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## A.1 MySQL 8.0 FAQ: General

A.1.1. [Which version of MySQL is production-ready (GA)?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-version-ga)

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A.1.4. [Can MySQL 8.0 perform multiple-table inserts, updates, and deletes?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-do-multiple-iud)

A.1.5. [Does MySQL 8.0 have Sequences?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-have-sequences)

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A.1.7. [Does MySQL 8.0 work with multi-core processors?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-support-multi-core)

A.1.8. [Why do I see multiple processes for mysqld?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-why-multiple-processes)

A.1.9. [Can MySQL 8.0 perform ACID transactions?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-have-acid-transactions)

|  |  |
| --- | --- |
| **A.1.1.** | Which version of MySQL is production-ready (GA)? |
|  | MySQL 8.0, 5.7, and MySQL 5.6 are supported for production use.  MySQL 8.0 achieved General Availability (GA) status with MySQL 8.0.11, which was released for production use on 19 April 2018.  MySQL 5.7 achieved General Availability (GA) status with MySQL 5.7.9, which was released for production use on 21 October 2015.  MySQL 5.6 achieved General Availability (GA) status with MySQL 5.6.10, which was released for production use on 5 February 2013.  MySQL 5.5 achieved General Availability (GA) status with MySQL 5.5.8, which was released for production use on 3 December 2010. Active development for MySQL 5.5 has ended.  MySQL 5.1 achieved General Availability (GA) status with MySQL 5.1.30, which was released for production use on 14 November 2008. Active development for MySQL 5.1 has ended.  MySQL 5.0 achieved General Availability (GA) status with MySQL 5.0.15, which was released for production use on 19 October 2005. Active development for MySQL 5.0 has ended. |
| **A.1.2.** | Why did MySQL version numbering skip versions 6 and 7 and go straight to 8.0? |
|  | Due to the many new and important features we were introducing in this MySQL version, we decided to start a fresh new series. As the series numbers 6 and 7 had actually been used before by MySQL, we went to 8.0. |
| **A.1.3.** | Can MySQL 8.0 do subqueries? |
|  | Yes. See [Section 13.2.11, “Subqueries”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#subqueries). |
| **A.1.4.** | Can MySQL 8.0 perform multiple-table inserts, updates, and deletes? |
|  | Yes. For the syntax required to perform multiple-table updates, see [Section 13.2.13, “UPDATE Statement”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#update); for that required to perform multiple-table deletes, see [Section 13.2.2, “DELETE Statement”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#delete).  A multiple-table insert can be accomplished using a trigger whose **FOR EACH ROW** clause contains multiple [**INSERT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#insert) statements within a **BEGIN ... END** block. See [Section 25.3, “Using Triggers”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\stored-objects.html#triggers). |
| **A.1.5.** | Does MySQL 8.0 have Sequences? |
|  | No. However, MySQL has an **AUTO\_INCREMENT** system, which in MySQL 8.0 can also handle inserts in a multi-source replication setup. With the [**auto\_increment\_increment**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\replication.html#sysvar_auto_increment_increment) and [**auto\_increment\_offset**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\replication.html#sysvar_auto_increment_offset) system variables, you can set each server to generate auto-increment values that don't conflict with other servers. The [**auto\_increment\_increment**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\replication.html#sysvar_auto_increment_increment) value should be greater than the number of servers, and each server should have a unique offset. |
| **A.1.6.** | Does MySQL 8.0 have a [**NOW()**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\functions.html#function_now) function with fractions of seconds? |
|  | Yes, see [Section 11.2.6, “Fractional Seconds in Time Values”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#fractional-seconds). |
| **A.1.7.** | Does MySQL 8.0 work with multi-core processors? |
|  | Yes. MySQL is fully multithreaded, and makes use of all CPUs made available to it. Not all CPUs may be available; modern operating systems should be able to utilize all underlying CPUs, but also make it possible to restrict a process to a specific CPU or sets of CPUs.  On Windows, there is currently a limit to the number of (logical) processors that [**mysqld**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#mysqld) can use: a single processor group, which is limited to a maximum of 64 logical processors.  Use of multiple cores may be seen in these ways:  A single core is usually used to service the commands issued from one session.  A few background threads make limited use of extra cores; for example, to keep background I/O tasks moving.  If the database is I/O-bound (indicated by CPU consumption less than capacity), adding more CPUs is futile. If the database is partitioned into an I/O-bound part and a CPU-bond part, adding CPUs may still be useful. |
| **A.1.8.** | Why do I see multiple processes for [**mysqld**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#mysqld)? |
|  | [**mysqld**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#mysqld) is a single-process program, not a multi-process program, and does not fork or launch other processes. However, [**mysqld**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#mysqld) is multithreaded and some process-reporting system utilities display separate entries for each thread of multithreaded processes, which may lead to the appearance of multiple [**mysqld**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#mysqld) processes when in fact there is only one. |
| **A.1.9.** | Can MySQL 8.0 perform ACID transactions? |
|  | Yes. All current MySQL versions support transactions. The **InnoDB** storage engine offers full ACID transactions with row-level locking, multi-versioning, nonlocking repeatable reads, and all four SQL standard isolation levels.  The [**NDB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html) storage engine supports the [**READ COMMITTED**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\innodb-storage-engine.html#isolevel_read-committed) transaction isolation level only. |

## A.2 MySQL 8.0 FAQ: Storage Engines

A.2.1. [Where can I obtain complete documentation for MySQL storage engines?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-what-storage-engines)

A.2.2. [Are there any new storage engines in MySQL 8.0?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-have-new-storage-engines)

A.2.3. [Have any storage engines been removed in MySQL 8.0?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-removed-storage-engines)

A.2.4. [Can I prevent the use of a particular storage engine?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-disabling-storage-engines)

A.2.5. [Is there an advantage to using the InnoDB storage engine exclusively, as opposed to a combination of InnoDB and non-InnoDB storage engines?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-innodb-backup-recovery-advantage)

A.2.6. [What are the unique benefits of the ARCHIVE storage engine?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-what-archive-engine)

|  |  |
| --- | --- |
| **A.2.1.** | Where can I obtain complete documentation for MySQL storage engines? |
|  | See [Chapter 16, *Alternative Storage Engines*](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html). That chapter contains information about all MySQL storage engines except for the [**InnoDB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\innodb-storage-engine.html) storage engine and the [**NDB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html) storage engine (used for MySQL Cluster). [**InnoDB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\innodb-storage-engine.html) is covered in [Chapter 15, *The InnoDB Storage Engine*](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\innodb-storage-engine.html). [**NDB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html) is covered in [Chapter 23, *MySQL NDB Cluster 8.0*](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html). |
| **A.2.2.** | Are there any new storage engines in MySQL 8.0? |
|  | No. **InnoDB** is the default storage engine for new tables. See [Section 15.1, “Introduction to InnoDB”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\innodb-storage-engine.html#innodb-introduction) for details. |
| **A.2.3.** | Have any storage engines been removed in MySQL 8.0? |
|  | The **PARTITION** storage engine plugin which provided partitioning support is replaced by a native partitioning handler. As part of this change, the server can no longer be built using -DWITH\_PARTITION\_STORAGE\_ENGINE. **partition** is also no longer displayed in the output of [**SHOW PLUGINS**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#show-plugins), or shown in the [**INFORMATION\_SCHEMA.PLUGINS**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\information-schema.html#information-schema-plugins-table) table.  In order to support partitioning of a given table, the storage engine used for the table must now provide its own (“native”) partitioning handler. [**InnoDB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\innodb-storage-engine.html) is the only storage engine supported in MySQL 8.0 that includes a native partitioning handler. An attempt to create partitioned tables in MySQL 8.0 using any other storage engine fails. (The [**NDB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html) storage engine used by MySQL Cluster also provides its own partitioning handler, but is currently not supported by MySQL 8.0.) |
| **A.2.4.** | Can I prevent the use of a particular storage engine? |
|  | Yes. The [**disabled\_storage\_engines**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sysvar_disabled_storage_engines) configuration option defines which storage engines cannot be used to create tables or tablespaces. By default, [**disabled\_storage\_engines**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sysvar_disabled_storage_engines) is empty (no engines disabled), but it can be set to a comma-separated list of one or more engines. |
| **A.2.5.** | Is there an advantage to using the **InnoDB** storage engine exclusively, as opposed to a combination of **InnoDB** and non-**InnoDB** storage engines? |
|  | Yes. Using **InnoDB** tables exclusively can simplify backup and recovery operations. MySQL Enterprise Backup does a [hot backup](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\glossary.html#glos_hot_backup) of all tables that use the **InnoDB** storage engine. For tables using **MyISAM** or other non-**InnoDB** storage engines, it does a “warm” backup, where the database continues to run, but those tables cannot be modified while being backed up. See [Section 30.2, “MySQL Enterprise Backup Overview”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-enterprise.html#mysql-enterprise-backup). |
| **A.2.6.** | What are the unique benefits of the **ARCHIVE** storage engine? |
|  | The **ARCHIVE** storage engine stores large amounts of data without indexes; it has a small footprint, and performs selects using table scans. See [Section 16.5, “The ARCHIVE Storage Engine”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#archive-storage-engine), for details. |

## A.3 MySQL 8.0 FAQ: Server SQL Mode

A.3.1. [What are server SQL modes?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-what-sql-modes)

A.3.2. [How many server SQL modes are there?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-count-sql-modes)

A.3.3. [How do you determine the server SQL mode?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-how-see-sql-mode)

A.3.4. [Is the mode dependent on the database or connection?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-sql-mode-dependency)

A.3.5. [Can the rules for strict mode be extended?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-extend-strict-mode)

A.3.6. [Does strict mode impact performance?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-strict-impact)

A.3.7. [What is the default server SQL mode when MySQL 8.0 is installed?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-what-default-mode)

|  |  |
| --- | --- |
| **A.3.1.** | What are server SQL modes? |
|  | Server SQL modes define what SQL syntax MySQL should support and what kind of data validation checks it should perform. This makes it easier to use MySQL in different environments and to use MySQL together with other database servers. The MySQL Server apply these modes individually to different clients. For more information, see [Section 5.1.11, “Server SQL Modes”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sql-mode). |
| **A.3.2.** | How many server SQL modes are there? |
|  | Each mode can be independently switched on and off. See [Section 5.1.11, “Server SQL Modes”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sql-mode), for a complete list of available modes. |
| **A.3.3.** | How do you determine the server SQL mode? |
|  | You can set the default SQL mode (for [**mysqld**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#mysqld) startup) with the [--sql-mode](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#option_mysqld_sql-mode) option. Using the statement [**SET [GLOBAL|SESSION] sql\_mode='*modes*'**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#set-variable), you can change the settings from within a connection, either locally to the connection, or to take effect globally. You can retrieve the current mode by issuing a **SELECT @@sql\_mode** statement. |
| **A.3.4.** | Is the mode dependent on the database or connection? |
|  | A mode is not linked to a particular database. Modes can be set locally to the session (connection), or globally for the server. you can change these settings using [**SET [GLOBAL|SESSION] sql\_mode='*modes*'**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#set-variable). |
| **A.3.5.** | Can the rules for strict mode be extended? |
|  | When we refer to strict mode, we mean a mode where at least one of the modes [**TRADITIONAL**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sqlmode_traditional), [**STRICT\_TRANS\_TABLES**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sqlmode_strict_trans_tables), or [**STRICT\_ALL\_TABLES**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sqlmode_strict_all_tables) is enabled. Options can be combined, so you can add restrictions to a mode. See [Section 5.1.11, “Server SQL Modes”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sql-mode), for more information. |
| **A.3.6.** | Does strict mode impact performance? |
|  | The intensive validation of input data that some settings requires more time than if the validation is not done. While the performance impact is not that great, if you do not require such validation (perhaps your application already handles all of this), then MySQL gives you the option of leaving strict mode disabled. However, if you do require it, strict mode can provide such validation. |
| **A.3.7.** | What is the default server SQL mode when MySQL 8.0 is installed? |
|  | The default SQL mode in MySQL 8.0 includes these modes: [**ONLY\_FULL\_GROUP\_BY**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sqlmode_only_full_group_by), [**STRICT\_TRANS\_TABLES**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sqlmode_strict_trans_tables), [**NO\_ZERO\_IN\_DATE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sqlmode_no_zero_in_date), [**NO\_ZERO\_DATE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sqlmode_no_zero_date), [**ERROR\_FOR\_DIVISION\_BY\_ZERO**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sqlmode_error_for_division_by_zero), and [**NO\_ENGINE\_SUBSTITUTION**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sqlmode_no_engine_substitution).  For information about all available modes and default MySQL behavior, see [Section 5.1.11, “Server SQL Modes”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sql-mode). |

## A.4 MySQL 8.0 FAQ: Stored Procedures and Functions

A.4.1. [Does MySQL 8.0 support stored procedures and functions?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-have-procedures-functions)

A.4.2. [Where can I find documentation for MySQL stored procedures and stored functions?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-where-procedures-functions-docs)

A.4.3. [Is there a discussion forum for MySQL stored procedures?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-where-procedures-forum)

A.4.4. [Where can I find the ANSI SQL 2003 specification for stored procedures?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-where-ansi-2003-spec)

A.4.5. [How do you manage stored routines?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-how-manage-routines)

A.4.6. [Is there a way to view all stored procedures and stored functions in a given database?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-how-view-procedures-functions)

A.4.7. [Where are stored procedures stored?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-where-procedures-stored)

A.4.8. [Is it possible to group stored procedures or stored functions into packages?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-how-group-procedures-functions)

A.4.9. [Can a stored procedure call another stored procedure?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-can-procedure-call-procedure)

A.4.10. [Can a stored procedure call a trigger?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-can-procedure-call-trigger)

A.4.11. [Can a stored procedure access tables?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-can-procedure-access-table)

A.4.12. [Do stored procedures have a statement for raising application errors?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-can-procedure-raise-error)

A.4.13. [Do stored procedures provide exception handling?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-have-exceptions)

A.4.14. [Can MySQL 8.0 stored routines return result sets?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-can-routine-results)

A.4.15. [Is WITH RECOMPILE supported for stored procedures?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-have-with-recompile)

A.4.16. [Is there a MySQL equivalent to using mod\_plsql as a gateway on Apache to talk directly to a stored procedure in the database?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-have-mod-plsql)

A.4.17. [Can I pass an array as input to a stored procedure?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-can-procedure-array)

A.4.18. [Can I pass a cursor as an IN parameter to a stored procedure?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-can-pass-cursor-in)

A.4.19. [Can I return a cursor as an OUT parameter from a stored procedure?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-can-return-cursor-out)

A.4.20. [Can I print out a variable's value within a stored routine for debugging purposes?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-can-print-var-in-procedure)

A.4.21. [Can I commit or roll back transactions inside a stored procedure?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-can-rollback-transaction-procedure)

A.4.22. [Do MySQL 8.0 stored procedures and functions work with replication?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-can-procedures-replicatation)

A.4.23. [Are stored procedures and functions created on a replication source server replicated to a replica?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-are-procedures-replicated)

A.4.24. [How are actions that take place inside stored procedures and functions replicated?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-how-procedures-replicated)

A.4.25. [Are there special security requirements for using stored procedures and functions together with replication?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-security-procedures-replication)

A.4.26. [What limitations exist for replicating stored procedure and function actions?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-limitations-procedures-replication)

A.4.27. [Do the preceding limitations affect the ability of MySQL to do point-in-time recovery?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-limitations-pit-recovery)

A.4.28. [What is being done to correct the aforementioned limitations?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-when-limitations-resolved)

|  |  |
| --- | --- |
| **A.4.1.** | Does MySQL 8.0 support stored procedures and functions? |
|  | Yes. MySQL 8.0 supports two types of stored routines, stored procedures and stored functions. |
| **A.4.2.** | Where can I find documentation for MySQL stored procedures and stored functions? |
|  | See [Section 25.2, “Using Stored Routines”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\stored-objects.html#stored-routines). |
| **A.4.3.** | Is there a discussion forum for MySQL stored procedures? |
|  | Yes. See <https://forums.mysql.com/list.php?98>. |
| **A.4.4.** | Where can I find the ANSI SQL 2003 specification for stored procedures? |
|  | Unfortunately, the official specifications are not freely available (ANSI makes them available for purchase). However, there are books, such as SQL-99 Complete, Really by Peter Gulutzan and Trudy Pelzer, that provide a comprehensive overview of the standard, including coverage of stored procedures. |
| **A.4.5.** | How do you manage stored routines? |
|  | It is always good practice to use a clear naming scheme for your stored routines. You can manage stored procedures with **CREATE [FUNCTION|PROCEDURE]**, **ALTER [FUNCTION|PROCEDURE]**, **DROP [FUNCTION|PROCEDURE]**, and **SHOW CREATE [FUNCTION|PROCEDURE]**. You can obtain information about existing stored procedures using the [**ROUTINES**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\information-schema.html#information-schema-routines-table) table in the **INFORMATION\_SCHEMA** database (see [Section 26.3.30, “The INFORMATION\_SCHEMA ROUTINES Table”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\information-schema.html#information-schema-routines-table)). |
| **A.4.6.** | Is there a way to view all stored procedures and stored functions in a given database? |
|  | Yes. For a database named ***dbname***, use this query on the [**INFORMATION\_SCHEMA.ROUTINES**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\information-schema.html#information-schema-routines-table) table:  SELECT ROUTINE\_TYPE, ROUTINE\_NAME  FROM INFORMATION\_SCHEMA.ROUTINES  WHERE ROUTINE\_SCHEMA='***dbname***';  For more information, see [Section 26.3.30, “The INFORMATION\_SCHEMA ROUTINES Table”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\information-schema.html#information-schema-routines-table).  The body of a stored routine can be viewed using [**SHOW CREATE FUNCTION**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#show-create-function) (for a stored function) or [**SHOW CREATE PROCEDURE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#show-create-procedure) (for a stored procedure). See [Section 13.7.7.9, “SHOW CREATE PROCEDURE Statement”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#show-create-procedure), for more information. |
| **A.4.7.** | Where are stored procedures stored? |
|  | Stored procedures are stored in the **mysql.routines** and **mysql.parameters** tables, which are part of the data dictionary. You cannot access these tables directly. Instead, query the **INFORMATION\_SCHEMA** [**ROUTINES**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\information-schema.html#information-schema-routines-table) and [**PARAMETERS**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\information-schema.html#information-schema-parameters-table) tables. See [Section 26.3.30, “The INFORMATION\_SCHEMA ROUTINES Table”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\information-schema.html#information-schema-routines-table), and [Section 26.3.20, “The INFORMATION\_SCHEMA PARAMETERS Table”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\information-schema.html#information-schema-parameters-table).  You can also use [**SHOW CREATE FUNCTION**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#show-create-function) to obtain information about stored functions, and [**SHOW CREATE PROCEDURE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#show-create-procedure) to obtain information about stored procedures. See [Section 13.7.7.9, “SHOW CREATE PROCEDURE Statement”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#show-create-procedure). |
| **A.4.8.** | Is it possible to group stored procedures or stored functions into packages? |
|  | No. This is not supported in MySQL 8.0. |
| **A.4.9.** | Can a stored procedure call another stored procedure? |
|  | Yes. |
| **A.4.10.** | Can a stored procedure call a trigger? |
|  | A stored procedure can execute an SQL statement, such as an [**UPDATE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#update), that causes a trigger to activate. |
| **A.4.11.** | Can a stored procedure access tables? |
|  | Yes. A stored procedure can access one or more tables as required. |
| **A.4.12.** | Do stored procedures have a statement for raising application errors? |
|  | Yes. MySQL 8.0 implements the SQL standard **SIGNAL** and **RESIGNAL** statements. See [Section 13.6.7, “Condition Handling”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#condition-handling). |
| **A.4.13.** | Do stored procedures provide exception handling? |
|  | MySQL implements [**HANDLER**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#handler) definitions according to the SQL standard. See [Section 13.6.7.2, “DECLARE ... HANDLER Statement”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#declare-handler), for details. |
| **A.4.14.** | Can MySQL 8.0 stored routines return result sets? |
|  | Stored procedures can, but stored functions cannot. If you perform an ordinary [**SELECT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#select) inside a stored procedure, the result set is returned directly to the client. You need to use the MySQL 4.1 (or higher) client/server protocol for this to work. This means that, for example, in PHP, you need to use the **mysqli** extension rather than the old **mysql** extension. |
| **A.4.15.** | Is **WITH RECOMPILE** supported for stored procedures? |
|  | Not in MySQL 8.0. |
| **A.4.16.** | Is there a MySQL equivalent to using **mod\_plsql** as a gateway on Apache to talk directly to a stored procedure in the database? |
|  | There is no equivalent in MySQL 8.0. |
| **A.4.17.** | Can I pass an array as input to a stored procedure? |
|  | Not in MySQL 8.0. |
| **A.4.18.** | Can I pass a cursor as an **IN** parameter to a stored procedure? |
|  | In MySQL 8.0, cursors are available inside stored procedures only. |
| **A.4.19.** | Can I return a cursor as an **OUT** parameter from a stored procedure? |
|  | In MySQL 8.0, cursors are available inside stored procedures only. However, if you do not open a cursor on a [**SELECT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#select), the result is sent directly to the client. You can also **SELECT INTO** variables. See [Section 13.2.10, “SELECT Statement”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#select). |
| **A.4.20.** | Can I print out a variable's value within a stored routine for debugging purposes? |
|  | Yes, you can do this in a stored procedure, but not in a stored function. If you perform an ordinary [**SELECT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#select) inside a stored procedure, the result set is returned directly to the client. You must use the MySQL 4.1 (or above) client/server protocol for this to work. This means that, for example, in PHP, you need to use the **mysqli** extension rather than the old **mysql** extension. |
| **A.4.21.** | Can I commit or roll back transactions inside a stored procedure? |
|  | Yes. However, you cannot perform transactional operations within a stored function. |
| **A.4.22.** | Do MySQL 8.0 stored procedures and functions work with replication? |
|  | Yes, standard actions carried out in stored procedures and functions are replicated from a replication source server to a replica. There are a few limitations that are described in detail in [Section 25.7, “Stored Program Binary Logging”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\stored-objects.html#stored-programs-logging). |
| **A.4.23.** | Are stored procedures and functions created on a replication source server replicated to a replica? |
|  | Yes, creation of stored procedures and functions carried out through normal DDL statements on a replication source server are replicated to a replica, so that the objects exist on both servers. **ALTER** and **DROP** statements for stored procedures and functions are also replicated. |
| **A.4.24.** | How are actions that take place inside stored procedures and functions replicated? |
|  | MySQL records each DML event that occurs in a stored procedure and replicates those individual actions to a replica. The actual calls made to execute stored procedures are not replicated.  Stored functions that change data are logged as function invocations, not as the DML events that occur inside each function. |
| **A.4.25.** | Are there special security requirements for using stored procedures and functions together with replication? |
|  | Yes. Because a replica has authority to execute any statement read from a source's binary log, special security constraints exist for using stored functions with replication. If replication or binary logging in general (for the purpose of point-in-time recovery) is active, then MySQL DBAs have two security options open to them:  Any user wishing to create stored functions must be granted the [**SUPER**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\security.html#priv_super) privilege.  Alternatively, a DBA can set the [**log\_bin\_trust\_function\_creators**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\replication.html#sysvar_log_bin_trust_function_creators) system variable to 1, which enables anyone with the standard [**CREATE ROUTINE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\security.html#priv_create-routine) privilege to create stored functions. |
| **A.4.26.** | What limitations exist for replicating stored procedure and function actions? |
|  | Nondeterministic (random) or time-based actions embedded in stored procedures may not replicate properly. By their very nature, randomly produced results are not predictable and cannot be exactly reproduced; therefore, random actions replicated to a replica do not mirror those performed on a source. Declaring stored functions to be **DETERMINISTIC** or setting the [**log\_bin\_trust\_function\_creators**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\replication.html#sysvar_log_bin_trust_function_creators) system variable to 0 keeps random operations producing random values from being invoked.  In addition, time-based actions cannot be reproduced on a replica because the timing of such actions in a stored procedure is not reproducible through the binary log used for replication. It records only DML events and does not factor in timing constraints.  Finally, nontransactional tables for which errors occur during large DML actions (such as bulk inserts) may experience replication issues in that a source may be partially updated from DML activity, but no updates are done to the replica because of the errors that occurred. A workaround is for a function's DML actions to be carried out with the **IGNORE** keyword so that updates on the source that cause errors are ignored and updates that do not cause errors are replicated to the replica. |
| **A.4.27.** | Do the preceding limitations affect the ability of MySQL to do point-in-time recovery? |
|  | The same limitations that affect replication do affect point-in-time recovery. |
| **A.4.28.** | What is being done to correct the aforementioned limitations? |
|  | You can choose either statement-based replication or row-based replication. The original replication implementation is based on statement-based binary logging. Row-based binary logging resolves the limitations mentioned earlier.  Mixed replication is also available (by starting the server with [--binlog-format=mixed](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\replication.html#sysvar_binlog_format)). This hybrid form of replication “knows” whether statement-level replication can safely be used, or row-level replication is required.  For additional information, see [Section 17.2.1, “Replication Formats”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\replication.html#replication-formats). |

## A.5 MySQL 8.0 FAQ: Triggers

A.5.1. [Where can I find the documentation for MySQL 8.0 triggers?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-where-triggers-docs)

A.5.2. [Is there a discussion forum for MySQL Triggers?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-where-triggers-forum)

A.5.3. [Does MySQL 8.0 have statement-level or row-level triggers?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-have-trigger-levels)

A.5.4. [Are there any default triggers?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-have-trigger-defaults)

A.5.5. [How are triggers managed in MySQL?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-how-triggers-managed)

A.5.6. [Is there a way to view all triggers in a given database?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-can-view-all-triggers)

A.5.7. [Where are triggers stored?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-how-triggers-stored)

A.5.8. [Can a trigger call a stored procedure?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-can-trigger-procedure)

A.5.9. [Can triggers access tables?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-can-triggers-tables)

A.5.10. [Can a table have multiple triggers with the same trigger event and action time?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-can-triggers-same-events)

A.5.11. [Can triggers call an external application through a UDF?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-can-triggers-udf)

A.5.12. [Is it possible for a trigger to update tables on a remote server?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-can-triggers-remote)

A.5.13. [Do triggers work with replication?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-can-triggers-replication)

A.5.14. [How are actions carried out through triggers on a source replicated to a replica?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-how-triggers-source-replica)

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| **A.5.1.** | Where can I find the documentation for MySQL 8.0 triggers? |
|  | See [Section 25.3, “Using Triggers”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\stored-objects.html#triggers). |
| **A.5.2.** | Is there a discussion forum for MySQL Triggers? |
|  | Yes. It is available at <https://forums.mysql.com/list.php?99>. |
| **A.5.3.** | Does MySQL 8.0 have statement-level or row-level triggers? |
|  | In MySQL 8.0, all triggers are **FOR EACH ROW**; that is, the trigger is activated for each row that is inserted, updated, or deleted. MySQL 8.0 does not support triggers using **FOR EACH STATEMENT**. |
| **A.5.4.** | Are there any default triggers? |
|  | Not explicitly. MySQL does have specific special behavior for some [**TIMESTAMP**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#datetime) columns, as well as for columns which are defined using **AUTO\_INCREMENT**. |
| **A.5.5.** | How are triggers managed in MySQL? |
|  | In MySQL 8.0, triggers can be created using the [**CREATE TRIGGER**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#create-trigger) statement, and dropped using [**DROP TRIGGER**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#drop-trigger). See [Section 13.1.22, “CREATE TRIGGER Statement”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#create-trigger), and [Section 13.1.34, “DROP TRIGGER Statement”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#drop-trigger), for more about these statements.  Information about triggers can be obtained by querying the [**INFORMATION\_SCHEMA.TRIGGERS**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\information-schema.html#information-schema-triggers-table) table. See [Section 26.3.45, “The INFORMATION\_SCHEMA TRIGGERS Table”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\information-schema.html#information-schema-triggers-table). |
| **A.5.6.** | Is there a way to view all triggers in a given database? |
|  | Yes. You can obtain a listing of all triggers defined on database **dbname** using a query on the [**INFORMATION\_SCHEMA.TRIGGERS**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\information-schema.html#information-schema-triggers-table) table such as the one shown here:  SELECT TRIGGER\_NAME, EVENT\_MANIPULATION, EVENT\_OBJECT\_TABLE, ACTION\_STATEMENT  FROM INFORMATION\_SCHEMA.TRIGGERS  WHERE TRIGGER\_SCHEMA='***dbname***';  For more information about this table, see [Section 26.3.45, “The INFORMATION\_SCHEMA TRIGGERS Table”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\information-schema.html#information-schema-triggers-table).  You can also use the [**SHOW TRIGGERS**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#show-triggers) statement, which is specific to MySQL. See [Section 13.7.7.40, “SHOW TRIGGERS Statement”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#show-triggers). |
| **A.5.7.** | Where are triggers stored? |
|  | Triggers are stored in the **mysql.triggers** system table, which is part of the data dictionary. |
| **A.5.8.** | Can a trigger call a stored procedure? |
|  | Yes. |
| **A.5.9.** | Can triggers access tables? |
|  | A trigger can access both old and new data in its own table. A trigger can also affect other tables, but it is not permitted to modify a table that is already being used (for reading or writing) by the statement that invoked the function or trigger. |
| **A.5.10.** | Can a table have multiple triggers with the same trigger event and action time? |
|  | In MySQL 8.0, it is possible to define multiple triggers for a given table that have the same trigger event and action time. For example, you can have two **BEFORE UPDATE** triggers for a table. By default, triggers that have the same trigger event and action time activate in the order they were created. To affect trigger order, specify a clause after **FOR EACH ROW** that indicates **FOLLOWS** or **PRECEDES** and the name of an existing trigger that also has the same trigger event and action time. With **FOLLOWS**, the new trigger activates after the existing trigger. With **PRECEDES**, the new trigger activates before the existing trigger. |
| **A.5.11.** | Can triggers call an external application through a UDF? |
|  | Yes. For example, a trigger could invoke the **sys\_exec()** UDF. |
| **A.5.12.** | Is it possible for a trigger to update tables on a remote server? |
|  | Yes. A table on a remote server could be updated using the **FEDERATED** storage engine. (See [Section 16.8, “The FEDERATED Storage Engine”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#federated-storage-engine)). |
| **A.5.13.** | Do triggers work with replication? |
|  | Yes. However, the way in which they work depends whether you are using MySQL's “classic” statement-based or row-based replication format.  When using statement-based replication, triggers on the replica are executed by statements that are executed on the source (and replicated to the replica).  When using row-based replication, triggers are not executed on the replica due to statements that were run on the source and then replicated to the replica. Instead, when using row-based replication, the changes caused by executing the trigger on the source are applied on the replica.  For more information, see [Section 17.5.1.36, “Replication and Triggers”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\replication.html#replication-features-triggers). |
| **A.5.14.** | How are actions carried out through triggers on a source replicated to a replica? |
|  | Again, this depends on whether you are using statement-based or row-based replication.  **Statement-based replication.** First, the triggers that exist on a source must be re-created on the replica server. Once this is done, the replication flow works as any other standard DML statement that participates in replication. For example, consider a table **EMP** that has an **AFTER** insert trigger, which exists on a replication source server. The same **EMP** table and **AFTER** insert trigger exist on the replica server as well. The replication flow would be:  An [**INSERT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#insert) statement is made to **EMP**.  The **AFTER** trigger on **EMP** activates.  The [**INSERT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#insert) statement is written to the binary log.  The replica picks up the [**INSERT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#insert) statement to **EMP** and executes it.  The **AFTER** trigger on **EMP** that exists on the replica activates.  **Row-based replication.** When you use row-based replication, the changes caused by executing the trigger on the source are applied on the replica. However, the triggers themselves are not actually executed on the replica under row-based replication. This is because, if both the source and the replica applied the changes from the source and, in addition, the trigger causing these changes were applied on the replica, the changes would in effect be applied twice on the replica, leading to different data on the source and the replica.  In most cases, the outcome is the same for both row-based and statement-based replication. However, if you use different triggers on the source and replica, you cannot use row-based replication. (This is because the row-based format replicates the changes made by triggers executing on the source to the replicas, rather than the statements that caused the triggers to execute, and the corresponding triggers on the replica are not executed.) Instead, any statements causing such triggers to be executed must be replicated using statement-based replication.  For more information, see [Section 17.5.1.36, “Replication and Triggers”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\replication.html#replication-features-triggers). |

## A.6 MySQL 8.0 FAQ: Views

A.6.1. [Where can I find documentation covering MySQL Views?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-where-docs-views)

A.6.2. [Is there a discussion forum for MySQL Views?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-where-views-forum)

A.6.3. [What happens to a view if an underlying table is dropped or renamed?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-where-view-dropped-table)

A.6.4. [Does MySQL 8.0 have table snapshots?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-have-table-snapshots)

A.6.5. [Does MySQL 8.0 have materialized views?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-have-materialized-views)

A.6.6. [Can you insert into views that are based on joins?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-can-insert-joins-views)

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| **A.6.1.** | Where can I find documentation covering MySQL Views? |
|  | See [Section 25.5, “Using Views”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\stored-objects.html#views). |
| **A.6.2.** | Is there a discussion forum for MySQL Views? |
|  | Yes. See <https://forums.mysql.com/list.php?100> |
| **A.6.3.** | What happens to a view if an underlying table is dropped or renamed? |
|  | After a view has been created, it is possible to drop or alter a table or view to which the definition refers. To check a view definition for problems of this kind, use the [**CHECK TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#check-table) statement. (See [Section 13.7.3.2, “CHECK TABLE Statement”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#check-table).) |
| **A.6.4.** | Does MySQL 8.0 have table snapshots? |
|  | No. |
| **A.6.5.** | Does MySQL 8.0 have materialized views? |
|  | No. |
| **A.6.6.** | Can you insert into views that are based on joins? |
|  | It is possible, provided that your [**INSERT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#insert) statement has a column list that makes it clear there is only one table involved.  You cannot insert into multiple tables with a single insert on a view. |

## A.7 MySQL 8.0 FAQ: INFORMATION\_SCHEMA

A.7.1. [Where can I find documentation for the MySQL INFORMATION\_SCHEMA database?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-where-docs-information-schema)

A.7.2. [Is there a discussion forum for INFORMATION\_SCHEMA?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-where-forum-information-schema)

A.7.3. [Where can I find the ANSI SQL 2003 specification for INFORMATION\_SCHEMA?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-where-ansi-information-schema)

A.7.4. [What is the difference between the Oracle Data Dictionary and MySQL INFORMATION\_SCHEMA?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-compare-oracle-data-dir-info-schema)

A.7.5. [Can I add to or otherwise modify the tables found in the INFORMATION\_SCHEMA database?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-can-modify-information-schema)

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| **A.7.1.** | Where can I find documentation for the MySQL **INFORMATION\_SCHEMA** database? |
|  | See [Chapter 26, *INFORMATION\_SCHEMA Tables*](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\information-schema.html) |
| **A.7.2.** | Is there a discussion forum for **INFORMATION\_SCHEMA**? |
|  | See <https://forums.mysql.com/list.php?101>. |
| **A.7.3.** | Where can I find the ANSI SQL 2003 specification for **INFORMATION\_SCHEMA**? |
|  | Unfortunately, the official specifications are not freely available. (ANSI makes them available for purchase.) However, there are books available, such as SQL-99 Complete, Really by Peter Gulutzan and Trudy Pelzer, that provide a comprehensive overview of the standard, including **INFORMATION\_SCHEMA**. |
| **A.7.4.** | What is the difference between the Oracle Data Dictionary and MySQL **INFORMATION\_SCHEMA**? |
|  | Both Oracle and MySQL provide metadata in tables. However, Oracle and MySQL use different table names and column names. The MySQL implementation is more similar to those found in DB2 and SQL Server, which also support **INFORMATION\_SCHEMA** as defined in the SQL standard. |
| **A.7.5.** | Can I add to or otherwise modify the tables found in the **INFORMATION\_SCHEMA** database? |
|  | No. Since applications may rely on a certain standard structure, this should not be modified. For this reason, we cannot support bugs or other issues which result from modifying ***INFORMATION\_SCHEMA*** tables or data. |

## A.8 MySQL 8.0 FAQ: Migration

A.8.1. [Where can I find information on how to migrate from MySQL 5.7 to MySQL 8.0?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-how-migration-mysql)

A.8.2. [How has storage engine (table type) support changed in MySQL 8.0 from previous versions?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-how-storage-engines-changed)

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| **A.8.1.** | Where can I find information on how to migrate from MySQL 5.7 to MySQL 8.0? |
|  | For detailed upgrade information, see [Section 2.11, “Upgrading MySQL”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\installing.html#upgrading). Do not skip a major version when upgrading, but rather complete the process in steps, upgrading from one major version to the next in each step. This may seem more complicated, but ultimately saves time and trouble. If you encounter problems during the upgrade, their origin is easier to identify, either by you or, if you have a MySQL Enterprise subscription, by MySQL support. |
| **A.8.2.** | How has storage engine (table type) support changed in MySQL 8.0 from previous versions? |
|  | Storage engine support has changed as follows:  Support for **ISAM** tables was removed in MySQL 5.0 and you should now use the **MyISAM** storage engine in place of **ISAM**. To convert a table ***tblname*** from **ISAM** to **MyISAM**, simply issue a statement such as this one:  ALTER TABLE ***tblname*** ENGINE=MYISAM;  Internal **RAID** for **MyISAM** tables was also removed in MySQL 5.0. This was formerly used to allow large tables in file systems that did not support file sizes greater than 2GB. All modern file systems allow for larger tables; in addition, there are now other solutions such as **MERGE** tables and views.  The [**VARCHAR**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#char) column type now retains trailing spaces in all storage engines.  **MEMORY** tables (formerly known as **HEAP** tables) can also contain [**VARCHAR**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#char) columns. |

## A.9 MySQL 8.0 FAQ: Security

A.9.1. [Where can I find documentation that addresses security issues for MySQL?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-where-docs-security)

A.9.2. [What is the default authentication plugin in MySQL 8.0?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-default-authentication-plugin)

A.9.3. [Does MySQL 8.0 have native support for SSL?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-have-native-ssl)

A.9.4. [Is SSL support built into MySQL binaries, or must I recompile the binary myself to enable it?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-is-ssl-available)

A.9.5. [Does MySQL 8.0 have built-in authentication against LDAP directories?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-have-builtin-ldap)

A.9.6. [Does MySQL 8.0 include support for Roles Based Access Control (RBAC)?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-have-builtin-rbac)

|  |  |
| --- | --- |
| **A.9.1.** | Where can I find documentation that addresses security issues for MySQL? |
|  | The best place to start is [Chapter 6, *Security*](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\security.html).  Other portions of the MySQL Documentation which you may find useful with regard to specific security concerns include the following:  [Section 6.1.1, “Security Guidelines”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\security.html#security-guidelines).  [Section 6.1.3, “Making MySQL Secure Against Attackers”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\security.html#security-against-attack).  [Section B.3.3.2, “How to Reset the Root Password”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\error-handling.html#resetting-permissions).  [Section 6.1.5, “How to Run MySQL as a Normal User”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\security.html#changing-mysql-user).  [UDF Security Precautions](https://dev.mysql.com/doc/extending-mysql/8.0/en/adding-udf.html#udf-security).  [Section 6.1.4, “Security-Related mysqld Options and Variables”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\security.html#security-options).  [Section 6.1.6, “Security Considerations for LOAD DATA LOCAL”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\security.html#load-data-local-security).  [Section 2.10, “Postinstallation Setup and Testing”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\installing.html#postinstallation).  [Section 6.3, “Using Encrypted Connections”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\security.html#encrypted-connections).  There is also the [Secure Deployment Guide](https://dev.mysql.com/doc/mysql-secure-deployment-guide/8.0/en/), which provides procedures for deploying a generic binary distribution of MySQL Enterprise Edition Server with features for managing the security of your MySQL installation. |
| **A.9.2.** | What is the default authentication plugin in MySQL 8.0? |
|  | The default authentication plugin in MySQL 8.0 is **caching\_sha2\_password**. For information about this plugin, see [Section 6.4.1.2, “Caching SHA-2 Pluggable Authentication”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\security.html#caching-sha2-pluggable-authentication).  The **caching\_sha2\_password** plugin provides more secure password encryption than the **mysql\_native\_password** plugin (the default plugin in previous MySQL series). For information about the implications of this change of default plugin for server operation and compatibility of the server with clients and connectors, see [caching\_sha2\_password as the Preferred Authentication Plugin](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\installing.html#upgrade-caching-sha2-password).  For general information about pluggable authentication and other available authentication plugins, see [Section 6.2.17, “Pluggable Authentication”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\security.html#pluggable-authentication), and [Section 6.4.1, “Authentication Plugins”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\security.html#authentication-plugins). |
| **A.9.3.** | Does MySQL 8.0 have native support for SSL? |
|  | Most 8.0 binaries have support for SSL connections between the client and server. See [Section 6.3, “Using Encrypted Connections”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\security.html#encrypted-connections).  You can also tunnel a connection using SSH, if (for example) the client application does not support SSL connections. For an example, see [Section 6.3.4, “Connecting to MySQL Remotely from Windows with SSH”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\security.html#windows-and-ssh). |
| **A.9.4.** | Is SSL support built into MySQL binaries, or must I recompile the binary myself to enable it? |
|  | Most 8.0 binaries have SSL enabled for client/server connections that are secured, authenticated, or both. See [Section 6.3, “Using Encrypted Connections”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\security.html#encrypted-connections). |
| **A.9.5.** | Does MySQL 8.0 have built-in authentication against LDAP directories? |
|  | The Enterprise edition includes a [PAM Authentication Plugin](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\security.html#pam-pluggable-authentication) that supports authentication against an LDAP directory. |
| **A.9.6.** | Does MySQL 8.0 include support for Roles Based Access Control (RBAC)? |
|  | Not at this time. |

## A.10 MySQL 8.0 FAQ: NDB Cluster

In the following section, we answer questions that are frequently asked about MySQL NDB Cluster and the [**NDB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html) storage engine.

