ordered between each phase of your multi-phase UDTF.

The first phase calls `SizedColumnTypes::addVarcharPartitionColumn` (rather than just `addVarcharColumn`) to set the phase's output table to be partitioned by the column containing the extracted words. It also calls `SizedColumnTypes::addOrderColumn` to order the output table by the document ID column. It calls this function instead of one of the data-type-specific functions (such as `addIntOrderColumn`

[http://SDK/html/class\\_vertica\\_1\\_1\\_sized\\_column\\_types.htm#a07d4b8cebb4cad1892d4bb180910a0d](http://SDK/html/class_vertica_1_1_sized_column_types.htm#a07d4b8cebb4cad1892d4bb180910a0d)) so it can pass the data type of the original column through to the output column.

**Note:** Any order by column or partition by column set by the final phase of the UDTF in its `getReturnType` function is ignored. Its output is returned to the initiator node rather than partitioned and reordered then sent to another phase.

- The `MultiPhaseTransformFunctionFactory` class implements the `getPrototype` function, that defines the schemas for the input and output of the multi-phase UDTF. This function is the same as the `TransformFunctionFactory::getPrototype` function.

The unique function implemented by the `MultiPhaseTransformFunctionFactory` class is `getPhases`. This function defines the order in which the phases are executed. The fields that represent the phases are pushed into this vector in the order they should execute.

The `MultiPhaseTransformFunctionFactory.getPhase` function is also where you flag the first phase of the UDTF as operating on data stored locally on the node (called a "pre-pass" phase) rather than on data partitioned across all nodes. Using this option increases the efficiency of your multi-phase UDTF by avoiding having to move significant amounts of data around the HP Vertica cluster.

**Note:** Only the first phase of your UDTF can be a pre-pass phase. You cannot have multiple pre-pass phases, and no later phase can be a pre-pass phase.

To mark the first phase as pre-pass, you call the `TransformFunctionPhase::setPrepass` function of the first phase's `TransformFunctionPhase` instance from within the `getPhase` function.

### Notes

- You need to ensure that the output schema of each phase matches the input schema expected by the next phase. In the example code, each `TransformFunctionPhase::getReturnType` implementation performs a sanity check on its input and output schemas. Your `TransformFunction` subclasses can also perform these checks in their `processPartition` function.
- There is no built-in limit on the number of phases that your multi-phase UDTF can have. However, more phases use more resources. When running in fenced mode, HP Vertica may terminate UDTFs that use too much memory. See **UDF Resource Use** (page [507](#)).

## Deploying and Using User Defined Transforms

To deploy a UDTF on your HP Vertica database:

- 1 Copy the UDF shared library file (`.so`) that contains your function to a node on your HP Vertica cluster.
- 2 Connect to the node where you copied the library (for example, using `vsql`).
- 3 Use the `CREATE LIBRARY` statement to load the UDF library into HP Vertica. You pass this statement the location of the UDF library file you copied to the node earlier. HP Vertica distributes the library to each node in the cluster.
- 4 Use the `CREATE TRANSFORM FUNCTION` statement to add the function to the HP Vertica catalog. This maps a SQL function name to the name of the UDF's factory class. If you are not sure of the name of the UDF's factory class, you can list all of the UDFs in the library (see **Listing the UDFs Contained in a Library** (page [542](#)) for details).

The following example demonstrates loading the `Tokenize` UDTF that is included in the SDK examples directory. It assumes that the `TransformFunctions.so` library that contains the function has been copied to the `dbadmin` user's home directory on the initiator node.

```
=> CREATE LIBRARY TransformFunctions AS
-> '/home/dbadmin/TransformFunctions.so';
CREATE LIBRARY
=> CREATE TRANSFORM FUNCTION tokenize
-> AS LANGUAGE 'C++' NAME 'TokenFactory' LIBRARY TransformFunctions;
CREATE TRANSFORM FUNCTION
=> CREATE TABLE T (url varchar(30), description varchar(2000));
CREATE TABLE
=> INSERT INTO T VALUES ('www.amazon.com', 'Online retail merchant and provider of
cloud services');
 OUTPUT

 1
(1 row)
```

```
=> INSERT INTO T VALUES ('www.hp.com','Leading provider of computer hardware and
imaging solutions');
OUTPUT

 1
(1 row)

=> INSERT INTO T VALUES ('www.vertica.com','World''s fastest analytic database');
OUTPUT

 1
(1 row)

=> COMMIT;
COMMIT
=> -- Invoke the UDT
=> SELECT url, tokenize(description) OVER (partition by url) FROM T;
 url | words
-----+-----
www.amazon.com | Online
www.amazon.com | retail
www.amazon.com | merchant
www.amazon.com | and
www.amazon.com | provider
www.amazon.com | of
www.amazon.com | c
www.amazon.com | loud
www.amazon.com | services
www.hp.com | Leading
www.hp.com | provider
www.hp.com | of
www.hp.com | computer
www.hp.com | hardware
www.hp.com | and
www.hp.com | im
www.hp.com | aging
www.hp.com | solutions
www.vertica.com | World's
www.vertica.com | fastest
www.vertica.com | analytic
www.vertica.com | database
(22 rows)
```

## UDTF Query Restrictions

A query that includes a UDTF cannot contain:

- any statements other than the SELECT statement containing the call to the UDTF and a PARTITION BY expression.
- any other analytic function.
- a call to another UDTF.
- a TIMESERIES clause.

- a pattern matching clause.
- a **gap filling and interpolation** (page [369](#)) clause.

## Partitioning by Data Stored on Nodes

UDTFs usually need to process data partitioned in a specific way. For example, a UDTF may process a web server log file to determine how many hits were referred from each partner web site. This UDTF needs to have its input partitioned by a referrer column, so that each instance of the UDTF sees the hits generated by a particular partner so it can total the number of hits. When you execute this UDTF, you supply a PARTITION BY clause to partition data in this way—each node in the HP Vertica database partitions the data it stores, sends some of these partitions off to other nodes, and then consolidates the partitions it receives from other nodes runs an instance of the UDTF to process them.

If your UDTF does not need to process data partitioned in a particular way, you can make its processing much more efficient by eliminating the overhead of partitioning the data. Instead, each instance of the UDTF processes just the data that is stored locally by the node on which it is running. As long as your UDTF does not need to see data partitioned in any particular manner (for example, a UDTF that parses data out of an Apache log file), you can tremendously speed up its processing using this option.

You tell your UDTF to only process local data by using the PARTITION AUTO clause, rather than specifying a column or expression to use to partition the data. For example, to call a UDTF that parses a locally-stored Apache log file, you could use the following statement:

```
SELECT ParseLogFile('/data/apache/log*') OVER (PARTITION AUTO);
```

## Using PARTITION AUTO to Process Local Data

UDTFs usually need to process data partitioned in a specific way. For example, a UDTF that processes a web server log file to count the number of hits referred by each partner web site UDTF needs to have its input partitioned by a referrer column. Each instance of the UDTF sees the hits referred by a particular partner site so it can count them. When you execute this UDTF, you supply a PARTITION BY clause to partition data in this way—each node in the HP Vertica database partitions the data it stores, sends some of these partitions off to other nodes, and then consolidates the partitions it receives from other nodes runs an instance of the UDTF to process them.

If your UDTF does not need its input data partitioned in a particular way, you can make its processing much more efficient by eliminating the overhead of partitioning the data. Instead, you have each instance of the UDTF process just the data that is stored locally by the node on which it is running. As long as your UDTF does not need to see data partitioned in any particular manner (for example, a UDTF that parses data out of an Apache log file), you can tremendously speed up its processing using this option.

You tell your UDTF to only process local data by using the PARTITION AUTO clause, rather than specifying a column or expression to use to partition the data. You need to supply a source table that is replicated across all nodes and contains a single row (similar to the DUAL table). For example, to call a UDTF that parses locally-stored Apache log files, you could use the following statements:

```
=> CREATE TABLE rep (dummy INTEGER) UNSEGMENTED ALL NODES;
```

```
CREATE TABLE
=> INSERT INTO rep VALUES (1);
 OUTPUT

 1
(1 row)
=> SELECT ParseLogFile('/data/apache/log*') OVER (PARTITION AUTO) FROM rep;
```

## Developing a user Defined Aggregate Function

Aggregate Functions perform an operation on a set of values and return one value. HP Vertica provides standard built-in Aggregate Functions such as AVG, MAX, and MIN. User Defined Aggregate Functions (UDAF) allow you to create custom aggregate functions specific to your needs.

UDAF's perform operations on a set of rows and reads one input argument and returns one output column.

Example code for User Defined Aggregates is available in

/opt/vertica/sdk/examples/AggregateFunctions. See **Setting up a UDF Development Environment** (page [433](#)) for details on setting up your environment and **The HP Vertica SDK** (page [433](#)) for details on building the examples.

## User Defined Aggregate Function Requirements

User Defined Aggregates work similarly to the built in HP Vertica aggregate functions.

User Defined Aggregates:

- Support a single input column (or set) of values.
- Provide a single output column.
- Supports automatic RLE decompression. RLE input is decompressed before it is sent to a User Defined Aggregate.
- Can be used with the GROUP BY and HAVING clauses. Only columns appearing in the GROUP BY clause can be selected.
- Correlated subquery with User Defined Aggregates is not supported.
- Cannot be used in a query containing multiple distinct User Defined Aggregate functions.
- Cannot be used in a query containing a single User Defined Aggregate and one or more non-distinct User Defined Aggregate functions.
- Must not allow an exception to be passed back to HP Vertica. Doing so could result in a memory leak, because any memory allocated by the exception is not reclaimed. It is a best practice to use a top-level try-catch block to catch any stray exceptions that may be thrown by your code or any functions or libraries your code calls.

## UDAF Class Overview

You create your UDAF by subclassing two classes defined by the Vertica SDK:

- `Vertica::AggregateFunctionFactory`
- `Vertica::AggregateFunction`

### The AggregateFunctionFactory Class

The `AggregateFunctionFactory` class specifies metadata information such as the argument and return types of your aggregate function. It provides these methods for you to customize:

- `getPrototype()` - Defines the number of parameters and data types accepted by the function. There is a single parameter for aggregate functions.
- `getIntermediateTypes()` - Defines the intermediate variable(s) used by the function.
- `getParameterType()` - Defines the names and types of parameters that this function uses (optional).
- `getReturnType()` - Defines the type of the output column.

HP Vertica uses this data when you call the CREATE AGGREGATE FUNCTION SQL statement to add the function to the database catalog.

The `AggregateFunctionFactory` returns an `AggregateFunction` instance that HP Vertica can call to process data.

### The AggregateFunction Class

The `AggregateFunction` class provides these methods for you to customize:

- `initAggregate()` - Initializes the class, defines variables, and sets the starting value for the variables. This function must be idempotent.
- `aggregate()` - The main aggregation operation.
- `combine()` - If multiple instances of `aggregate` is run, then `combine` is called to combine all the sub-aggregations into a final aggregation. Although this method may not be called, it must be defined.
- `terminate()` - Terminates the function and returns the result as a column.

**Important!** The `aggregate()` function may be not operate on the complete input set all at once. Depending on how the data is stored, multiple instances of `aggregate` may run on the data set. For this reason, `initAggregate()` must be idempotent.

The `AggregateFunction` class also provides optional methods that you can implement to allocate and free resources: `setup` and `destroy`. You should use these class functions to allocate and deallocate resources that you do not allocate through the UDAF API (see **Allocating Resources** (page [508](#)) for details).

## The ServerInterface Class

All of the class functions that you will define in your UDAF receive an instance of the ServerInterface class as a parameter. This object is used by the underlying HP Vertica SDK code to make calls back into the Vertica process. For example, the macro you use to instantiate a member of your AggregateFunction subclass (`vt_createFuncObj`) needs a pointer to a class function on this object to be able to ask HP Vertica to allocate the memory for the new object. You generally will not interact with this object directly, but instead pass it along to HP Vertica SDK function and macro calls.

## Subclassing Aggregate Function

### Example subclass of AggregateFunction

The following shows a subclass of AggregateFunction named `ag_max` that returns the highest value from a column of numbers.

The **initAggregate function** in this example gets the first argument to the function as a `vfloat` and sets the initial value to zero. Note that the example, as written for simplicity, does not take into account negative input values. Any negative values are returned as 0.

```
virtual void initAggregate(ServerInterface &srvInterface,
 IntermediateAggs &aggs)
{
 vfloat &max = aggs.getFloatRef(0);
 max = 0;
}
```

The **aggregate function** compares the current maximum with the maximum value it has seen so far, and if the new value is higher, then the new value becomes the highest value.

```
void aggregate(ServerInterface &srvInterface,
 BlockReader &arg_reader,
 IntermediateAggs &aggs)
{
 vfloat &max = aggs.getFloatRef(0);

 do {
 const vfloat &input = arg_reader.getFloatRef(0);
 // if input is bigger than the current max, make the max = input
 if (input > max) {
 max = input;
 }
 } while (arg_reader.next());
}
```

The **combine function** takes as its input the intermediate results of other invocations of aggregate method(s) and determines the overall max value from the complete input set.

```
virtual void combine(ServerInterface &srvInterface,
 IntermediateAggs &aggs,
 MultipleIntermediateAggs &aggs_other)
{
 vfloat myMax = aggs.getFloatRef(0);

 // Combine all the other intermediate aggregates
 do {
 const vfloat &otherMax = aggs_other.getFloatRef(0);
 // if input is bigger than the current max, make the max = input
 if (otherMax > myMax) {
 myMax = otherMax;
 }
 } while (aggs_other.next());
}
```

The **terminate function** is called when all input has been evaluated by the aggregate method. It returns the max value to the result writer.

```
virtual void terminate(ServerInterface &srvInterface,
 BlockWriter &res_writer,
 IntermediateAggs &aggs)
{
 // Metadata about the type (to allow creation)
 const vfloat max = aggs.getFloatRef(0);

 res_writer.setFloat(max);
}
```

**Example Code:**

```

class Max : public AggregateFunction
{
 virtual void initAggregate(ServerInterface &srvInterface,
 IntermediateAggs &aggs)
 {
 vfloat &max = aggs.getFloatRef(0);
 max = 0;
 }

 void aggregate(ServerInterface &srvInterface,
 BlockReader &arg_reader,
 IntermediateAggs &aggs)
 {
 vfloat &max = aggs.getFloatRef(0);

 do {
 const vfloat &input = arg_reader.getFloatRef(0);
 // if input is bigger than the current max, make the max = input
 if (input > max) {
 max = input;
 }
 } while (arg_reader.next());
 }

 virtual void combine(ServerInterface &srvInterface,
 IntermediateAggs &aggs,
 MultipleIntermediateAggs &aggs_other)
 {
 vfloat &myMax = aggs.getFloatRef(0);

 // Combine all the other intermediate aggregates
 do {
 const vfloat &otherMax = aggs_other.getFloatRef(0);
 // if input is bigger than the current max, make the max = input
 if (otherMax > myMax) {
 myMax = otherMax;
 }
 } while (aggs_other.next());
 }

 virtual void terminate(ServerInterface &srvInterface,
 BlockWriter &res_writer,
 IntermediateAggs &aggs)
 {
 // Metadata about the type (to allow creation)
 const vfloat max = aggs.getFloatRef(0);

 res_writer.setFloat(max);
 }

 InlineAggregate()
};


```

**InlineAggregate()** is called at the end of the class. You do not need to implement this function, but it automatically optimizes aggregates and speeds up calculations when called on your code.

## Subclassing AggregateFunctionFactory

### Example subclass of AggregateFunctionFactory

The following shows a subclass of AggregateFunctionFactory named ag\_maxFactory.

The **getPrototype** method allows you to define the variables that are sent to your aggregate function and returned to HP Vertica after your aggregate function runs. The example below accepts and returns a float from/to HP Vertica:

```
virtual void getPrototype(ServerInterface &srvfloaterface, ColumnTypes
&argTypes, ColumnTypes &returnType)
{
 argTypes.addFloat();
 returnType.addFloat();
}
```

The **getIntermediateTypes** method defines any intermediate variables that you use in your aggregate function. Intermediate variables are used to pass data between multiple invocations of an aggregate function ("max" in the example below) to combine results until a final result can be computed:

```
virtual void getIntermediateTypes(ServerInterface &srvInterface, const
SizedColumnTypes &input_types, SizedColumnTypes &intermediateTypeMetaData)
{
 intermediateTypeMetaData.addFloat("max");
}
```

The **getParameterType** method defines the name and types of parameters that the aggregate function uses:

```
virtual void getParameterType(ServerInterface &srvInterface,
SizedColumnTypes ¶meter_types)
{
 parameter_types.addFloat();
}
```

The **getReturnType** method defines and assigns a value to the variable that is sent back to HP Vertica when the aggregate function completes:

```
virtual void getReturnType(ServerInterface &srvfloaterface,
 const SizedColumnTypes &input_types,
 SizedColumnTypes &output_types)
{
 output_types.addFloat("max");
}
```

### Example Code:

```
class MaxFactory : public AggregateFunctionFactory
{

 virtual void getPrototype(ServerInterface &srvfloaterface, ColumnTypes
&argTypes, ColumnTypes &returnType)
 {
 argTypes.addFloat();
 returnType.addFloat();
 }

 virtual void getIntermediateTypes(ServerInterface &srvInterface, const
SizedColumnTypes &input_types, SizedColumnTypes &intermediateTypeMetaData)
 {
 intermediateTypeMetaData.addFloat("max");
 }

 virtual void getReturnType(ServerInterface &srvfloaterface,
 const SizedColumnTypes &input_types,
 SizedColumnTypes &output_types)
 {
 output_types.addFloat("max");
 }

 virtual AggregateFunction *createAggregateFunction(ServerInterface
&srvfloaterface)
 { return vt_createFuncObj(srvfloaterface.allocator, Max); }

};
```

## User Defined Aggregate - Complete Example

This is a complete working example of a User Defined Aggregate:

```
#include "Vertica.h"
#include <sstream>
#include <iostream>

using namespace Vertica;
using namespace std;

* Example implementation of Aggregate "Max" Function

class Max : public AggregateFunction
{
 virtual void initAggregate(ServerInterface &srvInterface,
 IntermediateAggs &aggs)
 {
 vfloat &max = aggs.getFloatRef(0);
 max = 0;
 }

 void aggregate(ServerInterface &srvInterface,
 BlockReader &arg_reader,
 IntermediateAggs &aggs)
 {
 vfloat &max = aggs.getFloatRef(0);

 do {
 const vfloat &input = arg_reader.getFloatRef(0);
 // if input is bigger than the current max, make the max = input
 if (input > max) {
 max = input;
 }
 } while (arg_reader.next());
 }

 virtual void combine(ServerInterface &srvInterface,
 IntermediateAggs &aggs,
 MultipleIntermediateAggs &aggs_other)
 {
 vfloat &myMax = aggs.getFloatRef(0);

 // Combine all the other intermediate aggregates
 do {
 const vfloat &otherMax = aggs_other.getFloatRef(0);
 // if input is bigger than the current max, make the max = input
 if (otherMax > myMax) {
 myMax = otherMax;
 }
 } while (aggs_other.next());
 }

 virtual void terminate(ServerInterface &srvInterface,
 BlockWriter &res_writer,
```

```

 IntermediateAggs &aggs)
{
 // Metadata about the type (to allow creation)
 const vfloat max = aggs.getFloatRef(0);

 res_writer.setFloat(max);
}

InlineAggregate()
};

class MaxFactory : public AggregateFunctionFactory
{
 virtual void getIntermediateTypes(ServerInterface &srvInterface, const
SizedColumnTypes &input_types, SizedColumnTypes &intermediateTypeMetaData)
{
 intermediateTypeMetaData.addFloat("max");
}

virtual void getPrototype(ServerInterface &srvfloaterface, ColumnTypes
&argTypes, ColumnTypes &returnType)
{
 argTypes.addFloat();
 returnType.addFloat();
}

virtual void getReturnType(ServerInterface &srvfloaterface,
 const SizedColumnTypes &input_types,
 SizedColumnTypes &output_types)
{
 output_types.addFloat("max");
}

virtual AggregateFunction *createAggregateFunction(ServerInterface
&srvfloaterface)
{ return vt_createFuncObj(srvfloaterface.allocator, Max); }

};

RegisterFactory(MaxFactory);

```

**Example usage:**

```

dbadmin=> CREATE LIBRARY AggregateFunctions AS
' /opt/vertica/sdk/examples/build/AggregateFunctions.so';
CREATE LIBRARY

```

```

dbadmin=> create aggregate function ag_max as LANGUAGE 'C++' name 'MaxFactory'
library AggregateFunctions;
CREATE AGGREGATE FUNCTION

```

```
dbadmin=> select * from example; i _----_ 1_ 1_ 8_ 2_ 3_ 0_ 5_ 13_ 21_(9 rows)
```

```
dbadmin=> select ag_max(i) from example;
ag_max

21
(1 row)
```

## Developing a User Defined Analytic Function

User Defined Analytic Functions (UDAnFs) are User Defined Functions that are used for analytics. See [Using SQL Analytics](#) (page 329) for an overview of HP Vertica's built-in analytics. Like User Defined Scalar Functions (UDSFs), UDAnFs must output a single value for each row of data read. Unlike UDSFs, the UDAnF's input reader and output reader can be advanced independently. This feature lets you create UDAnF's where the output value is calculated over multiple rows of data. By advancing the reader and writer independently, you can create functions similar to the built-in analytic functions such as LAG, which uses data from prior rows to output a value for the current row.

**Note:** Analytic functions are only supported in C++. They cannot be developed in R.

### User Defined Analytic Function Requirements

User Defined Analytic Functions (UDAnFs) must meet several requirements:

- They must produce a single output value for each row in the partition of data they are given to process.
- They must have 32 or less arguments.
- Like all UDF's, they must not allow an exception to be passed back to HP Vertica. Doing so could lead to issues such as memory leaks (caused by the memory allocated by the exception never being freed). Your UDAnF should always contain a top-level try-catch block to catch any stray exceptions caused by your code or libraries your code calls.
- If they allocate resources on their own, they must properly free it. Even a single byte of allocated memory that is not freed can become an issue in a UDAnF that is called over millions of rows. This is especially true if your UDAnF runs in unfenced mode (directly within the HP Vertica process) since it could destabilize the database. Instead of directly allocating memory, your function should use the memory allocation macros in the HP Vertica SDK. See [Allocating Resources](#) (page 508) for details.

### UDAnF Class Overview

To create a UDAnF, you need to subclass two classes defined by the HP Vertica SDK:

- `Vertica::AnalyticFunction` which carries out the processing you want your function to perform.
- `Vertica::AnalyticFunctionFactory` which defines the input and output data types of your function. It instantiates your `AnalyticFunction` subclass when needed.

The `AnalyticFunction` class is where you define the `processPartition` function that performs the analytic processing you want your function to perform. When a user calls your UDAAnF function in a SQL SELECT statement, HP Vertica breaks the data into partitions as specified in the OVER clause of the query, and calls the `processPartition` function to process them. If the query does not a partition by column, the

The input and output of the `processPartition` function are supplied by objects of the `Vertica::AnalyticPartitionReader` and `Vertica::AnalyticPartitionWriter` class. They define functions that you use to read the input data and write the output data for your UDAAnF.

In addition to `processPartition`, the `AnalyticFunction` class defines two optional class functions that you can implement to allocate and free resources: `setup` and `destroy`. You use these class functions to allocate and deallocate resources that you do not allocate through the UDF API (see [Allocating Resources](#) (page 508) for details).

## The ServerInterface Class

All of the class functions that you define in your UDAAnF receive a `ServerInterface` object as a parameter. It is used by the underlying HP Vertica SDK code to make calls back into the HP Vertica process. For example, the macro you use to instantiate a member of your `AnalyticFunction` subclass (`vt_createFuncObj`) needs a pointer to this object to able able to ask HP Vertica to allocate the memory for the new object. You generally will not interact with this object directly, but instead pass it along to HP Vertica SDK function and macro calls.

## Subclassing AnalyticFunction

Your subclass of `Vertica::AnalyticFunction` is where your User Defined Analytic Function (UDAAnF) performs its processing. The one function in the class that you must implement, `processPartition`, reads a partition of data, performs some sort of processing, and outputs single value for each input row.

For example, a UDAAnF that ranks rows based on how they are ordered has a `processPartition` function that reads each row, determines how to rank the row, and outputs the rank value. An example of running a rank function, named `an_rank` is:

```
=> SELECT * FROM hits;
 site | date | num_hits
-----+-----+-----
www.example.com | 2012-01-02 | 97
www.vertica.com | 2012-01-01 | 343435
www.example.com | 2012-01-01 | 123
www.example.com | 2012-01-04 | 112
www.vertica.com | 2012-01-02 | 503695
www.vertica.com | 2012-01-03 | 490387
www.example.com | 2012-01-03 | 123
```

```
(7 rows)

=> SELECT site,date,num_hits,an_rank() OVER (PARTITION BY site ORDER BY num_hits
DESC) AS an_rank FROM hits;
 site | date | num_hits | an_rank
-----+-----+-----+-----+
www.example.com | 2012-01-03 | 123 | 1
www.example.com | 2012-01-01 | 123 | 1
www.example.com | 2012-01-04 | 112 | 3
www.example.com | 2012-01-02 | 97 | 4
www.vertica.com | 2012-01-02 | 503695 | 1
www.vertica.com | 2012-01-03 | 490387 | 2
www.vertica.com | 2012-01-01 | 343435 | 3
(7 rows)
```

As with the built-in RANK analytic function, rows that have the same value for the ORDER BY column (num\_hits in this example) have the same rank, but the rank continues to increase, so that next row that has a different ORDER BY key gets a rank value based on the number of rows that preceded it.

HP Vertica calls the `processPartition()` function once for each partition of data. It supplies the partition using an `AnalyticPartitionReader` object from which your function reads its input data. In addition, there is a unique function on this object named `isNewOrderByKey`, which returns a Boolean value indicating whether your function has seen a row with the same ORDER BY key (or keys). This function is very useful for analytic functions (such as the example RANK function) which need to handle rows with identical ORDER BY keys differently than rows with different ORDER BY keys.

**Note:** You can specify multiple ORDER BY columns in the SQL query you use to call your UDAF. The `isNewOrderByKey` function returns true if any of the ORDER BY keys are different than the previous row.

Once your function has finished processing the row of data, you advance it to the next row of input by calling the `AnalyticPartitionReader::next` function.

Your function writes its output value using a `AnalyticPartitionWriter` object that HP Vertica supplies as a parameter to the `processPartition` function. This object has data-type-specific functions to write the output value (such as `setInt`). After setting the output value, call the `AnalyticPartitionWriter::next` function to advance to the next row in the output.

**Note:** You must be sure that your function produces a row of output for each row of input in the partition. You must also not output more rows than are in the partition, otherwise the zygote size process (if running in **fenced mode**) or HP Vertica itself could generate an out of bounds error.

The following example code defines a `AnalyticFunction` subclass named `Rank`, which implements the ranking function demonstrated earlier. It is based on example code distributed in the examples directory of the SDK.

```

/**
 * User defined analytic function: Rank - works mostly the same as SQL-99 rank
 * with the ability to define as many order by columns as desired
 *
 */
class Rank : public AnalyticFunction
{
 virtual void processPartition(ServerInterface &srvInterface,
 AnalyticPartitionReader &inputReader,
 AnalyticPartitionWriter &outputWriter)
 {
 // Always use a top-level try-catch block to prevent exceptions from
 // leaking back to Vertica or the fenced-mode side process.
 try {
 rank = 1; // The rank to assign a row
 rowCount = 0; // Number of rows processed so far
 do {
 rowCount++;
 // Do we have a new order by row?
 if (inputReader.isNewOrderByKey()) {
 // Yes, so set rank to the total number of rows that have been
 // processed. Otherwise, the rank remains the same value as
 // the previous iteration.
 rank = rowCount;
 }
 // Write the rank
 outputWriter.setInt(0, rank);
 // Move to the next row of the output
 outputWriter.next();
 } while (inputReader.next()); // Loop until no more input
 } catch(exception& e) {
 // Standard exception. Quit.
 vt_report_error(0, "Exception while processing partition: %s",
e.what());
 }
 }

private:
 vint rank, rowCount;
};

```

In this example, the `processPartition` function does not actually read any of the data from the input row, it just advances through the rows. It does not need to read data since just needs to count the number of rows that have been read and determine whether those rows have the same ORDER BY key as the previous row. If the current row is a new ORDER BY key, then the rank is set to the total number of rows that have been processed. If the current row has the same ORDER BY value as the previous row, then the rank remains the same.

Note that the function has a top-level try-catch block. All of your UDF functions should always have one to prevent stray exceptions from being passed back to HP Vertica (if you run the function unfenced) or the side process.

## Subclassing AnalyticFunctionFactory

Your subclass of the `AnalyticFunctionFactory` class provides the following metadata about your UDAnF to HP Vertica:

- The number and data types of your function's input arguments
- Your function's output data type (and its width or precision, if it returns a variable-width data type such as `VARCHAR` or a data type that has settable precision such as `TIMESTAMP`)
- The `AnalyticFunction` subclass that implements your function. HP Vertica calls your factory class to instantiate members of this class when it needs to execute your UDAnF.

There are three required functions that your `AnalyticFunctionFactory` subclass must implement:

- `getPrototype` describes the input parameters and output value of your function. You set these values by calling functions on two `ColumnTypes` objects that provided to the function via parameters.
- `createAnalyticFunction` supplies an instance of your `AnalyticFunction` factory that HP Vertica can call to process a UDAnF function call.
- `getReturnType` provides details about your function's output. This function is where you set the width of the output value if your function returns a variable-width value (such as `VARCHAR`) or the precision of the output value if it has a settable precision (such as `TIMESTAMP`).

The following example code defines the `AnalyticFunctionFactory` that corresponds with the example `Rank` class shown in [Subclassing AnalyticFunction](#) (page 469).

```

class RankFactory : public AnalyticFunctionFactory
{
 virtual void getPrototype(ServerInterface &srvInterface,
 ColumnTypes &argTypes, ColumnTypes &returnType)
 {
 returnType.addInt();
 }

 virtual void getReturnType(ServerInterface &srvInterface,
 const SizedColumnTypes &inputTypes,
 SizedColumnTypes &outputTypes)
 {
 outputTypes.addInt();
 }

 virtual AnalyticFunction *createAnalyticFunction(ServerInterface
 &srvInterface)
 { return vt_createFuncObj(srvInterface.allocator, Rank); }

};


```

The first function defined by the `RankFactory` subclass, `getPrototype`, sets the data type of the return value. Since the `Rank` UDAF does not read input, it does not define any arguments by calling functions on the `ColumnTypes` object passed in the `argTypes` parameter.

The next function is `getReturnType`. If your function returns a data type that needs to define a width or precision, your implementation of the `getReturnType` function calls a function on the `SizedColumnType` object passed in as a parameter to tell HP Vertica the width or precision. See the SDK entry for `SizedColumnTypes` for a list of these functions. `Rank` returns a fixed-width data type (an `INTEGER`) so it does not need to set the precision or width of its output; it just calls `addInt` to report its output data type.

Finally, `RankFactory` defines the `createAnalyticFunction` function that returns an instance of the `AnalyticFunction` class that HP Vertica can call. This code is mostly boilerplate. All you need to do is add the name of your analytic function class in the call to `vt_createFuncObj()` which takes care of allocating the object for you.

## Deploying and Using User Defined Analytic Functions

To deploy a UDAF on your HP Vertica database:

- 1 Copy the UDF shared library file (`.so`) that contains your function to a node on your HP Vertica cluster.
- 2 Connect to the node where you copied the library (for example, using `vsql`).
- 3 Use the `CREATE LIBRARY` statement to load the UDF library into HP Vertica. You pass this statement the location of the UDF library file you copied to the node earlier. HP Vertica distributes the library to each node in the cluster.

- 4 Use the CREATE ANALYTIC FUNCTION statement to add the function to the HP Vertica catalog. This maps a SQL function name to the name of the UDF's factory class. If you are not sure of the name of the UDF's factory class, you can list all of the UDFs in the library (see [Listing the UDFs Contained in a Library](#) (page 542) for details).

The following example demonstrates loading and using the Rank UDAF that is included in the SDK examples directory. It assumes that the `AnalyticFunctions.so` library that contains the function has been copied to the dbadmin user's home directory on the initiator node.

```
=> CREATE LIBRARY AnalyticFunctions AS '/home/dbadmin/AnalyticFunctions.so';
CREATE LIBRARY
=> CREATE ANALYTIC FUNCTION an_rank AS LANGUAGE 'C++'
-> NAME 'RankFactory' LIBRARY AnalyticFunctions;
CREATE ANALYTIC FUNCTION
=> SELECT * FROM hits;
 site | date | num_hits
-----+-----+-----
www.example.com | 2012-01-02 | 97
www.vertica.com | 2012-01-01 | 343435
www.example.com | 2012-01-01 | 123
www.example.com | 2012-01-04 | 112
www.vertica.com | 2012-01-02 | 503695
www.vertica.com | 2012-01-03 | 490387
www.example.com | 2012-01-03 | 123
(7 rows)

=> SELECT site,date,num_hits,an_rank() over (partition by site order by num_hits desc) from hits;
 site | date | num_hits | ?column?
-----+-----+-----+-----
www.example.com | 2012-01-03 | 123 | 1
www.example.com | 2012-01-01 | 123 | 1
www.example.com | 2012-01-04 | 112 | 3
www.example.com | 2012-01-02 | 97 | 4
www.vertica.com | 2012-01-02 | 503695 | 1
www.vertica.com | 2012-01-03 | 490387 | 2
www.vertica.com | 2012-01-01 | 343435 | 3
(7 rows)
```

## Notes

- UDAFs do not support **framing windows using ROWS** (page 338).
- As with HP Vertica's built-in analytic functions, UDAFs cannot be used with pattern matching functions.

## See Also

`CREATE LIBRARY` and `CREATE ANALYTIC FUNCTION` in the SQL Reference Manual.

## Developing User Defined Load (UDL) Functions

The User Defined Load (UDL) feature allows you to create custom routines to load your data into HP Vertica. You create custom libraries using the HP Vertica SDK to handle various steps in the loading process. Loading is used by the COPY statement and is comprised of three stages, all of which are optional:

- **User Defined Source:** Obtaining the source of the data. For example, over HTTP or through cURL.
- **User Defined Filter(s):** Filtering the data through one or more filters. For example, unzipping a file or converting UTF-16 to UTF-8, or by doing both in sequence.
- **User Defined Parser:** Parsing the data. For example, reading the filtered data and parsing it into tuples in HP Vertica.

### Deploying User Defined Load functions:

You use the CREATE LIBRARY statement to load your compiled UDL library into HP Vertica. For each function, you must use the appropriate CREATE statement to load the function into HP Vertica. There is a CREATE statement for each type of UDL:

- CREATE SOURCE
- CREATE FILTER
- CREATE PARSER

**IMPORTANT!** Installing an untrusted UDL function can compromise the security of the server. UDx's can contain arbitrary code. In particular, UD Source functions can read data from any arbitrary location. It is up to the developer of the function to enforce proper security limitations. Superusers must not grant access to UDx's to untrusted users.

Conversely, you remove UDL libraries with DROP LIBRARY and remove UDL functions with the following:

- DROP SOURCE
- DROP FILTER
- DROP PARSER

**Note:** You cannot ALTER UDL functions.

### UDL Requirements

User Defined Load Functions:

- Are used by the COPY statement.
- Are written in C++ using the HP Vertica SDK and compiled into a shared library.
- Can have up to one source process. This single process can obtain data from multiple sources.
- Can have zero or more Filters.
- Can have up to one Parser process.
- Cannot run in **fenced mode**.

- Like all UDF's, they must not allow an exception to be passed back to HP Vertica. Doing so could lead to issues such as memory leaks (caused by the memory allocated by the exception never being freed). Your UDL should always contain a top-level try-catch block to catch any stray exceptions caused by your code or libraries your code calls.
- If your UDL functions allocate resources on their own, then they must properly free it. Even a single byte of allocated memory that is not freed can become an issue in a UDL that is called over millions of rows. Instead of directly allocating memory, your function should use the memory allocation macros in the HP Vertica SDK. See **Allocating Resources** (page [508](#)) for details.
- The header files that define the majority of classes and methods are `VerticaUDx.h` and `VerticaUDl.h`. These header files, along with the main `Vertica.h` header file, are available in `/opt/vertica/sdk/include`.
- The SDK documentation is available in the SDK itself at `/opt/vertica/sdk/doc` and online: HP Vertica SDK documentation.

## UDL Source

### Developing Source Functions for User Defined Load

UDL Source functions allow you to process a source of data using a method that is not built into HP Vertica. For example, accessing the data from an HTTP source using cURL. Only a single User Defined Source can be defined in a COPY statement, but that source function can pull data from multiple sources.

A Source can optionally be used with UDFilters and a UDParse. The source can be obtained using a UDSource function, passed through one or more UDFilters, and finally parsed by a UDParse before being loaded.

You must implement a UDSource class and a SourceFactory class for sources.

The HP Vertica SDK provides example source functions in  
`/opt/vertica/sdk/examples/SourceFunctions`.

### Subclassing SourceFactory

#### About the Source Factory Class

The SourceFactory class performs initial validation and planning of the query and instantiates objects to perform further initialization on each node once the query has been distributed.

#### SourceFactory Methods:

**You implement the following methods in your SourceFactory class.**

- `plan()` - The plan method is used to check parameters, populate the plan data, and assign the work to one or more nodes.

When developing your plan() method you should check the parameters that have been passed from the function call and provide a helpful error message if the arguments do not conform, but it is not required. You can also optionally populate the NodeSpecifyingPlanContext object with any information that must be passed to the other nodes doing the work from the initiator node. Finally, you must specify which nodes the source(s) are obtained from. You can split up the work so that one or multiple specific nodes load data, or specify that any node load the data.

- `prepareUDSources()` - This method directly instantiates all provided sources and returns a vector of the sources.
- `getParameterType()` - The `getParameterType()` method allows you to define the name and types of parameters that the function uses. HP Vertica uses this information to warn function callers that certain parameters that they provide have no effect, or that certain parameters are not being set and are reverting to default values. You should, as a best practice, define the types and parameters for your function, but using this method is optional.

The name of the factory class is the value used for the NAME modifier in the in the CREATE SOURCE statement.

After creating your SourceFactory, you must register it with `RegisterFactory()`;

### **Example SourceFactory**

The following example is provided is part of:

`/opt/vertica/sdk/examples/SourceFunctions/cURL.cpp`. It defines the factory function for the curl source function.

```
class CurlSourceFactory : public SourceFactory {
public:

 virtual void plan(ServerInterface &srvInterface,
 NodeSpecifyingPlanContext &planCtx) {
 std::vector<std::string> args =
 srvInterface.getParamReader().getParamNames();

 /* Check parameters */
 if (args.size() != 1 || find(args.begin(), args.end(), "url") ==
 args.end()) {
 vt_report_error(0, "You must provide a single URL.");
 }

 /* Populate planData */

 planCtx.getWriter().getStringRef("url").copy(srvInterface.getParamReader().get
StringRef("url"));

 /* Assign Nodes */
 std::vector<std::string> executionNodes = planCtx.getClusterNodes();
 while (executionNodes.size() > 1) executionNodes.pop_back(); // Only run
on the first node in the list.
 planCtx.setTargetNodes(executionNodes);
 }

 virtual std::vector<UDSource*> prepareUDSources(ServerInterface
&srvInterface,
 NodeSpecifyingPlanContext &planCtx) {
 std::vector<UDSource*> retVal;

 retVal.push_back(vt_createFuncObj(srvInterface.getAllocator(), CurlSource,
 planCtx.getWriter().getStringRef("url").str()));
 return retVal;
 }

 virtual void getParameterType(ServerInterface &srvInterface,
 SizedColumnTypes ¶meterTypes) {
 parameterTypes.addVarchar(65000, "url");
 }
};

RegisterFactory(CurlSourceFactory);
```

## Subclassing UDSource

### About the UDSource Class

The UDSource class is responsible for acquiring the data from an external source and producing that data in a streaming manner. A wrapper is also provided for UDSource called ContinuousUDSource. ContinuousUDSource provides an abstraction that allows you to treat the input data as a continuous stream of data. This allows you to write the data from the source "at will" instead of having to create an iterator to use the base UDSource method.

ContinuousUDSource is available in

`/opt/vertica/sdk/examples/HelperLibraries/ContinuousUDSource.h`.

#### UDSource Methods:

- `setup()` - Invoked before the first time that `process()` is called. Use this method to do things such as open file handles.
- `destroy()` - Invoked after the last time that `process()` is called. Use this method to do things such as close file handles.
- `process()` - Invoked repeatedly until it returns DONE or the query is canceled by the function caller. On each invocation, `process()` acquires more data and writes the data to the DataBuffer specified by 'output'.  
Returns OUTPUT\_NEEDED if this source has more data to produce or DONE if it has no more data to produce.
- `getSize()` - Returns the estimates number of bytes that `process()` will return. This value is an estimate only and is used to indicate the file size in the LOAD\_STREAMS table. `getSize()` can be called before `setup` is called. See the SDK documentation for additional important details about the `getSize()` method.

#### ContinuousUDSource Functions:

The ContinuousUDSource wrapper allows you to write and process the data "at will" instead of having to iterate through the data. An example of using ContinuousUDSource is provided in `/opt/vertica/sdk/examples/SourceFunctions/MultiFileCurlSource.cpp`.

- `initialize()` - Invoked before `run()`. You can optionally override this function to perform setup and initialization.
- `run()` - Processes the data. Use `write()` on the ContinuousWriter to write the data from the source.
- `deinitialize()` - Invoked after `run()` has returned. You can optionally override this function to perform tear-down and destruction.

Functions that are already implemented that you use in your code:

- `yield()` - use to yield control back to the server during idle or busy loops so the server can check for status changes or query cancelations.
- `cw` - A ContinuousWriter which is defined in `/opt/vertica/sdk/examples/HelperLibraries/CoroutineHelpers.h`. Used to write the data to the output data buffer.

## Example UDSource

The following example loads the source with the url\_fread method in the helper library available in /opt/vertica/sdk/examples/HelperLibraries/. It allows you to use cURL to open and read in a file over HTTP. The data is loaded in chunks. If End Of File is received then the process() method returns DONE, otherwise it returns OUTPUT\_NEEDED and process() processes another chunk of data. The functions included in the helper library (url\_fread(), url\_fopen, etc.) are based on examples that come with the libcurl library. For example, see <http://curl.haxx.se/libcurl/c/fopen.html> <http://curl.haxx.se/libcurl/c/fopen.html>.

For setup, the handle to the file is opened, again using a function from the help library.

For destroy, the handle to the file is closed using a function from the helper library.

```
class CurlSource : public UDSource {
private:
 URL_FILE *handle;
 std::string url;

 virtual StreamState process(ServerInterface &srvInterface, DataBuffer
&output) {
 output.offset = url_fread(output.buf, 1, output.size, handle);
 return url_feof(handle) ? DONE : OUTPUT_NEEDED;
 }

public:
 CurlSource(std::string url) : url(url) {}

 void setup(ServerInterface &srvInterface) {
 handle = url_fopen(url.c_str(), "r");
 }

 void destroy(ServerInterface &srvInterface) {
 url_fclose(handle);
 }
};
```

## UDL Filter

### Developing Source Functions for User Defined Load

UDL Filter functions allow you to manipulate data obtained from a source in various ways. For example, you could process a compressed file in a compression format not natively supported by vertica, or take UTF-16 encoded data and transcode it to UTF-8 encoding, or even perform search and replace operations on data before it is loaded into HP Vertica.

You can also pass data through multiple filters before it is loaded into HP Vertica. For instance, you could unzip a file compressed with 7Zip, convert the content from UTF-16 to UTF-8, and finally search and replace various text strings before loading the data.

Filters can optionally be used with UDSources and UDParsers. The source can be obtained using a UDSource function, passed through one or more UDFilters, and finally parsed by a UDParse before being loaded.

You must implement a UDFilter class and a FilterFactory class for your filter.

The HP Vertica SDK provides example filter functions in  
/opt/vertica/sdk/examples/FilterFunctions.

## Subclassing FilterFactory

### About the Filter Factory Class:

The Filter Factory class performs initial validation and planning of the query and instantiates objects to perform further initialization on each node once the query has been distributed.

### FilterFactory Methods:

You implement the following methods in your FilterFactory class:

- **plan()** - Like the UDSource and UDParse plan() methods, the UDFilter plan() method is used to check parameters and populate the plan data. However, you cannot specify the nodes on which the work is done. HP Vertica automatically selects the best nodes to complete the work based on available resources.

When developing your plan() method you should check the parameters that have been passed from the function call and provide a helpful error message if the arguments do not conform, but it is not required. You can also optionally populate the NodeSpecifyingPlanContext object with any information that must be passed to the other nodes doing the work from the initiator node. Finally, you must specify which nodes the source(s) are obtained from. You can split up the work so that one or multiple specific nodes load data, or specify that any node load the data.

- **prepare()** - This method is called on each node prior to Load operator execution. It creates the function object using the vt\_createFuncObj method.
- **getParameterType()** - The getParameterType() method allows you to define the name and types of parameters that the function uses. HP Vertica uses this information to warn function callers that certain parameters that they provide have no effect, or that certain parameters are not being set and are reverting to default values. You should, as a best practice, define the types and parameters for your function, but using this method is optional.

The name of the factory class is the value used for the NAME modifier in the in the CREATE FILTER statement.

After creating your FilterFactory, you must register it with RegisterFactory();

### **Example FilterFactory**

The following example is provided as part of  
`/opt/vertica/sdk/examples/SourceFunctions/Iconverter.cpp`. It defines the  
factory class for the IConverter filter function.

```

class IconverterFactory : public FilterFactory
{
public:
 virtual void plan(ServerInterface &srvInterface,
 PlanContext &planCtxt) {
 std::vector<std::string> args =
 srvInterface.getParamReader().getParamNames();

 /* Check parameters */
 if (!(args.size() == 0 ||
 (args.size() == 1 && find(args.begin(), args.end(),
"from_encoding") != args.end()) ||
 (args.size() == 2
 && find(args.begin(), args.end(), "from_encoding") != args.end()
 && find(args.begin(), args.end(), "to_encoding") != args.end())))
 {
 vt_report_error(0, "Invalid arguments. Must specify either no
arguments, or 'from_encoding' alone, or 'from_encoding' and 'to_encoding'.");
 }

 /* Populate planData */
 // By default, we do UTF16->UTF8, and x->UTF8

 VString from_encoding =
 planCtxt.getWriter().getStringRef("from_encoding");
 VString to_encoding = planCtxt.getWriter().getStringRef("to_encoding");

 from_encoding.copy("UTF-16");
 to_encoding.copy("UTF-8");

 if (args.size() == 2)
 {

from_encoding.copy(srvInterface.getParamReader().getStringRef("from_encoding"))
;

to_encoding.copy(srvInterface.getParamReader().getStringRef("to_encoding"));
 }
 else if (args.size() == 1)
 {

from_encoding.copy(srvInterface.getParamReader().getStringRef("from_encoding"))
;
 }

 if (!from_encoding.length())
 vt_report_error(0, "The empty string is not a valid from_encoding
value");
 }
 if (!to_encoding.length())
 vt_report_error(0, "The empty string is not a valid to_encoding
value");
 }
}

```

```
}

virtual UDFilter* prepare(ServerInterface &srvInterface,
 PlanContext &planCtx) {
 return vt_createFuncObj(srvInterface.allocator, Iconverter,
 planCtx.getReader().getStringRef("from_encoding").str(),
 planCtx.getReader().getStringRef("to_encoding").str());
}

virtual void getParameterType(ServerInterface &srvInterface,
 SizedColumnTypes ¶meterTypes) {
 parameterTypes.addVarchar(32, "from_encoding");
 parameterTypes.addVarchar(32, "to_encoding");
}
};

RegisterFactory(IconverterFactory);
```

## Subclassing UDFilter

### About the UDFilter Class

The UDFilter class is responsible for reading raw input data from a source and preparing it to be loaded into HP Vertica or processed by a parser. This preparation may involve decompression, re-encoding, or any other sort of binary manipulation. A wrapper is also provided for UDFilter called ContinuousUDFFilter. ContinuousUDFFilter provides an abstraction that allows you to treat the input data as a continuous stream of data. This allows you to write the filtered data and process it "at will" instead of having to create an iterator to use the base UDFilter method. ContinuousUDFFilter is available in

/opt/vertica/sdk/examples/HelperLibraries/ContinuousUDFFilter.h.

### UDFFilter Methods:

- **setup()** - Invoked before the first time that **process()** is called.

Note: UDFilters must be restartable. If loading large numbers of files, a given UDFilter may be re-used for multiple files. HP Vertica follows the worker-pool design pattern: At the start of COPY execution, several Parsers and several Filters are instantiated per node by calling the corresponding **prepare()** method multiple times. Each Filter/Parser pair is then internally assigned to an initial Source (UDSource or internal). At that point, **setup()** is called; then **process()** is called until it is finished; then **destroy()** is called. If there are still sources in the pool waiting to be processed, then the UDFilter/UDSource pair will be given a second Source; **setup()** will be called a second time, then **process()** until it is finished, then **destroy()**. This repeats until all sources have been read.

- **destroy()** - Invoked after the last time that **process()** is called.
- **process()** - Invoked repeatedly until it returns DONE or the query is canceled by the function caller. On each invocation, **process()** acquires more data and writes the data to the DataBuffer specified by 'output'.

Returns:

- OUTPUT\_NEEDED if this source has more data to produce.
- INPUT\_NEEDED if it requires more data to continue working.

- DONE if it has no more data to produce.
- KEEP\_GOING if it cannot proceed for an extended period of time. It will be called again. Do not block indefinitely. If you do, then you prevent the user from canceling the query.

`Process()` must set `input.offset` to the number of bytes that were successfully read from the `input` buffer, and that will not need to be re-consumed by a subsequent invocation of `process()`. If `input\_state` == `END_OF_FILE`, then the last byte in `input` is the last byte in the input stream and returning `INPUT_NEEDED` does not result in any new input appearing. `process()` should return `DONE` in this case as soon as this operator has finished producing all output that it is going to produce.

`process()` must set `output.offset` to the number of bytes that were written to the `output` buffer. This may not be larger than `output.size`. If it is set to 0, this indicates that `process()` requires a larger output buffer.

### ContinuousUDFFilter Functions:

The ContinuousUDFFilter wrapper allows you to write and process the data "at will" instead of having to iterate through the data. An example of using ContinuousUDFFilter is provided in `/opt/vertica/sdk/examples/FilterFunctions/SearchAndReplaceFilter.cpp`.

- `initialize()` - Invoked before `run()`. You can optionally override this function to perform setup and initialization.
- `run()` - Processes the data. Use `reserve()` and `seek()`, or `read()` of the `ContinuousReader` to `read()`, and `reserve()` on the `ContinuousWriter` and `memcpy` to write the data to the output buffer.
- `deinitialize()` - Invoked after `run()` has returned. You can optionally override this function to perform tear-down and destruction.

Functions that are already implemented that you use in your code:

- `yield()` - use to yield control back to the server during idle or busy loops so the server can check for status changes or query cancelations.
- `cr` - A `ContinuousReader` which is defined in `/opt/vertica/sdk/examples/HelperLibraries/CoroutineHelpers.h`. Used to read from the data stream.
- `cw` - A `ContinuousWriter` which is defined in `/opt/vertica/sdk/examples/HelperLibraries/CoroutineHelpers.h`. Used to write the filtered data to the output data buffer.

### Example UDFilter

The following example shows how to convert encoding for a file from one type to another. The example converts UTF-16 encoded data to UTF-8 encoded data. This example is available in the SDK at `/opt/vertica/sdk/examples/FilterFunctions/IConverter.cpp`.

```

class Iconverter : public UDFFilter
{
private:
 std::string fromEncoding, toEncoding;
 iconv_t cd; // the conversion descriptor opened
 uint converted; // how many characters have been converted

protected:
 virtual StreamState process(ServerInterface &srvInterface, DataBuffer
&input, InputState input_state,
 DataBuffer &output)
 {
 char *input_buf = (char *)input.buf + input.offset;
 char *output_buf = (char *)output.buf + output.offset;
 size_t inBytesLeft = input.size - input.offset, outBytesLeft = output.size
- output.offset;

 // end of input
 if (input_state == END_OF_FILE && inBytesLeft == 0)
 {
 // Gnu libc iconv doc says, it is good practice to finalize the
 // outbuffer for stateful encodings (by calling with null inbuffer).
 //
 //
 http://www.gnu.org/software/libc/manual/html_node/Generic-Conversion-Interface
.html
 iconv(cd, NULL, NULL, &output_buf, &outBytesLeft);
 // output buffer can be updated by this operation
 output.offset = output.size - outBytesLeft;
 return DONE;
 }

 size_t ret = iconv(cd, &input_buf, &inBytesLeft, &output_buf,
&outBytesLeft);

 // if conversion is successful, we ask for more input, as input has not
reached EOF.
 StreamState retStatus = INPUT_NEEDED;
 if (ret == (size_t)(-1))
 {
 // seen an error
 switch (errno)
 {
 case E2BIG:
 // input size too big, not a problem, ask for more output.
 retStatus = OUTPUT_NEEDED;
 break;
 case EINVAL:
 // input stops in the middle of a byte sequence, not a problem,
ask for more input
 retStatus = input_state == END_OF_FILE ? DONE : INPUT_NEEDED;
 break;
 case EILSEQ:
 // invalid sequence seen, throw

```

```

 // TODO: reporting the wrong byte position
 vt_report_error(1, "Invalid byte sequence when doing %u-th
conversion", converted);
 case EBADF:
 // something wrong with descriptor, throw
 vt_report_error(0, "Invalid descriptor");
 default:
 vt_report_error(0, "Uncommon Error");
 break;
 }
}
else converted += ret;

// move position pointer
input.offset = input.size - inBytesLeft;
output.offset = output.size - outBytesLeft;

return retStatus;
}

public:
Iconverter(const std::string &from, const std::string &to)
: fromEncoding(from), toEncoding(to), converted(0)
{
 // note "to encoding" is first argument to iconv...
 cd = iconv_open(to.c_str(), from.c_str());
 if (cd == (iconv_t)(-1))
 {
 // error when creating converters.
 vt_report_error(0, "Error initializing iconv: %m");
 }
}

~Iconverter()
{
 // free iconv resources;
 iconv_close(cd);
}
};


```

## UDL Parser

### Developing Parser Functions for User Defined Load

Parsers take a stream of bytes and pass a corresponding sequence of tuples to the HP Vertica load process. UDL Parser functions can be used to parse data in formats not understood by the HP Vertica built-in parser, or for data that require more specific control than the built-in parser allows. For example, you could load a CSV file using a specific CSV library. Two CSV examples are provided with the HP Vertica SDK.

COPY supports a single UDL Parser that can be used in conjunction with a UDSource and zero or more UDFilters.

You must implement a UDParse class and a ParserFactory class for your parser.

The HP Vertica SDK provides example parser functions in `/opt/vertica/sdk/examples/ParserFunctions`. Included in the examples are two CSV parsers; "Traditional CSV" and an **RFC 4180** <http://tools.ietf.org/html/rfc4180> CSV parser. The traditional CSV parser uses the boost::tokenizer library to read the CSV output from common programs such as Microsoft Excel. The RFC 4180 parser parses CSV files written to the RFC 4180 standard and uses libcsv.

## Subclassing ParserFactory

### About the ParserFactory Class:

The ParserFactory class performs initial validation and planning of the query and instantiates objects to perform further initialization on each node once the query has been distributed.

### ParserFactory Methods:

You implement the following methods in your ParserFactory Class:

- `plan()` - Like the UDSource and UDFilter `plan()` methods, the UDParse `plan()` method is used to check parameters and populate the plan data. However, you cannot specify the nodes on which the work is done. HP Vertica automatically selects the best nodes to complete the work based on available resources.
- `prepare()` - This method is called on each node prior to Load operator execution. It creates the function object using the `vt_createFuncObj` method.
- `getParserReturnType()` - This method defines what the return types (and length/precision if necessary) are for this UDX.

By default, HP Vertica uses the same output column types as the destination table. This requires that the UDParse validate the expected output column types and emit appropriate tuples. Users can use COPY expressions to perform typecasting and conversion if necessary.

Define the output types as follows:

- For CHAR/VARCHAR types, specify the max length.
- For NUMERIC types, specify the precision and scale.
- For Time/Timestamp types (with or without time zone), specify the precision, -1 means unspecified.
- For IntervalYM/IntervalDS types, specify the precision and range.
- For all other types, no length/precision specification is required.
- `getParameterType()` - The `getParameterType()` method allows you to define the name and types of parameters that the function uses. HP Vertica uses this information to warn function callers that certain parameters that they provide have no effect, or that certain parameters are not being set and are reverting to default values. You should, as a best practice, define the types and parameters for your function, but using this method is optional.

## ParserFactory Class Example:

The following example is provided as part of `/opt/vertica/sdk/examples/ParserFunctions/BasicIntegerParser.cpp`. It defines the factory class for the `BasicIntegerParser` parser function.

```
class BasicIntegerParserFactory : public ParserFactory {
public:
 virtual void plan(ServerInterface &srvInterface,
 PerColumnParamReader &perColumnParamReader,
 PlanContext &planCtxt) {
 /* Check parameters */
 // TODO: Figure out what parameters I should have; then make sure I have
 them

 /* Populate planData */
 // Nothing to do here
 }

 virtual UDPParser* prepare(ServerInterface &srvInterface,
 PerColumnParamReader &perColumnParamReader,
 PlanContext &planCtxt,
 const SizedColumnTypes &returnType) {

 return vt_createFuncObj(srvInterface.allocator, BasicIntegerParser);
 }

 virtual void getParserReturnType(ServerInterface &srvInterface,
 PerColumnParamReader &perColumnParamReader,
 PlanContext &planCtxt,
 const SizedColumnTypes &argTypes,
 SizedColumnTypes &returnType) {
 // We only and always have a single integer column
 returnType.addInt(argTypes.getColumn(0));
 }
};

RegisterFactory(BasicIntegerParserFactory);
```

## Subclassing UDPParser

### About the UDPParser Class

The UDPParser Class is responsible for parsing an input stream into tuples/rows for insertion into an HP Vertica table. A wrapper is also provided for UDPParser called ContinuousUDParser. ContinuousUDParser provides an abstraction that allows you to treat the input data as a continuous stream of data. This allows you to read from the data and process it "at will" instead of having to create an iterator to use the base UDPParser method. ContinuousUDParser is available in `/opt/vertica/sdk/examples/HelperLibraries/ContinuousUDParser.h`.

The name of the factory class is the value used for the NAME modifier in the in the CREATE PARSER statement.

After creating your ParserFactory, you must register it with RegisterFactory();

### UDParser Methods:

- **setup()** - Invoked before the first time that process() is called.  
UDParsers must be restartable. If loading large numbers of files, a given UDParse may be re-used for multiple files. HP Vertica follows the worker-pool design pattern: At the start of COPY execution, several Parsers and several Filters are instantiated per node by calling the corresponding prepare() method multiple times. Each Filter/Parser pair is then internally assigned to an initial Source (UDSource or internal). At that point, setup() is called; then process() is called until it is finished; then destroy() is called. If there are still sources in the pool waiting to be processed, then the UDFilter/UDSource pair will be given a second Source; setup() will be called a second time, then process() until it is finished, then destroy(). This repeats until all sources have been read.
- **destroy()** - Invoked after the last time that process() is called.
- **process()** - Invoked repeatedly during query execution until it returns DONE or until the query is canceled by the user.

On each invocation, process() will be given an input buffer. It reads data from that buffer, converting it to fields and tuples and writes those tuples via 'writer'. Once it has consumed as much as it reasonably can (for example, once it has consumed the last complete row in the input buffer), it should return INPUT\_NEEDED to indicate that more data is needed, or DONE to indicate that it has completed parsing this input stream and will not be reading more bytes from it.

If 'input\_state' == END\_OF\_FILE, then the last byte in 'input' is the last byte in the input stream. Returning INPUT\_NEEDED will not result in any new input appearing. process() should return DONE in this case as soon as this operator has finished producing all output that it is going to produce.

Note that 'input' may contain null bytes, if the source file contains null bytes. Note also that 'input' is NOT automatically null-terminated.

Returns:

- INPUT\_NEEDED if this UDParse has more data to produce.
  - DONE if it has no more data to produce.
  - REJECT to reject a row (see "Row Rejection" below)
- **getRejectedRecord()** - returns information about the rejected data.
  - **writer** - A member variable of the class. It is used to write parsed tuples to and is of the type StreamWriter. This is the same API as PartitionWriter used in the User Defined Transforms framework.

### Row Rejection

When you want to reject some data, you need to do two things:

- Create a getRejectedRecord() method on your Parser class that returns an object of type Verticala::RejectedRecord, which contains the data that you want to reject, a string describing the reason for rejection, the size of the data, and the terminator string. See RejectedRecord in VerticalaUDI.h for details or view the SDK Documentation.

- When you encounter rejected data, have process() return REJECT. After process() returns REJECT, HP Vertica calls getRejectedRecord() to process the rejected record before the next call to process().

One simple way of fulfilling this is to include code in your parser class such as:

```
Vertica::RejectedRecord myRejRec;
Vertica::RejectedRecord getRejectedRecord() {
 return myRejRec;
}
```

In your process() method, add code such as:

```
(...)
if (some rejection condition) {
 RejectedRecord rr("Bad Record!", "foo data", 8, "\n");
 myRejRec = rr;
 return Vertica::REJECT;
}
(...)
```

That is just one simple approach. The only requirement is that there exist a getRejectedRecord() function that can (and always will) be called after process() returns REJECT, and it returns the data that HP Vertica needs to process the rejection.

### **ContinuousUDParser Functions:**

The ContinuousUDParser wrapper allows you to read and process the data stream "at will" instead of having to iterate through the data.

- initialize() - Invoked before run(). You can optionally override this function to perform setup and initialization.
- run() - Processes the data. Use reserve() and seek(), or read() to read the data and the writer StreamWriter object to write data to HP Vertica.
- deinitialize() - Invoked after run() has returned. You can optionally override this function to perform tear-down and destruction.

Functions that are already implemented that you use in your code:

- yield() - use to yield control back to the server during idle or busy loops so the server can check for status changes or query cancelations.
- cr - A ContinuousReader which is defined in  
`/opt/vertica/sdk/examples/HelperLibraries/CoroutineHelpers.h`. Used to read from the data stream.
- crej - A ContinuousReader which is defined in  
`/opt/vertica/sdk/examples/HelperLibraries/CoroutineHelpers.h`. Used to manage rejected rows.

**UDParser Class Example:**

The following example simply parses a single column of integers using the ContinuousUDParser and writes them to tuples using the writer object. This example uses the ContinuousUDParser wrapper.

```
class BasicIntegerParser : public ContinuousUDParser {
private:
 // campaign for the conservation of keystrokes
 char *ptr(size_t pos = 0) { return ((char*)cr.getDataPtr()) + pos; }

 vint strToInt(const string &str) {
 vint retVal;
 stringstream ss;
 ss << str;
 ss >> retVal;
 return retVal;
 }
public:
 virtual void run() {
 // WARNING: This implementation is not trying for efficiency.
 // It is trying to exercise ContinuousUDParser,
 // and to be quick to implement.

 // This parser assumes a single-column input, and
 // a stream of ASCII integers split by non-numeric characters.
 size_t pos = 0;
 size_t reserved = cr.reserve(pos+1);
 while (!cr.isEof() || reserved == pos+1) {
 while (reserved == pos+1 && (*ptr(pos) >= '0' && *ptr(pos) <= '9'))
{
 pos++;
 reserved = cr.reserve(pos+1);
 }
 string st(ptr(), pos);
 writer->setInt(0, strToInt(st));
 writer->next();
 while (reserved == pos+1 && !(*ptr(pos) >= '0' && *ptr(pos) <= '9'))
{
 pos++;
 reserved = cr.reserve(pos+1);
 }
 cr.seek(pos);
 pos = 0;
 reserved = cr.reserve(pos+1);
 }
 }
};
```

## Compiling Your UDF

`g++` is the only supported compiler for compiling User Defined Function libraries (see **Setting up a UDF Development Environment** (page 433) for details). You should compile your UDF code on the same version of Linux that you use on your HP Vertica cluster.

There are several requirements for compiling your library:

- You must pass the `-shared` and `-fPIC` flags to the linker. The easiest method is to just pass these flags to `g++` when you compile and link your library.
- You should also use the `-Wno-unused-value` flag to suppress warnings when macro arguments are not used. Otherwise, you may get "left-hand operand of comma has no effect" warnings.
- You must compile `sdk/include/Vertica.cpp` and link it into your library. The easiest way to do this is to include it in the `g++` command to compile your library. This file contains support routines that help your UDF communicate with HP Vertica. Supplying this file as C++ source rather than a library limits library compatibility issues.
- Add the HP Vertica SDK include directory in the include search path using the `g++ -I` flag.