A.10.1. [Which versions of the MySQL software support NDB Cluster? Do I have to compile from source?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-which-versions-support-cluster)

A.10.2. [What do “NDB” and “NDBCLUSTER” mean?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-what-is-ndb)

A.10.3. [What is the difference between using NDB Cluster versus using MySQL Replication?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-what-cluster-vs-replication)

A.10.4. [Do I need any special networking to run NDB Cluster? How do computers in a cluster communicate?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-how-cluster-network-need)

A.10.5. [How many computers do I need to run an NDB Cluster, and why?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-what-min-hosts-cluster)

A.10.6. [What do the different computers do in an NDB Cluster?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-what-hosts-do-clustering)

A.10.7. [When I run the SHOW command in the NDB Cluster management client, I see a line of output that looks like this:](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-what-show-nodegroup-star)

A.10.8. [With which operating systems can I use NDB Cluster?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-which-os-clustering)

A.10.9. [What are the hardware requirements for running NDB Cluster?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-what-cluster-requirements)

A.10.10. [How much RAM do I need to use NDB Cluster? Is it possible to use disk memory at all?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-what-memory-needed-cluster)

A.10.11. [What file systems can I use with NDB Cluster? What about network file systems or network shares?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-what-cluster-file-systems)

A.10.12. [Can I run NDB Cluster nodes inside virtual machines (such as those created by VMWare, VirtualBox, Parallels, or Xen)?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-can-cluster-vm)

A.10.13. [I am trying to populate an NDB Cluster database. The loading process terminates prematurely and I get an error message like this one:](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-why-error-1114)

A.10.14. [NDB Cluster uses TCP/IP. Does this mean that I can run it over the Internet, with one or more nodes in remote locations?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-can-cluster-remote-network)

A.10.15. [Do I have to learn a new programming or query language to use NDB Cluster?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-what-language-needed-cluster)

A.10.16. [What programming languages and APIs are supported by NDB Cluster?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-what-api-cluster-support)

A.10.17. [Does NDB Cluster include any management tools?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-what-cluster-management-tools)

A.10.18. [How do I find out what an error or warning message means when using NDB Cluster?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-what-cluster-errors-are)

A.10.19. [Is NDB Cluster transaction-safe? What isolation levels are supported?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-is-cluster-transaction-safe)

A.10.20. [What storage engines are supported by NDB Cluster?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-what-storage-engines-cluster)

A.10.21. [In the event of a catastrophic failure— for example, the whole city loses power and my UPS fails—would I lose all my data?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-is-data-loss-no-power)

A.10.22. [Is it possible to use FULLTEXT indexes with NDB Cluster?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-can-cluster-fullindex)

A.10.23. [Can I run multiple nodes on a single computer?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-can-multinode-cluster-one-host)

A.10.24. [Can I add data nodes to an NDB Cluster without restarting it?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-how-add-nodes-no-restart)

A.10.25. [Are there any limitations that I should be aware of when using NDB Cluster?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-what-cluster-limitations)

A.10.26. [Does NDB Cluster support foreign keys?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-have-foreign-keys-cluster)

A.10.27. [How do I import an existing MySQL database into an NDB Cluster?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-how-import-db-cluster)

A.10.28. [How do NDB Cluster nodes communicate with one another?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-how-nodes-communicate)

A.10.29. [What is an arbitrator?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-what-is-arbitrator)

A.10.30. [What data types are supported by NDB Cluster?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-what-types-cluster-support)

A.10.31. [How do I start and stop NDB Cluster?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-how-start-stop-cluster)

A.10.32. [What happens to NDB Cluster data when the NDB Cluster is shut down?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-what-shutdown-do-data)

A.10.33. [Is it a good idea to have more than one management node for an NDB Cluster?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-have-multiple-node-managers)

A.10.34. [Can I mix different kinds of hardware and operating systems in one NDB Cluster?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-have-different-cluster-hosts)

A.10.35. [Can I run two data nodes on a single host? Two SQL nodes?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-have-multiple-nodes-one-host)

A.10.36. [Can I use host names with NDB Cluster?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-have-host-names-cluster)

A.10.37. [Does NDB Cluster support IPv6?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-have-ipv6-support-cluster)

A.10.38. [How do I handle MySQL users in an NDB Cluster having multiple MySQL servers?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-have-multiple-users-servers-cluster)

A.10.39. [How do I continue to send queries in the event that one of the SQL nodes fails?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-how-continue-after-node-error)

A.10.40. [How do I back up and restore an NDB Cluster?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-how-backup-restore-cluster)

A.10.41. [What is an “angel process”?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cluster-what-angel-process)

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| **A.10.1.** | Which versions of the MySQL software support NDB Cluster? Do I have to compile from source? |
|  | NDB Cluster is not supported in standard MySQL Server 8.0 releases. Instead, MySQL NDB Cluster is provided as a separate product. Available NDB Cluster release series include the following:  **NDB Cluster 7.2.** This series is no longer supported for new deployments or maintained. Users of NDB Cluster 7.2 should upgrade to a newer release series as soon as possible. We recommend that new deployments use the latest NDB Cluster 8.0 release.  **NDB Cluster 7.3.** This series is a previous General Availability (GA) version of NDB Cluster, still available for production use, although we recommend that new deployments use the latest NDB Cluster 8.0 release. The most recent NDB Cluster 7.3 release can be obtained from <https://dev.mysql.com/downloads/cluster/>.  **NDB Cluster 7.4.** This series is a previous General Availability (GA) version of NDB Cluster, still available for production use, although we recommend that new deployments use the latest NDB Cluster 8.0 release. The most recent NDB Cluster 7.4 release can be obtained from <https://dev.mysql.com/downloads/cluster/>.  **NDB Cluster 7.5.** This series is a previous General Availability (GA) version of NDB Cluster, still available for production use, although we recommend that new deployments use the latest NDB Cluster 7.6 release. The latest NDB Cluster 7.5 releases can be obtained from <https://dev.mysql.com/downloads/cluster/>.  **NDB Cluster 7.6.** This series is a previous General Availability (GA) version of NDB Cluster, still available for production use, although we recommend that new deployments use the latest NDB Cluster 8.0 release. The latest NDB Cluster 7.6 releases can be obtained from <https://dev.mysql.com/downloads/cluster/>.  **NDB Cluster 8.0.** This series is the most recent General Availability (GA) version of NDB Cluster, based on version 8.0 of the [**NDB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html) storage engine and MySQL Server 8.0. NDB Cluster 8.0 is available for production use; new deployments intended for production should use the latest GA release in this series, which is currently NDB Cluster 8.0.24. You can obtain the most recent NDB Cluster 8.0 release from <https://dev.mysql.com/downloads/cluster/>. For information about new features and other important changes in this series, see [Section 23.1.4, “What is New in NDB Cluster”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-what-is-new).  You can obtain and compile NDB Cluster from source (see [Section 23.2.1.4, “Building NDB Cluster from Source on Linux”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-install-linux-source), and [Section 23.2.2.2, “Compiling and Installing NDB Cluster from Source on Windows”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-install-windows-source)), but for all but the most specialized cases, we recommend using one of the following installers provided by Oracle that is appropriate to your operating platform and circumstances:  The web-based [NDB Cluster Auto-Installer](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-installer) (works on all platforms supported by **NDB**)  Linux [binary release](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-install-linux-binary) (tar.gz file)  Linux [RPM package](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-install-linux-rpm)  Linux [.deb file](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-install-debian)  Windows [binary “no-install” release](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-install-windows-binary)  Windows [MSI Installer](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\installing.html#mysql-installer)  Installation packages may also be available from your platform's package management system.  You can determine whether your MySQL Server has [**NDB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html) support using one of the statements **SHOW VARIABLES LIKE 'have\_%'**, [**SHOW ENGINES**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#show-engines), or [**SHOW PLUGINS**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#show-plugins). |
| **A.10.2.** | What do “NDB” and “NDBCLUSTER” mean? |
|  | “NDB” stands for “***N***etwork ***D***ata***b***ase”. **NDB** and **NDBCLUSTER** are both names for the storage engine that enables clustering support with MySQL. **NDB** is preferred, but either name is correct. |
| **A.10.3.** | What is the difference between using NDB Cluster versus using MySQL Replication? |
|  | In traditional MySQL replication, a source MySQL server updates one or more replicas. Transactions are committed sequentially, and a slow transaction can cause the replica to lag behind the source. This means that if the source fails, it is possible that the replica might not have recorded the last few transactions. If a transaction-safe engine such as [**InnoDB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\innodb-storage-engine.html) is being used, a transaction is either completed on the replica or not applied at all, but replication does not guarantee that all data on the source and the replica remains consistent at all times. In NDB Cluster, all data nodes are kept in synchrony, and a transaction committed by any one data node is committed for all data nodes. In the event of a data node failure, all remaining data nodes remain in a consistent state.  In short, whereas standard MySQL replication is asynchronous, NDB Cluster is synchronous.  Asynchronous replication is also available in NDB Cluster. NDB Cluster Replication (also sometimes known as “geo-replication”) includes the capability to replicate both between two NDB Clusters, and from an NDB Cluster to a non-Cluster MySQL server. See [Section 23.6, “NDB Cluster Replication”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-replication). |
| **A.10.4.** | Do I need any special networking to run NDB Cluster? How do computers in a cluster communicate? |
|  | NDB Cluster is intended to be used in a high-bandwidth environment, with computers connecting using TCP/IP. Its performance depends directly upon the connection speed between the cluster's computers. The minimum connectivity requirements for NDB Cluster include a typical 100-megabit Ethernet network or the equivalent. We recommend you use gigabit Ethernet whenever available. |
| **A.10.5.** | How many computers do I need to run an NDB Cluster, and why? |
|  | A minimum of three computers is required to run a viable cluster. However, the minimum recommended number of computers in an NDB Cluster is four: one each to run the management and SQL nodes, and two computers to serve as data nodes. The purpose of the two data nodes is to provide redundancy; the management node must run on a separate machine to guarantee continued arbitration services in the event that one of the data nodes fails.  To provide increased throughput and high availability, you should use multiple SQL nodes (MySQL Servers connected to the cluster). It is also possible (although not strictly necessary) to run multiple management servers. |
| **A.10.6.** | What do the different computers do in an NDB Cluster? |
|  | An NDB Cluster has both a physical and logical organization, with computers being the physical elements. The logical or functional elements of a cluster are referred to as nodes, and a computer housing a cluster node is sometimes referred to as a cluster host. There are three types of nodes, each corresponding to a specific role within the cluster. These are:  **Management node.** This node provides management services for the cluster as a whole, including startup, shutdown, backups, and configuration data for the other nodes. The management node server is implemented as the application [**ndb\_mgmd**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-programs-ndb-mgmd); the management client used to control NDB Cluster is [**ndb\_mgm**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-programs-ndb-mgm). See [Section 23.4.4, “ndb\_mgmd — The NDB Cluster Management Server Daemon”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-programs-ndb-mgmd), and [Section 23.4.5, “ndb\_mgm — The NDB Cluster Management Client”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-programs-ndb-mgm), for information about these programs.  **Data node.** This type of node stores and replicates data. Data node functionality is handled by instances of the [**NDB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html) data node process [**ndbd**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-programs-ndbd). For more information, see [Section 23.4.1, “ndbd — The NDB Cluster Data Node Daemon”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-programs-ndbd).  **SQL node.** This is simply an instance of MySQL Server ([**mysqld**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#mysqld)) that is built with support for the [**NDBCLUSTER**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html) storage engine and started with the --ndb-cluster option to enable the engine and the --ndb-connectstring option to enable it to connect to an NDB Cluster management server. For more about these options, see [Section 23.3.3.9.1, “MySQL Server Options for NDB Cluster”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-program-options-mysqld).  **Note**  An API node is any application that makes direct use of Cluster data nodes for data storage and retrieval. An SQL node can thus be considered a type of API node that uses a MySQL Server to provide an SQL interface to the Cluster. You can write such applications (that do not depend on a MySQL Server) using the NDB API, which supplies a direct, object-oriented transaction and scanning interface to NDB Cluster data; see [NDB Cluster API Overview: The NDB API](https://dev.mysql.com/doc/ndbapi/en/overview-ndb-api.html), for more information. |
| **A.10.7.** | When I run the **SHOW** command in the NDB Cluster management client, I see a line of output that looks like this:  id=2 @10.100.10.32 (Version: 8.0.24-ndb-8.0.24 Nodegroup: 0, \*)  What does the **\*** mean? How is this node different from the others? |
|  | The simplest answer is, “It's not something you can control, and it's nothing that you need to worry about in any case, unless you're a software engineer writing or analyzing the NDB Cluster source code”.  If you don't find that answer satisfactory, here's a longer and more technical version:  A number of mechanisms in NDB Cluster require distributed coordination among the data nodes. These distributed algorithms and protocols include global checkpointing, DDL (schema) changes, and node restart handling. To make this coordination simpler, the data nodes “elect” one of their number to act as leader. There is no user-facing mechanism for influencing this selection, which is completely automatic; the fact that it is automatic is a key part of NDB Cluster's internal architecture.  When a node acts as the “leader” for any of these mechanisms, it is usually the point of coordination for the activity, and the other nodes act as “followers”, carrying out their parts of the activity as directed by the leader. If the node acting as leader fails, then the remaining nodes elect a new leader. Tasks in progress that were being coordinated by the old leader may either fail or be continued by the new leader, depending on the actual mechanism involved.  It is possible for some of these different mechanisms and protocols to have different leader nodes, but in general the same leader is chosen for all of them. The node indicated as the leader in the output of [**SHOW**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#ndbclient-show) in the management client is known internally as the [**DICT**](https://dev.mysql.com/doc/ndb-internals/en/ndb-internals-kernel-blocks-dbdict.html) manager, responsible for coordinating DDL and metadata activity.  NDB Cluster is designed in such a way that the choice of leader has no discernible effect outside the cluster itself. For example, the current leader does not have significantly higher CPU or resource usage than the other data nodes, and failure of the leader should not have a significantly different impact on the cluster than the failure of any other data node. |
| **A.10.8.** | With which operating systems can I use NDB Cluster? |
|  | NDB Cluster is supported on most Unix-like operating systems. NDB Cluster is also supported in production settings on Microsoft Windows operating systems.  For more detailed information concerning the level of support which is offered for NDB Cluster on various operating system versions, operating system distributions, and hardware platforms, please refer to <https://www.mysql.com/support/supportedplatforms/cluster.html>. |
| **A.10.9.** | What are the hardware requirements for running NDB Cluster? |
|  | NDB Cluster should run on any platform for which [**NDB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html)-enabled binaries are available. For data nodes and API nodes, faster CPUs and more memory are likely to improve performance, and 64-bit CPUs are likely to be more effective than 32-bit processors. There must be sufficient memory on machines used for data nodes to hold each node's share of the database (see How much RAM do I Need? for more information). For a computer which is used only for running the NDB Cluster management server, the requirements are minimal; a common desktop PC (or the equivalent) is generally sufficient for this task. Nodes can communicate through the standard TCP/IP network and hardware. They can also use the high-speed SCI protocol; however, special networking hardware and software are required to use SCI (see [Section 23.3.4, “Using High-Speed Interconnects with NDB Cluster”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-interconnects)). |
| **A.10.10.** | How much RAM do I need to use NDB Cluster? Is it possible to use disk memory at all? |
|  | NDB Cluster was originally implemented as in-memory only, but all versions currently available also provide the ability to store NDB Cluster on disk. See [Section 23.5.10, “NDB Cluster Disk Data Tables”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-disk-data), for more information.  For in-memory **NDB** tables, you can use the following formula for obtaining a rough estimate of how much RAM is needed for each data node in the cluster:  (SizeofDatabase × NumberOfReplicas × 1.1 ) / NumberOfDataNodes  To calculate the memory requirements more exactly requires determining, for each table in the cluster database, the storage space required per row (see [Section 11.7, “Data Type Storage Requirements”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#storage-requirements), for details), and multiplying this by the number of rows. You must also remember to account for any column indexes as follows:  Each primary key or hash index created for an [**NDBCLUSTER**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html) table requires 21−25 bytes per record. These indexes use **IndexMemory**.  Each ordered index requires 10 bytes storage per record, using **DataMemory**.  Creating a primary key or unique index also creates an ordered index, unless this index is created with **USING HASH**. In other words:  A primary key or unique index on a Cluster table normally takes up 31 to 35 bytes per record.  However, if the primary key or unique index is created with **USING HASH**, then it requires only 21 to 25 bytes per record.  Creating NDB Cluster tables with **USING HASH** for all primary keys and unique indexes generally causes table updates to run more quickly—in some cases by a much as 20 to 30 percent faster than updates on tables where **USING HASH** was not used in creating primary and unique keys. This is due to the fact that less memory is required (because no ordered indexes are created), and that less CPU must be utilized (because fewer indexes must be read and possibly updated). However, it also means that queries that could otherwise use range scans must be satisfied by other means, which can result in slower selects.  When calculating Cluster memory requirements, you may find useful the [**ndb\_size.pl**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-programs-ndb-size-pl) utility which is available in recent MySQL 8.0 releases. This Perl script connects to a current (non-Cluster) MySQL database and creates a report on how much space that database would require if it used the [**NDBCLUSTER**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html) storage engine. For more information, see [Section 23.4.28, “ndb\_size.pl — NDBCLUSTER Size Requirement Estimator”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-programs-ndb-size-pl).  It is especially important to keep in mind that every NDB Cluster table must have a primary key. The [**NDB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html) storage engine creates a primary key automatically if none is defined; this primary key is created without **USING HASH**.  You can determine how much memory is being used for storage of NDB Cluster data and indexes at any given time using the **REPORT MEMORYUSAGE** command in the [**ndb\_mgm**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-programs-ndb-mgm) client; see [Section 23.5.1, “Commands in the NDB Cluster Management Client”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-mgm-client-commands), for more information. In addition, warnings are written to the cluster log when 80% of available [**DataMemory**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#ndbparam-ndbd-datamemory) or (prior to NDB 7.6) [**IndexMemory**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#ndbparam-ndbd-indexmemory) is in use, and again when usage reaches 90%, 99%, and 100%. |
| **A.10.11.** | What file systems can I use with NDB Cluster? What about network file systems or network shares? |
|  | Generally, any file system that is native to the host operating system should work well with NDB Cluster. If you find that a given file system works particularly well (or not so especially well) with NDB Cluster, we invite you to discuss your findings in the [NDB Cluster Forums](https://forums.mysql.com/list.php?25).  For Windows, we recommend that you use **NTFS** file systems for NDB Cluster, just as we do for standard MySQL. We do not test NDB Cluster with **FAT** or **VFAT** file systems. Because of this, we do not recommend their use with MySQL or NDB Cluster.  NDB Cluster is implemented as a shared-nothing solution; the idea behind this is that the failure of a single piece of hardware should not cause the failure of multiple cluster nodes, or possibly even the failure of the cluster as a whole. For this reason, the use of network shares or network file systems is not supported for NDB Cluster. This also applies to shared storage devices such as SANs. |
| **A.10.12.** | Can I run NDB Cluster nodes inside virtual machines (such as those created by VMWare, VirtualBox, Parallels, or Xen)? |
|  | NDB Cluster is supported for use in virtual machines. We currently support and test using [Oracle VM](http://www.oracle.com/technetwork/server-storage/vm/index.html).  Some NDB Cluster users have successfully deployed NDB Cluster using other virtualization products; in such cases, Oracle can provide NDB Cluster support, but issues specific to the virtual environment must be referred to that product's vendor. |
| **A.10.13.** | I am trying to populate an NDB Cluster database. The loading process terminates prematurely and I get an error message like this one:  ERROR 1114: The table 'my\_cluster\_table' is full  Why is this happening? |
|  | The cause is very likely to be that your setup does not provide sufficient RAM for all table data and all indexes, including the primary key required by the [***NDB***](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html) storage engine and automatically created in the event that the table definition does not include the definition of a primary key.  It is also worth noting that all data nodes should have the same amount of RAM, since no data node in a cluster can use more memory than the least amount available to any individual data node. For example, if there are four computers hosting Cluster data nodes, and three of these have 3GB of RAM available to store Cluster data while the remaining data node has only 1GB RAM, then each data node can devote at most 1GB to NDB Cluster data and indexes.  In some cases it is possible to get Table is full errors in MySQL client applications even when [**ndb\_mgm -e "ALL REPORT MEMORYUSAGE"**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-programs-ndb-mgm) shows significant free [**DataMemory**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#ndbparam-ndbd-datamemory). You can force [**NDB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html) to create extra partitions for NDB Cluster tables and thus have more memory available for hash indexes by using the **MAX\_ROWS** option for [**CREATE TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#create-table). In general, setting **MAX\_ROWS** to twice the number of rows that you expect to store in the table should be sufficient.  For similar reasons, you can also sometimes encounter problems with data node restarts on nodes that are heavily loaded with data. The [**MinFreePct**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#ndbparam-ndbd-minfreepct) parameter can help with this issue by reserving a portion (5% by default) of [**DataMemory**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#ndbparam-ndbd-datamemory) and (prior to NDB 7.6) [**IndexMemory**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#ndbparam-ndbd-indexmemory) for use in restarts. This reserved memory is not available for storing [**NDB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html) tables or data. |
| **A.10.14.** | NDB Cluster uses TCP/IP. Does this mean that I can run it over the Internet, with one or more nodes in remote locations? |
|  | It is very unlikely that a cluster would perform reliably under such conditions, as NDB Cluster was designed and implemented with the assumption that it would be run under conditions guaranteeing dedicated high-speed connectivity such as that found in a LAN setting using 100 Mbps or gigabit Ethernet—preferably the latter. We neither test nor warrant its performance using anything slower than this.  Also, it is extremely important to keep in mind that communications between the nodes in an NDB Cluster are not secure; they are neither encrypted nor safeguarded by any other protective mechanism. The most secure configuration for a cluster is in a private network behind a firewall, with no direct access to any Cluster data or management nodes from outside. (For SQL nodes, you should take the same precautions as you would with any other instance of the MySQL server.) For more information, see [Section 23.5.17, “NDB Cluster Security Issues”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-security). |
| **A.10.15.** | Do I have to learn a new programming or query language to use NDB Cluster? |
|  | No. Although some specialized commands are used to manage and configure the cluster itself, only standard (My)SQL statements are required for the following operations:  Creating, altering, and dropping tables  Inserting, updating, and deleting table data  Creating, changing, and dropping primary and unique indexes  Some specialized configuration parameters and files are required to set up an NDB Cluster—see [Section 23.3.3, “NDB Cluster Configuration Files”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-config-file), for information about these.  A few simple commands are used in the NDB Cluster management client ([**ndb\_mgm**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-programs-ndb-mgm)) for tasks such as starting and stopping cluster nodes. See [Section 23.5.1, “Commands in the NDB Cluster Management Client”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-mgm-client-commands). |
| **A.10.16.** | What programming languages and APIs are supported by NDB Cluster? |
|  | NDB Cluster supports the same programming APIs and languages as the standard MySQL Server, including ODBC, .Net, the MySQL C API, and numerous drivers for popular scripting languages such as PHP, Perl, and Python. NDB Cluster applications written using these APIs behave similarly to other MySQL applications; they transmit SQL statements to a MySQL Server (in the case of NDB Cluster, an SQL node), and receive responses containing rows of data. For more information about these APIs, see [Chapter 29, *Connectors and APIs*](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\connectors-apis.html).  NDB Cluster also supports application programming using the NDB API, which provides a low-level C++ interface to NDB Cluster data without needing to go through a MySQL Server. See [The NDB API](https://dev.mysql.com/doc/ndbapi/en/ndbapi.html). In addition, many [**NDBCLUSTER**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html) management functions are exposed by the C-language MGM API; see [The MGM API](https://dev.mysql.com/doc/ndbapi/en/mgm-api.html), for more information.  NDB Cluster also supports Java application programming using ClusterJ, which supports a domain object model of data using sessions and transactions. See [Java and NDB Cluster](https://dev.mysql.com/doc/ndbapi/en/mccj-overview-java.html), for more information.  In addition, NDB Cluster provides support for **memcached**, allowing developers to access data stored in NDB Cluster using the **memcached** interface; for more information, see [ndbmemcache—Memcache API for NDB Cluster (NO LONGER SUPPORTED)](https://dev.mysql.com/doc/ndbapi/en/ndbmemcache.html).  NDB Cluster also includes adapters supporting NoSQL applications written against **Node.js**, with NDB Cluster as the data store. See [MySQL NoSQL Connector for JavaScript](https://dev.mysql.com/doc/ndbapi/en/ndb-nodejs.html), for more information. |
| **A.10.17.** | Does NDB Cluster include any management tools? |
|  | NDB Cluster includes a command line client for performing basic management functions. See [Section 23.4.5, “ndb\_mgm — The NDB Cluster Management Client”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-programs-ndb-mgm), and [Section 23.5.1, “Commands in the NDB Cluster Management Client”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-mgm-client-commands).  NDB Cluster 7.6 and earlier are also supported by MySQL Cluster Manager, a separate product providing an advanced command line interface that can automate many NDB Cluster management tasks such as rolling restarts and configuration changes. Beginning with version 1.4.8, MySQL Cluster Manager also provides experimental support for NDB Cluster 8.0. For more information about MySQL Cluster Manager, see [MySQL™ Cluster Manager 1.4.8 User Manual](https://dev.mysql.com/doc/mysql-cluster-manager/1.4/en/).  NDB Cluster also provides a graphical, browser-based Auto-Installer for setting up and deploying NDB Cluster, as part of the NDB Cluster software distribution. For more information, see [The NDB Cluster Auto-Installer (NDB 7.5) (No longer supported)](https://dev.mysql.com/doc/refman/5.7/en/mysql-cluster-install-auto.html). |
| **A.10.18.** | How do I find out what an error or warning message means when using NDB Cluster? |
|  | There are two ways in which this can be done:  From within the [**mysql**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#mysql) client, use **SHOW ERRORS** or **SHOW WARNINGS** immediately upon being notified of the error or warning condition.  From a system shell prompt, use [**perror --ndb *error\_code***](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#perror). |
| **A.10.19.** | Is NDB Cluster transaction-safe? What isolation levels are supported? |
|  | Yes. For tables created with the [**NDB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html) storage engine, transactions are supported. Currently, NDB Cluster supports only the [**READ COMMITTED**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\innodb-storage-engine.html#isolevel_read-committed) transaction isolation level. |
| **A.10.20.** | What storage engines are supported by NDB Cluster? |
|  | NDB Cluster requires the [**NDB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html) storage engine. That is, in order for a table to be shared between nodes in an NDB Cluster, the table must be created using **ENGINE=NDB** (or the equivalent option **ENGINE=NDBCLUSTER**).  It is possible to create tables using other storage engines (such as [**InnoDB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\innodb-storage-engine.html) or [**MyISAM**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#myisam-storage-engine)) on a MySQL server being used with NDB Cluster, but since these tables do not use [**NDB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html), they do not participate in clustering; each such table is strictly local to the individual MySQL server instance on which it is created.  NDB Cluster is quite different from [**InnoDB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\innodb-storage-engine.html) clustering with regard to architecture, requirements, and implementation; despite any similarity in their names, the two are not compatible. For more information about **InnoDB** clustering, see [Using MySQL AdminAPI](https://dev.mysql.com/doc/mysql-shell/8.0/en/admin-api-userguide.html). See also [Section 23.1.6, “MySQL Server Using InnoDB Compared with NDB Cluster”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-compared), for information about the differences between the **NDB** and **InnoDB** storage engines. |
| **A.10.21.** | In the event of a catastrophic failure— for example, the whole city loses power and my UPS fails—would I lose all my data? |
|  | All committed transactions are logged. Therefore, although it is possible that some data could be lost in the event of a catastrophe, this should be quite limited. Data loss can be further reduced by minimizing the number of operations per transaction. (It is not a good idea to perform large numbers of operations per transaction in any case.) |
| **A.10.22.** | Is it possible to use **FULLTEXT** indexes with NDB Cluster? |
|  | **FULLTEXT** indexing is currently supported only by the [**InnoDB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\innodb-storage-engine.html) and [**MyISAM**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#myisam-storage-engine) storage engines. See [Section 12.10, “Full-Text Search Functions”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\functions.html#fulltext-search), for more information. |
| **A.10.23.** | Can I run multiple nodes on a single computer? |
|  | It is possible but not always advisable. One of the chief reasons to run a cluster is to provide redundancy. To obtain the full benefits of this redundancy, each node should reside on a separate machine. If you place multiple nodes on a single machine and that machine fails, you lose all of those nodes. For this reason, if you do run multiple data nodes on a single machine, it is extremely important that they be set up in such a way that the failure of this machine does not cause the loss of all the data nodes in a given node group.  Given that NDB Cluster can be run on commodity hardware loaded with a low-cost (or even no-cost) operating system, the expense of an extra machine or two is well worth it to safeguard mission-critical data. It also worth noting that the requirements for a cluster host running a management node are minimal. This task can be accomplished with a 300 MHz Pentium or equivalent CPU and sufficient RAM for the operating system, plus a small amount of overhead for the [**ndb\_mgmd**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-programs-ndb-mgmd) and [**ndb\_mgm**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-programs-ndb-mgm) processes.  It is acceptable to run multiple cluster data nodes on a single host that has multiple CPUs, cores, or both. The NDB Cluster distribution also provides a multithreaded version of the data node binary intended for use on such systems. For more information, see [Section 23.4.3, “ndbmtd — The NDB Cluster Data Node Daemon (Multi-Threaded)”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-programs-ndbmtd).  It is also possible in some cases to run data nodes and SQL nodes concurrently on the same machine; how well such an arrangement performs is dependent on a number of factors such as number of cores and CPUs as well as the amount of disk and memory available to the data node and SQL node processes, and you must take these factors into account when planning such a configuration. |
| **A.10.24.** | Can I add data nodes to an NDB Cluster without restarting it? |
|  | It is possible to add new data nodes to a running NDB Cluster without taking the cluster offline. For more information, see [Section 23.5.7, “Adding NDB Cluster Data Nodes Online”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-online-add-node).  For other types of NDB Cluster nodes, a rolling restart is all that is required (see [Section 23.5.5, “Performing a Rolling Restart of an NDB Cluster”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-rolling-restart)). |
| **A.10.25.** | Are there any limitations that I should be aware of when using NDB Cluster? |
|  | Limitations on [**NDB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html) tables in MySQL NDB Cluster include the following:  Temporary tables are not supported; a [**CREATE TEMPORARY TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#create-table) statement using **ENGINE=NDB** or **ENGINE=NDBCLUSTER** fails with an error.  The only types of user-defined partitioning supported for [**NDBCLUSTER**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html) tables are **KEY** and **LINEAR KEY**. Trying to create an **NDB** table using any other partitioning type fails with an error.  **FULLTEXT** indexes are not supported.  Index prefixes are not supported. Only complete columns may be indexed.  Spatial indexes are not supported (although spatial columns can be used). See [Section 11.4, “Spatial Data Types”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#spatial-types).  Support for partial transactions and partial rollbacks is comparable to that of other transactional storage engines such as [**InnoDB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\innodb-storage-engine.html) that can roll back individual statements.  The maximum number of attributes allowed per table is 512. Attribute names cannot be any longer than 31 characters. For each table, the maximum combined length of the table and database names is 122 characters.  Priot to NDB 8.0, the maximum size for a table row is 14 kilobytes, not counting [**BLOB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#blob) values. In NDB 8.0, this maximum is increased to 30000 bytes. See [Section 23.1.7.5, “Limits Associated with Database Objects in NDB Cluster”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-limitations-database-objects), for more information.  There is no set limit for the number of rows per **NDB** table. Limits on table size depend on a number of factors, in particular on the amount of RAM available to each data node.  For a complete listing of limitations in NDB Cluster, see [Section 23.1.7, “Known Limitations of NDB Cluster”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-limitations). See also [Section 23.1.7.11, “Previous NDB Cluster Issues Resolved in NDB Cluster 8.0”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-limitations-resolved). |
| **A.10.26.** | Does NDB Cluster support foreign keys? |
|  | NDB Cluster provides support for foreign key constraints which is comparable to that found in the [**InnoDB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\innodb-storage-engine.html) storage engine; see [Section 1.7.3.2, “FOREIGN KEY Constraints”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\introduction.html#constraint-foreign-key), for more detailed information, as well as [Section 13.1.20.5, “FOREIGN KEY Constraints”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#create-table-foreign-keys). Applications requiring foreign key support should use NDB Cluster 7.3, 7.4, 7.5, or later. |
| **A.10.27.** | How do I import an existing MySQL database into an NDB Cluster? |
|  | You can import databases into NDB Cluster much as you would with any other version of MySQL. Other than the limitations mentioned elsewhere in this FAQ, the only other special requirement is that any tables to be included in the cluster must use the [**NDB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html) storage engine. This means that the tables must be created with **ENGINE=NDB** or **ENGINE=NDBCLUSTER**.  It is also possible to convert existing tables that use other storage engines to [**NDBCLUSTER**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html) using one or more [**ALTER TABLE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#alter-table) statement. However, the definition of the table must be compatible with the [**NDBCLUSTER**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html) storage engine prior to making the conversion. In MySQL 8.0, an additional workaround is also required; see [Section 23.1.7, “Known Limitations of NDB Cluster”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-limitations), for details. |
| **A.10.28.** | How do NDB Cluster nodes communicate with one another? |
|  | Cluster nodes can communicate through any of three different transport mechanisms: TCP/IP, SHM (shared memory), and SCI (Scalable Coherent Interface). Where available, SHM is used by default between nodes residing on the same cluster host; however, this is considered experimental. SCI is a high-speed (1 gigabit per second and higher), high-availability protocol used in building scalable multi-processor systems; it requires special hardware and drivers. See [Section 23.3.4, “Using High-Speed Interconnects with NDB Cluster”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-interconnects), for more about using SCI as a transport mechanism for NDB Cluster. |
| **A.10.29.** | What is an arbitrator? |
|  | If one or more data nodes in a cluster fail, it is possible that not all cluster data nodes are able to “see” one another. In fact, it is possible that two sets of data nodes might become isolated from one another in a network partitioning, also known as a “split-brain” scenario. This type of situation is undesirable because each set of data nodes tries to behave as though it is the entire cluster. An arbitrator is required to decide between the competing sets of data nodes.  When all data nodes in at least one node group are alive, network partitioning is not an issue, because no single subset of the cluster can form a functional cluster on its own. The real problem arises when no single node group has all its nodes alive, in which case network partitioning (the “split-brain” scenario) becomes possible. Then an arbitrator is required. All cluster nodes recognize the same node as the arbitrator, which is normally the management server; however, it is possible to configure any of the MySQL Servers in the cluster to act as the arbitrator instead. The arbitrator accepts the first set of cluster nodes to contact it, and tells the remaining set to shut down. Arbitrator selection is controlled by the **ArbitrationRank** configuration parameter for MySQL Server and management server nodes. You can also use the **ArbitrationRank** configuration parameter to control the arbitrator selection process. For more information about these parameters, see [Section 23.3.3.5, “Defining an NDB Cluster Management Server”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-mgm-definition).  The role of arbitrator does not in and of itself impose any heavy demands upon the host so designated, and thus the arbitrator host does not need to be particularly fast or to have extra memory especially for this purpose. |
| **A.10.30.** | What data types are supported by NDB Cluster? |
|  | NDB Cluster supports all of the usual MySQL data types, including those associated with MySQL's spatial extensions; however, the [**NDB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html) storage engine does not support spatial indexes. (Spatial indexes are supported only by [**MyISAM**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\storage-engines.html#myisam-storage-engine); see [Section 11.4, “Spatial Data Types”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#spatial-types), for more information.) In addition, there are some differences with regard to indexes when used with [**NDB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html) tables.  **Note**  NDB Cluster Disk Data tables (that is, tables created with **TABLESPACE ... STORAGE DISK ENGINE=NDB** or **TABLESPACE ... STORAGE DISK ENGINE=NDBCLUSTER**) have only fixed-width rows. This means that (for example) each Disk Data table record containing a [**VARCHAR(255)**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#char) column requires space for 255 characters (as required for the character set and collation being used for the table), regardless of the actual number of characters stored therein.  See [Section 23.1.7, “Known Limitations of NDB Cluster”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-limitations), for more information about these issues. |
| **A.10.31.** | How do I start and stop NDB Cluster? |
|  | It is necessary to start each node in the cluster separately, in the following order:  Start the management node, using the [**ndb\_mgmd**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-programs-ndb-mgmd) command.  You must include the [-f](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#option_ndb_mgmd_config-file) or [--config-file](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#option_ndb_mgmd_config-file) option to tell the management node where its configuration file can be found.  Start each data node with the [**ndbd**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-programs-ndbd) command.  Each data node must be started with the [-c](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#option_ndbd_ndb-connectstring) or [--ndb-connectstring](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#option_ndbd_ndb-connectstring) option so that the data node knows how to connect to the management server.  Start each MySQL Server (SQL node) using your preferred startup script, such as [**mysqld\_safe**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#mysqld-safe).  Each MySQL Server must be started with the [--ndbcluster](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#option_mysqld_ndbcluster) and [--ndb-connectstring](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#option_mysqld_ndb-connectstring) options. These options cause [**mysqld**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#mysqld) to enable [**NDBCLUSTER**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html) storage engine support and how to connect to the management server.  Each of these commands must be run from a system shell on the machine housing the affected node. (You do not have to be physically present at the machine—a remote login shell can be used for this purpose.) You can verify that the cluster is running by starting the [**NDB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html) management client [**ndb\_mgm**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-programs-ndb-mgm) on the machine housing the management node and issuing the **SHOW** or **ALL STATUS** command.  To shut down a running cluster, issue the command **SHUTDOWN** in the management client. Alternatively, you may enter the following command in a system shell:  shell> **ndb\_mgm -e "SHUTDOWN"**  (The quotation marks in this example are optional, since there are no spaces in the command string following the -e option; in addition, the **SHUTDOWN** command, like other management client commands, is not case-sensitive.)  Either of these commands causes the [**ndb\_mgm**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-programs-ndb-mgm), [**ndb\_mgm**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-programs-ndb-mgm), and any [**ndbd**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-programs-ndbd) processes to terminate gracefully. MySQL servers running as SQL nodes can be stopped using [**mysqladmin shutdown**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#mysqladmin).  For more information, see [Section 23.5.1, “Commands in the NDB Cluster Management Client”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-mgm-client-commands), and [Section 23.2.6, “Safe Shutdown and Restart of NDB Cluster”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-install-shutdown-restart).  MySQL Cluster Manager and the NDB Cluster Auto-Installer provide additional ways to handle starting ansd stopping of NDB Cluster nodes. See [MySQL™ Cluster Manager 1.4.8 User Manual](https://dev.mysql.com/doc/mysql-cluster-manager/1.4/en/), and [Section 23.2.8, “The NDB Cluster Auto-Installer (No longer supported)”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-installer), for more information about these tools. |
| **A.10.32.** | What happens to NDB Cluster data when the NDB Cluster is shut down? |
|  | The data that was held in memory by the cluster's data nodes is written to disk, and is reloaded into memory the next time that the cluster is started. |
| **A.10.33.** | Is it a good idea to have more than one management node for an NDB Cluster? |
|  | It can be helpful as a fail-safe. Only one management node controls the cluster at any given time, but it is possible to configure one management node as primary, and one or more additional management nodes to take over in the event that the primary management node fails.  See [Section 23.3.3, “NDB Cluster Configuration Files”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-config-file), for information on how to configure NDB Cluster management nodes. |
| **A.10.34.** | Can I mix different kinds of hardware and operating systems in one NDB Cluster? |
|  | Yes, as long as all machines and operating systems have the same “endianness” (all big-endian or all little-endian).  It is also possible to use software from different NDB Cluster releases on different nodes. However, we support such use only as part of a rolling upgrade procedure (see [Section 23.5.5, “Performing a Rolling Restart of an NDB Cluster”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-rolling-restart)). |
| **A.10.35.** | Can I run two data nodes on a single host? Two SQL nodes? |
|  | Yes, it is possible to do this. In the case of multiple data nodes, it is advisable (but not required) for each node to use a different data directory. If you want to run multiple SQL nodes on one machine, each instance of [**mysqld**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#mysqld) must use a different TCP/IP port.  Running data nodes and SQL nodes together on the same host is possible, but you should be aware that the [**ndbd**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-programs-ndbd) or [**ndbmtd**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-programs-ndbmtd) processes may compete for memory with [**mysqld**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#mysqld). |
| **A.10.36.** | Can I use host names with NDB Cluster? |
|  | Yes, it is possible to use DNS and DHCP for cluster hosts. However, if your application requires “five nines” availability, you should use fixed (numeric) IP addresses, since making communication between Cluster hosts dependent on services such as DNS and DHCP introduces additional potential points of failure. |
| **A.10.37.** | Does NDB Cluster support IPv6? |
|  | IPv6 is supported for connections between SQL nodes (MySQL servers), but connections between all other types of NDB Cluster nodes must use IPv4.  In practical terms, this means that you can use IPv6 for replication between NDB Clusters, but connections between nodes in the same NDB Cluster must use IPv4. For more information, see [Section 23.6.3, “Known Issues in NDB Cluster Replication”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-replication-issues). |
| **A.10.38.** | How do I handle MySQL users in an NDB Cluster having multiple MySQL servers? |
|  | MySQL user accounts and privileges are normally not automatically propagated between different MySQL servers accessing the same NDB Cluster. MySQL NDB Cluster provides support for shared and synchronized users and privileges using the [**NDB\_STORED\_USER**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\security.html#priv_ndb-stored-user) privilege; see [Section 23.5.12, “Distributed MySQL Privileges with NDB\_STORED\_USER”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-privilege-distribution), for more information. You should be aware that this implementation is new to NDB 8.0 and is not compatible with the shared privileges mechanism employed in earlier versions of NDB Cluster, which is no longer supported in NDB 8.0. |
| **A.10.39.** | How do I continue to send queries in the event that one of the SQL nodes fails? |
|  | MySQL NDB Cluster does not provide any sort of automatic failover between SQL nodes. Your application must be prepared to handle the loss of SQL nodes and to fail over between them. |
| **A.10.40.** | How do I back up and restore an NDB Cluster? |
|  | You can use the NDB Cluster native backup and restore functionality in the NDB management client and the [**ndb\_restore**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-programs-ndb-restore) program. See [Section 23.5.8, “Online Backup of NDB Cluster”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-backup), and [Section 23.4.23, “ndb\_restore — Restore an NDB Cluster Backup”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-programs-ndb-restore).  You can also use the traditional functionality provided for this purpose in [**mysqldump**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#mysqldump) and the MySQL server. See [Section 4.5.4, “mysqldump — A Database Backup Program”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#mysqldump), for more information. |
| **A.10.41.** | What is an “angel process”? |
|  | This process monitors and, if necessary, attempts to restart the data node process. If you check the list of active processes on your system after starting [**ndbd**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-programs-ndbd), you can see that there are actually 2 processes running by that name, as shown here (we omit the output from [**ndb\_mgmd**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-programs-ndb-mgmd) and [**ndbd**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-programs-ndbd) for brevity):  shell> **./ndb\_mgmd**  shell> **ps aux | grep ndb**  me 23002 0.0 0.0 122948 3104 ? Ssl 14:14 0:00 ./ndb\_mgmd  me 23025 0.0 0.0 5284 820 pts/2 S+ 14:14 0:00 grep ndb  shell> **./ndbd -c 127.0.0.1 --initial**  shell> **ps aux | grep ndb**  me 23002 0.0 0.0 123080 3356 ? Ssl 14:14 0:00 ./ndb\_mgmd  me 23096 0.0 0.0 35876 2036 ? Ss 14:14 0:00 ./ndbmtd -c 127.0.0.1 --initial  me 23097 1.0 2.4 524116 91096 ? Sl 14:14 0:00 ./ndbmtd -c 127.0.0.1 --initial  me 23168 0.0 0.0 5284 812 pts/2 R+ 14:15 0:00 grep ndb  The [**ndbd**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-programs-ndbd) process showing **0.0** for both memory and CPU usage is the angel process (although it actually does use a very small amount of each). This process merely checks to see if the main [**ndbd**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-programs-ndbd) or [**ndbmtd**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#mysql-cluster-programs-ndbmtd) process (the primary data node process which actually handles the data) is running. If permitted to do so (for example, if the [**StopOnError**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\mysql-cluster.html#ndbparam-ndbd-stoponerror) configuration parameter is set to **false**), the angel process tries to restart the primary data node process. |

## A.11 MySQL 8.0 FAQ: MySQL Chinese, Japanese, and Korean Character Sets

This set of Frequently Asked Questions derives from the experience of MySQL's Support and Development groups in handling many inquiries about CJK (Chinese-Japanese-Korean) issues.