The following command line compiles a UDF contained in a single source file named `MyUDF.cpp` into a shared library named `MyUDF.so`:

```
g++ -D HAVE_LONG_INT_64 -I /opt/vertica/sdk/include -Wall -shared -Wno-unused-value \
-fPIC -o MyUDF.so MyUDF.cpp /opt/vertica/sdk/include/Vertica.cpp
```

The above command line assumes that the HP Vertica SDK directory is located at `/opt/vertica/sdk/include` (the default location).

**Note:** HP only supports UDF development on 64-bit architectures. If you must compile your UDF code on a 32-bit system, add the flag `-D Linux32` to your compiler command line.

Once you have debugged your UDF and are ready to deploy it, you should recompile using the `-O3` flag to enable compiler optimization.

You can add additional source files to your library by adding them to the command line. You can also compile them separately and then link them together on your own.

**Note:** The examples subdirectory in the HP Vertica SDK directory contains a make file that you can use as starting point for your own UDF project.

## Handling External Libraries

If your UDF code relies on additional libraries (either ones you have developed, or provided by third-parties) you have two options on how you link them to your UDF library:

- Statically link them into your UDF. This is the best option, since your UDF library will not rely on any external files. Since HP Vertica takes care of distributing your library to each node in your cluster, bundling the additional library into your UDF library eliminates any additional work to deploy your UDF.

- Dynamically link the library to your UDF. You may need to use dynamic linking for some third-party libraries that do not allow static linking. In this case, you will need to manually install this external library on each of your HP Vertica nodes. This increases the maintenance you need to perform. It also adds a new step when adding new nodes to the cluster, since you need remember to install the library before adding the node. In addition, you need to ensure the version of the library is the same on each node.

## Handling Different Numbers and Types of Arguments

Usually, your UDFs accept a set number of arguments that are a specific data type (called its signature). You can create UDFs that handle multiple signatures, or even accept all arguments supplied to them by the user, using either of these techniques:

- Overloading your UDF by creating multiple factory classes, each of which defines a unique function signature. This technique is best if your UDF just needs to accept a few different signatures (for example, accepting two required and one optional argument).
- Using the special "Any" argument type that tells HP Vertica to send all arguments that the user supplies to your function. Your UDF decides whether it can handle the arguments or not.

The following topics explain each of these techniques.

### User Defined Function Overloading

You may want your UDF to accept several different signatures (sets of arguments). For example, you might want your UDF to accept:

- One or more optional arguments.
- One or more argument that can be one of several data types.
- Completely distinct signatures (either all INTEGER or all VARCHAR, for example).

You can create a function with this behavior by creating several factory classes each of which accept a different signature (the number and data types of arguments), and associate a single SQL function name with all of them. You can use the same SQL function name to refer to multiple factory classes as long as the signature defined by each factory is unique. When a user calls your UDF, HP Vertica matches the number and types of arguments supplied by the user to the arguments accepted by each of your function's factory classes. If one matches, HP Vertica uses it to instantiate a function class to process the data.

Multiple factory classes can instantiate the same function class, so you can re-use one function class that is able to process multiple sets of arguments and then create factory classes for each of the function signatures. You can also create multiple function classes if you want.

The following example code demonstrates creating a User Defined Scalar Function (UDSF) that adds two or three integers together. The `Add2or3ints` class is prepared to handle two or three arguments. The `processBlock` function checks the number of arguments that have been passed to it, and adds all two or three of them together. It also exits with an error message if it has been called with less than 2 or more than 3 arguments. In theory, this should never happen, since HP Vertica only calls the UDSF if the user's function call matches a signature on one of the factory classes you create for your function. In practice, it is a good idea to perform this sanity checking, in case your (or someone else's) factory class inaccurately reports a set of arguments your function class cannot handle.

```
#include "Vertica.h"
using namespace Vertica;
using namespace std;

// a ScalarFunction that accepts two or three
// integers and adds them together.
class Add2or3ints : public Vertica::ScalarFunction
{
public:
 virtual void processBlock(Vertica::ServerInterface &srvInterface,
 Vertica::BlockReader &arg_reader,
 Vertica::BlockWriter &res_writer)
 {
 const size_t numCols = arg_reader.getNumCols();

 // Ensure that only two or three parameters are passed in
 if (numCols < 2 || numCols > 3)
 vt_report_error(0, "Function only accept 2 or 3 arguments, "
 "but %zu provided", arg_reader.getNumCols());

 // Add two integers together
 do {
 const vint a = arg_reader.getIntRef(0);
 const vint b = arg_reader.getIntRef(1);
 vint c = 0;
 // Check for third argument, add it in if it exists.
 if (numCols == 3)
 c = arg_reader.getIntRef(2);
 res_writer.setInt(a+b+c);
 res_writer.next();
 } while (arg_reader.next());
 }
};

// This factory accepts function calls with two integer arguments.
class Add2intsFactory : public Vertica::ScalarFunctionFactory
{
 virtual Vertica::ScalarFunction
*createScalarFunction(Vertica::ServerInterface
 &srvInterface)
 { return vt_createFuncObj(srvInterface.allocator, Add2or3ints); }

 virtual void getPrototype(Vertica::ServerInterface &srvInterface,
 Vertica::ColumnTypes &argTypes,
 Vertica::ColumnTypes &returnType)
 { // Accept 2 integer values
 argTypes.addInt();
 argTypes.addInt();
 returnType.addInt();
 }
};

RegisterFactory(Add2intsFactory);
```

```

// This factory defines a function that accepts 3 ints.
class Add3intsFactory : public Vertica::ScalarFunctionFactory
{
 virtual Vertica::ScalarFunction
*createScalarFunction(Vertica::ServerInterface
 &srvInterface)
{ return vt_createFuncObj(srvInterface.allocator, Add2or3ints); }

 virtual void getPrototype(Vertica::ServerInterface &srvInterface,
 Vertica::ColumnTypes &argTypes,
 Vertica::ColumnTypes &returnType)
{ // accept 3 integer values
 argTypes.addInt();
 argTypes.addInt();
 argTypes.addInt();
 returnType.addInt();
}
};

RegisterFactory(Add3intsFactory);

```

The example has two `ScalarFunctionFactory` classes, one for each signature that the function accepts (two integers and three integers). There is nothing unusual about these factory classes, except that their implementation of `ScalarFunctionFactory::createScalarFunction` both create `Add2or3ints` objects.

The final step is to bind the same SQL function name to both factory classes. You can assign multiple factories to the same SQL function, as long as the signatures defined by each factory's `getPrototype` implementation are different.

```

=> CREATE LIBRARY add2or3IntsLib AS '/home/dbadmin/Add2or3Ints.so';
CREATE LIBRARY
=> CREATE FUNCTION add2or3Ints as NAME 'Add2intsFactory' LIBRARY add2or3IntsLib
FENCED;
CREATE FUNCTION
=> CREATE FUNCTION add2or3Ints as NAME 'Add3intsFactory' LIBRARY add2or3IntsLib
FENCED;
CREATE FUNCTION

=> SELECT add2or3Ints(1,2);
add2or3Ints

3
(1 row)

=> SELECT add2or3Ints(1,2,4);
add2or3Ints

7
(1 row)

```

```
=> SELECT add2or3Ints(1,2,3,4); -- Will generate an error
ERROR 3467: Function add2or3Ints(int, int, int, int) does not exist, or
permission is denied for add2or3Ints(int, int, int, int)
HINT: No function matches the given name and argument types. You may
need to add explicit type casts
```

The error message in response to the final call to the add2or3Ints function was generated by HP Vertica, since it could not find a factory class associated with add2or3Ints that accepted four integer arguments. To expand add2or3Ints further, you could create another factory class that accepted this signature, and either change the Add2or3Ints ScalarFunction class or create a totally different class to handle adding more integers together. However, adding more classes to accept each variation in the arguments quickly becomes overwhelming. In that case, you should consider creating a polymorphic UDF (see [Creating a Polymorphic UDF](#) (page 498) for more information).

## Creating a Polymorphic UDF

Polymorphic UDFs accept any number and type of argument that the user supplies. HP Vertica does not check the number or types of argument that the user passes to the UDF—it just passes the UDF all of the arguments supplied by the user. It is up to your polymorphic UDF's main processing function (for example, `processBlock` in User Defined Scalar Functions) to examine the number and types of arguments it received and determine if it can handle them.

**Note:** User Defined Transform Functions (UDTFs) can have an unlimited number of arguments. All other UDFs except UDTFs are limited to a maximum number of 32 arguments.

Polymorphic UDFs are more flexible than using multiple factory classes for your function (see [User Defined Function Overloading](#) (page 494)), since your function can determine at run time if it can process the arguments rather than accepting specific sets of arguments. However, your polymorphic function needs to perform more work to determine whether it can process the arguments that it has been given.

Your polymorphic UDF declares it accepts any number of arguments in its factory's `getPrototype` function by calling the `addAny` function on the `ColumnTypes` object that defines its arguments. This "any parameter" argument type is the only one that your function can declare. You cannot define required arguments and then call `addAny` to declare the rest of the signature as optional. If your function has requirements for the arguments it accepts, your `process` function must enforce them.

The following example shows an implementation of a `ScalarFunction` that adds together two or more integers.

```

#include "Vertica.h"

using namespace Vertica;
using namespace std;

// Adds two or more integers together.
class AddManyInts : public Vertica::ScalarFunction
{
public:
 virtual void processBlock(Vertica::ServerInterface &srvInterface,
 Vertica::BlockReader &arg_reader,
 Vertica::BlockWriter &res_writer)
 {
 // Always catch exceptions to prevent causing the side process or
 // Vertica itself from crashing.
 try
 {
 // Find the number of arguments sent.
 size_t numCols = arg_reader.getNumCols();

 // Make sure at least 2 arguments were supplied
 if (numCols < 2)
 vt_report_error(0, "Function expects at least 2 integer
parameters");

 // Make sure all types are ints
 const SizedColumnTypes &inTypes = arg_reader.getTypeMetaData();
 for (int param=0; param < (int)numCols; param++) {
 const VerticaType &t = inTypes.getColumnType(param);
 if (!t.isInt())
 {
 string typeDesc = t.getPrettyPrintStr();
 // Report that the user supplied a non-integer value.
 vt_report_error(0, "Function expects all arguments to be "
 "INTEGER. Argument %d was %s", param+1,
 typeDesc.c_str());
 }
 }
 do
 { // total up the arguments and write out the total.
 vint total = 0;
 int x;
 // Loop over all params, adding them up.
 for (x=0; x<(int)numCols; x++) {
 total += arg_reader.getIntRef(x);
 }
 res_writer.setInt(total);
 res_writer.next();
 } while (arg_reader.next());
 } catch(exception& e) {
 // Standard exception. Quit.
 vt_report_error(0, "Exception while processing partition: [%s]",
 e.what());
 }
}

```

```
}

// Defines the AddMany function.
class AddManyIntsFactory : public Vertica::ScalarFunctionFactory
{
 // Return the function object to process the data.
 virtual Vertica::ScalarFunction *createScalarFunction(
 Vertica::ServerInterface &srvInterface)
 { return vt_createFuncObj(srvInterface.allocator, AddManyInts); }

 // Define the number and types of arguments that this function accepts
 virtual void getPrototype(Vertica::ServerInterface &srvInterface,
 Vertica::ColumnTypes &argTypes,
 Vertica::ColumnTypes &returnType)
 {
 argTypes.addAny(); // Must be only argument type.
 returnType.addInt();
 }
};

RegisterFactory(AddManyIntsFactory);
```

Most of the work in the example is done by the `ScalarFunction.processBlock` function. It performs two checks on the arguments that have been passed in through the `BlockReader` object:

- Ensures there are at least two arguments
- Checks the data type of all arguments to ensure they are all integers

Once the checks are performed, the example processes the block of data by looping over the arguments and adding them together.

You assign a SQL name to your polymorphic UDF using the same statement you use to assign one to a non-polymorphic UDF. The following demonstration shows how you load and call the polymorphic function from the example.

```
=> CREATE LIBRARY addManyIntsLib AS '/home/dbadmin/AddManyInts.so';
CREATE LIBRARY
=> CREATE FUNCTION addManyInts AS NAME 'AddManyIntsFactory' LIBRARY addManyIntsLib
FENCED;
CREATE FUNCTION

=> SELECT addManyInts(1,2);
addManyInts

 3
(1 row)

=> SELECT addManyInts(1,2,3,40,50,60,70,80,900);
addManyInts

 1206
```

(1 row)

```
=> SELECT addManyInts(1); -- Too few parameters
ERROR 3412: Failure in UDX RPC call InvokeProcessBlock(): Error calling
processBlock() in User Defined Object [addManyInts] at
[AddManyInts.cpp:51], error code: 0, message: Exception while processing
partition: [Function expects at least 2 integer parameters]

=> SELECT addManyInts(1,2.232343); -- Wrong data type
ERROR 3412: Failure in UDX RPC call InvokeProcessBlock(): Error
calling processBlock() in User Defined Object [addManyInts] at
[AddManyInts.cpp:51], error code: 0, message: Exception while
processing partition: [Function expects all arguments to be INTEGER.
Argument 2 was Numeric(7,6)]
```

Notice that the errors returned by last two calls to the function were generated by the `processBlock` function. It is up to your UDF to ensure that the user supplies the correct number and types of arguments to your function and exit with an error if it cannot process them.

### Polymorphic UDFs and Schema Search Paths

If a user does not supply a schema name as part of a function call, HP Vertica searches each schema in the schema search path for a function whose name and signature match the function call. See Setting Schema Search Paths in the Administrator's Guide for more information about schema search paths.

Since polymorphic functions do not have a specific signature associated with them, HP Vertica initially skips them when searching for a function to handle the function call. If none of the schemas in the search path contain a function whose name and signature match the function call, HP Vertica searches the schema search path again for a polymorphic function whose name matches the function name in the function call.

This behavior gives precedence to functions whose signature exactly matches the function call. It allows you to create a "catch all" polymorphic function that is called only if none of the non-polymorphic functions with the same name have matching signatures.

This behavior may cause confusion if your users expect the the first polymorphic function in the schema search path to handle a function call. To avoid confusion, you should:

- Avoid using the same name for different functions. You should always uniquely name functions unless you intend to create an overloaded function with multiple signatures.
- When you cannot avoid having functions with the same name in different schemas, always supply the schema name as part of the function call. Using the schema name prevents ambiguity and ensures that HP Vertica uses the correct function to process your function calls.

## UDF Parameters

Parameters let you define arguments for your UDFs that remain constant across all of the rows processed by the SQL statement that calls your UDF. Typically, your UDFs accept arguments that come from columns in a SQL statement. For example, in the following SQL statement, the arguments `a` and `b` to the `add2ints` UDSF change value for each row processed by the `SELECT` statement:

```
=> SELECT a, b, add2ints(a,b) AS 'sum' FROM example;
 a | b | sum
---+---+---
 1 | 2 | 3
 3 | 4 | 7
 5 | 6 | 11
 7 | 8 | 15
 9 | 10 | 19
(5 rows)
```

Parameters remain constant for all the rows your UDF processes. You can also make parameters optional so that if the user does not supply it, your UDF uses a default value. For example, the following example demonstrates calling a UDSF named `add2intsWithConstant` that has a single parameter value named `constant` whose value is added to each the arguments supplied in each row of input:

```
=> SELECT a, b, add2intsWithConstant(a, b USING PARAMETERS constant=42)
-> AS 'a+b+42' from example;
 a | b | a+b+42
---+---+---
 1 | 2 | 45
 3 | 4 | 49
 5 | 6 | 53
 7 | 8 | 57
 9 | 10 | 61
(5 rows)
```

**Note:** When calling a UDF with parameters, there is no comma between the last argument and the `USING PARAMETERS` clause.

The topics in this section explain how to develop UDFs that accept parameters.

### Defining the Parameters Your UDF Accepts

You define the parameters that your UDF accepts in its factory class (`ScalarFunctionFactory`, `AggregateFunctionFactory`, etc.) by implementing the `getParameterType` function. This function is similar to the `getReturnType` function: you call data-type-specific functions on a `SizedColumnTypes` object that is passed in as a parameter. Each function call sets the name, data type, and width or precision (if the data type requires it) of the parameter.

The following code fragment demonstrates adding a single parameter to the add2ints UDSF example. The `getParameterType` function defines a single integer parameter that is named `constant`.

```

class Add2intsWithConstantFactory : public ScalarFunctionFactory
{
 // return an instance of Add2ints to perform the actual addition.
 virtual ScalarFunction *createScalarFunction(ServerInterface &interface)
 {
 // Calls the vt_createFuncObj to create the new Add2ints class instance.
 return vt_createFuncObj(interface.allocator, Add2intsWithConstant);
 }

 // Report the argument and return types to Vertica
 virtual void getPrototype(ServerInterface &interface,
 ColumnTypes &argTypes,
 ColumnTypes &returnType)
 {
 // Takes two ints as inputs, so add ints to the argTypes object
 argTypes.addInt();
 argTypes.addInt();
 // returns a single int.
 returnType.addInt();
 }

 // Defines the parameters for this UDSF. Works similarly to defining
 // arguments and return types.
 virtual void getParameterType(ServerInterface &srvInterface,
 SizedColumnTypes ¶meterTypes)
 {
 // One INTEGER parameter named constant
 parameterTypes.addInt("constant");
 }
};

RegisterFactory(Add2intsWithConstantFactory);

```

See the HP Vertica SDK entry for `SizedColumnTypes` for a full list of the data-type-specific functions you can call to define parameters.

## Getting Parameter Values in UDFs

Your UDF uses the parameter values it declared in its factory class (see [Defining the Parameters Your UDF Accepts](#) (page 502)) in its function class's process function (for example, `processBlock` or `processPartition`). It gets its parameter values from a `ParamReader` object, which is available from the `ServerInterface` object that is passed to your process function. Reading parameters from this object is similar to reading argument values from `BlockReader` or `PartitionReader` objects: you call a data-type-specific function with the name of the parameter to retrieve its value. For example:

```
// Get the parameter reader from the ServerInterface to see if
// there are supplied parameters
ParamReader paramReader = srvInterface.getParamReader();
// Get the value of an integer parameter named constant
const vint constant = paramReader.getIntRef("constant");
```

**Note:** String data values do not have any of their escape characters processed before they are passed to your function. Therefore, your function may need to process the escape sequences itself if it needs to operate on unescaped character values.

## Testing Whether the User Supplied Parameter Values

Unlike arguments, HP Vertica does not immediately return an error if a user's function call does not include a value for a parameter defined by your UDF's factory class. This means that your function can attempt to read a parameter value that the user did not supply. If it does so, HP Vertica returns a non-existent parameter error to the user, and the query containing the function call is canceled. This behavior is fine if you want a parameter to be required by your UDF—just attempt to access its value. If the user didn't supply a value, HP Vertica reports the resulting error about a missing parameter to the user.

If you want your parameter to be optional, you can test whether the user supplied a value for the parameter before attempting to access its value. Your function determines if a value exists for a particular parameter by calling the `ParamReader::containsParameter` function with the parameter's name. If this function returns true, your function can safely retrieve the value. If this function returns false, your UDF can use a default value or change its processing in some other way to compensate for not having the parameter value. As long as your UDF does not try to access the non-existent parameter value, HP Vertica does not generate an error or warning about missing parameters.

**Note:** If the user passes your UDF a parameter that it has not defined, HP Vertica issues a warning that the parameter is not used. It still executes the SQL statement, ignoring the parameter.

The following code fragment demonstrates using the parameter value that was defined in the example shown in [Defining the Parameters Your UDF Accepts](#) (page 502). The `Add2intsWithConstant` class defines a function that adds two integer values. If the user supplies it, the function also adds the value of the optional integer parameter named `constant`.

```

/**
 * A UDSF that adds two numbers together with a constant value.
 */
class Add2intsWithConstant : public ScalarFunction
{
public:

 // Processes a block of data sent by Vertica
 virtual void processBlock(ServerInterface &srvInterface,
 BlockReader &arg_reader,
 BlockWriter &res_writer)
 {
 try
 {
 // The default value for the constant parameter is 0.
 vint constant = 0;

 // Get the parameter reader from the ServerInterface to see if
 // there are supplied parameters
 ParamReader paramReader = srvInterface.getParamReader();

 // See if the user supplied the constant parameter
 if (paramReader.containsParameter("constant"))
 // There is a parameter, so get its value.
 constant = paramReader.getIntRef("constant");

 // While we have input to process
 do
 {
 // Read the two integer input parameters by calling the
 // BlockReader.getIntRef class function
 const vint a = arg_reader.getIntRef(0);
 const vint b = arg_reader.getIntRef(1);
 // Add arguments plus constant
 res_writer.setInt(a+b+constant);
 // Finish writing the row, and advance to the next
 // output row
 res_writer.next();
 // Continue looping until there are no more input rows
 }
 while (arg_reader.next());
 }
 catch (exception& e)
 {
 // Standard exception. Quit.
 vt_report_error(0, "Exception while processing partition: %s",
 e.what());
 }
 }
};

```

## Using Parameters in the Factory Class

In addition to using parameters in your UDF function class, you can also access the parameters in the factory class. You may want to access the parameters to let the user control the input or output values of your function in some way. For example, your UDF can have a parameter that lets the user choose to have your UDF return a single or double-precision value. The process of accessing parameters in the factory class is the same as accessing it in the function class: get a `ParamReader` object from the `ServerInterface::getParamReader` function, them read the parameter values.

## Calling UDFs with Parameters

You pass parameters to a UDF by adding a `USING PARAMETERS` clause in the function call after the last argument. There is no comma between the last argument and the `USING PARAMETERS` clause. After the `USING PARAMETERS` clause you add one or more parameter definitions which contains the parameter name, followed by an equal sign, then the parameter's value. Multiple parameter definitions are separated by commas.

**Note:** Parameter values can be a constant expression (for example `1234 + SQRT(5678)`). You cannot use volatile functions (such as `RANDOM`) in the expression, since they do not return a constant value. If you do supply a volatile expression as a parameter value, HP Vertica returns an incorrect parameter type warning, and tries to run the UDF without the parameter value. If the UDF requires the parameter, it returns its own error which cancels the query.

The following example demonstrates calling the `add2intsWithConstant` UDSF example from [Defining the Parameters Your UDF Accepts](#) (page 502) and [Getting Parameter Values in UDFs](#) (page 503):

```
=> SELECT a, b, add2intsWithConstant(a, b USING PARAMETERS constant=42)
-> AS 'a+b+42' from example;
 a | b | a+b+42
---+---+-----
 1 | 2 | 45
 3 | 4 | 49
 5 | 6 | 53
 7 | 8 | 57
 9 | 10 | 61
(5 rows)
```

Multiple parameters are separated by commas. The following example calls a version of the `tokenize` UDTF that has parameters to limit the shortest allowed word and force the words to be output in uppercase.

```
=> SELECT url, tokenize(description USING PARAMETERS
-> minLength=4, uppercase=true) OVER (partition by url) FROM t;
 url | words
-----+-----
www.amazon.com | ONLINE
www.amazon.com | RETAIL
www.amazon.com | MERCHANT
www.amazon.com | PROVIDER
www.amazon.com | CLOUD
www.amazon.com | SERVICES
www.hp.com | LEADING
```

```

www.hp.com | PROVIDER
www.hp.com | COMPUTER
www.hp.com | HARDWARE
www.hp.com | IMAGING
www.hp.com | SOLUTIONS
www.vertica.com | WORLD'S
www.vertica.com | FASTEST
www.vertica.com | ANALYTIC
www.vertica.com | DATABASE
(16 rows)

```

The `add2intsWithConstant` UDSF's constant parameter is optional; calling it without the parameter does not return an error or warning:

```

=> SELECT a,b,add2intsWithConstant(a, b) AS 'sum' FROM example;
 a | b | sum
-----+-----+
 1 | 2 | 3
 3 | 4 | 7
 5 | 6 | 11
 7 | 8 | 15
 9 | 10 | 19
(5 rows)

```

Calling a UDF with incorrect parameters does generate a warning, but the query still runs:

```

=> SELECT a, b, add2intsWithConstant(a, b USING PARAMETERS wrongparam=42)
-> AS 'result' from example;
WARNING 4332: Parameter wrongparam was not registered by the function and cannot
be coerced to a definite data type
 a | b | result
-----+-----+
 1 | 2 | 3
 3 | 4 | 7
 5 | 6 | 11
 7 | 8 | 15
 9 | 10 | 19
(5 rows)

```

## UDF Resource Use

Your UDFs consume at least a small amount of memory by instantiating classes and creating local variables. This basic memory usage by UDFs is small enough that you do not need to be concerned about it.

If your UDF needs to allocate more than one or two megabytes of memory for data structures, or requires access additional resources such as files, you must inform HP Vertica about its resource use. HP Vertica can then ensure that the resources your UDF requires are available before running a query that uses it. Even moderate memory use (10MB per invocation of a UDF, for example) can become an issue if there are many simultaneous queries that call it.

## Allocating Resources

You have two options for allocating memory and file handles for your User Defined Functions (UDFs):

- Use HP Vertica SDK macros to allocate resources. This is the best method, since it uses HP Vertica's own resource manager, and guarantees that resources used by your UDF are reclaimed. See **Allocating Resources with the SDK Macros** (page [509](#)).
- Allocate resources in your UDFs yourself using standard C++ methods (instantiating objects using `new`, allocating memory blocks using `malloc`, etc.). You must manually free these resources before your UDF exits.

**Note:** You must be extremely careful if you choose to allocate your own resources in your UDF. Failing to free resources properly will have significant negative impact, especially if your UDF is running in unfenced mode.

Whichever method you choose, you usually allocate resources in a function named `setup` (subclassed from `(Vertica::UDXObject::setup)`) in your function class. This function is called after your UDF function object is instantiated, but before HP Vertica calls it to process data.

If you allocate memory on your own in `setup` function, you must free it in a function named `destroy` (subclassed from `Vertica::UDXObject::destroy`) in your function class. This function is called after your UDF has performed all of its processing. This function is also called if your UDF returns an error (see **Handling Errors** (page [514](#))).

**Note:** Always use the `setup` and `destroy` functions to allocate and free resources instead of your own constructors and destructors. The memory for your UDF object is allocated from one of HP Vertica's own memory pools. HP Vertica always calls your UDF's `destroy` function before it deallocates the object's memory. There is no guarantee that your UDF's destructor is called before the object is deallocated. Using the `destroy` function ensures that your UDF has a chance to free its allocated resources before it is destroyed.

The following code fragment demonstrates allocating and freeing memory using a `setup` and `destroy` function.

```

class MemoryAllocationExample : public ScalarFunction
{
public:
 uint64* myarray;

 // Called before running the UDF to allocate memory used throughout
 // the entire UDF processing.
 virtual void setup(ServerInterface &srvInterface, const SizedColumnTypes
 &argTypes)
 {
 try
 {
 // Allocate an array. This memory is directly allocated, rather than
 // letting Vertica do it. Remember to properly calculate the amount
 // of memory you need based on the data type you are allocating.
 // This example divides 500MB by 8, since that's the number of
 // bytes in a 64-bit unsigned integer.
 myarray = new uint64[1024 * 1024 * 500 / 8];
 }
 catch (std::bad_alloc &ba)
 {
 // Always check for exceptions caused by failed memory
 // allocations.
 vt_report_error(1, "Couldn't allocate memory :[%s]", ba.what());
 }
 }

 // Called after the UDF has processed all of its information. Use to free
 // any allocated resources.
 virtual void destroy(ServerInterface &srvInterface, const SizedColumnTypes
 &argTypes)
 {
 // srvInterface.log("RowNumber processed %d records", *count_ptr);
 try
 {
 // Properly dispose of the allocated memory.
 delete[] myarray;
 }
 catch (std::bad_alloc &ba)
 {
 // Always check for exceptions caused by failed memory
 // allocations.
 vt_report_error(1, "Couldn't free memory :[%s]", ba.what());
 }
 }
}

```

## Allocating Resources with the SDK Macros

The HP Vertica SDK provides three macros to allocate memory:

- `vt_malloc` allocates a block of memory to fit a specific data type (vint, struct, etc.).
- `vt_mallocArray` allocates a block of memory to hold an array of a specific data type.
- `vt_mallocSize` allocates an arbitrarily-sized block of memory.

All of these macros allocate their memory from memory pools managed by HP Vertica. The main benefit of allowing HP Vertica to manage your UDF's memory is that the memory is automatically reclaimed after your UDF has finished. This ensures there is no memory leaks in your UDF.

You do not free any of the memory you allocate through any of these macros. The memory is automatically reclaimed by the HP Vertica process when the UDF has finished running. Attempting to free this memory will result in run-time errors.

## Informing HP Vertica of Resource Requirements

When you run your UDF in fenced mode, HP Vertica monitors its use of memory and file handles. If your UDF uses more than a few megabytes of memory or any file handles, it should tell HP Vertica about its resource requirements. Knowing the resource requirements of your UDF allows HP Vertica to determine whether it can run the UDF immediately or needs to queue the request until enough resources become available to run it.

Determining how much memory your UDF requires can be difficult in some case. For example, if your UDF extracts unique data elements from a data set, and there is potentially no bounds on the number of data items. In this case, a useful technique is to run your UDF in a test environment and monitor its memory use on a node as it handles several differently-sized queries, then extrapolate its memory use based on the worst case scenario it may face in your production environment. In all cases, it's usually a good idea to add a safety margin to the amount of memory you tell HP Vertica your UDF uses.

**Note:** The information on your UDF's resource needs that you pass to HP Vertica is used when planning the query execution. There is no way to change the amount of resources your UDF requests from HP Vertica while the UDF is actually running.

Your UDF informs HP Vertica of its resource needs by implementing the `getPerInstanceResources` function in its factory class (see `Vertica::UDXFactory::getPerInstanceResources` in the SDK documentation). If your UDF's factory class implements this function, HP Vertica calls it to determine the resources your UDF requires.

The `getPerInstanceResources` function receives an instance of the `Vertica::VResources` struct, which contains fields setting the amount of memory and the number of file handles your UDF may need to use. Your implementation of this function sets these fields based on the maximum resources your UDF may consume for each instance of the UDF function. So, if your UDF's `ProcessBlock` function creates a data structure that uses at most 100MB of memory, your UDF should set the `VResources.scratchMemory` field to at least 104857600 (the number of bytes in 100MB). Rounding up to a number like 115000000 (just under 110MB) is a good idea.

The following `ScalarFunctionFactory` class demonstrates calling `getPerInstanceResources` to inform HP Vertica about the memory requirements of the `MemoryAllocationExample` class shown in [Allocating Resources](#) (page 508). It tells HP Vertica that the UDSF requires 510MB of memory (which is a bit more than the UDSF actually allocates, to be on the safe size).

```
class MemoryAllocationExampleFactory : public ScalarFunctionFactory
{
 virtual Vertica::ScalarFunction
*createScalarFunction(Vertica::ServerInterface
 &srvInterface)
 {
 return vt_createFuncObj(srvInterface.allocator,
MemoryAllocationExample);
 }

 virtual void getPrototype(Vertica::ServerInterface &srvInterface,
 Vertica::ColumnTypes &argTypes,
 Vertica::ColumnTypes &returnType)
 {
 argTypes.addInt();
 argTypes.addInt();
 returnType.addInt();
 }

 // Tells Vertica the amount of resources that this UDF uses.
 virtual void getPerInstanceResources(ServerInterface &srvInterface,
 VResources &res)
 {
 res.scratchMemory += 1024LL * 1024 * 510; // request 510MB of memory
 }
};
```

## Setting Memory Limits for Fenced Mode UDFs

HP Vertica calls fenced-mode UDF's implementation of `Vertica::UDXFactory::getPerInstanceResources` to determine if there are enough free resources to run the query containing the UDF (see [Informing HP Vertica of Resource Requirements](#) (page 510)). Since these reports are not generated by actual memory use, they can be inaccurate. Once started by HP Vertica, a UDF could allocate far more memory or file handles than it reported it needs.

The `FencedUDxMemoryLimitMB` configuration parameter lets you create an absolute memory limit for UDFs. Any attempt by a UDF to allocate more memory than this limit results in a `bad_alloc` exception. For more information on configuration parameters, see Configuration Parameters in the Administrator's Guide. For an example of setting `FencedUDxMemoryLimitMB`, see [How Resource Limits Are Enforced](#) (page 512).

## How Resource Limits Are Enforced

Before running a query, HP Vertica determines how much memory it requires to run. If the query contains a fenced-mode UDF which implements the `getPerInstanceResources` function in its factory class, HP Vertica calls it to determine the amount of memory the UDF needs and adds this to the total required for the query. Based on these requirements, HP Vertica decides how to handle the query:

- If the total amount of memory required (including the amount that the UDFs report that they need) is larger than the session's `MEMORYCAP` or resource pool's `MAXMEMORYSIZE` setting, HP Vertica rejects the query. For more information about resource pools, see [Resource Pool Architecture in the Administrator's Guide](#).
- If the amount of memory is below the limit set by the session and resource pool limits, but there is currently not enough free memory to run the query, HP Vertica queues it until enough resources become available.
- If there is enough free resources to run the query, HP Vertica executes it.

**Note:** HP Vertica has no other way to determine the amount of resources a UDF requires other than the values it reports using the `getPerInstanceResources` function. A UDF could use more resources than it claims, which could cause performance issues for other queries that are denied resources. You can set an absolute limit on the amount of memory UDFs can allocate. See [\*\*Setting Memory Limits for Fenced Mode UDFs\*\*](#) (page [511](#)) for more information.

If the process executing your UDF attempts to allocate more memory than the limit set by the `FencedUDxMemoryLimitMB` configuration parameter, it receives a `bad_alloc` exception. For more information about `FencedUDxMemoryLimitMB`, see [\*\*Setting Memory Limits for Fenced Mode UDFs\*\*](#) (page [511](#)).

Below is the output of loading a UDSF that consumes 500MB of memory, then changing the memory settings to cause out of memory errors. The `MemoryAllocationExample` UDSF in the following example is just the `Add2Ints` UDSF example altered as shown in [\*\*Allocating Resources\*\*](#) (page [508](#)) and [\*\*Informing HP Vertica of Resource Requirements\*\*](#) (page [510](#)) to allocate 500MB of RAM.

```
=> CREATE LIBRARY mylib AS '/home/dbadmin/MemoryAllocationExample.so';
CREATE LIBRARY
=> CREATE FUNCTION usemem AS NAME 'MemoryAllocationExampleFactory' LIBRARY mylib
-> FENCED;
CREATE FUNCTION
=> SELECT usemem(1,2);
usemem

 3
(1 row)
```

The following statements demonstrate setting the session's `MEMORYCAP` to lower than the amount of memory that the UDSF reports it uses. This causes HP Vertica to return an error before it executes the UDSF.

```
=> SET SESSION MEMORYCAP '100M';
```

```

SET
=> SELECT usemem(1,2);
ERROR 3596: Insufficient resources to execute plan on pool sysquery [Request
exceeds session memory cap: 520328KB > 102400KB]
=> SET SESSION MEMORYCAP = default;
SET

```

The resource pool can also prevent a UDF from running if it requires more memory than is available in the pool. The following statements demonstrate the effect of creating and using a resource pool that has too little memory for the UDSF to run. Similar to the session's MAXMEMORYCAP limit, the pool's MAXMEMORYSIZE setting prevents HP Vertica from executing the query containing the UDSF.

```

=> CREATE RESOURCE POOL small MEMORIESIZE '100M' MAXMEMORYSIZE '100M';
CREATE RESOURCE POOL
=> SET SESSION RESOURCE POOL small;
SET
=> CREATE TABLE ExampleTable(a int, b int);
CREATE TABLE
=> INSERT /*+direct*/ INTO ExampleTable VALUES (1,2);
OUTPUT

1
(1 row)
=> SELECT usemem(a, b) FROM ExampleTable;
ERROR 3596: Insufficient resources to execute plan on pool small [Request Too
Large:Memory(KB) Exceeded: Requested = 523136, Free = 102400 (Limit = 102400, Used
= 0)]
=> DROP RESOURCE POOL small CASCADE; --Dropping the pool resets the session's pool
DROP RESOURCE POOL

```

Finally, setting the FencedUDxMemoryLimitMB configuration parameter to lower than the UDF actually allocates results in the UDF throwing an exception. This is a different case than either of the previous two examples, since the query actually executes. The UDF's code needs to catch and handle the exception. In this example, it uses the `vt_report_error` macro to report the error back to HP Vertica and exit.

```

=> SELECT set_config_parameter('FencedUDxMemoryLimitMB', '300');
set_config_parameter

Parameter set successfully
(1 row)
=> SELECT usemem(1,2);
ERROR 3412: Failure in UDX RPC call InvokeSetup(): Error calling setup() in User
Defined Object [usemem] at [MemoryAllocationExample.cpp:32], error code: 1,
message: Couldn't allocate memory :[std::bad_alloc]
=> SELECT set_config_parameter('FencedUDxMemoryLimitMB', '-1');
set_config_parameter

Parameter set successfully
(1 row)
=> SELECT usemem(1,2);
usemem

```

```
3
(1 row)
```

## See Also

- SET SESSION RESOURCE\_POOL
- SESSION MEMORYCAP
- SET\_CONFIG\_PARAMETER

## Handling Errors

If your UDF encounters some sort of error, it can report it back to HP Vertica using the `vt_report_error` macro. When called, this macro halts the execution of the UDF and causes the statement that called the function to fail. The macro takes two parameters: an error number and a error message string. Both the error number and message appear in the error that HP Vertica reports to the user. The error number is not defined by HP Vertica. You can use whatever value that you wish.

For example, the following `ScalarFunction` class divides two integers. To prevent division by zero, it tests the second parameter. If it is zero, the function reports the error back to HP Vertica.

```
/*
 * Demonstrate reporting an error
 */
class Div2ints : public ScalarFunction
{
public:

 virtual void processBlock(ServerInterface &srvInterface,
 BlockReader &arg_reader,
 BlockWriter &res_writer)
 {
 // While we have inputs to process
 do
 {
 const vint a = arg_reader.getIntRef(0);
 const vint b = arg_reader.getIntRef(1);
 if (b == 0)
 {
 vt_report_error(1,"Attempted divide by zero");
 }
 res_writer.setInt(a/b);
 res_writer.next();
 }
 while (arg_reader.next());
 }
};
```

Loading and invoking the function demonstrates how the error appears to the user.

```
=> CREATE LIBRARY Div2IntsLib AS '/home/dbadmin/Div2ints.so';
CREATE LIBRARY
=> CREATE FUNCTION div2ints AS LANGUAGE 'C++' NAME 'Div2intsInfo' LIBRARY
Div2IntsLib;
CREATE FUNCTION
=> SELECT div2ints(25, 5);
div2ints

 5
(1 row)

=> SELECT * FROM MyTable;
 a | b
---+---
 12 | 6
 7 | 0
 12 | 2
 18 | 9
(4 rows)

=> SELECT * FROM MyTable WHERE div2ints(a, b) > 2;
ERROR: Error in calling processBlock() for User Defined Scalar Function
div2ints at Div2ints.cpp:21, error code: 1, message: Attempted divide by zero
```

## Handling Cancel Requests

You can cancel a query that calls your UDF (usually, by pressing **CTRL+C** in vsql). How HP Vertica handles the cancellation of the query and your UDF depends on whether your UDF is running in fenced or unfenced mode:

- If your UDF is running in unfenced mode, HP Vertica either stops the function when it requests a new block of input or output, or waits until your function completes running and discards the results.
- If your UDF is running in **fenced mode**, HP Vertica kills the zygote process that is running your function if it continues processing past a timeout.

See **Fenced Mode** for more information about running functions in fenced mode.

To give you more control over what happens to your function when the user cancels its query, the HP Vertica SDK includes an API for some UDFs to handle cancellation. Any function class that inherits from the `Vertica::UDXObjectCancelable` class can test whether the query calling it has been canceled using a function named `isCanceled`. Your function can also implement a callback function named `cancel` that HP Vertica calls when the function's query is canceled. Currently, the two classes that inherit from `UDXObjectCancelable` are `TransformFunction` and `AnalyticFunction`.

The topics in this section explain how to use the `cancel` API.

## Exiting When the Calling Query Has Been Canceled

The `processPartition` function in your User Defined Transform Function (UDTF) or Analytic Function (UDAnF) can call `Vertica::UDXObjectCancelable.isCanceled` to determine if the user has canceled the query that called it. If `isCanceled` returns true, the query has been canceled and your `processPartition` function should exit immediately to prevent it from wasting CPU time. If your UDF is not running in **fenced mode**, HP Vertica cannot halt your function, and has to wait for it to finish. If it is running in fenced mode, HP Vertica can eventually kill the side process running it, but not until it has wasted some processing time.

How often your `processPartition` function calls `isCanceled` depends on how much processing it performs on each row of data. Calling `isCanceled` does add some overhead to your function, so you shouldn't call it too often. For transforms that do not perform lengthy processing, you could check for cancelation every 100 or 1000 rows or so. If your `processPartition` performs extensive processing for each row, you may want to check `isCanceled` every 10 or so rows.

The following code fragment shows how you could have the `StringTokenizer` UDTF example check whether its query has been canceled:

```
// The primary class for the StringTokenizer UDTF.
class StringTokenizer : public TransformFunction {
 // Called for each partition in the table. Recieves the data from
 // The source table and
 virtual void processPartition(ServerInterface &srvInterface,
 PartitionReader &inputReader,
 PartitionWriter &outputWriter) {
 try {
 // Loop through the input rows
 int rowCount = 0; // Count the number of rows processed.
 do {
 rowCount++; // Processing a new row of data
 // Check for cancelation every 100 rows.
 if (rowCount % 100 == 0)
 {
 if (isCanceled()) // See if query has been canceled
 {
 // Log cancelation
 srvInterface.log("Got canceled!");
 return; // Exit out of UDTF immediately.
 }
 }
 }
 // Rest of the function here
 }
 }
}
```

This example checks for cancelation after processing 100 rows in the partition of data. If the query has been canceled, the example logs a message, then returns to the caller to exit the function.

**Note:** You need to strike a balance between adding overhead to your functions by calling `isCanceled` and having your functions waste CPU time by running after their query has been canceled (usually, a rare event). For functions such as `StringTokenizer` which have a low overall processing cost, it usually does not make sense to test for cancellation. The cost of adding overhead to all function calls outweigh the amount of resources wasted by having the function run to completion or having its zygote process killed by HP Vertica on the rare occasions that its query is canceled.

## Implementing the Cancel Callback Function

Your User Defined Transform Function (UDTF) or Analytic Function (UDAnF) can implement a `cancel` callback function that HP Vertica calls if the query that called the function has been canceled. You usually implement this function to perform an orderly shutdown of any additional processing that your UDF spawned. For example, you can have your `cancel` function shut down threads that your UDF has spawned or signal a third-party library that it needs to stop processing and exit. Your `cancel` function should leave your UDF's function class ready to be destroyed, since HP Vertica calls the UDF's `destroy` function after the `cancel` function has exited.

### Notes

- If your UDTF or UDAnF does not implement `cancel`, HP Vertica assumes your UDF does not need to perform any special cancel processing, and calls the function class's `destroy` function to have it free any resources (see [UDF Resource Use](#) (page 507)).
- Your `cancel` function is called from a different thread than the thread running your UDF's `processPartition` function.
- The call to the `cancel` function is not synchronized in any way with your UDF's `processPartition` function. If you need your `processPartition` function to exit before your `cancel` function performs some action (killing threads, for example) you need to have the two function synchronize their actions.
- If your `cancel` function runs for too long, HP Vertica kills the side process running your function, if it is running in **fenced mode**.

## UDF Debugging Tips

You must thoroughly debug your UDF before deploying it to a production environment. The following tips can help you get your UDF ready for deployment.

### Use a Single Node For Initial Debugging

You can attach to the HP Vertica process using a debugger such as `gdb` to debug your UDF code. Doing this in a multi-node environment, however, is very difficult. Therefore, consider setting up a single-node HP Vertica test environment to initially debug your UDF.

## Write Messages to the HP Vertica Log

You can write to log files using the `ServerInterface.log` function. Every function in your UDF receives an instance of the `ServerInterface` object, so you can call the `log` function from anywhere in your UDF. The function acts similarly to `printf`, taking a formatted string, and an optional set of values and writing the string to a log file. Where the message is written depends on whether your function runs in fenced mode or unfenced mode:

- Functions running in unfenced mode write their messages into the `vertica.log` file in the catalog directory.
- Functions running in fenced mode write their messages into a log file named `UDxLogs/UDxFencedProcesses.log` in the catalog directory.

To help identify your function's output, HP Vertica adds the SQL function name bound to your UDF function (see [Deploying and Using UDSFs](#) (page 443) for an explanation) to the log message.

The following code fragment shows how you can add a call to `srvInterface.log` in the `Add2ints` example code's `processBlock` function to log its input values :

```
const vint a = arg_reader.getIntRef(0);
const vint b = arg_reader.getIntRef(1);
srvInterface.log("got a: %d and b: %d", (int) a, (int) b);
```

This code generates an entries in the log file for each row the . For example:

```
11-05-06 14:37:20.838 nameless:0x3f3a210 [UserMessage] <UDx> Add2ints - got a: 1 and b: 2
11-05-06 14:37:20.838 nameless:0x3f3a210 [UserMessage] <UDx> Add2ints - got a: 2 and b: 2
11-05-06 14:37:20.838 nameless:0x3f3a210 [UserMessage] <UDx> Add2ints - got a: 3 and b: 2
11-05-06 14:37:20.838 nameless:0x3f3a210 [UserMessage] <UDx> Add2ints - got a: 1 and b: 4
11-05-06 14:37:20.838 nameless:0x3f3a210 [UserMessage] <UDx> Add2ints - got a: 5 and b: 2
```

See [Monitoring the Log Files](#) in the Administrator's Guide for details on viewing the HP Vertica log files.

## Developing a User Defined Function in R

HP Vertica supports User Defined Functions written in the *R programming language* <http://www.r-project.org/>. R is a free, open source programming language used for statistical computing.

The topics in this section guide you through developing a User Defined Function in R.

### User Defined Functions in R Notes and Limitations

- You must first [\*\*install The R Language Pack for HP Vertica\*\*](#) before creating R functions inside of HP Vertica.
- User Defined Functions developed in R always run in **Fenced Mode** in a process outside of the main HP Vertica process.

- You can create Scalar Functions and Transform Functions using the R language. Other UDX types are not supported with the R language.
- NULL values in HP Vertica are translated to R **NA values** <http://cran.r-project.org/doc/manuals/R-intro.html##Missing-values> when sent to the R function. R NA values are translated into HP Vertica null values when returned from the R function to HP Vertica.
- R supports different data types than those available in HP Vertica, so data types are mapped between the two systems. This table details the data-type mapping for R:

| HP Vertica Data Type                                                                      | R Data Type |
|-------------------------------------------------------------------------------------------|-------------|
| Boolean                                                                                   | logical     |
| Date/Time:<br>DATE, DATETIME,<br>SMALLDATETIME, TIME,<br>TIMESTAMP, TIMESTAMPZ,<br>TIMETZ | numeric     |
| Approximate Numeric:<br>DOUBLE PRECISION, FLOAT,<br>REAL                                  | numeric     |
| Exact Numeric:<br>BIGINT, DECIMAL, INT,<br>NUMERIC, NUMBER, MONEY                         | numeric     |
| BINARY, VARBINARY                                                                         | character   |
| CHAR, VARCHAR                                                                             | character   |

## Installing/Upgrading the R Language Pack for HP Vertica

To use R with HP Vertica, install the RPM (or Debian .deb) R language package that matches your server version. The R language pack includes the R runtime and associated libraries for interfacing with HP Vertica.

This topic details:

- HP Vertica R Language Pack Prerequisites
- Installing the HP Vertica R Language Pack
- Upgrading the the HP Vertica R Language Pack

**Important:** You **must** install the R Language Pack on **each node** in the cluster.

**Note: The version of R has been updated in HP Vertica 6.1.2 to use R 3.0.** When upgrading from HP Vertica 6.1.0/6.1.1 (which uses R 2.14) to 6.1.2 or later, see the upgrade instructions at the end of this topic if you have installed additional R packages. If you do not follow the upgrade instructions then your additional R packages may not work.

## HP Vertica R Language Pack Prerequisites

The R Language Pack RPM requires libgfortran.so.1, which may not be installed by default on your system. Install the RPM that contains libgfortran.so.1. See the table below to determine how to install libgfortran.so.1:

| Linux Version                                           | How to Install libgfortran                                                                                                                                                                                                                                                                                                                                                                                                                        |
|---------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RHEL 6 and CentOS 6                                     | Install the compat-libgfortran-41 RPM with the command: <code>yum install compat-libgfortran-41</code>                                                                                                                                                                                                                                                                                                                                            |
| RHEL 5 and CentOS 5                                     | Install the libgfortran RPM with the command: <code>yum install libgfortran</code>                                                                                                                                                                                                                                                                                                                                                                |
| Other supported platforms that use yum, such as Suse11. | <p>You can determine the RPM needed for libgfortran.so.1 with the command:<br/> <code>yum whatprovides /usr/lib64/libgfortran.so.1</code></p> <p>Typical packages that include libgfortran.so.1 include:</p> <ul style="list-style-type: none"> <li>▪ <code>libgfortran-41-&lt;any_minor_version&gt;.rpm</code></li> <li>▪ <code>compat-libgfortran-41-&lt;any_minor_version&gt;.rpm;</code></li> <li>▪ <code>gcc41-fortran.rpm</code></li> </ul> |

## To Install the HP Vertica R Language Pack:

- 1 Download the R language package by going to the **myVertica portal** <http://my.vertica.com/>, clicking the downloads tab, and selecting the `vertica-R-lang_-version.rpm` (or .deb) file for your server version. The R language package version must match your server version to three decimal points. For example, if your server version is 6.1.1, then the R Language Pack version must also be 6.1.1.
- 2 Install the package as root or using sudo:
  - RPM: `rpm -Uvh vertica-R-lang_-version.rpm`
  - Debian: `dpkg -i vertica-R-lang_-version.deb`

The installer puts the R binary in `/opt/vertica/R`. The installer also adds the file `vertica-udx-R.conf` to `/etc/ld.so.conf.d/`. This file is removed if you uninstall the package.

## To Upgrade the HP Vertica R Language Pack:

When upgrading from HP Vertica 6.1.0 or 6.1.1 (which uses R 2.14) to 6.1.2 or later (which uses R 3.0), any R packages that you have manually installed may not work with R 3.0 and may have to be reinstalled. If you don't update your package(s), then R returns an error if the package cannot be used in R 3.0: *Error: package '[package name]' was built before R 3.0.0: please re-install it.* Instructions for upgrading these packages are below.

**Note:** The R packages provided in the R Language Pack are automatically upgraded and do not need to be reinstalled.

- 1 You must uninstall the R\_lang RPM before upgrading the server RPM. Any additional R packages that you manually installed remain in /opt/vertica/R and are not removed when you uninstall the RPM.
- 2 Upgrade your server RPM as detailed in Upgrading HP Vertica to a New Version.
- 3 After the server RPM has been updated, install the new R Language Pack on each host as detailed above in *To install the HP Vertica R Language Pack*.
- 4 If you have installed additional R packages, on each node:
  - a) as root run /opt/vertica/R/bin/R and issue the command:  
update.packages(checkBuilt=TRUE)
  - b) Select a CRAN mirror from the list displayed.
  - c) You are prompted to update each package that has an update available for it. Do **NOT** update:
    - Rcpp
    - Rinside
 You can optionally update any other packages installed with the R Language Pack. You must update any packages that you manually installed and are not compatible with R 3.0.  
 The packages you selected to be updated are installed. Quit R with the command: quit()

**Note:** HP Vertica UDx functions written in R do not need to be compiled and you do not need to reload your HP Vertica-R libraries and functions after an upgrade.

## R Packages

The HP Vertica R Language Pack includes the following R packages in addition to the default packages bundled with R:

- Rcpp
- RInside
- lpSolve
- lpSolveAPI

You can install additional R packages not included in the HP Vertica R Language Pack by using one of two methods. You **must** install the same packages on **all** nodes.

- 1) By using R Language Pack R binary at the command line and using the install.packages() R command. For example:

```
/opt/vertica/R/bin/R
...
> install.packages("Zelig");
```

- 2) By running the following command:

```
/opt/vertica/R/bin/R CMD INSTALL <path-to-package-tgz>
```

The install places the packages in: /opt/vertica/R/library.

## Using the HP Vertica SDK R Examples

HP Vertica provides example R functions in  
/opt/vertica/sdk/examples/RFunctions.RFunctions.R

You can load the examples into HP Vertica with the command:

```
CREATE LIBRARY rLib AS '/opt/vertica/sdk/examples/RFunctions.RFunctions.R'
LANGUAGE 'R';
```

You can then load the example functions included in the library. For example:

```
CREATE FUNCTION mul AS LANGUAGE 'R' NAME 'mulFactory' LIBRARY rLib;
```

## Creating R Functions

To create a user defined R function, you define:

- An R Factory Function.
- A main R function.
- Optionally, an *outtypecallback* function to define the type(s) and precision of the values returned to HP Vertica and a *parametertype* callback function to define parameter names and types.

### About the R Factory Function

User Defined Functions in R require a single factory function. The factory function wraps all of the information required by HP Vertica to load the user-defined R function. The factory function allows you to define the following:

| Parameter | Description                                                                                                                                                                                                                                                            |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| name      | The name of the primary R function in this User Defined Function.                                                                                                                                                                                                      |
| udxtype   | The type of User Defined function. Can be either "scalar" or "transform".                                                                                                                                                                                              |
| intype    | The type(s) of arguments accepted by the function. See the supported types below.<br><b>Note:</b> User Defined Scalar Functions (UDSFs) can have a maximum limit of 32 arguments. User Defined Scalar Functions (UDSFs) have no limitation on the number of arguments. |

|                       |                                                                                                                                                         |
|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| outtype               | The type(s) of arguments returned by the function. See the supported types below.                                                                       |
| outtypecallback       | (optional) The callback function to call before sending the data back to HP Vertica. It defines the types and precision that the main function returns. |
| parametertypecallback | (optional) The callback function to send parameter types and names to HP Vertica.                                                                       |
| volatility            | Indicate whether the function returns the same output given the same input, can be one of three types.                                                  |
| strictness            | Indicate whether the function always returns null when any of its input arguments is null.                                                              |

### Factory Function - Supported Data Types

The following data types are supported in the factory function:

- boolean
- int
- float
- real
- char
- varchar
- date
- datetime
- smalldatetime
- time
- timestamp
- timestamptz
- timetz
- numeric
- varbinary
- binary

### Example Factory Function

The following example is a factory function for a scalar function written in R named *mul* that takes two floats and returns a float. It also defines an outtypecallback function named *mulReturnType*.

```
mulFactory <- function()
{
 list(name=mul, udxtype=c("scalar"), intype=c("float", "float"),
 outtype=c("float"), outtypecallback=mulReturnType)
}
```

## About the Main R Function

The main function (which is defined in the name parameter of the factory function) is the first function called when HP Vertica runs your function. The main function takes as input exactly one data frame and returns a single data frame. The factory function converts the intype arguments into a data frame for the primary function. For example, intype=c("float", "float") is converted by the factory function into a two-dimensional matrix. The primary function returns a data frame, and the data frame is converted into the type defined by the outtype parameter of the factory function.

The following main function corresponds to the factory function defined earlier. It takes a data frame as input (converted from two floats) and multiplies the two values in each row of the data frame, then returns a data frame, which is converted to a single column of floats and passed back to HP Vertica.

```
mul<- function(x)
{
 pr <- x[,1] * x[,2]
 pr
}
```

## About the outtypecallback Function

You can optionally create an outtypecallback function to define the type(s), length/precision, and scale of the data being returned to HP Vertica. You return up to a four-column matrix:

- 1 data type
- 2 length/precision
- 3 scale
- 4 name of the column in the output (optional)

If any of the columns are left blank (or the outtypecallback function is omitted entirely), then HP Vertica uses default values.

When creating the outtypecallback function, you define one row for each value returned, using the same order as the outtypes that were defined in the factory function.

For example, if your function returns a data frame with three columns, containing INT, VARCHAR(24) and VARCHAR(2) data types, you could define the outtype as:

```
ret[1,1] = "int"
ret[1,4] = "product"
ret[2,1] = "varchar"
ret[2,2] = "24"
ret[3,1] = "varchar"
ret[3,2] = "2"
```

The following outtypecallback example mimics the defaults used by HP Vertica. If the outtypecallback function were omitted, then HP Vertica provides these settings as defaults.

```
mulReturnType <- function(x)
{
 ret = data.frame(datatype = rep(NA,1), length = rep(NA,1), scale =
rep(NA,1), name = rep(NA,1))
 ret[1,1] = "float"
 ret[1,4] = "product"
 ret
}
```

### Deploying the Function into HP Vertica

- To deploy a Scalar Function, see *Deploying and Using UDSFs* (page [443](#)).
- To deploy a Transform Function, see *Deploying and Using User Defined Transforms*.

Also see CREATE LIBRARY and CREATE FUNCTION in the SQL Reference Manual.

## Example R Scalar Function

```
#####
Example: Multiplication
Filename: mul.R
#####

###
@brief multiplies col1 and col2 of the input data frame.
###
mul<- function(x)
{
 pr <- x[,1] * x[,2]
 pr
}

mulFactory <- function()
{
 list(name=mul,udxtype=c("scalar"),intype=c("float","float"),
outtype=c("float"), outtypecallback=mulReturnType)
}

mulReturnType <- function(x)
{
 ret = data.frame(datatype = rep(NA,1), length = rep(NA,1), scale =
rep(NA,1), name = rep(NA,1))
 ret[1,1] = "float"
 ret[1,4] = "Multiplied"
 ret
}
```

## Example Usage:

```
dbadmin=> select * from twocols;
 x | y
----+---
 1 | 1
 2 | 2
 3 | 3
 4 | 4
 5 | 5
 6 | 6
 7 | 7
 8 | 8
 9 | 9
(9 rows)
```

```
dbadmin=> CREATE LIBRARY mulLib AS '/home/dbadmin/mul.R' LANGUAGE 'R';
CREATE LIBRARY
```

```
dbadmin=> CREATE FUNCTION mul AS NAME 'mulFactory' LIBRARY mulLib;
```

```
dbadmin=> select mul(x,y) from twocols;
Multiplied

 1
 4
 9
16
25
36
49
64
81
(9 rows)
```

## Setting Null Input and Volatility Behavior for R Functions

Starting in version 6.1, HP Vertica supports defining volatility and null-input settings for functions written in R. Both settings aid in the performance of your R function:

- Volatility settings describe the behavior of the function to the HP Vertica optimizer. For example, if you have identical rows of input data and you know the function is immutable, then you can define the function as IMMUTABLE. This tells the HP Vertica optimizer that it can return a cached value for subsequent identical rows on which the function is called rather than having the function run on each identical row.
- Null input setting determine how to respond to rows that have null input. For example, you can choose to return null if any inputs are null rather than calling the function and having the function deal with a NULL input.

### Volatility Settings

To indicate your function's volatility, set the volatility parameter of your R factory function to one of the following values:

| Value     | Description                                                                                                                                                      |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| VOLATILE  | Repeated calls to the function with the same input parameters always result in different values. HP Vertica always calls volatile functions for each invocation. |
| IMMUTABLE | Calls to the function with the same input parameters always results in the same output.                                                                          |

|                    |                                                                                                                                                                                                                                                                               |
|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| STABLE             | Repeated calls to the function with the same input <i>within the same statement</i> returns the same output. For example, a function that returns the current user name would be stable since the user cannot change within a statement, but could change between statements. |
| DEFAULT_VOLATILITY | The default volatility. This is the same as VOLATILE.                                                                                                                                                                                                                         |

If you do not define a volatility, then the function is considered to be VOLATILE.

The following example sets the volatility to STABLE in the mulFactory function:

```
mulFactory <- function()
{
 list(name=mulwithparams,udxtype=c("scalar"),intype=c("float","float"),
 outtype=c("float"),volatility=c("stable"),
 parametercallback=mulparams)
}
```

### Null Input Behavior

To indicate how your function reacts to NULL input, set the strictness parameter of your R factory function to one of the following values:

| Value                     | Description                                                               |
|---------------------------|---------------------------------------------------------------------------|
| CALLED_ON_NULL_INPUT      | The function must be called, even if one or more input values are NULL.   |
| RETURN_NULL_ON_NULL_INPUT | The function always returns a NULL value if any of its inputs are NULL.   |
| STRICT                    | A synonym for RETURN_NULL_ON_NULL_INPUT                                   |
| DEFAULT_STRICTNESS        | The default strictness setting. This is the same as CALLED_ON_NULL_INPUT. |

If you do not define a null input behavior, then the function is called on every row of data regardless of the presence of NULLS.

The following example sets the null input behavior to STRICT in the mulFactory function:

```
mulFactory <- function()
{
 list(name=mulwithparams,udxtype=c("scalar"),intype=c("float","float"),
 outtype=c("float"),strictness=c("strict"),
 parametercallback=mulparams)
}
```

## Using Parameters in R

Starting in version 6.1, HP Vertica supports using parameters in functions written in R. Parameters are passed to the R function with the **USING PARAMETERS** keyword followed by a series of key-value pairs. The function accesses parameters as the second argument it receives, which is a list of key-value pairs.

You also must specify a field in the factory function called `parametertypcallback`. This field points to the callback function that defines the parameters expected by the function. The callback function simply defines a four-column data frame:

- 1 data type
- 2 length/precision
- 3 scale
- 4 name of the column in the output (optional)

If any of the columns are left blank (or the `outtypcallback` function is omitted entirely), then HP Vertica uses default values.

### Syntax

```
SELECT <function-name>(<argument> [, ...] [USING PARAMETERS <key>=<value> [, ...]]) FROM foo;
SELECT <function-name>(<argument> [, ...] [USING PARAMETERS <key>=<value> [, ...]]) OVER (...) FROM foo;
```

### Example Usage

In version 6.0, if you created a `kmeans` function, you would have to hard code the value of K (the number of clusters in to which to group the data points) into your function. In version 6.1 and later you can, for example, specify a parameter for the value of K and assign a value to K when you call the function from within HP Vertica. For example:

```
SELECT kmeans(geonameid, latitude, longitude, country_code USING PARAMETERS k = 5) OVER (ORDER BY country_code) FROM geotab_kmeans;
```

Your R function receives everything before 'USING PARAMETERS' as the first dataframe, and the parameters are contained in the second parameter, which is a list.

## Complete R Example

```
mykmeansparams <- function(x, y)
{
 # error check and get the number of clusters to be formed
 # The y argument contains the parameters from the USING PARAMETERS clause in
 your SQL function call.
 if(!is.null(y[['k']]))

 k=as.numeric(y[['k']])
 else
 stop("Expected parameter k")
 # get the number of columns in the input data frame
 cols = ncol(x)
 # run the kmeans algorithm
 cl <- kmeans(x[,2:cols-1], k)
 # get the cluster information from the result of above
 Result <- cl$cluster
 #return result to vertica
 Result <- data.frame(VCol=Result)
 Result
}

call back function to return parameter types
kmeansParameters <- function()
{
 params <- data.frame(datatype=rep(NA, 1), length=rep(NA,1),
scale=rep(NA,1), name=rep(NA,1))
 param[1,1] = "int"
 param[1,4] = "k"
 param
}

Function that tells vertica the name of the actual R function, the parameter types
and the return types
keansFactoryParams <- function()
{
 list(name=mykmeansparams, udxtyle=c("transform"),
intype=c("int","float","float","float","float","varchar"), outtype=c("int"),
parametercallback=kmeansParameters, volatility=c("stable"),
strict=c("called_on_null_input"))
}
```

## Polymorphic Functions in R

Polymorphism in R functions allow you to easily modify how the function is used on different datasets. Polymorphic functions in R can accept any number and type of argument that the user supplies. HP Vertica does not check the number or types of argument that the user passes to the function - it just passes all of the arguments supplied by the user. It is up to your polymorphic-function's main function to examine the number and types of arguments it received and determine if it can handle them.

**Note:** Transform functions written in R can have an unlimited number of arguments. Scalar functions written in R are limited to a maximum number of 32 arguments.

Polymorphic functions are more flexible than using multiple factory classes for your function (see [User Defined Function Overloading](#) (page 494)), since your function can determine at run time if it can process the arguments rather than accepting specific sets of arguments. However, your polymorphic function needs to perform more work to determine whether it can process the arguments that it has been given.

### Declare the Function as Polymorphic

Your polymorphic R function declares it accepts any number of arguments in its factory's function by specifying "any" as the argument to the intype parameter and optionally the outtype parameter. If you define "any" argument for intype or outtype, then it is the only type that your function can declare for the respective parameter. You cannot define required arguments and then call "any" to declare the rest of the signature as optional. If your function has requirements for the arguments it accepts, your process function must enforce them.