A.11.1. [What CJK character sets are available in MySQL?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cjk-what-cjk-avail)

A.11.2. [I have inserted CJK characters into my table. Why does SELECT display them as “?” characters?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cjk-why-cjk-question-marks)

A.11.3. [What problems should I be aware of when working with the Big5 Chinese character set?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cjk-what-problems-big5)

A.11.4. [Why do Japanese character set conversions fail?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cjk-what-japanese-chars-fail)

A.11.5. [What should I do if I want to convert SJIS 81CA to cp932?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cjk-how-convert-81ca-cp932)

A.11.6. [How does MySQL represent the Yen (¥) sign?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cjk-how-represent-yen)

A.11.7. [Of what issues should I be aware when working with Korean character sets in MySQL?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cjk-what-problems-korean)

A.11.8. [Why do I get Incorrect string value error messages?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cjk-why-incorrect-string-value)

A.11.9. [Why does my GUI front end or browser display CJK characters incorrectly in my application using Access, PHP, or another API?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cjk-why-gui-not-display-cjk)

A.11.10. [I've upgraded to MySQL 8.0. How can I revert to behavior like that in MySQL 4.0 with regard to character sets?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cjk-how-use-4-0-charset)

A.11.11. [Why do some LIKE and FULLTEXT searches with CJK characters fail?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cjk-why-cjk-fail-searches)

A.11.12. [How do I know whether character X is available in all character sets?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cjk-how-know-avail-characters)

A.11.13. [Why do CJK strings sort incorrectly in Unicode? (I)](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cjk-how-cjk-sort-unicode-1)

A.11.14. [Why do CJK strings sort incorrectly in Unicode? (II)](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cjk-how-cjk-sort-unicode-2)

A.11.15. [Why are my supplementary characters rejected by MySQL?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cjk-why-supplement-char-rejected)

A.11.16. [Should “CJK” be “CJKV”?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cjk-why-cjk-not-cjkv)

A.11.17. [Does MySQL permit CJK characters to be used in database and table names?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cjk-how-cjk-db-table-names)

A.11.18. [Where can I find translations of the MySQL Manual into Chinese, Japanese, and Korean?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cjk-where-doc-translations)

A.11.19. [Where can I get help with CJK and related issues in MySQL?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-cjk-help-with-cjk)

|  |  |
| --- | --- |
| **A.11.1.** | What CJK character sets are available in MySQL? |
|  | The list of CJK character sets may vary depending on your MySQL version. For example, the **gb18030** character set is not supported prior to MySQL 5.7.4. However, since the name of the applicable language appears in the **DESCRIPTION** column for every entry in the [**INFORMATION\_SCHEMA.CHARACTER\_SETS**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\information-schema.html#information-schema-character-sets-table) table, you can obtain a current list of all the non-Unicode CJK character sets using this query:  mysql> **SELECT CHARACTER\_SET\_NAME, DESCRIPTION**  **FROM INFORMATION\_SCHEMA.CHARACTER\_SETS**  **WHERE DESCRIPTION LIKE '%Chin%'**  **OR DESCRIPTION LIKE '%Japanese%'**  **OR DESCRIPTION LIKE '%Korean%'**  **ORDER BY CHARACTER\_SET\_NAME;**  +--------------------+---------------------------------+  | CHARACTER\_SET\_NAME | DESCRIPTION |  +--------------------+---------------------------------+  | big5 | Big5 Traditional Chinese |  | cp932 | SJIS for Windows Japanese |  | eucjpms | UJIS for Windows Japanese |  | euckr | EUC-KR Korean |  | gb18030 | China National Standard GB18030 |  | gb2312 | GB2312 Simplified Chinese |  | gbk | GBK Simplified Chinese |  | sjis | Shift-JIS Japanese |  | ujis | EUC-JP Japanese |  +--------------------+---------------------------------+  (For more information, see [Section 26.3.4, “The INFORMATION\_SCHEMA CHARACTER\_SETS Table”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\information-schema.html#information-schema-character-sets-table).)  MySQL supports three variants of the GB (Guojia Biaozhun, or National Standard, or Simplified Chinese) character sets which are official in the People's Republic of China: **gb2312**, **gbk**, and (as of MySQL 5.7.4) **gb18030**.  Sometimes people try to insert **gbk** characters into **gb2312**, and it works most of the time because **gbk** is a superset of **gb2312**. But eventually they try to insert a rarer Chinese character and it does not work. (For an example, see Bug #16072).  Here, we try to clarify exactly what characters are legitimate in **gb2312** or **gbk**, with reference to the official documents. Please check these references before reporting **gb2312** or **gbk** bugs:  The MySQL **gbk** character set is in reality “Microsoft code page 936”. This differs from the official **gbk** for characters **A1A4** (middle dot), **A1AA** (em dash), **A6E0-A6F5**, and **A8BB-A8C0**.  For a listing of **gbk**/Unicode mappings, see <http://www.unicode.org/Public/MAPPINGS/VENDORS/MICSFT/WINDOWS/CP936.TXT>.  It is also possible to store CJK characters in Unicode character sets, although the available collations may not sort characters quite as you expect:  The **utf8** and **ucs2** character sets support the characters from Unicode Basic Multilingual Plane (BMP). These characters have code point values between **U+0000** and **U+FFFF**.  The **utf8mb4**, **utf16**, **utf16le**, and **utf32** character sets support BMP characters, as well as supplementary characters that lie outside the BMP. Supplementary characters have code point values between **U+10000** and **U+10FFFF**.  The collation used for a Unicode character set determines the ability to sort (that is, distinguish) characters in the set:  Collations based on Unicode Collation Algorithm (UCA) 4.0.0 distinguish only BMP characters.  Collations based on UCA 5.2.0 or 9.0.0 distinguish BMP and supplementary characters.  Non-UCA collations may not distinguish all Unicode characters. For example, the **utf8mb4** default collation is **utf8mb4\_general\_ci**, which distinguishes only BMP characters.  Moreover, distinguishing characters is not the same as ordering them per the conventions of a given CJK language. Currently, MySQL has only one CJK-specific UCA collation, **gb18030\_unicode\_520\_ci** (which requires use of the non-Unicode **gb18030** character set).  For information about Unicode collations and their differentiating properties, including collation properties for supplementary characters, see [Section 10.10.1, “Unicode Character Sets”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\charset.html#charset-unicode-sets). |
| **A.11.2.** | I have inserted CJK characters into my table. Why does [**SELECT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#select) display them as “?” characters? |
|  | This problem is usually due to a setting in MySQL that does not match the settings for the application program or the operating system. Here are some common steps for correcting these types of issues:  Be certain of what MySQL version you are using.  Use the statement **SELECT VERSION();** to determine this.  Make sure that the database is actually using the desired character set.  People often think that the client character set is always the same as either the server character set or the character set used for display purposes. However, both of these are false assumptions. You can make sure by checking the result of **SHOW CREATE TABLE *tablename*** or, better yet, by using this statement:  SELECT character\_set\_name, collation\_name  FROM information\_schema.columns  WHERE table\_schema = your\_database\_name  AND table\_name = your\_table\_name  AND column\_name = your\_column\_name;  Determine the hexadecimal value of the character or characters that are not being displayed correctly.  You can obtain this information for a column ***column\_name*** in the table ***table\_name*** using the following query:  SELECT HEX(***column\_name***)  FROM ***table\_name***;  **3F** is the encoding for the **?** character; this means that **?** is the character actually stored in the column. This most often happens because of a problem converting a particular character from your client character set to the target character set.  Make sure that a round trip is possible. When you select ***literal*** (or ***\_introducer hexadecimal-value***), do you obtain ***literal*** as a result?  For example, the Japanese Katakana character Pe (**ペ'**) exists in all CJK character sets, and has the code point value (hexadecimal coding) **0x30da**. To test a round trip for this character, use this query:  SELECT 'ペ' AS `ペ`; /\* or SELECT \_ucs2 0x30da; \*/  If the result is not also **ペ**, the round trip failed.  For bug reports regarding such failures, we might ask you to follow up with **SELECT HEX('ペ');**. Then we can determine whether the client encoding is correct.  Make sure that the problem is not with the browser or other application, rather than with MySQL.  Use the [**mysql**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#mysql) client program to accomplish this task. If [**mysql**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#mysql) displays characters correctly but your application does not, your problem is probably due to system settings.  To determine your settings, use the [**SHOW VARIABLES**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#show-variables) statement, whose output should resemble what is shown here:  mysql> **SHOW VARIABLES LIKE 'char%';**  +--------------------------+----------------------------------------+  | Variable\_name | Value |  +--------------------------+----------------------------------------+  | character\_set\_client | utf8 |  | character\_set\_connection | utf8 |  | character\_set\_database | latin1 |  | character\_set\_filesystem | binary |  | character\_set\_results | utf8 |  | character\_set\_server | latin1 |  | character\_set\_system | utf8 |  | character\_sets\_dir | /usr/local/mysql/share/mysql/charsets/ |  +--------------------------+----------------------------------------+  These are typical character-set settings for an international-oriented client (notice the use of **utf8** Unicode) connected to a server in the West (**latin1** is a West Europe character set).  Although Unicode (usually the **utf8** variant on Unix, and the **ucs2** variant on Windows) is preferable to Latin, it is often not what your operating system utilities support best. Many Windows users find that a Microsoft character set, such as **cp932** for Japanese Windows, is suitable.  If you cannot control the server settings, and you have no idea what setting your underlying computer uses, try changing to a common character set for the country that you're in (**euckr** = Korea; **gb18030**, **gb2312** or **gbk** = People's Republic of China; **big5** = Taiwan; **sjis**, **ujis**, **cp932**, or **eucjpms** = Japan; **ucs2** or **utf8** = anywhere). Usually it is necessary to change only the client and connection and results settings. The [**SET NAMES**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#set-names). statement changes all three at once. For example:  SET NAMES 'big5';  Once the setting is correct, you can make it permanent by editing my.cnf or my.ini. For example you might add lines looking like these:  [mysqld]  character-set-server=big5  [client]  default-character-set=big5  It is also possible that there are issues with the API configuration setting being used in your application; see Why does my GUI front end or browser not display CJK characters correctly...? for more information. |
| **A.11.3.** | What problems should I be aware of when working with the Big5 Chinese character set? |
|  | MySQL supports the Big5 character set which is common in Hong Kong and Taiwan (Republic of China). The MySQL **big5** character set is in reality Microsoft code page 950, which is very similar to the original **big5** character set.  A feature request for adding **HKSCS** extensions has been filed. People who need this extension may find the suggested patch for Bug #13577 to be of interest. |
| **A.11.4.** | Why do Japanese character set conversions fail? |
|  | MySQL supports the **sjis**, **ujis**, **cp932**, and **eucjpms** character sets, as well as Unicode. A common need is to convert between character sets. For example, there might be a Unix server (typically with **sjis** or **ujis**) and a Windows client (typically with **cp932**).  In the following conversion table, the **ucs2** column represents the source, and the **sjis**, **cp932**, **ujis**, and **eucjpms** columns represent the destinations; that is, the last 4 columns provide the hexadecimal result when we use [**CONVERT(ucs2)**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\functions.html#function_convert) or we assign a **ucs2** column containing the value to an **sjis**, **cp932**, **ujis**, or **eucjpms** column.   | **Character Name** | **ucs2** | **sjis** | **cp932** | **ujis** | **eucjpms** | | --- | --- | --- | --- | --- | --- | | **BROKEN BAR** | 00A6 | 3F | 3F | 8FA2C3 | 3F | | **FULLWIDTH BROKEN BAR** | FFE4 | 3F | FA55 | 3F | 8FA2 | | **YEN SIGN** | 00A5 | 3F | 3F | 20 | 3F | | **FULLWIDTH YEN SIGN** | FFE5 | 818F | 818F | A1EF | 3F | | **TILDE** | 007E | 7E | 7E | 7E | 7E | | **OVERLINE** | 203E | 3F | 3F | 20 | 3F | | **HORIZONTAL BAR** | 2015 | 815C | 815C | A1BD | A1BD | | **EM DASH** | 2014 | 3F | 3F | 3F | 3F | | **REVERSE SOLIDUS** | 005C | 815F | 5C | 5C | 5C | | **FULLWIDTH REVERSE SOLIDUS** | FF3C | 3F | 815F | 3F | A1C0 | | **WAVE DASH** | 301C | 8160 | 3F | A1C1 | 3F | | **FULLWIDTH TILDE** | FF5E | 3F | 8160 | 3F | A1C1 | | **DOUBLE VERTICAL LINE** | 2016 | 8161 | 3F | A1C2 | 3F | | **PARALLEL TO** | 2225 | 3F | 8161 | 3F | A1C2 | | **MINUS SIGN** | 2212 | 817C | 3F | A1DD | 3F | | **FULLWIDTH HYPHEN-MINUS** | FF0D | 3F | 817C | 3F | A1DD | | **CENT SIGN** | 00A2 | 8191 | 3F | A1F1 | 3F | | **FULLWIDTH CENT SIGN** | FFE0 | 3F | 8191 | 3F | A1F1 | | **POUND SIGN** | 00A3 | 8192 | 3F | A1F2 | 3F | | **FULLWIDTH POUND SIGN** | FFE1 | 3F | 8192 | 3F | A1F2 | | **NOT SIGN** | 00AC | 81CA | 3F | A2CC | 3F | | **FULLWIDTH NOT SIGN** | FFE2 | 3F | 81CA | 3F | A2CC |   Now consider the following portion of the table.   |  | **ucs2** | **sjis** | **cp932** | | --- | --- | --- | --- | | **NOT SIGN** | 00AC | 81CA | 3F | | **FULLWIDTH NOT SIGN** | FFE2 | 3F | 81CA |   This means that MySQL converts the **NOT SIGN** (Unicode **U+00AC**) to **sjis** code point **0x81CA** and to **cp932** code point **3F**. (**3F** is the question mark (“?”. This is what is always used when the conversion cannot be performed.) |
| **A.11.5.** | What should I do if I want to convert SJIS **81CA** to **cp932**? |
|  | Our answer is: “?”. There are disadvantages to this, and many people would prefer a “loose” conversion, so that **81CA (NOT SIGN)** in **sjis** becomes **81CA (FULLWIDTH NOT SIGN)** in **cp932**. |
| **A.11.6.** | How does MySQL represent the Yen (**¥**) sign? |
|  | A problem arises because some versions of Japanese character sets (both **sjis** and **euc**) treat **5C** as a reverse solidus (**\**, also known as a backslash), whereas others treat it as a yen sign (**¥**).  MySQL follows only one version of the JIS (Japanese Industrial Standards) standard description. In MySQL, ***5C*** is always the reverse solidus (***\***). |
| **A.11.7.** | Of what issues should I be aware when working with Korean character sets in MySQL? |
|  | In theory, while there have been several versions of the **euckr** (Extended Unix Code Korea) character set, only one problem has been noted. We use the “ASCII” variant of EUC-KR, in which the code point **0x5c** is REVERSE SOLIDUS, that is **\**, instead of the “KS-Roman” variant of EUC-KR, in which the code point **0x5c** is **WON SIGN** (**₩**). This means that you cannot convert Unicode **U+20A9** to **euckr**:  mysql> **SELECT**  **CONVERT('₩' USING euckr) AS euckr,**  **HEX(CONVERT('₩' USING euckr)) AS hexeuckr;**  +-------+----------+  | euckr | hexeuckr |  +-------+----------+  | ? | 3F |  +-------+----------+ |
| **A.11.8.** | Why do I get Incorrect string value error messages? |
|  | To see the problem, create a table with one Unicode (**ucs2**) column and one Chinese (**gb2312**) column.  mysql> **CREATE TABLE ch**  **(ucs2 CHAR(3) CHARACTER SET ucs2,**  **gb2312 CHAR(3) CHARACTER SET gb2312);**  In nonstrict SQL mode, try to place the rare character **汌** in both columns.  mysql> **SET sql\_mode = '';**  mysql> **INSERT INTO ch VALUES ('A汌B','A汌B');**  Query OK, 1 row affected, 1 warning (0.00 sec)  The [**INSERT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#insert) produces a warning. Use the following statement to see what it is:  mysql> **SHOW WARNINGS\G**  \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* 1. row \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*  Level: Warning  Code: 1366  Message: Incorrect string value: '\xE6\xB1\x8CB' for column 'gb2312' at row 1  So it is a warning about the **gb2312** column only.  mysql> SELECT ucs2,HEX(ucs2),gb2312,HEX(gb2312) FROM ch;  +-------+--------------+--------+-------------+  | ucs2 | HEX(ucs2) | gb2312 | HEX(gb2312) |  +-------+--------------+--------+-------------+  | A汌B | 00416C4C0042 | A?B | 413F42 |  +-------+--------------+--------+-------------+  Several things need explanation here:  The **汌** character is not in the **gb2312** character set, as described earlier.  If you are using an old version of MySQL, you may see a different message.  A warning occurs rather than an error because MySQL is not set to use strict SQL mode. In nonstrict mode, MySQL tries to do what it can, to get the best fit, rather than give up. With strict SQL mode, the Incorrect string value message occurs as an error rather than a warning, and the [**INSERT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#insert) fails. |
| **A.11.9.** | Why does my GUI front end or browser display CJK characters incorrectly in my application using Access, PHP, or another API? |
|  | Obtain a direct connection to the server using the [**mysql**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#mysql) client, and try the same query there. If [**mysql**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#mysql) responds correctly, the trouble may be that your application interface requires initialization. Use [**mysql**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#mysql) to tell you what character set or sets it uses with the statement **SHOW VARIABLES LIKE 'char%';**. If you are using Access, you are most likely connecting with Connector/ODBC. In this case, you should check [Configuring Connector/ODBC](https://dev.mysql.com/doc/connector-odbc/en/connector-odbc-configuration.html). If, for example, you use **big5**, you would enter **SET NAMES 'big5'**. (In this case, no **;** character is required.) If you are using ASP, you might need to add [**SET NAMES**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#set-names) in the code. Here is an example that has worked in the past:  <%  Session.CodePage=0  Dim strConnection  Dim Conn  strConnection="driver={MySQL ODBC 3.51 Driver};server=***server***;uid=***username***;" \  & "pwd=***password***;database=***database***;stmt=SET NAMES 'big5';"  Set Conn = Server.CreateObject("ADODB.Connection")  Conn.Open strConnection  %>  In much the same way, if you are using any character set other than **latin1** with Connector/NET, you must specify the character set in the connection string. See [Connector/NET Connections](https://dev.mysql.com/doc/connector-net/en/connector-net-connections.html), for more information.  If you are using PHP, try this:  <?php  $link = new mysqli($host, $usr, $pwd, $db);  if( mysqli\_connect\_errno() )  {  printf("Connect failed: %s\n", mysqli\_connect\_error());  exit();  }  $link->query("SET NAMES 'utf8'");  ?>  In this case, we used [**SET NAMES**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#set-names) to change [**character\_set\_client**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sysvar_character_set_client), [**character\_set\_connection**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sysvar_character_set_connection), and [**character\_set\_results**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sysvar_character_set_results).  Another issue often encountered in PHP applications has to do with assumptions made by the browser. Sometimes adding or changing a **<meta>** tag suffices to correct the problem: for example, to insure that the user agent interprets page content as **UTF-8**, include **<meta http-equiv="Content-Type" content="text/html; charset=utf-8">** in the **<head>** section of the HTML page.  If you are using Connector/J, see [Using Character Sets and Unicode](https://dev.mysql.com/doc/connector-j/8.0/en/connector-j-reference-charsets.html). |
| **A.11.10.** | I've upgraded to MySQL 8.0. How can I revert to behavior like that in MySQL 4.0 with regard to character sets? |
|  | In MySQL Version 4.0, there was a single “global” character set for both server and client, and the decision as to which character to use was made by the server administrator. This changed starting with MySQL Version 4.1. What happens now is a “handshake”, as described in [Section 10.4, “Connection Character Sets and Collations”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\charset.html#charset-connection):  When a client connects, it sends to the server the name of the character set that it wants to use. The server uses the name to set the [**character\_set\_client**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sysvar_character_set_client), [**character\_set\_results**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sysvar_character_set_results), and [**character\_set\_connection**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sysvar_character_set_connection) system variables. In effect, the server performs a [**SET NAMES**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#set-names) operation using the character set name.  The effect of this is that you cannot control the client character set by starting [**mysqld**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#mysqld) with [--character-set-server=utf8](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sysvar_character_set_server). However, some Asian customers prefer the MySQL 4.0 behavior. To make it possible to retain this behavior, we added a [**mysqld**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#mysqld) switch, [--character-set-client-handshake](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#option_mysqld_character-set-client-handshake), which can be turned off with [--skip-character-set-client-handshake](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#option_mysqld_character-set-client-handshake). If you start [**mysqld**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#mysqld) with [--skip-character-set-client-handshake](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#option_mysqld_character-set-client-handshake), then, when a client connects, it sends to the server the name of the character set that it wants to use. However, the server ignores this request from the client.  By way of example, suppose that your favorite server character set is **latin1**. Suppose further that the client uses **utf8** because this is what the client's operating system supports. Start the server with **latin1** as its default character set:  mysqld --character-set-server=latin1  And then start the client with the default character set **utf8**:  mysql --default-character-set=utf8  The resulting settings can be seen by viewing the output of [**SHOW VARIABLES**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#show-variables):  mysql> **SHOW VARIABLES LIKE 'char%';**  +--------------------------+----------------------------------------+  | Variable\_name | Value |  +--------------------------+----------------------------------------+  | character\_set\_client | utf8 |  | character\_set\_connection | utf8 |  | character\_set\_database | latin1 |  | character\_set\_filesystem | binary |  | character\_set\_results | utf8 |  | character\_set\_server | latin1 |  | character\_set\_system | utf8 |  | character\_sets\_dir | /usr/local/mysql/share/mysql/charsets/ |  +--------------------------+----------------------------------------+  Now stop the client, and stop the server using [**mysqladmin**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#mysqladmin). Then start the server again, but this time tell it to skip the handshake like so:  mysqld --character-set-server=utf8 --skip-character-set-client-handshake  Start the client with **utf8** once again as the default character set, then display the resulting settings:  mysql> **SHOW VARIABLES LIKE 'char%';**  +--------------------------+----------------------------------------+  | Variable\_name | Value |  +--------------------------+----------------------------------------+  | character\_set\_client | latin1 |  | character\_set\_connection | latin1 |  | character\_set\_database | latin1 |  | character\_set\_filesystem | binary |  | character\_set\_results | latin1 |  | character\_set\_server | latin1 |  | character\_set\_system | utf8 |  | character\_sets\_dir | /usr/local/mysql/share/mysql/charsets/ |  +--------------------------+----------------------------------------+  As you can see by comparing the differing results from [**SHOW VARIABLES**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#show-variables), the server ignores the client's initial settings if the [--skip-character-set-client-handshake](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#option_mysqld_character-set-client-handshake) option is used. |
| **A.11.11.** | Why do some [**LIKE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\functions.html#operator_like) and **FULLTEXT** searches with CJK characters fail? |
|  | For [**LIKE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\functions.html#operator_like) searches, there is a very simple problem with binary string column types such as [**BINARY**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#binary-varbinary) and [**BLOB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#blob): we must know where characters end. With multibyte character sets, different characters might have different octet lengths. For example, in **utf8**, **A** requires one byte but **ペ** requires three bytes, as shown here:  +-------------------------+---------------------------+  | OCTET\_LENGTH(\_utf8 'A') | OCTET\_LENGTH(\_utf8 'ペ') |  +-------------------------+---------------------------+  | 1 | 3 |  +-------------------------+---------------------------+  If we do not know where the first character in a string ends, we do not know where the second character begins, in which case even very simple searches such as [**LIKE '\_A%'**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\functions.html#operator_like) fail. The solution is to use a nonbinary string column type defined to have the proper CJK character set. For example: **mycol TEXT CHARACTER SET sjis**. Alternatively, convert to a CJK character set before comparing.  This is one reason why MySQL cannot permit encodings of nonexistent characters. If it is not strict about rejecting bad input, it has no way of knowing where characters end.  For **FULLTEXT** searches, we must know where words begin and end. With Western languages, this is rarely a problem because most (if not all) of these use an easy-to-identify word boundary: the space character. However, this is not usually the case with Asian writing. We could use arbitrary halfway measures, like assuming that all Han characters represent words, or (for Japanese) depending on changes from Katakana to Hiragana due to grammatical endings. However, the only sure solution requires a comprehensive word list, which means that we would have to include a dictionary in the server for each Asian language supported. This is simply not feasible. |
| **A.11.12.** | How do I know whether character ***X*** is available in all character sets? |
|  | The majority of simplified Chinese and basic nonhalfwidth Japanese Kana characters appear in all CJK character sets. The following stored procedure accepts a **UCS-2** Unicode character, converts it to other character sets, and displays the results in hexadecimal.  DELIMITER //  CREATE PROCEDURE p\_convert(ucs2\_char CHAR(1) CHARACTER SET ucs2)  BEGIN  CREATE TABLE tj  (ucs2 CHAR(1) character set ucs2,  utf8 CHAR(1) character set utf8,  big5 CHAR(1) character set big5,  cp932 CHAR(1) character set cp932,  eucjpms CHAR(1) character set eucjpms,  euckr CHAR(1) character set euckr,  gb2312 CHAR(1) character set gb2312,  gbk CHAR(1) character set gbk,  sjis CHAR(1) character set sjis,  ujis CHAR(1) character set ujis);  INSERT INTO tj (ucs2) VALUES (ucs2\_char);  UPDATE tj SET utf8=ucs2,  big5=ucs2,  cp932=ucs2,  eucjpms=ucs2,  euckr=ucs2,  gb2312=ucs2,  gbk=ucs2,  sjis=ucs2,  ujis=ucs2;  /\* If there are conversion problems, UPDATE produces warnings. \*/  SELECT hex(ucs2) AS ucs2,  hex(utf8) AS utf8,  hex(big5) AS big5,  hex(cp932) AS cp932,  hex(eucjpms) AS eucjpms,  hex(euckr) AS euckr,  hex(gb2312) AS gb2312,  hex(gbk) AS gbk,  hex(sjis) AS sjis,  hex(ujis) AS ujis  FROM tj;  DROP TABLE tj;  END//  DELIMITER ;  The input can be any single **ucs2** character, or it can be the code value (hexadecimal representation) of that character. For example, from Unicode's list of **ucs2** encodings and names (<http://www.unicode.org/Public/UNIDATA/UnicodeData.txt>), we know that the Katakana character Pe appears in all CJK character sets, and that its code value is **X'30DA'**. If we use this value as the argument to **p\_convert()**, the result is as shown here:  mysql> **CALL p\_convert(X'30DA');**  +------+--------+------+-------+---------+-------+--------+------+------+------+  | ucs2 | utf8 | big5 | cp932 | eucjpms | euckr | gb2312 | gbk | sjis | ujis |  +------+--------+------+-------+---------+-------+--------+------+------+------+  | 30DA | E3839A | C772 | 8379 | A5DA | ABDA | A5DA | A5DA | 8379 | A5DA |  +------+--------+------+-------+---------+-------+--------+------+------+------+  Since none of the column values is **3F** (that is, the question mark character, **?**), we know that every conversion worked. |
| **A.11.13.** | Why do CJK strings sort incorrectly in Unicode? (I) |
|  | CJK sorting problems that occurred in older MySQL versions can be solved as of MySQL 8.0 by using the **utf8mb4** character set and the **utf8mb4\_ja\_0900\_as\_cs** collation. |
| **A.11.14.** | Why do CJK strings sort incorrectly in Unicode? (II) |
|  | CJK sorting problems that occurred in older MySQL versions can be solved as of MySQL 8.0 by using the **utf8mb4** character set and the **utf8mb4\_ja\_0900\_as\_cs** collation. |
| **A.11.15.** | Why are my supplementary characters rejected by MySQL? |
|  | Supplementary characters lie outside the Unicode Basic Multilingual Plane / Plane 0. BMP characters have code point values between **U+0000** and **U+FFFF**. Supplementary characters have code point values between **U+10000** and **U+10FFFF**.  To store supplementary characters, you must use a character set that permits them:  The **utf8** and **ucs2** character sets support BMP characters only.  The **utf8** character set permits only **UTF-8** characters that take up to three bytes. This has led to reports such as that found in Bug #12600, which we rejected as “not a bug”. With **utf8**, MySQL must truncate an input string when it encounters bytes that it does no understand. Otherwise, it is unknown how long the bad multibyte character is.  One possible workaround is to use **ucs2** instead of **utf8**, in which case the “bad” characters are changed to question marks. However, no truncation takes place. You can also change the data type to [**BLOB**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#blob) or [**BINARY**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#binary-varbinary), which perform no validity checking.  The **utf8mb4**, **utf16**, **utf16le**, and **utf32** character sets support BMP characters, as well as supplementary characters outside the BMP. |
| **A.11.16.** | Should “CJK” be “CJKV”? |
|  | No. The term “CJKV” (Chinese Japanese Korean Vietnamese) refers to Vietnamese character sets which contain Han (originally Chinese) characters. MySQL supports the modern Vietnamese script with Western characters, but does not support the old Vietnamese script using Han characters.  As of MySQL 5.6, there are Vietnamese collations for Unicode character sets, as described in [Section 10.10.1, “Unicode Character Sets”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\charset.html#charset-unicode-sets). |
| **A.11.17.** | Does MySQL permit CJK characters to be used in database and table names? |
|  | Yes. |
| **A.11.18.** | Where can I find translations of the MySQL Manual into Chinese, Japanese, and Korean? |
|  | The Japanese translation of the MySQL 5.6 manual can be downloaded from <https://dev.mysql.com/doc/>. |
| **A.11.19.** | Where can I get help with CJK and related issues in MySQL? |
|  | The following resources are available:  A listing of MySQL user groups can be found at <https://wikis.oracle.com/display/mysql/List+of+MySQL+User+Groups>.  View feature requests relating to character set issues at <http://tinyurl.com/y6xcuf>.  Visit the MySQL [Character Sets, Collation, Unicode Forum](https://forums.mysql.com/list.php?103). <http://forums.mysql.com/> also provides foreign-language forums. |

## A.12 MySQL 8.0 FAQ: Connectors & APIs

For common questions, issues, and answers relating to the MySQL Connectors and other APIs, see the following areas of the Manual:

[Using C API Features](https://dev.mysql.com/doc/c-api/8.0/en/c-api-features.html)

[Common Problems with MySQL and PHP](https://dev.mysql.com/doc/apis-php/en/apis-php-problems.html)

[Connector/ODBC Notes and Tips](https://dev.mysql.com/doc/connector-odbc/en/connector-odbc-usagenotes.html)

[Connector/NET Programming](https://dev.mysql.com/doc/connector-net/en/connector-net-programming.html)

[MySQL Connector/J 8.0 Developer Guide](https://dev.mysql.com/doc/connector-j/8.0/en/)

## A.13 MySQL 8.0 FAQ: C API, libmysql

Frequently asked questions about MySQL C API and libmysql.

A.13.1. [What is “MySQL Native C API”? What are typical benefits and use cases?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-c-api-what-is-native-c-api)

A.13.2. [Which version of libmysql should I use?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-c-api-which-version-to-use)

A.13.3. [What if I want to use the “NoSQL” X DevAPI?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-c-api-using-x-devapi)

A.13.4. [How to I download libmysql?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-c-api-download)

A.13.5. [Where is the documentation?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-c-api-documentation)

A.13.6. [How do I report bugs?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-c-api-bugs)

A.13.7. [Is it possible to compile the library myself?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-mysql-c-api-compile)

|  |  |
| --- | --- |
| **A.13.1.** | What is “MySQL Native C API”? What are typical benefits and use cases? |
|  | libmysql is a C-based API that you can use in C applications to connect with the MySQL database server. It is also itself used as the foundation for drivers for standard database APIs like ODBC, Perl's DBI, and Python's DB API. |
| **A.13.2.** | Which version of libmysql should I use? |
|  | For MySQL 8.0, 5.7, 5.6, and 5.5, we recommend libmysql 8.0. |
| **A.13.3.** | What if I want to use the “NoSQL” X DevAPI? |
|  | For C-language and X DevApi Document Store for MySQL 8.0, we recommend MySQL Connector/C++. Connector/C++ 8.0 has compatible C headers. (This is not applicable to MySQL 5.7 or before.) |
| **A.13.4.** | How to I download libmysql? |
|  | Linux: The Client Utilities Package is available from the [MySQL Community Server](https://dev.mysql.com/downloads/mysql/) download page.  Repos: The Client Utilities Package is available from the [Yum](https://dev.mysql.com/downloads/repo/yum/), [APT](https://dev.mysql.com/downloads/repo/apt/), [SuSE repositories](https://dev.mysql.com/downloads/repo/suse/).  Windows: The Client Utilities Package is available from [Windows Installer](https://dev.mysql.com/downloads/installer/). |
| **A.13.5.** | Where is the documentation? |
|  | See [MySQL 8.0 C API Developer Guide](https://dev.mysql.com/doc/c-api/8.0/en/). |
| **A.13.6.** | How do I report bugs? |
|  | Please report any bugs or inconsistencies you observe to our [Bugs Database](https://bugs.mysql.com/). Select the C API Client as shown. |
| **A.13.7.** | Is it possible to compile the library myself? |
|  | Yes, you can download the libmysqlclient source code and compile it on your own. Here's an example:  $ git clone --depth 1 https://github.com/mysql/mysql-server  $ cd mysql-server  $ mkdir build  $ cd build  $ cmake .. -GNinja -DDOWNLOAD\_BOOST=1 \  -DWITH\_BOOST=/tmp -DCMAKE\_BUILD\_TYPE=Release -DWITHOUT\_SERVER=ON \  -DWITH\_SSL=system  $ ninja libmysqlclient.a  $ ls -la archive\_output\_directory/libmysqlclient.a  -rw-rw-r-- 1 kg kg 8,5M wrz 5 04:57 archive\_output\_directory/libmysqlclient.a    **Note**  This example uses https://ninja-build.org/ as a build system instead of make. |

## A.14 MySQL 8.0 FAQ: Replication

In the following section, we provide answers to questions that are most frequently asked about MySQL Replication.