For example, this is a factory function that declares that the function is polymorphic:

```
RFactory <- function()
{
 list(
 name=RFunction,
 udxtyle=c("transform"),
 intype=c("any"),
 outtype=c("any"),
 outtypecallback=ReturnType
)
}
```

### Define the outtypecallback for Polymorphic Functions

The outtypecallback method is used to indicate the argument types and sizes it has been called with, and is expected to indicate the types and sizes that the function returns. The outtypecallback method can also be used to check for unsupported types and/or number of arguments. For example, the function may require only integers, with no more than 10 of them. The outtypecallback function takes in two arguments, the first argument is a four-column dataframe containing the input types (data type, length/precision, scale, name of the column (optional)), and the second argument is a named list containing the parameters passed to the function.

```
Determine the return types based on the input types and sizes
polyTopKReturnType <- function(x,y)
{
 ret <- NULL
 for(i in 2:nrow(x))
 {
 rbind(ret,x[i,]) -> ret
 }
 ret
}
```

## K-means Example

The examples below uses the popular *Iris Flower Dataset*

[http://en.wikipedia.org/wiki/Iris\\_flower\\_data\\_set](http://en.wikipedia.org/wiki/Iris_flower_data_set) to demonstrate how the R k-means algorithm clusters the data and how you can use the polymorphic properties of the function to run kmeans against different columns.

```

#The k-means polymorphic algorithm

Input: A dataframe with 5 columns
Output: A dataframe with one column that tells the cluster to which each data
point belongs

mykmeansPoly <- function(x,y)
{
 # get the number of clusters to be formed
 if(!is.null(y[['k']]))

 k=as.numeric(y[['k']])
 else
 stop("Expected parameter k")

 # get the number of columns in the input data frame
 cols = ncol(x)
 # run the kmeans algorithm
 cl <- kmeans(x[,2:cols-1], k)
 # get the cluster information from the result of above
 Result <- cl$cluster
 #return result to vertica
 Result <- data.frame(VCol=Result)
 Result
}

Function that tells vertica the name of the actual R function, and the polymorphic
parameters
kmeansFactoryPoly <- function()
{
 list(name=mykmeansPoly,udxtype=c("transform"), intype=c("any"),
outtype=c("int"),parametertypecallback=kmeansParameters)
}

call back function to return parameter types
kmeansParameters <- function()
{
 params <- data.frame(datatype=rep(NA, 1), length=rep(NA,1),
scale=rep(NA,1),name=rep(NA,1))
 params[1,1] = "int"
 params[1,4] = "k"
 params
}

```

## To Use the k-means Example

- 1 Create a table to hold the Iris data:

```
create table iris (sl FLOAT, sw FLOAT, pl FLOAT, pw FLOAT, spec
VARCHAR(32));
```

- 2 Obtain the **Iris Flower Dataset** [http://en.wikipedia.org/wiki/Iris\\_flower\\_data\\_set](http://en.wikipedia.org/wiki/Iris_flower_data_set) and copy it into HP Vertica:

```
wget
http://archive.ics.uci.edu/ml/machine-learning-databases/iris/iris
.data
copy iris from '/home/dbadmin/iris.data' DELIMITER ',' EXCEPTIONS
'/home/dbadmin/iris_exceptions.txt';
```

- 3** Copy and paste the example into a file named kmean.r in the dbadmin home directory. Using vsql, create the library:

```
create library rlib2 as '/home/dbadmin/kmean.r' language 'R';
```

- 4** Create the function:

```
create transform function mykmeansPoly as language 'R' name
'kmeansFactoryPoly' library rlib2;
```

- 5** Run the function:

```
select spec, mykmeansPoly(sl,sw,pl,pw,spec) USING PARAMETERS k = 3
over(partition by spec) as kmean from iris;
```

- 6** Run the function with different number of arguments:

```
select spec, mykmeansPoly(sl,pl,spec) USING PARAMETERS k = 3
over(partition by spec) as kmean from iris;
```

- 7** To clean up the example library, function, and table:

```
drop transform function mykmeansPoly();
drop library rlib2;
drop table iris;
```

## Top K per Partition Example

Below is another example of a polymorphic function. This function computes the Top K per Partition:

```

Polymorphic Top K per partition
polyTopK<- function(x,y)
{
 # check if the input is valid
 if(ncol(x) < 2)
 {
 stop("Function takes at least 2 arguments, the first of which must be 'k'")
 }
 k = x[1,1]
 if(!check.integer(k))
 {
 stop("First argument must be an integer (the 'k' value)")
 }

 ret = NULL
 j = ncol(x)
 df = convert.factors.to.strings.in.dataframe(x)
 # output first k and break
 for(i in 1:nrow(x))
 {
 if(i > k)
 {
 break
 }
 rbind(ret,df[i,2:j])->ret
 }
 # return the top k tuples
 ret
}

Determine the return types based on the input types and sizes
polyTopKReturnType <- function(x,y)
{
 ret <- NULL
 for(i in 2:nrow(x))
 {
 rbind(ret,x[i,]) -> ret
 }
 ret
}

polyTopKFactory <- function()
{
 list(
 name=polyTopK,
 udxtyle=c("transform"),
 intype=c("any"),
 outtype=c("any") ,
 outtypecallback=polyTopKReturnType
)
}

```

```
check if a number is an integer
check.integer <- function(N) {
 !length(grep("[^[:digit:]]", as.character(N)))
}

convert factors in a data frame to strings
convert.factors.to.strings.in.dataframe <- function(dataframe)
{
 class.data <- sapply(dataframe, class)
 factor.vars <- class.data[class.data == "factor"]
 for (colname in names(factor.vars))
 {
 dataframe[,colname] <- as.character(dataframe[,colname])
 }
 return (dataframe)
}
```

## To Use the top-k Example

- 1 Copy and paste the example into a file named polyTopK.r in the dbadmin home directory.  
Using vsql, create the library:

```
create library rlib3 as '/home/dbadmin/polyTopK.R' language 'R';
```

- 2 Create the function:

```
create transform function polyTopK as language 'R' name
'polyTopKFactory' library rlib3;
```

- 3 Run the function:

```
select spec, polyTopK(3,sl,sw,pl,pw) over(partition by spec) from
iris;
```

- 4 Run the function with different number of arguments:

```
select spec, polyTopK(3,sl,pl) over(partition by spec) from iris;
```

## Logistic Regression in R using GLM

The following UDx function provides an example of how to use GLM as a logistical regression function in HP Vertica using R.

The `birthweight_glm.R` example uses the Low Infant Birthweight dataset available as part of the R "MASS" library. The example computes odds, ratios and confidence intervals of a low birthweight condition based on the value of the predictors.

The dataset contains the following information:

| Column | Details (value of 1 = true unless otherwise noted)     |
|--------|--------------------------------------------------------|
| low    | Whether birth weight is less than 2.5kg.               |
| age    | Age of mother in years.                                |
| lwt    | The mother's weight in lbs.                            |
| race   | Mothers race (1 = white, 2 = black, 3 = other).        |
| smoke  | Whether the mother smoked during pregnancy.            |
| ht     | History of hypertension.                               |
| ui     | Presence of uterine irritability.                      |
| ftv    | Number of physician visits during the first trimester. |
| ptl    | Number of previous premature labors.                   |
| bwt    | Birth weight in grams.                                 |

## Logistic Regression GLM Example (birthweight\_glm.R)

```
glmBirthweight <- function(birthwt)
{
 names(birthwt)<-c('low','age','lwt','race','smoke','ptl','ht','ui','ftv');

 # Add race2 to clarify what the integer values mean
 birthwt$race2<-factor(birthwt$race,labels=c("white","black","other"));

 # Logistic Regression model predicts the low birthwt condition given the
 predictors
 bwt<-glm(low~age+lwt+race2+smoke+ptl+ht+ui+ftv,data=birthwt,family=binomial);

 # Gather and format the model output
 sum.coef<-summary(bwt)$coef;
 qq<-data.frame(sum.coef);

 # compute odds ratios
 qq$odds<-exp(qq$Estimate);

 # compute confidence intervals
 qq$upper.ci<-exp(qq$odds+1.96*qq$Std..Error);
 qq$lower.ci<-exp(qq$odds-1.96*qq$Std..Error);

 # Add the predictors to the dataframe for printing
 qq$Parameters<-row.names(qq);
 row.names(qq)<-NULL;

 # return the object
 qq
}

glmBirthweightFactory <- function()
{
 list(name=glmBirthweight,udxtype=c("transform")
 ,intype=c("int","int","int","int","int","int","int","int")
 ,outtype=c("float","float","float","float","float","float","varchar")
 ,outnames=c("Estimate","Std..Error","z.value","Pr.z",
 "odds","upper.ci","lower.ci","Parameters"))
}
```

## Running the Example

You can obtain the example data from the web at:

<http://www.statlab.uni-heidelberg.de/data/linmod/birthweight.data>  
<http://www.statlab.uni-heidelberg.de/data/linmod/birthweight.data>

For example:

```
wget http://www.statlab.uni-heidelberg.de/data/linmod/birthweight.data
```

In VSQL, create the table for the dataset and load the data:

```
create table births_ex(low int,age int,lwt int,race int,smoke int,ptl int,ht
int,ui int,ftv int,bwt int);

copy births_ex2 from '/home/dbadmin/infant_birthweight.dat';
```

Then copy birthweight\_glm.R to dbadmin's home directory, and create the library and function:

```
create library BirthweightLib as '/home/dbadmin/birthweight_glm.R' language 'R';

create transform function glmBirthweight as language 'R' name
'glmBirthweightFactory' library BirthweightLib;
```

Finally, run the function:

```
SELECT glmBirthweight(low,age,lwt,race,smoke,ptl,ht,ui,ftv) OVER() FROM births_ex;
 Estimate | Std..Error | z.value | Pr.z | odds
| upper.ci | lower.ci | Parameters
-----+-----+-----+-----+-----+
0.48062320498266 | 1.19688757611052 | 0.401560860498295 | 0.688007239426341 |
1.61708186170698 | 52.6139614264981 | 0.482479045833905 | (Intercept)
-0.0295490268887551 | 0.0370307976710382 | -0.79795815232642 | 0.424894775128354 |
0.97088327708793 | 2.8390333954452 | 2.45543249224841 | age
-0.0154242839432244 | 0.00691924796727926 | -2.22918502359866 | 0.0258015965896862 |
0.984694061080653 | 2.71354469870095 | 2.64093318816631 | lwt
1.27225979472379 | 0.527357257587404 | 2.41251974144477 | 0.0158426794613584 |
3.5689084570941 | 99.7361981679225 | 12.6200678340669 | race2black
0.880495922911246 | 0.440777655513404 | 1.99759654759648 | 0.045760417849372 |
2.41209562333513 | 26.4702067818639 | 4.70286274760947 | race2other
0.938845698827358 | 0.402146887474267 | 2.33458402407114 | 0.0195651619400098 |
2.55702813359408 | 28.3672704897164 | 5.86393121310429 | smoke
0.543337030596766 | 0.345403019680752 | 1.57305234649935 | 0.115706697836339 |
1.72174279475664 | 11.0092157041215 | 2.84269593896983 | ptl
1.86330286760883 | 0.697533131006852 | 2.6712750760946 | 0.0075563695198027 |
6.44498860020803 | 2470.44490524196 | 160.424537944263 | ht
0.767648144937079 | 0.45931793280184 | 1.6712784111311 | 0.0946666986379542 |
2.15469276497994 | 21.2202499748911 | 3.50583813238038 | ui
0.0653018343579497 | 0.172393823524508 | 0.378794512604253 | 0.70484046257016 |
1.06748117825926 | 4.07704749133413 | 2.07422851417719 | ftv
(10 rows)
```

## Updating UDF Libraries

There are two cases where you need to update libraries that you have already deployed:

- When you have upgraded HP Vertica to a new version that contains changes to the SDK API. For your libraries to work with the new server version, you need to recompile them with new version of the SDK. See **UDF Library Compatibility with New Server Versions** (page 540) for more information.
- When you have made changes to your UDF functions and you want to deploy these changes. Before updating your UDF library, you need to determine if you have changed the signature of any of the functions contained in the library. If you have, you need to drop the functions from the HP Vertica catalog before you update the library.

## UDF Library Compatibility with New Server Versions

When you compile your UDF library, you link it with the HP Vertica SDK version that accompanies the version of the HP Vertica server you have installed on your cluster. When you upgrade your HP Vertica database to a new server version, the UDF libraries defined in your HP Vertica catalog may be incompatible with the new server if the HP Vertica SDK changed between the two server versions. Libraries linked against an old version of the SDK do not work with a server that uses a new version of the SDK.

**Note:** Since the R language is interpreted, UDFs written in R are not linked to the HP Vertica SDK. Therefore, changes to the HP Vertica SDK between HP Vertica versions will not necessarily make your R-based UDF libraries incompatible with a new server version. They will only need to be updated if the APIs in the SDK that your UDFs call actually change (i.e. change the number or data types of their arguments).

Changes to the SDK usually only take place between major version upgrades (from version 6.0 and version 6.1, for example). Usually, there is no change to the SDK between minor server updates (for example, from version 6.1.x.0 to 6.1.x.1).

**Note:** In rare cases, there may be changes to the SDK between minor versions of the HP Vertica server. You should review the HP Vertica release notes before performing an upgrade to determine if your old UDF libraries will need to be recompiled to work with the new server version.

If you upgrade your HP Vertica server to a new version and there was no change to the SDK between the two versions of HP Vertica, your UDF libraries will continue to work without you having to take any further steps. If the SDK of the new server version is incompatible with the old SDK, you need to recompile and redeploy the UDF library before your UDFs will work. In the meantime, any attempt to use UDFs defined in the incompatible library result in an error message:

```
ERROR 2858: Could not find function definition
HINT: This usually happens due to missing or corrupt libraries, libraries built
with the wrong SDK version, or due to a concurrent session dropping the library
or function. Try recreating the library and function
```

If your UDF library is incompatible with the new version of the new version of the HP Vertica server, you must:

- 1 Recompile your UDF library using the new version of the HP Vertica SDK. See ***Compiling Your UDF*** (page [493](#)) for more information.
- 2 Deploy the new version of your library. See ***Deploying A New Version of Your UDF Library*** (page [541](#)).

## Determining if a UDF Signature Has Changed

You need to be careful when making changes to UDF libraries that contain functions you have already deployed in your HP Vertica database. When you deploy a new version of your UDF library, HP Vertica does not ensure that the signatures of the functions that are defined in the library match the signature of the function that is already defined in the HP Vertica catalog. If you have changed the signature of a UDF in the library then update the library in the HP Vertica database, calls to the altered UDF will produce errors.

Making any of the following changes to a UDF alters its signature:

- Changing the number of arguments accepted or the data type of any argument accepted by your function (not including polymorphic functions).
- Changing the number or data types of any return values or output columns.
- Changing the name of the factory class that HP Vertica uses to create an instance of your function code.
- Changing the null handling or volatility behavior of your function.
- Removed the function's factory class from the library completely.

The following changes do not alter the signature of your function, and do not require you to drop the function before updating the library:

- Changing the number or type of arguments handled by a polymorphic function. HP Vertica does not process the arguments the user passes to a polymorphic function.
- Changing the the name, data type, or number of parameters accepted by your function. The parameters your function accepts are not determined by the function signature. Instead, HP Vertica passes all of the parameters the user included in the function call, and your function processes them at runtime. See **UDF Parameters** (page [502](#)) for more information about parameters.
- Changing any of the internal processing performed by your function.
- Adding new UDFs to the library.

After you drop any functions whose signatures have changed, you load the new library file, then re-create your altered functions. If you have not made any changes to the signature of your UDFs, you can just update the library file in your HP Vertica database without having to drop or alter your function definitions. As long as the UDF definitions in the HP Vertica catalog match the signatures of the functions in your library, function calls will work transparently after you have updated the library. See **Deploying A New Version of Your UDF Library** (page [541](#)).

## Deploying A New Version of Your UDF Library

You need to deploy a new version of your UDF library if:

- You have made changes to the library that you now want to roll out to your HP Vertica database.
- You have upgraded your HP Vertica to a new version whose SDK is incompatible with the previous version.

The process of deploying a new version of your library is similar to deploying it initially.

- 1 If you are deploying a UDF library developed in C++, you must compile it with the current version of the HP Vertica SDK. See [Compiling Your UDF](#) (page 493) for details.
- 2 Copy your UDF library's Linux shared object (.so) file or R source file to a host in your HP Vertica database.
- 3 Connect to the host using vsql.
- 4 If you have changed the signature of any of the functions in the shared library, you must drop these functions using DROP FUNCTION. If you are unsure whether any of the signatures of your functions have changed, see [Determining if a UDF Signature Has Changed](#) (page 541).

**Note:** If all of the function signatures in your library have changed, you may find it more convenient to drop the library using the DROP LIBRARY statement with the CASCADE option to drop the library and all of the functions that reference it. This can save you the time it would take to drop each function individually. You can then reload the library and recreate all of the functions using the same process you used to deploy the library in the first place. See CREATE LIBRARY in the SQL Reference Manual.

- 5 Use the ALTER FUNCTION statement to update the UDF library definition with the file you copied in step 1. For example, if you want to update the library named ScalarFunctions with a file named ScalarFunctions-2.0.so in the dbadmin user's home directory, you could use the command:

```
ALTER LIBRARY ScalarFunctions AS
 '/home/dbadmin/ScalarFunctions-2.0.so';
```

Once you have updated the UDF library definition to use the new version of your shared library, the functions defined in the UDF library begin using the new shared library file without any further changes.

- 6 If you had to drop any functions in step 3, recreate them using the new signature defined by the factory classes in your library. See CREATE FUNCTION Statements in the SQL Reference Manual.

## Listing the UDxs Contained in a Library

Once a library has been loaded using the CREATE LIBRARY statement, you can find the UDFs and UDLs it contains by querying the USER\_LIBRARY\_MANIFEST system table:

```
=> CREATE LIBRARY ScalarFunctions AS '/home/dbadmin/ScalarFunctions.so';
CREATE LIBRARY
=> \x
Expanded display is on.
=> SELECT * FROM USER_LIBRARY_MANIFEST WHERE lib_name = 'ScalarFunctions';
-[RECORD 1] -----
schema_name | public
lib_name | ScalarFunctions
lib_oid | 45035996273792402
obj_name | RemoveSpaceFactory
obj_type | Scalar Function
arg_types | Varchar
return_type | Varchar
-[RECORD 2] -----
schema_name | public
lib_name | ScalarFunctions
```

```
lib_oid | 45035996273792402
obj_name | Div2intsInfo
obj_type | Scalar Function
arg_types | Integer, Integer
return_type | Integer
-[RECORD 3] -----
schema_name | public
lib_name | ScalarFunctions
lib_oid | 45035996273792402
obj_name | Add2intsInfo
obj_type | Scalar Function
arg_types | Integer, Integer
return_type | Integer
```

The `obj_name` column lists the factory classes contained in the library. These are the names you use to define UDFs and UDLs in the database catalog using statements such as `CREATE FUNCTION` and `CREATE SOURCE`.

# Using the Hadoop Connector

---

Hadoop is a software platform for performing distributed data processing. HP has created an interface between HP Vertica and Hadoop that lets you take advantage of both platform's strengths. Using the interface, a Hadoop application can access and store data in an HP Vertica database.

You use the Hadoop Connector when you want Hadoop to be able to read data from and write data to HP Vertica. If you want HP Vertica to import data stored in a Hadoop Distributed File System (HDFS), use the HDFS Connector or the Secure HDFS Connector instead. See *Using the Hadoop Distributed File System Connectors* (page [575](#)).

## Prerequisites

Before you can use HP Vertica's Hadoop Connector, you must install and configure Hadoop and be familiar with developing Hadoop applications. For details on installing and using Hadoop, please see the *Apache Hadoop Web site* <http://hadoop.apache.org/>.

See the **Supported Platforms** document at <http://www.vertica.com/documentation> (<http://www.vertica.com/documentation>) for a list of the versions of Hadoop and Pig that the connector supports.

## How Hadoop and HP Vertica Work Together

Hadoop and HP Vertica share some common features—they are both platforms that use clusters of hosts to store and operate on very large sets of data. Their key difference is the type of data they work with best. Hadoop is best suited for tasks involving unstructured data such as natural language content. HP Vertica works best on structured data that can be loaded into database tables.

HP Vertica's Hadoop Connector lets you use these two platforms together to take advantage of their strengths. With the connector, you can use data from HP Vertica in a Hadoop job, and store the results of a Hadoop job in an HP Vertica database. For example, you can use Hadoop to extract and process keywords from a mass of unstructured text messages from a social media site, turning the material into structured data that is then loaded into an HP Vertica database. Once you have loaded the data into HP Vertica, you can perform many different analytic queries on the data far faster than by using Hadoop alone.

For more on how Hadoop and HP Vertica work together, see the **HP Vertica Map Reduce Web page** <http://www.vertica.com/mapreduce>.

**Note:** HP Vertica supports two different programming interfaces—user defined functions (UDFs), and external procedures—which can handle complex processing tasks that are hard to resolve using SQL. You should consider using either of these interfaces instead of Hadoop if possible, since they do not require the overhead of maintaining a Hadoop cluster.

Since code written to use either user defined functions or external procedures runs on the HP Vertica cluster, they can impact the performance of your database. In general, if your application has straightforward operation that is hard to do in SQL, you should consider using UDFs or external procedures rather than resorting to Hadoop. If your application needs to perform significant data extraction and processing, Hadoop is often a better solution, because the processing takes place off of the HP Vertica cluster.

### Hadoop and HP Vertica Cluster Scaling

Nodes in the Hadoop cluster connect directly to HP Vertica nodes when retrieving or storing data, allowing large volumes of data to be transferred in parallel. If the Hadoop cluster is larger than the HP Vertica cluster, this parallel data transfer can negatively impact the performance of the HP Vertica database.

To avoid performance impacts on your HP Vertica database, you should ensure that your Hadoop cluster cannot overwhelm your HP Vertica cluster. The exact sizing of each cluster depends on how fast your Hadoop cluster generates data requests and the load placed on the HP Vertica database by queries from other sources. A good rule of thumb to follow is for your Hadoop cluster to be no larger than your HP Vertica cluster.

## Hadoop Connector Features

HP Vertica's Hadoop Connector:

- gives Hadoop access to data stored in HP Vertica.
- lets Hadoop store its results in HP Vertica. The Connector will create a table for the Hadoop data if it does not already exist.
- lets applications written in **Apache Pig** <http://pig.apache.org/> access and store data in HP Vertica.
- works with **Hadoop streaming** <http://wiki.apache.org/hadoop/HadoopStreaming>.

The Hadoop Connector runs on each node in the Hadoop cluster, so the Hadoop nodes and HP Vertica nodes communicate with each other directly. Direct connections allow data to be transferred in parallel, dramatically increasing processing speed.

The Connector is written in Java, and is compatible with all platforms supported by Hadoop.

**Note:** To prevent Hadoop from potentially inserting multiple copies of data into HP Vertica, the Hadoop Connector disables Hadoop's speculative execution feature.

## Hadoop Connector Installation Procedure

Follow these steps to install HP Vertica's Hadoop Connector:

If you have not already done so, download the Hadoop Connector package from **myVertica portal** <http://my.vertica.com/>. Be sure to download the package that is compatible with your version of Hadoop. You can find your Hadoop version by issuing the following command on your Hadoop node:

```
hadoop version
```

You will also need a copy of the HP Vertica JDBC driver, which you can also download from the **myVertica portal** <http://my.vertica.com/>.

You need to perform the following steps on **each node** in your Hadoop cluster:

- 1 Copy the Hadoop Connector .zip archive you downloaded to a temporary location on the Hadoop node.
- 2 Copy the HP Vertica JDBC driver .jar file to the same location on your node. If you haven't already, you can download this driver from the **myVertica portal** <http://my.vertica.com/>.
- 3 Unzip the Hadoop Connector .zip archive into a temporary directory. On Linux, you usually use the command `unzip`.
- 4 Locate the Hadoop home directory (the directory where Hadoop is installed). The location of this directory depends on how you installed Hadoop (manual install versus a package supplied by your Linux distribution or Cloudera). If you do not know the location of this directory, you can try the following steps:
  - See if the `HADOOP_HOME` environment variable is set by issuing the command `echo $HADOOP_HOME` on the command line.
  - See if Hadoop is in your path by typing `hadoop classpath` on the command line. If it is, this command lists the paths of all the jar files used by Hadoop, which should tell you the location of the Hadoop home directory.
  - If you installed using a .deb or .rpm package, you can look in `/usr/lib/hadoop`, as this is often the location where these packages install Hadoop.
- 5 Copy the file `hadoop-vertica.jar` from the directory where you unzipped the Hadoop Connector archive to the `lib` subdirectory in the Hadoop home directory.
- 6 Copy the HP Vertica JDBC driver file (`vertica_x.x.x_jdk_5.jar`) to the `lib` subdirectory in the Hadoop home directory (`$HADOOP_HOME/lib`).
- 7 Edit the `$HADOOP_HOME/conf/hadoop-env.sh` file, and find the lines:

```
Extra Java CLASSPATH elements. Optional.
export HADOOP_CLASSPATH=
```

Uncomment the `export` line by removing the hash character (#) and add the absolute path of the JDBC driver file you copied in the previous step. For example:  
`export HADOOP_CLASSPATH=$HADOOP_HOME/lib/vertica_x.x.x_jdk_5.jar`  
This environment variable ensures that Hadoop can find the HP Vertica JDBC driver.
- 8 Also in the `$HADOOP_HOME/conf/hadoop-env.sh` file, ensure that the `JAVA_HOME` environment variable is set to your Java installation.
- 9 If you want your application written in Pig to be able to access HP Vertica, you need to:
  1. Locate the Pig home directory. Often, this directory is in the same parent directory as the Hadoop home directory.

2. Copy the file named `pig-vertica.jar` from the directory where you unpacked the Hadoop Connector `.zip` file to the `lib` subdirectory in the Pig home directory.
3. Copy the HP Vertica JDBC driver file (`vertica_x.x.x_jdk_5.jar`) to the `lib` subdirectory in the Pig home directory.

## Accessing HP Vertica Data from Hadoop

You need to follow three steps to have Hadoop fetch data from HP Vertica:

- Set the Hadoop job's input format to be `HP VerticalInputFormat`.
- Give the `HP VerticalInputFormat` class a query to be used to extract data from HP Vertica.
- Create a `Mapper` class that accepts `VerticalRecord` objects as input.

The following sections explain each of these steps in greater detail.

## Selecting HP VerticalInputFormat

The first step to reading HP Vertica data from within a Hadoop job is to set its input format. You usually set the input format within the `run()` method in your Hadoop application's class. To set up the input format, pass the `job.setInputFormatClass` method the `VerticalInputFormat.class`, as follows:

```
public int run(String[] args) throws Exception {
 // Set up the configuration and job objects
 Configuration conf = getConf();
 Job job = new Job(conf);

 (later in the code)

 // Set the input format to retrieve data from
 // Vertica.
 job.setInputFormatClass(VerticalInputFormat.class);
```

Setting the input to the `VerticalInputFormat` class means that the `map` method will get `VerticalRecord` objects as its input.

## Setting the Query to Retrieve Data from HP Vertica

A Hadoop job that reads data from your HP Vertica database has to execute a query that selects its input data. You pass this query to your Hadoop application using the `setInput` method of the `VerticalInputFormat` class. The Hadoop Connector sends this query to the Hadoop nodes which then individually connect to HP Vertica nodes to run the query and get their input data.

A primary consideration for this query is how it segments the data being retrieved from HP Vertica. Since each node in the Hadoop cluster needs data to process, the query result needs to be segmented between the nodes.

There are three formats you can use for the query you want your Hadoop job to use when retrieving input data. Each format determines how the query's results are split across the Hadoop cluster. These formats are:

- A simple, self-contained query.
- A parameterized query along with explicit parameters.
- A parameterized query along with a second query that retrieves the parameter values for the first query from HP Vertica.

The following sections explain each of these methods in detail.

### Using a Simple Query to Extract Data from HP Vertica

The simplest format for the query that Hadoop uses to extract data from HP Vertica is a self-contained hard-coded query. You pass this query in a String to the `setInput` method of the `VerticalInputFormat` class. You usually make this call in the `run` method of your Hadoop job class. For example, the following code retrieves the entire contents of the table named `allTypes`.

```
// Sets the query to use to get the data from the Vertica database.
// Simple query with no parameters
VerticalInputFormat.setInput(job,
 "SELECT * FROM allTypes ORDER BY key;");
```

The query you supply must have an `ORDER BY` clause, since the Hadoop Connector uses it to figure out how to segment the query results between the Hadoop nodes. When it gets a simple query, the Hadoop Connector calculates limits and offsets to be sent to each node in the Hadoop cluster, so they each retrieve a portion of the query results to process.

Having Hadoop use a simple query to retrieve data from HP Vertica is the least efficient method, since the Hadoop Connector needs to perform extra processing to determine how the data should be segmented across the Hadoop nodes.

### Using a Parameterized Query and Parameter Lists

You can have Hadoop retrieve data from HP Vertica using a parametrized query, to which you supply a set of parameters. The parameters in the query are represented by a question mark (?).

You pass the query and the parameters to the `setInput` method of the `VerticalInputFormat` class. You have two options for passing the parameters: using a discrete list, or by using a `Collection` object.

## Using a Discrete List of Values

To pass a discrete list of parameters for the query, you include them in the `setInput` method call in a comma-separated list of string values, as shown in the next example:

```
// Simple query with supplied parameters
VerticalInputFormat.setInput(job,
 "SELECT * FROM allTypes WHERE key = ?",
 "1001", "1002", "1003");
```

The Hadoop Connector tries to evenly distribute the query and parameters among the nodes in the Hadoop cluster. If the number of parameters is not a multiple of the number of nodes in the cluster, some nodes will get more parameters to process than others. Once the Connector divides up the parameters among the Hadoop nodes, each node connects to a host in the HP Vertica database and executes the query, substituting in the parameter values it received.

This format is when you have a discrete set of parameters that are unlikely to change over time. It is not very flexible, however, since any changes to the parameter list requires your Hadoop job to be recompiled. Also, the query can contain just a single parameter, since you can only supply a single list to the `setInput` method. The more flexible way to use parameterized queries is to use a collection to contain the parameters.

## Using a Collection Object

The more flexible method of supplying the parameters for the query is to store them into a `Collection` object, then include the object in the `setInput` method call. This method allows you to build the list of parameters at run time, rather than having them hard-coded. You can also use multiple parameters in the query, since you will pass a collection of `ArrayList` objects to `setInput` statement. Each `ArrayList` object supplies one set of parameter values, and can contain values for each parameter in the query.

The following example demonstrates using a collection to pass the parameter values for a query containing two parameters. The collection object passed to `setInput` is an instance of the `HashSet` class. This object contains four `ArrayList` objects added within the `for` loop. This example just adds dummy values (the loop counter and the string "FOUR"). In your own application, you usually calculate parameter values in some manner before adding them to the collection.

**Note:** If your parameter values are stored in HP Vertica, you should specify the parameters using a query instead of a collection. See [Using a Query to Retrieve Parameters for a Parameterized Query](#) (page 550) for details.

```
// Collection to hold all of the sets of parameters for the query.
Collection<List<Object>> params = new HashSet<List<Object>>() {
};

// Each set of parameters lives in an ArrayList. Each entry
// in the list supplies a value for a single parameter in
// the query. Here, ArrayList objects are created in a loop
// that adds the loop counter and a static string as the
// parameters. The ArrayList is then added to the collection.
for (int i = 0; i < 4; i++) {
 ArrayList<Object> param = new ArrayList<Object>();
 param.add(i);
 param.add("FOUR");
 params.add(param);
}

VerticalInputFormat.setInput(job,
 "select * from allTypes where key = ? AND NOT varcharcol = ?",
 params);
```

## Scaling Parameter Lists for the Hadoop Cluster

Whenever possible, you should make the number of parameter values you pass to the Hadoop Connector equal to the number of nodes in the Hadoop cluster, since each parameter value is assigned to a single Hadoop node. This ensures that the workload is spread across the entire Hadoop cluster. If you supply fewer parameter values than there are nodes in the Hadoop cluster, some of the nodes will not get a value and will sit idle. If the number of parameter values does not a multiple of the number of nodes in the cluster, Hadoop randomly assigns the extra values to nodes in the cluster. It does not perform scheduling, so it does not wait to see what nodes finish their task first before assigning additional tasks. In this case, a node could become a bottleneck if it is assigned the longer-running portions of the job.

In addition to the number of parameters in the query, you should also try to make the parameter values yield roughly the same number of results. This helps prevent a single node in the Hadoop cluster from becoming a bottleneck by having to process far more data than the other nodes in the cluster.

## Using a Query to Retrieve Parameter Values for a Parameterized Query

You can pass the Hadoop Connector a query to extract the parameter values for a parameterized query. This query must return a single column of data, which is then used as values for running the parameterized query.

To use a query to retrieve the parameter values, you supply the VerticalInputFormat class's setInput method with the parameterized query and the query to retrieve parameters. For example:

```
// Sets the query to use to get the data from the Vertical database.
// Query using a parameter that is supplied by another query
VerticalInputFormat.setInput(job,
 "select * from allTypes where key = ?",
 ...);
```

```
"select distinct key from regions");
```

When it receives a query for parameters, the Hadoop Connector runs the query itself, then groups the results together to send out to the Hadoop nodes, along with the parameterized query. The Hadoop nodes then run the parameterized query using the set of parameter values sent to them by the Hadoop Connector.

## Writing a Map Class that Processes HP Vertica Data

Once you have set up your Hadoop application to read data from HP Vertica, you need to create a Map class that actually processes the data. Your Map class's map method receives LongWritable values as keys and VerticalRecord objects as values. The key values are just sequential numbers that identify the row in the query results. The VerticalRecord class represents a single row from the result set returned by the query you supplied to the VerticalInput.setInput method.

### Working with the VerticalRecord Class

Your map method extracts the data it needs from the VerticalRecord class. This class contains three main methods you use to extract data from the record set:

- get retrieves a single value, either by index value or by name, from the row sent to the map method.
- getOrdinalPosition takes a string containing a column name and returns the column's number.
- getType returns the data type of a column in the row specified by index value or by name. This method is useful if you are unsure of the data types of the columns returned by the query. The types are stored as integer values defined by the java.sql.Types class.

The following example shows a Mapper class and map method that accepts VerticalRecord objects. In this example, no real work is done. Instead two values are selected as the key and value to be passed on to the reducer.

```
public static class Map extends
Mapper<LongWritable, VerticalRecord, Text, DoubleWritable> {
 // This mapper accepts VerticalRecords as input.
 public void map(LongWritable key, VerticalRecord value, Context context)
 throws IOException, InterruptedException {

 // In your mapper, you would do actual processing here.
 // This simple example just extracts two values from the row of
 // data and passes them to the reducer as the key and value.
 if (value.get(3) != null && value.get(0) != null) {
 context.write(new Text((String) value.get(3)),
 new DoubleWritable((Long) value.get(0)));
 }
 }
}
```

If your Hadoop job has a reduce stage, all of the `map` method output is managed by Hadoop. It is not stored or manipulated in any way by HP Vertica. If your Hadoop job does not have a reduce stage, and needs to store its output into HP Vertica, your `map` method must output its keys as `Text` objects and values as `VerticaRecord` objects.

## Writing Data to HP Vertica from Hadoop

There are three steps you need to take for your Hadoop application to store data in HP Vertica:

- Set the output value class of your Hadoop job to `VerticaRecord`.
- Set the details of the HP Vertica table where you want to store your data in the `VerticaOutputFormat` class.
- Create a `Reduce` class that adds data to a `VerticaRecord` object and calls its `write` method to store the data.

The following sections explain these steps in more detail.

## Configuring Hadoop to Output to HP Vertica

To tell your Hadoop application to output data to HP Vertica you configure your Hadoop application to output to the HP Vertica Hadoop Connector. You will normally perform these steps in your Hadoop application's `run` method. There are three methods that need to be called in order to set up the output to be sent to the Hadoop Connector and to set the output of the `Reduce` class, as shown in the following example:

```
// Set the output format of Reduce class. It will
// output VerticaRecords that will be stored in the
// database.
job.setOutputKeyClass(Text.class);
job.setOutputValueClass(VerticaRecord.class);

// Tell Hadoop to send its output to the Vertica
// Hadoop Connector.
job.setOutputFormatClass(VerticaOutputFormat.class);
```

The call to `setOutputValueClass` tells Hadoop that the output of the `Reduce.reduce` method is a `VerticaRecord` class object. This object represents a single row of an HP Vertica database table. You tell your Hadoop job to send the data to the Hadoop Connector by setting the output format class to `VerticaOutputFormat`.

## Defining the Output Table

Call the `VerticaOutputFormat.setOutput` method to define the table that will hold the Hadoop application output:

```
VerticaOutputFormat.setOutput(jobObject, tableName, [truncate, ["columnName1 dataType1"
[,"columnNamen dataTypen" ...]]]);
```

|                                         |                                                                                                                                                                                                                                                                                                       |
|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>jobObject</i>                        | The Hadoop job object for your application.                                                                                                                                                                                                                                                           |
| <i>tableName</i>                        | The name of the table to store Hadoop's output. If this table does not exist, the Hadoop Connector automatically creates it. The name can be a full database.schema.table reference.                                                                                                                  |
| <i>truncate</i>                         | A Boolean controlling whether to delete the contents of <i>tableName</i> if it already exists. If set to <i>true</i> , any existing data in the table is deleted before Hadoop's output is stored. If set to <i>false</i> or not given, the Hadoop output is added to the existing data in the table. |
| " <i>columnName1</i> <i>dataType1</i> " | The table column definitions, where <i>columnName1</i> is the column name and <i>dataType1</i> the SQL data type. These two values are separated by a space. If not specified, the existing table is used.                                                                                            |

The first two parameters are required. You can add as many column definitions as you need in your output table.

You usually call the `setOutput` method in your Hadoop class's `run` method, where all other setup work is done. The following example sets up an output table named `mrtarget` that contains 8 columns, each containing a different data type:

```
// Sets the output format for storing data in Vertica. It defines the
// table where data is stored, and the columns it will be stored in.
VerticaOutputFormat.setOutput(job, "mrtarget", true, "a int",
 "b boolean", "c char(1)", "d date", "f float", "t timestamp",
 "v varchar", "z varbinary");
```

If the `truncate` parameter is set to `true` for the method call, and target table already exists in the HP Vertica database, the Hadoop Connector deletes the table contents before storing the Hadoop job's output.

**Note:** If the table already exists in the database, and the method call `truncate` parameter is set to `false`, the Hadoop Connector adds new application output to the existing table. However, the Connector does not verify that the column definitions in the existing table match those defined in the `setOutput` method call. If the new application output values cannot be converted to the existing column values, your Hadoop application can throw casting exceptions.

## Writing the Reduce Class

Once your Hadoop application is configured to output data to HP Vertica and has its output table defined, you need to create the `Reduce` class that actually formats and writes the data for storage in HP Vertica.

The first step your `Reduce` class should take is to instantiate a `VerticaRecord` object to hold the output of the `reduce` method. This is a little more complex than just instantiating a base object, since the `VerticaRecord` object must have the columns defined in it that match the out table's columns (see [Defining the Output Table](#) (page 552) for details). To get the properly configured `VerticaRecord` object, you pass the constructor the configuration object.

You usually instantiate the `VerticaRecord` object in your `Reduce` class's `setup` method, which Hadoop calls before it calls the `reduce` method. For example:

```
// Sets up the output record that will be populated by
// the reducer and eventually written out.
public void setup(Context context) throws IOException,
 InterruptedException {
 super.setup(context);
 try {
 // Instantiate a VerticaRecord object that has the proper
 // column definitions. The object is stored in the record
 // field for use later.
 record = new VerticaRecord(context.getConfiguration());
 } catch (Exception e) {
 throw new IOException(e);
 }
}
```

## Storing Data in the `VerticaRecord`

Your `reduce` method starts the same way any other Hadoop reduce method does—it processes its input key and value, performing whatever reduction task your application needs. Afterwards, your `reduce` method adds the data to be stored in HP Vertica to the `VerticaRecord` object that was instantiated earlier. Usually you use the `set` method to add the data:

```
VerticaRecord.set(column, value);
```

|                     |                                                                                                                                                                                                                                                                                                                                                                                                   |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>column</code> | The column to store the value in. This is either an integer (the column number) or a <code>String</code> (the column name, as defined in the table definition).<br><b>Note:</b> The <code>set</code> method throws an exception if you pass it the name of a column that does not exist. You should always use a try/catch block around any <code>set</code> method call that uses a column name. |
| <code>value</code>  | The value to store in the column. The data type of this value must match the definition of the column in the table.                                                                                                                                                                                                                                                                               |

**Note:** If you do not have the `set` method validate that the data types of the value and the column match, the Hadoop Connector throws a `ClassCastException` if it finds a mismatch when it tries to commit the data to the database. This exception causes a rollback of the entire result. By having the `set` method validate the data type of the value, you can catch and resolve the exception before it causes a rollback.

In addition to the `set` method, you can also use the `setFromString` method to have the Hadoop Connector convert the value from `String` to the proper data type for the column:

```
VerticaRecord.setFromString(column, "value");
```

|                     |                                                                                                                                                                                                                                                                                                                          |
|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>column</code> | The column number to store the value in, as an integer.                                                                                                                                                                                                                                                                  |
| <code>value</code>  | A <code>String</code> containing the value to store in the column. If the <code>String</code> cannot be converted to the correct data type to be stored in the column, <code>setFromString</code> throws an exception ( <code>ParseException</code> for date values, <code>NumberFormatException</code> numeric values). |

Your `reduce` method must output a value for every column in the output table. If you want a column to have a null value you must explicitly set it.

After it populates the `VerticaRecord` object, your `reduce` method calls the `Context.write` method, passing it the name of the table to store the data in as the key, and the `VerticaRecord` object as the value.

The following example shows a simple `Reduce` class that stores data into HP Vertica. To make the example as simple as possible, the code doesn't actually process the input it receives, and instead just writes dummy data to the database. In your own application, you would process the key and values into data that you then store in the `VerticaRecord` object.

```
public static class Reduce extends
 Reducer<Text, DoubleWritable, Text, VerticalRecord> {
 // Holds the records that the reducer writes its values to.
 VerticalRecord record = null;

 // Sets up the output record that will be populated by
 // the reducer and eventually written out.
 public void setup(Context context) throws IOException,
 InterruptedException {

 super.setup(context);
 try {
 // Need to call VerticalOutputFormat to get a record object
 // that has the proper column definitions.
 record = new VerticalRecord(context.getConfiguration());
 } catch (Exception e) {
 throw new IOException(e);
 }
 }

 // The reduce method.
 public void reduce(Text key, Iterable<DoubleWritable> values,
 Context context) throws IOException, InterruptedException {

 // Ensure that the record object has been set up properly. This is
 // where the results are written.
 if (record == null) {
 throw new IOException("No output record found");
 }

 // In this part of your application, your reducer would process the
 // key and values parameters to arrive at values that you want to
 // store into the database. For simplicity's sake, this example
 // skips all of the processing, and just inserts arbitrary values
 // into the database.
 //
 // Use the .set method to store a value in the record to be stored
 // in the database. The first parameter is the column number,
 // the second is the value to store.
 //
 // Column numbers start at 0.
 //
 // Set record 0 to an integer value, you
 // should always use a try/catch block to catch the exception.

 try {
 record.set(0, 125);
 }
```

```

 } catch (Exception e) {
 // Handle the improper data type here.
 e.printStackTrace();
 }

 // You can also set column values by name rather than by column
 // number. However, this requires a try/catch since specifying a
 // non-existent column name will throw an exception.
 try {
 // The second column, named "b", contains a Boolean value.
 record.set("b", true);
 } catch (Exception e) {
 // Handle an improper column name here.
 e.printStackTrace();
 }

 // Column 2 stores a single char value.
 record.set(2, 'c');

 // Column 3 is a date. Value must be a java.sql.Date type.
 record.set(3, new java.sql.Date(
 Calendar.getInstance().getTimeInMillis()));

 // You can use the setFromString method to convert a string
 // value into the proper data type to be stored in the column.
 // You need to use a try...catch block in this case, since the
 // string to value conversion could fail (for example, trying to
 // store "Hello, World!" in a float column is not going to work).
 try {
 record.setFromString(4, "234.567");
 } catch (ParseException e) {
 // Thrown if the string cannot be parsed into the data type
 // to be stored in the column.
 e.printStackTrace();
 }

 // Column 5 stores a timestamp
 record.set(5, new java.sql.Timestamp(
 Calendar.getInstance().getTimeInMillis()));
 // Column 6 stores a varchar
 record.set(6, "example string");
 // Column 7 stores a varbinary
 record.set(7, new byte[10]);

 // Once the columns are populated, write the record to store
 // the row into the database.
 context.write(new Text("mrtarget"), record);
}

```

```
}
```

## Passing Parameters to the Hadoop Connector at Run Time

### Specifying the Location of the Connector .jar File

Recent versions of Hadoop fail to find the HP Vertica Hadoop Connector classes automatically, even though they are included in the Hadoop `lib` directory. Therefore, you need to manually tell Hadoop where to find the connector .jar file using the `libjars` argument:

```
hadoop jar myHadoopApp.jar com.myorg.hadoop.myHadoopApp \
-libjars $HADOOP_HOME/lib/hadoop-vertica.jar \
...
```

### Specifying the Database Connection Parameters

You need to pass connection parameters to the Hadoop Connector when starting your Hadoop application, so it knows how to connect to your database. At a minimum, these parameters must include the list of hostnames in the HP Vertica database cluster, the name of the database, and the user name. The common parameters for accessing the database appear in the following table. Usually, you will only need the basic parameters listed in this table in order to start your Hadoop application.

| Parameter                             | Description                                                                                                                                                                                                                                                                                                                                                                                                                            | Required | Default |
|---------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---------|
| <code>mapred.vertica.hostnames</code> | A comma-separated list of the names or IP addresses of the hosts in the HP Vertica cluster. You should list all of the nodes in the cluster here, since individual nodes in the Hadoop cluster connect directly with a randomly assigned host in the cluster.<br><br>The hosts in this cluster are used for both reading from and writing data to the HP Vertica database, unless you specify a different output database (see below). | Yes      | none    |
| <code>mapred.vertica.port</code>      | The port number for the HP Vertica database.                                                                                                                                                                                                                                                                                                                                                                                           | No       | 5433    |
| <code>mapred.vertica.database</code>  | The name of the database the Hadoop application should access.                                                                                                                                                                                                                                                                                                                                                                         | Yes      |         |
| <code>mapred.vertica.username</code>  | The username to use when connecting to the database.                                                                                                                                                                                                                                                                                                                                                                                   | Yes      |         |
| <code>mapred.vertica.password</code>  | The password to use when connecting to the database.                                                                                                                                                                                                                                                                                                                                                                                   | No       | empty   |

You pass the parameters to the Hadoop Connector using the `-D` command line switch in the command you use to start your Hadoop application. For example:

```

hadoop jar myHadoopApp.jar com.myorg.hadoop.myHadoopApp \
-libjars $HADOOP_HOME/lib/hadoop-vertica.jar \
-Dmapred.vertica.hostnames=Vertica01,Vertica02,Vertica03,Vertica04 \
-Dmapred.vertica.port=5433 -Dmapred.vertica.username=exampleuser \
-Dmapred.vertica.password=password123 -Dmapred.vertica.database=ExampleDB

```

### Parameters for a Separate Output Database

The parameters in the previous table are all you need if your Hadoop application accesses a single HP Vertica database. You can also have your Hadoop application read from one HP Vertica database and write to a different HP Vertica database. In this case, the parameters shown in the previous table apply to the input database (the one Hadoop reads data from). The following table lists the parameters that you use to supply your Hadoop application with the connection information for the output database (the one it writes its data to). None of these parameters is required. If you do not assign a value to one of these output parameters, it inherits its value from the input database parameters.

| Parameter                       | Description                                                                                        | Default                  |
|---------------------------------|----------------------------------------------------------------------------------------------------|--------------------------|
| mapred.vertica.hostnames.output | A comma-separated list of the names or IP addresses of the hosts in the output HP Vertica cluster. | Input hostnames          |
| mapred.vertica.port.output      | The port number for the output HP Vertica database.                                                | 5433                     |
| mapred.vertica.database.output  | The name of the output database.                                                                   | Input database name      |
| mapred.vertica.username.output  | The username to use when connecting to the output database.                                        | Input database user name |
| mapred.vertica.password.output  | The password to use when connecting to the output database.                                        | Input database password  |

## Example Hadoop Connector Application

This section presents an example of using the Hadoop Connector to retrieve and store data from an HP Vertica database. The example pulls together the code that has appeared on the previous topics to present a functioning example.

This application reads data from a table named `allTypes`. The mapper selects two values from this table to send to the reducer. The reducer doesn't perform any operations on the input, and instead inserts arbitrary data into the output table named `mrtarget`.

```
package com.vertica.hadoop;

import java.io.IOException;
import java.util.ArrayList;
import java.util.Calendar;
import java.util.Collection;
import java.util.HashSet;
import java.util.Iterator;
import java.util.List;
import java.math.BigDecimal;
import java.sql.Date;
import java.sql.Timestamp;

// Needed when using the setFromString method, which throws this exception.
import java.text.ParseException;

import org.apache.hadoop.conf.Configuration;
import org.apache.hadoop.conf.Configured;
import org.apache.hadoop.io.DoubleWritable;
import org.apache.hadoop.io.LongWritable;
import org.apache.hadoop.io.Text;
import org.apache.hadoop.mapreduce.Job;
import org.apache.hadoop.mapreduce.Mapper;
import org.apache.hadoop.mapreduce.Reducer;
import org.apache.hadoop.util.Tool;
import org.apache.hadoop.util.ToolRunner;

import com.vertica.hadoop.VerticaConfiguration;
import com.vertica.hadoop.VerticaInputFormat;
import com.vertica.hadoop.VerticaOutputFormat;
import com.vertica.hadoop.VerticaRecord;

// This is the class that contains the entire Hadoop example.
public class VerticaExample extends Configured implements Tool {

 public static class Map extends
 Mapper<LongWritable, VerticaRecord, Text, DoubleWritable> {
 // This mapper accepts VerticaRecords as input.
 public void map(LongWritable key, VerticaRecord value, Context context)
 throws IOException, InterruptedException {

 // In your mapper, you would do actual processing here.
 // This simple example just extracts two values from the row of
 // data and passes them to the reducer as the key and value.
 if (value.get(3) != null && value.get(0) != null) {
 context.write(new Text((String) value.get(3)),
 new DoubleWritable((Long) value.get(0)));
 }
 }
 }

 public static class Reduce extends
 Reducer<Text, DoubleWritable, Text, VerticaRecord> {
 // Holds the records that the reducer writes its values to.
 }
}
```

```

VerticaRecord record = null;

// Sets up the output record that will be populated by
// the reducer and eventually written out.
public void setup(Context context) throws IOException,
 InterruptedException {

 super.setup(context);
 try {
 // Need to call VerticaOutputFormat to get a record object
 // that has the proper column definitions.
 record = new VerticaRecord(context.getConfiguration());
 } catch (Exception e) {
 throw new IOException(e);
 }
}

// The reduce method.
public void reduce(Text key, Iterable<DoubleWritable> values,
 Context context) throws IOException, InterruptedException {

 // Ensure that the record object has been set up properly. This is
 // where the results are written.
 if (record == null) {
 throw new IOException("No output record found");
 }

 // In this part of your application, your reducer would process the
 // key and values parameters to arrive at values that you want to
 // store into the database. For simplicity's sake, this example
 // skips all of the processing, and just inserts arbitrary values
 // into the database.
 //

 // Use the .set method to store a value in the record to be stored
 // in the database. The first parameter is the column number,
 // the second is the value to store.
 //
 // Column numbers start at 0.
 //
 // Set record 0 to an integer value, you
 // should always use a try/catch block to catch the exception.

 try {
 record.set(0, 125);
 } catch (Exception e) {
 // Handle the improper data type here.
 e.printStackTrace();
 }
}

```

```
}

// You can also set column values by name rather than by column
// number. However, this requires a try/catch since specifying a
// non-existent column name will throw an exception.
try {
 // The second column, named "b", contains a Boolean value.
 record.set("b", true);
} catch (Exception e) {
 // Handle an improper column name here.
 e.printStackTrace();
}

// Column 2 stores a single char value.
record.set(2, 'c');

// Column 3 is a date. Value must be a java.sql.Date type.
record.set(3, new java.sql.Date(
 Calendar.getInstance().getTimeInMillis()));

// You can use the setFromString method to convert a string
// value into the proper data type to be stored in the column.
// You need to use a try...catch block in this case, since the
// string to value conversion could fail (for example, trying to
// store "Hello, World!" in a float column is not going to work).
try {
 record.setFromString(4, "234.567");
} catch (ParseException e) {
 // Thrown if the string cannot be parsed into the data type
 // to be stored in the column.
 e.printStackTrace();
}

// Column 5 stores a timestamp
record.set(5, new java.sql.Timestamp(
 Calendar.getInstance().getTimeInMillis()));
// Column 6 stores a varchar
record.set(6, "example string");
// Column 7 stores a varbinary
record.set(7, new byte[10]);

// Once the columns are populated, write the record to store
// the row into the database.
context.write(new Text("mrtarget"), record);
}
```

```

@Override
public int run(String[] args) throws Exception {
 // Set up the configuration and job objects
 Configuration conf = getConf();
 Job job = new Job(conf);
 conf = job.getConfiguration();
 conf.set("mapreduce.job.tracker", "local");
 job.setJobName("vertica test");
 // Set the input format to retrieve data from
 // Vertica.
 job.setInputFormatClass(VerticalInputFormat.class);

 // Set the output format of the mapper. This is the interim
 // data format passed to the reducer. Here, we will pass in a
 // Double. The interim data is not processed by Vertica in any
 // way.
 job.setMapOutputKeyClass(Text.class);
 job.setMapOutputValueClass(DoubleWritable.class);

 // Set the output format of the Hadoop application. It will
 // output VerticalRecords that will be stored in the
 // database.
 job.setOutputKeyClass(Text.class);
 job.setOutputValueClass(VerticalRecord.class);
 job.setOutputFormatClass(VerticalOutputFormat.class);
 job.setJarByClass(VerticalExample.class);
 job.setMapperClass(Map.class);
 job.setReducerClass(Reduce.class);

 // Sets the output format for storing data in Vertica. It defines the
 // table where data is stored, and the columns it will be stored in.
 VerticalOutputFormat.setOutput(job, "mrtarget", true, "a int",
 "b boolean", "c char(1)", "d date", "f float", "t timestamp",
 "v varchar", "z varbinary");

 // Sets the query to use to get the data from the Vertica database.
 // Query using a list of parameters.

 VerticalInputFormat.setInput(job, "select * from allTypes where key = ?",
 "1", "2", "3");

 job.waitForCompletion(true);
 return 0;
}

public static void main(String[] args) throws Exception {
 int res = ToolRunner.run(new Configuration(), new VerticalExample(),
 args);
 System.exit(res);
}

```

```
}
```

## Compiling and Running the Example Application

To run the example Hadoop application, you first need to set up the allTypes table that the example reads as input. To set up the input table, save the following Perl script as MakeAllTypes.pl to a location on one of your HP Vertica nodes:

```
#!/usr/bin/perl
open FILE, ">datasource" or die $!;
for ($i=0; $i < 10; $i++) {
 print FILE $i . "|" . rand(10000);
 print FILE "|one|ONE|1|1999-01-08|1999-02-23 03:11:52.35";
 print FILE '|1999-01-08 07:04:37|07:09:23|15:12:34 EST|0xabcd|';
 print FILE '0xabcd|1234532|03:03:03' . qq(\n);
}
close FILE;
```

Then follow these steps:

- 1 Connect to the node where you saved the MakeAllTypes.pl file.
- 2 Run the MakeAllTypes.pl file. This will generate a file named datasource in the current directory.  
**Note:** If your node does not have Perl installed, you can run this script on a system that does have Perl installed, then copy the datasource file to a database node.
- 3 On the same node, use vsql to connect to your HP Vertica database.
- 4 Run the following query to create the allTypes table:

```
CREATE TABLE allTypes (key identity, intcol integer,
 floatcol float,
 charcol char(10),
 varcharcol varchar,
 boolcol boolean,
 datecol date,
 timestampcol timestamp,
 timestampTzcol timestamptz,
 timecol time,
 timeTzcol timetz,
 varbincol varbinary,
 bincol binary,
 numcol numeric(38,0),
 intervalcol interval
);
```

- 5 Run the following query to load data from the datasource file into the table:

```
COPY allTypes COLUMN OPTION (varbincol FORMAT 'hex', bincol FORMAT 'hex')
FROM '/path-to-datasource/datasource' DIRECT;
```

Replace `path-to-datasource` with the absolute path to the `datasource` file located in the same directory where you ran `MakeAllTypes.pl`.

### Compiling the Example (optional)

The example code presented in this section is based on example code distributed along with HP Vertica's Hadoop Connector in the file `hadoop-vertica-example.jar`. If you just want to run the example, skip to the next section and use the `hadoop-vertica-example.jar` file that came as part of the Hadoop Connector package rather than a version you compiled yourself.

To compile the example code listed in ***Example Hadoop Connector Application*** (page [559](#)), follow these steps:

- 1 Log into a node on your Hadoop cluster.
- 2 Locate the Hadoop home directory. See ***Hadoop Connector Installation Procedure*** (page [545](#)) for tips on how to find this directory.
- 3 If it is not already set, set the environment variable `HADOOP_HOME` to the Hadoop home directory:

```
export HADOOP_HOME=path_to_Hadoop_home
```

If you installed Hadoop using an `.rpm` or `.deb` package, Hadoop is usually installed in `/usr/lib/hadoop`:

```
export HADOOP_HOME=/usr/lib/hadoop
```

- 4 Save the example source code to a file named `VerticaExample.java` on your Hadoop node.
- 5 In the same directory where you saved `VerticaExample.java`, create a directory named `classes`. On Linux, the command is:

```
mkdir classes
```

- 6 Compile the Hadoop example:

```
javac -classpath \
$HADOOP_HOME/hadoop-core.jar:$HADOOP_HOME/lib/hadoop-vertica.jar \
-d classes VerticaExample.java \
&& jar -cvf hadoop-vertica-example.jar -C classes .
```

**Note:** If you receive errors about missing Hadoop classes, check the name of the `hadoop-code.jar` file. Most Hadoop installers (including the Cloudera) create a symbolic link named `hadoop-core.jar` to a version specific `.jar` file (such as `hadoop-core-0.20.203.0.jar`). If your Hadoop installation did not create this link, you will have to supply the `.jar` file name with the version number.

When the compilation finishes, you will have a file named `hadoop-vertica-example.jar` in the same directory as the `VerticaExample.java` file. This is the file you will have Hadoop run.

### Running the Example Application

Once you have compiled the example, you run it using the following command line:

```
hadoop jar hadoop-vertica-example.jar \
com.vertica.hadoop.VerticaExample \
-Dmapred.vertica.hostnames=VerticaHost01,VerticaHost02,... \
```

```
-Dmapred.vertica.port=portNumber \
-Dmapred.vertica.username=userName \
-Dmapred.vertica.password=dbPassword \
-Dmapred.vertica.database=databaseName
```

This command tells Hadoop to run your application's .jar file, and supplies the parameters needed for your application to connect to your HP Vertica database. Fill in your own values for the hostnames, port, user name, password, and database name for your HP Vertica database.

After entering the command line, you will see output from Hadoop as it processes data that looks similar to the following:

```
12/01/11 10:41:19 INFO mapred.JobClient: Running job: job_201201101146_0005
12/01/11 10:41:20 INFO mapred.JobClient: map 0% reduce 0%
12/01/11 10:41:36 INFO mapred.JobClient: map 33% reduce 0%
12/01/11 10:41:39 INFO mapred.JobClient: map 66% reduce 0%
12/01/11 10:41:42 INFO mapred.JobClient: map 100% reduce 0%
12/01/11 10:41:45 INFO mapred.JobClient: map 100% reduce 22%
12/01/11 10:41:51 INFO mapred.JobClient: map 100% reduce 100%
12/01/11 10:41:56 INFO mapred.JobClient: Job complete: job_201201101146_0005
12/01/11 10:41:56 INFO mapred.JobClient: Counters: 23
12/01/11 10:41:56 INFO mapred.JobClient: Job Counters
12/01/11 10:41:56 INFO mapred.JobClient: Launched reduce tasks=1
12/01/11 10:41:56 INFO mapred.JobClient: SLOTS_MILLIS_MAPS=21545
12/01/11 10:41:56 INFO mapred.JobClient: Total time spent by all reduces waiting after reserving
slots (ms)=0
12/01/11 10:41:56 INFO mapred.JobClient: Total time spent by all maps waiting after reserving slots
(ms)=0
12/01/11 10:41:56 INFO mapred.JobClient: Launched map tasks=3
12/01/11 10:41:56 INFO mapred.JobClient: SLOTS_MILLIS_REDUCES=13851
12/01/11 10:41:56 INFO mapred.JobClient: File Output Format Counters
12/01/11 10:41:56 INFO mapred.JobClient: Bytes Written=0
12/01/11 10:41:56 INFO mapred.JobClient: FileSystemCounters
12/01/11 10:41:56 INFO mapred.JobClient: FILE_BYTES_READ=69
12/01/11 10:41:56 INFO mapred.JobClient: HDFS_BYTES_READ=318
12/01/11 10:41:56 INFO mapred.JobClient: FILE_BYTES_WRITTEN=89367
12/01/11 10:41:56 INFO mapred.JobClient: File Input Format Counters
12/01/11 10:41:56 INFO mapred.JobClient: Bytes Read=0
12/01/11 10:41:56 INFO mapred.JobClient: Map-Reduce Framework
12/01/11 10:41:56 INFO mapred.JobClient: Reduce input groups=1
12/01/11 10:41:56 INFO mapred.JobClient: Map output materialized bytes=81
12/01/11 10:41:56 INFO mapred.JobClient: Combine output records=0
12/01/11 10:41:56 INFO mapred.JobClient: Map input records=3
12/01/11 10:41:56 INFO mapred.JobClient: Reduce shuffle bytes=54
12/01/11 10:41:56 INFO mapred.JobClient: Reduce output records=1
12/01/11 10:41:56 INFO mapred.JobClient: Spilled Records=6
12/01/11 10:41:56 INFO mapred.JobClient: Map output bytes=57
12/01/11 10:41:56 INFO mapred.JobClient: Combine input records=0
12/01/11 10:41:56 INFO mapred.JobClient: Map output records=3
12/01/11 10:41:56 INFO mapred.JobClient: SPLIT_RAW_BYTES=318
12/01/11 10:41:56 INFO mapred.JobClient: Reduce input records=3
```

**Note:** The version of the example supplied in the Hadoop Connector download package will produce more output, since it runs several input queries.

## Verifying the Results

Once your Hadoop application finishes, you can verify it ran correctly by looking at the mrtarget table in your HP Vertica database:

Connect to your HP Vertica database using vsql and run the following query:

```
=> SELECT * FROM mrtarget;
```

The results should look like this:

```
a | b | c | d | f | t | v |
z
-----+-----+-----+-----+-----+-----+
-----+-----+-----+-----+-----+
125 | t | c | 2012-01-11 | 234.567 | 2012-01-11 10:41:48.837 | example string |
\000\000\000\000\000\000\000\000\000
(1 row)
```

## Using Hadoop Streaming with HP Vertica's Hadoop Connector

Hadoop streaming allows you to create an ad-hoc Hadoop job that uses standard commands (such as UNIX command-line utilities) for its map and reduce processing. When using streaming, Hadoop executes the command you pass to it a mapper and breaks each line from its standard output into key and value pairs. By default, the key and value are separated by the first tab character in the line. These values are then passed to the standard input to the command that you specified as the reducer. See the Hadoop wiki's [topic on streaming](#)

<http://wiki.apache.org/hadoop/HadoopStreaming> for more information. You can have a streaming job retrieve data from an HP Vertica database, store data into an HP Vertica database, or both.

## Reading Data from HP Vertica in a Streaming Hadoop Job

To have a streaming Hadoop job read data from an HP Vertica database, you set the `inputformat` argument of the Hadoop command line to `com.vertica.deprecated.VerticaStreamingInput`. You also need to supply parameters that tell the Hadoop job how to connect to your HP Vertica database. See ***Passing Parameters to the Hadoop Connector at Run Time*** (page [558](#)) for an explanation of these command-line parameters.

**Note:** The `VerticalStreamingInput` class is within the deprecated namespace because the current version of Hadoop (as of 0.20.1) has not defined a current API for streaming. Instead, the streaming classes conform to the Hadoop version 0.18 API.

In addition to the standard command-line parameters that tell Hadoop how to access your database, there are additional streaming-specific parameters you need to use that supply Hadoop with the query it should use to extract data from HP Vertica and other query-related options.

| Parameter                       | Description                                                                                                                                                    | Required               | Default |
|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------|
| mapred.vertica.input.query      | The query to use to retrieve data from the HP Vertica database. See <i>Setting the Query to Retrieve Data from HP Vertica</i> (page 548) for more information. | Yes                    | none    |
| mapred.vertica.input.paramquery | A query to execute to retrieve parameters for the query                                                                                                        | If query has parameter |         |

| Parameter                       | Description                                                                                                                                            | Required                                               | Default |
|---------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|---------|
|                                 | given in the .input.query parameter.                                                                                                                   | and no discrete parameters supplied                    |         |
| mapred.vertica.query.params     | Discrete list of parameters for the query.                                                                                                             | If query has parameter and no parameter query supplied |         |
| mapred.vertica.input.delimiter  | The character to use for separating column values. The command you use as a mapper needs to split individual column values apart using this delimiter. | No                                                     | 0xa     |
| mapred.vertica.input.terminator | The character used to signal the end of a row of data from the query result.                                                                           | No                                                     | 0xb     |

The following command demonstrates reading data from a table named allTypes. This command uses the UNIX cat command as a mapper and reducer so it will just pass the contents through.

```
$HADOOP_HOME/bin/hadoop jar $HADOOP_HOME/contrib/streaming/hadoop-streaming-*.jar \
-libjars $HADOOP_HOME/lib/hadoop-vertica.jar \
-Dmapred.vertica.hostnames=VerticaHost01,VerticaHost02,... \
-Dmapred.vertica.database=ExampleDB \
-Dmapred.vertica.username=ExampleUser \
-Dmapred.vertica.password=password123 \
-Dmapred.vertica.port=5433 \
-Dmapred.vertica.input.query="SELECT key, intcol, floatcol, varcharcol FROM allTypes ORDER BY key"
 \
-Dmapred.vertica.input.delimiter=, \
-Dmapred.map.tasks=1 \
-inputformat com.vertica.hadoop.deprecated.VerticalStreamingInput \
-input /tmp/input -output /tmp/output -reducer /bin/cat -mapper /bin/cat
```

The results of this command are saved in the /tmp/output directory on your HDFS filesystem. On a four-node Hadoop cluster, the results would be:

```
$HADOOP_HOME/bin/hadoop dfs -ls /tmp/output
Found 5 items
drwxr-xr-x - release supergroup 0 2012-01-19 11:47 /tmp/output/_logs
-rw-r--r-- 3 release supergroup 88 2012-01-19 11:47 /tmp/output/part-00000
-rw-r--r-- 3 release supergroup 58 2012-01-19 11:47 /tmp/output/part-00001
-rw-r--r-- 3 release supergroup 58 2012-01-19 11:47 /tmp/output/part-00002
-rw-r--r-- 3 release supergroup 87 2012-01-19 11:47 /tmp/output/part-00003

$HADOOP_HOME/bin/hadoop dfs -tail /tmp/output/part-00000
1 2,1,3165.75558015273,ONE,
5 6,5,1765.76024139635,ONE,
9 10,9,4142.54176256463,ONE,
$HADOOP_HOME/bin/hadoop dfs -tail /tmp/output/part-00001
2 3,2,8257.77313710329,ONE,
6 7,6,7267.69718012601,ONE,
$HADOOP_HOME/bin/hadoop dfs -tail /tmp/output/part-00002
```

```

3 4,3,443.188765520475,ONE,
7 8,7,4729.27825566408,ONE,
$HADOOP_HOME/bin/hadoop dfs -tail /tmp/output/part-00003
0 1,0,2456.83076632307,ONE,
4 5,4,9692.61214265391,ONE,
8 9,8,3327.25019418294,ONE,13 1015,15,15.1515,FIFTEEN
2 1003,3,333.0,THREE
3 1004,4,0.0,FOUR
4 1005,5,0.0,FIVE
5 1007,7,0.0,SEVEN
6 1008,8,1.0E36,EIGHT
7 1009,9,-1.0E36,NINE
8 1010,10,0.0,TEN
9 1011,11,11.11,ELEVEN

```

## Notes

- Even though the input is coming from HP Vertica, you need to supply the `-input` parameter to Hadoop for it to process the streaming job.
- The `-Dmapred.map.tasks=1` parameter prevents multiple Hadoop nodes from reading the same data from the database, which would result in Hadoop processing multiple copies of the data.

## Writing Data to HP Vertica in a Streaming Hadoop Job

Similar to reading from a streaming Hadoop job, you write data to HP Vertica by setting the `outputformat` parameter of your Hadoop command to `com.vertica.deprecated.VerticalStreamingOutput`. This class requires key/value pairs, but the keys are ignored. The values passed to `VerticalStreamingOutput` are broken into rows and inserted into a target table. Since keys are ignored, you can use the keys to partition the data for the reduce phase without affecting HP Vertica's data transfer.

As with reading from HP Vertica, you need to supply parameters that tell the streaming Hadoop job how to connect to the database. See [Passing Parameters to the Hadoop Connector at Run Time](#) (page 558) for an explanation of these command-line parameters. If you are reading data from one HP Vertica database and writing to another, you need to use the output parameters, similarly if you were reading and writing to separate databases using a Hadoop application. There are also additional parameters that configure the output of the streaming Hadoop job, listed in the following table.

| Parameter                                      | Description                                                                                                                                                                               | Required                                            | Default |
|------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|---------|
| <code>mapred.vertical.output.table.name</code> | The name of the table where Hadoop should store its data.                                                                                                                                 | Yes                                                 | none    |
| <code>mapred.vertical.output.table.def</code>  | The definition of the table. The format is the same as used for defining the output table for a Hadoop application. See <a href="#">Defining the Output Table</a> (page 552) for details. | If the table does not already exist in the database |         |

| Parameter                        | Description                                             | Required | Default                     |
|----------------------------------|---------------------------------------------------------|----------|-----------------------------|
| mapred.vertica.output.table.drop | Whether to truncate the table before adding data to it. | No       | false                       |
| mapred.vertica.output.delimiter  | The character to use for separating column values.      | No       | 0x7 (ASCII bell character ) |
| mapred.vertica.output.terminator | The character used to signal the end of a row of data.. | No       | 0x8 (ASCII backspace)       |

The following example demonstrates reading two columns of data from an HP Vertica database table named allTypes and writing it back to the same database in a table named hadoopout. The command provides the definition for the table, so you do not have to manually create the table beforehand.

```
hadoop jar $HADOOP_HOME/contrib/streaming/hadoop-streaming-* .jar \
-libjars $HADOOP_HOME/lib/hadoop-vertica.jar \
-Dmapred.vertica.output.table.name=hadoopout \
-Dmapred.vertica.output.table.def="intcol integer, varcharcol varchar" \
-Dmapred.vertica.output.table.drop=true \
-Dmapred.vertica.hostnames=VerticaHost01,VerticaHost02,VerticaHost03 \
-Dmapred.vertica.database=ExampleDB \
-Dmapred.vertica.username=ExampleUser \
-Dmapred.vertica.password=password123 \
-Dmapred.vertica.port=5433 \
-Dmapred.vertica.input.query="SELECT intcol, varcharcol FROM allTypes ORDER BY key" \
-Dmapred.vertica.input.delimiter=, \
-Dmapred.vertica.output.delimiter=, \
-Dmapred.vertica.input.terminator=0x0a \
-Dmapred.vertica.output.terminator=0x0a \
-inputformat com.vertica.hadoop.deprecated.VerticalStreamingInput \
-outputformat com.vertica.hadoop.deprecated.VerticalStreamingOutput \
-input /tmp/input \
-output /tmp/output \
-reducer /bin/cat \
-mapper /bin/cat
```

After running this command, you can view the result by querying your database:

```
=> SELECT * FROM hadoopout;
intcol | varcharcol
-----+-----
 1 | ONE
 5 | ONE
 9 | ONE
 2 | ONE
 6 | ONE
 0 | ONE
 4 | ONE
 8 | ONE
 3 | ONE
 7 | ONE
```

---

(10 rows)

## Loading a Text File from HDFS into HP Vertica

One common task when working with Hadoop and HP Vertica is loading text files from the Hadoop Distributed File System (HDFS) into an HP Vertica table. You can load these files using Hadoop streaming, saving yourself the trouble of having to write custom map and reduce classes.

**Note:** Hadoop streaming is less efficient than a Java map/reduce Hadoop job, since it passes data through several different interfaces. Streaming is best used for smaller, one-time loads. If you need to load large amounts of data on a regular basis, you should create a standard Hadoop map/reduce job in Java or a script in Pig.

For example, suppose you have a text file in the HDFS you want to load contains values delimited by pipe characters (|), with each line of the file is terminated by a carriage return:

```
$HADOOP_HOME/bin/hadoop dfs -cat /tmp/textdata.txt
1|1.0|ONE
2|2.0|TWO
3|3.0|THREE
```

In this case, the line delimiter poses a problem. You can easily include the column delimiter in the Hadoop command line arguments. However, it is hard to specify a carriage return in the Hadoop command line. To get around this issue, you can write a mapper script to strip the carriage return and replace it with some other character that is easy to enter in the command line and also does not occur in the data.

Below is an example of a mapper script written in Python. It performs two tasks:

- Strips the carriage returns from the input text and terminates each line with a tilde (~).
- Adds a key value (the string "streaming") followed by a tab character at the start of each line of the text file. The mapper script needs to do this because the streaming job to read text files skips the reducer stage. The reducer isn't necessary, since the all of the data being read in text file should be stored in the HP Vertica tables. However, `VerticaStreamingOutput` class requires key and values pairs, so the mapper script adds the key.

```
#!/usr/bin/python
import sys
for line in sys.stdin.readlines():
 # Get rid of carriage returns.
 # CR is used as the record terminator by Streaming.jar
 line = line.strip();
 # Add a key. The key value can be anything.
 # The convention is to use the name of the
 # target table, as shown here.
 sys.stdout.write("streaming\t%s~\n" % line)
```

The Hadoop command to stream text files from the HDFS into HP Vertica using the above mapper script appears below.

```
hadoop jar $HADOOP_HOME/contrib/streaming/hadoop-streaming-*.*jar \
-libjars $HADOOP_HOME/lib/hadoop-vertica.jar \
-Dmapred.reduce.tasks=0 \
-Dmapred.vertica.output.table.name=streaming \
-Dmapred.vertica.output.table.def="intcol integer, floatcol float, varcharcol varchar" \
```

```
-Dmapred.vertica.hostnames=VerticaHost01,VerticaHost02,VerticaHost03 \
-Dmapred.vertica.port=5433 \
-Dmapred.vertica.username=ExampleUser \
-Dmapred.vertica.password=password123 \
-Dmapred.vertica.database=ExampleDB \
-Dmapred.vertica.output.delimiter="|" \
-Dmapred.vertica.output.terminator="~" \
-input /tmp/textdata.txt \
-output output \
-mapper "python path-to-script/mapper.py" \
-outputformat com.vertica.hadoop.deprecated.VerticalStreamingOutput
```

## Notes

- The `-Dmapred.reduce-tasks=0` parameter disables the streaming job's reducer stage. It does not need a reducer since the mapper script processes the data into the format that the `VerticalStreamingOutput` class expects.
- Even though the `VerticalStreamingOutput` class is handling the output from the mapper, you need to supply a valid output directory to the Hadoop command.

The result of running the command is a new table in the HP Vertica database:

```
=> SELECT * FROM streaming;
 intcol | floatcol | varcharcol
-----+-----+-----
 3 | 3 | THREE
 1 | 1 | ONE
 2 | 2 | TWO
(3 rows)
```

## Accessing HP Vertica from Pig

HP Vertica's Hadoop Connector includes a Java package that lets you access an HP Vertica database using Pig. You must copy this `.jar` to somewhere in your Pig installation's `CLASSPATH` (see **Hadoop Connector Installation Procedure** (page [545](#)) for details).

### Registering the HP Vertica .jar files

Before it can access HP Vertica, your Pig Latin script must register the HP Vertica-related `.jar` files. All of your Pig scripts should start with the following commands:

```
REGISTER 'path-to-pig-home/lib/vertica_6.1.x.x_jdk_5.jar';
REGISTER 'path-to-pig-home/lib/pig-vertica.jar';
```

These commands ensure that Pig can locate the HP Vertica JDBC classes, as well as the interface for the Hadoop Connector.

### Reading Data from HP Vertica

To read data from an HP Vertica database, you tell Pig Latin's `LOAD` statement to use a SQL query and to use the `VerticalLoader` class as the load function. Your query can be hard coded, or contain a parameter. See **Setting the Query to Retrieve Data from HP Vertica** (page [548](#)) for details.

**Note:** You can only use a discrete parameter list or supply a query to retrieve parameter values—you cannot use a collection to supply parameter values as you can from within a Hadoop application.

The format for calling the VerticalLoader is:

```
com.vertica.pig.VerticalLoader('hosts','database','port','username','password');
```

|                 |                                                                                                                                                               |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>hosts</i>    | A comma-separated list of the hosts in the HP Vertica cluster.                                                                                                |
| <i>database</i> | The name of the database to be queried.                                                                                                                       |
| <i>port</i>     | The port number for the database.                                                                                                                             |
| <i>username</i> | The username to use when connecting to the database.                                                                                                          |
| <i>password</i> | The password to use when connecting to the database. This is the only optional parameter. If not present, the Hadoop Connector assumes the password is empty. |

The following Pig Latin command extracts all of the data from the table named allTypes using a simple query:

```
A = LOAD 'sql:///{SELECT * FROM allTypes ORDER BY key}' USING
 com.vertica.pig.VerticalLoader('Vertica01,Vertica02,Vertica03',
 'ExampleDB','5433','ExampleUser','password123');
```

This example uses a parameter and supplies a discrete list of parameter values:

```
A = LOAD 'sql:///{SELECT * FROM allTypes WHERE key = ?};{1,2,3}' USING
 com.vertica.pig.VerticalLoader('Vertica01,Vertica02,Vertica03',
 'ExampleDB','5433','ExampleUser','password123');
```

This final example demonstrates using a second query to retrieve parameters from the HP Vertica database.

```
A = LOAD 'sql:///{SELECT * FROM allTypes WHERE key = ?};sql:///{SELECT DISTINCT key FROM allTypes}' USING
 com.vertica.pig.VerticalLoader('Vertica01,Vertica02,Vertica03','ExampleDB',
 '5433','ExampleUser','password123');
```

## Writing Data to HP Vertica

To write data to an HP Vertica database, you tell Pig Latin's STORE statement to save data to a database table (optionally giving the definition of the table) and to use the VerticalStorer class as the save function. If the table you specify as the destination does not exist, and you supplied the table definition, the table is automatically created in your HP Vertica database and the data from the relation is loaded into it.

The syntax for calling the VerticalStorer is the same as calling VerticalLoader:

```
com.vertica.pig.VerticalStorer('hosts','database','port','username','password');
```

The following example demonstrates saving a relation into a table named hadoopOut which must already exist in the database:

```
STORE A INTO '{hadoopOut}' USING
 com.vertica.pig.VerticalStorer('Vertica01,Vertica02,Vertica03','ExampleDB','5433',
 'ExampleUser','password123');
```

This example shows how you can add a table definition to the table name, so that the table is created in HP Vertica if it does not already exist:

```
STORE A INTO '{outTable(a int, b int, c float, d char(10), e varchar, f boolean, g date,
h timestamp, i timestamptz, j time, k timetz, l varbinary, m binary,
n numeric(38,0), o interval})' USING
com.vertica.pig.VerticalStorer('Vertica01,Vertica02,Vertica03','ExampleDB','5433',
'ExampleUser','password123');
```

**Note:** If the table already exists in the database, and the definition that you supply differs from the table's definition, the table is not dropped and recreated. This may cause data type errors when data is being loaded.

# Using the Hadoop Distributed File System Connectors

---

The Hadoop Distributed File System (HDFS) is where Hadoop usually stores its input and output data. It stores files across the Hadoop cluster redundantly, ensuring files remain available even if some nodes are down. It also makes Hadoop more efficient, by spreading file access tasks across the cluster to help limit I/O bottlenecks.

HP Vertica's HDFS Connectors let you load files from HDFS into HP Vertica using the COPY statement. You can also create external tables that access data stored on HDFS as if it were a native HP Vertica table. The HDFS Connectors are useful to have HP Vertica import data from Hadoop when you want to analyze it in HP Vertica. It is different than the Hadoop Connector, which lets Hadoop map/reduce jobs access data stored in HP Vertica (see [Using the Hadoop Connector \(page 544\)](#)).

**Note:** The files you load from HDFS using the HDFS Connectors must be in a format that can be parsed by the COPY statement into column values. Usually this means they are in a delimited format, where column values are separated by a character such as a comma or a pipe character (|).

Like the Hadoop Connector, the HDFS Connector takes advantage of the distributed nature of both HP Vertica and Hadoop. Individual nodes in the HP Vertica cluster connect directly to nodes in the Hadoop cluster when loading multiple files from the HDFS. This parallel operation decreases load times.

The HDFS Connectors are read-only—they cannot write data to HDFS. Use them when you want to import data from HDFS into HP Vertica. If you want Hadoop to be able to read data from and write data to HP Vertica, use the [Hadoop Connector \(page 544\)](#).

There are two versions of the HDFS connector:

- The Standard HDFS Connector lets you connect to a Hadoop cluster that does not perform authentication.
- The Secure HDFS Connector lets you connect to a Hadoop cluster that uses Kerberos authentication.

## HDFS Connector Requirements

The HDFS Connector connects to the Hadoop file system using WebHDFS, a built-in component of HDFS that provides access to HDFS files to applications outside of Hadoop. WebHDFS was added to Hadoop in version 1.0, so your Hadoop installation must be version 1.0 or later. The HDFS Connector has been tested with Apache Hadoop 1.0.0, Hortonworks 1.1, and Cloudera CDH4.

In addition, the WebHDFS system must be enabled. See your Hadoop distribution's documentation for instructions on configuring and enabling WebHDFS.

**Note:** HTTPfs (also known as HOOP) is another method of accessing files stored in an HDFS. It relies on a separate server process that receives requests for files and retrieves them from the HDFS. Since it uses a REST API that is compatible with WebHDFS, it could theoretically work with the HDFS Connectors. However, the Connectors have not been tested with HTTPfs and HP does not support using the HDFS Connectors with HTTPfs. In addition, since all of the files retrieved from HDFS must pass through the HTTPfs server, it is less efficient than WebHDFS, which lets HP Vertica nodes directly connect to the Hadoop nodes storing the file blocks.

## Secure HDFS Connector Requirements

The Secure HDFS Connector has the same requirements as the standard HDFS Connector (see **HDFS Connector Requirements** (page [575](#))) plus these additional requirements:

- Your Hadoop cluster must be configured to use Kerberos authentication.
- The Kerberos server must be running version 5.
- The Kerberos server must be accessible from every node in your HP Vertica cluster.
- You must have Kerberos principals (users) that map to Hadoop users. You use these principals to authenticate your HP Vertica users with the Hadoop cluster.

**Note:** You should assign each data node in your Hadoop cluster its own Kerberos principal. If you do not, you risk having Kerberos deny authentication to one or more nodes if multiple Hadoop nodes request authentication at nearly the same instant using the same credentials. Kerberos sees these nearly simultaneous authentication attempts using the same credentials as a replay attack, causing it to deny one or more node's authentication request. This issue can result in incorrect results when using the Secure HDFS connector—repeating the same query returns a different number of rows depending on whether some of the nodes were denied authentication.

There are two configuration steps you need to perform before you can use the Secure HDFS Connector:

- **Install the Kerberos client and libraries** (page [576](#)) on your HP Vertica cluster.
- **Prepare keytab files** (page [577](#)) to use when authenticating HP Vertica users.

## Installing and Configuring Kerberos on Your HP Vertica Cluster

You must perform several steps to configure your HP Vertica cluster before the Secure HDFS Connector can authenticate an HP Vertica user using Kerberos.

**Note:** You only need to perform these configuration steps if you are using the Secure HDFS Connector. The standard HDFS Connector does not require your HP Vertica cluster to have any special configuration.

Perform the following steps on **each node** in your HP Vertica cluster:

- 1 Install the Kerberos libraries and client. To learn how to install these packages, see the documentation your Linux distribution.
- 2 Update the Kerberos configuration file (`/etc/krb5.conf`) to reflect your site's Kerberos configuration. The easiest method of doing this is to copy the `/etc/krb5.conf` file from your Kerberos Key Distribution Center (KDC) server.
- 3 Copy the keytab files for the users to a directory on the node (see **Preparing Keytab Files for the Secure HDFS Connector** (page 577)). The absolute path to these files must be the same on every node in your HP Vertica cluster.
- 4 Ensure the keytab files are readable by the database administrator's Linux account (usually dbadmin). The easiest way to do this is to change ownership of the files to dbadmin:  

```
sudo chown dbadmin *.keytab
```

## Preparing Keytab Files for the Secure HDFS Connector

The Secure HDFS Connector uses keytab files to authenticate HP Vertica users with Kerberos, so they can access files on the Hadoop HDFS filesystem. These files take the place of entering a password at a Kerberos login prompt.

You must have a keytab file for each HP Vertica user that needs to use the Secure HDFS Connector. The keytab file must match the Kerberos credentials of a Hadoop user that has access to the HDFS.

**Caution:** Exporting a keytab file for a user changes the version number associated with the user's Kerberos account. This change **invalidates any previously exported keytab file** for the user. If a keytab file has already been created for a user and is currently in use, you should use that keytab file rather than exporting a new keytab file. Otherwise, exporting a new keytab file will cause any processes using an existing keytab file to no longer be able to authenticate.

To export a keytab file for a user:

- 1 Start the kadmin utility:
  - If you have access to the root account on the Kerberos Key Distribution Center (KDC) system, log into it and use the `kadmin.local` command. (If this command is not in the system search path, try `/usr/kerberos/sbin/kadmin.local`.)
  - If you do not have access to the root account on the Kerberos KDC, then you can use the `kadmin` command from a Kerberos client system as long as you have the password for the Kerberos administrator account. When you start `kadmin`, it will prompt you for the Kerberos administrator's password. You may need to have root privileges on the client system in order to run `kadmin`.
- 2 Use `kadmin`'s `xst (export)` command to export the user's credentials to a keytab file:  
`xst -k username.keytab username@YOURDOMAIN.COM`  
 where `username` is the name of Kerberos principal you want to export, and `YOURDOMAIN.COM` is your site's Kerberos realm. This command creates a keytab file named `username.keytab` in the current directory.

The following example demonstrates exporting a keytab file for a user named `exampleuser@MYCOMPANY.COM` using the `kadmin` command on a Kerberos client system:

```
$ sudo kadmin
[sudo] password for dbadmin:
Authenticating as principal root/admin@MYCOMPANY.COM with password.
Password for root/admin@MYCOMPANY.COM:
kadmin: xst -k exampleuser.keytab exampleuser@MYCOMPANY.COM
Entry for principal exampleuser@MYCOMPANY.COM with kvno 2, encryption
type des3-cbc-sha1 added to keytab WRFILE:exampleuser.keytab.
Entry for principal exampleuser@VERTICACORP.COM with kvno 2, encryption
type des-cbc-crc added to keytab WRFILE:exampleuser.keytab.
```

After exporting the keyfile, you can use the `klist` command to list the keys stored in the file:

```
$ sudo klist -k exampleuser.keytab
[sudo] password for dbadmin:
Keytab name: FILE:exampleuser.keytab
KVNO Principal

2 exampleuser@MYCOMPANY.COM
2 exampleuser@MYCOMPANY.COM
```

## Testing Your Hadoop WebHDFS Configuration

To ensure that your Hadoop installation's WebHDFS system is configured and running, follow these steps:

- 1 Log into your Hadoop cluster and locate a small text file on the Hadoop filesystem. If you do not have a suitable file, you can create a file named `test.txt` in the `/tmp` directory using the following command:

```
echo -e "A|1|2|3\nB|4|5|6" | hadoop fs -put - /tmp/test.txt
```

- 2 Log into a host in your HP Vertica database using the database administrator account.

- 3 If you are using the Secure HDFS Connector, authenticate with the Kerberos server using the keytab file for a user who is authorized to access the file. For example, to authenticate as an user named `exampleuser@MYCOMPANY.COM`, use the command:

```
$ kinit exampleuser@MYCOMPANY.COM -k -t /path/exampleuser.keytab
```

Where `path` is the path to the keytab file you copied over to the node. You do not receive any message if you authenticate successfully. You can verify that you are authenticated by using the `klist` command:

```
$ klist
Ticket cache: FILE:/tmp/krb5cc_500
Default principal: exampleuser@MYCOMPANY.COM
```

| Valid starting                | Expires           | Service principal                  |
|-------------------------------|-------------------|------------------------------------|
| 07/24/13 14:30:19             | 07/25/13 14:30:19 | krbtgt/MYCOMPANY.COM@MYCOMPANY.COM |
| renew until 07/24/13 14:30:19 |                   |                                    |

- 4 Test retrieving the file:

- If you are using the Standard HDFS Connector, run the following command from the Linux command line:

```
curl -i -L \
"http://hadoopNameNode:50070/webhdfs/v1/tmp/test.txt?op=OPEN&user.name=hadoopUserName"
```

Replacing *hadoopNameNode* with the hostname or IP address of the name node in your Hadoop cluster, */tmp/test.txt* with the path to the file in the Hadoop filesystem you located in step 1, and *hadoopUserName* with the user name of a Hadoop user that has read access to the file.

If successful, the command you will see output similar to the following:

```
HTTP/1.1 200 OK
Server: Apache-Coyote/1.1
Set-Cookie:
hadoop.auth="u=hadoopUser&p=password&t=simple&e=1344383263490&s=n8
YB/CHFg56qNmRQRTq00IdRMvE="; Version=1; Path=/
Content-Type: application/octet-stream
Content-Length: 16
Date: Tue, 07 Aug 2012 13:47:44 GMT
```

```
A|1|2|3
B|4|5|6
```

- If you are using the Secure HDFS Connector, run the following command from the Linux command line:

```
curl --negotiate -i -L -u:anyUser
http://hadoopNameNode:50070/webhdfs/v1/tmp/test.txt?op=OPEN
```

Replace *hadoopNameNode* with the hostname or IP address of the name node in your Hadoop cluster, and */tmp/test.txt* with the path to the file in the Hadoop filesystem you located in step 1.

If successful, you will see output similar to the following:

```
HTTP/1.1 401 Unauthorized
Content-Type: text/html; charset=utf-8
WWW-Authenticate: Negotiate
Content-Length: 0
Server: Jetty(6.1.26)
```

```
HTTP/1.1 307 TEMPORARY_REDIRECT
Content-Type: application/octet-stream
Expires: Thu, 01-Jan-1970 00:00:00 GMT
Set-Cookie:
hadoop.auth="u=exampleuser&p=exampleuser@MYCOMPANY.COM&t=kerberos&
e=1375144834763&s=iY52iRvjuuoz5iYG8G5g12O2Vwo="; Path=/
Location:
http://hadoopnamenode.mycompany.com:1006/webhdfs/v1/user/release/d
ocexample/test.txt?
op=OPEN&delegation=JAAHcmVsZWFzZQdyZWx1YXNlAIoBQCrfpdGKAUBO7CnRju3
TbBS1ID_osB658jFGf
RpEt8-u9WHymRJXRUIREZTIGRlbGVnYXRpb24SMTAuMjAuMTAwLj kxOjUwMDcw&of
fset=0
Content-Length: 0
```

```
Server: Jetty(6.1.26)

HTTP/1.1 200 OK
Content-Type: application/octet-stream
Content-Length: 16
Server: Jetty(6.1.26)

A|1|2|3
B|4|5|6
```

If the curl command fails, you must review the error messages and resolve any issues before using the HDFS Connector with your Hadoop cluster. Some debugging steps include:

- Verify the HDFS service's port number.
- Verify that the Hadoop user you specified (either through the URL for the non-Kerberos authenticated HDFS, or the keytab file for the Kerberos authenticated HDFS) exists and has read access to the file you are attempting to retrieve.
- Make sure you are using the correct connector to access your HDFS. The Secure HDFS Connector can *only* connect to Hadoop clusters that use Kerberos authentication. The Standard HDFS Connector can *only* connect to Hadoop clusters that do not use Kerberos.

## Installing the HDFS Connector Package

The HDFS Connectors are not included as part of the HP Vertica Analytics Platform installation. You must download and install them on all nodes in your HP Vertica database. There are two separate HDFS connector packages: one for the Standard Connector, and one for the Secure Connector.

**Note:** You can install both HDFS Connectors in your HP Vertica database at the same time. They do not interfere with each other.

The HDFS Connector installation packages contains several support libraries in addition to the library for the Connector. Unlike some other packages supplied by HP, you need to install these package on **all of the hosts** in your HP Vertica database so each host has a copy of the support libraries.

### Downloading and Installing the HDFS Connector Package

Following these steps to install either or both of the HDFS connectors:

- 1 Use a Web browser to log into the **myVertica portal** <http://my.vertica.com/>.
- 2 Click the Download tab.
- 3 Locate the section for the Connector you want: The (standard) HDFS Connector or the Secure HDFS Connector and download the installation package that matches the Linux distribution on your HP Vertica cluster.
- 4 Copy the installation package to **each host** in your database.
- 5 Log into each host as root and run the following command to install the HDFS Connector package.
  - On Red Hat-based Linux distributions, use the command:

```
rpm -Uvh /path/installation-package.rpm
```

For example, if you downloaded the Red Hat installation package to the dbadmin home directory, the command to install the package is:

```
rpm -Uvh
/home/dbadmin/vertica-hdfs-connectors-6.1.x.x86_64.RHEL5.rpm
```

- On Debian-based systems, use the command:

```
dpkg -i /path/installation-package.deb
```

Once you have installed the connector package on each host, you need to load the HDFS Connector library into HP Vertica. See **[Loading the HDFS User Defined Source](#)** (page 581) for instructions.

## Loading the HDFS User Defined Source

Once you have installed one or both of the HDFS Connector packages on each host in your database, you need to load the Connector's library into HP Vertica and define the User Defined Source (UDS) in the HP Vertica catalog. The UDS is what you use to access data from the HDFS. The HDFS Connector install packages contain a SQL script named `install.sql` that performs these steps for you. To run it:

1 Log into to the Administration Host using the database administrator account.

2 Execute the installation script:

- For the Standard HDFS Connector:

```
vsql -f /opt/vertica/packages/hdfs_connectors/install.sql
```

- For the Secure HDFS Connector:

```
vsql -f
/opt/vertica/packages/secure_hdfs_connectors/ddl/install.sql
```

- To install both Connectors, execute both of the installation scripts.

3 Enter the database administrator password if prompted.

**Note:** You only need to run an installation script once in order to create the User Defined Source in the HP Vertica catalog. You do not need to run the install script on each node.

The SQL install script loads the HDFS Connector library and defines the HDFS User Defined Source named HDFS (for the Standard HDFS Connector) or SecureHDFS (for the Secure HDFS connector). The output of running the installation script successfully looks like this:

```
version

Vertica Analytic Database v6.1.x.x
(1 row)

CREATE LIBRARY
CREATE SOURCE FUNCTION
```

Once the install script finishes running, the Connector is ready to use.

## Loading Data Using the Standard HDFS Connector

Once you have installed the Standard HDFS Connector, you can use the Hdfs User Defined Source (UDS) in a COPY statement to load data from HDFS files.

The basic syntax for using the Hdfs UDS in a COPY statement is:

```
COPY tableName SOURCE Hdfs(url='HDFSfileURL', username='username');
```

|                    |                                                                                                                                                                                                                                                                             |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>tableName</i>   | The name of the table to receive the copied data.                                                                                                                                                                                                                           |
| <i>HDFSfileURL</i> | A string containing one or more comma-separated URLs that identify the file or files to be read. See below for details.<br><b>Note:</b> You must URL encode any commas in the URL (replacing the , with %2c) to prevent the comma being misinterpreted by the UDS function. |
| <i>username</i>    | The username of a Hadoop user that has permissions to access the files you want to copy.                                                                                                                                                                                    |

The HDFSFileURL parameter is a string containing one or more comma-separated HTTP URLs that identify the files in the HDFS that you want to load. The format for each URL in this string is:

`http://NameNode:port/webhdfs/v1/HDFSfilePath`

|                     |                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>NameNode</i>     | The host name or IP address of the Hadoop cluster's name node.                                                                                                                                                                                                                                                                                                                                                                    |
| <i>Port</i>         | The port number on which the WebHDFS service is running. This is usually 50070 or 14000, but may be different in your Hadoop installation.                                                                                                                                                                                                                                                                                        |
| <i>webhdfs/v1/</i>  | The protocol being used to retrieve the file. This portion of the URL is always the same, to tell Hadoop to use version 1 of the WebHDFS API.                                                                                                                                                                                                                                                                                     |
| <i>HDFSfilePath</i> | The path from the root of the HDFS filesystem to the file or files you want to load. This path can contain standard Linux wildcards.<br><b>Note:</b> Any wildcards you use to specify multiple input files must resolve to files only, and not include any directories. For example, if you specify the path /user/HadoopUser/output/*, and the output directory contains a subdirectory, the Connector returns an error message. |

For example, the following command loads a single file named /tmp/test.txt from the Hadoop cluster whose name node's host name is hadoop using the Standard HDFS Connector:

```
=> COPY testTable SOURCE Hdfs(url='http://hadoop:50070/webhdfs/v1/tmp/test.txt',
-> username='hadoopUser');
Rows Loaded
```

```

2
(1 row)
```

## Copying Files in Parallel

The basic COPY command shown above copies a single file using just a single host in the HP Vertica cluster. This is not efficient, since just a single HP Vertica host performs the data load.

To make the load process more efficient, the data you want to load should be in multiple files (which it usually is if you are loading the results of a Hadoop job). You can then load them all by using wildcards in the URL, by supplying multiple comma-separated URLs in the url parameter of the Hdfs user-defined source function call, or both. Loading multiple files through the HDFS connector results in a very efficient load since the HP Vertica hosts connect directly to individual nodes in the Hadoop cluster to retrieve files. It is less likely that a single node in either cluster will become a bottleneck that slows down the operation.

For example, the following statement loads all of the files whose filenames start with "part-" located in the /user/hadoopUser/output directory on the HDFS. Assuming there are at least as many files in this directory as there are nodes in your HP Vertica cluster, all of the nodes in your cluster will fetch and load the data from the HDFS.

```
=> COPY Customers SOURCE
-> Hdfs(url='http://hadoop:50070/webhdfs/v1/user/hadoopUser/output/part-*',
-> username='hadoopUser');
 Rows Loaded

 40008
(1 row)
```

Using multiple comma-separated URLs in the URL string you supply in the COPY statement lets you load data from multiple directories on the HDFS at once (or even data from different Hadoop clusters):

```
=> COPY Customers SOURCE
-> Hdfs(url='http://hadoop:50070/webhdfs/v1/user/HadoopUser/output/part-*',
-> http://hadoop:50070/webhdfs/v1/user/AnotherUser/part-*',
-> username='HadoopUser');
 Rows Loaded

 80016
(1 row)
```

**Note:** HP Vertica statements have a 65,000 character limit. If you supply too many long URLs in a single statement, you could go over this limit. This is usually more of a concern if you have automated the generation of the COPY statement.

## Viewing Rejected Rows and Exceptions

As with other types of bulk loading using the COPY command, rejected rows and exceptions are saved to log files stored by default in the CopyErrorLogs subdirectory in the database's catalog directory. Due to the distributed nature of the HDFS Connector, you cannot use the ON option to force all of the exception and rejected row information to be written to log files on a single HP Vertica host. You need to collect all of the log files from across the hosts in order to review all of the exception and rejection information.

## Loading Data Using the Secure HDFS Connector

Once you have installed the HDFS Connector, you can use the SecureHDFS User Defined Source (UDS) in a COPY statement to load data from HDFS files.

The basic syntax for using the SecureHDFS source in a COPY statement is:

```
COPY tableName SOURCE SecureHDFS(url='HDFSfileURL', username='username',
keytabFile='pathToFile');
```

|                    |                                                                                                                                                                                                                                                                                                                    |
|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>tableName</i>   | The name of the table to receive the copied data.                                                                                                                                                                                                                                                                  |
| <i>HDFSfileURL</i> | A string containing one or more comma-separated URLs that identify the file or files to be read. See below for details.<br><b>Note:</b> If the URL contains commas, they must be escaped                                                                                                                           |
| <i>username</i>    | The username of a Hadoop user that has permissions to access the files you want to copy.                                                                                                                                                                                                                           |
| <i>pathToFile</i>  | The absolute path from the node's filesystem root to the Kerberos keytab file that authenticates the user given by <i>username</i> . You must supply this parameter when using the Secure HDFS connector. See <b>Preparing Keytab Files for the Secure HDFS Connector</b> (page <a href="#">577</a> ) for details. |

The HDFSFileURL parameter is a string containing one or more comma-separated HTTP URLs that identify the files in the HDFS that you want to load. The format for each URL in this string is:

`http://NameNode:port/webhdfs/v1/HDFSfilePath`

|                     |                                                                                                                                               |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| <i>NameNode</i>     | The host name or IP address of the Hadoop cluster's name node.                                                                                |
| <i>Port</i>         | The port number on which the WebHDFS service is running. This is usually 50070 or 14000, but may be different in your Hadoop installation.    |
| <i>webhdfs /v1/</i> | The protocol being used to retrieve the file. This portion of the URL is always the same, to tell Hadoop to use version 1 of the WebHDFS API. |

|                     |                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>HDFSFilePath</i> | The path from the root of the HDFS filesystem to the file or files you want to load. This path can contain standard Linux wildcards.<br><b>Note:</b> Any wildcards you use to specify multiple input files must resolve to files only, and not include any directories. For example, if you specify the path /user/HadoopUser/output/*, and the output directory contains a subdirectory, the Connector returns an error message. |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

For example, to load the single file /tmp/test.txt from the Hadoop cluster whose name node's host name is hadoop using the Secure HDFS Connector, you would use the command:

```
=> COPY testTable SOURCE
SecureHDFS(url='http://hadoop:50070/webhdfs/v1/tmp/test.txt',
-> username='hadoopUser', keytabFile='/home/dbadmin/hadoopUser.keytab');
 Rows Loaded

 2
(1 row)
```

### Copying Files in Parallel

The basic COPY command shown above copies a single file using just a single host in the HP Vertica cluster. This is not efficient, since just a single HP Vertica host performs the data load.

To make the load process more efficient, the data you want to load should be in multiple files (which it generally is, if you are loading the results of a Hadoop job). You can then load them all by using wildcards in the URL, by supplying multiple comma-separated URLs in the url parameter of the SecureHDFS UDS function call, or both. Loading multiple files through the Secure HDFS Connector results in a very efficient load since the HP Vertica hosts connect directly to individual nodes in the Hadoop cluster to retrieve data. It is less likely that a single node in either cluster will become a bottleneck that slows down the operation.

For example, the following statement loads all of the files whose filenames start with "part-" located in the /user/hadoopUser/output directory on the HDFS. Assuming there are at least as many files in this directory as there are nodes in your HP Vertica cluster, all of the nodes in your cluster will fetch and load the data from the HDFS.

```
=> COPY Customers SOURCE
->
SecureHDFS(url='http://hadoop:50070/webhdfs/v1/user/hadoopUser/output/part-*',
-> username='hadoopUser', keytabFile='/home/dbadmin/hadoopUser.keytab');
 Rows Loaded

 40008
(1 row)
```

Using multiple comma-separated URLs in the URL string you supply in the COPY statement lets you load data from multiple directories on the HDFS at once (or even data from different Hadoop clusters):

```
=> COPY Customers SOURCE
```

```
->
SecureHDFS(url='http://hadoop:50070/webhdfs/v1/user/HadoopUser/output/part-*',
-> http://hadoop:50070/webhdfs/v1/user/AnotherUser/part-*',
-> username='HadoopUser', keytabFile='/home/dbadmin/hadoopUser.keytab');
Rows Loaded

80016
(1 row)
```

## Viewing Rejected Rows and Exceptions

As with other types of bulk loading using the COPY command, rejected rows and exceptions are logged to log files (stored by default in the CopyErrorLogs subdirectory in the database's catalog directory). Due to the distributed nature of the HDFS Connector, you cannot use the ON option to force all of the exception and rejected row information to be written to log files on a single HP Vertica host. You need to collect all of the log files from across the hosts in order to review all of the exception and rejection information.

## Creating an External Table Based on HDFS Files

You can use the HDFS Connectors as a source for an external table that lets you directly perform queries on the contents of files on the Hadoop Distributed File System (HDFS). See [Using External Tables](#) in the Administrator's Guide for more information on external tables. Using an external table to access data stored on an HDFS is useful for data exploration (perhaps before loading it into HP Vertica).

**Note:** When you query an external table based on HDFS, **all** of the files that make up the table are transferred from Hadoop to HP Vertica even if your query returns a small number of rows. The performance of external tables on HDFS is significantly slower than querying an internal HP Vertica table. You should only use external tables for infrequently-run queries. If you need to frequently query the content of the HDFS files, you should either use COPY to load the entire content of the files into HP Vertica or save the results of a query run on an external table to an internal table which you then use for repeated queries.

To create an external table that reads data from HDFS, you use the Hdfs or SecureHDFS User Defined Source (UDS) in a CREATE EXTERNAL TABLE AS COPY statement. The COPY portion of this statement has the same format as the COPY statement used to load data from HDFS. See [Loading Data Using the Standard HDFS Connector](#) (page 582) and [Loading Data Using the Secure HDFS Connector](#) (page 584) for more information.

The following simple example shows how to create an external table that extracts data from every file in the /user/hadoopUser/example/output directory using the Standard HDFS Connector.

```
=> CREATE EXTERNAL TABLE hadoopExample (A VARCHAR(10), B INTEGER, C INTEGER, D
INTEGER)
-> AS COPY SOURCE Hdfs(url=
-> 'http://hadoop01:50070/webhdfs/v1/user/hadoopUser/example/output/*',
-> username='hadoopUser');
CREATE TABLE
=> SELECT * FROM hadoopExample;
```

| A     | B  | C  | D  |
|-------|----|----|----|
| test3 | 10 | 11 | 12 |
| test3 | 13 | 14 | 15 |
| test2 | 6  | 7  | 8  |
| test2 | 9  | 0  | 10 |
| test1 | 1  | 2  | 3  |
| test1 | 3  | 4  | 5  |

(6 rows)

To create the same external table using the Secure HDFS Connector, you would use the statement:

```
=> CREATE EXTERNAL TABLE hadoopExample (A VARCHAR(10), B INTEGER, C INTEGER, D
INTEGER)
-> AS COPY SOURCE SecureHDFS(url=
-> 'http://hadoop01:50070/webhdfs/v1/user/hadoopUser/example/output/*',
-> username='hadoopUser', keytabFile='/home/dbadmin/hadoopUser.keytab');
```

## Load Errors in External Tables

Normally, querying an external table on HDFS does not produce any errors if rows rejected by the underlying COPY statement (for example, rows containing columns whose contents are incompatible with the data types in the table). Rejected rows are handled the same way they are in a standard COPY statement: they are written to a rejected data file, and are noted in the exceptions file. For more information on how COPY handles rejected rows and exceptions, see Capturing Load Exceptions and Rejections in the Administrator's Guide.

Rejections and exception files are created on all of the nodes that load data from the HDFS. You cannot specify a single node to receive all of the rejected row and exception information. These files are created on each HP Vertica node as they process files loaded through the HDFS Connectors.

**Note:** Since the HDFS Connectors are read-only, there is no way to store rejection and exception information on the HDFS.

Fatal errors during the transfer of data (for example, specifying files that do not exist on the HDFS) do not occur until you query the external table. The following example shows what happens if you recreate the table based on a file that does not exist on HDFS.

```
=> DROP TABLE hadoopExample;
DROP TABLE
=> CREATE EXTERNAL TABLE hadoopExample (A INTEGER, B INTEGER, C INTEGER, D INTEGER)
-> AS COPY SOURCE HDFS(url='http://hadoop01:50070/webhdfs/v1/tmp/nofile.txt',
-> username='hadoopUser');
CREATE TABLE
=> SELECT * FROM hadoopExample;
ERROR 0: Error calling plan() in User Function HdfsFactory at
[src/Hdfs.cpp:222], error code: 0, message: No files match
[http://hadoop01:50070/webhdfs/v1/tmp/nofile.txt]
```

Note that it is not until you actually query the table that the HDFS Connector attempts to read files from the HDFS. Only then does it return an error.

## HDFS Connector Troubleshooting Tips

Here are a few things to check if you have issue using the HDFS Connector or Secure HDFS Connector:

- Ensure you are using the correct Connector. The HDFS Connector can only connect to Hadoop clusters that do not have Kerberos authentication enabled. The Secure HDFS Connector can only connect to Hadoop clusters that do have Kerberos enabled.
  - If you find a user is suddenly unable to connect to Hadoop through the Secure HDFS connector, it could be that someone exported a new keytab file for the user which invalidates existing keytab files. You can determine if this is the problem by comparing the key version number associated with the user's principal in Kerberos with the key version number stored in the keytab file.
1. To find the key version number for a user in Kerberos, start the kadmin utility (`kadmin.local` if you are logged into the Kerberos Key Distribution Center) from the Linux command line and run the `getprinc` command for the user:

```
$ sudo kadmin
[sudo] password for dbadmin:
Authenticating as principal root/admin@MYCOMPANY.COM with password.
Password for root/admin@MYCOMPANY.COM:
kadmin: getprinc exampleuser@MYCOMPANY.COM
Principal: exampleuser@MYCOMPANY.COM
Expiration date: [never]
Last password change: Fri Jul 26 09:40:44 EDT 2013
Password expiration date: [none]
Maximum ticket life: 1 day 00:00:00
Maximum renewable life: 0 days 00:00:00
Last modified: Fri Jul 26 09:40:44 EDT 2013 (root/admin@MYCOMPANY.COM)
Last successful authentication: [never]
Last failed authentication: [never]
Failed password attempts: 0
Number of keys: 2
Key: vno 3, des3-cbc-sha1, no salt
Key: vno 3, des-cbc-crc, no salt
MKey: vno 0
Attributes:
Policy: [none]
```

In the above example, there are two keys stored for the user, both of which are at version number (vno) 3.

2. Use the `klist` command to get the version numbers of the keys stored in the keytab file:

```
$ sudo klist -ek exampleuser.keytab
Keytab name: FILE:exampleuser.keytab
KVNO Principal

2 exampleuser@MYCOMPANY.COM (des3-cbc-sha1)
2 exampleuser@MYCOMPANY.COM (des-cbc-crc)
```

```
3 exampleuser@MYCOMPANY.COM (des3-cbc-sha1)
3 exampleuser@MYCOMPANY.COM (des-cbc-crc)
```

The first column in the output lists the key version number. In the above example, the keytab includes both key versions 2 and 3, so the keytab file can be used to authenticate the user with Kerberos.

- If you receive an error message similar to this:

ERROR 5118: UDL specified no execution nodes; at least one execution node must be specified

ensure that all of the nodes in your cluster have the correct HDFS Connector package installed. This error can occur if one or more of the nodes do not have the Connector's supporting libraries installed. You may missed one of the nodes when initially installing the HDFS Connectors, a node may have recovered or been added to your HP Vertica cluster.

- If you notice that the Secure HDFS connector is returning too few rows of data, see if the Kerberos server is rejecting the authentication of some of the node sin your cluster. This can occur if multiple nodes are using the same keytab file for authentication.

# Using Informatica PowerCenter

---

Informatica's PowerCenter family of products lets you collect, transform, and store data. The products support a wide variety of data sources including databases, message queues, and many different file formats.

You can use HP Vertica with Informatica PowerCenter both as a source and as a target using an ODBC connection, the same way you would use any other ODBC data source with PowerCenter.

**Note:** The default buffer size for Informatica PowerCenter is set very conservatively. These settings can cause PowerCenter to send HP Vertica many small batches, rather than a few large batches. The overhead of these many small batches can cause loading performance issues. To resolve these performance issues, you should change PowerCenter's batch size settings, as described in [Setting PowerCenter's Buffer Size \(page 603\)](#).

There is an HP Vertica plug-in for PowerCenter that makes using HP Vertica as a target for PowerCenter more efficient than using ODBC. If you plan on using HP Vertica as a target for PowerCenter, you should install and use this plug-in.

**Note:** Currently, the HP Vertica plug-in for PowerCenter is write-only. If you need to use HP Vertica as a data source, you will need to use an ODBC connection.

The following sections explain how to use PowerCenter with HP Vertica.

## Installing the HP Vertica Plug-in for PowerCenter

There is a client and a server component for the HP Vertica Plug-in for PowerCenter that you need to download from [myVertica portal http://my.vertica.com/](http://my.vertica.com/).

The client portion of the plug-in is contained in the files named:

vertica-informatica-861-plugin-client-4.1.xx.zip  
vertica-informatica-901-plugin-client-4.1.xx.zip

**Note:** Choose the package that applies to your version of Informatica.

The package contains three files:

- vertica.xml contains the metadata definition needed by the PowerCenter repository to allow communication between PowerCenter and HP Vertica.
- verticacli.dll is the Windows library for the PowerCenter client.
- vertica.reg contains the settings for the Windows registry to support the plug-in.

There are two server component packages available, one for each platform:

- For Windows servers, download vertica-informatica-plugin-server-4.1.xx.zip
- For Linux/Solaris servers, download  
vertica-informatica-plugin-server-4.1.xx.tar.gz

Each of these packages contain libraries used by the PowerCenter server. The Windows package contains library files for both the 32-bit and 64-bit version of PowerCenter. The Linux/Solaris package contains libraries for 32-bit and 64-bit Linux and Solaris 5.10.

Installing the HP Vertica plug-in is a multi-step process:

- 1 Register the plug-in's metadata with the PowerCenter Repository Service with which you want to access HP Vertica.
- 2 Add the client plug-in's configuration information to the Window's registry of all the PowerCenter Clients that need to access HP Vertica.
- 3 Copy the HP Vertica client plug-in library to the Informatica PowerCenter Client's binary folder.
- 4 Copy the server plug-in to the PowerCenter server binary directory.

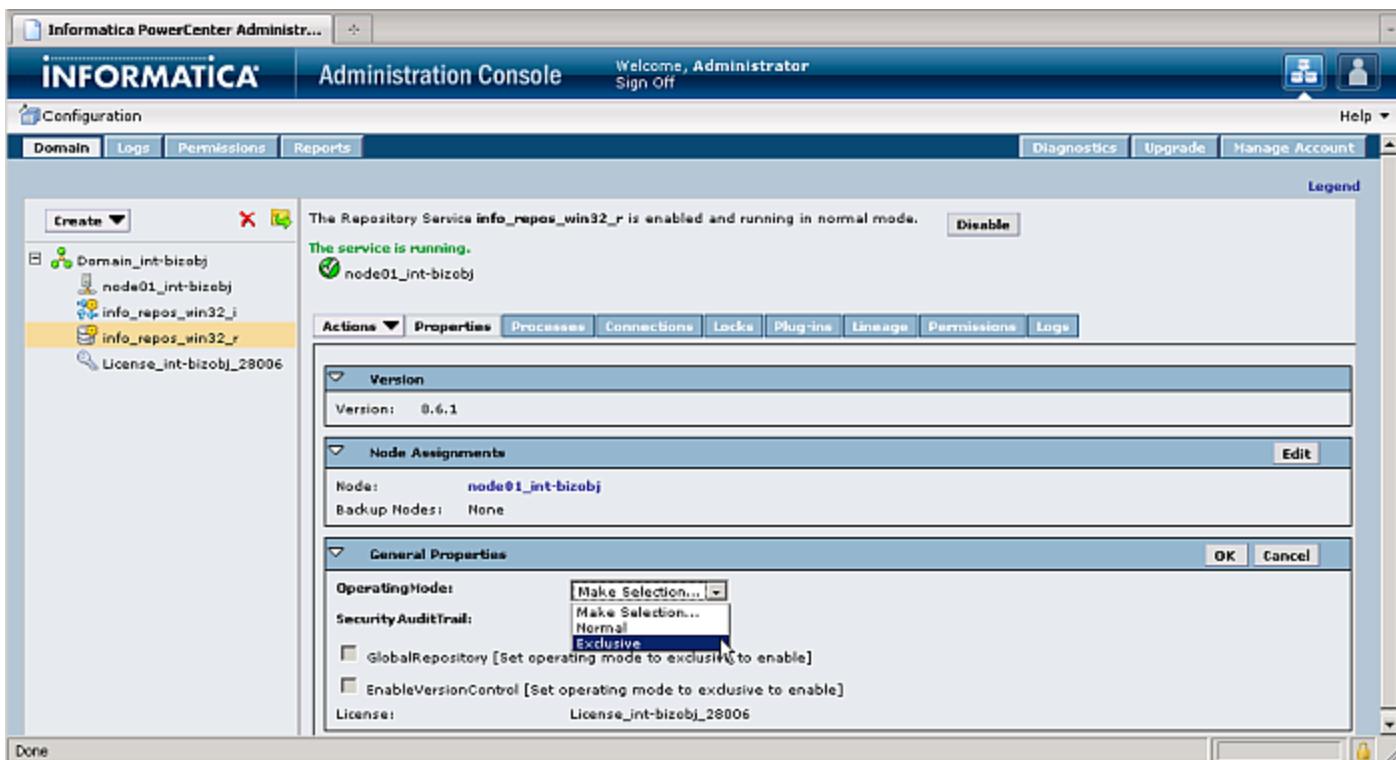
The following sections explain these steps in greater detail.

## Registering the Plug-in's Metadata

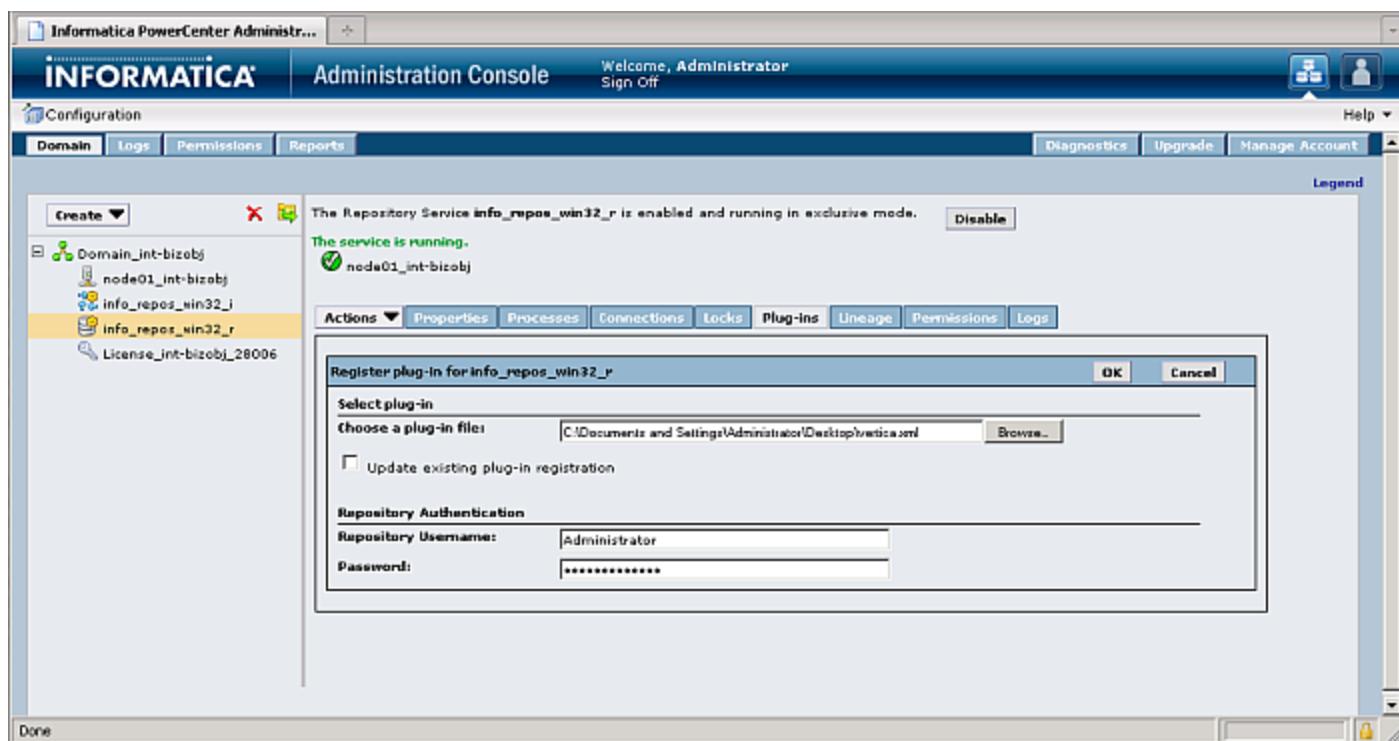
The PowerCenter repository needs information about the HP Vertica plug-in in order to enable clients to use it. This information is supplied in an XML-format file named `vertica.xml` located in the Windows client package (`vertica-informatica-plugin-client-6.1.x.nn.zip`).

To register the plug-in's metadata:

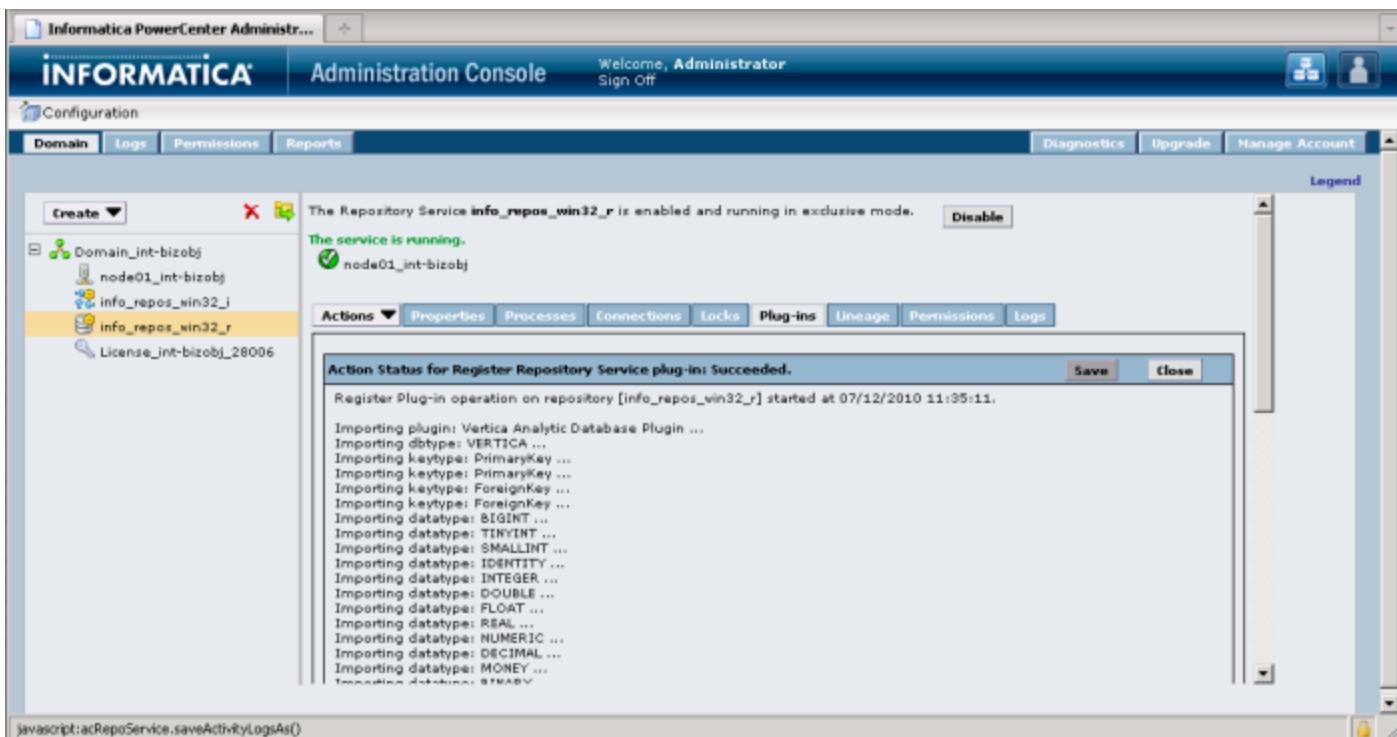
- 1 Unzip `vertica-informatica-plugin-client-6.1.x.nn.zip` to a convenient folder on your system.
- 2 Open a browser and log into the PowerCenter domain's Administration Console.
- 3 In the Navigator, click the entry for the repository that you want to connect to HP Vertica.
- 4 In the **Properties** tab click **Edit** in the General Properties section.



- 5 In the **OperatingMode** box, click **Exclusive** then click **OK**.
- 6 In the Restart Repository Service window, click **Yes** to confirm switching to exclusive mode.
- 7 When prompted for a disable option, select **Complete** and click **OK**. The Repository Service may take several minutes to restart and re-enable itself. You should wait until you see the green "The service is running" status message before continuing.
- 8 On the Plug-ins tab, click **Register Repository Service** plug-in.



- 9 Next to **Choose a plug-in file**, click **Browse** and select the `vertical.xml` in the folder where you earlier unzipped the client plug-in `.zip` file.
- 10 Enter your repository username and password under the Repository Authentication section.



- 11 Click **OK** to upload the metadata file. The Administration Console uploads the metadata file and registers the plug-in data. You should see a notice indicating that the registration for the plug-in succeeded.
- 12 On the Properties tab's General Properties section, click **Edit**.
- 13 In the **OperatingMode** box, click **Normal**.
- 14 In the Restart Repository Service window, click **Yes** to confirm switching to normal mode.
- 15 When prompted for a disable option, select **Complete** and click **OK**. The Repository Service may take several minutes to restart and re-enable itself.

## Preparing the PowerCenter Client

Each PowerCenter client system that you want to use with HP Vertica needs to have a copy of the `verticaccli.dll` file installed in the client binary folder. This folder is named `client\bin` in the PowerCenter install directory. For a typical PowerCenter install, the full path of this folder is:

```
C:\Informatica\PowerCenter8.6.1\client\bin
```

After copying the library file to the client binary directory, you need to add a registry entry to the Windows registry in that tells the PowerCenter Designer to load the plug-in library. The easiest way to do this is to double click the `vertica.reg` file in Windows Explorer. When asked whether you want to add the contents of the file to the registry, click Yes.

**Note:** The registry file is specific to Informatica PowerCenter version 8.6.1. The HP Vertica Plug-in for PowerCenter has only been tested with this version. If you want to try to use it with another version of PowerCenter, you will need to manually add configuration information to the Windows registry, as explained below.

If you prefer to add the registry entry manually, follow these steps:

- 1 Start the registry editor by typing `regedit.exe` in the Windows Start menu's command run command box.
- 2 Navigate to the correct location in the registry:

For 32-bit versions of Windows:

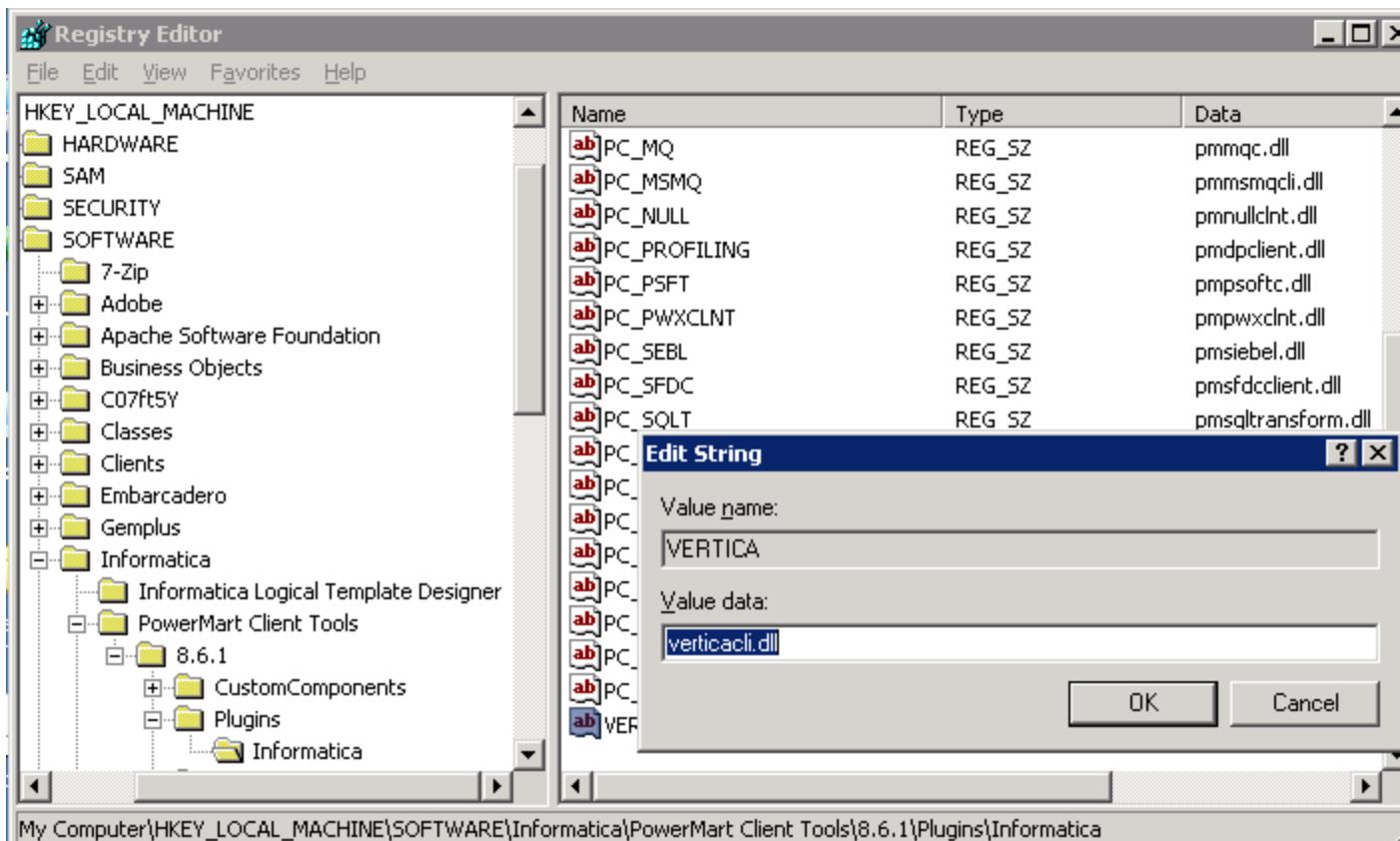
`HKEY_LOCAL_MACHINE\SOFTWARE\Informatica\PowerMart Client Tools\x.x.x\Plugins\Informatica`

For 64-bit versions of Windows:

`HKEY_LOCAL_MACHINE\SOFTWARE\Wow6432Node\Informatica\PowerMart Client Tools\x.x.x\Plugins\Informatica`

Where `x.x.x` is the version of Informatica you are using (for example 9.0.1).