A.14.1. [Must the replica be connected to the source all the time?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-replication-have-connected-replica)

A.14.2. [Must I enable networking on my source and replica to enable replication?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-replication-have-enable-networking)

A.14.3. [How do I know how late a replica is compared to the source? In other words, how do I know the date of the last statement replicated by the replica?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-replication-how-compare-replica-date)

A.14.4. [How do I force the source to block updates until the replica catches up?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-replication-how-block-updates)

A.14.5. [What issues should I be aware of when setting up two-way replication?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-replication-how-two-way-problems)

A.14.6. [How can I use replication to improve performance of my system?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-replication-how-improves-performance)

A.14.7. [What should I do to prepare client code in my own applications to use performance-enhancing replication?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-replication-how-prepare-for-replication)

A.14.8. [When and how much can MySQL replication improve the performance of my system?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-replication-how-benefits-me)

A.14.9. [How can I use replication to provide redundancy or high availability?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-replication-how-high-availability)

A.14.10. [How do I tell whether a replication source server is using statement-based or row-based binary logging format?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-replication-how-know-log-format)

A.14.11. [How do I tell a replica to use row-based replication?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-replication-how-use-row-based)

A.14.12. [How do I prevent GRANT and REVOKE statements from replicating to replica machines?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-replication-how-prevent-grant-revoke)

A.14.13. [Does replication work on mixed operating systems (for example, the source runs on Linux while replicas run on OS X and Windows)?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-replication-can-mix-os)

A.14.14. [Does replication work on mixed hardware architectures (for example, the source runs on a 64-bit machine while replicas run on 32-bit machines)?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-replication-can-mix-arch)

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| **A.14.1.** | Must the replica be connected to the source all the time? |
|  | No, it does not. The replica can go down or stay disconnected for hours or even days, and then reconnect and catch up on updates. For example, you can set up a source/replica relationship over a dial-up link where the link is up only sporadically and for short periods of time. The implication of this is that, at any given time, the replica is not guaranteed to be in synchrony with the source unless you take some special measures.  To ensure that catchup can occur for a replica that has been disconnected, you must not remove binary log files from the source that contain information that has not yet been replicated to the replicas. Asynchronous replication can work only if the replica is able to continue reading the binary log from the point where it last read events. |
| **A.14.2.** | Must I enable networking on my source and replica to enable replication? |
|  | Yes, networking must be enabled on the source and replica. If networking is not enabled, the replica cannot connect to the source and transfer the binary log. Verify that the [**skip\_networking**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sysvar_skip_networking) system variable has not been enabled in the configuration file for either server. |
| **A.14.3.** | How do I know how late a replica is compared to the source? In other words, how do I know the date of the last statement replicated by the replica? |
|  | Check the **Seconds\_Behind\_Master** column in the output from [**SHOW REPLICA | SLAVE STATUS**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#show-replica-status). See [Section 17.1.7.1, “Checking Replication Status”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\replication.html#replication-administration-status).  When the replication SQL thread executes an event read from the source, it modifies its own time to the event timestamp. (This is why [**TIMESTAMP**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\data-types.html#datetime) is well replicated.) In the **Time** column in the output of [**SHOW PROCESSLIST**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#show-processlist), the number of seconds displayed for the replication SQL thread is the number of seconds between the timestamp of the last replicated event and the real time of the replica machine. You can use this to determine the date of the last replicated event. Note that if your replica has been disconnected from the source for one hour, and then reconnects, you may immediately see large **Time** values such as 3600 for the replication SQL thread in [**SHOW PROCESSLIST**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#show-processlist). This is because the replica is executing statements that are one hour old. See [Section 17.2.3, “Replication Threads”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\replication.html#replication-implementation-details). |
| **A.14.4.** | How do I force the source to block updates until the replica catches up? |
|  | Use the following procedure:  On the source, execute these statements:  mysql> **FLUSH TABLES WITH READ LOCK;**  mysql> **SHOW MASTER STATUS;**  Record the replication coordinates (the current binary log file name and position) from the output of the [**SHOW**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#show) statement.  On the replica, issue the following statement, where the arguments to the [**MASTER\_POS\_WAIT()**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\functions.html#function_master-pos-wait) function are the replication coordinate values obtained in the previous step:  mysql> **SELECT MASTER\_POS\_WAIT('*log\_name*', *log\_pos*);**  The [**SELECT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#select) statement blocks until the replica reaches the specified log file and position. At that point, the replica is in synchrony with the source and the statement returns.  On the source, issue the following statement to enable the source to begin processing updates again:  mysql> **UNLOCK TABLES;** |
| **A.14.5.** | What issues should I be aware of when setting up two-way replication? |
|  | MySQL replication currently does not support any locking protocol between source and replica to guarantee the atomicity of a distributed (cross-server) update. In other words, it is possible for client A to make an update to co-source 1, and in the meantime, before it propagates to co-source 2, client B could make an update to co-source 2 that makes the update of client A work differently than it did on co-source 1. Thus, when the update of client A makes it to co-source 2, it produces tables that are different from what you have on co-source 1, even after all the updates from co-source 2 have also propagated. This means that you should not chain two servers together in a two-way replication relationship unless you are sure that your updates can safely happen in any order, or unless you take care of mis-ordered updates somehow in the client code.  You should also realize that two-way replication actually does not improve performance very much (if at all) as far as updates are concerned. Each server must do the same number of updates, just as you would have a single server do. The only difference is that there is a little less lock contention because the updates originating on another server are serialized in one replication thread. Even this benefit might be offset by network delays. |
| **A.14.6.** | How can I use replication to improve performance of my system? |
|  | Set up one server as the source and direct all writes to it. Then configure as many replicas as you have the budget and rackspace for, and distribute the reads among the source and the replicas. You can also start the replicas with the [--skip-innodb](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\innodb-storage-engine.html#option_mysqld_innodb) option, enable the [**low\_priority\_updates**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sysvar_low_priority_updates) system variable, and set the [**delay\_key\_write**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#sysvar_delay_key_write) system variable to **ALL** to get speed improvements on the replica end. In this case, the replica uses nontransactional **MyISAM** tables instead of **InnoDB** tables to get more speed by eliminating transactional overhead. |
| **A.14.7.** | What should I do to prepare client code in my own applications to use performance-enhancing replication? |
|  | See the guide to using replication as a scale-out solution, [Section 17.4.5, “Using Replication for Scale-Out”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\replication.html#replication-solutions-scaleout). |
| **A.14.8.** | When and how much can MySQL replication improve the performance of my system? |
|  | MySQL replication is most beneficial for a system that processes frequent reads and infrequent writes. In theory, by using a single-source/multiple-replica setup, you can scale the system by adding more replicas until you either run out of network bandwidth, or your update load grows to the point that the source cannot handle it.  To determine how many replicas you can use before the added benefits begin to level out, and how much you can improve performance of your site, you must know your query patterns, and determine empirically by benchmarking the relationship between the throughput for reads and writes on a typical source and a typical replica. The example here shows a rather simplified calculation of what you can get with replication for a hypothetical system. Let **reads** and **writes** denote the number of reads and writes per second, respectively.  Let's say that system load consists of 10% writes and 90% reads, and we have determined by benchmarking that **reads** is 1200 - 2 \* **writes**. In other words, the system can do 1,200 reads per second with no writes, the average write is twice as slow as the average read, and the relationship is linear. Suppose that the source and each replica have the same capacity, and that we have one source and ***N*** replicas. Then we have for each server (source or replica):  **reads** = 1200 - 2 \* **writes**  **reads** = 9 \* **writes** / (***N*** + 1) (reads are split, but writes replicated to all replicas)  9 \* **writes** / (***N*** + 1) + 2 \* **writes** = 1200  **writes** = 1200 / (2 + 9/(***N*** + 1))  The last equation indicates the maximum number of writes for ***N*** replicas, given a maximum possible read rate of 1,200 per second and a ratio of nine reads per write.  This analysis yields the following conclusions:  If ***N*** = 0 (which means we have no replication), our system can handle about 1200/11 = 109 writes per second.  If ***N*** = 1, we get up to 184 writes per second.  If ***N*** = 8, we get up to 400 writes per second.  If ***N*** = 17, we get up to 480 writes per second.  Eventually, as ***N*** approaches infinity (and our budget negative infinity), we can get very close to 600 writes per second, increasing system throughput about 5.5 times. However, with only eight servers, we increase it nearly four times.  These computations assume infinite network bandwidth and neglect several other factors that could be significant on your system. In many cases, you may not be able to perform a computation similar to the one just shown that accurately predicts what happens on your system if you add ***N*** replicas. However, answering the following questions should help you decide whether and by how much replication may improve the performance of your system:  What is the read/write ratio on your system?  How much more write load can one server handle if you reduce the reads?  For how many replicas do you have bandwidth available on your network? |
| **A.14.9.** | How can I use replication to provide redundancy or high availability? |
|  | How you implement redundancy is entirely dependent on your application and circumstances. High-availability solutions (with automatic failover) require active monitoring and either custom scripts or third party tools to provide the failover support from the original MySQL server to the replica.  To handle the process manually, you should be able to switch from a failed source to a pre-configured replica by altering your application to talk to the new server or by adjusting the DNS for the MySQL server from the failed server to the new server.  For more information and some example solutions, see [Section 17.4.8, “Switching Sources During Failover”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\replication.html#replication-solutions-switch). |
| **A.14.10.** | How do I tell whether a replication source server is using statement-based or row-based binary logging format? |
|  | Check the value of the [**binlog\_format**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\replication.html#sysvar_binlog_format) system variable:  mysql> **SHOW VARIABLES LIKE 'binlog\_format';**  The value shown is always one of **STATEMENT**, **ROW**, or **MIXED**. For **MIXED** mode, statement-based logging is used by default but replication switches automatically to row-based logging under certain conditions, such as unsafe statements. For information about when this may occur, see [Section 5.4.4.3, “Mixed Binary Logging Format”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#binary-log-mixed). |
| **A.14.11.** | How do I tell a replica to use row-based replication? |
|  | Replicas automatically know which format to use. |
| **A.14.12.** | How do I prevent [**GRANT**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#grant) and [**REVOKE**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#revoke) statements from replicating to replica machines? |
|  | Start the server with the [--replicate-wild-ignore-table=mysql.%](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\replication.html#option_mysqld_replicate-wild-ignore-table) option to ignore replication for tables in the **mysql** database. |
| **A.14.13.** | Does replication work on mixed operating systems (for example, the source runs on Linux while replicas run on OS X and Windows)? |
|  | Yes. |
| **A.14.14.** | Does replication work on mixed hardware architectures (for example, the source runs on a 64-bit machine while replicas run on 32-bit machines)? |
|  | Yes. |

## A.15 MySQL 8.0 FAQ: MySQL Enterprise Thread Pool

A.15.1. [What is the Thread Pool and what problem does it solve?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-thread-pool-what-solve)

A.15.2. [How does the Thread Pool limit and manage concurrent sessions and transactions for optimal performance and throughput?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-thread-pool-how-manage-operation)

A.15.3. [How is the Thread Pool different from the client side Connection Pool?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-thread-pool-how-diff-connector-pool)

A.15.4. [When should I use the Thread Pool?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-thread-pool-when-use)

A.15.5. [Are there recommended Thread Pool configurations?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-thread-pool-what-config-recommend)

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| **A.15.1.** | What is the Thread Pool and what problem does it solve? |
|  | The MySQL Thread Pool is a MySQL server plugin that extends the default connection-handling capabilities of the MySQL server to limit the number of concurrently executing statements/queries and transactions to ensure that each has sufficient CPU and memory resources to fulfill its task. For MySQL 8.0, the Thread Pool plugin is included in MySQL Enterprise Edition, a commercial product.  The default thread-handling model in MySQL Server executes statements using one thread per client connection. As more clients connect to the server and execute statements, overall performance degrades. The Thread Pool plugin provides an alternative thread-handling model designed to reduce overhead and improve performance. The Thread Pool plugin increases server performance by efficiently managing statement execution threads for large numbers of client connections, especially on modern multi-CPU/Core systems.  For more information, see [Section 5.6.3, “MySQL Enterprise Thread Pool”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#thread-pool). |
| **A.15.2.** | How does the Thread Pool limit and manage concurrent sessions and transactions for optimal performance and throughput? |
|  | The Thread Pool uses a “divide and conquer” approach to limiting and balancing concurrency. Unlike the default connection handling of the MySQL Server, the Thread Pool separates connections and threads, so there is no fixed relationship between connections and the threads that execute statements received from those connections. The Thread Pool then manages client connections within configurable thread groups, where they are prioritized and queued based on the nature of the work they were submitted to accomplish.  For more information, see [Section 5.6.3.3, “Thread Pool Operation”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#thread-pool-operation). |
| **A.15.3.** | How is the Thread Pool different from the client side Connection Pool? |
|  | The MySQL Connection Pool operates on the client side to ensure that a MySQL client does not constantly connect to and disconnect from the MySQL server. It is designed to cache idle connections in the MySQL client for use by other users as they are needed. This minimizes the overhead and expense of establishing and tearing down connections as queries are submitted to the MySQL server. The MySQL Connection Pool has no visibility as to the query handling capabilities or load of the back-end MySQL server. By contrast, the Thread Pool operates on the MySQL server side and is designed to manage the execution of inbound concurrent connections and queries as they are received from the client connections accessing the back-end MySQL database. Because of the separation of duties, the MySQL Connection Pool and Thread Pool are orthogonal and can be used independent of each other.  MySQL Connection Pooling via the MySQL Connectors is covered in [Chapter 29, *Connectors and APIs*](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\connectors-apis.html). |
| **A.15.4.** | When should I use the Thread Pool? |
|  | There are a few rules of thumb to consider for optimal Thread Pool use cases:  The MySQL [**Threads\_running**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#statvar_Threads_running) variable keeps track of the number of concurrent statements currently executing in the MySQL Server. If this variable consistently exceeds a region where the server won't operate optimally (usually going beyond 40 for InnoDB workloads), the Thread Pool should be beneficial, especially in extreme parallel overload situations.  If you are using the [**innodb\_thread\_concurrency**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\innodb-storage-engine.html#sysvar_innodb_thread_concurrency) to limit the number of concurrently executing statements, you should find that the Thread Pool solves the same problem, only better, by assigning connections to thread groups, then queuing executions based on transactional content, user defined designations, and so forth.  Lastly, if your workload comprises mainly short queries, the Thread Pool should be beneficial.  To learn more, see [Section 5.6.3.4, “Thread Pool Tuning”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#thread-pool-tuning). |
| **A.15.5.** | Are there recommended Thread Pool configurations? |
|  | The Thread Pool has a number of user case driven configuration parameters that affect its performance. To learn about these and tips on tuning, see [Section 5.6.3.4, “Thread Pool Tuning”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\server-administration.html#thread-pool-tuning). |

## A.16 MySQL 8.0 FAQ: InnoDB Change Buffer

A.16.1. [What types of operations modify secondary indexes and result in change buffering?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-innodb-change-buffer-operations)

A.16.2. [What is the benefit of the InnoDB change buffer?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-innodb-change-buffer-benefits)

A.16.3. [Does the change buffer support other types of indexes?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-innodb-change-buffer-index-types)

A.16.4. [How much space does InnoDB use for the change buffer?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-innodb-change-buffer-space-max-size)

A.16.5. [How do I determine the current size of the change buffer?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-innodb-change-buffer-current-size)

A.16.6. [When does change buffer merging occur?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-innodb-change-buffer-merging)

A.16.7. [When is the change buffer flushed?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-innodb-change-buffer-flush-time)

A.16.8. [When should the change buffer be used?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-innodb-change-buffer-when-to-enable)

A.16.9. [When should the change buffer not be used?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-innodb-change-buffer-when-to-disable)

A.16.10. [Where can I find additional information about the change buffer?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-innodb-change-buffer-info)

|  |  |
| --- | --- |
| **A.16.1.** | What types of operations modify secondary indexes and result in change buffering? |
|  | **INSERT**, **UPDATE**, and **DELETE** operations can modify secondary indexes. If an affected index page is not in the buffer pool, the changes can be buffered in the change buffer. |
| **A.16.2.** | What is the benefit of the **InnoDB** change buffer? |
|  | Buffering secondary index changes when secondary index pages are not in the buffer pool avoids expensive random access I/O operations that would be required to immediately read in affected index pages from disk. Buffered changes can be applied later, in batches, as pages are read into the buffer pool by other read operations. |
| **A.16.3.** | Does the change buffer support other types of indexes? |
|  | No. The change buffer only supports secondary indexes. Clustered indexes, full-text indexes, and spatial indexes are not supported. Full-text indexes have their own caching mechanism. |
| **A.16.4.** | How much space does **InnoDB** use for the change buffer? |
|  | Prior to the introduction of the [**innodb\_change\_buffer\_max\_size**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\innodb-storage-engine.html#sysvar_innodb_change_buffer_max_size) configuration option in MySQL 5.6, the maximum size of the on-disk change buffer in the system tablespace was 1/3 of the **InnoDB** buffer pool size.  In MySQL 5.6 and later, the [**innodb\_change\_buffer\_max\_size**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\innodb-storage-engine.html#sysvar_innodb_change_buffer_max_size) configuration option defines the maximum size of the change buffer as a percentage of the total buffer pool size. By default, [**innodb\_change\_buffer\_max\_size**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\innodb-storage-engine.html#sysvar_innodb_change_buffer_max_size) is set to 25. The maximum setting is 50.  **InnoDB** does not buffer an operation if it would cause the on-disk change buffer to exceed the defined limit.  Change buffer pages are not required to persist in the buffer pool and may be evicted by LRU operations. |
| **A.16.5.** | How do I determine the current size of the change buffer? |
|  | The current size of the change buffer is reported by **SHOW ENGINE INNODB STATUS \G**, under the **INSERT BUFFER AND ADAPTIVE HASH INDEX** heading. For example:  -------------------------------------  INSERT BUFFER AND ADAPTIVE HASH INDEX  -------------------------------------  Ibuf: size 1, free list len 0, seg size 2, 0 merges  Relevant data points include:  **size**: The number of pages used within the change buffer. Change buffer size is equal to **seg size - (1 + free list len)**. The **1 +** value represents the change buffer header page.  **seg size**: The size of the change buffer, in pages.  For information about monitoring change buffer status, see [Section 15.5.2, “Change Buffer”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\innodb-storage-engine.html#innodb-change-buffer). |
| **A.16.6.** | When does change buffer merging occur? |
|  | When a page is read into the buffer pool, buffered changes are merged upon completion of the read, before the page is made available.  Change buffer merging is performed as a background task. The [**innodb\_io\_capacity**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\innodb-storage-engine.html#sysvar_innodb_io_capacity) parameter sets an upper limit on the I/O activity performed by **InnoDB** background tasks such as merging data from the change buffer.  A change buffer merge is performed during crash recovery. Changes are applied from the change buffer (in the system tablespace) to leaf pages of secondary indexes as index pages are read into the buffer pool.  The change buffer is fully durable and can survive a system crash. Upon restart, change buffer merge operations resume as part of normal operations.  A full merge of the change buffer can be forced as part of a slow server shutdown using [**--innodb-fast-shutdown=0**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\innodb-storage-engine.html#sysvar_innodb_fast_shutdown). |
| **A.16.7.** | When is the change buffer flushed? |
|  | Updated pages are flushed by the same flushing mechanism that flushes the other pages that occupy the buffer pool. |
| **A.16.8.** | When should the change buffer be used? |
|  | The change buffer is a feature designed to reduce random I/O to secondary indexes as indexes grow larger and no longer fit in the **InnoDB** buffer pool. Generally, the change buffer should be used when the entire data set does not fit into the buffer pool, when there is substantial DML activity that modifies secondary index pages, or when there are lots of secondary indexes that are regularly changed by DML activity. |
| **A.16.9.** | When should the change buffer not be used? |
|  | You might consider disabling the change buffer if the entire data set fits within the **InnoDB** buffer pool, if you have relatively few secondary indexes, or if you are using solid-state storage, where random reads are about as fast as sequential reads. Before making configuration changes, it is recommended that you run tests using a representative workload to determine if disabling the change buffer provides any benefit. |
| **A.16.10.** | Where can I find additional information about the change buffer? |
|  | See [Section 15.5.2, “Change Buffer”](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\innodb-storage-engine.html#innodb-change-buffer). |

## A.17 MySQL 8.0 FAQ: InnoDB Data-at-Rest Encryption

A.17.1. [Is data decrypted for users who are authorized to see it?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-tablespace-encryption-access)

A.17.2. [What is the overhead associated with InnoDB data-at-rest encryption?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-tablespace-encryption-overhead)

A.17.3. [What are the encryption algorithms used with InnoDB data-at-rest encryption?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-tablespace-encryption-algorithm)

A.17.4. [Is it possible to use 3rd party encryption algorithms in place of the one provided by the InnoDB data-at-rest encryption feature?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-tablespace-encryption-other-algorithms)

A.17.5. [Can indexed columns be encrypted?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-tablespace-encryption-indexed-columns)

A.17.6. [What data types and data lengths does InnoDB data-at-rest encryption support?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-tablespace-encryption-data-types)

A.17.7. [Does data remain encrypted on the network?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-tablespace-encryption-network)

A.17.8. [Does database memory contain cleartext or encrypted data?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-tablespace-encryption-database-memory)

A.17.9. [How do I know which data to encrypt?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-tablespace-encryption-data-to-encrypt)

A.17.10. [How is InnoDB data-at-rest encryption different from encryption functions MySQL already provides?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-tablespace-encryption-mysql-encryption)

A.17.11. [Does the transportable tablespaces feature work with InnoDB data-at-rest encryption?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-tablespace-encryption-transportable-tablespaces)

A.17.12. [Does compression work with InnoDB data-at-rest encryption?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-tablespace-encryption-compression)

A.17.13. [Can I use mysqlpump or mysqldump with encrypted tables?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-tablespace-encryption-mysqldump)

A.17.14. [How do I change (rotate, re-key) the master encryption key?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-tablespace-encryption-key-rotation)

A.17.15. [How do I migrate data from a cleartext InnoDB tablespace to an encrypted InnoDB tablespace?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-tablespace-encryption-data-migration)

|  |  |
| --- | --- |
| **A.17.1.** | Is data decrypted for users who are authorized to see it? |
|  | Yes. **InnoDB** data-at-rest encryption is designed to transparently apply encryption within the database without impacting existing applications. Returning data in encrypted format would break most existing applications. **InnoDB** data-at-rest encryption provides the benefit of encryption without the overhead associated with traditional database encryption solutions, which would typically require expensive and substantial changes to applications, database triggers, and views. |
| **A.17.2.** | What is the overhead associated with **InnoDB** data-at-rest encryption? |
|  | There is no additional storage overhead. According to internal benchmarks, performance overhead amounts to a single digit percentage difference. |
| **A.17.3.** | What are the encryption algorithms used with **InnoDB** data-at-rest encryption? |
|  | **InnoDB** data-at-rest encryption supports the Advanced Encryption Standard (AES256) block-based encryption algorithm. It uses Electronic Codebook (ECB) block encryption mode for tablespace key encryption and Cipher Block Chaining (CBC) block encryption mode for data encryption. |
| **A.17.4.** | Is it possible to use 3rd party encryption algorithms in place of the one provided by the **InnoDB** data-at-rest encryption feature? |
|  | No, it is not possible to use other encryption algorithms. The provided encryption algorithm is broadly accepted. |
| **A.17.5.** | Can indexed columns be encrypted? |
|  | **InnoDB** data-at-rest encryption supports all indexes transparently. |
| **A.17.6.** | What data types and data lengths does **InnoDB** data-at-rest encryption support? |
|  | **InnoDB** data-at-rest encryption supports all supported data types. There is no data length limitation. |
| **A.17.7.** | Does data remain encrypted on the network? |
|  | Data encrypted by the **InnoDB** data-at-rest feature is decrypted when it is read from the tablespace file. Thus, if the data is on the network, it is in cleartext form. However, data on the network can be encrypted using MySQL network encryption, which encrypts data traveling to and from a database using SSL/TLS. |
| **A.17.8.** | Does database memory contain cleartext or encrypted data? |
|  | With **InnoDB** data-at-rest encryption, in-memory data is decrypted, which provides complete transparency. |
| **A.17.9.** | How do I know which data to encrypt? |
|  | Compliance with the PCI-DSS standard requires that credit card numbers (Primary Account Number, or 'PAN') be stored in encrypted form. Breach Notification Laws (for example, CA SB 1386, CA AB 1950, and similar laws in 43+ more US states) require encryption of first name, last name, driver license number, and other PII data. In early 2008, CA AB 1298 added medical and health insurance information to PII data. Additionally, industry specific privacy and security standards may require encryption of certain assets. For example, assets such as pharmaceutical research results, oil field exploration results, financial contracts, or personal data of law enforcement informants may require encryption. In the health care industry, the privacy of patient data, health records and X-ray images is of the highest importance. |
| **A.17.10.** | How is **InnoDB** data-at-rest encryption different from encryption functions MySQL already provides? |
|  | There are symmetric and asymmetric encryption APIs in MySQL that can be used to manually encrypt data within the database. However, the application must manage encryption keys and perform required encryption and decryption operations by calling API functions. **InnoDB** data-at-rest encryption requires no application changes, is transparent to end users, and provides automated, built-in key management. |
| **A.17.11.** | Does the transportable tablespaces feature work with **InnoDB** data-at-rest encryption? |
|  | Yes. It is supported for encrypted file-per-table tablespaces. For more information, see [Exporting Encrypted Tablespaces](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\innodb-storage-engine.html#innodb-data-encryption-exporting). |
| **A.17.12.** | Does compression work with **InnoDB** data-at-rest encryption? |
|  | Customers using **InnoDB** data-at-rest encryption receive the full benefit of compression because compression is applied before data blocks are encrypted. |
| **A.17.13.** | Can I use [**mysqlpump**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\programs.html#mysqlpump) or **mysqldump** with encrypted tables? |
|  | Yes. Because these utilities create logical backups, the data dumped from encrypted tables is not encrypted. |
| **A.17.14.** | How do I change (rotate, re-key) the master encryption key? |
|  | **InnoDB** data-at-rest encryption uses a two tier key mechanism. When data-at-rest encryption is used, individual tablespace keys are stored in the header of the underlying tablespace data file. Tablespace keys are encrypted using the master encryption key. The master encryption key is generated when tablespace encryption is enabled, and is stored outside the database. The master encryption key is rotated using the [**ALTER INSTANCE ROTATE INNODB MASTER KEY**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#alter-instance) statement, which generates a new master encryption key, stores the key, and rotates the key into use. |
| **A.17.15.** | How do I migrate data from a cleartext **InnoDB** tablespace to an encrypted **InnoDB** tablespace? |
|  | Transferring data from one tablespace to another is not required. To encrypt data in an **InnoDB** file-per-table tablespace, run [**ALTER TABLE *tbl\_name* ENCRYPTION = 'Y'**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#alter-table). To encrypt a general tablespace or the **mysql** tablespace, run [**ALTER TABLESPACE *tablespace\_name* ENCRYPTION = 'Y'**](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\sql-statements.html#alter-tablespace). Encryption support for general tablespaces was introduced in MySQL 8.0.13. Encryption support for the **mysql** system tablespace is available as of MySQL 8.0.16. |

## A.18 MySQL 8.0 FAQ: Virtualization Support

A.18.1. [Is MySQL supported on virtualized environments such as Oracle VM, VMWare, Docker, Microsoft Hyper-V, or others?](file:///E:\backup\%E4%B8%8B%E8%BD%BD\refman-8.0-en.html-chapter\refman-8.0-en.html-chapter\faqs.html#faq-virtualization-support)

|  |  |
| --- | --- |
| **A.18.1.** | Is MySQL supported on virtualized environments such as Oracle VM, VMWare, Docker, Microsoft Hyper-V, or others? |
|  | MySQL is supported on virtualized environments, but is certified only for [Oracle VM](http://www.oracle.com/technetwork/server-storage/vm/index.html). Contact Oracle Support for more information.  Be aware of potential problems when using virtualization software. The usual ones are related to performance, performance degradations, slowness, or unpredictability of disk, I/O, network, and memory. |

# 附录B 错误信息与常见问题

* [B.1 Error Message Sources and Elements](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/error-message-elements.html)
* [B.2 Error Information Interfaces](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/error-interfaces.html)
* [B.3 Problems and Common Errors](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/problems.html)
  + [B.3.1 How to Determine What Is Causing a Problem](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/what-is-crashing.html)
  + [B.3.2 Common Errors When Using MySQL Programs](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/common-errors.html)
  + [B.3.3 Administration-Related Issues](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/administration-issues.html)
  + [B.3.4 Query-Related Issues](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/query-issues.html)
  + [B.3.5 Optimizer-Related Issues](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/optimizer-issues.html)
  + [B.3.6 Table Definition-Related Issues](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/table-definition-issues.html)
  + [B.3.7 Known Issues in MySQL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/known-issues.html)

This appendix describes the types of error information MySQL provides and how to obtain information about them. The final section is for troubleshooting. It describes common problems and errors that may occur and potential resolutions.

## Additional Resources

Other error-related documentation includes:

* Information about configuring where and how the server writes the error log: [Section 5.4.2, “The Error Log”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/error-log.html)
* Information about the character set used for error messages: [Section 10.6, “Error Message Character Set”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/charset-errors.html)
* Information about the language used for error messages: [Section 10.12, “Setting the Error Message Language”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/error-message-language.html)
* Information about errors related to [InnoDB](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-storage-engine.html): [Section 15.21.5, “InnoDB Error Handling”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-error-handling.html)
* Information about errors specific to NDB Cluster: [NDB Cluster API Errors](https://dev.mysql.com/doc/ndb-internals/en/ndb-errors.html); see also [NDB API Errors and Error Handling](https://docs.oracle.com/cd/E17952_01/ndbapi-en/ndb-api-errors.html), and [MGM API Errors](https://docs.oracle.com/cd/E17952_01/ndbapi-en/mgm-errors.html)
* Descriptions of the error messages that the MySQL server and client programs generate: [MySQL 8.0 Error Message Reference](https://docs.oracle.com/cd/E17952_01/mysql-errors-8.0-en/)
* [PreviousMySQL 8.0 FAQ: Virtualization Support](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/faqs-virtualization.html)
* [HomeMySQL 8.0 Reference Manual Including MySQL NDB Cluster 8.0](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/index.html)
* [NextError Message Sources and Elements](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/error-message-elements.html)

[MySQL Documentation Library](https://docs.oracle.com/cd/E17952_01/index.html)

## B.1 Error Message Sources and Elements

This section discusses how error messages originate within MySQL and the elements they contain.

* [Error Message Sources](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/error-message-elements.html#error-sources)
* [Error Message Elements](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/error-message-elements.html#error-elements)
* [Error Code Ranges](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/error-message-elements.html#error-code-ranges)

### Error Message Sources

Error messages can originate on the server side or the client side:

* On the server side, error messages may occur during the startup and shutdown processes, as a result of issues that occur during SQL statement execution, and so forth.
  + The MySQL server writes some error messages to its error log. These indicate issues of interest to database administrators or that require DBA action.
  + The server sends other error messages to client programs. These indicate issues pertaining only to a particular client. The MySQL client library takes errors received from the server and makes them available to the host client program.
* Client-side error messages are generated from within the MySQL client library, usually involving problems communicating with the server.

Example server-side error messages written to the error log:

* This message produced during the startup process provides a status or progress indicator:
* 2018-10-28T13:01:32.735983Z 0 [Note] [MY-010303] [Server] Skipping
* generation of SSL certificates as options related to SSL are specified.
* This message indicates an issue that requires DBA action:
* 2018-10-02T03:20:39.410387Z 768 [ERROR] [MY-010045] [Server] Event Scheduler:
* [evtuser@localhost][myschema.e\_daily] Unknown database 'mydb'

Example server-side error message sent to client programs, as displayed by the [**mysql**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql.html) client:

mysql> **SELECT \* FROM no\_such\_table;**

ERROR 1146 (42S02): Table 'test.no\_such\_table' doesn't exist

Example client-side error message originating from within the client library, as displayed by the [**mysql**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql.html) client:

$> **mysql -h no-such-host**

ERROR 2005 (HY000): Unknown MySQL server host 'no-such-host' (-2)

Whether an error originates from within the client library or is received from the server, a MySQL client program may respond in varying ways. As just illustrated, the client may display the error message so the user can take corrective measures. The client may instead internally attempt to resolve or retry a failed operation, or take other action.

### Error Message Elements

When an error occurs, error information includes several elements: an error code, SQLSTATE value, and message string. These elements have the following characteristics:

* Error code: This value is numeric. It is MySQL-specific and is not portable to other database systems.

Each error number has a corresponding symbolic value. Examples:

* + The symbol for server error number **1146** is [**ER\_NO\_SUCH\_TABLE**](https://docs.oracle.com/cd/E17952_01/mysql-errors-8.0-en/server-error-reference.html#error_er_no_such_table).
  + The symbol for client error number **2005** is [**CR\_UNKNOWN\_HOST**](https://docs.oracle.com/cd/E17952_01/mysql-errors-8.0-en/client-error-reference.html#error_cr_unknown_host).

The set of error codes used in error messages is partitioned into distinct ranges; see [Error Code Ranges](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/error-message-elements.html#error-code-ranges).

Error codes are stable across General Availability (GA) releases of a given MySQL series. Before a series reaches GA status, new codes may still be under development and are subject to change.

* SQLSTATE value: This value is a five-character string (for example, **'42S02'**). SQLSTATE values are taken from ANSI SQL and ODBC and are more standardized than the numeric error codes. The first two characters of an SQLSTATE value indicate the error class:
  + Class = **'00'** indicates success.
  + Class = **'01'** indicates a warning.
  + Class = **'02'** indicates “not found.” This is relevant within the context of cursors and is used to control what happens when a cursor reaches the end of a data set. This condition also occurs for **SELECT ... INTO *var\_list*** statements that retrieve no rows.
  + Class > **'02'** indicates an exception.

For server-side errors, not all MySQL error numbers have corresponding SQLSTATE values. In these cases, **'HY000'** (general error) is used.

For client-side errors, the SQLSTATE value is always **'HY000'** (general error), so it is not meaningful for distinguishing one client error from another.

* Message string: This string provides a textual description of the error.

### Error Code Ranges

The set of error codes used in error messages is partitioned into distinct ranges, each with its own purpose:

* 1 to 999: Global error codes. This error code range is called “global” because it is a shared range that is used by the server as well as by clients.

When an error in this range originates on the server side, the server writes it to the error log, padding the error code with leading zeros to six digits and adding a prefix of **MY-**.

When an error in this range originates on the client side, the client library makes it available to the client program with no zero-padding or prefix.

* 1,000 to 1,999: Server error codes reserved for messages sent to clients.
* 2,000 to 2,999: Client error codes reserved for use by the client library.
* 3,000 to 4,999: Server error codes reserved for messages sent to clients.
* 5,000 to 5,999: Error codes reserved for use by X Plugin for messages sent to clients.
* 10,000 to 49,999: Server error codes reserved for messages to be written to the error log (not sent to clients).

When an error in this range occurs, the server writes it to the error log, padding the error code with leading zeros to six digits and adding a prefix of **MY-**.

* 50,000 to 51,999: Error codes reserved for use by third parties.

The server handles error messages written to the error log differently from error messages sent to clients:

* When the server writes a message to the error log, it pads the error code with leading zeros to six digits and adds a prefix of **MY-** (examples: [**MY-000022**](https://docs.oracle.com/cd/E17952_01/mysql-errors-8.0-en/global-error-reference.html#error_ee_unknown_charset), [**MY-010048**](https://docs.oracle.com/cd/E17952_01/mysql-errors-8.0-en/server-error-reference.html#error_er_scheduler_stopped)).
* When the server sends a message to a client program, it adds no zero-padding or prefix to the error code (examples: [**1036**](https://docs.oracle.com/cd/E17952_01/mysql-errors-8.0-en/server-error-reference.html#error_er_open_as_readonly), [**3013**](https://docs.oracle.com/cd/E17952_01/mysql-errors-8.0-en/server-error-reference.html#error_er_invalid_field_size)).

## B.2 Error Information Interfaces

Error messages can originate on the server side or the client side, and each error message includes an error code, SQLSTATE value, and message string, as described in [Section B.1, “Error Message Sources and Elements”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/error-message-elements.html). For lists of server-side, client-side, and global (shared between server and clients) errors, see [MySQL 8.0 Error Message Reference](https://docs.oracle.com/cd/E17952_01/mysql-errors-8.0-en/).

For error checking from within programs, use error code numbers or symbols, not error message strings. Message strings do not change often, but it is possible. Also, if the database administrator changes the language setting, that affects the language of message strings; see [Section 10.12, “Setting the Error Message Language”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/error-message-language.html).

Error information in MySQL is available in the server error log, at the SQL level, from within client programs, and at the command line.

* [Error Log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/error-interfaces.html#error-interface-log)
* [SQL Error Message Interface](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/error-interfaces.html#error-interface-sql)
* [Client Error Message Interface](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/error-interfaces.html#error-interface-client)
* [Command-Line Error Message Interface](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/error-interfaces.html#error-interface-command)

### Error Log

On the server side, some messages are intended for the error log. For information about configuring where and how the server writes the log, see [Section 5.4.2, “The Error Log”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/error-log.html).

Other server error messages are intended to be sent to client programs and are available as described in [Client Error Message Interface](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/error-interfaces.html#error-interface-client).

The range within which a particular error code lies determines whether the server writes an error message to the error log or sends it to clients. For information about these ranges, see [Error Code Ranges](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/error-message-elements.html#error-code-ranges).

### SQL Error Message Interface

At the SQL level, there are several sources of error information in MySQL:

* SQL statement warning and error information is available through the [**SHOW WARNINGS**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/show-warnings.html) and [**SHOW ERRORS**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/show-errors.html) statements. The [**warning\_count**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_warning_count) system variable indicates the number of errors, warnings, and notes (with notes excluded if the [**sql\_notes**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_sql_notes) system variable is disabled). The [**error\_count**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_error_count) system variable indicates the number of errors. Its value excludes warnings and notes.
* The [**GET DIAGNOSTICS**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/get-diagnostics.html) statement may be used to inspect the diagnostic information in the diagnostics area. See [Section 13.6.7.3, “GET DIAGNOSTICS Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/get-diagnostics.html).
* [**SHOW SLAVE STATUS**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/show-slave-status.html) statement output includes information about replication errors occurring on replica servers.
* [**SHOW ENGINE INNODB STATUS**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/show-engine.html) statement output includes information about the most recent foreign key error if a [**CREATE TABLE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/create-table.html) statement for an [**InnoDB**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-storage-engine.html) table fails.

### Client Error Message Interface

Client programs receive errors from two sources:

* Errors that originate on the client side from within the MySQL client library.
* Errors that originate on the server side and are sent to the client by the server. These are received within the client library, which makes them available to the host client program.

The range within which a particular error code lies determines whether it originated from within the client library or was received by the client from the server. For information about these ranges, see [Error Code Ranges](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/error-message-elements.html#error-code-ranges).

Regardless of whether an error originates from within the client library or is received from the server, a MySQL client program obtains the error code, SQLSTATE value, message string, and other related information by calling C API functions in the client library:

* [**mysql\_errno()**](https://docs.oracle.com/cd/E17952_01/c-api-8.0-en/mysql-errno.html) returns the MySQL error code.
* [**mysql\_sqlstate()**](https://docs.oracle.com/cd/E17952_01/c-api-8.0-en/mysql-sqlstate.html) returns the SQLSTATE value.
* [**mysql\_error()**](https://docs.oracle.com/cd/E17952_01/c-api-8.0-en/mysql-error.html) returns the message string.
* [**mysql\_stmt\_errno()**](https://docs.oracle.com/cd/E17952_01/c-api-8.0-en/mysql-stmt-errno.html), [**mysql\_stmt\_sqlstate()**](https://docs.oracle.com/cd/E17952_01/c-api-8.0-en/mysql-stmt-sqlstate.html), and [**mysql\_stmt\_error()**](https://docs.oracle.com/cd/E17952_01/c-api-8.0-en/mysql-stmt-error.html) are the corresponding error functions for prepared statements.
* [**mysql\_warning\_count()**](https://docs.oracle.com/cd/E17952_01/c-api-8.0-en/mysql-warning-count.html) returns the number of errors, warnings, and notes for the most recent statement.

For descriptions of the client library error functions, see [MySQL 8.0 C API Developer Guide](https://docs.oracle.com/cd/E17952_01/c-api-8.0-en/).

A MySQL client program may respond to an error in varying ways. The client may display the error message so the user can take corrective measures, internally attempt to resolve or retry a failed operation, or take other action. For example, (using the [**mysql**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql.html) client), a failure to connect to the server might result in this message:

$> **mysql -h no-such-host**

ERROR 2005 (HY000): Unknown MySQL server host 'no-such-host' (-2)

### Command-Line Error Message Interface

The [**perror**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/perror.html) program provides information from the command line about error numbers. See [Section 4.8.2, “perror — Display MySQL Error Message Information”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/perror.html).

$> **perror 1231**

MySQL error code MY-001231 (ER\_WRONG\_VALUE\_FOR\_VAR): Variable '%-.64s'

can't be set to the value of '%-.200s'

For MySQL NDB Cluster errors, use [**ndb\_perror**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-programs-ndb-perror.html). See [Section 23.5.16, “ndb\_perror — Obtain NDB Error Message Information”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-programs-ndb-perror.html).

$> **ndb\_perror 323**

NDB error code 323: Invalid nodegroup id, nodegroup already existing:

Permanent error: Application error

## B.3 Problems and Common Errors

* [B.3.1 How to Determine What Is Causing a Problem](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/what-is-crashing.html)
* [B.3.2 Common Errors When Using MySQL Programs](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/common-errors.html)
* [B.3.3 Administration-Related Issues](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/administration-issues.html)
* [B.3.4 Query-Related Issues](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/query-issues.html)
* [B.3.5 Optimizer-Related Issues](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/optimizer-issues.html)
* [B.3.6 Table Definition-Related Issues](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/table-definition-issues.html)
* [B.3.7 Known Issues in MySQL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/known-issues.html)

This section lists some common problems and error messages that you may encounter. It describes how to determine the causes of the problems and what to do to solve them.

### B.3.1 How to Determine What Is Causing a Problem

When you run into a problem, the first thing you should do is to find out which program or piece of equipment is causing it:

* If you have one of the following symptoms, then it is probably a hardware problems (such as memory, motherboard, CPU, or hard disk) or kernel problem:
  + The keyboard does not work. This can normally be checked by pressing the Caps Lock key. If the Caps Lock light does not change, you have to replace your keyboard. (Before doing this, you should try to restart your computer and check all cables to the keyboard.)
  + The mouse pointer does not move.
  + The machine does not answer to a remote machine's pings.
  + Other programs that are not related to MySQL do not behave correctly.
  + Your system restarted unexpectedly. (A faulty user-level program should never be able to take down your system.)

In this case, you should start by checking all your cables and run some diagnostic tool to check your hardware! You should also check whether there are any patches, updates, or service packs for your operating system that could likely solve your problem. Check also that all your libraries (such as **glibc**) are up to date.

It is always good to use a machine with ECC memory to discover memory problems early.

* If your keyboard is locked up, you may be able to recover by logging in to your machine from another machine and executing **kbd\_mode -a**.
* Please examine your system log file (/var/log/messages or similar) for reasons for your problem. If you think the problem is in MySQL, you should also examine MySQL's log files. See [Section 5.4, “MySQL Server Logs”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-logs.html).
* If you do not think you have hardware problems, you should try to find out which program is causing problems. Try using **top**, **ps**, Task Manager, or some similar program, to check which program is taking all CPU or is locking the machine.
* Use **top**, **df**, or a similar program to check whether you are out of memory, disk space, file descriptors, or some other critical resource.
* If the problem is some runaway process, you can always try to kill it. If it does not want to die, there is probably a bug in the operating system.

If you have examined all other possibilities and concluded that the MySQL server or a MySQL client is causing the problem, it is time to create a bug report, see [Section 1.6, “How to Report Bugs or Problems”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/bug-reports.html). In the bug report, try to give a complete description of how the system is behaving and what you think is happening. Also state why you think that MySQL is causing the problem. Take into consideration all the situations described in this chapter. State any problems exactly how they appear when you examine your system. Use the “copy and paste” method for any output and error messages from programs and log files.

Try to describe in detail which program is not working and all symptoms you see. We have in the past received many bug reports that state only “the system does not work.” This provides us with no information about what could be the problem.

If a program fails, it is always useful to know the following information:

* Has the program in question made a segmentation fault (did it dump core)?
* Is the program taking up all available CPU time? Check with **top**. Let the program run for a while, it may simply be evaluating something computationally intensive.
* If the [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) server is causing problems, can you get any response from it with [**mysqladmin -u root ping**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqladmin.html) or [**mysqladmin -u root processlist**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqladmin.html)?
* What does a client program say when you try to connect to the MySQL server? (Try with [**mysql**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql.html), for example.) Does the client jam? Do you get any output from the program?

When sending a bug report, you should follow the outline described in [Section 1.6, “How to Report Bugs or Problems”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/bug-reports.html).

### B.3.2 Common Errors When Using MySQL Programs

* [B.3.2.1 Access denied](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/error-access-denied.html)
* [B.3.2.2 Can't connect to [local] MySQL server](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/can-not-connect-to-server.html)
* [B.3.2.3 Lost connection to MySQL server](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/error-lost-connection.html)
* [B.3.2.4 Password Fails When Entered Interactively](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/password-too-long.html)
* [B.3.2.5 Too many connections](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/too-many-connections.html)
* [B.3.2.6 Out of memory](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/out-of-memory.html)
* [B.3.2.7 MySQL server has gone away](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/gone-away.html)
* [B.3.2.8 Packet Too Large](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/packet-too-large.html)
* [B.3.2.9 Communication Errors and Aborted Connections](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/communication-errors.html)
* [B.3.2.10 The table is full](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/full-table.html)
* [B.3.2.11 Can't create/write to file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/cannot-create.html)
* [B.3.2.12 Commands out of sync](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/commands-out-of-sync.html)
* [B.3.2.13 Ignoring user](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/ignoring-user.html)
* [B.3.2.14 Table 'tbl\_name' doesn't exist](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/cannot-find-table.html)
* [B.3.2.15 Can't initialize character set](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/cannot-initialize-character-set.html)
* [B.3.2.16 File Not Found and Similar Errors](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/not-enough-file-handles.html)
* [B.3.2.17 Table-Corruption Issues](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/table-corruption.html)

This section lists some errors that users frequently encounter when running MySQL programs. Although the problems show up when you try to run client programs, the solutions to many of the problems involves changing the configuration of the MySQL server.

#### B.3.2.1 Access denied

An **Access denied** error can have many causes. Often the problem is related to the MySQL accounts that the server permits client programs to use when connecting. See [Section 6.2, “Access Control and Account Management”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/access-control.html), and [Section 6.2.22, “Troubleshooting Problems Connecting to MySQL”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/problems-connecting.html).

#### B.3.2.2 Can't connect to [local] MySQL server

* [B.3.2.2.1 Connection to MySQL Server Failing on Windows](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/can-not-connect-to-server.html#can-not-connect-to-server-on-windows)

A MySQL client on Unix can connect to the [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) server in two different ways: By using a Unix socket file to connect through a file in the file system (default /tmp/mysql.sock), or by using TCP/IP, which connects through a port number. A Unix socket file connection is faster than TCP/IP, but can be used only when connecting to a server on the same computer. A Unix socket file is used if you do not specify a host name or if you specify the special host name **localhost**.

If the MySQL server is running on Windows, you can connect using TCP/IP. If the server is started with the [**named\_pipe**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_named_pipe) system variable enabled, you can also connect with named pipes if you run the client on the host where the server is running. The name of the named pipe is **MySQL** by default. If you do not give a host name when connecting to [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html), a MySQL client first tries to connect to the named pipe. If that does not work, it connects to the TCP/IP port. You can force the use of named pipes on Windows by using **.** as the host name.

The error (2002) **Can't connect to ...** normally means that there is no MySQL server running on the system or that you are using an incorrect Unix socket file name or TCP/IP port number when trying to connect to the server. You should also check that the TCP/IP port you are using has not been blocked by a firewall or port blocking service.

The error (2003) **Can't connect to MySQL server on '*server*' (10061)** indicates that the network connection has been refused. You should check that there is a MySQL server running, that it has network connections enabled, and that the network port you specified is the one configured on the server.

Start by checking whether there is a process named [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) running on your server host. (Use **ps xa | grep mysqld** on Unix or the Task Manager on Windows.) If there is no such process, you should start the server. See [Section 2.10.2, “Starting the Server”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/starting-server.html).

If a [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) process is running, you can check it by trying the following commands. The port number or Unix socket file name might be different in your setup. **host\_ip** represents the IP address of the machine where the server is running.

$> **mysqladmin version**

$> **mysqladmin variables**

$> **mysqladmin -h `hostname` version variables**

$> **mysqladmin -h `hostname` --port=3306 version**

$> **mysqladmin -h host\_ip version**

$> **mysqladmin --protocol=SOCKET --socket=/tmp/mysql.sock version**

Note the use of backticks rather than forward quotation marks with the **hostname** command; these cause the output of **hostname** (that is, the current host name) to be substituted into the [**mysqladmin**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqladmin.html) command. If you have no **hostname** command or are running on Windows, you can manually type the host name of your machine (without backticks) following the **-h** option. You can also try **-h 127.0.0.1** to connect with TCP/IP to the local host.

Make sure that the server has not been configured to ignore network connections or (if you are attempting to connect remotely) that it has not been configured to listen only locally on its network interfaces. If the server was started with the [**skip\_networking**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_skip_networking) system variable enabled, it cannot accept TCP/IP connections at all. If the server was started with the [**bind\_address**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_bind_address) system variable set to **127.0.0.1**, it listens for TCP/IP connections only locally on the loopback interface and does not accept remote connections.

Check to make sure that there is no firewall blocking access to MySQL. Your firewall may be configured on the basis of the application being executed, or the port number used by MySQL for communication (3306 by default). Under Linux or Unix, check your IP tables (or similar) configuration to ensure that the port has not been blocked. Under Windows, applications such as ZoneAlarm or Windows Firewall may need to be configured not to block the MySQL port.

Here are some reasons the **Can't connect to local MySQL server** error might occur:

* [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) is not running on the local host. Check your operating system's process list to ensure the [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) process is present.
* You're running a MySQL server on Windows with many TCP/IP connections to it. If you're experiencing that quite often your clients get that error, you can find a workaround here: [Section B.3.2.2.1, “Connection to MySQL Server Failing on Windows”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/can-not-connect-to-server.html#can-not-connect-to-server-on-windows).
* Someone has removed the Unix socket file that [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) uses (/tmp/mysql.sock by default). For example, you might have a **cron** job that removes old files from the /tmp directory. You can always run [**mysqladmin version**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqladmin.html) to check whether the Unix socket file that [**mysqladmin**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqladmin.html) is trying to use really exists. The fix in this case is to change the **cron** job to not remove mysql.sock or to place the socket file somewhere else. See [Section B.3.3.6, “How to Protect or Change the MySQL Unix Socket File”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/problems-with-mysql-sock.html).
* You have started the [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) server with the [--socket=/path/to/socket](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-options.html#option_mysqld_socket) option, but forgotten to tell client programs the new name of the socket file. If you change the socket path name for the server, you must also notify the MySQL clients. You can do this by providing the same [--socket](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/connection-options.html#option_general_socket) option when you run client programs. You also need to ensure that clients have permission to access the mysql.sock file. To find out where the socket file is, you can do:
* $> **netstat -ln | grep mysql**

See [Section B.3.3.6, “How to Protect or Change the MySQL Unix Socket File”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/problems-with-mysql-sock.html).

* You are using Linux and one server thread has died (dumped core). In this case, you must kill the other [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) threads (for example, with [**kill**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/kill.html)) before you can restart the MySQL server. See [Section B.3.3.3, “What to Do If MySQL Keeps Crashing”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/crashing.html).
* The server or client program might not have the proper access privileges for the directory that holds the Unix socket file or the socket file itself. In this case, you must either change the access privileges for the directory or socket file so that the server and clients can access them, or restart [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) with a [--socket](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-options.html#option_mysqld_socket) option that specifies a socket file name in a directory where the server can create it and where client programs can access it.

If you get the error message **Can't connect to MySQL server on some\_host**, you can try the following things to find out what the problem is:

* Check whether the server is running on that host by executing **telnet some\_host 3306** and pressing the Enter key a couple of times. (3306 is the default MySQL port number. Change the value if your server is listening to a different port.) If there is a MySQL server running and listening to the port, you should get a response that includes the server's version number. If you get an error such as **telnet: Unable to connect to remote host: Connection refused**, then there is no server running on the given port.
* If the server is running on the local host, try using [**mysqladmin -h localhost variables**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqladmin.html) to connect using the Unix socket file. Verify the TCP/IP port number that the server is configured to listen to (it is the value of the [**port**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_port) variable.)
* If you are running under Linux and Security-Enhanced Linux (SELinux) is enabled, see [Section 6.7, “SELinux”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/selinux.html).

##### B.3.2.2.1 Connection to MySQL Server Failing on Windows

When you're running a MySQL server on Windows with many TCP/IP connections to it, and you're experiencing that quite often your clients get a **Can't connect to MySQL server** error, the reason might be that Windows does not allow for enough ephemeral (short-lived) ports to serve those connections.

The purpose of **TIME\_WAIT** is to keep a connection accepting packets even after the connection has been closed. This is because Internet routing can cause a packet to take a slow route to its destination and it may arrive after both sides have agreed to close. If the port is in use for a new connection, that packet from the old connection could break the protocol or compromise personal information from the original connection. The **TIME\_WAIT** delay prevents this by ensuring that the port cannot be reused until after some time has been permitted for those delayed packets to arrive.

It is safe to reduce **TIME\_WAIT** greatly on LAN connections because there is little chance of packets arriving at very long delays, as they could through the Internet with its comparatively large distances and latencies.

Windows permits ephemeral (short-lived) TCP ports to the user. After any port is closed, it remains in a **TIME\_WAIT** status for 120 seconds. The port is not available again until this time expires. The default range of port numbers depends on the version of Windows, with a more limited number of ports in older versions:

* Windows through Server 2003: Ports in range 1025–5000
* Windows Vista, Server 2008, and newer: Ports in range 49152–65535

With a small stack of available TCP ports (5000) and a high number of TCP ports being open and closed over a short period of time along with the **TIME\_WAIT** status you have a good chance for running out of ports. There are two ways to address this problem:

* Reduce the number of TCP ports consumed quickly by investigating connection pooling or persistent connections where possible
* Tune some settings in the Windows registry (see below)

**Important**

The following procedure involves modifying the Windows registry. Before you modify the registry, make sure to back it up and make sure that you understand how to restore it if a problem occurs. For information about how to back up, restore, and edit the registry, view the following article in the Microsoft Knowledge Base: <http://support.microsoft.com/kb/256986/EN-US/>.

1. Start Registry Editor (Regedt32.exe).
2. Locate the following key in the registry:
3. HKEY\_LOCAL\_MACHINE\SYSTEM\CurrentControlSet\Services\Tcpip\Parameters
4. On the **Edit** menu, click **Add Value**, and then add the following registry value:
5. Value Name: MaxUserPort
6. Data Type: REG\_DWORD
7. Value: 65534

This sets the number of ephemeral ports available to any user. The valid range is between 5000 and 65534 (decimal). The default value is 0x1388 (5000 decimal).

1. On the **Edit** menu, click **Add Value**, and then add the following registry value:
2. Value Name: TcpTimedWaitDelay
3. Data Type: REG\_DWORD
4. Value: 30

This sets the number of seconds to hold a TCP port connection in **TIME\_WAIT** state before closing. The valid range is between 30 and 300 decimal, although you may wish to check with Microsoft for the latest permitted values. The default value is 0x78 (120 decimal).

1. Quit Registry Editor.
2. Reboot the machine.

Note: Undoing the above should be as simple as deleting the registry entries you've created.

#### B.3.2.3 Lost connection to MySQL server

There are three likely causes for this error message.

Usually it indicates network connectivity trouble and you should check the condition of your network if this error occurs frequently. If the error message includes “during query,” this is probably the case you are experiencing.

Sometimes the “during query” form happens when millions of rows are being sent as part of one or more queries. If you know that this is happening, you should try increasing [**net\_read\_timeout**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_net_read_timeout) from its default of 30 seconds to 60 seconds or longer, sufficient for the data transfer to complete.

More rarely, it can happen when the client is attempting the initial connection to the server. In this case, if your [**connect\_timeout**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_connect_timeout) value is set to only a few seconds, you may be able to resolve the problem by increasing it to ten seconds, perhaps more if you have a very long distance or slow connection. You can determine whether you are experiencing this more uncommon cause by using **SHOW GLOBAL STATUS LIKE 'Aborted\_connects'**. It increases by one for each initial connection attempt that the server aborts. You may see “reading authorization packet” as part of the error message; if so, that also suggests that this is the solution that you need.

If the cause is none of those just described, you may be experiencing a problem with [**BLOB**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/blob.html) values that are larger than [**max\_allowed\_packet**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_max_allowed_packet), which can cause this error with some clients. Sometime you may see an [**ER\_NET\_PACKET\_TOO\_LARGE**](https://docs.oracle.com/cd/E17952_01/mysql-errors-8.0-en/server-error-reference.html#error_er_net_packet_too_large) error, and that confirms that you need to increase [**max\_allowed\_packet**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_max_allowed_packet).

#### B.3.2.4 Password Fails When Entered Interactively

MySQL client programs prompt for a password when invoked with a [--password](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/connection-options.html#option_general_password) or -p option that has no following password value:

$> **mysql -u *user\_name* -p**

Enter password:

On some systems, you may find that your password works when specified in an option file or on the command line, but not when you enter it interactively at the **Enter password:** prompt. This occurs when the library provided by the system to read passwords limits password values to a small number of characters (typically eight). That is a problem with the system library, not with MySQL. To work around it, change your MySQL password to a value that is eight or fewer characters long, or put your password in an option file.

#### B.3.2.5 Too many connections

If clients encounter **Too many connections** errors when attempting to connect to the [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) server, all available connections are in use by other clients.

The permitted number of connections is controlled by the [**max\_connections**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_max_connections) system variable. To support more connections, set [**max\_connections**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_max_connections) to a larger value.

[**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) actually permits [**max\_connections**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_max_connections) + 1 client connections. The extra connection is reserved for use by accounts that have the [**CONNECTION\_ADMIN**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/privileges-provided.html#priv_connection-admin) privilege (or the deprecated [**SUPER**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/privileges-provided.html#priv_super) privilege). By granting the privilege to administrators and not to normal users (who should not need it), an administrator can connect to the server and use [**SHOW PROCESSLIST**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/show-processlist.html) to diagnose problems even if the maximum number of unprivileged clients are connected. See [Section 13.7.7.29, “SHOW PROCESSLIST Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/show-processlist.html).

The server also permits administrative connections on a dedicated interface. For more information about how the server handles client connections, see [Section 5.1.12.1, “Connection Interfaces”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/connection-interfaces.html).

#### B.3.2.6 Out of memory

If you issue a query using the [**mysql**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql.html) client program and receive an error like the following one, it means that [**mysql**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql.html) does not have enough memory to store the entire query result:

mysql: Out of memory at line 42, 'malloc.c'

mysql: needed 8136 byte (8k), memory in use: 12481367 bytes (12189k)

ERROR 2008: MySQL client ran out of memory

To remedy the problem, first check whether your query is correct. Is it reasonable that it should return so many rows? If not, correct the query and try again. Otherwise, you can invoke [**mysql**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql.html) with the [--quick](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-command-options.html#option_mysql_quick) option. This causes it to use the [**mysql\_use\_result()**](https://docs.oracle.com/cd/E17952_01/c-api-8.0-en/mysql-use-result.html) C API function to retrieve the result set, which places less of a load on the client (but more on the server).

#### B.3.2.7 MySQL server has gone away

This section also covers the related **Lost connection to server during query** error.

The most common reason for the **MySQL server has gone away** error is that the server timed out and closed the connection. In this case, you normally get one of the following error codes (which one you get is operating system-dependent).

| **Error Code** | **Description** |
| --- | --- |
| [**CR\_SERVER\_GONE\_ERROR**](https://docs.oracle.com/cd/E17952_01/mysql-errors-8.0-en/client-error-reference.html#error_cr_server_gone_error) | The client couldn't send a question to the server. |
| [**CR\_SERVER\_LOST**](https://docs.oracle.com/cd/E17952_01/mysql-errors-8.0-en/client-error-reference.html#error_cr_server_lost) | The client didn't get an error when writing to the server, but it didn't get a full answer (or any answer) to the question. |

By default, the server closes the connection after eight hours if nothing has happened. You can change the time limit by setting the [**wait\_timeout**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_wait_timeout) variable when you start [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html). See [Section 5.1.8, “Server System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html).

If you have a script, you just have to issue the query again for the client to do an automatic reconnection. This assumes that you have automatic reconnection in the client enabled (which is the default for the **mysql** command-line client).

Some other common reasons for the **MySQL server has gone away** error are:

* You (or the db administrator) has killed the running thread with a [**KILL**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/kill.html) statement or a [**mysqladmin kill**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqladmin.html) command.
* You tried to run a query after closing the connection to the server. This indicates a logic error in the application that should be corrected.
* A client application running on a different host does not have the necessary privileges to connect to the MySQL server from that host.
* You got a timeout from the TCP/IP connection on the client side. This may happen if you have been using the commands: [**mysql\_options(..., MYSQL\_OPT\_READ\_TIMEOUT,...)**](https://docs.oracle.com/cd/E17952_01/c-api-8.0-en/mysql-options.html) or [**mysql\_options(..., MYSQL\_OPT\_WRITE\_TIMEOUT,...)**](https://docs.oracle.com/cd/E17952_01/c-api-8.0-en/mysql-options.html). In this case increasing the timeout may help solve the problem.
* You have encountered a timeout on the server side and the automatic reconnection in the client is disabled (the **reconnect** flag in the **MYSQL** structure is equal to 0).
* You are using a Windows client and the server had dropped the connection (probably because [**wait\_timeout**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_wait_timeout) expired) before the command was issued.

The problem on Windows is that in some cases MySQL does not get an error from the OS when writing to the TCP/IP connection to the server, but instead gets the error when trying to read the answer from the connection.

The solution to this is to either do a [**mysql\_ping()**](https://docs.oracle.com/cd/E17952_01/c-api-8.0-en/mysql-ping.html) on the connection if there has been a long time since the last query (this is what Connector/ODBC does) or set [**wait\_timeout**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_wait_timeout) on the [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) server so high that it in practice never times out.

* You can also get these errors if you send a query to the server that is incorrect or too large. If [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) receives a packet that is too large or out of order, it assumes that something has gone wrong with the client and closes the connection. If you need big queries (for example, if you are working with big [**BLOB**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/blob.html) columns), you can increase the query limit by setting the server's [**max\_allowed\_packet**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_max_allowed_packet) variable, which has a default value of 64MB. You may also need to increase the maximum packet size on the client end. More information on setting the packet size is given in [Section B.3.2.8, “Packet Too Large”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/packet-too-large.html).

An [**INSERT**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/insert.html) or [**REPLACE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replace.html) statement that inserts a great many rows can also cause these sorts of errors. Either one of these statements sends a single request to the server irrespective of the number of rows to be inserted; thus, you can often avoid the error by reducing the number of rows sent per [**INSERT**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/insert.html) or [**REPLACE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replace.html).

* It is also possible to see this error if host name lookups fail (for example, if the DNS server on which your server or network relies goes down). This is because MySQL is dependent on the host system for name resolution, but has no way of knowing whether it is working—from MySQL's point of view the problem is indistinguishable from any other network timeout.

You may also see the **MySQL server has gone away** error if MySQL is started with the [**skip\_networking**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_skip_networking) system variable enabled.

Another networking issue that can cause this error occurs if the MySQL port (default 3306) is blocked by your firewall, thus preventing any connections at all to the MySQL server.

* You can also encounter this error with applications that fork child processes, all of which try to use the same connection to the MySQL server. This can be avoided by using a separate connection for each child process.
* You have encountered a bug where the server died while executing the query.

You can check whether the MySQL server died and restarted by executing [**mysqladmin version**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqladmin.html) and examining the server's uptime. If the client connection was broken because [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) crashed and restarted, you should concentrate on finding the reason for the crash. Start by checking whether issuing the query again kills the server again. See [Section B.3.3.3, “What to Do If MySQL Keeps Crashing”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/crashing.html).

You can obtain more information about lost connections by starting [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) with the [**log\_error\_verbosity**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_log_error_verbosity) system variable set to 3. This logs some of the disconnection messages in the **hostname.err** file. See [Section 5.4.2, “The Error Log”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/error-log.html).

If you want to create a bug report regarding this problem, be sure that you include the following information:

* Indicate whether the MySQL server died. You can find information about this in the server error log. See [Section B.3.3.3, “What to Do If MySQL Keeps Crashing”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/crashing.html).
* If a specific query kills [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) and the tables involved were checked with [**CHECK TABLE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/check-table.html) before you ran the query, can you provide a reproducible test case? See [Section 5.9, “Debugging MySQL”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/debugging-mysql.html).
* What is the value of the [**wait\_timeout**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_wait_timeout) system variable in the MySQL server? ([**mysqladmin variables**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqladmin.html) gives you the value of this variable.)
* Have you tried to run [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) with the general query log enabled to determine whether the problem query appears in the log? (See [Section 5.4.3, “The General Query Log”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/query-log.html).)

See also [Section B.3.2.9, “Communication Errors and Aborted Connections”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/communication-errors.html), and [Section 1.6, “How to Report Bugs or Problems”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/bug-reports.html).

#### B.3.2.8 Packet Too Large

A communication packet is a single SQL statement sent to the MySQL server, a single row that is sent to the client, or a binary log event sent from a replication source server to a replica.

The largest possible packet that can be transmitted to or from a MySQL 8.0 server or client is 1GB.

When a MySQL client or the [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) server receives a packet bigger than [**max\_allowed\_packet**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_max_allowed_packet) bytes, it issues an [**ER\_NET\_PACKET\_TOO\_LARGE**](https://docs.oracle.com/cd/E17952_01/mysql-errors-8.0-en/server-error-reference.html#error_er_net_packet_too_large) error and closes the connection. With some clients, you may also get a **Lost connection to MySQL server during query** error if the communication packet is too large.

Both the client and the server have their own [**max\_allowed\_packet**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_max_allowed_packet) variable, so if you want to handle big packets, you must increase this variable both in the client and in the server.

If you are using the [**mysql**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql.html) client program, its default [**max\_allowed\_packet**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_max_allowed_packet) variable is 16MB. To set a larger value, start [**mysql**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql.html) like this:

$> **mysql --max\_allowed\_packet=32M**

That sets the packet size to 32MB.

The server's default [**max\_allowed\_packet**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_max_allowed_packet) value is 64MB. You can increase this if the server needs to handle big queries (for example, if you are working with big [**BLOB**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/blob.html) columns). For example, to set the variable to 128MB, start the server like this:

$> **mysqld --max\_allowed\_packet=128M**

You can also use an option file to set [**max\_allowed\_packet**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_max_allowed_packet). For example, to set the size for the server to 128MB, add the following lines in an option file:

[mysqld]

max\_allowed\_packet=128M

It is safe to increase the value of this variable because the extra memory is allocated only when needed. For example, [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) allocates more memory only when you issue a long query or when [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) must return a large result row. The small default value of the variable is a precaution to catch incorrect packets between the client and server and also to ensure that you do not run out of memory by using large packets accidentally.

You can also get strange problems with large packets if you are using large [**BLOB**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/blob.html) values but have not given [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) access to enough memory to handle the query. If you suspect this is the case, try adding **ulimit -d 256000** to the beginning of the [**mysqld\_safe**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld-safe.html) script and restarting [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html).

#### B.3.2.9 Communication Errors and Aborted Connections

If connection problems occur such as communication errors or aborted connections, use these sources of information to diagnose problems:

* The error log. See [Section 5.4.2, “The Error Log”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/error-log.html).
* The general query log. See [Section 5.4.3, “The General Query Log”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/query-log.html).
* The **Aborted\_*xxx*** and **Connection\_errors\_*xxx*** status variables. See [Section 5.1.10, “Server Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-status-variables.html).
* The host cache, which is accessible using the Performance Schema [**host\_cache**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/performance-schema-host-cache-table.html) table. See [Section 5.1.12.3, “DNS Lookups and the Host Cache”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/host-cache.html), and [Section 27.12.21.2, “The host\_cache Table”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/performance-schema-host-cache-table.html).

If the [**log\_error\_verbosity**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_log_error_verbosity) system variable is set to 3, you might find messages like this in your error log:

[Note] Aborted connection 854 to db: 'employees' user: 'josh'

If a client is unable even to connect, the server increments the [**Aborted\_connects**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-status-variables.html#statvar_Aborted_connects) status variable. Unsuccessful connection attempts can occur for the following reasons:

* A client attempts to access a database but has no privileges for it.
* A client uses an incorrect password.
* A connection packet does not contain the right information.
* It takes more than [**connect\_timeout**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_connect_timeout) seconds to obtain a connect packet. See [Section 5.1.8, “Server System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html).

If these kinds of things happen, it might indicate that someone is trying to break into your server! If the general query log is enabled, messages for these types of problems are logged to it.

If a client successfully connects but later disconnects improperly or is terminated, the server increments the [**Aborted\_clients**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-status-variables.html#statvar_Aborted_clients) status variable, and logs an Aborted connection message to the error log. The cause can be any of the following:

* The client program did not call [**mysql\_close()**](https://docs.oracle.com/cd/E17952_01/c-api-8.0-en/mysql-close.html) before exiting.
* The client had been sleeping more than [**wait\_timeout**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_wait_timeout) or [**interactive\_timeout**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_interactive_timeout) seconds without issuing any requests to the server. See [Section 5.1.8, “Server System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html).
* The client program ended abruptly in the middle of a data transfer.

Other reasons for problems with aborted connections or aborted clients:

* The [**max\_allowed\_packet**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_max_allowed_packet) variable value is too small or queries require more memory than you have allocated for [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html). See [Section B.3.2.8, “Packet Too Large”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/packet-too-large.html).
* Use of Ethernet protocol with Linux, both half and full duplex. Some Linux Ethernet drivers have this bug. You should test for this bug by transferring a huge file using FTP between the client and server machines. If a transfer goes in burst-pause-burst-pause mode, you are experiencing a Linux duplex syndrome. Switch the duplex mode for both your network card and hub/switch to either full duplex or to half duplex and test the results to determine the best setting.
* A problem with the thread library that causes interrupts on reads.
* Badly configured TCP/IP.
* Faulty Ethernets, hubs, switches, cables, and so forth. This can be diagnosed properly only by replacing hardware.

See also [Section B.3.2.7, “MySQL server has gone away”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/gone-away.html).

#### B.3.2.10 The table is full

If a table-full error occurs, it may be that the disk is full or that the table has reached its maximum size. The effective maximum table size for MySQL databases is usually determined by operating system constraints on file sizes, not by MySQL internal limits. See [Section 8.4.6, “Limits on Table Size”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/table-size-limit.html).

#### B.3.2.11 Can't create/write to file

If you get an error of the following type for some queries, it means that MySQL cannot create a temporary file for the result set in the temporary directory:

Can't create/write to file '\\sqla3fe\_0.ism'.

The preceding error is a typical message for Windows; the Unix message is similar.

One fix is to start [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) with the [--tmpdir](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-options.html#option_mysqld_tmpdir) option or to add the option to the **[mysqld]** section of your option file. For example, to specify a directory of C:\temp, use these lines:

[mysqld]

tmpdir=C:/temp

The C:\temp directory must exist and have sufficient space for the MySQL server to write to. See [Section 4.2.2.2, “Using Option Files”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/option-files.html).

Another cause of this error can be permissions issues. Make sure that the MySQL server can write to the [**tmpdir**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_tmpdir) directory.

Check also the error code that you get with [**perror**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/perror.html). One reason the server cannot write to a table is that the file system is full:

$> **perror 28**

OS error code 28: No space left on device

If you get an error of the following type during startup, it indicates that the file system or directory used for storing data files is write protected. Provided that the write error is to a test file, the error is not serious and can be safely ignored.

Can't create test file /usr/local/mysql/data/master.lower-test

#### B.3.2.12 Commands out of sync

If you get **Commands out of sync; you can't run this command now** in your client code, you are calling client functions in the wrong order.

This can happen, for example, if you are using [**mysql\_use\_result()**](https://docs.oracle.com/cd/E17952_01/c-api-8.0-en/mysql-use-result.html) and try to execute a new query before you have called [**mysql\_free\_result()**](https://docs.oracle.com/cd/E17952_01/c-api-8.0-en/mysql-free-result.html). It can also happen if you try to execute two queries that return data without calling [**mysql\_use\_result()**](https://docs.oracle.com/cd/E17952_01/c-api-8.0-en/mysql-use-result.html) or [**mysql\_store\_result()**](https://docs.oracle.com/cd/E17952_01/c-api-8.0-en/mysql-store-result.html) in between.

#### B.3.2.13 Ignoring user

If you get the following error, it means that when [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) was started or when it reloaded the grant tables, it found an account in the **user** table that had an invalid password.

**Found wrong password for user '*some\_user*'@'*some\_host*'; ignoring user**

As a result, the account is simply ignored by the permission system. To fix this problem, assign a new, valid password to the account.

#### B.3.2.14 Table 'tbl\_name' doesn't exist

If you get either of the following errors, it usually means that no table exists in the default database with the given name:

Table '***tbl\_name***' doesn't exist

Can't find file: '***tbl\_name***' (errno: 2)

In some cases, it may be that the table does exist but that you are referring to it incorrectly:

* Because MySQL uses directories and files to store databases and tables, database and table names are case-sensitive if they are located on a file system that has case-sensitive file names.
* Even for file systems that are not case-sensitive, such as on Windows, all references to a given table within a query must use the same lettercase.

You can check which tables are in the default database with [**SHOW TABLES**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/show-tables.html). See [Section 13.7.7, “SHOW Statements”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/show.html).

#### B.3.2.15 Can't initialize character set

You might see an error like this if you have character set problems:

MySQL Connection Failed: Can't initialize character set ***charset\_name***

This error can have any of the following causes:

* The character set is a multibyte character set and you have no support for the character set in the client. In this case, you need to recompile the client by running **CMake** with the [-DDEFAULT\_CHARSET=***charset\_name***](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/source-configuration-options.html#option_cmake_default_charset) option. See [Section 2.9.7, “MySQL Source-Configuration Options”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/source-configuration-options.html).

All standard MySQL binaries are compiled with support for all multibyte character sets.

* The character set is a simple character set that is not compiled into [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html), and the character set definition files are not in the place where the client expects to find them.

In this case, you need to use one of the following methods to solve the problem:

* + Recompile the client with support for the character set. See [Section 2.9.7, “MySQL Source-Configuration Options”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/source-configuration-options.html).
  + Specify to the client the directory where the character set definition files are located. For many clients, you can do this with the --character-sets-dir option.
  + Copy the character definition files to the path where the client expects them to be.

#### B.3.2.16 File Not Found and Similar Errors

If you get **ERROR '*file\_name*' not found (errno: 23)**, **Can't open file: *file\_name* (errno: 24)**, or any other error with **errno 23** or **errno 24** from MySQL, it means that you have not allocated enough file descriptors for the MySQL server. You can use the [**perror**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/perror.html) utility to get a description of what the error number means:

$> **perror 23**

OS error code 23: File table overflow

$> **perror 24**

OS error code 24: Too many open files

$> **perror 11**

OS error code 11: Resource temporarily unavailable

The problem here is that [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) is trying to keep open too many files simultaneously. You can either tell [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) not to open so many files at once or increase the number of file descriptors available to [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html).

To tell [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) to keep open fewer files at a time, you can make the table cache smaller by reducing the value of the [**table\_open\_cache**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_table_open_cache) system variable (the default value is 64). This may not entirely prevent running out of file descriptors because in some circumstances the server may attempt to extend the cache size temporarily, as described in [Section 8.4.3.1, “How MySQL Opens and Closes Tables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/table-cache.html). Reducing the value of [**max\_connections**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_max_connections) also reduces the number of open files (the default value is 100).

To change the number of file descriptors available to [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html), you can use the [--open-files-limit](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld-safe.html#option_mysqld_safe_open-files-limit) option to [**mysqld\_safe**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld-safe.html) or set the [**open\_files\_limit**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_open_files_limit) system variable. See [Section 5.1.8, “Server System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html). The easiest way to set these values is to add an option to your option file. See [Section 4.2.2.2, “Using Option Files”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/option-files.html). If you have an old version of [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) that does not support setting the open files limit, you can edit the [**mysqld\_safe**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld-safe.html) script. There is a commented-out line **ulimit -n 256** in the script. You can remove the **#** character to uncomment this line, and change the number **256** to set the number of file descriptors to be made available to [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html).

[--open-files-limit](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld-safe.html#option_mysqld_safe_open-files-limit) and **ulimit** can increase the number of file descriptors, but only up to the limit imposed by the operating system. There is also a “hard” limit that can be overridden only if you start [**mysqld\_safe**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld-safe.html) or [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) as **root** (just remember that you also need to start the server with the [--user](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-options.html#option_mysqld_user) option in this case so that it does not continue to run as **root** after it starts up). If you need to increase the operating system limit on the number of file descriptors available to each process, consult the documentation for your system.

**Note**

If you run the **tcsh** shell, **ulimit** does not work! **tcsh** also reports incorrect values when you ask for the current limits. In this case, you should start [**mysqld\_safe**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld-safe.html) using **sh**.

#### B.3.2.17 Table-Corruption Issues

If you have started [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) with the [**myisam\_recover\_options**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_myisam_recover_options) system variable set, MySQL automatically checks and tries to repair **MyISAM** tables if they are marked as 'not closed properly' or 'crashed'. If this happens, MySQL writes an entry in the **hostname.err** file **'Warning: Checking table ...'** which is followed by **Warning: Repairing table** if the table needs to be repaired. If you get a lot of these errors, without [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) having died unexpectedly just before, then something is wrong and needs to be investigated further.

When the server detects **MyISAM** table corruption, it writes additional information to the error log, such as the name and line number of the source file, and the list of threads accessing the table. Example: **Got an error from thread\_id=1, mi\_dynrec.c:368**. This is useful information to include in bug reports.

See also [Section 5.1.7, “Server Command Options”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-options.html), and [Section 5.9.1.7, “Making a Test Case If You Experience Table Corruption”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/reproducible-test-case.html).

### B.3.3 Administration-Related Issues

* [B.3.3.1 Problems with File Permissions](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/file-permissions.html)
* [B.3.3.2 How to Reset the Root Password](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/resetting-permissions.html)
* [B.3.3.3 What to Do If MySQL Keeps Crashing](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/crashing.html)
* [B.3.3.4 How MySQL Handles a Full Disk](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/full-disk.html)
* [B.3.3.5 Where MySQL Stores Temporary Files](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/temporary-files.html)
* [B.3.3.6 How to Protect or Change the MySQL Unix Socket File](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/problems-with-mysql-sock.html)
* [B.3.3.7 Time Zone Problems](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/timezone-problems.html)

#### B.3.3.1 Problems with File Permissions

If you have problems with file permissions, the **UMASK** or **UMASK\_DIR** environment variable might be set incorrectly when [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) starts. For example, [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) might issue the following error message when you create a table:

ERROR: Can't find file: 'path/with/***file\_name***' (Errcode: 13)

The default **UMASK** and **UMASK\_DIR** values are **0640** and **0750**, respectively. [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) assumes that the value for **UMASK** or **UMASK\_DIR** is in octal if it starts with a zero. For example, setting **UMASK=0600** is equivalent to **UMASK=384** because 0600 octal is 384 decimal.

Assuming that you start [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) using [**mysqld\_safe**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld-safe.html), change the default **UMASK** value as follows:

UMASK=384 # = 600 in octal

export UMASK

mysqld\_safe &

**Note**

An exception applies for the error log file if you start [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) using [**mysqld\_safe**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld-safe.html), which does not respect **UMASK**: [**mysqld\_safe**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld-safe.html) may create the error log file if it does not exist prior to starting [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html), and [**mysqld\_safe**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld-safe.html) uses a umask set to a strict value of **0137**. If this is unsuitable, create the error file manually with the desired access mode prior to executing [**mysqld\_safe**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld-safe.html).

By default, [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) creates database directories with an access permission value of **0750**. To modify this behavior, set the **UMASK\_DIR** variable. If you set its value, new directories are created with the combined **UMASK** and **UMASK\_DIR** values. For example, to give group access to all new directories, start [**mysqld\_safe**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld-safe.html) as follows:

UMASK\_DIR=504 # = 770 in octal

export UMASK\_DIR

mysqld\_safe &

For additional details, see [Section 4.9, “Environment Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/environment-variables.html).

#### B.3.3.2 How to Reset the Root Password

* [B.3.3.2.1 Resetting the Root Password: Windows Systems](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/resetting-permissions.html#resetting-permissions-windows)
* [B.3.3.2.2 Resetting the Root Password: Unix and Unix-Like Systems](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/resetting-permissions.html#resetting-permissions-unix)
* [B.3.3.2.3 Resetting the Root Password: Generic Instructions](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/resetting-permissions.html#resetting-permissions-generic)

If you have never assigned a **root** password for MySQL, the server does not require a password at all for connecting as **root**. However, this is insecure. For instructions on assigning a password, see [Section 2.10.4, “Securing the Initial MySQL Account”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/default-privileges.html).

If you know the **root** password and want to change it, see [Section 13.7.1.1, “ALTER USER Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-user.html), and [Section 13.7.1.10, “SET PASSWORD Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/set-password.html).

If you assigned a **root** password previously but have forgotten it, you can assign a new password. The following sections provide instructions for Windows and Unix and Unix-like systems, as well as generic instructions that apply to any system.

##### B.3.3.2.1 Resetting the Root Password: Windows Systems

On Windows, use the following procedure to reset the password for the MySQL **'root'@'localhost'** account. To change the password for a **root** account with a different host name part, modify the instructions to use that host name.

1. Log on to your system as Administrator.
2. Stop the MySQL server if it is running. For a server that is running as a Windows service, go to the Services manager: From the **Start** menu, select **Control Panel**, then **Administrative Tools**, then **Services**. Find the MySQL service in the list and stop it.

If your server is not running as a service, you may need to use the Task Manager to force it to stop.

1. Create a text file containing the password-assignment statement on a single line. Replace the password with the password that you want to use.
2. ALTER USER 'root'@'localhost' IDENTIFIED BY 'MyNewPass';
3. Save the file. This example assumes that you name the file C:\mysql-init.txt.
4. Open a console window to get to the command prompt: From the **Start** menu, select **Run**, then enter **cmd** as the command to be run.
5. Start the MySQL server with the [**init\_file**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_init_file) system variable set to name the file (notice that the backslash in the option value is doubled):
6. C:\> **cd "C:\Program Files\MySQL\MySQL Server 8.0\bin"**
7. C:\> **mysqld --init-file=C:\\mysql-init.txt**

If you installed MySQL to a different location, adjust the **cd** command accordingly.

The server executes the contents of the file named by the [**init\_file**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_init_file) system variable at startup, changing the **'root'@'localhost'** account password.

To have server output to appear in the console window rather than in a log file, add the [--console](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-options.html#option_mysqld_console) option to the [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) command.

If you installed MySQL using the MySQL Installation Wizard, you may need to specify a [--defaults-file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/option-file-options.html#option_general_defaults-file) option. For example:

C:\> **mysqld**

**--defaults-file="C:\\ProgramData\\MySQL\\MySQL Server 8.0\\my.ini"**

**--init-file=C:\\mysql-init.txt**

The appropriate [--defaults-file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/option-file-options.html#option_general_defaults-file) setting can be found using the Services Manager: From the **Start** menu, select **Control Panel**, then **Administrative Tools**, then **Services**. Find the MySQL service in the list, right-click it, and choose the **Properties** option. The **Path to executable** field contains the [--defaults-file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/option-file-options.html#option_general_defaults-file) setting.

1. After the server has started successfully, delete C:\mysql-init.txt.

You should now be able to connect to the MySQL server as **root** using the new password. Stop the MySQL server and restart it normally. If you run the server as a service, start it from the Windows Services window. If you start the server manually, use whatever command you normally use.

##### B.3.3.2.2 Resetting the Root Password: Unix and Unix-Like Systems

On Unix, use the following procedure to reset the password for the MySQL **'root'@'localhost'** account. To change the password for a **root** account with a different host name part, modify the instructions to use that host name.

The instructions assume that you start the MySQL server from the Unix login account that you normally use for running it. For example, if you run the server using the **mysql** login account, you should log in as **mysql** before using the instructions. Alternatively, you can log in as **root**, but in this case you must start [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) with the [--user=mysql](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-options.html#option_mysqld_user) option. If you start the server as **root** without using [--user=mysql](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-options.html#option_mysqld_user), the server may create **root**-owned files in the data directory, such as log files, and these may cause permission-related problems for future server startups. If that happens, you must either change the ownership of the files to **mysql** or remove them.

1. Log on to your system as the Unix user that the MySQL server runs as (for example, **mysql**).
2. Stop the MySQL server if it is running. Locate the .pid file that contains the server's process ID. The exact location and name of this file depend on your distribution, host name, and configuration. Common locations are /var/lib/mysql/, /var/run/mysqld/, and /usr/local/mysql/data/. Generally, the file name has an extension of .pid and begins with either mysqld or your system's host name.

Stop the MySQL server by sending a normal **kill** (not **kill -9**) to the [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) process. Use the actual path name of the .pid file in the following command:

$> **kill `cat /mysql-data-directory/host\_name.pid`**

Use backticks (not forward quotation marks) with the **cat** command. These cause the output of **cat** to be substituted into the **kill** command.

1. Create a text file containing the password-assignment statement on a single line. Replace the password with the password that you want to use.
2. ALTER USER 'root'@'localhost' IDENTIFIED BY 'MyNewPass';
3. Save the file. This example assumes that you name the file /home/me/mysql-init. The file contains the password, so do not save it where it can be read by other users. If you are not logged in as **mysql** (the user the server runs as), make sure that the file has permissions that permit **mysql** to read it.
4. Start the MySQL server with the [**init\_file**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_init_file) system variable set to name the file:
5. $> **mysqld --init-file=/home/me/mysql-init &**

The server executes the contents of the file named by the [**init\_file**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_init_file) system variable at startup, changing the **'root'@'localhost'** account password.

Other options may be necessary as well, depending on how you normally start your server. For example, [--defaults-file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/option-file-options.html#option_general_defaults-file) may be needed before the [**init\_file**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_init_file) argument.

1. After the server has started successfully, delete /home/me/mysql-init.

You should now be able to connect to the MySQL server as **root** using the new password. Stop the server and restart it normally.

##### B.3.3.2.3 Resetting the Root Password: Generic Instructions

The preceding sections provide password-resetting instructions specifically for Windows and Unix and Unix-like systems. Alternatively, on any platform, you can reset the password using the [**mysql**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql.html) client (but this approach is less secure):

1. Stop the MySQL server if necessary, then restart it with the [--skip-grant-tables](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-options.html#option_mysqld_skip-grant-tables) option. This enables anyone to connect without a password and with all privileges, and disables account-management statements such as [**ALTER USER**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-user.html) and [**SET PASSWORD**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/set-password.html). Because this is insecure, if the server is started with the [--skip-grant-tables](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-options.html#option_mysqld_skip-grant-tables) option, it also disables remote connections by enabling [**skip\_networking**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_skip_networking).
2. Connect to the MySQL server using the [**mysql**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql.html) client; no password is necessary because the server was started with [--skip-grant-tables](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-options.html#option_mysqld_skip-grant-tables):
3. $> **mysql**
4. In the **mysql** client, tell the server to reload the grant tables so that account-management statements work:
5. mysql> **FLUSH PRIVILEGES;**

Then change the **'root'@'localhost'** account password. Replace the password with the password that you want to use. To change the password for a **root** account with a different host name part, modify the instructions to use that host name.

mysql> **ALTER USER 'root'@'localhost' IDENTIFIED BY 'MyNewPass';**

You should now be able to connect to the MySQL server as **root** using the new password. Stop the server and restart it normally (without the [--skip-grant-tables](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-options.html#option_mysqld_skip-grant-tables) option and without enabling the [**skip\_networking**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_skip_networking) system variable).

#### B.3.3.3 What to Do If MySQL Keeps Crashing

Each MySQL version is tested on many platforms before it is released. This does not mean that there are no bugs in MySQL, but if there are bugs, they should be very few and can be hard to find. If you have a problem, it always helps if you try to find out exactly what crashes your system, because you have a much better chance of getting the problem fixed quickly.

First, you should try to find out whether the problem is that the [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) server dies or whether your problem has to do with your client. You can check how long your [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) server has been up by executing [**mysqladmin version**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqladmin.html). If [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) has died and restarted, you may find the reason by looking in the server's error log. See [Section 5.4.2, “The Error Log”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/error-log.html).

On some systems, you can find in the error log a stack trace of where [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) died. Note that the variable values written in the error log may not always be 100% correct.

Many unexpected server exits are caused by corrupted data files or index files. MySQL updates the files on disk with the **write()** system call after every SQL statement and before the client is notified about the result. (This is not true if you are running with the [**delay\_key\_write**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_delay_key_write) system variable enabled, in which case data files are written but not index files.) This means that data file contents are safe even if [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) crashes, because the operating system ensures that the unflushed data is written to disk. You can force MySQL to flush everything to disk after every SQL statement by starting [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) with the [--flush](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-options.html#option_mysqld_flush) option.