- 3 Right-click in the right pane of the Registry Editor window, select New then select String Value.
- 4 Change the name of the string value from New Value #1 to VERTICA.



- 5 Double-click the new VERTICA entry and enter `verticacli.dll` when prompted for a new value.

- 6 Exit the registry editor.

## Copying the Plug-in Library on the Server

The final step in setting up the HP Vertica plug-in for PowerCenter is to copy the server-side library to the proper directory on the PowerCenter server. The particular library file you need to copy depends on the platform on which the PowerCenter server is running.

For a Windows server, unzip the `vertica-informatica-plugin-server-4.0.nn.zip`. There are two library files contained within the `.zip` file:

- `lib/verticawrt.dll` is for the PowerCenter 32-bit server.
- `lib64/verticawrt.dll` is for the PowerCenter 64-bit server.

Copy the appropriate library file to your server's binary directory which is the `\server\bin` subdirectory in the PowerCenter server install directory. The full path to this directory is usually:

`C:\Informatica\PowerCenter8.6.1\server\bin`

For a Linux or Solaris server, you need to untar

`vertica-informatica-plugin-server-4.0.nn.tar.gz` to a temporary directory on the server:

```
cd /tmp
tar xzf vertica-informatica-plugin-server-4.0.nn.tar.gz
```

This archive contains three library files:

- `linux/lib/libverticawrt.so` for PowerCenter Linux 32-bit server.
- `linux/lib64/libverticawrt.so` for PowerCenter Linux 64-bit server.
- `SunOS510/libverticawrt.so` for Solaris server.

Copy the appropriate library file to the `server/bin` subdirectory of the directory where PowerCenter is installed. For a typical PowerCenter install, this path is:

`/Infra/PowerCenter8.6.1/server/bin/`

## Using the HP Vertica Plug-in for PowerCenter

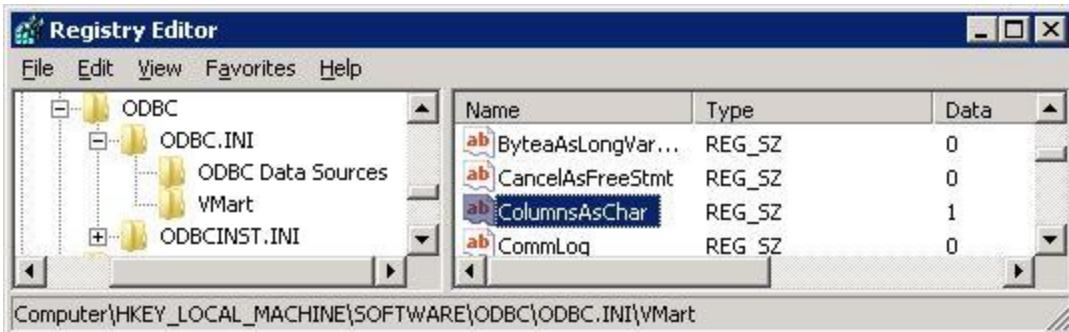
### Getting Table Designs from HP Vertica

Once you have installed the HP Vertica plug-in for PowerCenter, you can use HP Vertica as a target in PowerCenter Designer. Because the HP Vertica plug-in for PowerCenter is write-only, PowerCenter Designer cannot read the table's definition from the database directly. For simple tables, the quickest way to get the table's design into PowerCenter is to manually recreate it.

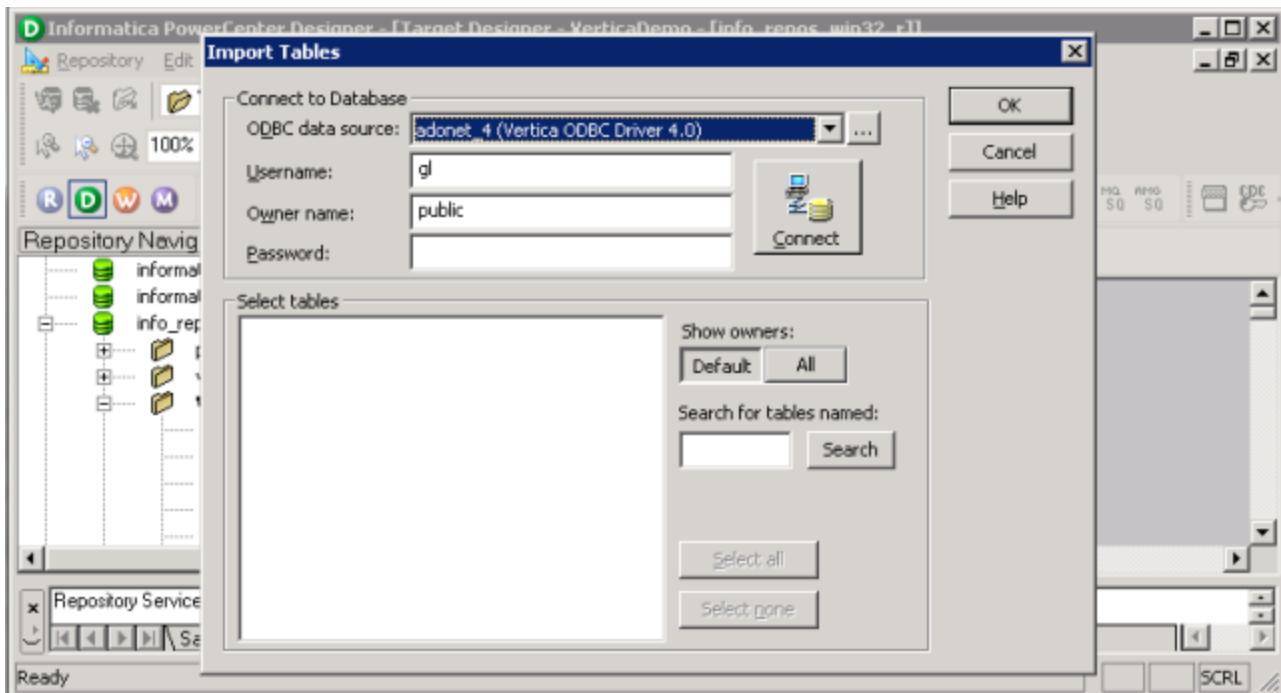
For more complex tables, you can create the target definition using an ODBC connection to the database so that PowerCenter Designer can import table definitions from HP Vertica. After the definitions have been imported, you change the table's database type to VERTICA, so it will use the plug-in to connect to HP Vertica. To use this technique, you first need to **[create a DSN for the HP Vertica database](#)** (page 29) even if you do not plan on connecting to the database using ODBC in your live environment.

For example, to target a table in an HP Vertica database, you could follow these steps:

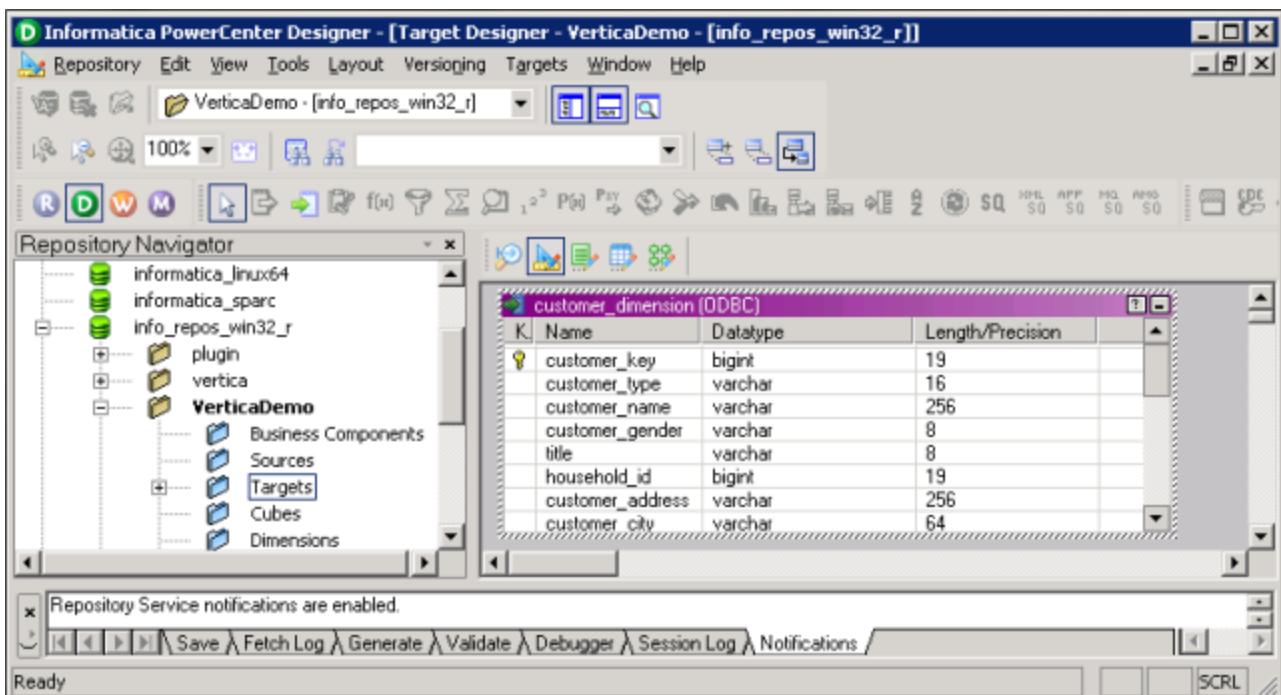
- 1 On your Informatica PowerCenter host, **[create a DSN for your HP Vertica database](#)** (page 29).
- 2 Press Win+R to open the Run prompt, and enter `regedit`.
- 3 In the Registry Editor window, navigate to `HKEY_LOCAL_MACHINE\SOFTWARE\ODBC\ODBC.INI\DSNname` where `DSNname` is the name of the DSN you created for your HP Vertica database in step 1.



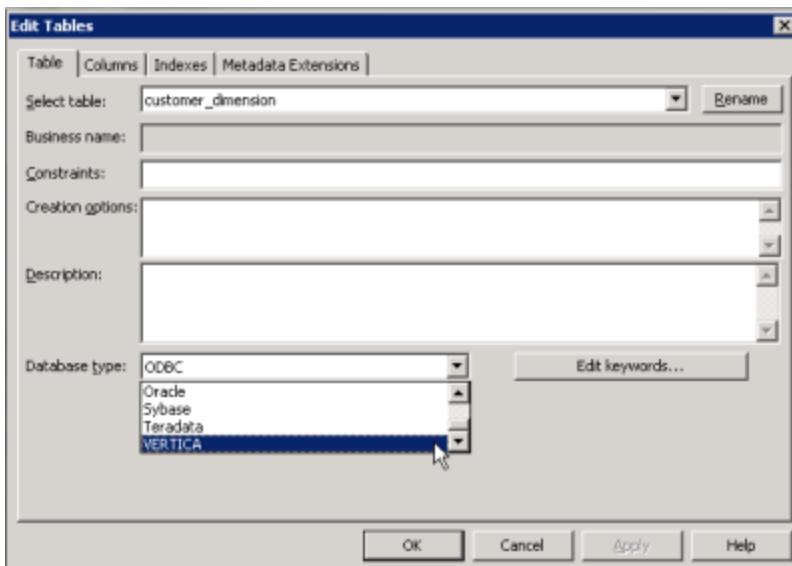
- 4 In the right pane of the Registry Editor, locate and double-click the entry for `ColumnsAsChar`.
  - 5 In the Edit String window, enter `1` in the **Value data** box.
- Note:** Changing this setting ensures that NVARCHAR data types are converted to VARCHARs as they are read by PowerCenter. Failing to set this value can result in "unexpected EOF" errors when importing data from HP Vertica.
- 6 Close the Registry Editor window.
  - 7 In PowerCenter Designer Navigator, select the folder in the repository where you want to create your HP Vertica target.
  - 8 On the **Tools** menu, click **Target Designer**.
  - 9 On the **Targets** menu, click **Import from Database**.



- 10 In the **ODBC data source** box, click the name of the DSN you created for your HP Vertica database.
- 11 Enter the **Username**, **Owner name**, and **Password** for your database, then click **Connect**. PowerCenter Designer connects to your database and retrieves a list of the tables it contains.
- 12 In the **Select tables** box, click the table into which you want PowerCenter to store data and click **OK**. PowerCenter Designer reads the definition of the table and displays it in the Workspace.



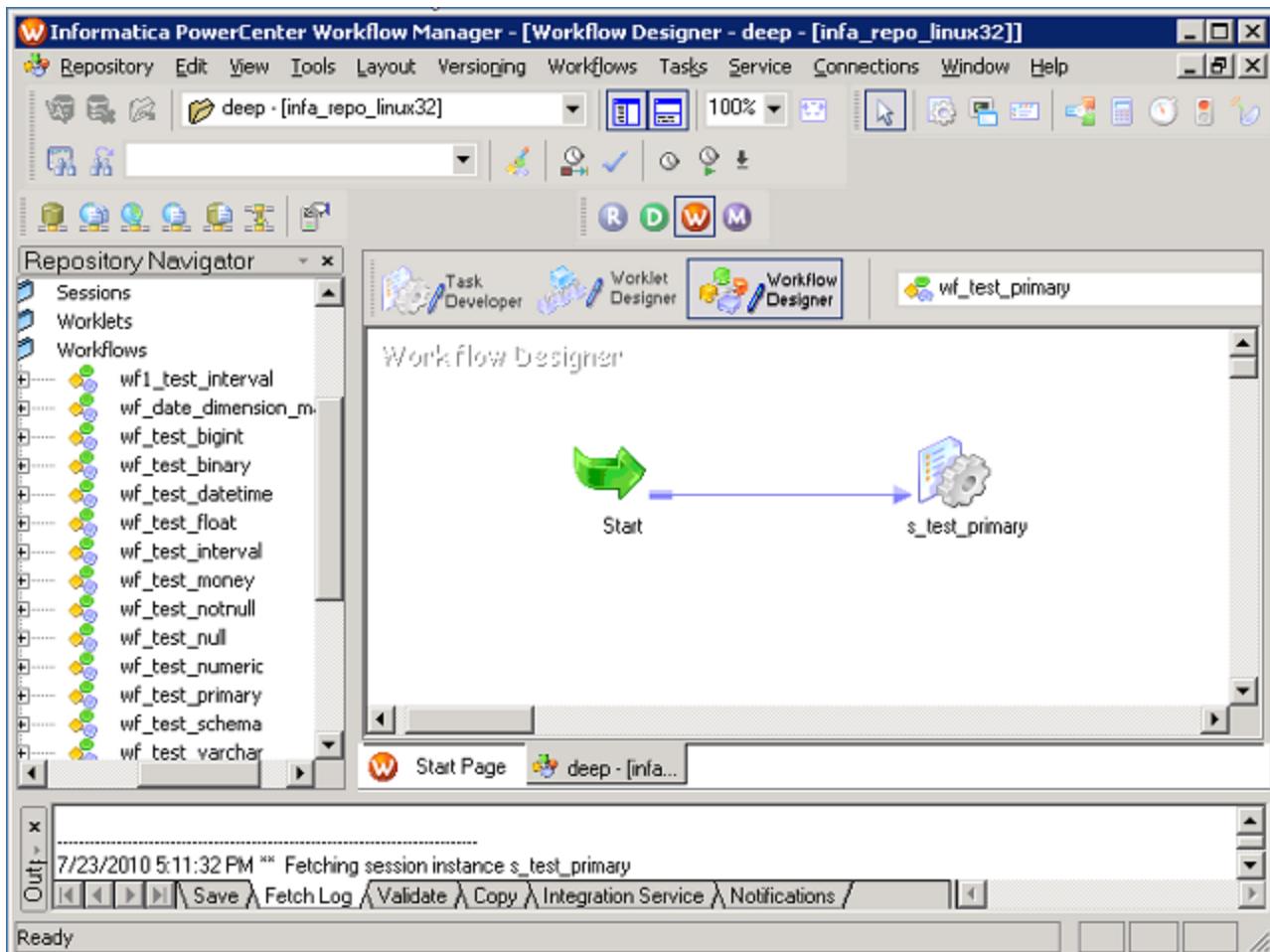
13 Right-click the table in the Workspace and click **Edit**.



14 In the Edit Table window's **Database type** box, click **VERTICA**, then click **OK**.

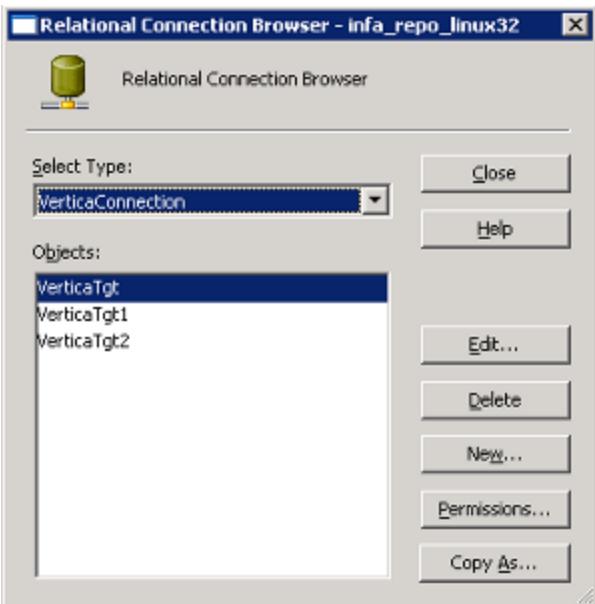
## Using the Plug-in in a Workflow

To use the plug-in's connection to HP Vertica within your workflows, you need to select it from the workflow's connection properties.



- 1 In the Workflow Manager, select the workflow that you want to target HP Vertica.
- 2 On the **Connections** menu, click **Relational**.

- 3 In the Relational Connection Browser's **Select Type** box, click **VerticaConnection**.



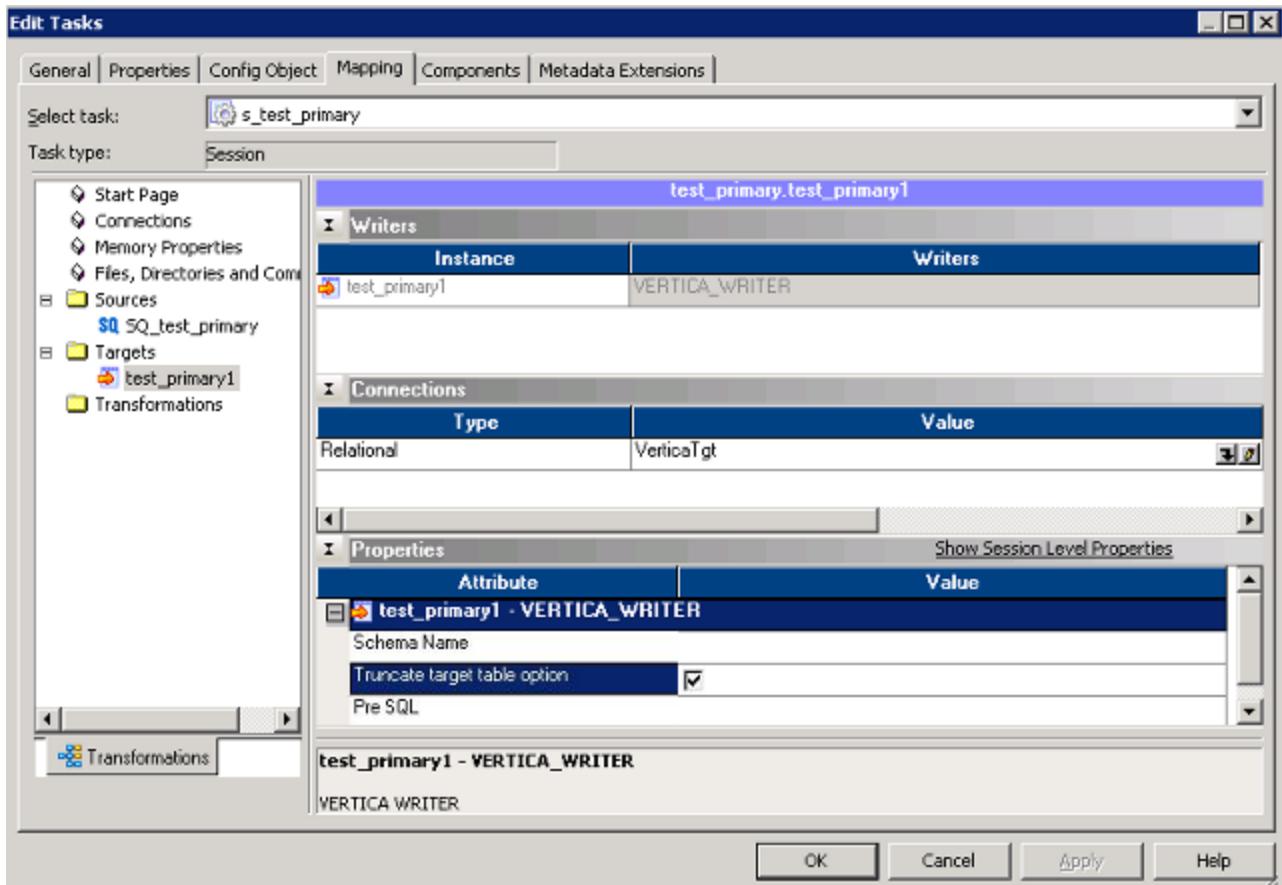
- 4 In the **Objects** box, click the connection to the HP Vertica that you want to be the target of the workflow.
- 5 Before starting the workflow, you should change PowerCenter's buffer size to more efficiently load data into HP Vertica. See **Setting PowerCenter's Buffer Size** (page [603](#)) for details.

### Truncating the Target Table

You may have a workflow that should truncate its targeted table before loading data. You can change a plug-in setting to truncate the table for you:

- 1 In Workflow Manager, select the workflow that should truncate its target table.
- 2 In the Workspace, double-click the data load task to open the Edit Tasks window.
- 3 In the Edit Tasks window, click the **Mapping** tab.

- 4 In the navigation pane, click the connection to your HP Vertica database under **Targets**.



- 5 In the Properties section, select the **Truncate target table option**.

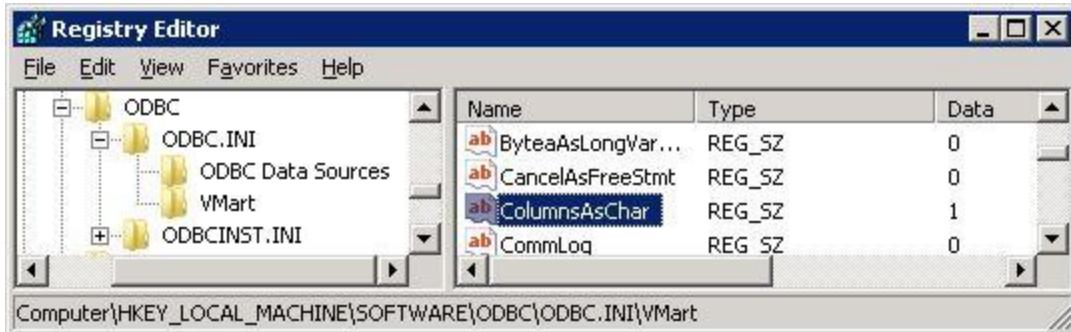
**Note:** By default, the high-precision setting is disabled for HP Vertica targets. Enabling high precision increases processing overhead and can slow data throughput.

## Configuring PowerCenter to Read Data from HP Vertica

Since the PowerCenter plug-in is write-only, you need to create an ODBC connection for your HP Vertica database if you want Informatica PowerCenter to be able to read data from it.

- 1 On your Informatica PowerCenter host, [create a DSN for your HP Vertica database \(page 29\)](#).
- 2 Press Win+R to open the Run prompt, and enter `regedit`.

- 3 In the Registry Editor window, navigate to  
 HKEY\_LOCAL\_MACHINE\SOFTWARE\ODBC\ODBC.INI\DSNname where *DSNname* is the name of the DSN you created for your HP Vertica database in step 1.



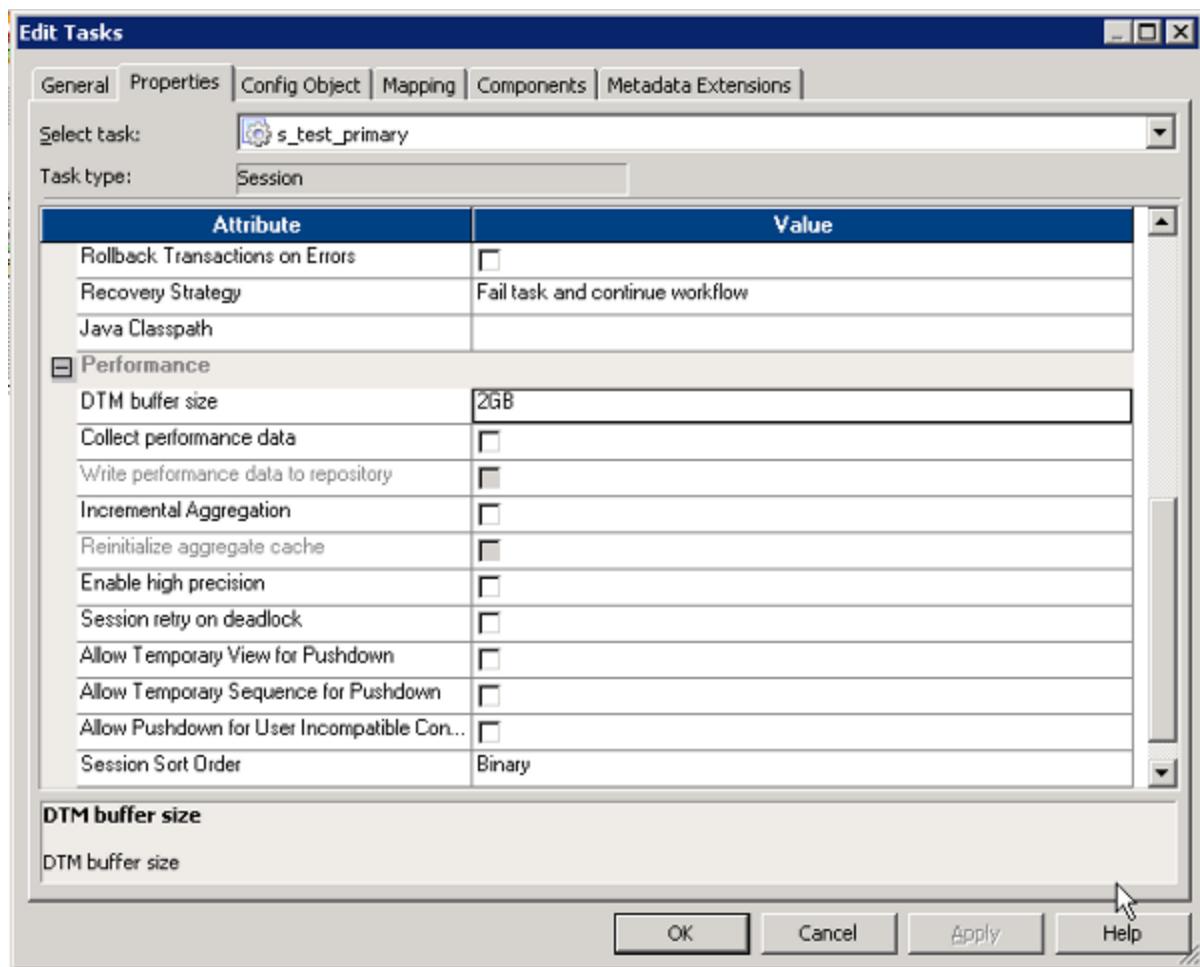
- 4 In the right pane of the Registry Editor, locate and double-click the entry for **ColumnsAsChar**.  
 5 In the Edit String window, enter **1** in the **Value data** box.  
**Note:** Changing this setting ensures that NVARCHAR data types are converted to VARCHARs as they are read by PowerCenter. Failing to set this value can result in "unexpected EOF" errors when importing data from HP Vertica.  
 6 Close the Registry Editor window.  
 7 In the PowerCenter Designer, define your source for HP Vertica the same as you would for any other ODBC source. See the PowerCenter documentation for details.

## Setting PowerCenter's Buffer Size

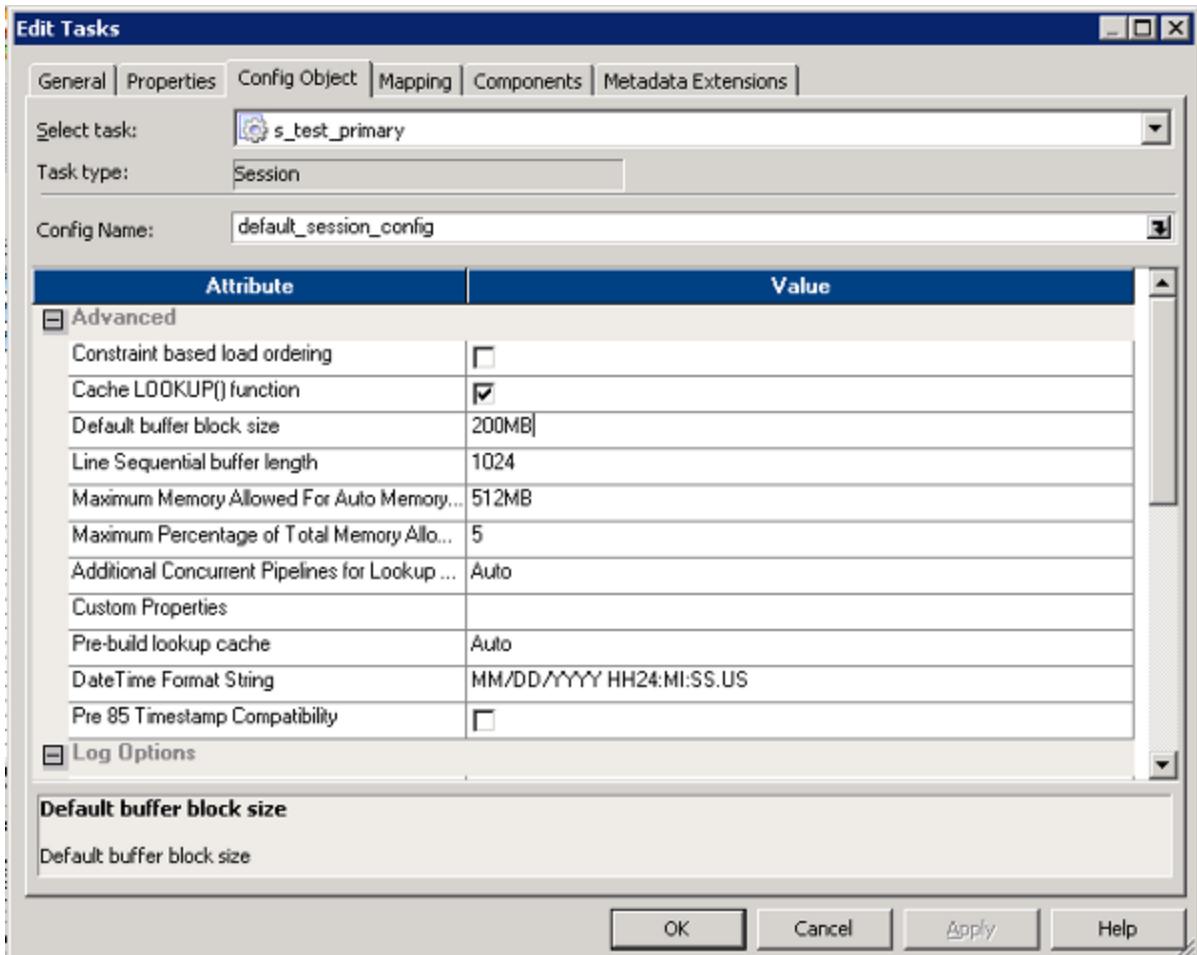
By default, Informatica Powercenter's buffer are set to very conservative values (12MB overall buffer size, with the buffer block size set automatically). This can cause performance issues when loading data into HP Vertica, since PowerCenter will send many small batches, rather than fewer large batches.

To improve performance, you should adjust the batch buffer sizes for connections to HP Vertica:

- 1 In the Workflow Manager, double-click the task that connects to HP Vertica.



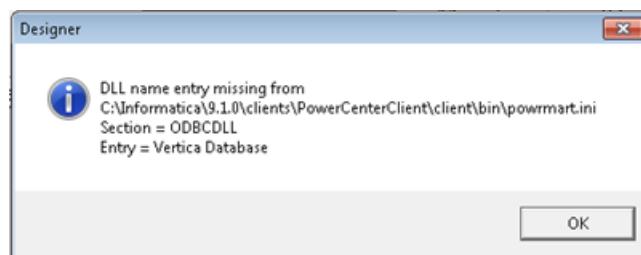
- 2 In the Edit Tasks window's **Properties** tab, set the DTM buffer size to 2GB.



- 3 On the **Config Object** tab, set the **Default buffer** block size to 200MB.

## Resolving a Message Involving a Missing DLL

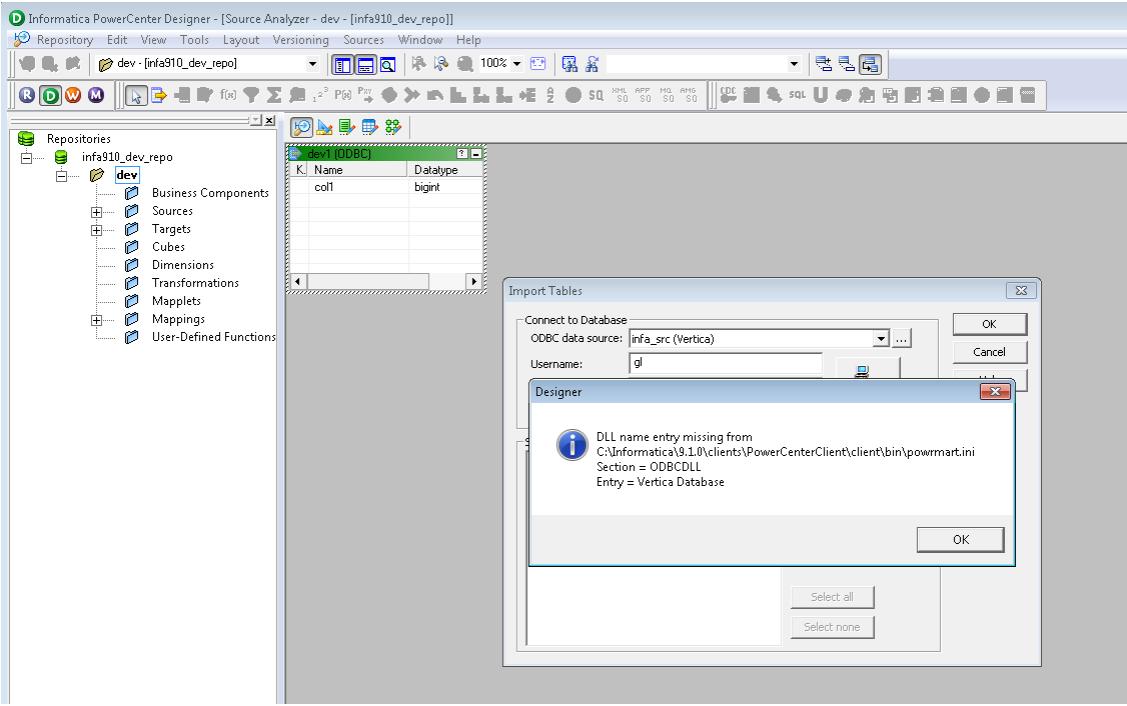
When reading or importing a table, you can receive a pop-up warning such as the following, concerning a missing DLL.



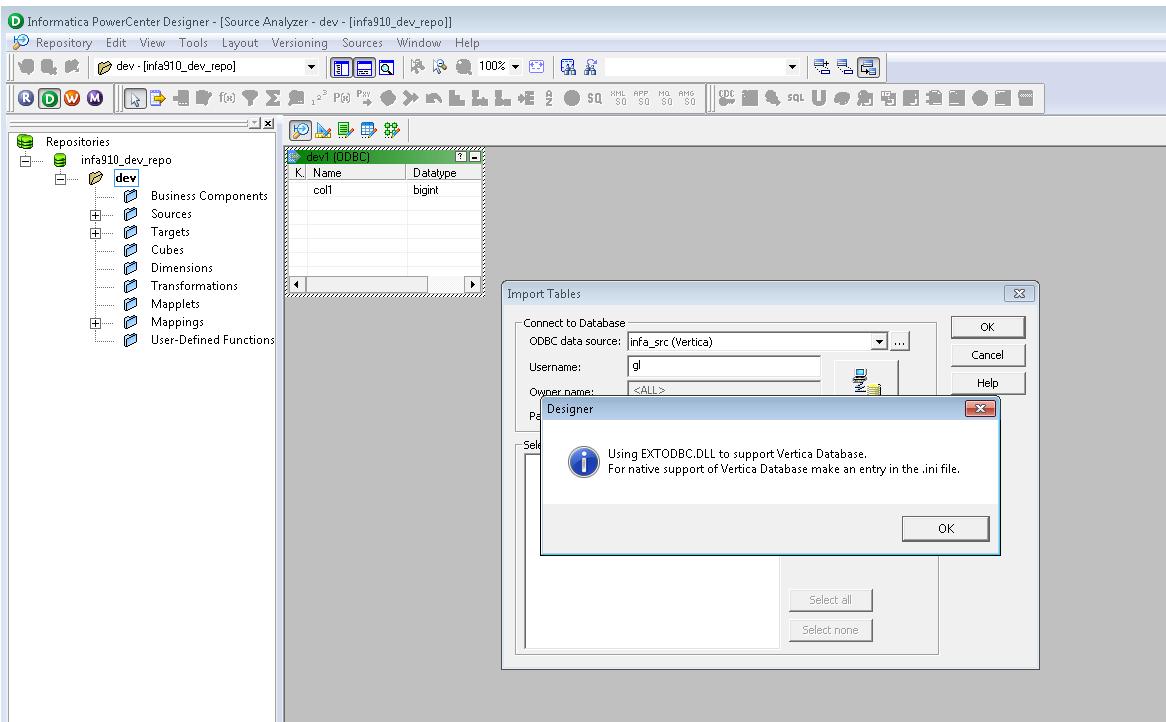
You can make a correction so that the warning no longer appears by adding the line `Vertica Database=EXTODBC.DLL` to the `powrmart.ini` file in the section `EXTODBC.DLL`.

A full example follows.

- 1 Using the Import Tables option in the Informatica PowerCenter Designer, the system displays a pop-up warning about a missing DLL. Click OK.



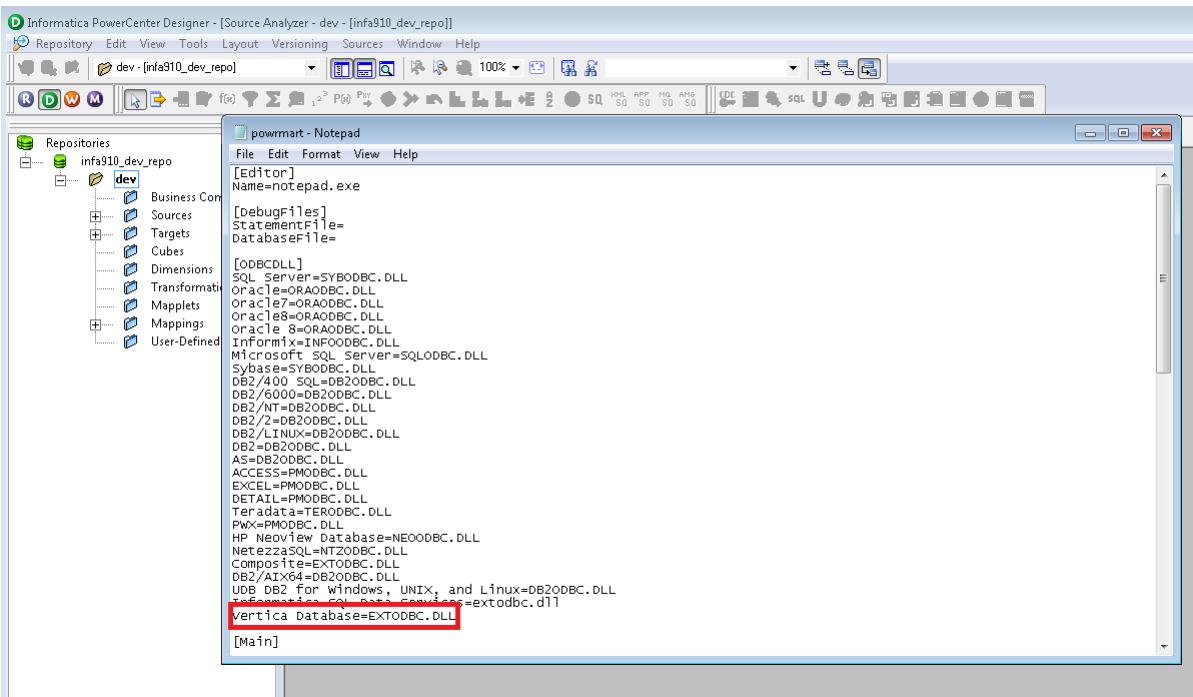
- 2 The system displays another pop-up letting you know that Informatica is using EXTODBC.DLL to support Vertica. Click OK.



**Note:** The two pop-up messages are warnings only and do not affect the import of tables or the execution of workflows.

- 3 Open the `powrmart.ini` file for editing.
- 4 Add the following line in the section `EXTODBC.DLL`.

`Vertica Database=EXTODBC.DLL`



## **Appendix: Error Codes**

---

## SQLSTATEs and Error Codes

HP Vertica reports warnings and errors via two different mechanisms: SQLSTATEs and error messages. SQLSTATEs are intended for use by client applications, such as those accessing HP Vertica via ODBC or JDBC. Error messages are displayed to interactive users (for example, users connected to HP Vertica through vsql) and written to error logs.

### SQLSTATE

HP Vertica reports the success or failure of each statement it executes to client applications using a five-character SQLSTATE value. Many of these values are defined by the SQL standard. Others (identified by the letter "V" in their values) are HP Vertica-specific.

SQLSTATE values are grouped into classes which are defined by the first two characters in the SQLSTATE value. The last three characters indicate a specific condition within a class. For example, the SQLSTATE class 22 represents all data errors. The specific SQLSTATE value 22012 represents a division by zero error. SQLSTATE classes let an application that does not recognize a specific SQLSTATE value to still get a general idea of the result.

### Warning and Error Messages

Each error and warning message displayed to interactive users or written to a log file by HP Vertica has its own numeric error code assigned to it. For example:

```
ERROR 3117: Division by zero
WARNING 4098: No projections found
ERROR 5617: Multiple WITH clauses not allowed
```

The error code number is not related to the SQLSTATE value. However, error and warning messages do correspond to a specific SQLSTATE. They are just a more-specific human-readable message compared to the SQLSTATE, which is mainly intended for client applications.

For example, all warning messages displayed by HP Vertica correspond to the SQLSTATE class 01. The warning message "WARNING 3084: Design Workspace couldn't be dropped" corresponds to the SQLSTATE value 01000 ERRCODE\_WARNING.

Error codes do not change between HP Vertica releases, but individual error and warning messages may be added or removed in new releases. Your client application should not depend on particular error code appearing from one release to the next. Instead, it should use the SQLSTATE value to determine the result of executing a statement.

See the **HP Vertica SQLSTATE List** (page [609](#)) for a list of all the SQLSTATE classes and values defined by HP Vertica. This table also links to lists of error or warning messages that are associated with each SQLSTATE value.

## HP Vertica SQLSTATE List

The following table lists the SQLSTATE classes and individual SQLSTATE codes.

| SQLSTATE                                         | Description                                               | Details                                                        |
|--------------------------------------------------|-----------------------------------------------------------|----------------------------------------------------------------|
| <b>Class 00 - Successful Completion</b>          |                                                           |                                                                |
| 00000                                            | ERRCODE_SUCCESSFUL_COMPLETION                             |                                                                |
| <b>Class 01 - Warning</b>                        |                                                           |                                                                |
| 01000                                            | ERRCODE_WARNING                                           | <i>associated warning messages</i> (page <a href="#">620</a> ) |
| 01003                                            | ERRCODE_WARNING_NULL_VALUE_ELIMINATED_IN_SET_FUNCTION     |                                                                |
| 01004                                            | ERRCODE_WARNING_STRING_DATA_RIGHT_TRUNCATION              |                                                                |
| 01006                                            | ERRCODE_WARNING_PRIVILEGE_NOT_REVOKED                     | <i>associated warning messages</i> (page <a href="#">621</a> ) |
| 01007                                            | ERRCODE_WARNING_PRIVILEGE_NOT_GRANTED                     | <i>associated warning messages</i> (page <a href="#">621</a> ) |
| 01008                                            | ERRCODE_WARNING_PRIVILEGE_ALREADY_GRANTED                 |                                                                |
| 01009                                            | ERRCODE_WARNING_PRIVILEGE_ALREADY_REVOKED                 |                                                                |
| 0100C                                            | ERRCODE_WARNING_DYNAMIC_RESULT_SETS_RETURNED              |                                                                |
| 01V01                                            | ERRCODE_WARNING_DEPRECATED_FEATURE                        | <i>associated warning messages</i> (page <a href="#">622</a> ) |
| <b>Class 02 - No Data</b>                        |                                                           |                                                                |
| 02000                                            | ERRCODE_NO_DATA                                           |                                                                |
| 02001                                            | ERRCODE_NO_ADDITIONAL_DYNAMIC_RESULT_SETS_RETURNED        |                                                                |
| <b>Class 03 - SQL Statement Not Yet Complete</b> |                                                           |                                                                |
| 03000                                            | ERRCODE_SQL_STATEMENT_NOT_YET_COMPLETE                    |                                                                |
| <b>Class 08 - Client Connection Exception</b>    |                                                           |                                                                |
| 08000                                            | ERRCODE_CONNECTION_EXCEPTION                              | <i>associated error messages</i> (page <a href="#">622</a> )   |
| 08001                                            | ERRCODE_SQLCLIENT_UNABLE_TO_ESTABLISH_SQLCONNECTION       | <i>associated error messages</i> (page <a href="#">623</a> )   |
| 08003                                            | ERRCODE_CONNECTION_DOES_NOT_EXIST                         | <i>associated error messages</i> (page <a href="#">623</a> )   |
| 08004                                            | ERRCODE_SQLSERVER_REJECTED_ESTABLISHMENT_OF_SQLCONNECTION |                                                                |
| 08006                                            | ERRCODE_CONNECTION_FAILURE                                | <i>associated error messages</i> (page <a href="#">624</a> )   |
| 08007                                            | ERRCODE_TRANSACTION_RESOLUTION_UNKNOWN                    |                                                                |
| 08V01                                            | ERRCODE_PROTOCOL_VIOLATION                                | <i>associated error messages</i>                               |

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|                                                  |                                              | (page <a href="#">624</a> )                                     |
| <b>Class 09 - Triggered Action Exception</b>     |                                              |                                                                 |
| 09000                                            | ERRCODE_TRIGGERED_ACTION_EXCEPTION           |                                                                 |
| <b>Class 0A - Feature Not Supported</b>          |                                              |                                                                 |
| 0A000                                            | ERRCODE_FEATURE_NOT_SUPPORTED                | <b>associated error messages</b><br>(page <a href="#">625</a> ) |
| <b>Class 0B - Invalid Transaction Initiation</b> |                                              |                                                                 |
| 0B000                                            | ERRCODE_INVALID_TRANSACTION_INITIATION       | <b>associated error messages</b><br>(page <a href="#">637</a> ) |
| <b>Class 0F - Locator Exception</b>              |                                              |                                                                 |
| 0F000                                            | ERRCODE_LOCATOR_EXCEPTION                    |                                                                 |
| 0F001                                            | ERRCODE_L_E_INVALID_SPECIFICATION            |                                                                 |
| <b>Class 0L - Invalid Grantor</b>                |                                              |                                                                 |
| 0L000                                            | ERRCODE_INVALID_GRANTOR                      |                                                                 |
| 0LV01                                            | ERRCODE_INVALID_GRANT_OPERATION              | <b>associated error messages</b><br>(page <a href="#">637</a> ) |
| <b>Class 0P - Invalid Role Specification</b>     |                                              |                                                                 |
| 0P000                                            | ERRCODE_INVALID_ROLE_SPECIFICATION           |                                                                 |
| <b>Class 21 - Cardinality Violation</b>          |                                              |                                                                 |
| 21000                                            | ERRCODE_CARDINALITY_VIOLATION                |                                                                 |
| <b>Class 22 - Data Exception</b>                 |                                              |                                                                 |
| 22000                                            | ERRCODE_DATA_EXCEPTION                       | <b>associated error messages</b><br>(page <a href="#">638</a> ) |
| 22001                                            | ERRCODE_STRING_DATA_RIGHT_TRUNCATION         | <b>associated error messages</b><br>(page <a href="#">638</a> ) |
| 22002                                            | ERRCODE_NULL_VALUE_NO_INDICATOR_PARAMETER    |                                                                 |
| 22003                                            | ERRCODE_NUMERIC_VALUE_OUT_OF_RANGE           | <b>associated error messages</b><br>(page <a href="#">639</a> ) |
| 22004                                            | ERRCODE_NULL_VALUE_NOT_ALLOWED               | <b>associated error messages</b><br>(page <a href="#">640</a> ) |
| 22005                                            | ERRCODE_ERROR_IN_ASSIGNMENT                  |                                                                 |
| 22007                                            | ERRCODE_INVALID_DATE_TIME_FORMAT             | <b>associated error messages</b><br>(page <a href="#">640</a> ) |
| 22008                                            | ERRCODE_DATE_TIME_FIELD_OVERFLOW             | <b>associated error messages</b><br>(page <a href="#">641</a> ) |
| 22009                                            | ERRCODE_INVALID_TIME_ZONE_DISPLACEMENT_VALUE | <b>associated error messages</b><br>(page <a href="#">641</a> ) |

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| 2200B | ERRCODE_ESCAPE_CHARACTER_CONFLICT                  | <b>associated error messages</b><br>(page <a href="#">641</a> ) |
| 2200C | ERRCODE_INVALID_USE_OF_ESCAPE_CHARACTER            |                                                                 |
| 2200D | ERRCODE_INVALID_ESCAPE_OCTET                       | <b>associated error messages</b><br>(page <a href="#">642</a> ) |
| 2200F | ERRCODE_ZERO_LENGTH_CHARACTER_STRING               |                                                                 |
| 2200G | ERRCODE_MOST_SPECIFIC_TYPE_MISMATCH                |                                                                 |
| 22010 | ERRCODE_INVALID_INDICATOR_PARAMETER_VALUE          |                                                                 |
| 22011 | ERRCODE_SUBSTRING_ERROR                            | <b>associated error messages</b><br>(page <a href="#">642</a> ) |
| 22012 | ERRCODE_DIVISION_BY_ZERO                           | <b>associated error messages</b><br>(page <a href="#">643</a> ) |
| 22015 | ERRCODE_INTERVAL_FIELD_OVERFLOW                    | <b>associated error messages</b><br>(page <a href="#">643</a> ) |
| 22018 | ERRCODE_INVALID_CHARACTER_VALUE_FOR_CAST           |                                                                 |
| 22019 | ERRCODE_INVALID_ESCAPE_CHARACTER                   | <b>associated error messages</b><br>(page <a href="#">643</a> ) |
| 2201B | ERRCODE_INVALID_REGULAR_EXPRESSION                 | <b>associated error messages</b><br>(page <a href="#">644</a> ) |
| 2201E | ERRCODE_INVALID_ARGUMENT_FOR_LOG                   |                                                                 |
| 2201F | ERRCODE_INVALID_ARGUMENT_FOR_POWER_FUNCTION        |                                                                 |
| 2201G | ERRCODE_INVALID_ARGUMENT_FOR_WIDTH_BUCKET_FUNCTION | <b>associated error messages</b><br>(page <a href="#">644</a> ) |
| 22020 | ERRCODE_INVALID_LIMIT_VALUE                        |                                                                 |
| 22021 | ERRCODE_CHARACTER_NOT_IN_REPERTOIRE                | <b>associated error messages</b><br>(page <a href="#">645</a> ) |
| 22022 | ERRCODE_INDICATOR_OVERFLOW                         |                                                                 |
| 22023 | ERRCODE_INVALID_PARAMETER_VALUE                    | <b>associated error messages</b><br>(page <a href="#">645</a> ) |
| 22024 | ERRCODE_UNTERMINATED_C_STRING                      |                                                                 |
| 22025 | ERRCODE_INVALID_ESCAPE_SEQUENCE                    | <b>associated error messages</b><br>(page <a href="#">655</a> ) |
| 22026 | ERRCODE_STRING_DATA_LENGTH_MISMATCH                |                                                                 |
| 22027 | ERRCODE_TRIM_ERROR                                 |                                                                 |
| 2202E | ERRCODE_ARRAY_ELEMENT_ERROR                        |                                                                 |
| 22906 | ERRCODE_NONSTANDARD_USE_OF_ESCAPE_CHARACTER        | <b>associated error messages</b><br>(page <a href="#">655</a> ) |
| 22V01 | ERRCODE_FLOATING_POINT_EXCEPTION                   |                                                                 |

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|-------|---------------------------------------|-----------------------------------------------------------------|
| 22V02 | ERRCODE_INVALID_TEXT REPRESENTATION   | <b>associated error messages</b><br>(page <a href="#">655</a> ) |
| 22V03 | ERRCODE_INVALID_BINARY REPRESENTATION | <b>associated error messages</b><br>(page <a href="#">656</a> ) |
| 22V04 | ERRCODE_BAD_COPY_FILE FORMAT          | <b>associated error messages</b><br>(page <a href="#">657</a> ) |
| 22V05 | ERRCODE_UNTRANSLATABLE_CHARACTER      |                                                                 |
| 22V0B | ERRCODE_ESCAPE_CHARACTER_ON_NOESCAPE  | <b>associated error messages</b><br>(page <a href="#">658</a> ) |
| 22V21 | ERRCODE_INVALID_EPOCH                 | <b>associated error messages</b><br>(page <a href="#">658</a> ) |
| 22V22 | ERRCODE_PLPGSQL_ERROR                 |                                                                 |
| 22V23 | ERRCODE_RAISE_EXCEPTION               | <b>associated error messages</b><br>(page <a href="#">659</a> ) |
| 22V24 | ERRCODE_COPY_PARSE_ERROR              | <b>associated error messages</b><br>(page <a href="#">659</a> ) |

**Class 23 - Integrity Constraint Violation**

|       |                                        |                                                                 |
|-------|----------------------------------------|-----------------------------------------------------------------|
| 23000 | ERRCODE_INTEGRITY_CONSTRAINT_VIOLATION |                                                                 |
| 23001 | ERRCODE_RESTRICT_VIOLATION             |                                                                 |
| 23502 | ERRCODE_NOT_NULL_VIOLATION             | <b>associated error messages</b><br>(page <a href="#">661</a> ) |
| 23503 | ERRCODE_FOREIGN_KEY_VIOLATION          | <b>associated error messages</b><br>(page <a href="#">661</a> ) |
| 23505 | ERRCODE_UNIQUE_VIOLATION               | <b>associated error messages</b><br>(page <a href="#">661</a> ) |
| 23514 | ERRCODE_CHECK_VIOLATION                |                                                                 |

**Class 24 - Invalid Cursor State**

|       |                              |  |
|-------|------------------------------|--|
| 24000 | ERRCODE_INVALID_CURSOR_STATE |  |
|-------|------------------------------|--|

**Class 25 - Invalid Transaction State**

|       |                                                              |  |
|-------|--------------------------------------------------------------|--|
| 25000 | ERRCODE_INVALID_TRANSACTION_STATE                            |  |
| 25001 | ERRCODE_ACTIVE_SQL_TRANSACTION                               |  |
| 25002 | ERRCODE_BRANCH_TRANSACTION_ALREADY_ACTIVE                    |  |
| 25003 | ERRCODE_INAPPROPRIATE_ACCESS_MODE_FOR_BRANCH_TRANSACTION     |  |
| 25004 | ERRCODE_INAPPROPRIATE_ISOLATION_LEVEL_FOR_BRANCH_TRANSACTION |  |
| 25005 | ERRCODE_NO_ACTIVE_SQL_TRANSACTION_FOR_BRANCH_TRANSACTION     |  |

|                                                               |                                                        |                                                                 |
|---------------------------------------------------------------|--------------------------------------------------------|-----------------------------------------------------------------|
| 25006                                                         | ERRCODE_READ_ONLY_SQL_TRANSACTION                      |                                                                 |
| 25007                                                         | ERRCODE_SCHEMA_AND_DATA_STATEMENT_MIXING_NOT_SUPPORTED |                                                                 |
| 25008                                                         | ERRCODE_HELD_CURSORQUIRES_SAME_ISOLATION_LEVEL         |                                                                 |
| 25V01                                                         | ERRCODE_NO_ACTIVE_SQL_TRANSACTION                      | <b>associated error messages</b><br>(page <a href="#">662</a> ) |
| 25V02                                                         | ERRCODE_IN_FAILED_SQL_TRANSACTION                      |                                                                 |
| <b>Class 26 - Invalid SQL Statement Name</b>                  |                                                        |                                                                 |
| 26000                                                         | ERRCODE_INVALID_SQL_STATEMENT_NAME                     |                                                                 |
| <b>Class 27 - Triggered Data Change Violation</b>             |                                                        |                                                                 |
| 27000                                                         | ERRCODE_TRIGGERED_DATA_CHANGE_VIOLATION                |                                                                 |
| <b>Class 28 - Invalid Authorization Specification</b>         |                                                        |                                                                 |
| 28000                                                         | ERRCODE_INVALID_AUTHORIZATION_SPECIFICATION            | <b>associated error messages</b><br>(page <a href="#">662</a> ) |
| 28001                                                         | ERRCODE_ACCOUNT_LOCKED                                 |                                                                 |
| 28002                                                         | ERRCODE_PASSWORD_EXPIRED                               |                                                                 |
| 28003                                                         | ERRCODE_PASSWORD_IN_GRACE_PERIOD                       |                                                                 |
| <b>Class 2B - Dependent Privilege Descriptors Still Exist</b> |                                                        |                                                                 |
| 2B000                                                         | ERRCODE_DEPENDENT_PRIVILEGE_DESCRIPTORSTILL_EXIST      |                                                                 |
| 2BV01                                                         | ERRCODE_DEPENDENT_OBJECTS_STILL_EXIST                  | <b>associated error messages</b><br>(page <a href="#">663</a> ) |
| <b>Class 2D - Invalid Transaction Termination</b>             |                                                        |                                                                 |
| 2D000                                                         | ERRCODE_INVALID_TRANSACTION_TERMINATION                |                                                                 |
| <b>Class 2F - SQL Routine Exception</b>                       |                                                        |                                                                 |
| 2F000                                                         | ERRCODE_SQL_ROUTINE_EXCEPTION                          |                                                                 |
| 2F002                                                         | ERRCODE_S_R_E MODIFYING_SQL_DATA_NOT_PERMITTED         |                                                                 |
| 2F003                                                         | ERRCODE_S_R_E PROHIBITED_SQL_STATEMENT_ATTEMPTED       |                                                                 |
| 2F004                                                         | ERRCODE_S_R_E READING_SQL_DATA_NOT_PERMITTED           |                                                                 |
| 2F005                                                         | ERRCODE_S_R_E FUNCTION_EXECUTED_NO_RETURN_STATEMENT    |                                                                 |
| <b>Class 34 - Invalid Cursor Name</b>                         |                                                        |                                                                 |
| 34000                                                         | ERRCODE_INVALID_CURSOR_NAME                            |                                                                 |
| <b>Class 38 - External Routine Exception</b>                  |                                                        |                                                                 |

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|-------|--------------------------------------------------|--|
| 38000 | ERRCODE_EXTERNAL_ROUTINE_EXCEPTION               |  |
| 38001 | ERRCODE_E_R_E_CONTAINING_SQL_NOT_PERMITTED       |  |
| 38002 | ERRCODE_E_R_E MODIFYING_SQL_DATA_NOT_PERMITTED   |  |
| 38003 | ERRCODE_E_R_E_PROHIBITED_SQL_STATEMENT_ATTEMPTED |  |
| 38004 | ERRCODE_E_R_E_READING_SQL_DATA_NOT_PERMITTED     |  |

**Class 39 - External Routine Invocation Exception**

|       |                                               |  |
|-------|-----------------------------------------------|--|
| 39000 | ERRCODE_EXTERNAL_ROUTINE_INVOCATION_EXCEPTION |  |
| 39001 | ERRCODE_E_R_I_E_INVALID_SQLSTATE_RETURNED     |  |
| 39004 | ERRCODE_E_R_I_E_NULL_VALUE_NOT_ALLOWED        |  |
| 39V01 | ERRCODE_E_R_I_E_TRIGGER_PROTOCOL_VIOLATED     |  |
| 39V02 | ERRCODE_E_R_I_E_SRF_PROTOCOL_VIOLATED         |  |

**Class 3B - Savepoint Exception**

|       |                                   |  |
|-------|-----------------------------------|--|
| 3B000 | ERRCODE_SAVEPOINT_EXCEPTION       |  |
| 3B001 | ERRCODE_S_E_INVALID_SPECIFICATION |  |

**Class 3D - Invalid Catalog Name**

|       |                              |  |
|-------|------------------------------|--|
| 3D000 | ERRCODE_INVALID_CATALOG_NAME |  |
|-------|------------------------------|--|

**Class 3F - Invalid Schema Name**

|       |                             |  |
|-------|-----------------------------|--|
| 3F000 | ERRCODE_INVALID_SCHEMA_NAME |  |
|-------|-----------------------------|--|

**Class 40 - Transaction Rollback**

|       |                                            |                                                                 |
|-------|--------------------------------------------|-----------------------------------------------------------------|
| 40000 | ERRCODE_TRANSACTION_ROLLBACK               |                                                                 |
| 40001 | ERRCODE_T_R_SERIALIZATION_FAILURE          |                                                                 |
| 40002 | ERRCODE_T_R_INTEGRITY_CONSTRAINT_VIOLATION |                                                                 |
| 40003 | ERRCODE_T_R_STATEMENT_COMPLETION_UNKNOWN   |                                                                 |
| 40V01 | ERRCODE_T_R_DEADLOCK_DETECTED              | <b>associated error messages</b><br>(page <a href="#">663</a> ) |

**Class 42 - Syntax Error or Access Rule Violation**

|       |                                               |                                                                 |
|-------|-----------------------------------------------|-----------------------------------------------------------------|
| 42000 | ERRCODE_SYNTAX_ERROR_OR_ACCESS_RULE_VIOLATION |                                                                 |
| 42501 | ERRCODE_INSUFFICIENT_PRIVILEGE                | <b>associated error messages</b><br>(page <a href="#">663</a> ) |
| 42601 | ERRCODE_SYNTAX_ERROR                          | <b>associated error messages</b><br>(page <a href="#">666</a> ) |
| 42602 | ERRCODE_INVALID_NAME                          | <b>associated error messages</b><br>(page <a href="#">674</a> ) |
| 42611 | ERRCODE_INVALID_COLUMN_DEFINITION             | <b>associated error messages</b>                                |