The preceding means that normally you should not get corrupted tables unless one of the following happens:

* The MySQL server or the server host was killed in the middle of an update.
* You have found a bug in [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) that caused it to die in the middle of an update.
* Some external program is manipulating data files or index files at the same time as [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) without locking the table properly.
* You are running many [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) servers using the same data directory on a system that does not support good file system locks (normally handled by the **lockd** lock manager), or you are running multiple servers with external locking disabled.
* You have a crashed data file or index file that contains very corrupt data that confused [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html).
* You have found a bug in the data storage code. This isn't likely, but it is at least possible. In this case, you can try to change the storage engine to another engine by using [**ALTER TABLE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-table.html) on a repaired copy of the table.

Because it is very difficult to know why something is crashing, first try to check whether things that work for others result in an unexpected exit for you. Try the following things:

* Stop the [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) server with [**mysqladmin shutdown**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqladmin.html), run [**myisamchk --silent --force \*/\*.MYI**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/myisamchk.html) from the data directory to check all **MyISAM** tables, and restart [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html). This ensures that you are running from a clean state. See [Chapter 5, MySQL Server Administration](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-administration.html).
* Start [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) with the general query log enabled (see [Section 5.4.3, “The General Query Log”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/query-log.html)). Then try to determine from the information written to the log whether some specific query kills the server. About 95% of all bugs are related to a particular query. Normally, this is one of the last queries in the log file just before the server restarts. See [Section 5.4.3, “The General Query Log”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/query-log.html). If you can repeatedly kill MySQL with a specific query, even when you have checked all tables just before issuing it, then you have isolated the bug and should submit a bug report for it. See [Section 1.6, “How to Report Bugs or Problems”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/bug-reports.html).
* Try to make a test case that we can use to repeat the problem. See [Section 5.9, “Debugging MySQL”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/debugging-mysql.html).
* Try the **fork\_big.pl** script. (It is located in the tests directory of source distributions.)
* Configuring MySQL for debugging makes it much easier to gather information about possible errors if something goes wrong. Reconfigure MySQL with the [-DWITH\_DEBUG=1](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/source-configuration-options.html#option_cmake_with_debug) option to **CMake** and then recompile. See [Section 5.9, “Debugging MySQL”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/debugging-mysql.html).
* Make sure that you have applied the latest patches for your operating system.
* Use the [--skip-external-locking](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-options.html#option_mysqld_external-locking) option to [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html). On some systems, the **lockd** lock manager does not work properly; the [--skip-external-locking](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-options.html#option_mysqld_external-locking) option tells [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) not to use external locking. (This means that you cannot run two [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) servers on the same data directory and that you must be careful if you use [**myisamchk**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/myisamchk.html). Nevertheless, it may be instructive to try the option as a test.)
* If [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) appears to be running but not responding, try [**mysqladmin -u root processlist**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqladmin.html). Sometimes [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) is not hung even though it seems unresponsive. The problem may be that all connections are in use, or there may be some internal lock problem. [**mysqladmin -u root processlist**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqladmin.html) usually is able to make a connection even in these cases, and can provide useful information about the current number of connections and their status.
* Run the command [**mysqladmin -i 5 status**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqladmin.html) or [**mysqladmin -i 5 -r status**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqladmin.html) in a separate window to produce statistics while running other queries.
* Try the following:
  1. Start [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) from **gdb** (or another debugger). See [Section 5.9, “Debugging MySQL”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/debugging-mysql.html).
  2. Run your test scripts.
  3. Print the backtrace and the local variables at the three lowest levels. In **gdb**, you can do this with the following commands when [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) has crashed inside **gdb**:
  4. backtrace
  5. info local
  6. up
  7. info local
  8. up
  9. info local

With **gdb**, you can also examine which threads exist with **info threads** and switch to a specific thread with **thread *N***, where ***N*** is the thread ID.

* Try to simulate your application with a Perl script to force MySQL to exit or misbehave.
* Send a normal bug report. See [Section 1.6, “How to Report Bugs or Problems”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/bug-reports.html). Be even more detailed than usual. Because MySQL works for many people, the crash might result from something that exists only on your computer (for example, an error that is related to your particular system libraries).
* If you have a problem with tables containing dynamic-length rows and you are using only [**VARCHAR**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/char.html) columns (not [**BLOB**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/blob.html) or [**TEXT**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/blob.html) columns), you can try to change all [**VARCHAR**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/char.html) to [**CHAR**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/char.html) with [**ALTER TABLE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-table.html). This forces MySQL to use fixed-size rows. Fixed-size rows take a little extra space, but are much more tolerant to corruption.

The current dynamic row code has been in use for several years with very few problems, but dynamic-length rows are by nature more prone to errors, so it may be a good idea to try this strategy to see whether it helps.

* Consider the possibility of hardware faults when diagnosing problems. Defective hardware can be the cause of data corruption. Pay particular attention to your memory and disk subsystems when troubleshooting hardware.

#### B.3.3.4 How MySQL Handles a Full Disk

This section describes how MySQL responds to disk-full errors (such as “no space left on device”), and to quota-exceeded errors (such as “write failed” or “user block limit reached”).

This section is relevant for writes to **MyISAM** tables. It also applies for writes to binary log files and binary log index file, except that references to “row” and “record” should be understood to mean “event.”

When a disk-full condition occurs, MySQL does the following:

* It checks once every minute to see whether there is enough space to write the current row. If there is enough space, it continues as if nothing had happened.
* Every 10 minutes it writes an entry to the log file, warning about the disk-full condition.

To alleviate the problem, take the following actions:

* To continue, you only have to free enough disk space to insert all records.
* Alternatively, to abort the thread, use [**mysqladmin kill**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqladmin.html). The thread is aborted the next time it checks the disk (in one minute).
* Other threads might be waiting for the table that caused the disk-full condition. If you have several “locked” threads, killing the one thread that is waiting on the disk-full condition enables the other threads to continue.

Exceptions to the preceding behavior are when you use [**REPAIR TABLE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/repair-table.html) or [**OPTIMIZE TABLE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/optimize-table.html) or when the indexes are created in a batch after [**LOAD DATA**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/load-data.html) or after an [**ALTER TABLE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-table.html) statement. All of these statements may create large temporary files that, if left to themselves, would cause big problems for the rest of the system. If the disk becomes full while MySQL is doing any of these operations, it removes the big temporary files and mark the table as crashed. The exception is that for [**ALTER TABLE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-table.html), the old table is left unchange

#### B.3.3.5 Where MySQL Stores Temporary Files

On Unix, MySQL uses the value of the **TMPDIR** environment variable as the path name of the directory in which to store temporary files. If **TMPDIR** is not set, MySQL uses the system default, which is usually /tmp, /var/tmp, or /usr/tmp.

On Windows, MySQL checks in order the values of the **TMPDIR**, **TEMP**, and **TMP** environment variables. For the first one found to be set, MySQL uses it and does not check those remaining. If none of **TMPDIR**, **TEMP**, or **TMP** are set, MySQL uses the Windows system default, which is usually C:\windows\temp\.

If the file system containing your temporary file directory is too small, you can use the [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) [--tmpdir](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-options.html#option_mysqld_tmpdir) option to specify a directory in a file system where you have enough space.

The [--tmpdir](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-options.html#option_mysqld_tmpdir) option can be set to a list of several paths that are used in round-robin fashion. Paths should be separated by colon characters (**:**) on Unix and semicolon characters (**;**) on Windows.

**Note**

To spread the load effectively, these paths should be located on different physical disks, not different partitions of the same disk.

If the MySQL server is acting as a replica, you can set the system variable [**replica\_load\_tmpdir**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-options-replica.html#sysvar_replica_load_tmpdir) (from MySQL 8.0.26) or [**slave\_load\_tmpdir**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-options-replica.html#sysvar_slave_load_tmpdir) (before MySQL 8.0.26) to specify a separate directory for holding temporary files when replicating [**LOAD DATA**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/load-data.html) statements. This directory should be in a disk-based file system (not a memory-based file system) so that the temporary files used to replicate LOAD DATA can survive machine restarts. The directory also should not be one that is cleared by the operating system during the system startup process. However, replication can now continue after a restart if the temporary files have been removed.

MySQL arranges that temporary files are removed if [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) is terminated. On platforms that support it (such as Unix), this is done by unlinking the file after opening it. The disadvantage of this is that the name does not appear in directory listings and you do not see a big temporary file that fills up the file system in which the temporary file directory is located. (In such cases, **lsof +L1** may be helpful in identifying large files associated with [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html).)

When sorting (**ORDER BY** or **GROUP BY**), MySQL normally uses one or two temporary files. The maximum disk space required is determined by the following expression:

(length of what is sorted + sizeof(row pointer))

\* number of matched rows

\* 2

The row pointer size is usually four bytes, but may grow in the future for really big tables.

For some statements, MySQL creates temporary SQL tables that are not hidden and have names that begin with #sql.

Some [**SELECT**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/select.html) queries creates temporary SQL tables to hold intermediate results.

DDL operations that rebuild the table and are not performed online using the **ALGORITHM=INPLACE** technique create a temporary copy of the original table in the same directory as the original table.

Online DDL operations may use temporary log files for recording concurrent DML, temporary sort files when creating an index, and temporary intermediate tables files when rebuilding the table. For more information, see [Section 15.12.3, “Online DDL Space Requirements”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-online-ddl-space-requirements.html).

**InnoDB** user-created temporary tables and on-disk internal temporary tables are created in a temporary tablespace file named ibtmp1 in the MySQL data directory. For more information, see [Section 15.6.3.5, “Temporary Tablespaces”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-temporary-tablespace.html).

See also [Section 15.15.7, “InnoDB INFORMATION\_SCHEMA Temporary Table Info Table”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-information-schema-temp-table-info.html).

The optional **EXTENDED** modifier causes [**SHOW TABLES**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/show-tables.html) to list hidden tables created by failed [**ALTER TABLE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-table.html) statements. See [Section 13.7.7.39, “SHOW TABLES Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/show-tables.html).

#### B.3.3.6 How to Protect or Change the MySQL Unix Socket File

The default location for the Unix socket file that the server uses for communication with local clients is /tmp/mysql.sock. (For some distribution formats, the directory might be different, such as /var/lib/mysql for RPMs.)

On some versions of Unix, anyone can delete files in the /tmp directory or other similar directories used for temporary files. If the socket file is located in such a directory on your system, this might cause problems.

On most versions of Unix, you can protect your /tmp directory so that files can be deleted only by their owners or the superuser (**root**). To do this, set the **sticky** bit on the /tmp directory by logging in as **root** and using the following command:

$> **chmod +t /tmp**

You can check whether the **sticky** bit is set by executing **ls -ld /tmp**. If the last permission character is **t**, the bit is set.

Another approach is to change the place where the server creates the Unix socket file. If you do this, you should also let client programs know the new location of the file. You can specify the file location in several ways:

* Specify the path in a global or local option file. For example, put the following lines in **/etc/my.cnf**:
* [mysqld]
* socket=/path/to/socket
* [client]
* socket=/path/to/socket

See [Section 4.2.2.2, “Using Option Files”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/option-files.html).

* Specify a [--socket](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/connection-options.html#option_general_socket) option on the command line to [**mysqld\_safe**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld-safe.html) and when you run client programs.
* Set the **MYSQL\_UNIX\_PORT** environment variable to the path of the Unix socket file.
* Recompile MySQL from source to use a different default Unix socket file location. Define the path to the file with the [MYSQL\_UNIX\_ADDR](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/source-configuration-options.html#option_cmake_mysql_unix_addr) option when you run **CMake**. See [Section 2.9.7, “MySQL Source-Configuration Options”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/source-configuration-options.html).

You can test whether the new socket location works by attempting to connect to the server with this command:

$> **mysqladmin --socket=/path/to/socket version**

#### B.3.3.7 Time Zone Problems

If you have a problem with **SELECT NOW()** returning values in UTC and not your local time, you have to tell the server your current time zone. The same applies if [**UNIX\_TIMESTAMP()**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/date-and-time-functions.html#function_unix-timestamp) returns the wrong value. This should be done for the environment in which the server runs (for example, in [**mysqld\_safe**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld-safe.html) or [**mysql.server**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-server.html)). See [Section 4.9, “Environment Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/environment-variables.html).

You can set the time zone for the server with the [--timezone=***timezone\_name***](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld-safe.html#option_mysqld_safe_timezone) option to [**mysqld\_safe**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld-safe.html). You can also set it by setting the **TZ** environment variable before you start [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html).

The permissible values for [--timezone](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld-safe.html#option_mysqld_safe_timezone) or **TZ** are system dependent. Consult your operating system documentation to see what values are acceptable.

### B.3.4 Query-Related Issues

* [B.3.4.1 Case Sensitivity in String Searches](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/case-sensitivity.html)
* [B.3.4.2 Problems Using DATE Columns](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/using-date.html)
* [B.3.4.3 Problems with NULL Values](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/problems-with-null.html)
* [B.3.4.4 Problems with Column Aliases](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/problems-with-alias.html)
* [B.3.4.5 Rollback Failure for Nontransactional Tables](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/nontransactional-tables.html)
* [B.3.4.6 Deleting Rows from Related Tables](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/deleting-from-related-tables.html)
* [B.3.4.7 Solving Problems with No Matching Rows](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/no-matching-rows.html)
* [B.3.4.8 Problems with Floating-Point Values](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/problems-with-float.html)

#### B.3.4.1 Case Sensitivity in String Searches

For nonbinary strings ([**CHAR**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/char.html), [**VARCHAR**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/char.html), [**TEXT**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/blob.html)), string searches use the collation of the comparison operands. For binary strings ([**BINARY**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/binary-varbinary.html), [**VARBINARY**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/binary-varbinary.html), [**BLOB**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/blob.html)), comparisons use the numeric values of the bytes in the operands; this means that for alphabetic characters, comparisons are case-sensitive.

A comparison between a nonbinary string and binary string is treated as a comparison of binary strings.

Simple comparison operations (**>=, >, =, <, <=**, sorting, and grouping) are based on each character's “sort value.” Characters with the same sort value are treated as the same character. For example, if **e** and **é** have the same sort value in a given collation, they compare as equal.

The default character set and collation are **utf8mb4** and **utf8mb4\_0900\_ai\_ci**, so nonbinary string comparisons are case-insensitive by default. This means that if you search with ***col\_name* LIKE 'a%'**, you get all column values that start with **A** or **a**. To make this search case-sensitive, make sure that one of the operands has a case-sensitive or binary collation. For example, if you are comparing a column and a string that both have the **utf8mb4** character set, you can use the **COLLATE** operator to cause either operand to have the **utf8mb4\_0900\_as\_cs** or **utf8mb4\_bin** collation:

***col\_name*** COLLATE utf8mb4\_0900\_as\_cs LIKE 'a%'

***col\_name*** LIKE 'a%' COLLATE utf8mb4\_0900\_as\_cs

***col\_name*** COLLATE utf8mb4\_bin LIKE 'a%'

***col\_name*** LIKE 'a%' COLLATE utf8mb4\_bin

If you want a column always to be treated in case-sensitive fashion, declare it with a case-sensitive or binary collation. See [Section 13.1.20, “CREATE TABLE Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/create-table.html).

To cause a case-sensitive comparison of nonbinary strings to be case-insensitive, use **COLLATE** to name a case-insensitive collation. The strings in the following example normally are case-sensitive, but **COLLATE** changes the comparison to be case-insensitive:

mysql> **SET NAMES 'utf8mb4';**

mysql> **SET @s1 = 'MySQL' COLLATE utf8mb4\_bin,**

**@s2 = 'mysql' COLLATE utf8mb4\_bin;**

mysql> **SELECT @s1 = @s2;**

+-----------+

| @s1 = @s2 |

+-----------+

| 0 |

+-----------+

mysql> **SELECT @s1 COLLATE utf8mb4\_0900\_ai\_ci = @s2;**

+--------------------------------------+

| @s1 COLLATE utf8mb4\_0900\_ai\_ci = @s2 |

+--------------------------------------+

| 1 |

+--------------------------------------+

A binary string is case-sensitive in comparisons. To compare the string as case-insensitive, convert it to a nonbinary string and use **COLLATE** to name a case-insensitive collation:

mysql> **SET @s = BINARY 'MySQL';**

mysql> **SELECT @s = 'mysql';**

+--------------+

| @s = 'mysql' |

+--------------+

| 0 |

+--------------+

mysql> **SELECT CONVERT(@s USING utf8mb4) COLLATE utf8mb4\_0900\_ai\_ci = 'mysql';**

+----------------------------------------------------------------+

| CONVERT(@s USING utf8mb4) COLLATE utf8mb4\_0900\_ai\_ci = 'mysql' |

+----------------------------------------------------------------+

| 1 |

+----------------------------------------------------------------+

To determine whether a value is compared as a nonbinary or binary string, use the [**COLLATION()**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/information-functions.html#function_collation) function. This example shows that [**VERSION()**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/information-functions.html#function_version) returns a string that has a case-insensitive collation, so comparisons are case-insensitive:

mysql> **SELECT COLLATION(VERSION());**

+----------------------+

| COLLATION(VERSION()) |

+----------------------+

| utf8\_general\_ci |

+----------------------+

For binary strings, the collation value is **binary**, so comparisons are case sensitive. One context in which you can expect to see **binary** is for compression functions, which return binary strings as a general rule: string:

mysql> **SELECT COLLATION(COMPRESS('x'));**

+--------------------------+

| COLLATION(COMPRESS('x')) |

+--------------------------+

| binary |

+--------------------------+

To check the sort value of a string, the [**WEIGHT\_STRING()**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/string-functions.html#function_weight-string) may be helpful. See [Section 12.8, “String Functions and Operators”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/string-functions.html).

#### B.3.4.2 Problems Using DATE Columns

The format of a [**DATE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/datetime.html) value is **'*YYYY-MM-DD*'**. According to standard SQL, no other format is permitted. You should use this format in [**UPDATE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/update.html) expressions and in the **WHERE** clause of [**SELECT**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/select.html) statements. For example:

SELECT \* FROM t1 WHERE date >= '2003-05-05';

As a convenience, MySQL automatically converts a date to a number if the date is used in numeric context and vice versa. MySQL also permits a “relaxed” string format when updating and in a **WHERE** clause that compares a date to a [**DATE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/datetime.html), [**DATETIME**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/datetime.html), or [**TIMESTAMP**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/datetime.html) column. “Relaxed” format means that any punctuation character may be used as the separator between parts. For example, **'2004-08-15'** and **'2004#08#15'** are equivalent. MySQL can also convert a string containing no separators (such as **'20040815'**), provided it makes sense as a date.

When you compare a [**DATE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/datetime.html), [**TIME**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/time.html), [**DATETIME**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/datetime.html), or [**TIMESTAMP**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/datetime.html) to a constant string with the **<**, **<=**, **=**, **>=**, **>**, or **BETWEEN** operators, MySQL normally converts the string to an internal long integer for faster comparison (and also for a bit more “relaxed” string checking). However, this conversion is subject to the following exceptions:

* When you compare two columns
* When you compare a [**DATE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/datetime.html), [**TIME**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/time.html), [**DATETIME**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/datetime.html), or [**TIMESTAMP**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/datetime.html) column to an expression
* When you use any comparison method other than those just listed, such as **IN** or [**STRCMP()**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/string-comparison-functions.html#function_strcmp).

For those exceptions, the comparison is done by converting the objects to strings and performing a string comparison.

To be on the safe side, assume that strings are compared as strings and use the appropriate string functions if you want to compare a temporal value to a string.

The special “zero” date **'0000-00-00'** can be stored and retrieved as **'0000-00-00'.** When a **'0000-00-00'** date is used through Connector/ODBC, it is automatically converted to **NULL** because ODBC cannot handle that kind of date.

Because MySQL performs the conversions just described, the following statements work (assume that **idate** is a [**DATE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/datetime.html) column):

INSERT INTO t1 (idate) VALUES (19970505);

INSERT INTO t1 (idate) VALUES ('19970505');

INSERT INTO t1 (idate) VALUES ('97-05-05');

INSERT INTO t1 (idate) VALUES ('1997.05.05');

INSERT INTO t1 (idate) VALUES ('1997 05 05');

INSERT INTO t1 (idate) VALUES ('0000-00-00');

SELECT idate FROM t1 WHERE idate >= '1997-05-05';

SELECT idate FROM t1 WHERE idate >= 19970505;

SELECT MOD(idate,100) FROM t1 WHERE idate >= 19970505;

SELECT idate FROM t1 WHERE idate >= '19970505';

However, the following statement does not work:

SELECT idate FROM t1 WHERE STRCMP(idate,'20030505')=0;

[**STRCMP()**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/string-comparison-functions.html#function_strcmp) is a string function, so it converts **idate** to a string in **'*YYYY-MM-DD*'** format and performs a string comparison. It does not convert **'20030505'** to the date **'2003-05-05'** and perform a date comparison.

If you enable the [**ALLOW\_INVALID\_DATES**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/sql-mode.html#sqlmode_allow_invalid_dates) SQL mode, MySQL permits you to store dates that are given only limited checking: MySQL requires only that the day is in the range from 1 to 31 and the month is in the range from 1 to 12. This makes MySQL very convenient for Web applications where you obtain year, month, and day in three different fields and you want to store exactly what the user inserted (without date validation).

MySQL permits you to store dates where the day or month and day are zero. This is convenient if you want to store a birthdate in a [**DATE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/datetime.html) column and you know only part of the date. To disallow zero month or day parts in dates, enable the [**NO\_ZERO\_IN\_DATE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/sql-mode.html#sqlmode_no_zero_in_date) mode.

MySQL permits you to store a “zero” value of **'0000-00-00'** as a “dummy date.” This is in some cases more convenient than using **NULL** values. If a date to be stored in a [**DATE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/datetime.html) column cannot be converted to any reasonable value, MySQL stores **'0000-00-00'**. To disallow **'0000-00-00'**, enable the [**NO\_ZERO\_DATE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/sql-mode.html#sqlmode_no_zero_date) mode.

To have MySQL check all dates and accept only legal dates (unless overridden by **IGNORE**), set the [**sql\_mode**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_sql_mode) system variable to **"NO\_ZERO\_IN\_DATE,NO\_ZERO\_DATE"**.

#### B.3.4.3 Problems with NULL Values

The concept of the **NULL** value is a common source of confusion for newcomers to SQL, who often think that **NULL** is the same thing as an empty string **''**. This is not the case. For example, the following statements are completely different:

mysql> **INSERT INTO my\_table (phone) VALUES (NULL);**

mysql> **INSERT INTO my\_table (phone) VALUES ('');**

Both statements insert a value into the **phone** column, but the first inserts a **NULL** value and the second inserts an empty string. The meaning of the first can be regarded as “phone number is not known” and the meaning of the second can be regarded as “the person is known to have no phone, and thus no phone number.”

To help with **NULL** handling, you can use the [**IS NULL**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/comparison-operators.html#operator_is-null) and [**IS NOT NULL**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/comparison-operators.html#operator_is-not-null) operators and the [**IFNULL()**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/flow-control-functions.html#function_ifnull) function.

In SQL, the **NULL** value is never true in comparison to any other value, even **NULL**. An expression that contains **NULL** always produces a **NULL** value unless otherwise indicated in the documentation for the operators and functions involved in the expression. All columns in the following example return **NULL**:

mysql> **SELECT NULL, 1+NULL, CONCAT('Invisible',NULL);**

To search for column values that are **NULL**, you cannot use an **expr = NULL** test. The following statement returns no rows, because **expr = NULL** is never true for any expression:

mysql> **SELECT \* FROM my\_table WHERE phone = NULL;**

To look for **NULL** values, you must use the [**IS NULL**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/comparison-operators.html#operator_is-null) test. The following statements show how to find the **NULL** phone number and the empty phone number:

mysql> **SELECT \* FROM my\_table WHERE phone IS NULL;**

mysql> **SELECT \* FROM my\_table WHERE phone = '';**

See [Section 3.3.4.6, “Working with NULL Values”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/working-with-null.html), for additional information and examples.

You can add an index on a column that can have **NULL** values if you are using the **MyISAM**, **InnoDB**, or **MEMORY** storage engine. Otherwise, you must declare an indexed column **NOT NULL**, and you cannot insert **NULL** into the column.

When reading data with [**LOAD DATA**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/load-data.html), empty or missing columns are updated with **''**. To load a **NULL** value into a column, use **\N** in the data file. The literal word **NULL** may also be used under some circumstances. See [Section 13.2.7, “LOAD DATA Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/load-data.html).

When using **DISTINCT**, **GROUP BY**, or **ORDER BY**, all **NULL** values are regarded as equal.

When using **ORDER BY**, **NULL** values are presented first, or last if you specify **DESC** to sort in descending order.

Aggregate (group) functions such as [**COUNT()**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/aggregate-functions.html#function_count), [**MIN()**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/aggregate-functions.html#function_min), and [**SUM()**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/aggregate-functions.html#function_sum) ignore **NULL** values. The exception to this is [**COUNT(\*)**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/aggregate-functions.html#function_count), which counts rows and not individual column values. For example, the following statement produces two counts. The first is a count of the number of rows in the table, and the second is a count of the number of non-**NULL** values in the **age** column:

mysql> **SELECT COUNT(\*), COUNT(age) FROM person;**

For some data types, MySQL handles **NULL** values specially. If you insert **NULL** into a [**TIMESTAMP**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/datetime.html) column, the current date and time is inserted. If you insert **NULL** into an integer or floating-point column that has the **AUTO\_INCREMENT** attribute, the next number in the sequence is inserted.

#### B.3.4.4 Problems with Column Aliases

An alias can be used in a query select list to give a column a different name. You can use the alias in **GROUP BY**, **ORDER BY**, or **HAVING** clauses to refer to the column:

SELECT SQRT(a\*b) AS root FROM ***tbl\_name***

GROUP BY root HAVING root > 0;

SELECT id, COUNT(\*) AS cnt FROM ***tbl\_name***

GROUP BY id HAVING cnt > 0;

SELECT id AS 'Customer identity' FROM ***tbl\_name***;

Standard SQL disallows references to column aliases in a **WHERE** clause. This restriction is imposed because when the **WHERE** clause is evaluated, the column value may not yet have been determined. For example, the following query is illegal:

SELECT id, COUNT(\*) AS cnt FROM ***tbl\_name***

WHERE cnt > 0 GROUP BY id;

The **WHERE** clause determines which rows should be included in the **GROUP BY** clause, but it refers to the alias of a column value that is not known until after the rows have been selected, and grouped by the **GROUP BY**.

In the select list of a query, a quoted column alias can be specified using identifier or string quoting characters:

SELECT 1 AS `one`, 2 AS 'two';

Elsewhere in the statement, quoted references to the alias must use identifier quoting or the reference is treated as a string literal. For example, this statement groups by the values in column **id**, referenced using the alias **`a`**:

SELECT id AS 'a', COUNT(\*) AS cnt FROM ***tbl\_name***

GROUP BY `a`;

This statement groups by the literal string **'a'** and does not work as you may expect:

SELECT id AS 'a', COUNT(\*) AS cnt FROM ***tbl\_name***

GROUP BY 'a';

#### B.3.4.5 Rollback Failure for Nontransactional Tables

If you receive the following message when trying to perform a [**ROLLBACK**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/commit.html), it means that one or more of the tables you used in the transaction do not support transactions:

Warning: Some non-transactional changed tables couldn't be rolled back

These nontransactional tables are not affected by the [**ROLLBACK**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/commit.html) statement.

If you were not deliberately mixing transactional and nontransactional tables within the transaction, the most likely cause for this message is that a table you thought was transactional actually is not. This can happen if you try to create a table using a transactional storage engine that is not supported by your [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) server (or that was disabled with a startup option). If [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) does not support a storage engine, it instead creates the table as a **MyISAM** table, which is nontransactional.

You can check the storage engine for a table by using either of these statements:

SHOW TABLE STATUS LIKE '***tbl\_name***';

SHOW CREATE TABLE ***tbl\_name***;

See [Section 13.7.7.38, “SHOW TABLE STATUS Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/show-table-status.html), and [Section 13.7.7.10, “SHOW CREATE TABLE Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/show-create-table.html).

To check which storage engines your [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) server supports, use this statement:

SHOW ENGINES;

See [Section 13.7.7.16, “SHOW ENGINES Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/show-engines.html) for full details.

#### B.3.4.6 Deleting Rows from Related Tables

If the total length of the [**DELETE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/delete.html) statement for **related\_table** is more than the default value of the [**max\_allowed\_packet**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_max_allowed_packet) system variable, you should split it into smaller parts and execute multiple [**DELETE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/delete.html) statements. You probably get the fastest [**DELETE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/delete.html) by specifying only 100 to 1,000 **related\_column** values per statement if the **related\_column** is indexed. If the **related\_column** isn't indexed, the speed is independent of the number of arguments in the **IN** clause.

#### B.3.4.7 Solving Problems with No Matching Rows

If you have a complicated query that uses many tables but that returns no rows, you should use the following procedure to find out what is wrong:

1. Test the query with [**EXPLAIN**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/explain.html) to check whether you can find something that is obviously wrong. See [Section 13.8.2, “EXPLAIN Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/explain.html).
2. Select only those columns that are used in the **WHERE** clause.
3. Remove one table at a time from the query until it returns some rows. If the tables are large, it is a good idea to use **LIMIT 10** with the query.
4. Issue a [**SELECT**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/select.html) for the column that should have matched a row against the table that was last removed from the query.
5. If you are comparing [**FLOAT**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/floating-point-types.html) or [**DOUBLE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/floating-point-types.html) columns with numbers that have decimals, you cannot use equality (**=**) comparisons. This problem is common in most computer languages because not all floating-point values can be stored with exact precision. In some cases, changing the [**FLOAT**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/floating-point-types.html) to a [**DOUBLE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/floating-point-types.html) fixes this. See [Section B.3.4.8, “Problems with Floating-Point Values”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/problems-with-float.html).
6. If you still cannot figure out what is wrong, create a minimal test that can be run with **mysql test < query.sql** that shows your problems. You can create a test file by dumping the tables with [**mysqldump --quick db\_name *tbl\_name\_1* ... *tbl\_name\_n* > query.sql**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqldump.html). Open the file in an editor, remove some insert lines (if there are more than needed to demonstrate the problem), and add your [**SELECT**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/select.html) statement at the end of the file.

Verify that the test file demonstrates the problem by executing these commands:

$> **mysqladmin create test2**

$> **mysql test2 < query.sql**

Attach the test file to a bug report, which you can file using the instructions in [Section 1.6, “How to Report Bugs or Problems”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/bug-reports.html).

#### B.3.4.8 Problems with Floating-Point Values

Floating-point numbers sometimes cause confusion because they are approximate and not stored as exact values. A floating-point value as written in an SQL statement may not be the same as the value represented internally. Attempts to treat floating-point values as exact in comparisons may lead to problems. They are also subject to platform or implementation dependencies. The [**FLOAT**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/floating-point-types.html) and [**DOUBLE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/floating-point-types.html) data types are subject to these issues. For [**DECIMAL**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/fixed-point-types.html) columns, MySQL performs operations with a precision of 65 decimal digits, which should solve most common inaccuracy problems.

The following example uses [**DOUBLE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/floating-point-types.html) to demonstrate how calculations that are done using floating-point operations are subject to floating-point error.

mysql> **CREATE TABLE t1 (i INT, d1 DOUBLE, d2 DOUBLE);**

mysql> **INSERT INTO t1 VALUES (1, 101.40, 21.40), (1, -80.00, 0.00),**

-> **(2, 0.00, 0.00), (2, -13.20, 0.00), (2, 59.60, 46.40),**

-> **(2, 30.40, 30.40), (3, 37.00, 7.40), (3, -29.60, 0.00),**

-> **(4, 60.00, 15.40), (4, -10.60, 0.00), (4, -34.00, 0.00),**

-> **(5, 33.00, 0.00), (5, -25.80, 0.00), (5, 0.00, 7.20),**

-> **(6, 0.00, 0.00), (6, -51.40, 0.00);**

mysql> **SELECT i, SUM(d1) AS a, SUM(d2) AS b**

-> **FROM t1 GROUP BY i HAVING a <> b;**

+------+-------+------+

| i | a | b |

+------+-------+------+

| 1 | 21.4 | 21.4 |

| 2 | 76.8 | 76.8 |

| 3 | 7.4 | 7.4 |

| 4 | 15.4 | 15.4 |

| 5 | 7.2 | 7.2 |

| 6 | -51.4 | 0 |

+------+-------+------+

The result is correct. Although the first five records look like they should not satisfy the comparison (the values of **a** and **b** do not appear to be different), they may do so because the difference between the numbers shows up around the tenth decimal or so, depending on factors such as computer architecture or the compiler version or optimization level. For example, different CPUs may evaluate floating-point numbers differently.

If columns **d1** and **d2** had been defined as [**DECIMAL**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/fixed-point-types.html) rather than [**DOUBLE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/floating-point-types.html), the result of the [**SELECT**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/select.html) query would have contained only one row—the last one shown above.

The correct way to do floating-point number comparison is to first decide on an acceptable tolerance for differences between the numbers and then do the comparison against the tolerance value. For example, if we agree that floating-point numbers should be regarded the same if they are same within a precision of one in ten thousand (0.0001), the comparison should be written to find differences larger than the tolerance value:

mysql> **SELECT i, SUM(d1) AS a, SUM(d2) AS b FROM t1**

-> **GROUP BY i HAVING ABS(a - b) > 0.0001;**

+------+-------+------+

| i | a | b |

+------+-------+------+

| 6 | -51.4 | 0 |

+------+-------+------+

1 row in set (0.00 sec)

Conversely, to get rows where the numbers are the same, the test should find differences within the tolerance value:

mysql> **SELECT i, SUM(d1) AS a, SUM(d2) AS b FROM t1**

-> **GROUP BY i HAVING ABS(a - b) <= 0.0001;**

+------+------+------+

| i | a | b |

+------+------+------+

| 1 | 21.4 | 21.4 |

| 2 | 76.8 | 76.8 |

| 3 | 7.4 | 7.4 |

| 4 | 15.4 | 15.4 |

| 5 | 7.2 | 7.2 |

+------+------+------+

5 rows in set (0.03 sec)

Floating-point values are subject to platform or implementation dependencies. Suppose that you execute the following statements:

CREATE TABLE t1(c1 FLOAT(53,0), c2 FLOAT(53,0));

INSERT INTO t1 VALUES('1e+52','-1e+52');

SELECT \* FROM t1;

On some platforms, the **SELECT** statement returns **inf** and **-inf**. On others, it returns **0** and **-0**.

An implication of the preceding issues is that if you attempt to create a replica by dumping table contents with [**mysqldump**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqldump.html) on the source and reloading the dump file into the replica, tables containing floating-point columns might differ between the two hosts.

### B.3.5 Optimizer-Related Issues

MySQL uses a cost-based optimizer to determine the best way to resolve a query. In many cases, MySQL can calculate the best possible query plan, but sometimes MySQL does not have enough information about the data at hand and has to make “educated” guesses about the data.

For the cases when MySQL does not do the "right" thing, tools that you have available to help MySQL are:

* Use the [**EXPLAIN**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/explain.html) statement to get information about how MySQL processes a query. To use it, just add the keyword [**EXPLAIN**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/explain.html) to the front of your [**SELECT**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/select.html) statement:
* mysql> **EXPLAIN SELECT \* FROM t1, t2 WHERE t1.i = t2.i;**

[**EXPLAIN**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/explain.html) is discussed in more detail in [Section 13.8.2, “EXPLAIN Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/explain.html).

* Use **ANALYZE TABLE *tbl\_name*** to update the key distributions for the scanned table. See [Section 13.7.3.1, “ANALYZE TABLE Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/analyze-table.html).
* Use **FORCE INDEX** for the scanned table to tell MySQL that table scans are very expensive compared to using the given index:
* SELECT \* FROM t1, t2 FORCE INDEX (index\_for\_column)
* WHERE t1.col\_name=t2.col\_name;

**USE INDEX** and **IGNORE INDEX** may also be useful. See [Section 8.9.4, “Index Hints”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/index-hints.html).

* Global and table-level **STRAIGHT\_JOIN**. See [Section 13.2.10, “SELECT Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/select.html).
* You can tune global or thread-specific system variables. For example, start [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) with the [--max-seeks-for-key=1000](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_max_seeks_for_key) option or use **SET max\_seeks\_for\_key=1000** to tell the optimizer to assume that no key scan causes more than 1,000 key seeks. See [Section 5.1.8, “Server System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html).

### B.3.6 Table Definition-Related Issues

* [B.3.6.1 Problems with ALTER TABLE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-table-problems.html)
* [B.3.6.2 TEMPORARY Table Problems](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/temporary-table-problems.html)

#### B.3.6.1 Problems with ALTER TABLE

If you get a duplicate-key error when using [**ALTER TABLE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-table.html) to change the character set or collation of a character column, the cause is either that the new column collation maps two keys to the same value or that the table is corrupted. In the latter case, you should run [**REPAIR TABLE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/repair-table.html) on the table. [**REPAIR TABLE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/repair-table.html) works for **MyISAM**, **ARCHIVE**, and **CSV** tables.

If you use [**ALTER TABLE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-table.html) on a transactional table or if you are using Windows, [**ALTER TABLE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-table.html) unlocks the table if you had done a [**LOCK TABLE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/lock-tables.html) on it. This is done because **InnoDB** and these operating systems cannot drop a table that is in use.

#### B.3.6.2 TEMPORARY Table Problems

Temporary tables created with [**CREATE TEMPORARY TABLE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/create-table.html) have the following limitations:

* **TEMPORARY** tables are supported only by the **InnoDB**, **MEMORY**, **MyISAM**, and **MERGE** storage engines.
* Temporary tables are not supported for NDB Cluster.
* The [**SHOW TABLES**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/show-tables.html) statement does not list **TEMPORARY** tables.
* To rename **TEMPORARY** tables, **RENAME TABLE** does not work. Use [**ALTER TABLE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-table.html) instead:
* ALTER TABLE old\_name RENAME new\_name;
* You cannot refer to a **TEMPORARY** table more than once in the same query. For example, the following does not work:
* SELECT \* FROM temp\_table JOIN temp\_table AS t2;

The statement produces this error:

ERROR 1137: Can't reopen table: 'temp\_table'

You can work around this issue if your query permits use of a common table expression (CTE) rather than a **TEMPORARY** table. For example, this fails with the Can't reopen table error:

CREATE TEMPORARY TABLE t SELECT 1 AS col\_a, 2 AS col\_b;

SELECT \* FROM t AS t1 JOIN t AS t2;

To avoid the error, use a [**WITH**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/with.html) clause that defines a CTE, rather than the **TEMPORARY** table:

WITH cte AS (SELECT 1 AS col\_a, 2 AS col\_b)

SELECT \* FROM cte AS t1 JOIN cte AS t2;

* The Can't reopen table error also occurs if you refer to a temporary table multiple times in a stored function under different aliases, even if the references occur in different statements within the function. It may occur for temporary tables created outside stored functions and referred to across multiple calling and callee functions.
* If a **TEMPORARY** is created with the same name as an existing non-**TEMPORARY** table, the non-**TEMPORARY** table is hidden until the **TEMPORARY** table is dropped, even if the tables use different storage engines.
* There are known issues in using temporary tables with replication. See [Section 17.5.1.31, “Replication and Temporary Tables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-features-temptables.html), for more information.

### B.3.7 Known Issues in MySQL

This section lists known issues in recent versions of MySQL.

For information about platform-specific issues, see the installation and debugging instructions in [Section 2.1, “General Installation Guidance”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/general-installation-issues.html), and [Section 5.9, “Debugging MySQL”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/debugging-mysql.html).

The following problems are known:

* Subquery optimization for **IN** is not as effective as for **=**.
* Even if you use **lower\_case\_table\_names=2** (which enables MySQL to remember the case used for databases and table names), MySQL does not remember the case used for database names for the function [**DATABASE()**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/information-functions.html#function_database) or within the various logs (on case-insensitive systems).
* Dropping a **FOREIGN KEY** constraint does not work in replication because the constraint may have another name on the replica.
* [**REPLACE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replace.html) (and [**LOAD DATA**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/load-data.html) with the [**REPLACE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replace.html) option) does not trigger **ON DELETE CASCADE**.
* **DISTINCT** with **ORDER BY** does not work inside [**GROUP\_CONCAT()**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/aggregate-functions.html#function_group-concat) if you do not use all and only those columns that are in the **DISTINCT** list.
* When inserting a big integer value (between 263 and 264−1) into a decimal or string column, it is inserted as a negative value because the number is evaluated in signed integer context.
* With statement-based binary logging, the source server writes the executed queries to the binary log. This is a very fast, compact, and efficient logging method that works perfectly in most cases. However, it is possible for the data on the source and replica to become different if a query is designed in such a way that the data modification is nondeterministic (generally not a recommended practice, even outside of replication).

For example:

* + [**CREATE TABLE ... SELECT**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/create-table-select.html) or [**INSERT ... SELECT**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/insert-select.html) statements that insert zero or **NULL** values into an **AUTO\_INCREMENT** column.
  + [**DELETE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/delete.html) if you are deleting rows from a table that has foreign keys with **ON DELETE CASCADE** properties.
  + [**REPLACE ... SELECT**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replace.html), **INSERT IGNORE ... SELECT** if you have duplicate key values in the inserted data.

***If and only if the preceding queries have no ORDER BY clause guaranteeing a deterministic order***.

For example, for [**INSERT ... SELECT**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/insert-select.html) with no **ORDER BY**, the [**SELECT**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/select.html) may return rows in a different order (which results in a row having different ranks, hence getting a different number in the **AUTO\_INCREMENT** column), depending on the choices made by the optimizers on the source and replica.

A query is optimized differently on the source and replica only if:

* + The table is stored using a different storage engine on the source than on the replica. (It is possible to use different storage engines on the source and replica. For example, you can use **InnoDB** on the source, but **MyISAM** on the replica if the replica has less available disk space.)
  + MySQL buffer sizes ([**key\_buffer\_size**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_key_buffer_size), and so on) are different on the source and replica.
  + The source and replica run different MySQL versions, and the optimizer code differs between these versions.

This problem may also affect database restoration using **mysqlbinlog|mysql**.

The easiest way to avoid this problem is to add an **ORDER BY** clause to the aforementioned nondeterministic queries to ensure that the rows are always stored or modified in the same order. Using row-based or mixed logging format also avoids the problem.

* Log file names are based on the server host name if you do not specify a file name with the startup option. To retain the same log file names if you change your host name to something else, you must explicitly use options such as [--log-bin=***old\_host\_name***-bin](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-options-binary-log.html#option_mysqld_log-bin). See [Section 5.1.7, “Server Command Options”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-options.html). Alternatively, rename the old files to reflect your host name change. If these are binary logs, you must edit the binary log index file and fix the binary log file names there as well. (The same is true for the relay logs on a replica.)
* [**mysqlbinlog**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqlbinlog.html) does not delete temporary files left after a [**LOAD DATA**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/load-data.html) statement. See [Section 4.6.9, “mysqlbinlog — Utility for Processing Binary Log Files”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqlbinlog.html).
* **RENAME** does not work with **TEMPORARY** tables or tables used in a **MERGE** table.
* When using **SET CHARACTER SET**, you cannot use translated characters in database, table, and column names.
* Prior to MySQL 8.0.17, you cannot use **\_** or **%** with **ESCAPE** in [**LIKE ... ESCAPE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/string-comparison-functions.html#operator_like).
* The server uses only the first [**max\_sort\_length**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_max_sort_length) bytes when comparing data values. This means that values cannot reliably be used in **GROUP BY**, **ORDER BY**, or **DISTINCT** if they differ only after the first [**max\_sort\_length**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_max_sort_length) bytes. To work around this, increase the variable value. The default value of [**max\_sort\_length**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_max_sort_length) is 1024 and can be changed at server startup time or at runtime.
* Numeric calculations are done with [**BIGINT**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/integer-types.html) or [**DOUBLE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/floating-point-types.html) (both are normally 64 bits long). Which precision you get depends on the function. The general rule is that bit functions are performed with [**BIGINT**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/integer-types.html) precision, [**IF()**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/flow-control-functions.html#function_if) and [**ELT()**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/string-functions.html#function_elt) with [**BIGINT**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/integer-types.html) or [**DOUBLE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/floating-point-types.html) precision, and the rest with [**DOUBLE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/floating-point-types.html) precision. You should try to avoid using unsigned long long values if they resolve to be larger than 63 bits (9223372036854775807) for anything other than bit fields.
* You can have up to 255 [**ENUM**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/enum.html) and [**SET**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/set.html) columns in one table.
* In [**MIN()**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/aggregate-functions.html#function_min), [**MAX()**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/aggregate-functions.html#function_max), and other aggregate functions, MySQL currently compares [**ENUM**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/enum.html) and [**SET**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/set.html) columns by their string value rather than by the string's relative position in the set.
* In an [**UPDATE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/update.html) statement, columns are updated from left to right. If you refer to an updated column, you get the updated value instead of the original value. For example, the following statement increments **KEY** by **2**, ***not*** **1**:
* mysql> **UPDATE *tbl\_name* SET KEY=KEY+1,KEY=KEY+1;**
* You can refer to multiple temporary tables in the same query, but you cannot refer to any given temporary table more than once. For example, the following does not work:
* mysql> **SELECT \* FROM temp\_table, temp\_table AS t2;**
* ERROR 1137: Can't reopen table: 'temp\_table'
* The optimizer may handle **DISTINCT** differently when you are using “hidden” columns in a join than when you are not. In a join, hidden columns are counted as part of the result (even if they are not shown), whereas in normal queries, hidden columns do not participate in the **DISTINCT** comparison.

An example of this is:

SELECT DISTINCT mp3id FROM band\_downloads

WHERE userid = 9 ORDER BY id DESC;

and

SELECT DISTINCT band\_downloads.mp3id

FROM band\_downloads,band\_mp3

WHERE band\_downloads.userid = 9

AND band\_mp3.id = band\_downloads.mp3id

ORDER BY band\_downloads.id DESC;

In the second case, you may get two identical rows in the result set (because the values in the hidden **id** column may differ).

Note that this happens only for queries that do not have the **ORDER BY** columns in the result.

* If you execute a **PROCEDURE** on a query that returns an empty set, in some cases the **PROCEDURE** does not transform the columns.
* Creation of a table of type **MERGE** does not check whether the underlying tables are compatible types.
* If you use [**ALTER TABLE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-table.html) to add a **UNIQUE** index to a table used in a **MERGE** table and then add a normal index on the **MERGE** table, the key order is different for the tables if there was an old, non-**UNIQUE** key in the table. This is because [**ALTER TABLE**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-table.html) puts **UNIQUE** indexes before normal indexes to be able to detect duplicate keys as early as possible.

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!

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### ndb\_print\_backup

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### ndb\_print\_backup\_file

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### ndb\_redo\_log\_reader

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### NET START

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### NET STOP

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### NET STOP mysqld\_service\_name

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### NET STOP service\_name

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### nslookup

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### numactl

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### openssl

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### P

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### patchelf

[Section 2.9.7, “MySQL Source-Configuration Options”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/source-configuration-options.html)

### perf

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### perror

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### PGP

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### ping6

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### pkgadd

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### pkgrm

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### ppm

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### ps

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### R

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### rename

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### resolve\_stack\_dump

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### resolveip

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### restart

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### rm

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### rpm

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### rpmbuild

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### SC

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### SC DELETE

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### SC DELETE mysqld\_service\_name

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[Section 2.3.4.8, “Starting MySQL as a Windows Service”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/windows-start-service.html)

### SC DELETE service\_name

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### SC START

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### SC START mysqld\_service\_name

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### sc start mysqld\_service\_name

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### SC STOP

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### SC STOP mysqld\_service\_name

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### sc stop mysqld\_service\_name

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### SC STOP service\_name

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### sed

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### SELECT

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### semanage

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### CASE value WHEN compare\_value THEN result END

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### CASE WHEN condition THEN result END

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### CASE WHEN expr1 = expr2 THEN NULL ELSE expr1 END

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### column->>path

[Section 12.18.3, “Functions That Search JSON Values”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/json-search-functions.html)

### column->path

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### expr BETWEEN min AND max

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### expr IN ()

[Section 12.4.2, “Comparison Functions and Operators”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/comparison-operators.html)

### expr LIKE pat

[Section 12.8.1, “String Comparison Functions and Operators”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/string-comparison-functions.html)

### expr NOT BETWEEN min AND max

[Section 12.4.2, “Comparison Functions and Operators”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/comparison-operators.html)

### expr NOT IN ()

[Section 12.4.2, “Comparison Functions and Operators”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/comparison-operators.html)

### expr NOT LIKE pat

[Section 12.8.1, “String Comparison Functions and Operators”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/string-comparison-functions.html)

### expr NOT REGEXP pat

[Section 12.8.2, “Regular Expressions”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/regexp.html)

### expr NOT RLIKE pat

[Section 12.8.2, “Regular Expressions”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/regexp.html)

### expr REGEXP pat

[Section 12.8.2, “Regular Expressions”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/regexp.html)

### expr RLIKE pat

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### expr1 SOUNDS LIKE expr2

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### IN()

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[Section 12.3, “Type Conversion in Expression Evaluation”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/type-conversion.html)

### IS

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### IS boolean\_value

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### IS NOT boolean\_value

[Section 12.4.2, “Comparison Functions and Operators”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/comparison-operators.html)

### IS NOT NULL

[Section 12.4.2, “Comparison Functions and Operators”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/comparison-operators.html)

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### IS NULL

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### --add-drop-table

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### --add-drop-user

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### --add-locks

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### --all-tablespaces

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### --allow-keywords

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### --allow-mismatches

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### --auto-vertical-output

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### --cert-file

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### --cflags

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### --charset

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### --check

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### --check-missing

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### --check-only-changed

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### --check-orphans

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### --check-upgrade

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### --chroot

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### --clone

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### --cluster-config-suffix

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### cluster-config-suffix

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### CMAKE\_C\_FLAGS

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### CMAKE\_C\_FLAGS\_build\_type

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### CMAKE\_C\_FLAGS\_RELWITHDEBINFO

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### CMAKE\_CXX\_FLAGS

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### CMAKE\_CXX\_FLAGS\_build\_type

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### CMAKE\_CXX\_FLAGS\_RELWITHDEBINFO

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### CMAKE\_INSTALL\_PREFIX

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### --collation-server

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### --collation\_server

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### --color

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### --column-names

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### --column-statistics

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### --column-type-info

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### --columns

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### --comments

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### --commit

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### --compact

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### --compatible

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### --complete-insert

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### --component-dir

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### --compress

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### --compress-output

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### --compression-algorithms

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### --concurrency

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### --config-cache

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### --config-dir

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### --config-file

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### --config-from-node

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### --config\_from\_node

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### --configinfo

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### --connect

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### --connect-delay

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### --connect-retries

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### --connect-retry-delay

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### --connect-string

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### --connect-timeout

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### --connection-control

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### --connection-control-failed-login-attempts

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### --connection-server-id

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### --connection-timeout

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### --context

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### --continue

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### --control-directory-number

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### --default-parallelism

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### --default-storage-engine

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### --default-time-zone

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### --defer-table-indexes

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### --delay

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### --delay-key-write

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### delay\_key\_write

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### --delete

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### --delete-master-logs

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### --delete-orphans

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### --delete-source-logs

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### --delimiter

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### --des-key-file

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### --descending

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### --description

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### --destination-keyring

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### --destination-keyring-configuration-dir

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### --detach

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### --diff-default

[Section 23.5.7, “ndb\_config — Extract NDB Cluster Configuration Information”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-programs-ndb-config.html)

### --disable

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### --disable-admin-ssl

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### --disable-auto-rehash

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### --disable-indexes

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### --disable-keys

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### --disable-log-bin

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### --disable-named-commands

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### --disable-plugin\_name

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### --disable-ssl

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### DISABLE\_SHARED

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### --disconnect-slave-event-count

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### --i-am-a-dummy

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### --id

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### --idempotent

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### --idlesleep

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### --idlespin

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### --ignore

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### ignore-\*

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### --ignore-db-dir

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### --ignore-error

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### --ignore-lines

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### --ignore-spaces

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### --ignore-table

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### --in-file-errlog

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### --include-\*

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### --include-databases

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### --include-events

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### --include-gtids

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### --include-master-host-port

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### --include-routines

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### --include-source-host-port

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### --include-stored-grants

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### --include-tables

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### --include-triggers

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### --include-users

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### --info

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### --information

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### --init\_connect

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### --initial

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### --initialize

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### --innodb-adaptive-hash-index

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### --innodb-file-per-table

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### innodb-file-per-table

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### --innodb-rollback-on-timeout

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### --innodb-status-file

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### --input-type

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### --insert-ignore

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### --install

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### --install-manual

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### --lock-all-tables

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### --lock-order

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### --log-slave-updates

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### --log-tc

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### --log-tc-size

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### --loops

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### --loose

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### --loose-opt\_name

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### --lossy-conversions

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### --low-priority

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### --low-priority-updates

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### -m

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### --malloc-lib

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### --master-data

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### --master-info-file

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### --master-retry-count

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### --max-allowed-packet

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### --max-binlog-dump-events

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### --max-binlog-size

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### --max-join-size

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### --max-record-length

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### --max-relay-log-size

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### --max-rows

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### --max-seeks-for-key

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### --maximum

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### --maximum-back\_log

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### --maximum-innodb-log-file-size

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### --maximum-max\_heap\_table\_size

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### --maximum-var\_name

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### --measured-load

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### --medium-check

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### --memlock

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### --monitor

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### --mount

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### --my-plugin

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### --my\_plugin

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### --mycnf

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### --myisam-block-size

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### --myisam\_sort\_buffer\_size

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### MYSQL\_DATABASE

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### MYSQL\_LOG\_CONSOLE

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### MYSQL\_RANDOM\_ROOT\_PASSWORD

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### MYSQL\_ROOT\_HOST

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### MYSQL\_ROOT\_PASSWORD

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### --mysqld

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### --mysqld-safe-log-timestamps

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### --mysqld-version

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### --mysqlx

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### mysqlx

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### N

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### --name-file

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### --named-commands

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### --ndb

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### --ndb-allow-copying-alter-table

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### --ndb-applier-allow-skip-epoch

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### --ndb-blob-read-batch-bytes

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### --ndb-blob-write-batch-bytes

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### --ndb-default-column-format

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### --ndb-deferred-constraints

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### --ndb-distribution

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### --ndb-force-send

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### --ndb-index-stat-enable

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### --ndb-log-apply-status

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### --ndb-log-bin

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### --ndb-log-empty-epochs

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### --ndb-log-empty-update

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### --ndb-log-exclusive-reads

[Section 23.4.3.9.1, “MySQL Server Options for NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-program-options-mysqld)

### --ndb-log-fail-terminate

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### --ndb-log-orig

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### --ndb-log-transaction-id

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### --ndb-log-update-as-write

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### --ndb-log-update-minimal

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### --ndb-log-updated-only

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### --ndb-mgmd-host

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[Section 23.5.8, “ndb\_delete\_all — Delete All Rows from an NDB Table”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-programs-ndb-delete-all.html)

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### --ndb-nodegroup-map

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### --ndb-nodeid

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### --ndb-optimization-delay

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### --ndb-optimized-node-selection

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### --ndb-schema-dist-timeout

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### --ndb-transid-mysql-connection-map

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### --ndb-use-exact-count

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### --ndb-wait-connected

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### --ndb-wait-setup

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### --ndbcluster

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### --ndbinfo

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### --net-buffer-length

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[Section 4.5.6, “mysqlpump — A Database Backup Program”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqlpump.html)

### net\_retry\_count

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### net\_write\_timeout

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### --network

[Section 2.5.6.2, “More Topics on Deploying MySQL Server with Docker”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/docker-mysql-more-topics.html)

### --network-namespace

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[Section 5.1.14, “Network Namespace Support”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/network-namespace-support.html)

### --network-timeout

[Section 4.5.4, “mysqldump — A Database Backup Program”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqldump.html)

### --nice

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### --no-asynch

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### --no-auto-rehash

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### --no-autocommit

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### --no-beep

[Section 4.5.1.1, “mysql Client Options”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-command-options.html)

[Section 4.5.2, “mysqladmin — A MySQL Server Administration Program”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqladmin.html)

### --no-binlog

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### --no-browser

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### --no-check

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### --no-contact

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### --no-create-db

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[Section 4.5.6, “mysqlpump — A Database Backup Program”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqlpump.html)

### --no-create-info

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[Section 4.5.4, “mysqldump — A Database Backup Program”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqldump.html)

[Section 4.5.6, “mysqlpump — A Database Backup Program”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqlpump.html)

### --no-data

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### --no-dd-upgrade

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### --no-defaults

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### --no-drop

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### --no-hint

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### --no-history-logging

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### --no-log

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### --no-monitor

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### --no-nodeid-checks

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### --no-print-rows

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### --no-restore-disk-objects

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### --no-set-names

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### --no-symlinks

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### --no-tablespaces

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### --no-upgrade

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### --nodaemon

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### --nodata

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### --node-id

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### --nodeid

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### --nodes

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### --nostart

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### --not-started

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### --nowait-nodes

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### --num-slices

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### --number-char-cols

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### --number-int-cols

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### --number-of-queries

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### -o

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### --offset

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### --old-style-user-limits

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### old\_passwords

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### --oldpackage

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### ON

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### --one-database

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### --online-migration

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### --only-print

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### --opbatch

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### --opbytes

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### --open-files-limit

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### --opt

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### --opt\_name

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### --optimize

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### --optimizer-switch

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### options

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### --order

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### --order-by-primary

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### --os-load

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### --out-dir

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### --out-file

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### --output-type

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### --output-workers

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### --post-query

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### --post-system

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### --pre-query

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### --pre-system

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### --print-full-config

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### --print-header-words

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### --print-meta

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### --print-restored-rows

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### --print-sql-log

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### --print-table-metadata

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### --progress-frequency

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### --promote-attributes

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### --real\_table\_name

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### --rebuild-indexes

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### --reconnect

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### --recover

[Section 4.6.4.2, “myisamchk Check Options”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/myisamchk-check-options.html)

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[Section 4.6.4.6, “myisamchk Memory Usage”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/myisamchk-memory.html)

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### --rejects

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### --relative

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### --relay-log

[Section 17.2.2.3, “Startup Options and Replication Channels”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/channels-startup-options.html)

[Section 18.5.6, “Using MySQL Enterprise Backup with Group Replication”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/group-replication-enterprise-backup.html)

### --relay-log-index

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### --relay-log-purge

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### --relay-log-recovery

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[Section 13.7.7.35, “SHOW REPLICA STATUS Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/show-replica-status.html)

[Section 5.1.19, “The Server Shutdown Process”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-shutdown.html)

### --relay-log-space-limit

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[Section 17.2.2.3, “Startup Options and Replication Channels”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/channels-startup-options.html)

### --reload

[Section 23.6.7.2, “Adding NDB Cluster Data Nodes Online: Basic procedure”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-online-add-node-basics.html)

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[Section 23.4.3, “NDB Cluster Configuration Files”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-config-file.html)

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### --remap-column

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### --remove

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[Section 5.8.2.2, “Starting Multiple MySQL Instances as Windows Services”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/multiple-windows-services.html)

[Section 2.3.4.8, “Starting MySQL as a Windows Service”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/windows-start-service.html)

### --remove{

[Section 23.5.4, “ndb\_mgmd — The NDB Cluster Management Server Daemon”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-programs-ndb-mgmd.html)

### --repair

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### --replace

[Section 4.5.4, “mysqldump — A Database Backup Program”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqldump.html)

[Section 4.5.5, “mysqlimport — A Data Import Program”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqlimport.html)

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### --replica-net-timeout

[Section 17.2.2.3, “Startup Options and Replication Channels”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/channels-startup-options.html)

### --replica-parallel-workers

[Section 17.2.2.3, “Startup Options and Replication Channels”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/channels-startup-options.html)

### --replica-skip-counter

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### --replicate-\*

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[Section 17.2.5, “How Servers Evaluate Replication Filtering Rules”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-rules.html)

[Section 17.1.6.3, “Replica Server Options and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-options-replica.html)

[Section 17.2.5.4, “Replication Channel Based Filters”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-rules-channel-based-filters.html)

[Section 27.12.11.10, “The replication\_applier\_filters Table”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/performance-schema-replication-applier-filters-table.html)

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### --replicate-\*-db

[Section 17.1.6.3, “Replica Server Options and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-options-replica.html)

[Section 25.8, “Restrictions on Stored Programs”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/stored-program-restrictions.html)

### --replicate-do-\*

[Section 23.7.3, “Known Issues in NDB Cluster Replication”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-replication-issues.html)

### --replicate-do-db

[Section 17.1.6.4, “Binary Logging Options and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-options-binary-log.html)

[Section 13.4.2.2, “CHANGE REPLICATION FILTER Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/change-replication-filter.html)

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[Section 17.4.6, “Replicating Different Databases to Different Replicas”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-solutions-partitioning.html)

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[Section 13.7.7.35, “SHOW REPLICA STATUS Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/show-replica-status.html)

[Section 13.3.1, “START TRANSACTION, COMMIT, and ROLLBACK Statements”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/commit.html)

[Section 5.4.4, “The Binary Log”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/binary-log.html)

### --replicate-do-db:channel\_1:db\_name

[Section 17.1.6.3, “Replica Server Options and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-options-replica.html)

### --replicate-do-table

[Section 13.4.2.2, “CHANGE REPLICATION FILTER Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/change-replication-filter.html)

[Section 17.2.5.2, “Evaluation of Table-Level Replication Options”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-rules-table-options.html)

[Section 17.2.5.3, “Interactions Between Replication Filtering Options”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-rules-examples.html)

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[Section 17.5.1.26, “Replication and Reserved Words”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-features-reserved-words.html)

[Section 17.5.1.31, “Replication and Temporary Tables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-features-temptables.html)

[Section 13.7.7.35, “SHOW REPLICA STATUS Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/show-replica-status.html)

[Section 16.6, “The BLACKHOLE Storage Engine”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/blackhole-storage-engine.html)

### --replicate-do-table:channel\_1:db\_name.tbl\_name

[Section 17.1.6.3, “Replica Server Options and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-options-replica.html)

### --replicate-ignore-\*

[Section 23.7.3, “Known Issues in NDB Cluster Replication”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-replication-issues.html)

### --replicate-ignore-db

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[Section 13.4.2.2, “CHANGE REPLICATION FILTER Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/change-replication-filter.html)

[Section 17.2.5.1, “Evaluation of Database-Level Replication and Binary Logging Options”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-rules-db-options.html)

[Section 17.2.5, “How Servers Evaluate Replication Filtering Rules”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-rules.html)

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[Section 13.7.7.35, “SHOW REPLICA STATUS Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/show-replica-status.html)

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[Section 5.4.4, “The Binary Log”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/binary-log.html)

### --replicate-ignore-db:channel\_1:db\_name

[Section 17.1.6.3, “Replica Server Options and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-options-replica.html)

### --replicate-ignore-table

[Section 13.4.2.2, “CHANGE REPLICATION FILTER Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/change-replication-filter.html)

[Section 17.2.5.2, “Evaluation of Table-Level Replication Options”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-rules-table-options.html)

[Section 23.7.3, “Known Issues in NDB Cluster Replication”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-replication-issues.html)

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[Section 17.5.1.26, “Replication and Reserved Words”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-features-reserved-words.html)

[Section 17.5.1.31, “Replication and Temporary Tables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-features-temptables.html)

[Section 13.4.2.5, “RESET REPLICA Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/reset-replica.html)

[Section 13.7.7.35, “SHOW REPLICA STATUS Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/show-replica-status.html)

[Section 16.6, “The BLACKHOLE Storage Engine”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/blackhole-storage-engine.html)

### --replicate-ignore-table:channel\_1:db\_name.tbl\_name

[Section 17.1.6.3, “Replica Server Options and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-options-replica.html)

### --replicate-rewrite-db

[Section 13.4.2.2, “CHANGE REPLICATION FILTER Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/change-replication-filter.html)

[Section 17.2.5, “How Servers Evaluate Replication Filtering Rules”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-rules.html)

[Section 17.1.6.3, “Replica Server Options and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-options-replica.html)

### --replicate-same-server-id

[Section 13.4.2.1, “CHANGE MASTER TO Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/change-master-to.html)

[Section 13.4.2.3, “CHANGE REPLICATION SOURCE TO Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/change-replication-source-to.html)

[Section 17.1.4.3, “Disabling GTID Transactions Online”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-mode-change-online-disable-gtids.html)

[Section 17.1.6.3, “Replica Server Options and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-options-replica.html)

[Section 17.1.6, “Replication and Binary Logging Options and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-options.html)

### --replicate-wild-do-table

[Section 13.4.2.2, “CHANGE REPLICATION FILTER Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/change-replication-filter.html)

[Section 17.2.5.2, “Evaluation of Table-Level Replication Options”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-rules-table-options.html)

[Section 17.2.5, “How Servers Evaluate Replication Filtering Rules”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-rules.html)

[Section 17.1.6.3, “Replica Server Options and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-options-replica.html)

[Section 17.4.6, “Replicating Different Databases to Different Replicas”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-solutions-partitioning.html)

[Section 17.5.1.31, “Replication and Temporary Tables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-features-temptables.html)

[Section 25.8, “Restrictions on Stored Programs”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/stored-program-restrictions.html)

[Section 13.7.7.35, “SHOW REPLICA STATUS Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/show-replica-status.html)

### --replicate-wild-do-table:channel\_1:db\_name.tbl\_name

[Section 17.1.6.3, “Replica Server Options and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-options-replica.html)

### --replicate-wild-ignore-table

[Section 13.4.2.2, “CHANGE REPLICATION FILTER Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/change-replication-filter.html)

[Section 17.2.5.2, “Evaluation of Table-Level Replication Options”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-rules-table-options.html)

[Section 23.7.3, “Known Issues in NDB Cluster Replication”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-replication-issues.html)

[Section A.14, “MySQL 8.0 FAQ: Replication”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/faqs-replication.html)

[Section 17.1.6.3, “Replica Server Options and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-options-replica.html)

[Section 17.5.1.31, “Replication and Temporary Tables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-features-temptables.html)

[Section 13.7.7.35, “SHOW REPLICA STATUS Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/show-replica-status.html)

### --replicate-wild-ignore:channel\_1:db\_name.tbl\_name

[Section 17.1.6.3, “Replica Server Options and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-options-replica.html)

### replication-ignore-table

[Section 17.5.1.40, “Replication and Views”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-features-views.html)

### --report-host

[Section 17.1.7.1, “Checking Replication Status”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-administration-status.html)

[Section 18.10, “Frequently Asked Questions”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/group-replication-frequently-asked-questions.html)

[Section 13.7.7.33, “SHOW REPLICAS Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/show-replicas.html)

### --report-password

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### --short-form

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### --show

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### --show-create-skip-secondary-engine

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### --show-replica-auth-info

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### --show-slave-auth-info

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### --show-table-type

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### --show-temp-status

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### --show-warnings

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### --sigint-ignore

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### --single-user

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### --skip-add-drop-table

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### --skip-add-locks

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### --skip-admin-ssl

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### --skip-auto-rehash

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### --skip-binary-as-hex

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### --skip-binlog

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### --skip-broken-objects

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### --skip-character-set-client-handshake

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### --skip-color

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### --skip-colors

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### --skip-column-names

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### --skip-comments

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### --skip-config-cache

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### --skip-config-file

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### --skip-data

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### --skip-database

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### --skip-defer-table-indexes

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### --skip-definer

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### --skip-disable-keys

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### --skip-dump-date

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### --skip-dump-rows

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### --skip-engine\_name

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### --skip-federated

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### --skip-graphs

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### --skip-gtids

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### --skip-innodb

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### --skip-innodb-adaptive-hash-index

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### --skip-kill-mysqld

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### --skip-line-numbers

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### --skip-lock-tables

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### --skip-mysql-schema

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### --skip-mysqlx

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### --skip-named-commands

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### --skip-ndb-optimized-node-selection

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### --skip-ndbcluster

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### --skip-network-timeout

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### --skip-new

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### --skip-nodegroup

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### --skip-opt

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### --skip-pager

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### --skip-partition

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### --skip-password

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### --skip-password1

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### --skip-plugin-innodb-file-per-table

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### --skip-plugin\_name

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### --skip-quick

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### --skip-quote-names

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### --skip-reconnect

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### --skip-relaylog

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### --skip-replica-start

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### --skip-routines

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[Section 4.5.6, “mysqlpump — A Database Backup Program”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqlpump.html)

### --skip-safe-updates

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### --skip-set-charset

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### --skip-show-database

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### --skip-slave-preserve-commit-order

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### --skip-slave-start

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### --skip-sort

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### --skip-ssl

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### --skip-stack-trace

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### --skip-super-large-pages

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### --skip-symbolic-links

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### --skip-sys-schema

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### --skip-syslog

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### --skip-table-check

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### --skip-triggers

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### --skip-tz-utc

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### --skip-unknown-objects

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### --skip-version-check

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### --skip-warn

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### --skip-watch-progress

[Section 4.5.6, “mysqlpump — A Database Backup Program”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqlpump.html)

### --skip-write-binlog

[Section 4.5.3, “mysqlcheck — A Table Maintenance Program”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqlcheck.html)

### --skip\_grant\_tables

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### --slave-net-timeout

[Section 17.2.2.3, “Startup Options and Replication Channels”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/channels-startup-options.html)

### --slave-parallel-workers

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### --slave-preserve-commit-order

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### --slave-skip-counter

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### --slave-skip-errors

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### --slave-sql-verify-checksum

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### --sleep

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### --sleep-time

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### --slice-id

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### slice-id

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### --slow-start-timeout

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### --slow\_query\_log

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### --slow\_query\_log\_file

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### --socket

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### --ssl-capath

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### --tls-version

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### --tmpdir

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### --to-last-log

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### --transaction-isolation

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### --transaction-read-only

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### --transactional

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### --triggers

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### --try-reconnect

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### --tupscan

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### --type

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### --tz-utc

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### U

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### --uid

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### --unbuffered

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### --unpack

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### --unqualified

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### --update

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### --update-state

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### --upgrade

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### --upgrade-system-tables

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### --uri

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### --usage

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### --use-default

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### --use-frm

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### --use-http

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### --use-https

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### --use-threads

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### --useHexFormat

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### --user

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[Section 2.11.13, “Rebuilding or Repairing Tables or Indexes”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/rebuilding-tables.html)

[Section 14.2, “Removal of File-based Metadata Storage”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/data-dictionary-file-removal.html)

[Section 13.1.36, “RENAME TABLE Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/rename-table.html)

[Section 17.5.1.1, “Replication and AUTO\_INCREMENT”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-features-auto-increment.html)

[Section 17.5.1.26, “Replication and Reserved Words”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-features-reserved-words.html)

[Section 17.5.1.9.1, “Replication with More Columns on Source or Replica”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-features-differing-tables.html#replication-features-more-columns)

[Section 24.6, “Restrictions and Limitations on Partitioning”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/partitioning-limitations.html)

[Section 25.9, “Restrictions on Views”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/view-restrictions.html)

[Section 5.4.1, “Selecting General Query Log and Slow Query Log Output Destinations”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/log-destinations.html)

[Section 5.1.7, “Server Command Options”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-options.html)

[Section 5.1.11, “Server SQL Modes”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/sql-mode.html)

[Section 5.1.8, “Server System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html)

[Section 13.1.20.11, “Setting NDB\_TABLE Options”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/create-table-ndb-table-comment-options.html)

[Section 5.4.4.2, “Setting The Binary Log Format”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/binary-log-setting.html)

[Section 16.1, “Setting the Storage Engine”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/storage-engine-setting.html)

[Section 13.7.7.15, “SHOW ENGINE Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/show-engine.html)

[Section 13.7.7.22, “SHOW INDEX Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/show-index.html)

[Section 13.7.7.39, “SHOW TABLES Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/show-tables.html)

[Section 13.7.7.42, “SHOW WARNINGS Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/show-warnings.html)

[Section 13.1.20.7, “Silent Column Specification Changes”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/silent-column-changes.html)

[Section 15.12.6, “Simplifying DDL Statements with Online DDL”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-online-ddl-single-multi.html)

[Section 15.9.1.7, “SQL Compression Syntax Warnings and Errors”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-compression-syntax-warnings.html)

[Section 13.3.3, “Statements That Cause an Implicit Commit”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/implicit-commit.html)

[Section 11.3.1, “String Data Type Syntax”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/string-type-syntax.html)

[Section 10.3.4, “Table Character Set and Collation”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/charset-table.html)

[Section 15.6.3.9, “Tablespace AUTOEXTEND\_SIZE Configuration”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-tablespace-autoextend-size.html)

[Section B.3.6.2, “TEMPORARY Table Problems”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/temporary-table-problems.html)

[Section 26.4.23, “The INFORMATION\_SCHEMA INNODB\_TABLES Table”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/information-schema-innodb-tables-table.html)

[Section 26.3.21, “The INFORMATION\_SCHEMA PARTITIONS Table”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/information-schema-partitions-table.html)

[Section 26.3.34, “The INFORMATION\_SCHEMA STATISTICS Table”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/information-schema-statistics-table.html)

[Section 16.3, “The MEMORY Storage Engine”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/memory-storage-engine.html)

[Section 16.2, “The MyISAM Storage Engine”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/myisam-storage-engine.html)

[Section 5.4.5, “The Slow Query Log”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/slow-query-log.html)

[Section 23.2.7.6, “Unsupported or Missing Features in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-limitations-unsupported.html)

[Section 3.6.9, “Using AUTO\_INCREMENT”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/example-auto-increment.html)

[Section 17.4.4, “Using Replication with Different Source and Replica Storage Engines”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-solutions-diffengines.html)

[Section 8.12.2.2, “Using Symbolic Links for MyISAM Tables on Unix”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/symbolic-links-to-tables.html)

[Section 1.3, “What Is New in MySQL 8.0”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-nutshell.html)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

[Section B.3.3.3, “What to Do If MySQL Keeps Crashing”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/crashing.html)

[Section B.3.3.5, “Where MySQL Stores Temporary Files”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/temporary-files.html)

### ALTER TABLE ... ADD COLUMN

[Section 26.4.9, “The INFORMATION\_SCHEMA INNODB\_COLUMNS Table”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/information-schema-innodb-columns-table.html)

### ALTER TABLE ... ADD COLUMN ... ALGORITHM=INSTANT

[Section 24.6, “Restrictions and Limitations on Partitioning”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/partitioning-limitations.html)

### ALTER TABLE ... ADD FOREIGN KEY

[Section 13.1.9, “ALTER TABLE Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-table.html)

### ALTER TABLE ... ADD PARTITION

[Section 24.3.1, “Management of RANGE and LIST Partitions”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/partitioning-management-range-list.html)

### ALTER TABLE ... ALGORITHM=COPY

[Section 13.1.9, “ALTER TABLE Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-table.html)

[Section 13.1.20.5, “FOREIGN KEY Constraints”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/create-table-foreign-keys.html)

### ALTER TABLE ... ALGORITHM=INPLACE

[Section 13.1.9, “ALTER TABLE Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-table.html)

[Section 13.1.20.5, “FOREIGN KEY Constraints”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/create-table-foreign-keys.html)

[Section 15.12.8, “Online DDL Limitations”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-online-ddl-limitations.html)

### ALTER TABLE ... ALGORITHM=INPLACE, REORGANIZE PARTITION

[Section 23.6.7.2, “Adding NDB Cluster Data Nodes Online: Basic procedure”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-online-add-node-basics.html)

[Section 23.6.7.3, “Adding NDB Cluster Data Nodes Online: Detailed Example”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-online-add-node-example.html)

### ALTER TABLE ... AUTO\_INCREMENT = N

[Section 15.6.1.6, “AUTO\_INCREMENT Handling in InnoDB”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-auto-increment-handling.html)

### ALTER TABLE ... COMPRESSION

[Section 15.9.2, “InnoDB Page Compression”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-page-compression.html)

### ALTER TABLE ... COMPRESSION=None

[Section 15.9.2, “InnoDB Page Compression”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-page-compression.html)

### ALTER TABLE ... CONVERT TO CHARACTER SET

[Section 13.7.3.1, “ANALYZE TABLE Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/analyze-table.html)

### ALTER TABLE ... DISABLE KEYS

[Section 13.2.7, “LOAD DATA Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/load-data.html)

### ALTER TABLE ... DISCARD PARTITION ... TABLESPACE

[Section 15.6.1.3, “Importing InnoDB Tables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-table-import.html)

### ALTER TABLE ... DISCARD TABLESPACE

[Section 13.1.21, “CREATE TABLESPACE Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/create-tablespace.html)

[Section 15.6.3.3, “General Tablespaces”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/general-tablespaces.html)

[Section 15.6.1.3, “Importing InnoDB Tables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-table-import.html)

[MySQL Glossary](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html)

[Section 26.4.24, “The INFORMATION\_SCHEMA INNODB\_TABLESPACES Table”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/information-schema-innodb-tablespaces-table.html)

### ALTER TABLE ... DROP FOREIGN KEY

[Section 13.1.9, “ALTER TABLE Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-table.html)

### ALTER TABLE ... DROP PARTITION

[Section 17.5.1.24, “Replication and Partitioning”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-features-partitioning.html)

### ALTER TABLE ... ENABLE KEYS

[Section 13.2.7, “LOAD DATA Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/load-data.html)

### ALTER TABLE ... ENCRYPTION

[Section 13.1.5, “ALTER INSTANCE Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-instance.html)

### ALTER TABLE ... ENGINE

[Section 5.1.8, “Server System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html)

### ALTER TABLE ... ENGINE = MEMORY

[Section 17.5.1.21, “Replication and MEMORY Tables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-features-memory.html)

### ALTER TABLE ... ENGINE permitted\_engine

[Section 5.1.8, “Server System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html)

### ALTER TABLE ... ENGINE=INNODB

[Section 23.7.4, “NDB Cluster Replication Schema and Tables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-replication-schema.html)

[Section 1.3, “What Is New in MySQL 8.0”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-nutshell.html)

### ALTER TABLE ... ENGINE=NDB

[Section 23.5.13, “ndb\_import — Import CSV Data Into NDB”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-programs-ndb-import.html)

### ALTER TABLE ... EXCHANGE PARTITION

[Section 13.1.9, “ALTER TABLE Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-table.html)

[Section 24.3.3, “Exchanging Partitions and Subpartitions with Tables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/partitioning-management-exchange.html)

### ALTER TABLE ... FORCE

[Section 13.7.3.4, “OPTIMIZE TABLE Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/optimize-table.html)

### ALTER TABLE ... IMPORT PARTITION ... TABLESPACE

[Section 15.6.1.3, “Importing InnoDB Tables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-table-import.html)

### ALTER TABLE ... IMPORT TABLESPACE

[Section 15.6.1.3, “Importing InnoDB Tables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-table-import.html)

[Section 15.6.1.4, “Moving or Copying InnoDB Tables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-migration.html)

[MySQL Glossary](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html)

### ALTER TABLE ... OPTIMIZE PARTITION

[Section 24.3.4, “Maintenance of Partitions”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/partitioning-maintenance.html)

[Section 24.6.2, “Partitioning Limitations Relating to Storage Engines”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/partitioning-limitations-storage-engines.html)

### ALTER TABLE ... PARTITION BY

[Section 24.6.1, “Partitioning Keys, Primary Keys, and Unique Keys”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/partitioning-limitations-partitioning-keys-unique-keys.html)

### ALTER TABLE ... PARTITION BY ...

[Section 24.3.1, “Management of RANGE and LIST Partitions”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/partitioning-management-range-list.html)

[Section 24.6, “Restrictions and Limitations on Partitioning”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/partitioning-limitations.html)

### ALTER TABLE ... REMOVE PARTITIONING

[Section 1.3, “What Is New in MySQL 8.0”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-nutshell.html)

### ALTER TABLE ... RENAME

[Section 8.12.2.2, “Using Symbolic Links for MyISAM Tables on Unix”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/symbolic-links-to-tables.html)

### ALTER TABLE ... REORGANIZE PARTITION

[Section 23.6.7.3, “Adding NDB Cluster Data Nodes Online: Detailed Example”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-online-add-node-example.html)

[Section 23.6.7.1, “Adding NDB Cluster Data Nodes Online: General Issues”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-online-add-node-remarks.html)

[Section 23.6.1, “Commands in the NDB Cluster Management Client”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-mgm-client-commands.html)

[Section 2.11.5, “Preparing Your Installation for Upgrade”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/upgrade-prerequisites.html)

### ALTER TABLE ... REPAIR PARTITION

[Section 24.3.3, “Exchanging Partitions and Subpartitions with Tables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/partitioning-management-exchange.html)

[Section 24.3.4, “Maintenance of Partitions”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/partitioning-maintenance.html)

### ALTER TABLE ... TABLESPACE

[Section 13.1.21, “CREATE TABLESPACE Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/create-tablespace.html)

### ALTER TABLE ... TRUNCATE PARTITION

[Section 24.3.4, “Maintenance of Partitions”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/partitioning-maintenance.html)

[Section 24.3, “Partition Management”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/partitioning-management.html)

### ALTER TABLE ... TRUNCATE PARTITION ALL

[Section 24.3.4, “Maintenance of Partitions”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/partitioning-maintenance.html)

### ALTER TABLE ...IMPORT TABLESPACE

[Section 13.1.21, “CREATE TABLESPACE Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/create-tablespace.html)

[Section 15.6.3.3, “General Tablespaces”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/general-tablespaces.html)

### ALTER TABLE EXCHANGE PARTITION

[Section 24.3.3, “Exchanging Partitions and Subpartitions with Tables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/partitioning-management-exchange.html)

### ALTER TABLE mysql.ndb\_apply\_status ENGINE=MyISAM

[Section 23.7.3, “Known Issues in NDB Cluster Replication”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-replication-issues.html)

### ALTER TABLE ndb\_table ... ALGORITHM=INPLACE, TABLESPACE=new\_tablespace

[Section 23.6.11, “Online Operations with ALTER TABLE in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-online-operations.html)

### ALTER TABLE t TRUNCATE PARTITION ()

[Section 13.2.2, “DELETE Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/delete.html)

### ALTER TABLE table ENGINE = NDB

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### ALTER TABLE table\_name ENGINE=InnoDB;

[Section 15.1.4, “Testing and Benchmarking with InnoDB”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-benchmarking.html)

### ALTER TABLE table\_name REORGANIZE PARTITION

[Section 23.6.7.3, “Adding NDB Cluster Data Nodes Online: Detailed Example”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-online-add-node-example.html)

### ALTER TABLE tbl\_name ENCRYPTION = 'Y'

[Section A.17, “MySQL 8.0 FAQ: InnoDB Data-at-Rest Encryption”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/faqs-tablespace-encryption.html)

### ALTER TABLE tbl\_name ENGINE=engine\_name

[Section 15.8.2, “Configuring InnoDB for Read-Only Operation”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-read-only-instance.html)

[Section 14.7, “Data Dictionary Usage Differences”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/data-dictionary-usage-differences.html)

[Section 15.14, “InnoDB Startup Options and System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html)

### ALTER TABLE tbl\_name ENGINE=INNODB

[Section 13.1.9, “ALTER TABLE Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-table.html)

[Section 15.11.4, “Defragmenting a Table”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-file-defragmenting.html)

### ALTER TABLE tbl\_name FORCE

[Section 13.1.9, “ALTER TABLE Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-table.html)

[Section 15.11.4, “Defragmenting a Table”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-file-defragmenting.html)

### ALTER TABLE tbl\_name TABLESPACE tablespace\_name

[Section 13.1.21, “CREATE TABLESPACE Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/create-tablespace.html)

[Section 15.6.3.3, “General Tablespaces”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/general-tablespaces.html)

[MySQL Glossary](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html)

### ALTER TABLESPACE

[Section 13.1.10, “ALTER TABLESPACE Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-tablespace.html)

[Section 13.1.21, “CREATE TABLESPACE Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/create-tablespace.html)

[Section 23.4.3.6, “Defining NDB Cluster Data Nodes”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndbd-definition.html)

[Section 13.1.33, “DROP TABLESPACE Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/drop-tablespace.html)

[Section 15.6.3.3, “General Tablespaces”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/general-tablespaces.html)

[Section 15.13, “InnoDB Data-at-Rest Encryption”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-data-encryption.html)

[Section 23.2.7.8, “Issues Exclusive to NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-limitations-exclusive-to-cluster.html)

[Section 23.6.10.1, “NDB Cluster Disk Data Objects”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-disk-data-objects.html)

[Section 13.3.3, “Statements That Cause an Implicit Commit”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/implicit-commit.html)

[Section 15.6.3.9, “Tablespace AUTOEXTEND\_SIZE Configuration”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-tablespace-autoextend-size.html)