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|-------|-----------------------------|-----------------------------------------------------------------|
|       |                             | (page <a href="#">675</a> )                                     |
| 42622 | ERRCODE_NAME_TOO_LONG       | <b>associated error messages</b><br>(page <a href="#">675</a> ) |
| 42701 | ERRCODE_DUPLICATE_COLUMN    | <b>associated error messages</b><br>(page <a href="#">675</a> ) |
| 42702 | ERRCODE_AMBIGUOUS_COLUMN    | <b>associated error messages</b><br>(page <a href="#">676</a> ) |
| 42703 | ERRCODE_UNDEFINED_COLUMN    | <b>associated error messages</b><br>(page <a href="#">676</a> ) |
| 42704 | ERRCODE_UNDEFINED_OBJECT    | <b>associated error messages</b><br>(page <a href="#">677</a> ) |
| 42710 | ERRCODE_DUPLICATE_OBJECT    | <b>associated error messages</b><br>(page <a href="#">680</a> ) |
| 42712 | ERRCODE_DUPLICATE_ALIAS     | <b>associated error messages</b><br>(page <a href="#">681</a> ) |
| 42723 | ERRCODE_DUPLICATE_FUNCTION  | <b>associated error messages</b><br>(page <a href="#">681</a> ) |
| 42725 | ERRCODE_AMBIGUOUS_FUNCTION  | <b>associated error messages</b><br>(page <a href="#">682</a> ) |
| 42803 | ERRCODE_GROUPING_ERROR      | <b>associated error messages</b><br>(page <a href="#">682</a> ) |
| 42804 | ERRCODE_DATATYPE_MISMATCH   | <b>associated error messages</b><br>(page <a href="#">683</a> ) |
| 42809 | ERRCODE_WRONG_OBJECT_TYPE   | <b>associated error messages</b><br>(page <a href="#">684</a> ) |
| 42830 | ERRCODE_INVALID_FOREIGN_KEY | <b>associated error messages</b><br>(page <a href="#">685</a> ) |
| 42846 | ERRCODE_CANNOT_COERCE       | <b>associated error messages</b><br>(page <a href="#">685</a> ) |
| 42883 | ERRCODE_UNDEFINED_FUNCTION  | <b>associated error messages</b><br>(page <a href="#">686</a> ) |
| 42939 | ERRCODE_RESERVED_NAME       | <b>associated error messages</b><br>(page <a href="#">687</a> ) |
| 42P20 | ERRCODE_WINDOWING_ERROR     | <b>associated error messages</b><br>(page <a href="#">687</a> ) |
| 42V01 | ERRCODE_UNDEFINED_TABLE     | <b>associated error messages</b><br>(page <a href="#">689</a> ) |
| 42V02 | ERRCODE_UNDEFINED_PARAMETER | <b>associated error messages</b><br>(page <a href="#">690</a> ) |
| 42V03 | ERRCODE_DUPLICATE_CURSOR    | <b>associated error messages</b><br>(page <a href="#">690</a> ) |

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| 42V04                                         | ERRCODE_DUPLICATE_DATABASE            | <b>associated error messages</b><br>(page <a href="#">691</a> ) |
| 42V05                                         | ERRCODE_DUPLICATE_PSTATEMENT          |                                                                 |
| 42V06                                         | ERRCODE_DUPLICATE_SCHEMA              | <b>associated error messages</b><br>(page <a href="#">691</a> ) |
| 42V07                                         | ERRCODE_DUPLICATE_TABLE               | <b>associated error messages</b><br>(page <a href="#">691</a> ) |
| 42V08                                         | ERRCODE_AMBIGUOUS_PARAMETER           | <b>associated error messages</b><br>(page <a href="#">692</a> ) |
| 42V09                                         | ERRCODE_AMBIGUOUS_ALIAS               | <b>associated error messages</b><br>(page <a href="#">692</a> ) |
| 42V10                                         | ERRCODE_INVALID_COLUMN_REFERENCE      | <b>associated error messages</b><br>(page <a href="#">692</a> ) |
| 42V11                                         | ERRCODE_INVALID_CURSOR_DEFINITION     | <b>associated error messages</b><br>(page <a href="#">693</a> ) |
| 42V12                                         | ERRCODE_INVALID_DATABASE_DEFINITION   |                                                                 |
| 42V13                                         | ERRCODE_INVALID_FUNCTION_DEFINITION   | <b>associated error messages</b><br>(page <a href="#">693</a> ) |
| 42V14                                         | ERRCODE_INVALID_PSTATEMENT_DEFINITION |                                                                 |
| 42V15                                         | ERRCODE_INVALID_SCHEMA_DEFINITION     | <b>associated error messages</b><br>(page <a href="#">695</a> ) |
| 42V16                                         | ERRCODE_INVALID_TABLE_DEFINITION      | <b>associated error messages</b><br>(page <a href="#">695</a> ) |
| 42V17                                         | ERRCODE_INVALID_OBJECT_DEFINITION     | <b>associated error messages</b><br>(page <a href="#">696</a> ) |
| 42V18                                         | ERRCODE_INDETERMINATE_DATATYPE        | <b>associated error messages</b><br>(page <a href="#">697</a> ) |
| 42V21                                         | ERRCODE_UNDEFINED_PROJECTION          | <b>associated error messages</b><br>(page <a href="#">698</a> ) |
| 42V22                                         | ERRCODE_UNDEFINED_NODE                |                                                                 |
| 42V23                                         | ERRCODE_UNDEFINED_PERMUTATION         |                                                                 |
| 42V24                                         | ERRCODE_UNDEFINED_USER                |                                                                 |
| 42V25                                         | ERRCODE_PATTERN_MATCH_ERROR           | <b>associated error messages</b><br>(page <a href="#">698</a> ) |
| 42V26                                         | ERRCODE_DUPLICATE_NODE                | <b>associated error messages</b><br>(page <a href="#">699</a> ) |
| <b>Class 44 - WITH CHECK OPTION Violation</b> |                                       |                                                                 |
| 44000                                         | ERRCODE_WITH_CHECK_OPTION_VIOLATION   |                                                                 |
| <b>Class 53 - Insufficient Resources</b>      |                                       |                                                                 |

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| 53000                                              | ERRCODE_INSUFFICIENT_RESOURCES           | <b>associated error messages</b><br>(page <a href="#">700</a> ) |
| 53100                                              | ERRCODE_DISK_FULL                        | <b>associated error messages</b><br>(page <a href="#">700</a> ) |
| 53200                                              | ERRCODE_OUT_OF_MEMORY                    | <b>associated error messages</b><br>(page <a href="#">701</a> ) |
| 53300                                              | ERRCODE_TOO_MANY_CONNECTIONS             |                                                                 |
| <b>Class 54 - Program Limit Exceeded</b>           |                                          |                                                                 |
| 54000                                              | ERRCODE_PROGRAM_LIMIT_EXCEEDED           | <b>associated error messages</b><br>(page <a href="#">702</a> ) |
| 54001                                              | ERRCODE_STATEMENT_TOO_COMPLEX            | <b>associated error messages</b><br>(page <a href="#">702</a> ) |
| 54011                                              | ERRCODE_TOO_MANY_COLUMNS                 | <b>associated error messages</b><br>(page <a href="#">703</a> ) |
| 54023                                              | ERRCODE_TOO_MANY_ARGUMENTS               | <b>associated error messages</b><br>(page <a href="#">703</a> ) |
| <b>Class 55 - Object Not In Prerequisite State</b> |                                          |                                                                 |
| 55000                                              | ERRCODE_OBJECT_NOT_IN_PREREQUISITE_STATE | <b>associated error messages</b><br>(page <a href="#">704</a> ) |
| 55006                                              | ERRCODE_OBJECT_IN_USE                    | <b>associated error messages</b><br>(page <a href="#">709</a> ) |
| 55V02                                              | ERRCODE_CANT_CHANGE_RUNTIME_PARAM        | <b>associated error messages</b><br>(page <a href="#">710</a> ) |
| 55V03                                              | ERRCODE_LOCK_NOT_AVAILABLE               | <b>associated error messages</b><br>(page <a href="#">710</a> ) |
| 55V04                                              | ERRCODE_TM_MARKER_NOT_AVAILABLE          | <b>associated error messages</b><br>(page <a href="#">711</a> ) |
| <b>Class 57 - Operator Intervention</b>            |                                          |                                                                 |
| 57000                                              | ERRCODE_OPERATOR_INTERVENTION            |                                                                 |
| 57014                                              | ERRCODE_QUERY_CANCELED                   | <b>associated error messages</b><br>(page <a href="#">711</a> ) |
| 57V01                                              | ERRCODE_ADMIN_SHUTDOWN                   | <b>associated error messages</b><br>(page <a href="#">712</a> ) |
| 57V02                                              | ERRCODE_CRASH_SHUTDOWN                   |                                                                 |
| 57V03                                              | ERRCODE_CANNOT_CONNECT_NOW               | <b>associated error messages</b><br>(page <a href="#">712</a> ) |
| <b>Class 58 - System Error</b>                     |                                          |                                                                 |
| 58030                                              | ERRCODE_IO_ERROR                         | <b>associated error messages</b><br>(page <a href="#">713</a> ) |

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| 58V01                                                         | ERRCODE_UNDEFINED_FILE          | <b>associated error messages</b><br>(page <a href="#">714</a> ) |
| 58V02                                                         | ERRCODE_DUPLICATE_FILE          |                                                                 |
| <b>Class V1 - Vertica-specific multi-node errors class</b>    |                                 |                                                                 |
| V1001                                                         | ERRCODE_LOST_CONNECTIVITY       | <b>associated error messages</b><br>(page <a href="#">715</a> ) |
| V1002                                                         | ERRCODE_K_SAFETY_VIOLATION      | <b>associated error messages</b><br>(page <a href="#">715</a> ) |
| V1003                                                         | ERRCODE_CLUSTER_CHANGE          | <b>associated error messages</b><br>(page <a href="#">716</a> ) |
| <b>Class V2 - Vertica-specific miscellaneous errors class</b> |                                 |                                                                 |
| V2000                                                         | ERRCODE_AUTH_FAILED             | <b>associated error messages</b><br>(page <a href="#">716</a> ) |
| V2001                                                         | ERRCODE_LICENSE_ISSUE           | <b>associated error messages</b><br>(page <a href="#">717</a> ) |
| V2002                                                         | ERRCODE_MOVEOUT_ABORTED         |                                                                 |
| <b>Class VC - Configuration File Error</b>                    |                                 |                                                                 |
| VC001                                                         | ERRCODE_CONFIG_FILE_ERROR       | <b>associated error messages</b><br>(page <a href="#">717</a> ) |
| VC002                                                         | ERRCODE_LOCK_FILE_EXISTS        |                                                                 |
| <b>Class VD - DB Designer errors</b>                          |                                 |                                                                 |
| VD001                                                         | ERRCODE_DESIGNER_FUNCTION_ERROR | <b>associated error messages</b><br>(page <a href="#">718</a> ) |
| <b>Class VP - User procedure errors</b>                       |                                 |                                                                 |
| VP000                                                         | ERRCODE_USER_PROC_ERROR         | <b>associated error messages</b><br>(page <a href="#">725</a> ) |
| VP001                                                         | ERRCODE_USER_PROC_EXEC_ERROR    | <b>associated error messages</b><br>(page <a href="#">726</a> ) |
| <b>Class VX - Internal Error</b>                              |                                 |                                                                 |
| VX001                                                         | ERRCODE_INTERNAL_ERROR          | <b>associated error messages</b><br>(page <a href="#">727</a> ) |
| VX002                                                         | ERRCODE_DATA_CORRUPTED          | <b>associated error messages</b><br>(page <a href="#">728</a> ) |
| VX003                                                         | ERRCODE_INDEX_CORRUPTED         | <b>associated error messages</b><br>(page <a href="#">729</a> ) |

## Warning Messages Associated with SQLSTATE 01000

This topic lists the warning associated with the SQLSTATE value 01000. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 01000 Description

ERRCODE\_WARNING

#### Warning messages associated with this SQLState

```
WARNING 2021: string Directory for errors files was not created.
 Unable to write errors for this instance of COPY command

WARNING 2022: string Directory for exceptions files was not created.
 Unable to write errors for this instance of COPY command

WARNING 2023: string Directory for rejected data files was not created.
 Unable to write errors for this instance of COPY command

WARNING 2362: Cannot begin transaction; transaction is already running

WARNING 3084: Design Workspace couldn't be dropped

WARNING 3152: Duplicate values in columns marked as UNIQUE will now be ignored for
 the remainder of your session or until reenable_duplicate_key_error() is called

WARNING 3372: Failed to disable profiling: string

WARNING 3373: Failed to enable profiling: string

WARNING 3539: Incorrect results are possible. Please contact Vertica Support if
 unsure

WARNING 3791: Invalid view string: string

WARNING 4071: NO COMMIT option will be ignored for external table "string"

WARNING 4088: No new valid default roles specified. Retaining previous set of
 default roles for user string

WARNING 4098: No projections found

WARNING 4102: No rows are inserted into table "string"."string" because ON COMMIT
 DELETE ROWS is the default for create temporary table

WARNING 4116: No super projections created for table string.

WARNING 4246: Only GLOBAL scope is supported for clearing string profiles

WARNING 4463: Projection string is not up to date

WARNING 4468: Projection <string> is not available for query processing. Execute
 the select start_refresh() function to copy data into this projection.
 The projection must have a sufficient number of buddy projections and all
 nodes must be up before starting a refresh

WARNING 4792: Storage option "string" will be ignored for external table "string"

WARNING 4871: System view string for tuning rule string is currently invalid

WARNING 4873: System view for tuning rule string does not exist
```

WARNING 4996: This request may deadlock the system. Please report the details to technical support

WARNING 5068: Total declared length of columns of one of the constraints exceeds the limit, truncation may happen

WARNING 5119: UDX code didn't respond when Vertica tried to get function prototype for *string* in library *string: string*

WARNING 5448: View *string* is currently invalid

WARNING 5451: Violations of some of foreign key constraints may not be reported because of no privilege on the foreign tables

WARNING 5642: Projection *string* is not persistent or not up to date; it will not be copied

WARNING 5643: Projection *string* is prejoin projection; it will not be copied

WARNING 5717: No statistics has been exported. Either the DB is empty or you try to export an external table or you do not have access to the available objects

WARNING 5724: Segmentation clause contains a *string* - data loads may be slowed significantly

WARNING 5727: Sort clause contains a *string* - data loads may be slowed significantly

WARNING 5741: View *string* depends on other relations

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Warning Messages Associated with SQLSTATE 01006

This topic lists the warning associated with the SQLSTATE value 01006. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 01006 Description

ERRCODE\_WARNING\_PRIVILEGE\_NOT\_REVOKED

### Warning messages associated with this SQLState

WARNING 4925: The *string* "*string*" cannot be *string* *string* "*string*"

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Warning Messages Associated with SQLSTATE 01007

This topic lists the warning associated with the SQLSTATE value 01007. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 01007 Description

ERRCODE\_WARNING\_PRIVILEGE\_NOT\_GRANTED

### Warning messages associated with this SQLState

WARNING 5682: USAGE privilege on schema "string" also needs to be granted to "string"

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Warning Messages Associated with SQLSTATE 01V01

This topic lists the warning associated with the SQLSTATE value 01V01. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 01V01 Description

ERRCODE\_WARNING\_DEPRECATED\_FEATURE

### Warning messages associated with this SQLState

WARNING 2693: Configuration parameter *string* has been deprecated; setting it has no effect

WARNING 4736: set\_local\_segment\_threshold has been deprecated; setting it has no effect

WARNING 5669: The command has been deprecated

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 08000

This topic lists the error associated with the SQLSTATE value 08000. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 08000 Description

ERRCODE\_CONNECTION\_EXCEPTION

### Error messages associated with this SQLState

ERROR 2029: *string* from stdin failed: *string*

ERROR 2708: Connection to database [*string*] is invalid

ERROR 2896: Could not receive data from server:*string*

ERROR 2908: Could not send data to server: *string*

ERROR 3276: Error while waiting on socket. *value*

ERROR 4342: Password encryption failed

ERROR 5197: Unknown authentication method (*value*) requested by server

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 08001

This topic lists the error associated with the SQLSTATE value 08001. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 08001 Description

ERRCODE\_SQLCLIENT\_UNABLE\_TO\_ESTABLISH\_SQLCONNECTION

#### Error messages associated with this SQLState

ERROR 2322: Cancel() -- connect() failed:

ERROR 2324: Cancel() -- socket() failed:

ERROR 2823: Could not connect to server [string]: string  
Is the server running and accepting  
TCP/IP connections on port string?

ERROR 2824: Could not connect to server: string  
Is the server running on host [string] and accepting  
TCP/IP connections on port string?

ERROR 2839: Could not create socket: string

ERROR 2865: Could not get client address from socket: string

ERROR 2869: Could not get socket error status: string

ERROR 2912: Could not set socket to close-on-exec mode: string

ERROR 2913: Could not set socket to non-blocking mode: string

ERROR 2914: Could not set socket to TCP no delay mode: string

ERROR 2921: Could not translate host name "string" to address: string

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 08003

This topic lists the error associated with the SQLSTATE value 08003. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 08003 Description

ERRCODE\_CONNECTION\_DOES\_NOT\_EXIST

### Error messages associated with this SQLState

ERROR 4717: Server closed the connection unexpectedly  
This probably means the server terminated abnormally  
before or while processing the request.

**Note:** The **myVertica** (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 08006

This topic lists the error associated with the SQLSTATE value 08006. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 08006 Description

ERRCODE\_CONNECTION\_FAILURE

### Error messages associated with this SQLState

ERROR 2323: Cancel() -- send() failed: *string*  
ERROR 2606: Client failed when looking for pending signals  
ERROR 2607: Client has disconnected  
ERROR 4539: Received no response from *stringstring*

**Note:** The **myVertica** (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 08V01

This topic lists the error associated with the SQLSTATE value 08V01. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 08V01 Description

ERRCODE\_PROTOCOL\_VIOLATION

### Error messages associated with this SQLState

ERROR 2055: *string* Unexpected message type *string* reading from stdin  
ERROR 2257: Bind message has *value* parameter formats but *value* parameters  
ERROR 2258: Bind message has *value* result formats but query has *value* columns  
ERROR 3334: Expected a RowDescription Message  
ERROR 3335: Expected a SendExport Message  
ERROR 3575: Insufficient data left in message  
ERROR 3631: Invalid CLOSE message subtype *value*

```
ERROR 3651: Invalid DESCRIBE message subtype value
ERROR 3699: Invalid message format
ERROR 3701: Invalid message type
ERROR 3702: Invalid message type value
ERROR 3755: Invalid string in message
ERROR 3887: Lost synchronization with server: length value
ERROR 4074: No data left in message
ERROR 4718: Server did not identify with a pid & key
ERROR 5181: Unexpected message type 0xhex value
ERROR 5208: Unknown message from server
```

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 0A000

This topic lists the error associated with the SQLSTATE value 0A000. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 0A000 Description

ERRCODE\_FEATURE\_NOT\_SUPPORTED

### Error messages associated with this SQLState

```
ERROR 2009: string can not be used in function string
ERROR 2013: string clause is not supported for expressions
ERROR 2014: string Concatenated GZIP/BZIP is not supported with NATIVE/NATIVE
 VARCHAR formats
ERROR 2036: string is not a legal time unit
ERROR 2058: string VIEW is not supported
ERROR 2074: (OEE) External Tables not supported in this context
ERROR 2089: A correlated column in a subquery expression is not supported
ERROR 2114: ADD COLUMN over temporary tables is not supported
ERROR 2130: Aggregate function string (value) is not supported
ERROR 2133: Aggregate function calls cannot contain subqueries
ERROR 2138: Aggregate functions can only be called on columns of a table
ERROR 2161: ALL subquery with a correlated expression is not supported
ERROR 2165: ALTER COLUMN TYPE over temporary tables is not supported
ERROR 2166: ALTER TABLE does not support ADD COLUMN with other clauses
```

ERROR 2167: ALTER TABLE does not support ALTER COLUMN TYPE with other clauses  
ERROR 2168: ALTER TABLE does not support DROP COLUMN with other clauses  
ERROR 2169: ALTER TABLE does not support SET SCHEMA with other clauses  
ERROR 2178: An expression containing a correlated subquery with aggregate function  
is not supported  
ERROR 2183: Analytic functions are not allowed in an ORDER BY on a  
UNION/INTERSECT/EXCEPT  
ERROR 2184: Analytic functions are not supported in the ORDER BY of an analytic  
function OVER clause  
ERROR 2190: Analytics query with having clause expression that involves aggregates  
and subquery is not supported  
ERROR 2192: ANALYZE\_CONSTRAINTS is currently not supported in non-default locales  
ERROR 2206: Another deployment or design is in progress. Please wait and retry  
later...  
ERROR 2208: Another Design/Deployment is in progress  
ERROR 2210: ANTI join with segmented inner not supported  
ERROR 2220: Argument *string* must not contain subqueries  
ERROR 2226: Argument to seeded random\_*must* be a constant  
ERROR 2233: Array References are not supported  
ERROR 2235: ArrayExpr is not supported  
ERROR 2329: Cannot accept a value of type any  
ERROR 2330: Cannot accept a value of type anyarray  
ERROR 2331: Cannot accept a value of type anyelement  
ERROR 2332: Cannot accept a value of type internal  
ERROR 2333: Cannot accept a value of type language\_handler  
ERROR 2334: Cannot accept a value of type opaque  
ERROR 2335: Cannot accept a value of type trigger  
ERROR 2340: Cannot add IDENTITY/AUTO-INCREMENT columns  
ERROR 2345: Cannot alter a column's default when a node is down  
ERROR 2350: Cannot alter type of column "*string*" since it is referenced in the  
constraint "*string*"  
ERROR 2351: Cannot alter type of column "*string*" since it is referenced in the  
default expression of column "*string*"  
ERROR 2352: Cannot alter type of column "*string*" since it is referenced in the  
partition expression  
ERROR 2353: Cannot alter type of column "*string*" since it is referenced in the  
segmentation expression of projection "*string*"  
ERROR 2354: Cannot alter type of column with a default expression

ERROR 2360: Cannot assign to system column "*string*"  
ERROR 2363: Cannot broadcast non-subquery outer input to a join  
ERROR 2368: Cannot change owner of temporary table  
ERROR 2377: Cannot convert column "*string*" from "*string*" to type "*string*"  
ERROR 2392: Cannot delete from a view  
ERROR 2399: Cannot display a value of type any  
ERROR 2400: Cannot display a value of type anyelement  
ERROR 2401: Cannot display a value of type internal  
ERROR 2402: Cannot display a value of type language\_handler  
ERROR 2403: Cannot display a value of type opaque  
ERROR 2404: Cannot display a value of type trigger  
ERROR 2407: Cannot drop a table column when a node is down  
ERROR 2411: Cannot drop column "*string*" since it is referenced in the partition expression  
ERROR 2412: Cannot drop column "*string*" since it is referenced in the primary key constraint  
ERROR 2425: Cannot export virtual *string string*  
ERROR 2443: Cannot insert into a view  
ERROR 2458: Cannot mergeout uncommitted data in the presence of savepoints  
ERROR 2461: Cannot moveout uncommitted data in the presence of savepoints  
ERROR 2503: Cannot set a subfield to DEFAULT  
ERROR 2504: Cannot set an array element to DEFAULT  
ERROR 2532: Cannot update a view  
ERROR 2533: Cannot Update/Merge with Limit clause without an Order By on all columns  
ERROR 2546: Cannot use aggregate functions in default expressions  
ERROR 2547: Cannot use analytic or time series aggregate functions in default expressions  
ERROR 2549: Cannot use DISTINCT with user-defined transform functions  
ERROR 2552: Cannot use meta function or non-deterministic function in PARTITION BY expression  
ERROR 2556: Cannot use SAVEPOINT with uncommitted tuple mover enabled  
ERROR 2557: Cannot use subqueries in default expressions  
ERROR 2558: Cannot use subquery in EXECUTE parameter  
ERROR 2559: Cannot use subquery in expressions within COPY  
ERROR 2560: Cannot use subquery in PARTITION BY expression  
ERROR 2561: Cannot use subquery in SEGMENTED BY expression

ERROR 2562: Cannot use Vertica's built-in file source and a UDSOURCE in the same query  
ERROR 2569: Catalog object *string* does not exist  
ERROR 2602: Clause "NO PROJECTION" conflicts with the column list  
ERROR 2603: Clause "NO PROJECTION" is supported only on temporary tables  
ERROR 2618: CoerceToDomain is not supported  
ERROR 2619: CoerceToDomainValue is not supported  
ERROR 2628: Column "*string*" in PARTITION BY expression is not allowed, since it contains NULL values  
ERROR 2646: Column *string* has the NOT NULL constraint set and has no default value defined  
ERROR 2648: Column *string* in PARTITION BY expression is not allowed, since it is not present in some projections  
ERROR 2649: Column *string* in PARTITION BY expression is not allowed, since it may contain NULL values  
ERROR 2652: Column *string* occurred multiple times in the definition of Projection *string*  
ERROR 2660: Column *column string* is no longer at position *value* in table *string*  
ERROR 2667: Column name list is not allowed in CREATE TABLE / AS EXECUTE  
ERROR 2672: Column type int2 is not supported  
ERROR 2673: Column type int4 is not supported  
ERROR 2676: Command *string* is not supported  
ERROR 2679: COMMENT not supported for system objects  
ERROR 2680: COMMENT not supported for this object type  
ERROR 2692: Conditional UNION/INTERSECT/EXCEPT statements are not implemented  
ERROR 2698: Conflicting or redundant column options  
ERROR 2721: ConvertRowtypeExpr is not supported  
ERROR 2725: Copy cannot return rejected rows from executor nodes  
ERROR 2726: Copy cannot return rejected rows from more than one file  
ERROR 2739: COPY force not null is available only in CSV mode, but CSV mode is not supported  
ERROR 2740: COPY force quote is available only in CSV mode, but CSV mode is not supported  
ERROR 2741: COPY FROM does not support the BINARY option  
ERROR 2742: COPY FROM does not support the CSV option  
ERROR 2743: COPY FROM does not support the OIDS option  
ERROR 2744: COPY LOCAL does not support rejected row numbers with exceptions or rejected data options

ERROR 2751: COPY quote is available only in CSV mode, but CSV mode is not supported

ERROR 2770: Correlated EXISTS/NOT EXISTS subquery containing having clause with aggregates is not supported

ERROR 2772: Correlated EXISTS/NOT EXISTS subquery with limit 0 is not supported

ERROR 2773: Correlated EXISTS/NOT EXISTS with aggregate COUNT is not supported

ERROR 2776: Correlated EXISTS/NOT EXISTS with User Defined Aggregate is not supported

ERROR 2777: Correlated expression in ON clause is not supported

ERROR 2778: Correlated expression in set operator subquery is not supported

ERROR 2779: Correlated expressions in SELECT list of subquery are not supported

ERROR 2780: Correlated subqueries cannot have more than one level

ERROR 2781: Correlated subqueries with analytics in the select list is not supported

ERROR 2782: Correlated subqueries with no group by and a non-strict expression containing an aggregate in the select list is not supported

ERROR 2783: Correlated subquery column in select/gby/oby not supported

ERROR 2784: Correlated subquery could not be flattened as a join

ERROR 2785: Correlated subquery could not get flattened, a correlated expression could not be treated as a join

ERROR 2786: Correlated subquery expression without aggregates and with limit is not supported

ERROR 2787: Correlated subquery expressions under OR not supported

ERROR 2788: Correlated subquery in expression with operator <> is not supported

ERROR 2790: Correlated subquery with aggregate and limit 0 is not supported

ERROR 2792: Correlated subquery with aggregate function COUNT is not supported

ERROR 2793: Correlated subquery with distinct/group by is not supported

ERROR 2794: Correlated subquery with having clause expression that involves aggregates and subquery is not supported

ERROR 2795: Correlated subquery with NOT IN is not supported

ERROR 2796: Correlated subquery with outer joins and uncorrelated exists is not supported

ERROR 2797: Correlated subquery with User Defined Aggregate is not supported

ERROR 2854: Could not find array type for data type string

ERROR 2856: Could not find column string in table string

ERROR 2942: CREATE ASSERTION is not supported

ERROR 2943: CREATE FUNCTION / INOUT parameters are not supported

ERROR 2944: CREATE FUNCTION / OUT parameters are not supported

ERROR 2980: Data type not supported

ERROR 2981: Data type not supported (value)

ERROR 2983: Database "*string*" does not exist  
ERROR 2987: Database references are not supported: "*string.string.string*"  
ERROR 3019: Default expressions may not refer to other columns with default expressions  
ERROR 3020: Default expressions must not return a set  
ERROR 3026: Defining query must have a from clause  
ERROR 3115: DistinctExpr not supported  
ERROR 3116: Distrib overrides are too restrictive. Can not find completed Join Order  
ERROR 3118: DML on projection/view is not supported  
ERROR 3119: DML query with a predicate that could not be pushed below joins and does not refer solely to the target table is not supported  
ERROR 3123: DROP ASSERTION is not supported  
ERROR 3126: DROP COLUMN over temporary tables is not supported  
ERROR 3132: DROP SEQUENCE does not support CASCADE  
ERROR 3135: drop\_location for DATA locations is not supported  
ERROR 3141: Dropping local and global objects in one statement is not supported  
ERROR 3157: Dynamic load not supported  
ERROR 3163: Embedded SQL involving local objects is not supported  
ERROR 3174: ENCODED BY is supported in CREATE TABLE ... AS SELECT statement only  
ERROR 3246: Error parsing distrib overrides (unexpected end of override); *string*  
ERROR 3247: Error parsing distrib value; *string*  
ERROR 3291: Event ANY\_ROW is not supported  
ERROR 3317: Executing when OPT:PLAN\_ALL\_NODES\_ACTIVE option is set  
ERROR 3343: Explicit JOIN clause contains a join predicate between relations previously joined  
ERROR 3351: Expressions in COPY may not contain aggregate functions  
ERROR 3352: Expressions in COPY may not contain analytic or Time Series Aggregate Functions  
ERROR 3353: Expressions not supported in Times Series Aggregate Function  
ERROR 3357: External tables only support files or a User Defined Source  
ERROR 3403: FieldSelect is not supported  
ERROR 3404: FieldStore is not supported  
ERROR 3417: Final phase output size mismatch  
ERROR 3420: First argument of date\_part must be a constant string  
ERROR 3434: For INSERT SELECT statement, replicated/broadcasted source data not supported

ERROR 3436: For SELECT DISTINCT, ORDER BY expressions must appear in the SELECT clause

ERROR 3451: Function *string* can't be used as a case expression

ERROR 3452: Function *string* can't be used in a boolean

ERROR 3453: Function *string* can't be used in a WHEN clause

ERROR 3454: Function *string* can't be used in as a segment expression

ERROR 3455: Function *string* can't be used with an operator

ERROR 3488: Group By, Order By, Aggregates, Having & limits not allowed in update/delete

ERROR 3510: IGNORE NULLS argument must be a Boolean constant

ERROR 3553: INHERITS not supported

ERROR 3566: Input of anonymous composite types is not implemented

ERROR 3600: Interpolated predicates can accept arguments of the same type only

ERROR 3601: Interpolated predicates can be part of AND expressions only

ERROR 3613: Interval units "*string*" not supported

ERROR 3821: Joins with an interpolated predicate can have a conjunctive expression containing equality predicates. The equality predicates cannot have expressions or column references with different modifiers

ERROR 3822: Joins with an interpolated predicate cannot have expressions or column references with different modifiers in any of the expressions

ERROR 3857: Library built with unsupported version of Vertica SDK [Version: *string*, Revision: *string*]

ERROR 3858: Library cannot be created under system schema

ERROR 3859: Library file [*string*] is not valid for language [*string*]

ERROR 3876: Locale must be a constant

ERROR 3900: MATCH PARTIAL is not supported

ERROR 3972: Multi-column subquery expressions can only be used with the =, <=> and <> operators

ERROR 3973: Multi-column subquery type ALL can only be used with the = and <=> operators

ERROR 3974: Multi-column subquery type ANY can only be used with the =, <=> and <> operators

ERROR 4106: No single-source bulk loads have been executed in this session

ERROR 4147: Node issuing the query cannot be marked as down

ERROR 4160: Non-equality correlated subquery expression is not supported

ERROR 4170: Not a Star or Snow-Flake Query block

ERROR 4171: Not a Star or Snow-Flake Query block; dimension table not a star or snowflake

ERROR 4172: Not a Star or Snow-Flake Query block; no fact table found

ERROR 4173: Not a Star or Snow-Flake Query block; there are multiple fact tables  
ERROR 4197: NULL value found in a column used by a subquery  
ERROR 4228: ON COMMIT DROP not supported in CREATE TABLE  
ERROR 4238: Only a temporary table projection can be pinned  
ERROR 4248: Only inner joins are allowed in the projection defining query  
ERROR 4256: Only relations and subqueries are allowed in the FROM clause  
ERROR 4258: Only super user can call export\_catalog with an output file name  
ERROR 4259: Only super user can get the rebalance data script  
ERROR 4262: Only superuser can drop all workspaces  
ERROR 4263: Only superuser can drop system schema  
ERROR 4264: Only superuser can rebalance data  
ERROR 4265: Only superuser can rebalance data for replicated projections  
ERROR 4266: Only superuser can rebalance data for segmented projections  
ERROR 4280: Operator *string* (*value*) is not supported  
ERROR 4281: Operator *string* is not supported for row expressions  
ERROR 4298: ORDER BY on a UNION/INTERSECT/EXCEPT result must be on one of the result columns  
ERROR 4299: ORDER mode not supported  
ERROR 4306: OUTER join with broadcasted outer data not supported  
ERROR 4307: OUTER or SEMI join - done through CROSS join and FILTER - with replicated outer and segmented inner not supported  
ERROR 4308: OUTER relation in OUTER join is not the fact table nor a snowflake dimension table  
ERROR 4309: Outer replicated/segmented input to a join cannot be resegmented  
ERROR 4310: LEFTOUTER/SEMI/ANTI join with replicated/broadcasted outer data not supported  
ERROR 4329: Partition Auto cannot be used with pattern matching  
ERROR 4331: PARTITION BY expression cannot return a tuple  
ERROR 4332: PARTITION BY expression has an unknown type  
ERROR 4333: PARTITION BY expression may not contain aggregate functions  
ERROR 4335: Partitioning expression not supported for temporary tables  
ERROR 4336: Partitioning not supported for temporary tables  
ERROR 4352: Pattern "E" is not supported  
ERROR 4375: PINNED clause conflicts with KSAFE setting  
ERROR 4376: PINNED clause is not supported in CREATE TABLE statement  
ERROR 4412: Prepared statements are currently unsupported

ERROR 4465: Projection *string* of local temporary table cannot be created under user schema *string*

ERROR 4471: Projection choices are too restrictive - cannot create correct join between tables

ERROR 4486: Projections are always created and persisted in the default Vertica locale. The current locale is *string*

ERROR 4502: Query Repository has been deprecated

ERROR 4584: RENAME COLUMN over temporary tables is not supported

ERROR 4586: replicate\_catalog has been shut off

ERROR 4628: Row Expressions are not supported in this context

ERROR 4631: ROW syntax is not supported

ERROR 4644: Scalar array expression cannot contain column references or subqueries

ERROR 4645: Scalar array op *string* (*value*) is not supported

ERROR 4664: Segmentation clause can not have offset in CREATE TABLE statement

ERROR 4665: Segmentation clause with offset conflicts with KSAFE setting

ERROR 4666: Segmentation expression must have integer type

ERROR 4671: SELECT FOR UPDATE cannot be applied to a function

ERROR 4672: SELECT FOR UPDATE cannot be applied to a join

ERROR 4673: SELECT FOR UPDATE cannot be applied to NEW or OLD

ERROR 4674: SELECT FOR UPDATE is not allowed with EXTERNAL TABLES

ERROR 4675: SELECT FOR UPDATE is not allowed with libraries

ERROR 4676: SELECT FOR UPDATE is not allowed with sequences

ERROR 4677: SELECT FOR UPDATE is not allowed with UNION/INTERSECT/EXCEPT

ERROR 4678: SELECT FOR UPDATE is not allowed with views

ERROR 4680: Self joins in UPDATE statements are not allowed

ERROR 4703: Sequence cannot be moved between system schema and user schema

ERROR 4711: Sequence or IDENTITY/AUTO\_INCREMENT column in merge query is not supported

ERROR 4714: Sequences are not allowed in default expressions of local temp tables

ERROR 4715: Sequences cannot be called in views

ERROR 4716: Sequences cannot be created under system schemas

ERROR 4728: Set Operator *string* ALL not supported

ERROR 4730: Set Operator queries without a FROM clause are not supported

ERROR 4733: SET SCHEMA over temporary tables is not supported

ERROR 4735: Set-valued function called in context that cannot accept a set

ERROR 4747: SetToDefault is not supported

ERROR 4786: Statement *string* is not supported

ERROR 4808: Subqueries are not supported as the left hand argument to another subquery

ERROR 4809: Subqueries are not supported in the ORDER BY of a timeseries OVER clause

ERROR 4810: Subqueries are not supported in the ORDER BY of an analytic function OVER clause

ERROR 4812: Subqueries are not supported in the PARTITION BY of an analytic function OVER clause

ERROR 4816: Subqueries in the ON clause are not supported

ERROR 4817: Subqueries in the SELECT or ORDER BY are not supported if the query has aggregates and the subquery is not part of the GROUP BY

ERROR 4818: Subqueries in the SELECT or ORDER BY are not supported if the subquery is not part of the GROUP BY

ERROR 4820: Subqueries in UPDATE/DELETE/MERGE is not supported

ERROR 4821: Subqueries not allowed in target of insert

ERROR 4822: Subqueries referring to no outer columns in HAVING clause when query has aggregates and no GROUP BY are not supported

ERROR 4824: Subquery aggregate expression that refers a correlated column is not supported

ERROR 4839: Subquery type ARRAY is not supported

ERROR 4842: Subquery without a from clause is not supported

ERROR 4850: Support for UPDATE/DELETE/MERGE is not enabled

ERROR 4854: SyncMarkers are not supported

ERROR 4865: System table *string* cannot be created under user schema *string*

ERROR 4869: System view "*string*" cannot be dropped

ERROR 4870: System view *string* cannot be created under user schema *string*

ERROR 4884: Table *string* cannot be created under system schema *string*

ERROR 4897: Table cannot be moved between system schema and user schema

ERROR 4910: Table revalidation error

ERROR 4918: Temporary Sequences are not supported

ERROR 4933: The argument types in a subquery expression in the where/having clause do not match

ERROR 4938: The constant value following the LIMIT clause cannot be negative

ERROR 4939: The constant value following the OFFSET clause cannot be negative

ERROR 4948: The fourth input argument of TIME\_SLICE must be START or END

ERROR 4960: The ORDER BY ... USING clause is not supported

ERROR 4966: The second parameter of export\_catalog is invalid: *string*

ERROR 4968: The slice length parameter of TIME\_SLICE must be a positive integer

ERROR 5005: Time Series Aggregate Function with interpolation scheme LINEAR may only have an INTEGER or FLOAT type as its first argument

ERROR 5016: Time units "*string*" not supported

ERROR 5023: Timeseries output functions are not supported in the ORDER BY of a timeseries OVER clause

ERROR 5028: Timestamp units "*string*" not supported

ERROR 5110: Type *string* (*value*) is not supported

ERROR 5159: Uncorrelated EXISTS subqueries are not supported when the query has both HAVING clause subqueries involving aggregates and when the query has either OUTER JOINS or NOT IN subqueries

ERROR 5160: Uncorrelated EXISTS subqueries in HAVING clause when query has aggregates and no GROUP BY are not supported

ERROR 5195: UNIQUE predicate is not supported

ERROR 5262: Unsafe use of string constant with Unicode escapes

ERROR 5264: Unsupported access to session-scoped (LOCAL) object

ERROR 5270: Unsupported COPY command clause

ERROR 5275: Unsupported Join in From clause

ERROR 5276: Unsupported Join in From clause: FULL OUTER JOINS not supported

ERROR 5278: Unsupported join of two non-alike segmented projections

ERROR 5280: Unsupported mix of Joins

ERROR 5284: Unsupported query syntax

ERROR 5289: Unsupported subquery expression

ERROR 5291: Unsupported use of aggregates

ERROR 5292: Unsupported use of cursors

ERROR 5293: Unsupported use of DISTINCT clause

ERROR 5294: Unsupported use of FROM clause

ERROR 5295: Unsupported use of GROUP BY or DISTINCT clause

ERROR 5296: Unsupported use of HAVING clause

ERROR 5297: Unsupported use of LIMIT/OFFSET clause

ERROR 5298: Unsupported use of ORDER BY clause

ERROR 5299: Unsupported use of outer joins

ERROR 5300: Unsupported use of query/subquery without FROM clause

ERROR 5301: Unsupported use of sub-queries

ERROR 5302: Unsupported use of target relation

ERROR 5303: Unsupported use of UDF in WHERE clause

ERROR 5304: Unsupported use of UNION/INTERSECT/EXCEPT

ERROR 5313: Update is disallowed on Primary/Foreign Keys columns. Use Delete followed by Insert instead

ERROR 5314: UPDATE may not refer to tables in prejoin projections

ERROR 5366: User defined aggregate cannot be used in query with other distinct aggregates

ERROR 5388: User has insufficient privilege on *string string*

ERROR 5392: User must have the DBDUSER role to run the database designer

ERROR 5396: User projection *string* cannot be created under system schema *string*

ERROR 5402: User-defined transform functions are not supported in the ORDER BY clause

ERROR 5407: VALINDEX column must be the first column in ORDER BY list

ERROR 5426: Vertica currently allows a maximum of *value* physical storage containers per projection

ERROR 5427: Vertica does not support GRANT / REVOKE ON LANGUAGE

ERROR 5428: Vertica does not support GRANT / REVOKE ON TABLESPACE

ERROR 5447: View *string* cannot be created under system schema *string*

ERROR 5456: Volatile functions may not be used in fillers when other computed columns refer to them

ERROR 5465: Window frame exclusion is not supported

ERROR 5530: Audit of external tables is not supported

ERROR 5537: Cannot alter user-defined type "*string*" of column "*string*"

ERROR 5550: COPY from UDSource does not support rejected row numbers with exceptions or rejected data options

ERROR 5551: COPY LOCAL cannot process more than ONE NATIVE or NATIVE VARCHAR file at a time

ERROR 5562: Creating temp tables by LIKE clause is not supported

ERROR 5595: Invalid argument type *string* in function *string*

ERROR 5607: Language of replacement library [*string*] must match language of existing library [*string*]

ERROR 5681: Unsupported base type *string* for User-defined type *string*

ERROR 5698: Cannot export statistics for the specified object

ERROR 5725: Size specification not supported for User Defined Type *string*

ERROR 5731: The second parameter must be a table/projection/column name

**Note:** The **myVertica** (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 0B000

This topic lists the error associated with the SQLSTATE value 0B000. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 0B000 Description

ERRCODE\_INVALID\_TRANSACTION\_INITIATION

#### Error messages associated with this SQLState

ERROR 2321: Can't start a Transaction in this context

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 0LV01

This topic lists the error associated with the SQLSTATE value 0LV01. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 0LV01 Description

ERRCODE\_INVALID\_GRANT\_OPERATION

#### Error messages associated with this SQLState

ERROR 2120: Admin option for a role cannot be granted to *string*"public"

ERROR 2601: Circular assignation of roles is not allowed

ERROR 3484: Grant option for a privilege cannot be granted to "public"

ERROR 3485: Grant option for a privilege cannot be granted to (and thus revoked from) "public"

ERROR 3486: Grant options cannot be granted back to your own grantor

ERROR 3616: Invalid *string* statement

ERROR 3719: Invalid option specified for *string* statement

ERROR 3723: Invalid privilege type "*string*"

ERROR 3724: Invalid privilege type *string* for aggregate function

ERROR 3725: Invalid privilege type *string* for analytic function

ERROR 3726: Invalid privilege type *string* for database

ERROR 3727: Invalid privilege type *string* for function

ERROR 3728: Invalid privilege type *string* for library

ERROR 3729: Invalid privilege type *string* for procedure

ERROR 3730: Invalid privilege type *string* for relation

ERROR 3731: Invalid privilege type *string* for resource pool

```
ERROR 3732: Invalid privilege type string for schema
ERROR 3733: Invalid privilege type string for sequence
ERROR 3734: Invalid privilege type string for storage location
ERROR 3735: Invalid privilege type string for transform
ERROR 3745: Invalid role name string
ERROR 4056: New string
ERROR 4613: Role "string" cannot be set as default
ERROR 5601: Invalid privilege type string for filter function
ERROR 5602: Invalid privilege type string for parser function
ERROR 5603: Invalid privilege type string for source function
```

**Note:** The *myVertica* (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 22000

This topic lists the error associated with the SQLSTATE value 22000. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 22000 Description

ERRCODE\_DATA\_EXCEPTION

### Error messages associated with this SQLState

```
ERROR 3646: Invalid Datum pointer
ERROR 4163: Non-positive value supplied to randomint: value
ERROR 4921: Test Error @string
ERROR 4922: Test Error from @string
```

**Note:** The *myVertica* (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 22001

This topic lists the error associated with the SQLSTATE value 22001. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 22001 Description

ERRCODE\_STRING\_DATA\_RIGHT\_TRUNCATION

### Error messages associated with this SQLState

```
ERROR 2991: Date 'string' string too long for type string(value)
```

```

ERROR 3426: Float 'string' string too long for type string
ERROR 3589: Integer 'string' string is too long for type string(value)
ERROR 3605: Interval 'string' string too long for type string(value)
ERROR 4208: Numeric 'string' is too long for type string
ERROR 4315: Padded octet length (value) exceeds the value octet limit
ERROR 4604: Result (value characters) exceeds the field width (value)
ERROR 4800: String of value octets is too long for type string(value)
ERROR 5004: Time 'string' string too long for type string(value)
ERROR 5024: Timestamp 'string' string too long for type string(value)
ERROR 5032: Timestamptz 'string' string too long for type string(value)
ERROR 5035: Timetz 'string' string too long for type string(value)
ERROR 5417: Value too long for type character varying(value)
ERROR 5418: Value too long for type character(value)

```

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 22003

This topic lists the error associated with the SQLSTATE value 22003. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 22003 Description

ERRCODE\_NUMERIC\_VALUE\_OUT\_OF\_RANGE

### Error messages associated with this SQLState

```

ERROR 2429: Cannot find matching query in the system
ERROR 2828: Could not convert 'string' string to an int8
ERROR 3425: Float "value" is out of range for type string
ERROR 3675: Invalid input for string, exceeds 32 bits: "string"
ERROR 3676: Invalid input for string, exceeds 64 bits: "string"
ERROR 3786: Invalid value for float: "string"
ERROR 4200: Number of buckets must be a positive integer
ERROR 4361: Percentile value must be a number between 0 and 1
ERROR 4704: Sequence exceeded max value
ERROR 4705: Sequence exceeded min value
ERROR 4756: Smoothing factor must between 0 and 1
ERROR 4795: String "string" string is out of range as a float8

```

```
ERROR 4796: String "string" string is out of range as an int8
ERROR 4845: Sum() overflowed
ERROR 5408: Value "value" is out of range for type string
ERROR 5409: Value "string" is out of range for type int8
ERROR 5411: Value exceeds range of type string
ERROR 5412: Value is too long for type string: "value"
```

**Note:** The *myVertica* (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 22004

This topic lists the error associated with the SQLSTATE value 22004. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 22004 Description

ERRCODE\_NULL\_VALUE\_NOT\_ALLOWED

#### Error messages associated with this SQLState

```
ERROR 2110: ACL arrays must not contain null values
ERROR 2501: Cannot set a NOT NULL column (value) to a NULL value in value statement
ERROR 2502: Cannot set a NOT NULL column (string) to a NULL value in INSERT/UPDATE statement
ERROR 2514: Cannot set NOT NULL columns (string) to a NULL value in INSERT/UPDATE statement
ERROR 4195: NULL value detected in data partitioning expression
```

**Note:** The *myVertica* (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 22007

This topic lists the error associated with the SQLSTATE value 22007. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 22007 Description

ERRCODE\_INVALID\_DATETIME\_FORMAT

#### Error messages associated with this SQLState

```
ERROR 2171: AM/PM hour (value) must be between 1 and 12
ERROR 2364: Cannot calculate day of year without year information
ERROR 3439: Format string is invalid for an Interval value
```

ERROR 3535: Inconsistent use of year value and "BC"  
ERROR 3647: Invalid day-of-week 'string'  
ERROR 3679: Invalid input syntax for string: "string"  
ERROR 3721: Invalid partition key  
ERROR 3785: Invalid value for string: "string"

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 22008

This topic lists the error associated with the SQLSTATE value 22008. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 22008 Description

ERRCODE\_DATETIME\_FIELD\_OVERFLOW

### Error messages associated with this SQLState

ERROR 2992: Date/time field value out of range: "string"  
ERROR 4065: next\_day(infinity, DOW) is not defined

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 22009

This topic lists the error associated with the SQLSTATE value 22009. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 22009 Description

ERRCODE\_INVALID\_TIME\_ZONE\_DISPLACEMENT\_VALUE

### Error messages associated with this SQLState

ERROR 3768: Invalid timezone interval displacement  
ERROR 5044: Timezone displacement out of range: "string"

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 2200B

This topic lists the error associated with the SQLSTATE value 2200B. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### **SQLSTATE 2200B Description**

ERRCODE\_ESCAPE\_CHARACTER\_CONFLICT

### **Error messages associated with this SQLState**

ERROR 2699: Conflicting or redundant options

**Note:** The *myVertica* (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## **Error Messages Associated with SQLSTATE 2200D**

This topic lists the error associated with the SQLSTATE value 2200D. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### **SQLSTATE 2200D Description**

ERRCODE\_INVALID\_ESCAPE\_OCTET

### **Error messages associated with this SQLState**

ERROR 3285: ESCAPE strings must be a single octet, not "value"

**Note:** The *myVertica* (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## **Error Messages Associated with SQLSTATE 22011**

This topic lists the error associated with the SQLSTATE value 22011. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### **SQLSTATE 22011 Description**

ERRCODE\_SUBSTRING\_ERROR

### **Error messages associated with this SQLState**

ERROR 4034: Negative count not allowed

ERROR 4035: Negative length not allowed

ERROR 4036: Negative or zero substring start position not allowed

ERROR 4039: Negative substring length not allowed

ERROR 4784: Start position cannot be 0

**Note:** The *myVertica* (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 22012

This topic lists the error associated with the SQLSTATE value 22012. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 22012 Description

ERRCODE\_DIVISION\_BY\_ZERO

#### Error messages associated with this SQLState

ERROR 3117: Division by zero

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 22015

This topic lists the error associated with the SQLSTATE value 22015. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 22015 Description

ERRCODE\_INTERVAL\_FIELD\_OVERFLOW

#### Error messages associated with this SQLState

ERROR 3606: Interval field value out of range: "string"

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 22019

This topic lists the error associated with the SQLSTATE value 22019. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 22019 Description

ERRCODE\_INVALID\_ESCAPE\_CHARACTER

#### Error messages associated with this SQLState

ERROR 2729: COPY DELIMITER for column *string* must be a single character

ERROR 2730: COPY delimiter must be a single character

ERROR 2731: COPY ENCLOSED BY cannot be a whitespace character

ERROR 2732: COPY ENCLOSED BY for column *string* cannot be a whitespace character

ERROR 2733: COPY ENCLOSED BY for column *string* must be a single character

ERROR 2734: COPY ENCLOSED BY must be a single character  
ERROR 2736: COPY ESCAPE AS for column *string* must be a single character  
ERROR 2737: COPY ESCAPE must be a single character  
ERROR 2758: COPY TRIM for column *string* must be an empty string or a single character  
ERROR 2759: COPY trim must be an empty string or a single character  
ERROR 3284: ESCAPE strings must be a single character, not "*value*"

**Note:** The **myVertica** (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 2201B

This topic lists the error associated with the SQLSTATE value 2201B. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 2201B Description

ERRCODE\_INVALID\_REGULAR\_EXPRESSION

#### Error messages associated with this SQLState

ERROR 3742: Invalid regexp match\_param: '*character*'  
ERROR 4552: Regexp match or recursion limit exceeded (rc *value*)  
ERROR 4553: Regexp pattern error at offset *value*: *string*  
ERROR 4554: Regexp pattern study error: *string*  
ERROR 5064: Too many regular expression subexpressions

**Note:** The **myVertica** (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 2201G

This topic lists the error associated with the SQLSTATE value 2201G. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 2201G Description

ERRCODE\_INVALID\_ARGUMENT\_FOR\_WIDTH\_BUCKET\_FUNCTION

#### Error messages associated with this SQLState

ERROR 2939: Count must be greater than zero  
ERROR 3888: Lower and upper bounds must be finite  
ERROR 3889: Lower bound cannot equal upper bound  
ERROR 4277: Operand, lower bound and upper bound cannot be NaN

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 22021

This topic lists the error associated with the SQLSTATE value 22021. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 22021 Description

ERRCODE\_CHARACTER\_NOT\_IN\_REPERTOIRE

### Error messages associated with this SQLState

ERROR 4551: Regexp encountered an invalid UTF-8 character

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 22023

This topic lists the error associated with the SQLSTATE value 22023. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 22023 Description

ERRCODE\_INVALID\_PARAMETER\_VALUE

### Error messages associated with this SQLState

ERROR 2007: *string* can not be greater than PASSWORD\_MAX\_LENGTH value

ERROR 2008: *string* can not be set to a negative number

ERROR 2028: *string* exceptions and rejected\_data can not be the same filename

ERROR 2033: *string* input file and exceptions can not be the same filename

ERROR 2034: *string* input file and rejected\_data can not be the same filename

ERROR 2042: *string* must be a positive integer

ERROR 2048: *string* Path [*string*] is a directory

ERROR 2049: *string* Path [*string*] is a socket

ERROR 2051: *string* Record terminator length (value) is larger than load read buffer size (value)

ERROR 2056: *string* Unrecognized format '*string*' for column value

ERROR 2071: '*string*' is not a valid size description

ERROR 2075: @INCLUDE without filename in timezone file "*string*", line value

ERROR 2077: [*string*] cannot be dropped. There will be no storage locations for data files

```
ERROR 2078: [string] cannot be dropped. There will be no storage locations for temporary files
ERROR 2079: [string] cannot be retired. There will be no storage locations for data files
ERROR 2080: [string] cannot be retired. There will be no storage locations for temporary files
ERROR 2081: [string] is not a valid storage location on node string
ERROR 2108: ACL array contains wrong data type
ERROR 2109: ACL arrays must be one-dimensional
ERROR 2158: All columns of soft unique key statistics must be from the same table
ERROR 2194: analyze_statistics: Can not analyze statistics of a non-local temporary table/projection 'string'
ERROR 2195: analyze_statistics: Can not analyze statistics of a virtual table/projection string
ERROR 2196: analyze_statistics: Cannot analyze statistics of a virtual table string
ERROR 2197: analyze_statistics: invalid accuracy value A number between 0 and 100 is required
ERROR 2254: Bad snapshot name 'string' (cannot contain / or start with a .)
ERROR 2298: Can not lock/unlock super user account
ERROR 2300: Can not reuse any recent passwords
ERROR 2301: Can not reuse current password
ERROR 2302: Can not reuse the previous value passwords
ERROR 2317: Can't purge projection(s); AHM is at epoch 0
ERROR 2319: Can't set a REJECTED file on node 'string', which the current query is not executing on
ERROR 2320: Can't set an EXCEPTIONS file on node 'string', which the current query is not executing on
ERROR 2365: Cannot calculate week number without year information
ERROR 2370: Cannot close a protected session
ERROR 2414: Cannot drop extended statistics on a projection (string)
ERROR 2415: Cannot drop extended statistics on projection string. Dropping base statistics only
ERROR 2452: Cannot load data from node string as it is down
ERROR 2457: Cannot merge partitions in multiple tables at the same time
ERROR 2468: Cannot partition by value multiple tables at the same time
ERROR 2478: Cannot release savepoint; no transaction in progress
ERROR 2500: Cannot set string maxConcurrency to unlimited
ERROR 2508: Cannot set maxConcurrency of string pool to 0
```

ERROR 2509: Cannot set maxMemorySize of *string* pool to *string* (value KB), as it is above 75% [75% = value KB]

ERROR 2510: Cannot set maxMemorySize of *string* pool to none, as this could prevent moveout from running

ERROR 2511: Cannot set maxMemorySize of recovery pool to *string* (value KB), as it is below 25% [value KB]

ERROR 2513: Cannot set memorySize of general pool

ERROR 2523: Cannot specify exceptions or rejected-data files ON ANY NODE

ERROR 2540: Cannot use 0 for a key, used internally

ERROR 2548: Cannot use both COPY LOCAL and ON ANY NODE: LOCAL files are stored on the client, not on any Vertica node

ERROR 2621: Collection type must be specified

ERROR 2624: Column "*string*" does not exist

ERROR 2653: Column *string* of projection *string* has ACCESSRANK < 0

ERROR 2695: Conflicting "datestyle" keywords

ERROR 2720: Conversion to timezone "*string*" failed

ERROR 2722: COPY .. LOCAL cannot store *string* on a Vertica node

ERROR 2723: COPY ... LOCAL can read files from the client only

ERROR 2724: COPY ... LOCAL can read files with same compression only

ERROR 2727: COPY column option *string* not supported with format *string*

ERROR 2728: COPY delimiter *string* must not appear in the NULL specification

ERROR 2735: COPY ENCLOSING CHARACTER *string* must not appear in the NULL specification

ERROR 2748: COPY NULL must be an empty string or a single character for FIXED WIDTH data

ERROR 2749: COPY option *string* not supported

ERROR 2750: COPY option *string* not supported with format *string*

ERROR 2752: COPY RECORD TERMINATOR must be at least ONE character long

ERROR 2753: COPY REJECTMAX should be >= 0

ERROR 2756: COPY skip characters should be >= 0

ERROR 2757: COPY skip should be >= 0

ERROR 2760: COPY WITH PARSER Error (column *value*): Parser specified a column of type [*string*]; table needs [*string*]

ERROR 2761: COPY WITH PARSER Error: Parser specified *value* column(s); table needs *value* column(s)

ERROR 2765: COPY: width and length of null string does not match for column *string*

ERROR 2766: COPY: width for column *string* has to be greater than 0

ERROR 2830: Could not convert to timezone "*string*"

ERROR 2932: Couldn't find the specified task  
ERROR 2950: Current design does not meet the requirements for K = value  
    Current design is valid for K *string* value  
    *string*  
ERROR 2963: CURRENT\_TIME(*value*) precision must not be negative  
ERROR 2964: CURRENT\_TIME(*value*) precision reduced to maximum allowed, *value*  
ERROR 2965: CURRENT\_TIMESTAMP(*value*) precision must not be negative  
ERROR 2966: CURRENT\_TIMESTAMP(*value*) precision reduced to maximum allowed, *value*  
ERROR 2993: Datepart "*string*" not recognized  
ERROR 2994: Datepart is invalid  
ERROR 3006: DDL statement interfered with snapshot; an object no longer exists  
ERROR 3012: DECIMAL precision *value* must be between 1 and *value*  
ERROR 3013: DECIMAL scale *value* must be between 0 and precision *value*  
ERROR 3032: Delimiter and record terminator cannot be the same value  
ERROR 3033: Delimiter and record terminator for *string* cannot be the same value  
ERROR 3137: drop\_statistics: Can not drop base or histogram statistics of a  
    non-local temporary table/projection *string*  
ERROR 3138: drop\_statistics: Can not drop statistics for a virtual table/projection  
    *string*  
ERROR 3139: drop\_statistics: Invalid stats type '*string*'. Valid values are 'base',  
    'histograms' and 'extended'  
ERROR 3168: ENCLOSED BY and delimiter *string* can not be the same value  
ERROR 3169: ENCLOSED BY and ESCAPE AS *string* can not be the same value  
ERROR 3170: ENCLOSED BY and record terminator *string* can not be the same value  
ERROR 3178: ENFORCLENGTH cannot be specified for *string*  
ERROR 3280: ESCAPE AS and delimiter *string* can not be the same value  
ERROR 3281: ESCAPE AS and NULL specification *string* can not be the same value  
ERROR 3282: ESCAPE AS and record terminator *string* can not be the same value  
ERROR 3383: Failed to parse object name *string*  
ERROR 3423: Fixed width record size (*value*) is too large. Record size has to be  
    lesser than *value* (0x*value*)  
ERROR 3424: Fixed width record size is too large. Record size has to be lesser than  
    *value* (0x*value*)  
ERROR 3440: Format cannot be specified for *string*  
ERROR 3503: ICU *string* error: '*string*'  
ERROR 3505: ICU does not support locale '*string*'  
ERROR 3513: Illegal argument to change\_runtime\_priority: NULL  
ERROR 3514: Illegal argument to set\_config\_parameter: NULL

ERROR 3524: In the SAMPLE STORAGE n or SAMPLE STORAGE n,b clause, n must be a constant greater than or equal to 0

ERROR 3525: In the SAMPLE STORAGE n PERCENT or SAMPLE STORAGE n PERCENT,b clause, n must be a constant greater than or equal to 0 and less than or equal to 100

ERROR 3526: In the SAMPLE STORAGE n PERCENT,b clause, n must be a constant greater than or equal to 0 and less than or equal to 100, while b must be a constant greater than or equal to 0

ERROR 3527: In the SAMPLE STORAGE n,b clause, both n and b must be constants greater than or equal to 0

ERROR 3528: In the SAMPLE STORAGE n,b or SAMPLE STORAGE n PERCENT,b clause, b must be a constant greater than or equal to 0

ERROR 3540: Incorrect statement ID for session

ERROR 3541: Increase in pool size to *string* (value KB) causes general pool to fall below minimum [25% = value KB]

ERROR 3607: INTERVAL leading field precision increased to *value*

ERROR 3608: INTERVAL leading field precision reduced to *value*

ERROR 3610: INTERVAL SECOND precision reduced to *value*

ERROR 3612: Interval units "*value*" not recognized

ERROR 3618: Invalid accuracy value for analyze\_histogram

ERROR 3632: Invalid collection type *string* specified

ERROR 3652: Invalid Directives type: *string*

ERROR 3673: Invalid hint identifier '*string*'

ERROR 3686: Invalid interval value for timezone

ERROR 3688: Invalid K value: *value* K cannot be less than zero

ERROR 3689: Invalid K value: *value* Maximum K value for *value* nodes is: *value*

ERROR 3692: Invalid limit type (*string*): must be HIGH or LOW

ERROR 3695: Invalid list syntax for "datestyle"

ERROR 3707: Invalid node: [*string*]

ERROR 3710: Invalid number for timezone offset in timezone file "*string*", line *value*

ERROR 3741: Invalid range

ERROR 3743: Invalid resource type (*string*)

ERROR 3746: Invalid runtime priority string

ERROR 3750: Invalid service name for '*string*'

ERROR 3759: Invalid syntax in timezone file "*string*", line *value*

ERROR 3767: Invalid timezone file name "*string*"

ERROR 3777: Invalid Usage type: *string*

ERROR 3780: Invalid user/role name "*string*"

ERROR 3783: Invalid value *string*=*string*

```
ERROR 3787: Invalid value for parameter
ERROR 3788: Invalid value for parameter string: string
ERROR 3789: Invalid value for search path: "string"
ERROR 3798: IPv4 address "string" is invalid
ERROR 3840: Keyword 'string' (string=string) is not supported
ERROR 3845: Latency should be > 0
ERROR 3852: Length for type string cannot exceed value
ERROR 3853: Length for type string must be at least 1
ERROR 3877: LOCALTIME(value) precision must not be negative
ERROR 3878: LOCALTIME(value) precision reduced to maximum allowed, value
ERROR 3879: LOCALTIMESTAMP(value) precision must not be negative
ERROR 3880: LOCALTIMESTAMP(value) precision reduced to maximum allowed, value
ERROR 3912: maxMemorySize of string (value KB) is not in bounds [max is value KB]
ERROR 3920: memoryCap of string (value KB) would exceed [value KB]
ERROR 3922: memorySize string (value KB) would exceed maxMemorySize string (value KB)
ERROR 3923: memorySize of string (value KB) would exceed [value KB]
ERROR 3960: Missing timezone abbreviation in timezone file "string", line value
ERROR 3961: Missing timezone offset in timezone file "string", line value
ERROR 3967: More than one string specified for a node
ERROR 4027: Must supply a CATALOGPATH
ERROR 4028: Must supply a HOSTNAME
ERROR 4037: Negative run time cap is not allowed
ERROR 4038: Negative runTimeCap is not allowed
ERROR 4084: No interruptible statement running
ERROR 4089: No objects specified
ERROR 4174: Not allowed to cancel statement
ERROR 4175: Not allowed to close session
ERROR 4186: NULL is an invalid K value
ERROR 4187: NULL is invalid object name for analyze_extended_statistics
ERROR 4188: NULL is invalid object name for analyze_histogram
ERROR 4189: NULL is invalid object name for drop_statistics
ERROR 4190: NULL is invalid scope type for analyze_extended_statistics
ERROR 4191: NULL is invalid statistics type for analyze_extended_statistics
ERROR 4192: NULL is invalid statistics type for drop_statistics
ERROR 4194: NULL string and record terminator string can not be the same value
```

ERROR 4211: NUMERIC precision *value* must be between 1 and *value*  
ERROR 4212: NUMERIC scale *value* must be between 0 and precision *value*  
ERROR 4222: Occurrence number must be > 0  
ERROR 4250: Only ONE exception file should be specified for a LOCAL copy  
ERROR 4252: Only ONE rejected data file should be specified for a LOCAL copy  
ERROR 4318: Parameter *string* in default profile can not be set to DEFAULT  
ERROR 4319: Parameter *string* may not exceed 9999  
ERROR 4330: PARTITION BY clause must contain table columns in a valid expression  
ERROR 4334: Partition key too long  
ERROR 4344: PASSWORD\_MAX\_LENGTH must be within the range from *value* to *value*  
ERROR 4345: PASSWORD\_MIN\_DIGITS + PASSWORD\_MIN\_SYMBOLS + PASSWORD\_MIN\_LETTERS  
  *value* can not be greater than PASSWORD\_MAX\_LENGTH *value*  
ERROR 4346: PASSWORD\_MIN\_DIGITS + PASSWORD\_MIN\_SYMBOLS +  
  PASSWORD\_MIN\_LOWERCASE LETTERS + PASSWORD\_MIN\_UPPERCASE LETTERS *value* can not  
  be greater than PASSWORD\_MAX\_LENGTH *value*  
ERROR 4347: Path cannot be an empty string  
ERROR 4399: populate\_projection\_statistics doesn't take empty parameter string  
ERROR 4400: populate\_projection\_statistics: Can not populate statistics for a  
  virtual table/projection *string*  
ERROR 4401: populate\_projection\_statistics: Can only populate statistics for a  
  projection, not for a table  
ERROR 4402: populate\_projection\_statistics: Invalid table/projection name *string*  
ERROR 4406: Precision for type float must be at least 1 bit  
ERROR 4407: Precision for type float must be less than 54 bits  
ERROR 4408: Precision must be less than *value*; result would be numeric(*value,value*)  
ERROR 4454: Projection *string* cannot be analyzed, because it is not up to date  
ERROR 4456: Projection *string* cannot drop statistics, because it is not up to date  
ERROR 4529: Rebalance skew percent must be in the range [0,100]  
ERROR 4556: Regexp starting position must be greater than zero  
ERROR 4595: Resource pool "*string*" is an internal pool and cannot be dropped  
ERROR 4606: Retention settings must be less than 2TB  
ERROR 4639: Run time cap cannot exceed 1 year  
ERROR 4642: runTimeCap cannot exceed 1 year  
ERROR 4647: Scaling factor must be greater than zero  
ERROR 4648: Scaling factor must be less than 33  
ERROR 4653: Schema *string* is virtual  
ERROR 4701: Sequence *string* is already owned by *string*

ERROR 4702: SEQUENCE CACHE should be greater than 0  
ERROR 4708: SEQUENCE MAXVALUE is too large and will overflow  
ERROR 4709: SEQUENCE MINVALUE is too small and will underflow  
ERROR 4710: SEQUENCE MINVALUE should be lesser than MAXVALUE  
ERROR 4712: SEQUENCE START WITH should be between MINVALUE and MAXVALUE  
ERROR 4723: SET *string* takes only one argument  
ERROR 4745: Setting sysdata maxMemorySize below 4 MB to *string* (value KB) will prevent system table queries from running  
ERROR 4766: Specified too few widths for the given number of columns  
ERROR 4770: Specify at least one table-column for soft unique key statistics  
ERROR 4802: STROKE collations are not supported  
ERROR 4807: Subnet mask is empty  
ERROR 4862: System pool priority must be between -110 and 110 inclusive  
ERROR 4889: Table *string* is already owned by *string*  
ERROR 4893: Table *string* is session scoped  
ERROR 4894: Table *string* is virtual  
ERROR 4923: That password is not acceptable  
ERROR 4937: The confidence level must be between 0 and 100 inclusive.  
          *string*  
ERROR 4961: The permissible error must between 0 and 100 inclusive.  
          *string*  
ERROR 4985: There is no reason to set *string.string*. Consult documentation  
ERROR 5002: Throughput should be > 0  
ERROR 5014: Time units "value" not recognized  
ERROR 5015: Time units "string" not recognized  
ERROR 5019: TIME(*value*)*string* precision must not be negative  
ERROR 5020: TIME(*value*)*string* precision reduced to maximum allowed, *value*  
ERROR 5026: Timestamp units "value" not recognized  
ERROR 5027: Timestamp units "string" not recognized  
ERROR 5029: TIMESTAMP(*value*) precision reduced to maximum allowed, *value*  
ERROR 5030: TIMESTAMP(*value*)*string* precision must not be negative  
ERROR 5031: TIMESTAMP(*value*)*string* precision reduced to maximum allowed, *value*  
ERROR 5034: TIMESTAMPTZ(*value*) precision must not be negative  
ERROR 5036: TIMETZ(*value*) precision must not be negative  
ERROR 5037: TIMETZ(*value*) precision reduced to maximum allowed, *value*  
ERROR 5038: Timezone "string" not recognized

ERROR 5039: Timezone "*string*" uses leap seconds  
ERROR 5041: Timezone abbreviation "*string*" is multiply defined  
ERROR 5042: Timezone abbreviation "*string*" is too long (maximum value characters) in timezone file "*string*", line value  
ERROR 5045: Timezone file recursion limit exceeded in file "*string*"  
ERROR 5046: Timezone offset value is not a multiple of 900 sec (15 min) in timezone file "*string*", line value  
ERROR 5047: Timezone offset value is out of range in timezone file "*string*", line value  
ERROR 5048: Timezone value "*string*" is more than *value* hours  
ERROR 5067: Total data collector memory retention of *valueKB* is too large given system memory size  
ERROR 5106: TuningRecommendations data collection is disabled  
ERROR 5118: UDL specified no execution nodes; at least one execution node must be specified  
ERROR 5136: Unable to log this tuning analysis event  
ERROR 5202: Unknown configuration parameter  
ERROR 5209: Unknown node: *string*  
ERROR 5211: Unknown or unsupported object: *string*  
ERROR 5213: Unknown session ID  
ERROR 5215: Unknown value *string*=*string*  
ERROR 5220: Unrecognized "datestyle" keyword: "*string*"  
ERROR 5229: Unrecognized format '*string*'  
ERROR 5248: Unrecognized privilege type: "*string*"  
ERROR 5258: Unrecognized timezone name: "*string*"  
ERROR 5271: Unsupported format code: *value*  
ERROR 5316: Usage cannot be an empty string  
ERROR 5317: Usage of [*string*] cannot be changed from *string* to *string*  
ERROR 5319: Usage of [*string*] cannot be changed to *string*. There will be no storage locations for data files  
ERROR 5320: Usage of [*string*] cannot be changed to *string*. There will be no storage locations for temporary files  
ERROR 5322: Usage:  
  
ERROR 5393: User pool priority must be between -100 and 100 inclusive  
ERROR 5437: Vertica should not be run with less than 1GB of RAM  
ERROR 5520: *string* compresses network traffic. *string* does NOT compress network traffic. Please change the configuration to be consistent

ERROR 5521: *string* does NOT compresses network traffic. *string* compresses network traffic. Please change the configuration to be consistent

ERROR 5538: Cannot COPY user-defined types directly. Please compute them using copy expressions

ERROR 5542: Cannot INSERT or COPY user-defined types directly. Please compute them using appropriate user-defined functions

ERROR 5545: Cluster layout must include all non-ephemeral nodes and should also not include any ephemeral nodes

ERROR 5549: Conversion from *string* to DataType *string* failed. Invalid value

ERROR 5571: Empty storage tier label is not allowed

ERROR 5576: Every non-ephemeral node should only be listed once

ERROR 5598: Invalid or unavailable type 'LONG VARBINARY'

ERROR 5599: Invalid or unavailable type 'LONG VARCHAR'

ERROR 5605: Invalid projection createtype '*string*'

ERROR 5613: Length for type *string* must be between 1 and *value*

ERROR 5631: Object *string* does not exist or is not of supported type

ERROR 5632: Object *string* is not a table

ERROR 5634: Path [*string*] is a directory

ERROR 5644: Projection basename "*string*" is not a prefix of projection name "*string*"

ERROR 5645: Projection basename cannot be empty

ERROR 5646: Projection createtype cannot be empty

ERROR 5647: Provided Node "*string*" does not exist

ERROR 5648: Provided Node "*string*" is ephemeral

ERROR 5668: Target table name can not be empty

ERROR 5685: User Defined Filter expected but found *string*

ERROR 5686: User Defined Parser expected but found *string*

ERROR 5687: User Defined Source expected but found *string*

ERROR 5693: Using 1 year for QUEUETIMEOUT

ERROR 5703: Couldn't find the specified task, or the Resource Manager has not received the request

ERROR 5728: Specified too many widths (*value*) for the given number of columns (*value*)

**Note:** The **myVertica** (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 22025

This topic lists the error associated with the SQLSTATE value 22025. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 22025 Description

ERRCODE\_INVALID\_ESCAPE\_SEQUENCE

#### Error messages associated with this SQLState

ERROR 3656: Invalid escape sequence

ERROR 3657: Invalid escape string

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 22906

This topic lists the error associated with the SQLSTATE value 22906. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 22906 Description

ERRCODE\_NONSTANDARD\_USE\_OF\_ESCAPE\_CHARACTER

#### Error messages associated with this SQLState

ERROR 4166: Nonstandard use of \' in a string literal at or near "string"

ERROR 4167: Nonstandard use of \\ in a string literal at or near "string"

ERROR 4168: Nonstandard use of escape in a string literal at or near "string"

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 22V02

This topic lists the error associated with the SQLSTATE value 22V02. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 22V02 Description

ERRCODE\_INVALID\_TEXT REPRESENTATION

#### Error messages associated with this SQLState

ERROR 2825: Could not convert "string" to a boolean

ERROR 2826: Could not convert "string" to a float8

```
ERROR 2827: Could not convert "string" to an int8
ERROR 3677: Invalid input for string: "string"
ERROR 3680: Invalid input syntax for boolean: "string"
ERROR 3681: Invalid input syntax for integer: "string"
ERROR 3682: Invalid input syntax for numeric: "value"
ERROR 3711: Invalid number: "string"
ERROR 3712: Invalid numeric format string
ERROR 3714: Invalid numeric value: "string"
ERROR 3751: Invalid Session ID format
ERROR 3757: Invalid syntax for float: "string"
ERROR 3758: Invalid syntax for numeric: "string"
ERROR 3894: Malformed record literal: "string"
ERROR 4169: Not a number: "string"
ERROR 4198: Number exceeds format: "string"
```

**Note:** The **myVertica** (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 22V03

This topic lists the error associated with the SQLSTATE value 22V03. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 22V03 Description

ERRCODE\_INVALID\_BINARY REPRESENTATION

### Error messages associated with this SQLState

```
ERROR 2829: Could not convert integer valuestring to a boolean
ERROR 3536: Incorrect binary data format in bind parameter value
ERROR 3623: Invalid binary input syntax: 'value'
ERROR 3624: Invalid bitstring "string"
ERROR 3648: Invalid default string format "string"
ERROR 3671: Invalid hex string "string"
ERROR 3678: Invalid input syntax for string
ERROR 3716: Invalid octal string format "string"
ERROR 3717: Invalid octal string format (octal string length
ERROR 5416: Value too long for type string(value)
```

**Note:** The **myVertica** (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 22V04

This topic lists the error associated with the SQLSTATE value 22V04. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 22V04 Description

ERRCODE\_BAD\_COPY\_FILE\_FORMAT

#### Error messages associated with this SQLState

```
ERROR 2006: string value records have been rejected
ERROR 2031: string Header size (value) is corrupted
ERROR 2032: string Header size (value) is too small
ERROR 2035: string Input record value has been rejected (string)
ERROR 2053: string Row size (value) is corrupted
ERROR 2054: string Unexpected EOF while reading header. Expected value but read
 value
ERROR 2738: COPY file signature not recognized
ERROR 2767: COPY: Wrong Header size value. Expected value
ERROR 3562: Input has extra trailing bytes
ERROR 3640: Invalid COPY file header (unsupported Version Number)
ERROR 4206: Number of fields is value, expected value
ERROR 4627: Row delimiter not found; corrupt file input (read value bytes from
 input)
ERROR 5495: Wrong size value for bool column value (string)
ERROR 5496: Wrong size value for date column value (string)
ERROR 5497: Wrong size value for float column value (string)
ERROR 5498: Wrong size value for integer column value (string)
ERROR 5499: Wrong size value for Interval column value (string)
ERROR 5500: Wrong size value for Numeric column value (string)
ERROR 5501: Wrong size value for Time column value (string)
ERROR 5502: Wrong size value for Timestamp column value (string)
ERROR 5503: Wrong size value for TimestampTz column value (string)
ERROR 5504: Wrong size value for TimeTz column value (string)
```

**Note:** The **myVertica** (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 22V0B

This topic lists the error associated with the SQLSTATE value 22V0B. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 22V0B Description

ERRCODE\_ESCAPE\_CHARACTER\_ON\_NOESCAPE

#### Error messages associated with this SQLState

ERROR 2746: COPY NO ESCAPE cannot also contain an ESCAPE clause

ERROR 2747: COPY NO ESCAPE for column *string* cannot also contain an ESCAPE clause

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 22V21

This topic lists the error associated with the SQLSTATE value 22V21. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 22V21 Description

ERRCODE\_INVALID\_EPOCH

#### Error messages associated with this SQLState

ERROR 2144: AHM can't advance past the cluster last backup epoch. (Last Backup Epoch: *value*)

ERROR 2145: AHM can't advance past the cluster last backup time. (Last Backup time: *string*)

ERROR 2146: AHM can't advance past the cluster last good epoch (LGE) time (Cluster LGE time: *string*)

ERROR 2147: AHM can't advance past the cluster last good epoch (LGE). (Cluster LGE: *value*)

ERROR 2148: AHM can't advance past the latest epoch time (Latest epoch time: *string*)

ERROR 2153: AHM must be less than the current epoch (Current Epoch: *value*)

ERROR 2154: AHM must lag behind the create epoch of unrefreshed projection "*string*" (Create epoch: *value*)

ERROR 2155: AHM must lag behind the create time of unrefreshed projection "*string*" (Create time: *string*)

ERROR 2318: Can't run historical queries at epochs prior to the Ancient History Mark

ERROR 3184: Epoch specified is not in historical epoch range

ERROR 3559: Input epoch must be greater than or equal to the earliest epoch (earliest epoch: value)

ERROR 3560: Input epoch must be greater than the current AHM (Current AHM: value)

ERROR 3561: Input epoch must be less than or equal to the AHM epoch (AHM epoch: value)

ERROR 3567: Input time can't be rounded down to an epoch higher than the current AHM epoch (Current AHM epoch: value, Current AHM time: string)

ERROR 3568: Input time must be greater than or equal to the earliest epoch time (Earliest epoch time: string)

ERROR 3569: Input time must be greater than the current AHM time (Current AHM time: string)

ERROR 3570: Input time must be less than or equal to the AHM epoch time (AHM epoch time: string)

ERROR 3654: Invalid epoch

ERROR 3844: Last good epoch not set

ERROR 3926: MergeOut start epoch (=value) greater than end epoch (=value)

ERROR 4940: The current AHM is already value

ERROR 5013: Time specified is not in historical epoch range

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 22V23

This topic lists the error associated with the SQLSTATE value 22V23. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 22V23 Description

ERRCODE\_RAISE\_EXCEPTION

### Error messages associated with this SQLState

ERROR 3872: Load Stack has been corrupted! Expected a Source (or subclass); got a string

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 22V24

This topic lists the error associated with the SQLSTATE value 22V24. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

## SQLSTATE 22V24 Description

ERRCODE\_COPY\_PARSE\_ERROR

### Error messages associated with this SQLState

ERROR 2518: Cannot set trailing column to NULL as column value (*string*) is NOT NULL  
ERROR 3401: Field size (*value*) is corrupted for column value (*string*)  
ERROR 3402: Field size (*value*) is corrupted for column value (*string*). It does not fit within the row  
ERROR 3565: Input numeric value OUT OF RANGE for column value (*string*)  
ERROR 3588: int8 out of range '*string*' for column value (*string*)  
ERROR 3617: Invalid *string* value '*string*' for column value (*string*).*string*  
ERROR 3625: Invalid boolean format '*string*' for column value (*string*)  
ERROR 3643: Invalid date format '*string*' for column value (*string*)  
ERROR 3644: Invalid date format '*string*' for column value (*string*).*string*  
ERROR 3665: Invalid float format '*string*' for column value (*string*)  
ERROR 3666: Invalid float format '*string*' for column value (*string*):No digits were found  
ERROR 3683: Invalid integer format '*string*' for column value (*string*)  
ERROR 3684: Invalid integer format '*string*' for column value (*string*):No digits were found  
ERROR 3685: Invalid interval format '*string*' for column value (*string*).*string*  
ERROR 3713: Invalid numeric format '*string*' for column value (*string*)  
ERROR 3763: Invalid time format '*string*' for column value (*string*).*string*  
ERROR 3764: Invalid timestamp format '*string*' for column value (*string*).*string*  
ERROR 3765: Invalid timestamptz format '*string*' for column value (*string*).*string*  
ERROR 3766: Invalid timetz format '*string*' for column value (*string*).*string*  
ERROR 3784: Invalid value '*string*' for column value (*string*).*string*  
ERROR 4196: Null value for NOT NULL column value (*string*)  
ERROR 4209: Numeric out of range '*string*' for column value (*string*)  
ERROR 4749: Size value too large for Binary/Varbinary column value (*string*)  
ERROR 4750: Size value too large for Char/Varchar column value (*string*)  
ERROR 4924: The value-byte value is too long for type string(*value*), column value (*string*)  
ERROR 5017: Time value *value* microseconds OUT OF RANGE for column value (*string*)  
ERROR 5018: Time value *value* OUT OF RANGE for column value (*string*)  
ERROR 5040: Timezone value secs OUT OF RANGE for column value (*string*)  
ERROR 5053: Too few columns found

ERROR 5059: Too many columns found

**Note:** The *myVertica* (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 23502

This topic lists the error associated with the SQLSTATE value 23502. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 23502 Description

ERRCODE\_NOT\_NULL\_VIOLATION

#### Error messages associated with this SQLState

ERROR 2416: Cannot drop NOT NULL constraint on column "string" when it is referenced in PARTITION BY expression

ERROR 2417: Cannot drop NOT NULL constraint on column "string" when it is referenced in primary key constraint

ERROR 2623: Column "string" definition changed to NOT NULL

ERROR 4182: NOT NULL constraint on column "string" already exists

ERROR 4183: NOT NULL constraint on column "string" does not exist

**Note:** The *myVertica* (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 23503

This topic lists the error associated with the SQLSTATE value 23503. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 23503 Description

ERRCODE\_FOREIGN\_KEY\_VIOLATION

#### Error messages associated with this SQLState

ERROR 4165: Nonexistent foreign key value detected in FK-PK join [string]; value [string]

**Note:** The *myVertica* (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 23505

This topic lists the error associated with the SQLSTATE value 23505. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

## SQLSTATE 23505 Description

ERRCODE\_UNIQUE\_VIOLATION

### Error messages associated with this SQLState

ERROR 3147: Duplicate MERGE key detected in join [string]; value [string]

ERROR 3149: Duplicate primary/unique key detected in join [string]; value [string]

ERROR 4840: Subquery used as an expression returned more than one row

**Note:** The *myVertica* (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 25V01

This topic lists the error associated with the SQLSTATE value 25V01. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

## SQLSTATE 25V01 Description

ERRCODE\_NO\_ACTIVE\_SQL\_TRANSACTION

### Error messages associated with this SQLState

ERROR 2342: Cannot advance epoch without a transaction

**Note:** The *myVertica* (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 28000

This topic lists the error associated with the SQLSTATE value 28000. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

## SQLSTATE 28000 Description

ERRCODE\_INVALID\_AUTHORIZATION\_SPECIFICATION

### Error messages associated with this SQLState

ERROR 2701: Conflicting, redundant or unsupported option: string

ERROR 2702: Conflicting, redundant or unsupported option: groupElts

ERROR 2959: Current user cannot be dropped

ERROR 4293: Option "string" not recognized

ERROR 4722: Session user cannot be dropped

ERROR 4846: Superuser cannot be dropped

ERROR 5387: User does not exist

**Note:** The *myVertica* (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 2BV01

This topic lists the error associated with the SQLSTATE value 2BV01. See *HP Vertica SQLSTATE List* (page [609](#)) for more information.

### SQLSTATE 2BV01 Description

ERRCODE\_DEPENDENT\_OBJECTS\_STILL\_EXIST

### Error messages associated with this SQLState

ERROR 3052: Dependent privileges exist

ERROR 3128: DROP failed due to dependencies

ERROR 3130: DROP PROFILE failed due to dependencies

ERROR 3131: DROP ROLE failed due to dependencies

**Note:** The *myVertica* (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 40V01

This topic lists the error associated with the SQLSTATE value 40V01. See *HP Vertica SQLSTATE List* (page [609](#)) for more information.

### SQLSTATE 40V01 Description

ERRCODE\_T\_R\_DEADLOCK\_DETECTED

### Error messages associated with this SQLState

ERROR 3010: Deadlock: *string - string*

ERROR 3011: Deadlock: [Txn value] *string - string* error *string*

**Note:** The *myVertica* (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42501

This topic lists the error associated with the SQLSTATE value 42501. See *HP Vertica SQLSTATE List* (page [609](#)) for more information.

### SQLSTATE 42501 Description

ERRCODE\_INSUFFICIENT\_PRIVILEGE

## **Error messages associated with this SQLState**

```
ERROR 2065: string: Invalid table/projection/column string
ERROR 2198: analyze_statistics: Requires modify permissions for
 table/projection/column string
ERROR 2347: Cannot alter predefined role "string"
ERROR 2348: Cannot alter superuser string's default roles
ERROR 2349: Cannot alter superuser roles
ERROR 2389: Cannot create system built-in tuning rule
ERROR 2419: Cannot drop system built-in tuning rule
ERROR 2460: Cannot move user string to general pool, they lack privileges
ERROR 2481: Cannot remove memoryCap
ERROR 2482: Cannot remove runTimeCap
ERROR 2484: Cannot remove tempSpaceCap
ERROR 2515: Cannot set resource pool: user string lacks privileges on resource pool
 string
ERROR 2812: Could not add location [string]: Permission denied
ERROR 2935: Couldn't nice(value) thread: value
ERROR 2953: Current password must be supplied to set new password
ERROR 2958: Current user can't change runtime priority of another user's task
ERROR 2960: Current user doesn't have the privilege to change the task runtime
 priority to be higher than its resource pool
ERROR 3577: Insufficient permissions on projection "string"
ERROR 3578: Insufficient permissions on schema "string"
ERROR 3579: Insufficient permissions on table "string"
ERROR 3580: Insufficient privilege: USAGE on SCHEMA 'string' not granted for
 current user
ERROR 3581: Insufficient privileges for projection string
ERROR 3582: Insufficient privileges for table string
ERROR 3583: Insufficient privileges on string
ERROR 3584: Insufficient privileges on string, modify privileges
 (INSERT|UPDATE|DELETE) needed
ERROR 3585: Insufficient privileges to populate statistics for projection string
ERROR 3722: Invalid passphrase: string
ERROR 3919: memoryCap of value KB would exceed user limit of value KB
ERROR 3989: Must be owner of string string
ERROR 3990: Must be owner of string [string]
ERROR 3991: Must be superuser to alter database
```

ERROR 3992: Must be superuser to alter profile  
ERROR 3993: Must be superuser to alter tuning rule  
ERROR 3994: Must be superuser to alter user default roles  
ERROR 3995: Must be superuser to audit license size  
ERROR 3996: Must be superuser to audit license term  
ERROR 3997: Must be superuser to change export address field  
ERROR 3998: Must be superuser to clear Query/EE profiles  
ERROR 3999: Must be superuser to crash the database  
ERROR 4000: Must be superuser to create interface  
ERROR 4001: Must be superuser to create library  
ERROR 4002: Must be superuser to create profile  
ERROR 4003: Must be superuser to create subnet  
ERROR 4004: Must be superuser to create tuning rule  
ERROR 4005: Must be superuser to create users  
ERROR 4006: Must be superuser to drop an interface  
ERROR 4007: Must be superuser to drop library  
ERROR 4008: Must be superuser to drop profile  
ERROR 4009: Must be superuser to drop resource pool  
ERROR 4010: Must be superuser to drop role  
ERROR 4011: Must be superuser to drop subnet  
ERROR 4012: Must be superuser to drop tuning rule  
ERROR 4013: Must be superuser to drop users  
ERROR 4014: Must be superuser to modify resource pools  
ERROR 4015: Must be superuser to rename interface  
ERROR 4016: Must be superuser to rename profile  
ERROR 4017: Must be superuser to rename role  
ERROR 4018: Must be superuser to rename subnet  
ERROR 4019: Must be superuser to run *string*  
ERROR 4020: Must be superuser to run *analyze\_workloadstring()*  
ERROR 4059: New runTimeCap value ms would exceed user limit of value ms  
ERROR 4061: New tempSpaceCap value KB would exceed user limit of value KB  
ERROR 4178: Not enough privileges for projection *string*  
ERROR 4179: Not enough privileges for table *string*  
ERROR 4244: Only database superuser can drop procedures  
ERROR 4260: Only superuser can check privileges on other users

```
ERROR 4261: Only superuser can create roles
ERROR 4269: Only the database super user can create procedures
ERROR 4366: Permission denied
ERROR 4367: Permission denied for string string
ERROR 4368: Permission denied for string [string]
ERROR 4369: Permission denied to create temporary tables
ERROR 4370: Permission denied: "string" is a system catalog
ERROR 4453: Projection string already has statistics
ERROR 4546: RecvFiles on string: Can't write to file [string]
ERROR 4741: setThreadCPUNiceValue: couldn't nice(value) thread: value
ERROR 4742: setThreadIONiceValue: couldn't ionice(value) thread: value
ERROR 5149: Unable to set role "string"
ERROR 5389: User has insufficient privileges on schema string
ERROR 5458: We do not populate statistics for prejoin projections
ERROR 5488: Workspace schema string does not exist
ERROR 5517: Your Vertica license is invalid or has expired
ERROR 5618: Must be superuser to alter fault group
ERROR 5619: Must be superuser to create fault group
ERROR 5620: Must be superuser to drop fault group
ERROR 5622: Must be superuser to use remote_file_copy
ERROR 5635: Path to file [string] contains a symbolic link
ERROR 5715: Must be superuser to close_all_sockets
ERROR 5716: Must have create permissions in schema string to drop type
```

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42601

This topic lists the error associated with the SQLSTATE value 42601. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### **SQLSTATE 42601 Description**

**ERRCODE\_SYNTAX\_ERROR**

### **Error messages associated with this SQLState**

```
ERROR 2030: string has been deprecated as string string Vertica option
ERROR 2069: 'string' is not a table name in the current search_path
```

ERROR 2085: A column cannot occur in an equality predicate and an interpolation predicate

ERROR 2086: A column definition list is only allowed for functions that return "record"

ERROR 2087: A column definition list is required for functions returning "record"

ERROR 2093: A join can have only one set of interpolated predicates

ERROR 2100: A query with Time Series Aggregate Function *string* must have a timeseries clause

ERROR 2156: All columns are evaluated by expressions. At least one column should be read from input

ERROR 2157: All columns in select list must be columns used by projection

ERROR 2164: Alter Column Type driver: Unrecognized command type

ERROR 2180: Analytic function *string* must have an OVER clause

ERROR 2191: ANALYZE CONSTRAINT is not supported

ERROR 2203: Anchor table not found

ERROR 2214: Argument *value* has invalid type *value* in ANALYZE\_WORKLOAD

ERROR 2215: Argument *value* in ANALYZE\_WORKLOAD must be constant

ERROR 2223: Argument in ANALYZE\_CONSTRAINTS must be constant

ERROR 2230: Arguments of row IN must all be row expressions

ERROR 2238: At least two arguments are required

ERROR 2239: At most one path number can be entered

ERROR 2346: Cannot alter a sequence with START

ERROR 2374: Cannot compare row expressions of zero length

ERROR 2381: Cannot create a sequence with RESTART

ERROR 2444: Cannot insert into or update IDENTITY/AUTO\_INCREMENT column "*string*"

ERROR 2445: Cannot insert into system column "*string*"

ERROR 2446: Cannot insert multiple commands into a prepared statement

ERROR 2521: Cannot specify anything other than user defined transforms *string* in the *string* list

ERROR 2525: Cannot specify more than one user-defined transform function in the SELECT list

ERROR 2526: Cannot specify more than one window clause with a user defined transform

ERROR 2534: Cannot use "PR" with "S"/"PL"/"MI"/"SG"

ERROR 2535: Cannot use "S" with "MI"

ERROR 2536: Cannot use "S" with "PL"

ERROR 2537: Cannot use "S" with "PL"/"MI"/"SG"/"PR"

ERROR 2538: Cannot use "S" with "SG"

ERROR 2539: Cannot use "V" with a decimal point  
ERROR 2545: Cannot use aggregate function in VALUES  
ERROR 2627: Column "*string*" in ENCODED BY clause is not found in the table  
ERROR 2641: Column "*string.string*" must appear in the PARTITION BY list of Timeseries clause or be used in a Time Series Aggregate Function  
ERROR 2642: Column *string* cannot be evaluated  
ERROR 2645: Column *string* has other computed columns in its expression  
ERROR 2647: Column *string* in ORDER BY list is not found in TABLE  
ERROR 2659: Column alias list for "*string*" has too many entries  
ERROR 2669: COLUMN OPTION is not supported  
ERROR 2670: Column options are not supported  
ERROR 2696: Conflicting INTERVAL subtypes  
ERROR 2697: Conflicting NULL/NOT NULL declarations for column "*string*" of table "*string*"  
ERROR 2715: Constraint declared INITIALLY DEFERRED must be DEFERRABLE  
ERROR 2754: COPY requires a data source; either a FROM clause or a WITH SOURCE for a user-defined source  
ERROR 2764: COPY: Expression for column *string* cannot be coerced  
ERROR 2946: CREATE TABLE AS specifies too many column names  
ERROR 2947: CREATE VIEW specifies more column names than columns  
ERROR 2986: Database name is required (too few dotted names): *string*  
ERROR 3023: Default values specified for IDENTITY/AUTO\_INCREMENT column "*string*" of table "*string*"  
ERROR 3125: Drop Column driver: Unrecognized command type  
ERROR 3142: Duplicate column "*string*" in create table statement  
ERROR 3143: Duplicate column *string* in constraint  
  
ERROR 3146: Duplicate columns in select list of projection not allowed  
ERROR 3151: Duplicate tables in projection not allowed  
ERROR 3155: Duplicated parameters *string* not allowed  
ERROR 3158: Each *string* query must have the same number of columns  
ERROR 3164: Empty column name is invalid  
ERROR 3165: Empty constraint name is invalid  
ERROR 3171: ENCODED BY is not supported in CREATE PROJECTION statement when column renaming list is defined  
ERROR 3172: ENCODED BY is not supported in CREATE PROJECTION statement with column definition list

ERROR 3173: ENCODED BY is not supported in CREATE TABLE AS SELECT statement when column list is defined

ERROR 3176: End epoch (*value*) number out of range

ERROR 3177: End epoch (*value*) precedes start epoch (*value*)

ERROR 3183: Epoch number out of range

ERROR 3185: Epoch time out of range

ERROR 3261: Error setting *string* in *string*: Unknown Property

ERROR 3262: Error setting basic directives: '*string*'

ERROR 3263: Error setting designer directives: '*string*'

ERROR 3264: Error setting optimizer directives: '*string*'

ERROR 3344: EXPORT ... SELECT may not specify INTO

ERROR 3348: Expression "(<*string*> - <*string*>) <interval qualifier>" is not supported

ERROR 3349: Expression for column *string* cannot be coerced

ERROR 3458: Function *string* is not allowed in Time Series queries

ERROR 3461: Function *string* requires at least one argument

ERROR 3487: Group by is not allowed in a projection

ERROR 3500: HAVING / GROUP BY not allowed with Time Series query

ERROR 3511: IGNORE NULLS can only be used with FIRST\_VALUE or LAST\_VALUE

ERROR 3517: Improper %%TYPE reference (too few dotted names): *string*

ERROR 3518: Improper %%TYPE reference (too many dotted names): *string*

ERROR 3519: Improper qualified column name: *string*

ERROR 3520: Improper qualified name (too many dot): *string*

ERROR 3521: Improper qualified name (too many dots): *string*

ERROR 3522: Improper qualified name (too many dotted names): *string*

ERROR 3523: Improper relation name (too many dotted names): *string*

ERROR 3538: Incorrect parameter type provided: *string* is supposed to be of type *string*

ERROR 3548: Indirection is not allowed in a target column

ERROR 3549: Indirection is not allowed in the name of a FILLER column

ERROR 3571: INSERT ... SELECT may not specify INTO

ERROR 3572: INSERT has more expressions than target columns

ERROR 3573: INSERT has more target columns than expressions

ERROR 3599: Interpolated predicates are allowed only in ON CLAUSE of ANSI Join syntax

ERROR 3602: Interpolated predicates should refer to columns from both relations of the join

ERROR 3603: INTERPOLATED predicates should refer to columns from both relations of the join  
ERROR 3615: INTO is only allowed on first SELECT of UNION/INTERSECT/EXCEPT  
ERROR 3619: Invalid argument type value in ANALYZE\_CONSTRAINTS  
ERROR 3672: Invalid hexadecimal number at or near "string"  
ERROR 3706: Invalid node name in hint  
ERROR 3709: Invalid number at or near "string"  
ERROR 3738: Invalid projection name in hint: *string*  
ERROR 3775: Invalid Unicode escape character '*character*'  
ERROR 3776: Invalid Unicode hex number "string"  
ERROR 3812: Join condition in merge query must include at least one table attribute  
ERROR 3841: Label can accept only one argument  
ERROR 3865: LIMIT #,# syntax is not supported  
ERROR 3944: Misplaced DEFERRABLE clause  
ERROR 3945: Misplaced INITIALLY DEFERRED clause  
ERROR 3946: Misplaced INITIALLY IMMEDIATE clause  
ERROR 3947: Misplaced NOT DEFERRABLE clause  
ERROR 3949: Missing argument  
ERROR 3958: Missing savepoint name  
ERROR 3959: Missing the path number  
ERROR 3976: Multiple assignments to same column "string"  
ERROR 3978: Multiple decimal points  
ERROR 3979: Multiple default values specified for column "string" of table "string"  
ERROR 3980: Multiple DEFERRABLE/NOT DEFERRABLE clauses not allowed  
ERROR 3981: Multiple FOR UPDATE clauses are not allowed  
ERROR 3982: Multiple INITIALLY IMMEDIATE/DEFERRED clauses not allowed  
ERROR 3984: Multiple LIMIT clauses are not allowed  
ERROR 3985: Multiple OFFSET clauses are not allowed  
ERROR 3986: Multiple ORDER BY clauses are not allowed  
ERROR 4023: Must specify memorySize parameter  
ERROR 4024: Must specify one new name for each schema  
ERROR 4025: Must specify one new name for each table  
ERROR 4026: Must specify one new name for each view  
ERROR 4062: NEW used in query that is not in a rule  
ERROR 4066: No actions specified  
ERROR 4070: No columns specified in select list

ERROR 4072: No constraints defined  
ERROR 4105: No second argument needed when analyzing all constraints  
ERROR 4161: Non-integer constant in *string*  
ERROR 4164: Nonexistent columns: '*string*'  
ERROR 4203: Number of columns defined in CREATE TABLE statement is less than in SELECT query output  
ERROR 4204: Number of columns defined in CREATE TABLE statement is more than in SELECT query output  
ERROR 4205: Number of columns in the PROJECTION statement must be the same as the number of columns in the SELECT statement  
ERROR 4225: OLD used in query that is not in a rule  
ERROR 4227: ON COMMIT clause may only be specified for TEMPORARY tables  
ERROR 4237: Only a single "S" is allowed  
ERROR 4239: Only ASC is allowed in ORDER BY list of auto projection for CREATE TABLE  
ERROR 4240: Only columns are allowed in ORDER BY list of auto projection for CREATE TABLE  
ERROR 4241: Only columns are allowed in SELECT list of projection  
ERROR 4247: Only inner joins are allowed in a projection defining query  
ERROR 4253: Only one table allowed  
ERROR 4268: Only tables are allowed in FROM clause of projection  
ERROR 4291: Operator too long at or near "*string*"  
ERROR 4294: Option *string* conflicts with prior options  
ERROR 4296: Options not set  
ERROR 4297: ORDER BY column in timeseries OVER clause must be Timestamp type  
ERROR 4325: Parameters can only contain constants or constant expressions  
ERROR 4327: Parsing error "*string*" at or near "*string*"  
ERROR 4328: PARTITION AUTO can only be used with single-phase user defined transform functions  
ERROR 4348: Path Number must be in [ 0, value ]  
ERROR 4350: Pattern "0" must come before "PR"  
ERROR 4351: Pattern "9" must come before "PR"  
ERROR 4383: plannedConcurrency must be greater than 0  
ERROR 4487: Projections can only be sorted in ascending order  
ERROR 4629: Row expressions being compared must have the same number of entries  
ERROR 4669: SELECT \* with no tables specified is not valid  
ERROR 4670: SELECT DISTINCT ON is not standard SQL, use just SELECT DISTINCT  
ERROR 4706: Sequence functions accept constant strings arguments only

ERROR 4707: Sequence Manipulation functions are allowed in OUTER SELECT LIST only  
and cannot be in SELECT LIST of a WITH clause

ERROR 4732: Set Operators are not allowed in a projection

ERROR 4761: Sort key *string* should be in the target list

ERROR 4814: Subqueries in a MERGE statement are not allowed

ERROR 4815: Subqueries in MERGE statement are not allowed

ERROR 4828: Subquery has too few columns

ERROR 4829: Subquery has too many columns

ERROR 4831: Subquery in FROM may not have SELECT INTO

ERROR 4833: Subquery in FROM must have an alias

ERROR 4835: Subquery must return a column

ERROR 4836: Subquery must return only one column

ERROR 4837: Subquery not allowed in a projection

ERROR 4838: Subquery not allowed in SELECT list and/or ORDER BY clause for Time Series queries

ERROR 4855: Syntactic Optimizer requires joins written using ANSI JOIN syntax

ERROR 4856: Syntax error at or near "*string*"

ERROR 4947: The foreign key in this constraint has already been defined as a foreign key for relation "*string*"

ERROR 4955: The number of target columns (*value*) does not match the number of columns (*value*) in the EXPORT statement

ERROR 4956: The number of target columns (*value*) is less than the number of columns (*value*) in the EXPORT statement

ERROR 5007: Time Series Aggregate Functions cannot be nested

ERROR 5008: Time Series queries cannot refer to column of outer query

ERROR 5009: Time Series queries cannot refer to column of outer query:  
"*string.string*"

ERROR 5011: Time slice length must be a positive integer constant

ERROR 5012: Time slice length must be an interval constant

ERROR 5161: Unequal number of entries in row expression

ERROR 5162: Unequal number of entries in row expressions

ERROR 5272: Unsupported From clause expression

ERROR 5285: Unsupported SET option

ERROR 5286: Unsupported SET option *string*

ERROR 5287: Unsupported SHOW option *string*

ERROR 5290: Unsupported transaction option *string*

ERROR 5305: Unterminated /\* comment at or near "*string*"

ERROR 5306: Unterminated bit string literal at or near "string"  
ERROR 5307: Unterminated dollar-quoted string at or near "string"  
ERROR 5308: Unterminated hexadecimal string literal at or near "string"  
ERROR 5310: Unterminated quoted identifier at or near "string"  
ERROR 5311: Unterminated quoted string at or near "string"  
ERROR 5323: Usage: clear\_profiling( *string* , *string* )  
ERROR 5324: Usage: disable\_profiling( *string* )  
ERROR 5325: Usage: enable\_profiling( *string* )  
ERROR 5326: Use "string(\*)" to call this aggregate function  
ERROR 5383: User Defined Transform Functions are allowed only in a SELECT list  
ERROR 5386: User defined transform will return value columns, whereas value aliases provided  
ERROR 5401: User-defined transform function *string* must have an OVER clause  
ERROR 5413: Value must be either "units" or "plain"  
ERROR 5414: Value must be either on or off  
ERROR 5415: Value must be either ON or OFF  
ERROR 5452: Virtual tables are not allowed in FROM clause of projection  
ERROR 5492: Wrong number of parameters for prepared statement "string"  
ERROR 5493: Wrong number of parameters on left side of OVERLAPS expression  
ERROR 5494: Wrong number of parameters on right side of OVERLAPS expression  
ERROR 5505: You can specify a node name only once in a create projection statement,  
node *string* appears more than once  
ERROR 5518: Zero-length delimited identifier at or near "string"  
ERROR 5524: A projection can have only one basename  
ERROR 5525: A projection can have only one createtype  
ERROR 5566: Dimension tables may not have data that shorter lived than the fact  
table  
ERROR 5577: Expression for user-defined type column *string* cannot be coerced  
ERROR 5600: Invalid predicate in projection-select. Only PK=FK equijoins are  
allowed  
ERROR 5617: Multiple WITH clauses not allowed  
ERROR 5629: Not a Star or Snow-Flake Query  
ERROR 5630: Nullable FKs are not allowed in projection definition  
ERROR 5651: Recursive With is not supported  
ERROR 5664: Subqueries not allowed in projection definition  
ERROR 5665: Subquery in MERGE is not supported

ERROR 5670: The number of alias columns must be the same as the number of selected columns  
ERROR 5691: User-defined function *string* is not a supported scalar function  
ERROR 5696: WITH query name "*string*" specified more than once  
ERROR 5711: Invalid function arguments  
ERROR 5714: Missing the random seed  
ERROR 5730: The second argument, sampling method, should be always be 1 -- naive sampling(biased)  
ERROR 5733: The third argument must be large than 0  
ERROR 5734: Three arguments at most: sampling seed, sampling method (optional, default 1), sampling size (optional, default 10)

**Note:** The **myVertica** (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42602

This topic lists the error associated with the SQLSTATE value 42602. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 42602 Description

ERRCODE\_INVALID\_NAME

### Error messages associated with this SQLState

ERROR 2383: Cannot create projections due to naming conflicts with existing projections  
ERROR 2398: Cannot determine the best encoding options for some columns in table *string.string* due to insufficient data  
ERROR 3059: DEPRECATED syntax. Segment expression "*string*" is a projection column name, segmenting on attribute "*string*" instead  
ERROR 3378: Failed to generate a unique relation or sequence name  
ERROR 3674: Invalid identifier name (value octets) "*string*"  
ERROR 3703: Invalid name syntax  
ERROR 3747: Invalid savepoint identifier *string*  
ERROR 4159: Non-ASCII characters in names are prohibited  
ERROR 4267: Only table column names & filler column names can appear in the list  
ERROR 4451: Projection "*string*" does not exist  
ERROR 4506: Query weight must be positive  
ERROR 5360: User "*string*" does not exist  
ERROR 5403: User/role "*string*" already exists

ERROR 5569: Either column "string" does not exist or table alias "string" is not allowed in "WHEN MATCHED THEN UPDATE SET"

ERROR 5710: Invalid column expression in COPY column list

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42611

This topic lists the error associated with the SQLSTATE value 42611. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 42611 Description

ERRCODE\_INVALID\_COLUMN\_DEFINITION

### Error messages associated with this SQLState

ERROR 2506: Cannot set default for column "string" since it is referenced in default expression of column "string"

ERROR 3017: Default expression for column "string" may not refer to itself

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42622

This topic lists the error associated with the SQLSTATE value 42622. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 42622 Description

ERRCODE\_NAME\_TOO\_LONG

### Error messages associated with this SQLState

ERROR 2462: Cannot open FileColumn because path is too long string

ERROR 3507: Identifier "string" is value octets long. Maximum limit is value octets

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42701

This topic lists the error associated with the SQLSTATE value 42701. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

## SQLSTATE 42701 Description

ERRCODE\_DUPLICATE\_COLUMN

### Error messages associated with this SQLState

ERROR 2629: Column "string" is already of type "string"  
ERROR 2638: Column "string" specified more than once  
ERROR 2654: Column *string* specified more than once  
ERROR 2655: Column *string* specified more than once in options list  
ERROR 2662: Column name "string" already exists  
ERROR 2663: Column name "string" appears more than once in USING clause  
ERROR 2664: Column name "string" does not exist  
ERROR 3144: Duplicate column *string* in ORDER BY list  
ERROR 3145: Duplicate column name  
ERROR 3150: Duplicate projection column name (projection: *string*)  
ERROR 3154: Duplicated parameter "string" in parameter list  
ERROR 5450: View definition can not contain duplicate column names "string"

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42702

This topic lists the error associated with the SQLSTATE value 42702. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

## SQLSTATE 42702 Description

ERRCODE\_AMBIGUOUS\_COLUMN

### Error messages associated with this SQLState

ERROR 2604: Clause *string* "string" is ambiguous  
ERROR 2671: Column reference "string" is ambiguous  
ERROR 2681: Common column name "string" appears more than once in left table  
ERROR 2682: Common column name "string" appears more than once in right table

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42703

This topic lists the error associated with the SQLSTATE value 42703. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

**SQLSTATE 42703 Description**

ERRCODE\_UNDEFINED\_COLUMN

**Error messages associated with this SQLState**

ERROR 2359: Cannot assign to field "string" of column "string" because there is no such column in data type *string*

ERROR 2625: Column "string" does not exist;  
Vertica does not support 'SELECT <table\_name> FROM <table\_name>'

ERROR 2633: Column "string" named as primary key does not exist

ERROR 2634: Column "string" not found in data type *string*

ERROR 2635: Column "string" of relation "string" does not exist

ERROR 2636: Column "string" specified in USING clause does not exist in left table

ERROR 2637: Column "string" specified in USING clause does not exist in right table

ERROR 2639: Column "string"."string" does not exist as a projection column

ERROR 2643: Column *string* does not exist

ERROR 2644: Column *string* does not exist in table

ERROR 2651: Column *string* must be loaded or computed

ERROR 2656: Column *string.string* does not exist

ERROR 2870: Could not identify column "string" in record data type

**Note:** The *myVertica* (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

**Error Messages Associated with SQLSTATE 42704**

This topic lists the error associated with the SQLSTATE value 42704. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

**SQLSTATE 42704 Description**

ERRCODE\_UNDEFINED\_OBJECT

**Error messages associated with this SQLState**

ERROR 2067: '*string*' is not a known granularity for audits.  
*string*

ERROR 2068: '*string*' is not a known TM task.  
*string*

ERROR 2070: '*string*' is not a valid granularity for *string*.  
*string*

ERROR 2073: '*string*' is not supported by index tool

```
ERROR 2274: Bootstrap error (most likely in Bootstrap.cpp): Unregistered name
 string
ERROR 2275: Bootstrap error (most likely in Bootstrap.cpp): Unregistered oid value
ERROR 2710: Constraint "string" does not exist
ERROR 2711: Constraint "string" does not exist on table "string"
ERROR 3001: DDL statement interfered with string.nextval
ERROR 3256: Error reported by client: string
ERROR 3442: Found eligible value processes to invite, but no matching nodes in
 catalog
ERROR 3637: Invalid Component Name 'string'
ERROR 3655: Invalid epoch range
ERROR 3698: Invalid mergeout task identifier (Possible values are: [0, value])
ERROR 3715: Invalid object name
ERROR 3748: Invalid scope in ANALYZE_WORKLOADstring: schema or table string was
 altered
ERROR 3749: Invalid scope in ANALYZE_WORKLOAD: schema or table string does not exist
ERROR 3756: Invalid Sub-Component Name 'string'
ERROR 3769: Invalid TM operation
ERROR 3779: Invalid user ID: value
ERROR 3842: Language does not exist: string
ERROR 3855: Library "string" does not exist
ERROR 3862: Library with name 'string' does not exist
ERROR 4045: Network interface "string" does not exist
ERROR 4047: Network interface "string" is setup on another node
ERROR 4101: No role "string" exists
ERROR 4109: No storages in the specified epoch range
ERROR 4110: No such node string
ERROR 4111: No such object
ERROR 4112: No such projection
ERROR 4113: No such projection 'string'
ERROR 4123: No user or role "string" exists
ERROR 4129: No value found for parameter "string"
ERROR 4130: No value found for parameter value
ERROR 4137: Node string does not exist
ERROR 4216: Object 'string' is not a projection
ERROR 4217: Object 'string' is not a table
```

```
ERROR 4218: Object 'string' is not a table or projection
ERROR 4223: OID value is not a sequence
ERROR 4224: OID value is not a Table or a View
ERROR 4446: Profile "string" does not exist
ERROR 4447: Profile 'string' does not exist
ERROR 4594: Resource pool "string" does not exist
ERROR 4596: Resource pool 'string' does not exist
ERROR 4614: Role "string" does not exist
ERROR 4616: Role "string" not found
ERROR 4650: Schema "string" does not exist
ERROR 4656: Schema, table, or projection "string" does not exist.
 string
ERROR 4697: Sequence "string" does not exist
ERROR 4713: Sequence with name 'string' does not exist
ERROR 4806: Subnet "string" does not exist
ERROR 4876: Table "string" does not exist
ERROR 4926: The string "string" does not exist
ERROR 4928: The string ["string"] does not exist
ERROR 5105: Tuning rule "string" does not exist
ERROR 5108: Type "string" does not exist
ERROR 5109: Type "string" is only a shell
ERROR 5112: Type string is only a shell
ERROR 5115: Type with OID value does not exist
ERROR 5227: Unrecognized drop object type: value
ERROR 5362: User "string" not found
ERROR 5365: User available location ["string"] does not exist on node ["string"]
ERROR 5446: View "string" does not exist
ERROR 5459: Window "string" does not exist
ERROR 5532: Can not find any eligible locations in tier string
ERROR 5586: Fault group "string" does not exist
ERROR 5614: Library string does not exist
ERROR 5688: User Defined Type "string" does not exist
```

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42710

This topic lists the error associated with the SQLSTATE value 42710. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 42710 Description

ERRCODE\_DUPLICATE\_OBJECT

#### Error messages associated with this SQLState

```
ERROR 2101: A sequence named "string" already exists
ERROR 2105: A table named "string" already exists
ERROR 2107: A view named "string" already exists
ERROR 2273: Bootstrap error (most likely in Bootstrap.cpp): Oid value is already registered
ERROR 2276: Bootstrap error (most likely in Bootstrap.cpp): Name string is already registered
ERROR 2713: Constraint string already exists
ERROR 3153: Duplicated local temp table found in design queries: string
ERROR 3327: Existing object "string" is not a view
ERROR 3881: Location [string] already exists for node string
ERROR 4043: Network Interface "string" already exists
ERROR 4135: Node "string" already exists
ERROR 4136: Node "string" does not exist
ERROR 4213: Object "string" already exists
ERROR 4445: Profile "string" already exists
ERROR 4482: Projection with base name "string" already exists
ERROR 4564: Relation "string" already exists
ERROR 4565: Relation "string" already exists in schema "string"
ERROR 4593: Resource pool "string" already exists
ERROR 4621: Role\User "string" already exists
ERROR 4804: Subnet "string" already exists
ERROR 4805: Subnet "string" already exists for [string]
ERROR 5582: Fault Group "string" already exists
ERROR 5584: Fault Group "string" cannot depend on itself directly or indirectly
ERROR 5585: Fault Group "string" does not exist
ERROR 5615: Location [string] conflicts with existing location [string] on node string
ERROR 5623: Network Interface "string" already exists for [string]
```

ERROR 5736: Unable to guarantee the same base name for all replicated buddy projections

ERROR 5737: Unable to guarantee the same base name for all segmented buddy projections

**Note:** The *myVertica* (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42712

This topic lists the error associated with the SQLSTATE value 42712. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 42712 Description

ERRCODE\_DUPLICATE\_ALIAS

#### Error messages associated with this SQLState

ERROR 4901: Table name "string" specified more than once

**Note:** The *myVertica* (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42723

This topic lists the error associated with the SQLSTATE value 42723. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 42723 Description

ERRCODE\_DUPLICATE\_FUNCTION

#### Error messages associated with this SQLState

ERROR 2278: Built-in function with the same name already exists: string

ERROR 3472: Function with same name and number of parameters already exists: string

ERROR 4220: Object with same name and number of parameters already exists: string

ERROR 4428: Procedure/Function with same name and number of parameters already exists in schema string

ERROR 4429: Procedure/Function with same name and number of parameters already exists: string

**Note:** The *myVertica* (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42725

This topic lists the error associated with the SQLSTATE value 42725. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 42725 Description

ERRCODE\_AMBIGUOUS\_FUNCTION

#### Error messages associated with this SQLState

ERROR 3459: Function *string* is not unique

ERROR 4289: Operator is not unique: *string*

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42803

This topic lists the error associated with the SQLSTATE value 42803. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 42803 Description

ERRCODE\_GROUPING\_ERROR

#### Error messages associated with this SQLState

ERROR 2134: Aggregate function calls in subqueries cannot refer to columns in parent (outer) query

ERROR 2135: Aggregate function calls may not be nested

ERROR 2140: Aggregates not allowed in GROUP BY clause

ERROR 2141: Aggregates not allowed in JOIN conditions

ERROR 2142: Aggregates not allowed in WHERE clause

ERROR 2219: Argument *string* must not contain aggregates

ERROR 2543: Cannot use aggregate function in EXECUTE parameter

ERROR 2544: Cannot use aggregate function in function expression in FROM

ERROR 2640: Column "*string.string*" must appear in the GROUP BY clause or be used in an aggregate function

ERROR 4634: Rule WHERE condition may not contain aggregate functions

ERROR 4667: SEGMENTED BY expression may not contain aggregate functions

ERROR 4841: Subquery uses ungrouped column "*string.string*" from outer query

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42804

This topic lists the error associated with the SQLSTATE value 42804. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 42804 Description

ERRCODE\_DATATYPE\_MISMATCH

#### Error messages associated with this SQLState

ERROR 2217: Argument *string* must be type float, not type *string*  
ERROR 2218: Argument *string* must be type integer, not type *string*  
ERROR 2222: Argument *string* must not return a set  
ERROR 2224: Argument of *string* must be type boolean, not type *string*  
ERROR 2225: Argument of *string* must not return a set  
ERROR 2231: Array assignment requires type *string* but expression is of type *string*  
ERROR 2232: Array assignment to "string" requires type *string* but expression is of type *string*  
ERROR 2234: Array subscript must have type integer  
ERROR 2358: Cannot assign to field "string" of column "string" because its type *string* is not a composite type  
ERROR 2527: Cannot subscript type *string* because it is not an array  
ERROR 2630: Column "string" is of type *string* but default expression is of type *string*  
ERROR 2631: Column "string" is of type *string* but expression is of type *string*  
ERROR 2846: Could not determine actual result type for function "string" declared to return type *string*  
ERROR 2850: Could not determine row description for function returning record  
ERROR 3429: For 'string', types *string* and *string* are inconsistent  
ERROR 3447: Function "string" in FROM has unsupported return type *string*  
ERROR 3545: Index expression may not return a set  
ERROR 3801: IS DISTINCT FROM requires = operator to yield boolean  
ERROR 3943: Mismatched types in VALUES LESS THAN expressions  
ERROR 4069: No column alias was provided  
ERROR 4199: Number of aliases does not match number of columns  
ERROR 4284: Operator *string* must not return a set  
ERROR 4285: Operator *string* must return type boolean, not type *string*  
ERROR 4317: Parameter \$value of type *string* cannot be coerced to the expected type *string*

ERROR 4625: Row comparison operator must not return a set  
ERROR 4626: Row comparison operator must yield type boolean, not type *string*  
ERROR 4803: Subfield "*string*" is of type *string* but expression is of type *string*

**Note:** The **myVertica** (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42809

This topic lists the error associated with the SQLSTATE value 42809. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 42809 Description

ERRCODE\_WRONG\_OBJECT\_TYPE

### Error messages associated with this SQLState

ERROR 2037: *string* is not a supported analytic function  
ERROR 2062: *string*(\*) specified, but *string* is not an aggregate function  
ERROR 2131: Aggregate function calls cannot contain analytic function calls  
ERROR 2132: Aggregate function calls cannot contain sequence function calls  
ERROR 2668: Column notation .*string* applied to type *string*, which is not a composite type  
ERROR 2755: COPY requires relation *string* to be a Table, not a *string*  
ERROR 2810: Could not add location [*string*]: Directory not empty  
ERROR 2811: Could not add location [*string*]: Not a directory  
ERROR 3114: DISTINCT specified, but *string* is not an aggregate function  
ERROR 3421: First argument to modularhash\_wrapper must be an integer constant  
ERROR 3422: First argument to modularhash\_wrapper must be of type integer, not *string*  
ERROR 3463: Function *string(string)* is not an aggregate  
ERROR 3552: Inherited relation "*string*" is not a table  
ERROR 3669: Invalid function given  
ERROR 3965: modularhash\_wrapper must have two arguments: an integer constant and a call to modularhash\_internal  
ERROR 3966: modularhash\_wrapper second argument is not modularhash\_internal or a constant  
ERROR 4215: Object "*string*" is not a projection  
ERROR 4270: Op ANY/ALL (array) requires array on right side  
ERROR 4271: Op ANY/ALL (array) requires operator not to return a set  
ERROR 4272: Op ANY/ALL (array) requires operator to yield boolean

ERROR 4542: Record type has not been registered  
ERROR 4657: Second argument to *string* must be a non-negative integer constant  
ERROR 4931: The argument to *string* cannot be null  
ERROR 4932: The argument to *string* must be a constant  
ERROR 4987: Third argument to *string* must be a constant  
ERROR 5111: Type *string* is not composite

**Note:** The **myVertica** (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42830

This topic lists the error associated with the SQLSTATE value 42830. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 42830 Description

ERRCODE\_INVALID\_FOREIGN\_KEY

#### Error messages associated with this SQLState

ERROR 3438: Foreign keys not specified  
ERROR 3531: Incompatible data types between primary and foreign key columns: fk: *string*, pk: *string*  
ERROR 4207: Number of primary and foreign keys must be the same

**Note:** The **myVertica** (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42846

This topic lists the error associated with the SQLSTATE value 42846. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 42846 Description

ERRCODE\_CANNOT\_COERCE

#### Error messages associated with this SQLState

ERROR 2015: *string* could not convert type *string* to *string*  
ERROR 2366: Cannot cast type *string* to *string*  
ERROR 2632: Column "string" is of type *string* but the default expression is of type *string*  
ERROR 4986: Third argument of *string* could not be converted from type *string* to type *string*

**Note:** The **myVertica** (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42883

This topic lists the error associated with the SQLSTATE value 42883. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 42883 Description

ERRCODE\_UNDEFINED\_FUNCTION

### Error messages associated with this SQLState

```
ERROR 2126: Aggregate string(string) does not exist
ERROR 2127: Aggregate string(*) does not exist
ERROR 3456: Function string does not exist
ERROR 3457: Function string does not exist, or permission is denied for string
ERROR 3462: Function string with the specified arguments does not exist
ERROR 3930: Meta-function string cannot be used in COPY
ERROR 3931: Meta-function string cannot be used in INSERT
ERROR 3932: Meta-function string cannot be used in UPDATE
ERROR 3933: Meta-function string cannot be used with FROM
ERROR 3934: Meta-function ("string") can be used only in the Select clause
ERROR 3935: Meta-function ("string") cannot be used with non-Select clauses
ERROR 3936: Meta-functions cannot be used in default expressions
ERROR 4067: No binary input function available for type string
ERROR 4068: No binary output function available for type string
ERROR 4083: No input function available for type string
ERROR 4091: No output function available for type string
ERROR 4286: Operator does not exist: string
ERROR 4290: Operator requires run-time type coercion: string
ERROR 5394: User procedure call (value) is not supported with FROM
ERROR 5455: VOLATILE functions cannot be used in a default expression when adding
 a column
```

**Note:** The **myVertica** (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42939

This topic lists the error associated with the SQLSTATE value 42939. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 42939 Description

ERRCODE\_RESERVED\_NAME

#### Error messages associated with this SQLState

ERROR 2297: Can not drop default profile  
ERROR 2299: Can not rename default profile  
ERROR 2418: Cannot drop role "string"  
ERROR 2488: Cannot rename role *string*  
ERROR 2489: Cannot rename system column epoch  
ERROR 2665: Column name "string" is reserved  
ERROR 2666: Column name *string* is reserved  
ERROR 3778: Invalid use of reserved the column name "string"  
ERROR 4030: Names starting with "v\_" are reserved names  
ERROR 4953: The name "string" is a reserved name  
ERROR 4962: The prefix "sys\_" is reserved for system tuning rule

**Note:** The **myVertica** (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42P20

This topic lists the error associated with the SQLSTATE value 42P20. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 42P20 Description

ERRCODE\_WINDOWING\_ERROR

#### Error messages associated with this SQLState

ERROR 2011: *string* cannot use the WITHIN GROUP clause  
ERROR 2041: *string* may only have one sort expression in the WITHIN GROUP clause  
ERROR 2043: *string* must contain an ORDER BY clause within its analytic clause  
ERROR 2044: *string* must NOT contain an ORDER BY clause or WINDOWING clause within its analytic clause  
ERROR 2045: *string* must NOT contain WINDOWING clause within its analytic clause  
ERROR 2047: *string* only supports the Integer, Float, Interval and Numeric data types

ERROR 2182: Analytic functions are allowed only in a SELECT list and/or ORDER BY clause

ERROR 2185: Analytic functions are not supported in the PARTITION BY of an OVER clause

ERROR 2187: Analytic functions cannot be nested

ERROR 2188: Analytic functions must have a FROM clause

ERROR 2189: Analytic functions not allowed in *string*

ERROR 2305: Can't cast the window bound into Int

ERROR 2306: Can't cast the window bound into the same data type of the ORDER BY column

ERROR 2465: Cannot override ORDER BY clause of window "*string*"

ERROR 2466: Cannot override PARTITION BY clause of window "*string*"

ERROR 2524: Cannot specify frame clause of window "*string*"

ERROR 3435: For range moving window, OrderBy expression must be one of Int, Float, Time, Timestamp, Interval, Date or Numeric

ERROR 3446: Frame clause not allowed without windowing order by

ERROR 3839: Keyword "ALL" is invalid in analytic functions

ERROR 4362: PERCENTILE\_CONT/PERCENTILE\_DISC must have the WITHIN GROUP clause

ERROR 4363: PERCENTILE\_CONT/PERCENTILE\_DISC must NOT contain an ORDER BY clause or WINDOWING clause within its analytic clause

ERROR 4811: Subqueries are not supported in the PARTITION BY of a timeseries OVER clause

ERROR 5006: Time Series Aggregate Functions are not supported in the PARTITION BY of a timeseries OVER clause

ERROR 5010: Time Series timestamp alias/Time Series Aggregate Functions not allowed in *string*

ERROR 5460: Window "*string*" is already defined

ERROR 5461: Window frame cannot end with PRECEDING if start is CURRENT ROW

ERROR 5462: Window frame cannot end with PRECEDING or CURRENT ROW if start is FOLLOWING

ERROR 5463: Window frame cannot end with UNBOUNDED PRECEDING

ERROR 5464: Window frame cannot start with UNBOUNDED FOLLOWING

ERROR 5466: Window frame logical offset must be a non-negative number to be consistent with the sort column type

ERROR 5467: Window frame logical offset must be an Interval (Day to Second or Year to Month) to be consistent with the sort column type

ERROR 5468: Window frame logical offset must be an Interval (Day to Second) to be consistent with the sort column type

ERROR 5469: Window frame logical offset must be an interval to be consistent with the sort column type

ERROR 5470: Window frame logical offset must be Int when the sort column type is Int

ERROR 5471: Window frame logical offset must be the same type as the sort column type (Interval Day to Second)

ERROR 5472: Window frame logical offset must be the same type as the sort column type (Interval Year to Month)

ERROR 5473: Window frame logical or physical offset must be a constant

ERROR 5474: Window frame logical or physical offset must be non-negative number or interval

ERROR 5475: Window frame physical offset must be non-negative number

ERROR 5477: Window ordering clause can only contain a single sort key if RANGE is used

ERROR 5478: Windowing not supported for User Defined Analytic functions

**Note:** The *myVertica* (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42V01

This topic lists the error associated with the SQLSTATE value 42V01. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 42V01 Description

ERRCODE\_UNDEFINED\_TABLE

### Error messages associated with this SQLState

ERROR 2072: 'string' is not a valid table

ERROR 2308: Can't find anchor table

ERROR 2312: Can't find table

ERROR 2313: Can't find table "string"

ERROR 2714: Constraint *string* does not exist

ERROR 2948: CTAS: table "string" was dropped in another session (DDL interference)

ERROR 3367: Failed to create projection for 'string'

ERROR 3642: Invalid CTAS query: *string*

ERROR 3760: Invalid table name

ERROR 3761: Invalid table name "string"

ERROR 3762: Invalid table name *string*

ERROR 3953: Missing FROM-clause entry for table "string"

ERROR 3954: Missing FROM-clause entry in subquery for table "string"

ERROR 4046: Network Interface "string" does not exist

```
ERROR 4416: Primary table "string" does not exist
ERROR 4566: Relation "string" does not exist
ERROR 4567: Relation "string" in FOR UPDATE clause not found in FROM clause
ERROR 4568: Relation "string.string" does not exist
ERROR 4570: Relation with OID value does not exist
ERROR 4883: Table "string.string" does not exist
ERROR 4898: Table does not exist (oid=value)
ERROR 4911: Table with OID value does not exist
ERROR 4912: Table/View with name 'string' does not exist
```

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42V02

This topic lists the error associated with the SQLSTATE value 42V02. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 42V02 Description

ERRCODE\_UNDEFINED\_PARAMETER

#### Error messages associated with this SQLState

```
ERROR 3638: Invalid configuration parameter string; aborting configuration change
ERROR 4321: Parameter value is not set
ERROR 4984: There is no parameter $value
```

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42V03

This topic lists the error associated with the SQLSTATE value 42V03. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 42V03 Description

ERRCODE\_DUPLICATE\_CURSOR

#### Error messages associated with this SQLState

```
ERROR 2615: Closing existing cursor "string"
ERROR 2968: Cursor "string" already exists
```

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42V04

This topic lists the error associated with the SQLSTATE value 42V04. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 42V04 Description

ERRCODE\_DUPLICATE\_DATABASE

#### Error messages associated with this SQLState

ERROR 2706: Connection to database [string] already exists

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42V06

This topic lists the error associated with the SQLSTATE value 42V06. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 42V06 Description

ERRCODE\_DUPLICATE\_SCHEMA

#### Error messages associated with this SQLState

ERROR 4649: Schema "string" already exists

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42V07

This topic lists the error associated with the SQLSTATE value 42V07. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 42V07 Description

ERRCODE\_DUPLICATE\_TABLE

#### Error messages associated with this SQLState

ERROR 4753: Skip lazy projection creation since super projection for table string.string already exists

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42V08

This topic lists the error associated with the SQLSTATE value 42V08. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 42V08 Description

ERRCODE\_AMBIGUOUS\_PARAMETER

#### Error messages associated with this SQLState

ERROR 2848: Could not determine data type of parameter \$value

ERROR 3534: Inconsistent types deduced for parameter \$value

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42V09

This topic lists the error associated with the SQLSTATE value 42V09. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 42V09 Description

ERRCODE\_AMBIGUOUS\_ALIAS

#### Error messages associated with this SQLState

ERROR 4908: Table reference "string" is ambiguous

ERROR 4909: Table reference value is ambiguous

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42V10

This topic lists the error associated with the SQLSTATE value 42V10. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 42V10 Description

ERRCODE\_INVALID\_COLUMN\_REFERENCE

#### Error messages associated with this SQLState

ERROR 2046: string not allowed in string clause

ERROR 2050: string position value is not in select list

ERROR 2221: Argument string must not contain variables

ERROR 3467: Function expression in FROM may not refer to other relations of same query level  
ERROR 3820: JOIN/ON clause refers to "string", which is not part of JOIN  
ERROR 4832: Subquery in FROM may not refer to other relations of same query level  
ERROR 4877: Table "string" has value columns available but value columns specified  
ERROR 5057: Too many column aliases specified for function string  
ERROR 5194: UNION/INTERSECT/EXCEPT member statement may not refer to other relations of same query level

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42V11

This topic lists the error associated with the SQLSTATE value 42V11. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 42V11 Description

ERRCODE\_INVALID\_CURSOR\_DEFINITION

### Error messages associated with this SQLState

ERROR 2522: Cannot specify both SCROLL and NO SCROLL

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42V13

This topic lists the error associated with the SQLSTATE value 42V13. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 42V13 Description

ERRCODE\_INVALID\_FUNCTION\_DEFINITION

### Error messages associated with this SQLState

ERROR 2038: *string* is not a supported Time Series Aggregate Function

ERROR 2139: Aggregates may not return sets

ERROR 2173: An error occurred on node [*string*] when setting up the function [*string*]: [*string*]

ERROR 2177: An error occurred when setting up function "string"

ERROR 2397: Cannot determine result data type

ERROR 2451: Cannot load data from 0 sources; please specify 1 or more (on node [*string*])

ERROR 2494: Cannot RETURNREJECTED with multiple files or data sources  
ERROR 3113: DISTINCT is supported only for single-argument aggregates  
ERROR 3476: Functions in language *string* can be created only in fenced mode  
ERROR 3604: Interpolation scheme *string* for Time Series Aggregate Function *string*  
is not supported  
ERROR 3708: Invalid null argument for TSA function *string*  
ERROR 3843: Language(*string*) does not match the language associated with the  
library(*string*)  
ERROR 3854: Length of a string in a return type must be greater than zero  
ERROR 3860: Library file is not loaded  
ERROR 3861: Library not found: *string*  
ERROR 3929: Meta functions cannot be used in UDX definitions  
ERROR 4086: No language specified  
ERROR 4095: No procedure source specified  
ERROR 4096: No procedure user specified  
ERROR 4243: Only COUNT() can have star(\*) as its argument  
ERROR 4249: Only MIN/MAX are allowed to use DISTINCT  
ERROR 4251: Only one expression is allowed  
ERROR 4257: Only simple "RETURN expression" is allowed  
ERROR 4409: Precision of a numeric in a return type must be greater than zero  
ERROR 4608: Return type *string* is not supported for SQL functions  
ERROR 4609: Return type mismatch in a function declared to return *string*  
ERROR 4610: Return type mismatch in function declared to return *string*  
ERROR 4746: Setting up function "*string*" failed  
ERROR 4794: Strictness in the DDL and the function factory class don't match.  
Function was not created  
ERROR 4858: Syntax error in syntax definition at offset *value*  
ERROR 4949: The interpolation argument for Time Series Aggregate Function *string*  
must be a constant string  
ERROR 5457: Volatility in the DDL and the function factory class don't match.  
Function was not created  
ERROR 5476: Window functions cannot return sets  
ERROR 5692: User-Defined Load functions cannot be created in fenced mode

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42V15

This topic lists the error associated with the SQLSTATE value 42V15. See ***HP Vertica SQLSTATE List*** (page [609](#)) for more information.

### SQLSTATE 42V15 Description

ERRCODE\_INVALID\_SCHEMA\_DEFINITION

#### Error messages associated with this SQLState

ERROR 2470: Cannot plan query because no super projections are safe, some node(s) are down

ERROR 2945: CREATE specifies a schema (*string*) different from the one being created (*string*)

ERROR 3365: Failed to create default projections for table "*string*".*"string"*:  
*string*

ERROR 3586: Insufficient projections to answer query

ERROR 4097: No projections eligible to answer query

ERROR 4878: Table "*string*" has an out-of-date super projection "*string*"

**Note:** The ***myVertica*** (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42V16

This topic lists the error associated with the SQLSTATE value 42V16. See ***HP Vertica SQLSTATE List*** (page [609](#)) for more information.

### SQLSTATE 42V16 Description

ERRCODE\_INVALID\_TABLE\_DEFINITION

#### Error messages associated with this SQLState

ERROR 2104: A table cannot have only IDENTITY/AUTO-INCREMENT columns

ERROR 2420: Cannot drop the constraint. (Table "*string*" has a foreign key constraint referencing the specified primary key constraint)

ERROR 2421: Cannot drop the constraint. (There is at least one prejoin projection dependent on the specified foreign key constraint)

ERROR 2588: CHECK constraints not supported

ERROR 2622: Column "*string*" cannot be declared SETOF

ERROR 2626: Column "*string*" from table "*string*" in the SEGMENTED BY expression is required to be present in the projection, but is not

ERROR 2712: Constraint "*string*" for relation "*string*" already exists

ERROR 3508: IDENTITY/AUTO-INCREMENT columns are not allowed in temporary tables

ERROR 3874: Local temporary table constraint cannot reference a non-local table  
ERROR 3875: Local temporary tables may not specify a schema name  
ERROR 3901: MATCH types other than SIMPLE (the default) are not supported for foreign key constraints  
ERROR 3987: Multiple primary keys for table "*string*" are not allowed  
ERROR 4162: Non-local table constraint cannot reference a local temporary table  
ERROR 4229: ON DELETE actions other than NO ACTION are not supported for foreign key constraints  
ERROR 4234: ON UPDATE actions other than NO ACTION are not supported for foreign key constraints  
ERROR 4413: Primary constraint for relation "*string*" already exists  
ERROR 4415: Primary keys not specified  
ERROR 4469: Projection anchor table is not partitioned  
ERROR 4550: Referenced primary key constraint does not exist  
ERROR 4881: Table "*string*" is not partitioned  
ERROR 4892: Table *string* is not partitioned  
ERROR 4899: Table is not partitioned  
ERROR 4900: Table must have at least one column  
ERROR 5269: Unsupported constraint type  
ERROR 5548: Constraint not supported for user defined type column *string*  
ERROR 5552: Correlation constraint not supported for user defined types

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42V17

This topic lists the error associated with the SQLSTATE value 42V17. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### **SQLSTATE 42V17 Description**

**ERRCODE\_INVALID\_OBJECT\_DEFINITION**

### **Error messages associated with this SQLState**

ERROR 2387: Cannot create projections involving external table *string*  
ERROR 3075: Design mode *string* is invalid  
ERROR 3078: Design policy *string* is invalid  
ERROR 3206: Error during extend catalog while querying deployments table for workspace *string*  
ERROR 3227: Error in querying *string.string*

```
ERROR 3271: Error while querying designs table for workspace string
ERROR 3636: Invalid column value string
ERROR 3968: More than one IDENTITY/AUTO_INCREMENT column defined for table "string"
ERROR 3983: Multiple instances of deployment string in workspace string
ERROR 4128: No valid projections found
ERROR 4230: ON DELETE rule may not use NEW
ERROR 4231: ON INSERT rule may not use OLD
ERROR 4232: ON SELECT rule may not use NEW
ERROR 4233: ON SELECT rule may not use OLD
ERROR 4635: Rule WHERE condition may not contain references to other relations
ERROR 4636: Rules with WHERE conditions may only have SELECT, INSERT, UPDATE, or
 DELETE actions
ERROR 4919: Temporary table projections are not allowed for this operation
ERROR 4982: There is no deployment string in workspace string
ERROR 4989: This function cannot be called on design string located in design
 workspace string
ERROR 4990: This function cannot be called on design string located in design
 workspace string, when its design mode is string
ERROR 5367: User defined aggregate must return exactly one column. Function string
 returns value
ERROR 5369: User defined analytic must return exactly one column
ERROR 5384: User defined transform must provide names or aliases for return columns
ERROR 5385: User defined transform must return at least one column
ERROR 5527: An error occurred on node string when setting up the type, message:
 string
ERROR 5721: Purge is not allowed on temporary tables
```

**Note:** The **myVertica** (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42V18

This topic lists the error associated with the SQLSTATE value 42V18. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 42V18 Description

ERRCODE\_INDETERMINATE\_DATATYPE

### Error messages associated with this SQLState

```
ERROR 2847: Could not determine data type of column $value
```

ERROR 3609: Interval must be single datetime field

**Note:** The *myVertica* (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42V21

This topic lists the error associated with the SQLSTATE value 42V21. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 42V21 Description

ERRCODE\_UNDEFINED\_PROJECTION

### Error messages associated with this SQLState

ERROR 2311: Can't find projection value

ERROR 2430: Cannot find projection column value

ERROR 3005: DDL statement interfered with refresh operation

ERROR 3736: Invalid projection name

ERROR 3737: Invalid projection name *string*

ERROR 4452: Projection "*string*" does not exist or was just dropped

ERROR 4474: Projection does not exist

ERROR 4905: Table or projection "*string*" does not exist

ERROR 5563: DDL statement interfered with this operation

**Note:** The *myVertica* (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42V25

This topic lists the error associated with the SQLSTATE value 42V25. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 42V25 Description

ERRCODE\_PATTERN\_MATCH\_ERROR

### Error messages associated with this SQLState

ERROR 2227: Argument to test\_pattern\_event\_eval must be > 0 and less than the total number of events

ERROR 2228: Argument to test\_pattern\_event\_eval must be a constant

ERROR 2553: Cannot use more than one pattern

ERROR 2555: Cannot use pattern test functions with pattern match functions

ERROR 3025: Defining more than 52 events is not supported

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ERROR 3288: Event "string" in PATTERN clause is not defined in the DEFINE clause  
 ERROR 3289: Event ANY\_ROW cannot be used under \*, +, ?, or | when the select list contains the pattern function event\_name()  
 ERROR 3290: Event ANY\_ROW is a reserved event and cannot be user defined  
 ERROR 3294: Event expressions cannot contain analytic functions  
 ERROR 3295: Event expressions cannot contain correlated expressions  
 ERROR 3296: Event expressions cannot contain subqueries  
 ERROR 3297: Event name "string" defined more than once  
 ERROR 4353: Pattern events must be mutually exclusive  
 ERROR 4354: Pattern match query cannot contain having clause, group clause, aggregates, or distinct  
 ERROR 4355: Pattern match query cannot contain timeseries clause  
 ERROR 4356: Pattern matching recursion limit reached  
 ERROR 4358: PatternMatchingMaxPartition must be greater than 0  
 ERROR 4359: PatternMatchingMaxPartitionMatches must be greater than 0  
 ERROR 4360: PatternMatchingPerMatchWorkspaceSize must be greater than 0 and less than 1024  
 ERROR 4494: Queries with user-defined transform functions (string) cannot have a MATCH clause  
 ERROR 4507: Query with analytic function string cannot have a MATCH clause  
 ERROR 4509: Query with pattern matching function string must include a MATCH clause  
 ERROR 4605: RESULTS GROUPED BY MATCH is not supported  
 ERROR 5283: Unsupported pattern operator

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 42V26

This topic lists the error associated with the SQLSTATE value 42V26. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 42V26 Description

ERRCODE\_DUPLICATE\_NODE

### Error messages associated with this SQLState

ERROR 4058: New node matches existing node string  
 ERROR 4063: New values for node string matches existing node string

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 53000

This topic lists the error associated with the SQLSTATE value 53000. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 53000 Description

ERRCODE\_INSUFFICIENT\_RESOURCES

#### Error messages associated with this SQLState

ERROR 2245: Attempted to create too many ROS containers for projection *string*  
ERROR 2843: Could not create thread for recoverProjectionLocal  
ERROR 2844: Could not create thread for SubsessionHandler  
ERROR 2845: Could not create thread for SubsessionHandler Hurry  
ERROR 2997: DBDesigner memory usage (*value* bytes) exceeded system limit  
ERROR 3300: Exceeded temp space cap, requested *value* with *value* remaining (*used value*) bytes  
ERROR 3416: Filter tried to allocate too much memory (*value*, out of *value allowed*)  
ERROR 3587: Insufficient resources to execute plan on pool *string* [*string*]  
ERROR 3921: MemoryPool *string* used more memory than allowed  
ERROR 3937: MIN/MAX window function could not operate in memory  
ERROR 5000: Thread limit *value*, but statement needs *value* threads  
ERROR 5001: ThreadManager failed to create thread *string*: *string*  
ERROR 5022: Timer service failed to run *value*: *string*  
ERROR 5065: Too many ROS containers exist for the following projections: *string*

**Note:** The **myVertica** (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 53100

This topic lists the error associated with the SQLSTATE value 53100. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 53100 Description

ERRCODE\_DISK\_FULL

#### Error messages associated with this SQLState

ERROR 2475: Cannot rebalance cluster. Insufficient disk space on the following nodes: *string*  
ERROR 2927: Could not write to [*string*]: *string*

ERROR 5661: Storage Location *string* has *value* free bytes left, but the plan requires at least *value* bytes

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 53200

This topic lists the error associated with the SQLSTATE value 53200. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 53200 Description

ERRCODE\_OUT\_OF\_MEMORY

#### Error messages associated with this SQLState

ERROR 2296: Calloc of *value* bytes for *string* failed  
ERROR 2344: Cannot allocate sufficient memory for COPY statement (*value* requested, *value* permitted)  
ERROR 3499: Hash table out of memory  
ERROR 3811: Join [*string*] inner partition did not fit in memory; *value* [*string*]  
ERROR 3813: Join did not fit in memory  
ERROR 3814: Join inner did not fit in memory  
ERROR 3815: Join inner did not fit in memory [*string*]  
ERROR 3816: Join NULLs did not fit in memory [*string*]  
ERROR 3819: Join table did not fit in memory  
ERROR 3895: Malloc of *value* bytes for *string* failed  
ERROR 4176: Not enough memory for test directive numTopKHeaps  
ERROR 4302: Out of memory  
ERROR 4303: Out of memory when expanding glob: *string*  
ERROR 4305: Out of system WOS memory during catalog SELECT  
ERROR 4357: Pattern partition will not fit into memory  
ERROR 4381: Plan memory limit exhausted: [*string*]  
ERROR 4495: Query *value* exceeded memory usage limit. Design result for this query might be suboptimal  
ERROR 4512: Ran out of WOS memory during *string*  
ERROR 4524: Realloc of *value* bytes for *string* failed  
ERROR 5062: Too many hash table entries  
ERROR 5063: Too many matches in a single partition  
ERROR 5147: Unable to reserve memory (*value* K) for the WOS

**Note:** The **myVertica** (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 54000

This topic lists the error associated with the SQLSTATE value 54000. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 54000 Description

ERRCODE\_PROGRAM\_LIMIT\_EXCEEDED

### Error messages associated with this SQLState

```
ERROR 2052: string Row size value is too large
ERROR 2472: Cannot prepare statement - too many prepared statements
ERROR 3460: Function string may give a value-octet result; the limit is value octets
ERROR 3626: Invalid buffer enlargement request size value
ERROR 3866: Line is too long in timezone file "string", line value
ERROR 4282: Operator string may give a value-octet Varbinary result; the limit is
 value octets
ERROR 4283: Operator string may give a value-octet Varchar result; the limit is
 value octets
ERROR 4557: regexp_replace result is too long
ERROR 4913: Target lists can have at most value entries
ERROR 5043: Timezone directory stack overflow
ERROR 5060: Too many data partitions
ERROR 5263: Unsupported access to external table
ERROR 5265: Unsupported access to virtual schema
ERROR 5266: Unsupported access to virtual table
ERROR 5267: Unsupported access to virtual view
```

**Note:** The **myVertica** (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 54001

This topic lists the error associated with the SQLSTATE value 54001. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 54001 Description

ERRCODE\_STATEMENT\_TOO\_COMPLEX

## Error messages associated with this SQLState

ERROR 4588: Request size too big. Please try to simplify the query

ERROR 4963: The query contains a SET operation tree that is too complex to analyze

ERROR 4964: The query contains an expression that is too complex to analyze

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 54011

This topic lists the error associated with the SQLSTATE value 54011. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 54011 Description

ERRCODE\_TOO\_MANY\_COLUMNS

## Error messages associated with this SQLState

ERROR 2106: A table/projection/view can only have up to *value* columns -- this create statement has *value*

ERROR 2118: Adding column causes row size (*value*) to exceed MaxRowSize (*value*)

ERROR 2136: Aggregate function cannot have *value* input argument(s)

ERROR 2137: Aggregate function cannot have *value* return value(s)

ERROR 2181: Analytic function cannot have *value* return value(s)

ERROR 2291: Call to ColumnTypes.addAny() is not allowed in Aggregate functions

ERROR 3466: Function cannot have *value* return value(s)

ERROR 4202: Number of columns (*value*) exceeds limit (*value*)

ERROR 4481: Projection row size (*value*) exceeds MaxRowSize (*value*)

ERROR 4630: Row size exceeds MaxRowSize: *value* > *value*

ERROR 4875: Table "string" can only have up to *value* columns -- adding one will exceed this limit

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 54023

This topic lists the error associated with the SQLSTATE value 54023. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 54023 Description

ERRCODE\_TOO\_MANY\_ARGUMENTS

### Error messages associated with this SQLState

ERROR 2441: Cannot have more than *value* segmentation columns  
ERROR 2469: Cannot pass more than *value* arguments to a function  
ERROR 4431: Procedures cannot have more than *value* parameters  
ERROR 4646: Scalar/Transform functions cannot have more than *value* parameters  
ERROR 5055: Too many arguments  
ERROR 5056: Too many arguments to evaluate\_delete\_performance function

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 55000

This topic lists the error associated with the SQLSTATE value 55000. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 55000 Description

ERRCODE\_OBJECT\_NOT\_IN\_PREREQUISITE\_STATE

### Error messages associated with this SQLState

ERROR 2088: A concurrent load into the partition or a concurrent mergeout operation interfered with this statement  
ERROR 2143: AHM advanced beyond snapshot epoch  
ERROR 2149: AHM can't be set  
ERROR 2150: AHM can't be set while retentive refresh is running  
ERROR 2151: AHM can't be set. (*value* nodes are down, out of *value*.)  
ERROR 2152: AHM can't be set. (*value* nodes are down.)  
ERROR 2159: All nodes must be UP to rebalance a cluster  
ERROR 2163: Already released  
ERROR 2174: An error occurred when loading library file *string*. Details: *string*  
ERROR 2175: An error occurred when loading library file on node *string*, message: *string*  
ERROR 2200: AnalyzeStatsPlanMaxColumns configuration parameter 'value' invalid; must be greater than zero  
ERROR 2201: AnalyzeStatsSampleBands configuration parameter 'value' invalid; must be greater than zero  
ERROR 2241: Attempt to create view using an invalid relation  
ERROR 2242: Attempt to run multi-node KV plan  
ERROR 2294: CALL\_USE\_SESSION\_NODES used without setting nodes

ERROR 2303: Can not tell if tables have data, too few responses (value) to be conclusive

ERROR 2316: Can't match imported node '*string*' to node in current database

ERROR 2371: Cannot commit DML/DDL while a node is shutting down

ERROR 2378: Cannot convert column "*string*" to type "*string*"

ERROR 2380: Cannot create a library without an initialized LibraryPath on node: *string*

ERROR 2388: Cannot create projections on a temporary table that has data

ERROR 2409: Cannot drop any more columns in *string*

ERROR 2410: Cannot drop column "*string*" since it is referenced in the default expression of column "*string*"

ERROR 2413: Cannot drop column "*string*" since it was referenced in the default expression of added column "*string*"

ERROR 2424: Cannot execute query with temporary table because a node has recovered since the start of this session

ERROR 2448: Cannot issue this command in a read-only transaction

ERROR 2459: Cannot modify temporary table *string* because a node has recovered or rebalance data took place since the start of this *string*

ERROR 2467: Cannot overwrite object

ERROR 2476: Cannot reference Storage

ERROR 2483: Cannot remove snapshots without an initialized SnapshotPath

ERROR 2496: Cannot revoke EXECUTE permission from the owner: *string*

ERROR 2497: Cannot revoke EXECUTE permission from the super user

ERROR 2498: Cannot revoke USAGE permissions on the resource pool to which user *string* is assigned

ERROR 2505: Cannot set column "*string*" in table "*string*" to NOT NULL since it contains null values

ERROR 2512: Cannot set memoryCap for session whose current user has been dropped

ERROR 2516: Cannot set runTimeCap for session whose current user has been dropped

ERROR 2517: Cannot set tempSpaceCap for session whose current user has been dropped

ERROR 2531: Cannot undelete storage

ERROR 2541: Cannot use addAny() with any other input column types

ERROR 2542: Cannot use addAny() with any other output column types

ERROR 2550: Cannot use KV hint with a non-query

ERROR 2551: Cannot use KV query inside a transaction

ERROR 2563: Cannot validate DV storage

ERROR 2564: Cannot validate storage

ERROR 2587: Changes cannot be made to [*string*]. It has been retired

ERROR 2691: Concurrent DDL interfered with this statement  
ERROR 2762: COPY: Cannot load into IDENTITY column "*string*"  
ERROR 2763: COPY: Cannot specify parsing options for IDENTITY column "*string*"  
ERROR 2903: Could not reset epoch because DML locks are held  
ERROR 2904: Could not reset epoch because projections exist  
ERROR 2933: Couldn't force partition projection *string*  
ERROR 2934: Couldn't force partition projections *string*  
ERROR 2954: Current phase of recovery failed due to missed event at epoch value  
ERROR 2955: Current set of up nodes do not satisfy dependencies  
ERROR 2956: Current set of up nodes do not satisfy dependencies for table *string*  
ERROR 2961: Current user has been dropped so no defaults are available  
ERROR 2962: Current user has been dropped so no roles are available  
ERROR 2969: Cursor can only scan forward  
ERROR 3000: DDL interfered with this statement  
ERROR 3002: DDL statement interfered with alter column type  
ERROR 3018: Default expression of IDENTITY/AUTO\_INCREMENT column "*string*" cannot be altered  
ERROR 3136: drop\_partition failed for *string* on node *string*. The projection contains unpartitioned data  
ERROR 3196: Error deserializing objects  
ERROR 3216: Error during setting up function *string*, message: *string*  
ERROR 3229: Error loading library file:[*string*]  
ERROR 3254: Error reading from file  
ERROR 3278: Error writing to file  
ERROR 3318: Execution aborted by node state change  
ERROR 3392: Failed to update local min/max objects for column "*string*"  
ERROR 3807: JobTracker::getMarkedStorages(): Unknown job value  
ERROR 3808: JobTracker::jobComplete(*string*): Unknown job value  
ERROR 3809: JobTracker::setDetails(*value,value,value*): Unknown job value  
ERROR 3810: JobTracker::setJobDescription(*string*): Unknown job value  
ERROR 3838: Key value already in use  
ERROR 3882: Location cannot be dropped as it stores data files  
ERROR 3911: maxMemorySize for *string* can be changed only when the *string* WOS is empty  
ERROR 3924: merge\_partitions() failed on *string* because of unpartitioned data  
ERROR 3925: Mergeout failed: projection *string* is not up-to-date

ERROR 4032: Naming conflict: *string* exists  
ERROR 4092: No plan received at node  
ERROR 4120: No transaction running on node  
ERROR 4121: No transaction running, does previous load\_snapshot\_prep succeeded?  
ERROR 4127: No valid cache found  
ERROR 4138: Node *string* is not available for queries  
ERROR 4144: Node has not been set up for plan execution  
ERROR 4146: Node is not active or recovering, cannot plan query  
ERROR 4148: Node not prepared to accept plan  
ERROR 4151: Node unprepared for rebalance  
ERROR 4177: Not enough nodes are up for Projection <*string*> to be available, marking it as out of date  
ERROR 4219: Object oid *value* reused  
ERROR 4403: Portal "*string*" cannot be run  
ERROR 4457: Projection *string* checkpoint epoch lags snapshot epoch  
ERROR 4458: Projection *string* contains data in the WOS  
ERROR 4459: Projection *string* create epoch is greater than the epoch in the query  
ERROR 4462: Projection *string* has HSE > snapshot epoch and buddy *string* has HSE <= snapshot epoch  
ERROR 4464: Projection *string* is not up-to-date  
ERROR 4467: Projection (name: *string*, oid: *value*) is newly added during current recovery  
ERROR 4485: Projections *string* contain data in the WOS  
ERROR 4530: Rebalance unable to moveout all data on projection *string*  
ERROR 4592: reset\_epoch is disabled because the EnableResetEpoch configuration parameter is 0  
ERROR 4611: Returned string value '[*string*]' with length [*value*] is greater than declared field length of [*value*] of field [*string*] at output column index [*value*]  
ERROR 4698: Sequence "string" has been created by an IDENTITY/AUTO\_INCREMENT column and cannot be dropped  
ERROR 4699: Sequence "string" has been created by an IDENTITY/AUTO\_INCREMENT column and cannot be used in a default expression  
ERROR 4700: Sequence *string* has not been accessed in the session  
ERROR 4757: SnapshotMemento does not match. Oid conflicts are possible  
ERROR 4760: Some nodes are down. These nodes will not receive the configuration change unless a manual step is taken, or the set\_config\_parameter utility is reissued after the node is brought back up  
ERROR 4765: Specified K-safety for projection creation is insufficient to support currently down nodes

ERROR 4791: Storage extends beyond specified segment range  
ERROR 4793: Stream error: *string*  
ERROR 4860: System is not k-safe. DDL is disallowed  
ERROR 4861: System is not k-safe. DDL/DML is disallowed  
ERROR 4879: Table "*string*" has projections in non-up-to-date state  
ERROR 4880: Table "*string*" has projections that are not up-to-date that can refresh from buddy  
ERROR 4903: Table no longer exists  
ERROR 4934: The attribute "*string*" in table "*string*" needs to be included in projection "*string*" because it is used in the partitioning expression  
ERROR 4941: The data type requires length/precision specification  
ERROR 4965: The restore violates K safety  
ERROR 4972: The types/sizes of source column (index *value*, length *value*) and destination column (index *value*, length *value*) do not match  
ERROR 5049: TM interfered with object-level backup  
ERROR 5084: Tried to add field '*string*' that already exists  
ERROR 5085: Tried to add unknown node '*string*' to user-defined query plan  
ERROR 5132: Unable to evaluate the delete performance after dropping this column for projection "*string*"  
ERROR 5151: Unable to validate data in *string*: *string*  
ERROR 5204: Unknown data type  
ERROR 5210: Unknown object: *string*  
ERROR 5321: Usage of [*string*] cannot be changed. It has been retired  
ERROR 5381: User Defined Scalar Function can only have 1 return column, but *value* is provided  
ERROR 5491: Wrong MD5 checksum for library file *string*  
ERROR 5522: A concurrent operation interfered with this statement  
ERROR 5533: Can not move partition to the same table  
ERROR 5534: Can't create table in specified target schema  
ERROR 5535: Can't find target table's schema  
ERROR 5536: Cannot add ephemeral nodes to a fault group  
ERROR 5543: Cannot use column type 'any' with any other input column types  
ERROR 5544: Cannot use column type 'any' with any other output column types  
ERROR 5568: DVWos can not be moved  
ERROR 5572: Error during setting up type *string*, message: *string*  
ERROR 5583: Fault Group "*string*" already exists in a fault group  
ERROR 5587: Fault Group "*string*" not found in Fault Group "*string*"

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ERROR 5590: Found value unsegmented projections with basename *string*; inconsistent with permanent nodes count *value*

ERROR 5626: Node "*string*" already exists in a fault group

ERROR 5627: Node "*string*" not found in Fault Group "*string*"

ERROR 5659: Source and target table does not match

ERROR 5660: Source table can not be temp, virtual, system, or external

ERROR 5662: Storage tier *string* has not been found on all nodes

ERROR 5666: Table "*string*" has prejoin projections

ERROR 5667: Target table can not be temp, virtual, system, or external

ERROR 5674: TM interfered with this statement

ERROR 5676: Unable to move partitions because some projection(s) contain unpartitioned data

ERROR 5705: Dvmergeout failed: projection *string* is not up-to-date

ERROR 5712: JobTracker::reportStart: Unknown job *value*

ERROR 5735: Tier *string* is referenced by storage policies. Can not make storage location changes as requested

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 55006

This topic lists the error associated with the SQLSTATE value 55006. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 55006 Description

ERRCODE\_OBJECT\_IN\_USE

### Error messages associated with this SQLState

ERROR 2060: *string* WOS is not empty; cannot renew. Do a moveout

ERROR 2307: Can't drop self

ERROR 3003: DDL statement interfered with Database Designer

ERROR 3004: DDL statement interfered with query replan

ERROR 3007: DDL statement interfered with this statement

ERROR 3896: Manual mergeout not supported while tuple mover is running

ERROR 3897: Manual moveout not supported while tuple mover is running

ERROR 4122: No up-to-date super projection left on the anchor table of projection *string*

ERROR 4139: Node *string* transitioned to state UP during this statement

ERROR 4145: Node is active and cannot be altered

ERROR 4455: Projection *string* cannot be dropped because K-safety would be violated  
ERROR 4470: Projection cannot be dropped because history after AHM would be lost  
ERROR 4488: Projections cannot be dropped or data would be lost due to down nodes  
ERROR 4527: Rebalance is already running  
ERROR 4528: Rebalance is already scheduled to run in the background  
ERROR 4882: Table "*string*" is used as a dimension in a prejoined projection  
ERROR 4896: Table (*value*) has been dropped  
ERROR 4971: The status of one or more nodes changed during query planning

**Note:** The **myVertica** (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 55V02

This topic lists the error associated with the SQLSTATE value 55V02. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 55V02 Description

ERRCODE\_CANT\_CHANGE\_RUNTIME\_PARAM

### Error messages associated with this SQLState

ERROR 4324: Parameter will not take effect until database restart

**Note:** The **myVertica** (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 55V03

This topic lists the error associated with the SQLSTATE value 55V03. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 55V03 Description

ERRCODE\_LOCK\_NOT\_AVAILABLE

### Error messages associated with this SQLState

ERROR 5156: Unavailable: *string* - Locking failure: *string*

ERROR 5157: Unavailable: [Txn value] *string* - *string* error *string*

**Note:** The **myVertica** (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 55V04

This topic lists the error associated with the SQLSTATE value 55V04. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 55V04 Description

ERRCODE\_TM\_MARKER\_NOT\_AVAILABLE

### Error messages associated with this SQLState

ERROR 2082: A *string* operation is already in progress on projection *string.string*  
[container value *txnid* value session *string*]

ERROR 2083: A *string* operation is already in progress on projection *string.string*  
[*txnid* value session *string*]

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 57014

This topic lists the error associated with the SQLSTATE value 57014. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 57014 Description

ERRCODE\_QUERY\_CANCELED

### Error messages associated with this SQLState

ERROR 2246: Audit canceled

ERROR 2279: Bulk Import canceled

ERROR 2310: Can't find projection

ERROR 2325: Canceled (in *string*)

ERROR 2326: Canceled: *string* - Locking canceled: *string*

ERROR 2327: Canceled: [Txn value] *string* - *string string*

ERROR 2576: Catchup recovery interrupted

ERROR 2704: Connection canceled

ERROR 2996: DBDesigner canceled by user

ERROR 3086: Design/Deployment canceled by user

ERROR 3286: evaluate\_delete\_performance canceled

ERROR 3319: Execution canceled (compile)

ERROR 3320: Execution canceled (prepare)

ERROR 3321: Execution canceled (start)

```
ERROR 3322: Execution canceled by operator
ERROR 3323: Execution got unlucky!
ERROR 3324: Execution intentionally failed
ERROR 3326: Execution time exceeded run time cap of string
ERROR 3515: import_catalog_objects canceled
ERROR 4114: No super projection available for analyze_statistics
ERROR 4142: Node failure during execution
ERROR 4143: Node failure in string
ERROR 4287: Operator intervention on string
ERROR 4380: Plan canceled prior to execute call
ERROR 4439: Processing aborted by peer on string
ERROR 4496: Query canceled while waiting for resources
ERROR 4787: Statement abandoned due to subsequent DDL
ERROR 4789: Statement is canceled
ERROR 4843: Subsession interrupted
```

**Note:** The **myVertica** (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 57V01

This topic lists the error associated with the SQLSTATE value 57V01. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 57V01 Description

ERRCODE\_ADMIN\_SHUTDOWN

### Error messages associated with this SQLState

```
ERROR 3556: Initiating node is down
ERROR 4150: Node status is not UP
```

**Note:** The **myVertica** (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 57V03

This topic lists the error associated with the SQLSTATE value 57V03. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 57V03 Description

ERRCODE\_CANNOT\_CONNECT\_NOW

## Error messages associated with this SQLState

```

ERROR 2863: Could not fork UDX zygote process, string
ERROR 2929: Couldn't create new UDX side process, failed to get UDX side process
 info from zygote: string
ERROR 2930: Couldn't create new UDX side process, the language string is not
 supported
ERROR 2937: Couldn't set TCP_NODELAY option, might get latency in RPC message
 delivery: string
ERROR 3363: Failed to connect to side process, string
ERROR 3364: Failed to connect to UDX zygote, string
ERROR 3366: Failed to create new UDX side process, couldn't connect to it: string
ERROR 4720: Session manager cannot add an external session - disabled
ERROR 4973: The UDX zygote process is down, restarting it...
ERROR 5699: Cannot find java binary: neither the Linux environment variable
 JAVA_HOME nor Vertica config parameter JavaBinaryForUDX is set
ERROR 5702: Couldn't create new UDX side process: string

```

**Note:** The **myVertica** (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 58030

This topic lists the error associated with the SQLSTATE value 58030. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 58030 Description

ERRCODE\_IO\_ERROR

## Error messages associated with this SQLState

```

ERROR 2024: string Error occurred during BZIP decompression.
 BZIP error code: value
ERROR 2026: string Error occurred during ZLIB decompression.
 ZLIB error code: value, Message: string
ERROR 2253: Bad return from WaitForMultipleObjects: value (value)
ERROR 2432: Cannot get LibraryPath from node: string
ERROR 2433: Cannot get MD5 checksum from node: string
ERROR 2600: Checksums do not match (computed=0xvalue, fromdisk=0xvalue) discarding
 checkpoint!
ERROR 2674: ColumnAccessBase open error
ERROR 3197: Error deserializing snapshot info from file string
ERROR 3255: Error reading from file string

```

```
ERROR 3303: Exception during measurement deserialization
ERROR 3304: Exception during ProjectionSnapshot deserialization:string
ERROR 3305: Exception during Stats deserialization:string
ERROR 3370: Failed to create socket waiting event: value
ERROR 3385: Failed to reset socket waiting event: value
ERROR 3408: File size on disk does not match catalog for string
ERROR 3478: getnameinfo_all() failed: string
ERROR 3550: Info file string does not exist
ERROR 3796: IO_ERROR writing data file [string]
ERROR 4364: Performance measurement of [string] failed
ERROR 4377: Pixw finish error
ERROR 4378: Pixw open error
ERROR 4379: Pixw write error
ERROR 4518: Read error when expanding glob: string
ERROR 4632: RowAccessBase open error
ERROR 5124: Unable to close catalog file [string]
ERROR 5126: Unable to create catalog file [string]
ERROR 5131: Unable to drop catalog file [string]
ERROR 5133: Unable to fsync catalog file [string]
ERROR 5141: Unable to open file [string]
ERROR 5152: Unable to write catalog file [string]
ERROR 5153: Unable to write checksum to catalog file [string]
ERROR 5154: Unable to write object to catalog file [string]
```

**Note:** The **myVertica** (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE 58V01

This topic lists the error associated with the SQLSTATE value 58V01. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE 58V01 Description

ERRCODE\_UNDEFINED\_FILE

### Error messages associated with this SQLState

```
ERROR 3664: Invalid filename. Input filename is an empty string
```

**Note:** The **myVertica** (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE V1001

This topic lists the error associated with the SQLSTATE value V1001. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE V1001 Description

ERRCODE\_LOST\_CONNECTIVITY

#### Error messages associated with this SQLState

```
ERROR 2709: Connection to spread closed
ERROR 4048: NetworkReceive: Decompression failed
ERROR 4054: NetworkSend on string: failed to open connection to node string (string)
ERROR 4055: NetworkSend on string: failed to send to node string [string]
ERROR 4140: Node string was not successfully added to the cluster
ERROR 4533: Receive: Decompression failed
ERROR 4534: Receive on string: Message receipt from string failed [string]
ERROR 4536: Receive on string: open failed for node string (string)
ERROR 4541: ReceiveFiles on string: Unexpected end of stream from string [string]
ERROR 4547: RecvFiles on string: Open failed on node [string] (string)
ERROR 4572: RemoteSend: Open failed on node [string] (string)
ERROR 4683: Send: Connection not open [string tag:value plan value]
ERROR 4684: Send: Open failed on node [string] (string)
ERROR 4689: SendFiles on string: Open failed on node [string] (string)
ERROR 5579: Failure in send on socket string: string
ERROR 5624: NetworkReceive on string: failed to open connection to node string (string)
ERROR 5625: NetworkReceive on string: Message receipt from string failed: string
ERROR 5658: Send on string: Open failed on node [string] (Address lookup for string(string) failed)
```

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE V1002

This topic lists the error associated with the SQLSTATE value V1002. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE V1002 Description

ERRCODE\_K\_SAFETY\_VIOLATION

### Error messages associated with this SQLState

ERROR 2406: Cannot drop value nodes from a value node cluster with value nodes down - cluster would appear partitioned and database would shutdown. Bring some nodes up and try again

ERROR 2529: Cannot support K=value on only value nodes

ERROR 2957: Current system KSAFE level is not fault tolerant

ERROR 4477: Projection KSAFE value can not be met with only value nodes

ERROR 4478: Projection KSAFE override value cannot be less than current system K-safe value value

**Note:** The *myVertica* (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE V1003

This topic lists the error associated with the SQLSTATE value V1003. See *HP Vertica SQLSTATE List* (page [609](#)) for more information.

### SQLSTATE V1003 Description

ERRCODE\_CLUSTER\_CHANGE

### Error messages associated with this SQLState

ERROR 2094: A node has come UP which missed ALTER COLUMN check

ERROR 2095: A node has come UP which missed drop partition keys check

ERROR 2096: A node has come UP which missed partitioning check

ERROR 2097: A node has entered the cluster since the session started

ERROR 2098: A node has entered the cluster since the session was started

ERROR 2099: A node has entered/left the database cluster

ERROR 3428: Following nodes are UP but not in the backup node set: *string*

ERROR 3941: Mismatch between plan and session node states (possibly because a node entered/left the cluster since the session was started)

ERROR 5312: Up node set changed in between load\_snapshot\_prep and load\_snapshot

ERROR 5523: A node has come UP which missed ADD COLUMN statement

**Note:** The *myVertica* (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE V2000

This topic lists the error associated with the SQLSTATE value V2000. See *HP Vertica SQLSTATE List* (page [609](#)) for more information.

## SQLSTATE V2000 Description

ERRCODE\_AUTH\_FAILED

### Error messages associated with this SQLState

ERROR 3493: GSS error: *string*. Error details: (*string/string*)

ERROR 3718: Invalid old password

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE V2001

This topic lists the error associated with the SQLSTATE value V2001. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

## SQLSTATE V2001 Description

ERRCODE\_LICENSE\_ISSUE

### Error messages associated with this SQLState

ERROR 2382: Cannot create another node. The current license permits *value* node(s) and the database catalog already contains *value* node(s)

ERROR 2447: Cannot install new license to the database. New license permits *value* node(s) but the database catalog already contains *value* node(s)

ERROR 3248: Error parsing license end date

ERROR 3863: License issue: *string*

ERROR 4943: The Enterprise Edition is installed. You cannot downgrade from the Enterprise Edition to the Community Edition

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE VC001

This topic lists the error associated with the SQLSTATE value VC001. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

## SQLSTATE VC001 Description

ERRCODE\_CONFIG\_FILE\_ERROR

### Error messages associated with this SQLState

ERROR 2879: Could not load server certificate file "*string*": *string*

ERROR 3833: Kerberos keytab file must be owned by the database user, and have no permissions for "group" or "other"

ERROR 4951: The Kerberos keytab file is either empty or too small in size to be valid

ERROR 5261: Unsafe permissions on private key file "*string*"

**Note:** The **myVertica** (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE VD001

This topic lists the error associated with the SQLSTATE value VD001. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE VD001 Description

ERRCODE\_DESIGNER\_FUNCTION\_ERROR

#### Error messages associated with this SQLState

ERROR 2010: *string* cannot be NULL

ERROR 2012: *string* clause does not exist in the query

ERROR 2202: Anchor table for projection *string* does not exist, so it cannot be added to deployment

ERROR 2204: Anchor table of projection *string* is a Session scoped table

ERROR 2205: Anchor table of projection *string* is a System table

ERROR 2207: Another design workspace already exists

ERROR 2211: API *string* not available in old DBD engine

ERROR 2212: API cannot take query input file and query string, only one can be set

ERROR 2304: Can only load *value* *string* under the *string* design mode

ERROR 2328: Cannot *string* as design was created already

ERROR 2336: Cannot add another Initial design to deployment *string*

ERROR 2337: Cannot add design projections in extend catalog type deployment *string* in workspace *string*

ERROR 2338: Cannot add design tables to workspace *string* because there are populated designs

ERROR 2339: Cannot add design to deployment *string* because design *string* has not been populated

ERROR 2355: Cannot apply correlations for a system schema

ERROR 2356: Cannot apply correlations for a system table

ERROR 2357: Cannot apply correlations for an external table

ERROR 2369: Cannot clear design tables from workspace *string* because there are populated designs

ERROR 2375: Cannot compute projections to be dropped for only incremental designs deployment

ERROR 2384: Cannot create projections for a NULL table  
ERROR 2385: Cannot create projections for a system table  
ERROR 2386: Cannot create projections for a temporary table  
ERROR 2393: Cannot deploy an incremental design with ksafety (*value*) smaller than current database ksafety  
ERROR 2394: Cannot design encoding for Projection *string* as it does not have any AUTO encoded columns  
ERROR 2395: Cannot design encoding for Projection *string* as it is not SAFE -- Create its buddies  
ERROR 2396: Cannot design/deploy for virtual system schema *string*  
ERROR 2423: Cannot execute deployment when there are non-up-to-date safe projections for table *string*  
ERROR 2426: Cannot find correlations for a system schema  
ERROR 2427: Cannot find correlations for a system table  
ERROR 2428: Cannot find correlations for an external table  
ERROR 2434: Cannot get script for a NULL table  
ERROR 2435: Cannot get script for a system table  
ERROR 2436: Cannot get script for a temporary table  
ERROR 2454: Cannot load invalid query: *string*  
ERROR 2456: Cannot load queries as design was populated already  
ERROR 2463: Cannot output design projections because design is not available  
ERROR 2464: Cannot output query because query id is invalid  
ERROR 2471: Cannot populate drop projections in extend catalog type deployment *string* in workspace *string*  
ERROR 2477: Cannot refresh projections for table *value* as it was dropped  
ERROR 2480: Cannot remove any design table from workspace *string* because there are populated designs  
ERROR 2485: Cannot remove workspace *string* because it does not exist  
ERROR 2486: Cannot remove workspace that has designs  
ERROR 2487: Cannot remove workspace while deployment is in progress or another session is working on this workspace  
ERROR 2492: Cannot retrieve design tables for design *string* in workspace *string*  
ERROR 2493: Cannot retrieve information for design *string* in workspace *string*  
ERROR 2507: Cannot set k-safety when design *string* has been populated  
ERROR 2657: Column '*string*' does not exist in Table *string*  
ERROR 2658: Column '*string*' is duplicated in the column list  
ERROR 2798: Correlation constraints must be removed from *string* before apply\_correlations can be run

```
ERROR 2799: Correlation level cannot be NULL
ERROR 2800: Correlation level must be between 95 and 100
ERROR 2813: Could not apply correlations: string
ERROR 2871: Could not initialize configuration for string
ERROR 2985: Database contains no tables
ERROR 3053: Deployment string already exists in workspace string
ERROR 3054: Deployment got canceled
ERROR 3056: Deployment ksafety should be equal or greater than design ksafety.
 Deployment ksafety is value and design ksafety is value
ERROR 3057: Deployment name cannot be NULL
ERROR 3058: Deployment Projections status is set to Error
ERROR 3060: Design string already exists
ERROR 3061: Design string already exists for workspace string
ERROR 3062: Design string cannot be populated when there is a down node
ERROR 3063: Design string has already been added to deployment string
ERROR 3064: Design string has not been populated in workspace string so projection
 cannot be added
ERROR 3065: Design string hasn't been populated
ERROR 3066: Design string in workspace string is not available
ERROR 3067: Design string is already populated
ERROR 3068: Design string is populated, remove design first (dbd_remove_design)
ERROR 3069: Design string was aborted since there is a down node
ERROR 3070: Design and workspace name cannot be NULL
ERROR 3071: Design and workspace name cannot have more than value characters
ERROR 3072: Design and workspace name may contain only alphanumeric, hyphen or
 underscore characters
ERROR 3073: Design did not complete successfully, so deployment did not start
ERROR 3074: Design K-safety should be 0
ERROR 3076: Design name cannot be NULL
ERROR 3077: Design name cannot have character '.'
ERROR 3079: Design policy cannot be NULL
ERROR 3080: Design query with design_query_id value does not exist
ERROR 3081: Design Query with design_query_id string does not exist
ERROR 3082: Design workspace string does not exist
ERROR 3083: Design workspace cannot be NULL
ERROR 3085: Design workspace name cannot be NULL
```

ERROR 3087: design\_override\_type *string* for query (design\_query\_id value) already exists

ERROR 3088: design\_override\_type *string* for table *string* already exists

ERROR 3089: design\_override\_type *string* for table *string* does not exist

ERROR 3100: Did not find any projections to design encodings for

ERROR 3101: Did not find design projections for projection ids given

ERROR 3102: Did not find design projections for tablePattern *string*

ERROR 3103: Did not find design tables to add

ERROR 3104: Did not find design tables to remove

ERROR 3105: Did not find projection id value in deployment *string* in workspace *string*

ERROR 3106: Did not find projections for design *string* in workspace *string*

ERROR 3107: Did not find rows in deployment table for deployment *string* in workspace *string*

ERROR 3108: Did not find rows in designs table for workspace *string*

ERROR 3140: Dropping design without getting design projections, API call is of no use

ERROR 3166: Empty design name is not allowed

ERROR 3188: Error after projection refresh: *string*

ERROR 3194: Error creating workspace: Invalid workspace name

ERROR 3195: Error deleting deployment status table

ERROR 3202: Error during deployment while setting ksafety before deployment starts

ERROR 3203: Error during design: *string*

ERROR 3205: Error during drop projections: *string*

ERROR 3208: Error during projection creation: *string*

ERROR 3214: Error during remove design *string*

ERROR 3215: Error during rename projections: *string*

ERROR 3241: Error opening query input file [*string*]

ERROR 3250: Error querying deployment projections statements table

ERROR 3251: Error querying deployment projections table

ERROR 3252: Error querying design projections table for design *string* in workspace *string*

ERROR 3253: Error querying: *string*

ERROR 3266: Error status for projections to add for table *string*

ERROR 3267: Error status for projections to drop for table *string*

ERROR 3268: Error updating deployment projections table

ERROR 3270: Error while loading statistics into design tables for design *string*

```
ERROR 3277: Error writing to string
ERROR 3356: External table string is not a design table
ERROR 3358: Failed during select mark_design_ksafe(value)
ERROR 3415: Filename cannot be NULL
ERROR 3480: Given design string does not exist
ERROR 3481: Given workspace string does not exist
ERROR 3489: Group-by override value on query value cannot be satisfied
ERROR 3543: Incremental design needs a query or an input query file to be set
ERROR 3574: INSERT query without SELECT is not supported: string
ERROR 3649: Invalid Deploy Operation string string
ERROR 3650: Invalid deploy status string string
ERROR 3740: Invalid query input file [string]
ERROR 3795: Invalid workspace schema creator name
ERROR 3817: Join override value on query value cannot be satisfied
ERROR 3824: K cannot be value (maximum allowed is value)
ERROR 3825: K must be equal to or greater than value, cannot reduce current k-safety
 level
ERROR 3826: K-safety can be between 0 and value
ERROR 3827: K-safety cannot be NULL
ERROR 3867: List of projections cannot be NULL
ERROR 3898: mark_design_ksafe(value) failed; some projections may not be k-safe
ERROR 3899: mark_design_ksafe(value) failed; some projections might not be k-safe
ERROR 3988: Multiple workspaces are not allowed. Design workspace ("string") exists
ERROR 4031: Namespace for LOCAL temporary tables cannot be used to add design tables
ERROR 4057: New ksafety cannot be less than 0
ERROR 4078: No deployment data in string.string
ERROR 4080: No drop entries found for deployment string in workspace string
ERROR 4099: No projections found for the projection ids string string
ERROR 4103: No rows in deployment projections table
ERROR 4117: No tables found in schema string
ERROR 4118: No tables found in the table pattern given
ERROR 4119: No tables to design projections for
ERROR 4235: One of the design tables no longer exist
ERROR 4311: Override (design_override_id value) is ignored because the table string
 is no longer a design table
```

ERROR 4312: Override (design\_override\_id value) is ignored because the table does not exist

ERROR 4313: override\_type string for query (design\_query\_id value) does not exist

ERROR 4314: override\_type string is invalid

ERROR 4460: Projection string does not exist

ERROR 4461: Projection string does not exist

ERROR 4466: Projection string to be refreshed was dropped

ERROR 4475: Projection id cannot be NULL

ERROR 4476: Projection id list cannot be NULL

ERROR 4479: Projection name cannot be NULL

ERROR 4497: Query Id cannot be NULL

ERROR 4498: Query referencing EPOCH column is not supported

ERROR 4499: Query referencing local temporary table string is not supported: string

ERROR 4500: Query referencing projection string is not supported: string

ERROR 4501: Query without referencing any catalog table is not supported: string

ERROR 4503: Query table string does not exist

ERROR 4504: Query table contains multiple entries with qid = value

ERROR 4505: Query weight must be a positive number

ERROR 4525: Rebalance data cannot proceed when there are non-up-to-date projections in the catalog

ERROR 4526: Rebalance data failed during select mark\_design\_ksafe(value)

ERROR 4651: Schema string does not exist

ERROR 4652: Schema string is not a designer created schema, so it cannot be dropped

ERROR 4655: Schema name cannot be NULL

ERROR 4721: Session scoped table string is not a design table

ERROR 4783: Start deploy: deploy is already running on this node

ERROR 4819: Subqueries in UPDATE/DELETE is not supported: string

ERROR 4866: System table string is not a design table

ERROR 4874: Systems tables within system schema string cannot be added as design tables

ERROR 4885: Table string does not exist

ERROR 4886: Table string does not exist anymore in the catalog, use dbd\_remove\_design\_table('workspace', 'schema', 'table\_name')

ERROR 4888: Table string has no statistics. As a result, the proposed projections on this table may be suboptimal

ERROR 4890: Table string is not a design table

```
ERROR 4891: Table string is not a design table, referenced in query (qid=value):
 string
ERROR 4902: Table name cannot be NULL
ERROR 4906: Table or schema does not exist: string
ERROR 4907: Table pattern cannot be NULL
ERROR 4920: Terminated after SO enum. See log for the content of the SOs
ERROR 4942: The design table entry with table name string.string is corrupted, as
 that table has been renamed in the Vertica catalog
ERROR 4976: There are value nodes. Deployment K = value is not possible
ERROR 4977: There are no projections to add in deployment string for workspace
 string so no projections can be dropped
ERROR 4980: There is 1 node. Deployment K = value is not possible
ERROR 4981: There is more than one design string in workspace string
ERROR 4983: There is no design tables system table in workspace string
ERROR 4991: This invalid query cannot be loaded: string
ERROR 4994: This non-SELECT query is not supported: string
ERROR 4995: This query is not supported in DBDesigner
ERROR 5363: User string does not have privileges to access design table: string
ERROR 5364: User string does not have privileges to access table: string
ERROR 5390: User has insufficient privileges on table string
ERROR 5479: Workspace string already exists
ERROR 5480: Workspace string cannot be a virtual system schema
ERROR 5481: Workspace string does not exist
ERROR 5482: Workspace string is configured for extend_catalog so no designs can
 be computed in this workspace
ERROR 5483: Workspace string is configured for extend_catalog so remove drops is
 not supported
ERROR 5484: Workspace string is configured for extend_catalog so there are no design
 tables in this workspace
ERROR 5485: Workspace string is configured for extend_catalog, there are no design
 tables in this workspace
ERROR 5486: Workspace cannot be NULL
ERROR 5487: Workspace name cannot be NULL
ERROR 5489: Workspace schema creator name cannot be NULL
ERROR 5564: Deployment Parallelism cannot be less than zero
ERROR 5565: Deployment parallelism cannot be NULL
ERROR 5573: Error generating results set
ERROR 5575: Error querying designs table
```

ERROR 5588: Fenced mode false is not supported for *string* functions  
 ERROR 5589: Fenced mode is not supported for SQL functions  
 ERROR 5591: Hurryup parameter cannot be NULL  
 ERROR 5597: Invalid input query: '*string*'  
 ERROR 5650: Query without referencing any design tables is not supported: *string*  
 ERROR 5657: Segmentation type of the projection *string* is not supported for encoding  
     design, skipping  
 ERROR 5694: Weight for query\_text '*string*' is '*value*'. Only positive weight values  
     are accepted

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE VP000

This topic lists the error associated with the SQLSTATE value VP000. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE VP000 Description

ERRCODE\_USER\_PROC\_ERROR

### Error messages associated with this SQLState

ERROR 2059: *string* with specified name and parameters does not exist: *string*  
 ERROR 2315: Can't have more than one parameters with the same name: *string*  
 ERROR 3354: External procedures directory has not been set  
 ERROR 3355: External procedures have not been installed  
 ERROR 3465: Function cannot be moved into a system schema  
 ERROR 4322: Parameter must have names  
 ERROR 4323: Parameter type is not valid for an external procedure: *string*  
 ERROR 4373: Phase value of multi-phase transform function marked prepass  
 ERROR 4430: Procedures cannot be created in a system schema  
 ERROR 5232: Unrecognized identifier: *string*  
 ERROR 5368: User Defined Aggregates do not support fenced execution mode  
 ERROR 5370: User Defined Filters do not support fenced execution mode  
 ERROR 5372: User Defined Function type not found  
 ERROR 5373: User Defined Parsers do not support fenced execution mode  
 ERROR 5374: User Defined Scalar Function *string* is giving bad numeric precision  
     *value*, the maximum is *value*  
 ERROR 5375: User Defined Scalar Function *string* is giving bad string typmod *value*,  
     the minimum is *value*

ERROR 5376: User Defined Scalar Function *string* is giving typmod of precision *value*, larger than the max precision value

ERROR 5377: User Defined Scalar Function *string* provided non-zero precision (*value*) for Interval Year To Month

ERROR 5378: User Defined Scalar Function *string* provided precision *value*, larger than the maximum precision value

ERROR 5379: User Defined Scalar Function *string* provided range for Day To Second, but the function's return type is Interval Year To Month

ERROR 5380: User Defined Scalar Function *string* provided range for Year To Month, but the function's return type is Interval Day To Second

ERROR 5382: User Defined Sources do not support fenced execution mode

ERROR 5684: User Defined Extension cannot be created in a system schema

**Note:** The **myVertica** (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE VP001

This topic lists the error associated with the SQLSTATE value VP001. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE VP001 Description

ERRCODE\_USER\_PROC\_EXEC\_ERROR

### Error messages associated with this SQLState

ERROR 2376: Cannot connect to UDX side process (pid = *value*) during cancel: *string*

ERROR 2837: Could not create pipe for user procedure execution, errno=*value*

ERROR 2853: Could not execute user procedure: fork error

ERROR 2858: Could not find function definition

ERROR 2861: Could not find running procedure for *string*, proc ID=[*value*]

ERROR 3223: Error in calling *string()* for User Defined Function *string* at [*string:value*], error code: *value*, message: *string*

ERROR 3224: Error in calling *string()* for User Defined Scalar Function *string* at [*string:value*], error code: *value*, message: *string*

ERROR 3398: Failure in UDX RPC call *string()* (pid = *value*): *string*

ERROR 3399: Failure in UDX RPC call *string(): string*

ERROR 4424: Procedure execution error: exit status=*value*

ERROR 4425: Procedure execution error: procedure killed by signal (*value*)

ERROR 4538: Received message with unexpected type *string*

ERROR 5170: Unexpected exception from in calling *string()* for User Defined Scalar Function *string*

```
ERROR 5171: Unexpected exception in calling string() in User Defined Function
 string
ERROR 5205: Unknown error killing procedure string
ERROR 5395: User procedure execution failed
ERROR 5398: User-defined Analytic Function string produced fewer output rows than
 input rows
ERROR 5399: User-defined Scalar Function string outputted a timezone (value) not
 in allowed range (value, value)
ERROR 5400: User-defined Scalar Function string produced fewer output rows (value)
 than input rows (value)
ERROR 5430: Vertica process is not allowed to kill procedure string
ERROR 5580: Failure sending parameters block because the value parameters require
 value bytes, which exceeds the maximum size of value bytes
ERROR 5604: Invalid procedure file: [string]
ERROR 5638: Procedure file [string] cannot be owned by root
ERROR 5639: Procedure file [string] must be executable by vertica user (dbAdmin)
ERROR 5640: Procedure file [string] must be owned by specified procedure user
ERROR 5641: Procedure file [string] must enable set UID attribute
ERROR 5656: Root cannot execute external procedure
ERROR 5683: User 'string' not found on node
```

**Note:** The **myVertica** (<http://my.vertica.com>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE VX001

This topic lists the error associated with the SQLSTATE value VX001. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE VX001 Description

ERRCODE\_INTERNAL\_ERROR

### Error messages associated with this SQLState

```
ERROR 2025: string Error occurred during BZIP initialization
 BZIP error code: value
ERROR 2027: string Error occurred during ZLIB initialization
 ZLIB error code: value, Message: string
ERROR 2405: Cannot do boundary analysis on type value
ERROR 2616: Cluster recovery failed, try again
ERROR 2928: Couldn't check this session's state
ERROR 3099: Did not find a variable
```

```
ERROR 3198: Error dropping table partition, data in WOS
ERROR 3211: Error during recovery running string queries, cannot continue: string
ERROR 3212: Error during recovery running string: string
ERROR 3220: Error generating query for: string
ERROR 3245: Error parsing string
ERROR 3257: Error retrieving string in string: string
ERROR 3292: Event apply failed
ERROR 3302: Exception decoding the response we just locally encoded
ERROR 3483: Got unexpected error code from spread: value, string
ERROR 3818: JOIN qualifications to not refer to the correct relation(s)
ERROR 3969: More than one variable found
ERROR 4372: pg_analyze_and_rewrite for View query failed
ERROR 4514: Raw parse of View query string failed
ERROR 4545: Recovery Error: Cannot get projections on local node
ERROR 5236: Unrecognized node type value
ERROR 5237: Unrecognized node type value in postprocess conditions
ERROR 5526: Already have a ready_recv string, ignoring
ERROR 5539: Cannot find buddy projection's statistics for collecting row counts,
 min and max
ERROR 5540: Cannot find buddy projections for collecting row counts, min and max
ERROR 5541: Cannot find the up-nodes of buddy projection for collecting row counts,
 min and max
ERROR 5679: Unrecognized order by expression
ERROR 5680: Unrecognized select column list
ERROR 5695: With query is not a Select Statement
ERROR 5719: Path Sampling failed. Try a different random seed for the pathSampling
 hint
```

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

## Error Messages Associated with SQLSTATE VX002

This topic lists the error associated with the SQLSTATE value VX002. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

### SQLSTATE VX002 Description

ERRCODE\_DATA\_CORRUPTED

### Error messages associated with this SQLState

```

ERROR 2940: CRC Check Failure Details:
 File Name: string
 File Offset: value
 Compressed size in file: value
 Memory Address of Read Buffer: value
 Pointer to Compressed Data: value
 Memory Contents:
 string

ERROR 3030: Delete: could not find a data row to delete (data integrity violation?)

ERROR 3217: Error finalizing data file [string]

ERROR 3218: Error finalizing ROS DataTarget

ERROR 3219: Error flushing data file [string]

ERROR 3409: FileColumnReader: block string @ value's CRC value doesn't match record
 value

ERROR 3410: FileColumnReader: Decompression error in string at offset value

ERROR 4762: Sort Order Violation:
 Row Position: value
 Column Index: value
 Last Row: string
 This Row: string

ERROR 5704: Delete (Join): could not find a data row to delete (data integrity
 violation?)

```

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

### Error Messages Associated with SQLSTATE VX003

This topic lists the error associated with the SQLSTATE value VX003. See **HP Vertica SQLSTATE List** (page [609](#)) for more information.

#### SQLSTATE VX003 Description

ERRCODE\_INDEX\_CORRUPTED

### Error messages associated with this SQLState

```
ERROR 3544: Index corruption. string: string
```

**Note:** The **myVertica** (<http://my.vertica.com/>) portal's Solutions tab contains helpful troubleshooting information that may help you resolve these errors.

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