[Section 26.3.15, “The INFORMATION\_SCHEMA FILES Table”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/information-schema-files-table.html)

[Section 1.3, “What Is New in MySQL 8.0”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-nutshell.html)

### ALTER TABLESPACE ... ADD DATAFILE

[Section 13.1.21, “CREATE TABLESPACE Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/create-tablespace.html)

### ALTER TABLESPACE ... DROP DATAFILE

[Section 13.1.33, “DROP TABLESPACE Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/drop-tablespace.html)

### ALTER TABLESPACE ... DROP DATATFILE

[Section 13.1.21, “CREATE TABLESPACE Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/create-tablespace.html)

### ALTER TABLESPACE ... ENCRYPTION

[Section 15.12.1, “Online DDL Operations”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-online-ddl-operations.html)

### ALTER TABLESPACE ... ENGINE

[Section 5.1.8, “Server System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html)

### ALTER TABLESPACE ... RENAME TO

[Section 15.6.3.3, “General Tablespaces”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/general-tablespaces.html)

[Section 15.12.1, “Online DDL Operations”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-online-ddl-operations.html)

[Section 1.3, “What Is New in MySQL 8.0”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-nutshell.html)

### ALTER TABLESPACE tablespace\_name ENCRYPTION = 'Y'

[Section A.17, “MySQL 8.0 FAQ: InnoDB Data-at-Rest Encryption”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/faqs-tablespace-encryption.html)

### ALTER UNDO TABLESPACE

[Section 2.11.4, “Changes in MySQL 8.0”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/upgrading-from-previous-series.html)

[Section 15.6.3.4, “Undo Tablespaces”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-undo-tablespaces.html)

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### ALTER UNDO TABLESPACE ... SET INACTIVE

[Section 26.4.24, “The INFORMATION\_SCHEMA INNODB\_TABLESPACES Table”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/information-schema-innodb-tablespaces-table.html)

### ALTER UNDO TABLESPACE tablespace\_name SET ACTIVE

[Section 15.6.3.4, “Undo Tablespaces”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-undo-tablespaces.html)

### ALTER UNDO TABLESPACE tablespace\_name SET INACTIVE

[Section 15.6.3.4, “Undo Tablespaces”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-undo-tablespaces.html)

### ALTER USER

[Section 6.2.6, “Access Control, Stage 1: Connection Verification”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/connection-access.html)

[Section 6.2.20, “Account Locking”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/account-locking.html)

[Section 13.7.1.1, “ALTER USER Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-user.html)

[Section 6.2.14, “Assigning Account Passwords”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/assigning-passwords.html)

[Section 2.11.4, “Changes in MySQL 8.0”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/upgrading-from-previous-series.html)

[Section 4.2.3, “Command Options for Connecting to the Server”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/connection-options.html)

[Section 6.3.1, “Configuring MySQL to Use Encrypted Connections”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/using-encrypted-connections.html)

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[Section 13.7.1.3, “CREATE USER Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/create-user.html)

[Section 6.1.2.1, “End-User Guidelines for Password Security”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/password-security-user.html)

[Section 6.4.1.11, “FIDO Pluggable Authentication”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/fido-pluggable-authentication.html)

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[Section 2.10.1, “Initializing the Data Directory”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/data-directory-initialization.html)

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[Section 4.4.5, “mysql\_upgrade — Check and Upgrade MySQL Tables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-upgrade.html)

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[Section 5.1.8, “Server System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html)

[Section 13.7.1.9, “SET DEFAULT ROLE Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/set-default-role.html)

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### ALTER USER ... MODIFY

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### ALTER USER ... UNLOCK

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### ALTER USER user DROP factor

[Section 6.2.18, “Multifactor Authentication”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/multifactor-authentication.html)

### ALTER USER user MODIFY factor

[Section 6.2.18, “Multifactor Authentication”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/multifactor-authentication.html)

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### DEFAULT ENCRYPTION='N'

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### DEFAULT ENCRYPTION='Y'

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### SELECT \*

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[Section 11.3.4, “The BLOB and TEXT Types”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/blob.html)

### SELECT \* FROM

[Section 23.6.14.38, “The ndbinfo memory\_per\_fragment Table”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndbinfo-memory-per-fragment.html)

### SELECT \* FROM t AS a LEFT JOIN t AS b ON a.x=0 AND b.y>5

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### SELECT \* FROM t PARTITION ()

[Section 24.1, “Overview of Partitioning in MySQL”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/partitioning-overview.html)

### SELECT \* INTO OUTFILE 'file\_name' FROM tbl\_name

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### SELECT ... FOR SHARE

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[Section 6.2.3, “Grant Tables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/grant-tables.html)

[Section 15.7.5.3, “How to Minimize and Handle Deadlocks”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-deadlocks-handling.html)

[Section 15.7.1, “InnoDB Locking”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-locking.html)

[Section 15.7.2.4, “Locking Reads”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-locking-reads.html)

[Section 15.7.3, “Locks Set by Different SQL Statements in InnoDB”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-locks-set.html)

[Section 15.7.2.1, “Transaction Isolation Levels”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-transaction-isolation-levels.html)

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### SELECT ... FOR UPDATE

[Section 17.2.1.1, “Advantages and Disadvantages of Statement-Based and Row-Based Replication”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-sbr-rbr.html)

[Section 15.1.2, “Best Practices for InnoDB Tables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-best-practices.html)

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[Section 15.7.3, “Locks Set by Different SQL Statements in InnoDB”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-locks-set.html)

### SELECT ... FROM

[Section 15.7.3, “Locks Set by Different SQL Statements in InnoDB”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-locks-set.html)

### SELECT ... INTO

[Section 13.1.13, “CREATE EVENT Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/create-event.html)

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[Section 13.2.10, “SELECT Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/select.html)

### SELECT ... INTO DUMPFILE

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[Section 5.1.8, “Server System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html)

### SELECT ... INTO OUTFILE

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[Section 5.1.8, “Server System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html)

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[Section 2.3.7, “Windows Platform Restrictions”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/windows-restrictions.html)

### SELECT ... INTO OUTFILE 'file\_name'

[Section 13.2.10.1, “SELECT ... INTO Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/select-into.html)

### SELECT ... INTO var\_list

[Section 25.8, “Restrictions on Stored Programs”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/stored-program-restrictions.html)

[Section 13.6.4, “Variables in Stored Programs”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/stored-program-variables.html)

### SELECT ... LOCK IN SHARE MODE

[Section 23.2.7.3, “Limits Relating to Transaction Handling in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-limitations-transactions.html)

### SELECT DISTINCT

[Section 15.8.10.1.3, “Configuring the Number of Sampled Pages for InnoDB Optimizer Statistics”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-persistent-stats.html#innodb-persistent-stats-pages-sampled)

[Section 8.14.3, “General Thread States”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/general-thread-states.html)

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### SELECT FROM table

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### SELECT INTO ... OUTFILE

[Section 23.5.13, “ndb\_import — Import CSV Data Into NDB”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-programs-ndb-import.html)

### SELECT INTO DUMPFILE

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### SELECT INTO OUTFILE

[Section 23.5.13, “ndb\_import — Import CSV Data Into NDB”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-programs-ndb-import.html)

[Section 5.1.8, “Server System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html)

### SELECT SLEEP()

[Section 5.1.11, “Server SQL Modes”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/sql-mode.html)

### SET

[Section 12.4.4, “Assignment Operators”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/assignment-operators.html)

[Section 6.4.5.10, “Audit Log Reference”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/audit-log-reference.html)

[Section 17.1.6.4, “Binary Logging Options and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-options-binary-log.html)

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[Section 15.8.10.2, “Configuring Non-Persistent Optimizer Statistics Parameters”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-statistics-estimation.html)

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[Section 13.7.7.41, “SHOW VARIABLES Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/show-variables.html)

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[Section 13.6.7.7, “The MySQL Diagnostics Area”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/diagnostics-area.html)

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[Section 6.4.4.10, “Using the HashiCorp Vault Keyring Plugin”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/keyring-hashicorp-plugin.html)

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[Section 1.3, “What Is New in MySQL 8.0”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-nutshell.html)

### SET @@GLOBAL.gtid\_purged

[Section 4.5.6, “mysqlpump — A Database Backup Program”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqlpump.html)

### SET @@GLOBAL.ndb\_slave\_conflict\_role = 'NONE'

[Section 23.4.3.9.2, “NDB Cluster System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-system-variables)

### SET @x=2, @y=4, @z=8

[Section 13.2.10.1, “SELECT ... INTO Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/select-into.html)

### SET autocommit

[Section 8.5.5, “Bulk Data Loading for InnoDB Tables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/optimizing-innodb-bulk-data-loading.html)

[Section 13.3, “Transactional and Locking Statements”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/sql-transactional-statements.html)

### SET autocommit = 0

[Section 17.4.10, “Semisynchronous Replication”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-semisync.html)

### SET CHARACTER SET

[Section 10.4, “Connection Character Sets and Collations”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/charset-connection.html)

[Section 13.7.6.2, “SET CHARACTER SET Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/set-character-set.html)

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[Section 10.9, “Unicode Support”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/charset-unicode.html)

### SET CHARACTER SET 'charset\_name'

[Section 10.4, “Connection Character Sets and Collations”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/charset-connection.html)

### SET CHARACTER SET charset\_name

[Section 10.4, “Connection Character Sets and Collations”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/charset-connection.html)

### SET DEFAULT ROLE

[Section 13.7.1.1, “ALTER USER Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-user.html)

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[Section 6.2.10, “Using Roles”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/roles.html)

### SET GLOBAL

[Section 15.5.2, “Change Buffer”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-change-buffer.html)

[Section 15.8.3.4, “Configuring InnoDB Buffer Pool Prefetching (Read-Ahead)”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-performance-read_ahead.html)

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[Section 15.6.3.2, “File-Per-Table Tablespaces”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-file-per-table-tablespaces.html)

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[Section 15.8.3.3, “Making the Buffer Pool Scan Resistant”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-performance-midpoint_insertion.html)

[Section 6.2.18, “Multifactor Authentication”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/multifactor-authentication.html)

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### SET NAMES

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[Section 5.1.8, “Server System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html)

[Section 13.7.6.3, “SET NAMES Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/set-names.html)

[Section 13.7.6, “SET Statements”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/set-statement.html)

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[Section 12.3, “Type Conversion in Expression Evaluation”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/type-conversion.html)

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[Section 1.3, “What Is New in MySQL 8.0”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-nutshell.html)

### SET NAMES 'charset\_name'

[Section 10.4, “Connection Character Sets and Collations”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/charset-connection.html)

### SET NAMES 'cp1251'

[Section 10.4, “Connection Character Sets and Collations”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/charset-connection.html)

### SET NAMES charset\_name

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### SET NAMES default\_character\_set

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### SET PASSWORD

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[Section B.3.3.2.3, “Resetting the Root Password: Generic Instructions”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/resetting-permissions.html#resetting-permissions-generic)

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[Section 6.2.13, “When Privilege Changes Take Effect”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/privilege-changes.html)

### SET PASSWORD ... = PASSWORD()

[Section 1.3, “What Is New in MySQL 8.0”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-nutshell.html)

### SET PERSIST

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[Section 4.2.8, “Connection Compression Control”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/connection-compression-control.html)

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[Section 4.2.2.2, “Using Option Files”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/option-files.html)

[Section 6.2.10, “Using Roles”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/roles.html)

### SET PERSIST\_ONLY

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### SET RESOURCE GROUP

[Section 8.9.3, “Optimizer Hints”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/optimizer-hints.html)

[Section 6.2.2, “Privileges Provided by MySQL”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/privileges-provided.html)

[Section 5.1.16, “Resource Groups”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/resource-groups.html)

[Section 13.7.2.4, “SET RESOURCE GROUP Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/set-resource-group.html)

### SET ROLE

[Section 12.16, “Information Functions”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/information-functions.html)

[Section 5.1.8, “Server System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html)

[Section 13.7.1.11, “SET ROLE Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/set-role.html)

[Section 13.7.6, “SET Statements”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/set-statement.html)

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[Section 6.2.10, “Using Roles”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/roles.html)

[Section 6.2.13, “When Privilege Changes Take Effect”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/privilege-changes.html)

### SET ROLE DEFAULT

[Section 13.7.1.1, “ALTER USER Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-user.html)

[Section 13.7.1.3, “CREATE USER Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/create-user.html)

[Section 13.7.1.9, “SET DEFAULT ROLE Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/set-default-role.html)

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### SET SESSION

[Section 5.1.9.1, “System Variable Privileges”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/system-variable-privileges.html)

### SET SESSION TRANSACTION ISOLATION LEVEL

[Section 5.1.8, “Server System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html)

### SET SESSION TRANSACTION {READ WRITE | READ ONLY}

[Section 5.1.8, “Server System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html)

### SET sql\_log\_bin = 0

[Section 4.6.9, “mysqlbinlog — Utility for Processing Binary Log Files”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqlbinlog.html)

### SET sql\_log\_bin=OFF

[Section 5.4.4, “The Binary Log”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/binary-log.html)

### SET sql\_mode='modes'

[Section A.3, “MySQL 8.0 FAQ: Server SQL Mode”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/faqs-sql-modes.html)

### SET TIMESTAMP = value

[Section 8.14.1, “Accessing the Process List”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/processlist-access.html)

### SET TRANSACTION

[Section 15.2, “InnoDB and the ACID Model”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-acid.html)

[Section 5.1.7, “Server Command Options”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-options.html)

[Section 5.1.8, “Server System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html)

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[Section 15.7.2.1, “Transaction Isolation Levels”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-transaction-isolation-levels.html)

### SET TRANSACTION ISOLATION LEVEL

[Section 5.1.8, “Server System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html)

[Section 13.7.6, “SET Statements”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/set-statement.html)

[Section 13.3.1, “START TRANSACTION, COMMIT, and ROLLBACK Statements”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/commit.html)

### SET TRANSACTION ISOLATION LEVEL READ UNCOMMITTED

[Section 15.20.7, “The InnoDB memcached Plugin and Replication”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-memcached-replication.html)

### SET TRANSACTION {READ WRITE | READ ONLY}

[Section 5.1.8, “Server System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html)

### SET var\_name = value

[Section 13.7.6, “SET Statements”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/set-statement.html)

### SHOW

[Section 17.1.2.8, “Adding Replicas to a Replication Environment”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-howto-additionalslaves.html)

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[Section 25.8, “Restrictions on Stored Programs”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/stored-program-restrictions.html)

[Section 17.1.2.6.2, “Setting Up Replication with Existing Data”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-setup-replicas.html#replication-howto-existingdata)

[Section 13.7.7.5, “SHOW COLUMNS Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/show-columns.html)

[Section 13.7.7, “SHOW Statements”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/show.html)

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[Section 13.4.1, “SQL Statements for Controlling Source Servers”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-statements-master.html)

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[Section 10.2.2, “UTF-8 for Metadata”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/charset-metadata.html)

### SHOW BINARY LOGS

[Section 17.3.2, “Encrypting Binary Log Files and Relay Log Files”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-binlog-encryption.html)

[Section 4.6.9, “mysqlbinlog — Utility for Processing Binary Log Files”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqlbinlog.html)

[Section 6.2.2, “Privileges Provided by MySQL”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/privileges-provided.html)

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[Section 13.7.7.1, “SHOW BINARY LOGS Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/show-binary-logs.html)

[Section 13.4.1, “SQL Statements for Controlling Source Servers”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-statements-master.html)

[Section 4.6.9.3, “Using mysqlbinlog to Back Up Binary Log Files”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqlbinlog-backup.html)

### SHOW BINLOG EVENTS

[Section 5.4.4.5.1, “Behaviors When Binary Log Transaction Compression is Enabled”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/binary-log-transaction-compression.html#binary-log-transaction-compression-enabled)

[Section 5.4.4.5, “Binary Log Transaction Compression”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/binary-log-transaction-compression.html)

[Section 23.7.4, “NDB Cluster Replication Schema and Tables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-replication-schema.html)

[Section 6.2.2, “Privileges Provided by MySQL”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/privileges-provided.html)

[Section 13.6.6.5, “Restrictions on Server-Side Cursors”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/cursor-restrictions.html)

[Section 13.7.7.2, “SHOW BINLOG EVENTS Statement”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/show-binlog-events.html)

[Section 17.1.7.3, “Skipping Transactions”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-administration-skip.html)

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### Innodb\_row\_lock\_time

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### Innodb\_undo\_tablespaces\_explicit

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### Mysqlx\_address

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### Mysqlx\_bytes\_received\_compressed\_payload

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### Mysqlx\_bytes\_received\_uncompressed\_frame

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### Mysqlx\_bytes\_sent\_compressed\_payload

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### Mysqlx\_bytes\_sent\_uncompressed\_frame

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### Mysqlx\_compression\_level

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### Mysqlx\_connection\_errors

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### Mysqlx\_connections\_closed

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### Mysqlx\_connections\_rejected

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### Mysqlx\_crud\_create\_view

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### Mysqlx\_crud\_delete

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### Mysqlx\_crud\_drop\_view

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### Mysqlx\_crud\_find

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### Mysqlx\_crud\_insert

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### Mysqlx\_crud\_modify\_view

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### Mysqlx\_cursor\_close

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### Mysqlx\_cursor\_fetch

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### Mysqlx\_cursor\_open

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### Mysqlx\_expect\_open

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### Mysqlx\_init\_error

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### Mysqlx\_messages\_sent

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### Mysqlx\_notice\_global\_sent

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### Mysqlx\_notice\_other\_sent

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### Mysqlx\_notice\_warning\_sent

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### Mysqlx\_notified\_by\_group\_replication

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### Mysqlx\_port

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### Mysqlx\_prep\_deallocate

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### Mysqlx\_prep\_execute

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### Mysqlx\_sessions\_accepted

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### Mysqlx\_sessions\_closed

[Section 20.5.6.3, “X Plugin Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/x-plugin-status-variables.html)

### Mysqlx\_sessions\_fatal\_error

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### Mysqlx\_sessions\_killed

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### Mysqlx\_sessions\_rejected

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### Mysqlx\_socket

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### Mysqlx\_ssl\_accept\_renegotiates

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### Mysqlx\_ssl\_active

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### Mysqlx\_ssl\_cipher

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### Mysqlx\_ssl\_cipher\_list

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### Mysqlx\_ssl\_ctx\_verify\_mode

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### Mysqlx\_ssl\_finished\_accepts

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### Mysqlx\_ssl\_server\_not\_after

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### Mysqlx\_ssl\_verify\_depth

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### Mysqlx\_ssl\_version

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### Mysqlx\_stmt\_create\_collection\_index

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[Section 20.5.6.3, “X Plugin Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/x-plugin-status-variables.html)

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### Mysqlx\_stmt\_drop\_collection\_index

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### Mysqlx\_stmt\_enable\_notices

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### Mysqlx\_stmt\_ensure\_collection

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### Mysqlx\_stmt\_execute\_mysqlx

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### Mysqlx\_stmt\_execute\_sql

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### Mysqlx\_stmt\_get\_collection\_options

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### Mysqlx\_stmt\_kill\_client

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### Mysqlx\_stmt\_list\_clients

[Section 20.5.6.3, “X Plugin Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/x-plugin-status-variables.html)

### Mysqlx\_stmt\_list\_notices

[Section 20.5.6.3, “X Plugin Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/x-plugin-status-variables.html)

### Mysqlx\_stmt\_list\_objects

[Section 20.5.6.3, “X Plugin Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/x-plugin-status-variables.html)

### Mysqlx\_stmt\_modify\_collection\_options

[Section 20.5.6.3, “X Plugin Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/x-plugin-status-variables.html)

### Mysqlx\_stmt\_ping

[Section 20.5.6.3, “X Plugin Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/x-plugin-status-variables.html)

### Mysqlx\_worker\_threads

[Section 20.5.6.3, “X Plugin Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/x-plugin-status-variables.html)

### Mysqlx\_worker\_threads\_active

[Section 20.5.6.3, “X Plugin Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/x-plugin-status-variables.html)

### N

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### Ndb\_api\_adaptive\_send\_deferred\_count

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_adaptive\_send\_deferred\_count\_replica

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_adaptive\_send\_deferred\_count\_session

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_adaptive\_send\_deferred\_count\_slave

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_adaptive\_send\_forced\_count

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_adaptive\_send\_forced\_count\_replica

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_adaptive\_send\_forced\_count\_session

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_adaptive\_send\_forced\_count\_slave

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_adaptive\_send\_unforced\_count

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_adaptive\_send\_unforced\_count\_replica

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_adaptive\_send\_unforced\_count\_session

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_adaptive\_send\_unforced\_count\_slave

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_bytes\_received\_count

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_bytes\_received\_count\_replica

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_bytes\_received\_count\_session

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_bytes\_received\_count\_slave

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_bytes\_sent\_count

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_bytes\_sent\_count\_replica

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_bytes\_sent\_count\_session

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_bytes\_sent\_count\_slave

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_event\_bytes\_count

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_event\_bytes\_count\_injector

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_event\_data\_count

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_event\_data\_count\_injector

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_event\_nondata\_count

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_event\_nondata\_count\_injector

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_pk\_op\_count

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_pk\_op\_count\_replica

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_pk\_op\_count\_session

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_pk\_op\_count\_slave

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_pruned\_scan\_count

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_pruned\_scan\_count\_replica

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_pruned\_scan\_count\_session

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_pruned\_scan\_count\_slave

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_range\_scan\_count

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_range\_scan\_count\_replica

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_range\_scan\_count\_session

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_range\_scan\_count\_slave

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

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### Ndb\_api\_read\_row\_count

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_read\_row\_count\_replica

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_read\_row\_count\_session

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_read\_row\_count\_slave

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_scan\_batch\_count

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_scan\_batch\_count\_replica

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_scan\_batch\_count\_session

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_scan\_batch\_count\_slave

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

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[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_table\_scan\_count

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_table\_scan\_count\_replica

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_table\_scan\_count\_session

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

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### Ndb\_api\_table\_scan\_count\_slave

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

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[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_trans\_abort\_count

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_trans\_abort\_count\_replica

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_trans\_abort\_count\_session

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_trans\_abort\_count\_slave

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_trans\_close\_count

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_trans\_close\_count\_replica

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_trans\_close\_count\_session

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_trans\_close\_count\_slave

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_trans\_commit\_count

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_trans\_commit\_count\_replica

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_trans\_commit\_count\_session

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_trans\_commit\_count\_slave

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_trans\_local\_read\_row\_count

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_trans\_local\_read\_row\_count\_replica

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_trans\_local\_read\_row\_count\_session

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_trans\_local\_read\_row\_count\_slave

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_trans\_start\_count

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_trans\_start\_count\_replica

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_trans\_start\_count\_session

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_trans\_start\_count\_slave

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_uk\_op\_count

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_uk\_op\_count\_replica

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_uk\_op\_count\_session

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_uk\_op\_count\_slave

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_wait\_exec\_complete\_count

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_wait\_exec\_complete\_count\_replica

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_wait\_exec\_complete\_count\_session

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_wait\_exec\_complete\_count\_slave

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_wait\_meta\_request\_count

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_wait\_meta\_request\_count\_replica

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_wait\_meta\_request\_count\_session

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_wait\_meta\_request\_count\_slave

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_wait\_nanos\_count

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_wait\_nanos\_count\_replica

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_wait\_nanos\_count\_session

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_wait\_nanos\_count\_slave

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_wait\_scan\_result\_count

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_wait\_scan\_result\_count\_replica

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_api\_wait\_scan\_result\_count\_session

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_api\_wait\_scan\_result\_count\_slave

[Section 23.6.13, “NDB API Statistics Counters and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-ndb-api-statistics.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

[Section 23.2.4, “What is New in NDB Cluster”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-what-is-new.html)

### Ndb\_cluster\_node\_id

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_config\_from\_host

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_config\_from\_port

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_config\_generation

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_conflict\_fn\_epoch

[Section 23.7.11, “NDB Cluster Replication Conflict Resolution”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-replication-conflict-resolution.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_conflict\_fn\_epoch2

[Section 23.7.11, “NDB Cluster Replication Conflict Resolution”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-replication-conflict-resolution.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_conflict\_fn\_epoch2\_trans

[Section 23.7.11, “NDB Cluster Replication Conflict Resolution”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-replication-conflict-resolution.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_conflict\_fn\_epoch\_trans

[Section 23.7.11, “NDB Cluster Replication Conflict Resolution”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-replication-conflict-resolution.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_conflict\_fn\_max

[Section 23.7.11, “NDB Cluster Replication Conflict Resolution”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-replication-conflict-resolution.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_conflict\_fn\_max\_del\_win

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_conflict\_fn\_old

[Section 23.7.11, “NDB Cluster Replication Conflict Resolution”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-replication-conflict-resolution.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_conflict\_last\_conflict\_epoch

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_conflict\_last\_stable\_epoch

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_conflict\_reflected\_op\_discard\_count

[Section 23.7.11, “NDB Cluster Replication Conflict Resolution”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-replication-conflict-resolution.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_conflict\_reflected\_op\_prepare\_count

[Section 23.7.11, “NDB Cluster Replication Conflict Resolution”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-replication-conflict-resolution.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_conflict\_refresh\_op\_count

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_conflict\_trans\_conflict\_commit\_count

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_conflict\_trans\_detect\_iter\_count

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_conflict\_trans\_reject\_count

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_conflict\_trans\_row\_conflict\_count

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_conflict\_trans\_row\_reject\_count

[Section 23.7.11, “NDB Cluster Replication Conflict Resolution”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-replication-conflict-resolution.html)

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_epoch\_delete\_delete\_count

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_execute\_count

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

### Ndb\_last\_commit\_epoch\_server

[Section 23.4.3.9.3, “NDB Cluster Status Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-options-variables.html#mysql-cluster-status-variables)

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### Ndb\_number\_of\_data\_nodes

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### Performance\_schema\_cond\_classes\_lost

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### admin\_port

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### admin\_ssl\_ca

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### admin\_ssl\_capath

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### admin\_ssl\_cert

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### admin\_ssl\_cipher

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### admin\_ssl\_crl

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### admin\_ssl\_crlpath

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### admin\_ssl\_key

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### admin\_tls\_ciphersuites

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### admin\_tls\_version

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[Section 5.1.8, “Server System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html)

### audit\_log\_buffer\_size

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### audit\_log\_compression

[Section 6.4.5.10, “Audit Log Reference”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/audit-log-reference.html)

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### audit\_log\_connection\_policy

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[Section 6.4.5.8, “Writing Audit Log Filter Definitions”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/audit-log-filter-definitions.html)

### audit\_log\_current\_session

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### audit\_log\_encryption

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### audit\_log\_exclude\_accounts

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### audit\_log\_file

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[Section 6.4.5.6, “Reading Audit Log Files”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/audit-log-file-reading.html)

### audit\_log\_filter\_id

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### audit\_log\_flush

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### audit\_log\_format

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[Section 6.4.6, “The Audit Message Component”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/audit-api-message-emit.html)

### audit\_log\_format\_unix\_timestamp

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### audit\_log\_include\_accounts

[Section 6.4.5.10, “Audit Log Reference”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/audit-log-reference.html)

[Section 6.4.5.9, “Legacy Mode Audit Log Filtering”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/audit-log-legacy-filtering.html)

[Section 6.4.5.8, “Writing Audit Log Filter Definitions”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/audit-log-filter-definitions.html)

### audit\_log\_max\_size

[Section 6.4.5.10, “Audit Log Reference”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/audit-log-reference.html)

[Section 6.4.5.5, “Configuring Audit Logging Characteristics”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/audit-log-logging-configuration.html)

### audit\_log\_password\_history\_keep\_days

[Section 6.4.5.10, “Audit Log Reference”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/audit-log-reference.html)

[Section 6.4.5.5, “Configuring Audit Logging Characteristics”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/audit-log-logging-configuration.html)

### audit\_log\_policy

[Section 6.4.5.10, “Audit Log Reference”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/audit-log-reference.html)

[Section 6.4.5.9, “Legacy Mode Audit Log Filtering”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/audit-log-legacy-filtering.html)

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[Section 6.4.5.8, “Writing Audit Log Filter Definitions”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/audit-log-filter-definitions.html)

### audit\_log\_prune\_seconds

[Section 6.4.5.10, “Audit Log Reference”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/audit-log-reference.html)

[Section 6.4.5.5, “Configuring Audit Logging Characteristics”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/audit-log-logging-configuration.html)

### audit\_log\_read\_buffer\_size

[Section 6.4.5.10, “Audit Log Reference”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/audit-log-reference.html)

[Section 6.4.5.6, “Reading Audit Log Files”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/audit-log-file-reading.html)

### audit\_log\_rotate\_on\_size

[Section 6.4.5.10, “Audit Log Reference”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/audit-log-reference.html)

[Section 6.4.5.5, “Configuring Audit Logging Characteristics”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/audit-log-logging-configuration.html)

### audit\_log\_statement\_policy

[Section 6.4.5.10, “Audit Log Reference”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/audit-log-reference.html)

[Section 6.4.5.9, “Legacy Mode Audit Log Filtering”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/audit-log-legacy-filtering.html)

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### audit\_log\_strategy

[Section 6.4.5.10, “Audit Log Reference”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/audit-log-reference.html)

[Section 6.4.5.5, “Configuring Audit Logging Characteristics”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/audit-log-logging-configuration.html)

### authentication\_fido\_rp\_id

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[Section 6.4.1.13, “Pluggable Authentication System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/pluggable-authentication-system-variables.html)

### authentication\_kerberos\_service\_key\_tab

[Section 6.4.1.8, “Kerberos Pluggable Authentication”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/kerberos-pluggable-authentication.html)

[Section 6.4.1.13, “Pluggable Authentication System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/pluggable-authentication-system-variables.html)

### authentication\_kerberos\_service\_principal

[Section 6.4.1.8, “Kerberos Pluggable Authentication”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/kerberos-pluggable-authentication.html)

[Section 6.4.1.13, “Pluggable Authentication System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/pluggable-authentication-system-variables.html)

### authentication\_ldap\_sasl\_auth\_method\_name

[Section 6.4.1.7, “LDAP Pluggable Authentication”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/ldap-pluggable-authentication.html)

[Section 6.4.1.13, “Pluggable Authentication System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/pluggable-authentication-system-variables.html)

### authentication\_ldap\_sasl\_bind\_base\_dn

[Section 6.4.1.7, “LDAP Pluggable Authentication”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/ldap-pluggable-authentication.html)

[Section 6.4.1.13, “Pluggable Authentication System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/pluggable-authentication-system-variables.html)

### authentication\_ldap\_sasl\_bind\_root\_dn

[Section 6.4.1.7, “LDAP Pluggable Authentication”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/ldap-pluggable-authentication.html)

[Section 6.4.1.13, “Pluggable Authentication System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/pluggable-authentication-system-variables.html)

### authentication\_ldap\_sasl\_bind\_root\_pwd

[Section 6.4.1.7, “LDAP Pluggable Authentication”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/ldap-pluggable-authentication.html)

[Section 6.4.1.13, “Pluggable Authentication System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/pluggable-authentication-system-variables.html)

### authentication\_ldap\_sasl\_ca\_path

[Section 6.4.1.7, “LDAP Pluggable Authentication”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/ldap-pluggable-authentication.html)

[Section 6.4.1.13, “Pluggable Authentication System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/pluggable-authentication-system-variables.html)

### authentication\_ldap\_sasl\_group\_search\_attr

[Section 6.4.1.7, “LDAP Pluggable Authentication”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/ldap-pluggable-authentication.html)

[Section 6.4.1.13, “Pluggable Authentication System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/pluggable-authentication-system-variables.html)

### authentication\_ldap\_sasl\_group\_search\_filter

[Section 6.4.1.13, “Pluggable Authentication System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/pluggable-authentication-system-variables.html)

### authentication\_ldap\_sasl\_init\_pool\_size

[Section 6.4.1.13, “Pluggable Authentication System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/pluggable-authentication-system-variables.html)

### authentication\_ldap\_sasl\_log\_status

[Section 6.4.1.13, “Pluggable Authentication System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/pluggable-authentication-system-variables.html)

### authentication\_ldap\_sasl\_max\_pool\_size

[Section 6.4.1.13, “Pluggable Authentication System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/pluggable-authentication-system-variables.html)

### authentication\_ldap\_sasl\_referral

[Section 6.4.1.7, “LDAP Pluggable Authentication”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/ldap-pluggable-authentication.html)

[Section 6.4.1.13, “Pluggable Authentication System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/pluggable-authentication-system-variables.html)

### authentication\_ldap\_sasl\_server\_host

[Section 6.4.1.7, “LDAP Pluggable Authentication”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/ldap-pluggable-authentication.html)

[Section 6.4.1.13, “Pluggable Authentication System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/pluggable-authentication-system-variables.html)

### authentication\_ldap\_sasl\_server\_port

[Section 6.4.1.7, “LDAP Pluggable Authentication”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/ldap-pluggable-authentication.html)

[Section 6.4.1.13, “Pluggable Authentication System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/pluggable-authentication-system-variables.html)

### authentication\_ldap\_sasl\_tls

[Section 6.4.1.7, “LDAP Pluggable Authentication”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/ldap-pluggable-authentication.html)

[Section 6.4.1.13, “Pluggable Authentication System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/pluggable-authentication-system-variables.html)

### authentication\_ldap\_sasl\_user\_search\_attr

[Section 6.4.1.7, “LDAP Pluggable Authentication”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/ldap-pluggable-authentication.html)

[Section 6.4.1.13, “Pluggable Authentication System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/pluggable-authentication-system-variables.html)

### authentication\_ldap\_simple\_auth\_method\_name

[Section 6.4.1.7, “LDAP Pluggable Authentication”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/ldap-pluggable-authentication.html)

[Section 6.4.1.13, “Pluggable Authentication System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/pluggable-authentication-system-variables.html)

### authentication\_ldap\_simple\_bind\_base\_dn

[Section 6.4.1.13, “Pluggable Authentication System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/pluggable-authentication-system-variables.html)

### authentication\_ldap\_simple\_bind\_root\_dn

[Section 6.4.1.13, “Pluggable Authentication System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/pluggable-authentication-system-variables.html)

### authentication\_ldap\_simple\_bind\_root\_pwd

[Section 6.4.1.13, “Pluggable Authentication System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/pluggable-authentication-system-variables.html)

### authentication\_ldap\_simple\_ca\_path

[Section 6.4.1.7, “LDAP Pluggable Authentication”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/ldap-pluggable-authentication.html)

[Section 6.4.1.13, “Pluggable Authentication System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/pluggable-authentication-system-variables.html)

### authentication\_ldap\_simple\_group\_search\_attr

[Section 6.4.1.7, “LDAP Pluggable Authentication”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/ldap-pluggable-authentication.html)

[Section 6.4.1.13, “Pluggable Authentication System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/pluggable-authentication-system-variables.html)

### authentication\_ldap\_simple\_group\_search\_filter

[Section 6.4.1.13, “Pluggable Authentication System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/pluggable-authentication-system-variables.html)

### authentication\_ldap\_simple\_init\_pool\_size

[Section 6.4.1.13, “Pluggable Authentication System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/pluggable-authentication-system-variables.html)

### authentication\_ldap\_simple\_log\_status

[Section 6.4.1.13, “Pluggable Authentication System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/pluggable-authentication-system-variables.html)

### authentication\_ldap\_simple\_max\_pool\_size

[Section 6.4.1.13, “Pluggable Authentication System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/pluggable-authentication-system-variables.html)

### authentication\_ldap\_simple\_referral

[Section 6.4.1.7, “LDAP Pluggable Authentication”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/ldap-pluggable-authentication.html)

[Section 6.4.1.13, “Pluggable Authentication System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/pluggable-authentication-system-variables.html)

### authentication\_ldap\_simple\_server\_host

[Section 6.4.1.13, “Pluggable Authentication System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/pluggable-authentication-system-variables.html)

### authentication\_ldap\_simple\_server\_port

[Section 6.4.1.13, “Pluggable Authentication System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/pluggable-authentication-system-variables.html)

### authentication\_ldap\_simple\_tls

[Section 6.4.1.7, “LDAP Pluggable Authentication”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/ldap-pluggable-authentication.html)

[Section 6.4.1.13, “Pluggable Authentication System Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/pluggable-authentication-system-variables.html)

### authentication\_ldap\_simple\_user\_search\_attr

[Section 6.4.1.7, “LDAP Pluggable Authentication”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/ldap-pluggable-authentication.html)

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### ndb\_use\_exact\_count

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### ndbinfo\_max\_bytes

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### ndbinfo\_max\_rows

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### ndbinfo\_show\_hidden

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# MySQL词汇表

# MySQL Glossary

These terms are commonly used in information about the MySQL database server.

### A

.ARM file

Metadata for ARCHIVE tables. Contrast with ***.ARZ file***. Files with this extension are always included in backups produced by the mysqlbackup command of the ***MySQL Enterprise Backup*** product.

See Also [.ARZ file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_arz_file), [MySQL Enterprise Backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysql_enterprise_backup), [mysqlbackup command](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysqlbackup_command).

.ARZ file

Data for ARCHIVE tables. Contrast with ***.ARM file***. Files with this extension are always included in backups produced by the mysqlbackup command of the ***MySQL Enterprise Backup*** product.

See Also [.ARM file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_arm_file), [MySQL Enterprise Backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysql_enterprise_backup), [mysqlbackup command](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysqlbackup_command).

ACID

An acronym standing for atomicity, consistency, isolation, and durability. These properties are all desirable in a database system, and are all closely tied to the notion of a ***transaction***. The transactional features of InnoDB adhere to the ACID principles.

Transactions are ***atomic*** units of work that can be ***committed*** or ***rolled back***. When a transaction makes multiple changes to the database, either all the changes succeed when the transaction is committed, or all the changes are undone when the transaction is rolled back.

The database remains in a consistent state at all times — after each commit or rollback, and while transactions are in progress. If related data is being updated across multiple tables, queries see either all old values or all new values, not a mix of old and new values.

Transactions are protected (isolated) from each other while they are in progress; they cannot interfere with each other or see each other's uncommitted data. This isolation is achieved through the ***locking*** mechanism. Experienced users can adjust the ***isolation level***, trading off less protection in favor of increased performance and ***concurrency***, when they can be sure that the transactions really do not interfere with each other.

The results of transactions are durable: once a commit operation succeeds, the changes made by that transaction are safe from power failures, system crashes, race conditions, or other potential dangers that many non-database applications are vulnerable to. Durability typically involves writing to disk storage, with a certain amount of redundancy to protect against power failures or software crashes during write operations. (In InnoDB, the ***doublewrite buffer*** assists with durability.)

See Also [atomic](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_atomic), [commit](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_commit), [concurrency](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_concurrency), [doublewrite buffer](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_doublewrite_buffer), [isolation level](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_isolation_level), [locking](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_locking), [rollback](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_rollback), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

adaptive flushing

An algorithm for ***InnoDB*** tables that smooths out the I/O overhead introduced by ***checkpoints***. Instead of ***flushing*** all modified ***pages*** from the ***buffer pool*** to the ***data files*** at once, MySQL periodically flushes small sets of modified pages. The adaptive flushing algorithm extends this process by estimating the optimal rate to perform these periodic flushes, based on the rate of flushing and how fast ***redo*** information is generated.

See Also [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [checkpoint](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_checkpoint), [data files](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_data_files), [flush](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_flush), [InnoDB](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_innodb), [page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_page), [redo log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_redo_log).

adaptive hash index

An optimization for InnoDB tables that can speed up lookups using = and IN operators, by constructing a ***hash index*** in memory. MySQL monitors index searches for InnoDB tables, and if queries could benefit from a hash index, it builds one automatically for index ***pages*** that are frequently accessed. In a sense, the adaptive hash index configures MySQL at runtime to take advantage of ample main memory, coming closer to the architecture of main-memory databases. This feature is controlled by the [innodb\_adaptive\_hash\_index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_adaptive_hash_index) configuration option. Because this feature benefits some workloads and not others, and the memory used for the hash index is reserved in the ***buffer pool***, typically you should benchmark with this feature both enabled and disabled.

The hash index is always built based on an existing ***B-tree*** index on the table. MySQL can build a hash index on a prefix of any length of the key defined for the B-tree, depending on the pattern of searches against the index. A hash index can be partial; the whole B-tree index does not need to be cached in the buffer pool.

In MySQL 5.6 and higher, another way to take advantage of fast single-value lookups with InnoDB tables is to use the InnoDB ***memcached*** plugin. See [Section 15.20, “InnoDB memcached Plugin”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-memcached.html) for details.

See Also [B-tree](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_b_tree), [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [hash index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_hash_index), [memcached](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_memcached), [page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_page), [secondary index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_secondary_index).

ADO.NET

An object-relational mapping (ORM) framework for applications built using .NET technologies such as ***ASP.NET***. Such applications can interface with MySQL through the ***Connector/NET*** component.

See Also [.NET](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos__net), [ASP.net](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_asp_net), [Connector/NET](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_net), [Mono](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mono), [Visual Studio](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_visual_studio).

AIO

Acronym for ***asynchronous I/O***. You might see this acronym in InnoDB messages or keywords.

See Also [asynchronous I/O](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_asynchronous_io).

ANSI

In ***ODBC***, an alternative method of supporting character sets and other internationalization aspects. Contrast with ***Unicode***. ***Connector/ODBC*** 3.51 is an ANSI driver, while Connector/ODBC 5.1 is a Unicode driver.

See Also [Connector/ODBC](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_odbc), [ODBC](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_odbc), [Unicode](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_unicode).

API

APIs provide low-level access to the MySQL protocol and MySQL resources from ***client*** programs. Contrast with the higher-level access provided by a ***Connector***.

See Also [C API](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_c_api), [client](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_client), [connector](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector), [native C API](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_native_c_api), [Perl API](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_perl_api), [PHP API](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_php_api), [Python API](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_python_api), [Ruby API](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ruby_api).

application programming interface (API)

A set of functions or procedures. An API provides a stable set of names and types for functions, procedures, parameters, and return values.

apply

When a backup produced by the ***MySQL Enterprise Backup*** product does not include the most recent changes that occurred while the backup was underway, the process of updating the backup files to include those changes is known as the ***apply*** step. It is specified by the apply-log option of the mysqlbackup command.

Before the changes are applied, we refer to the files as a ***raw backup***. After the changes are applied, we refer to the files as a ***prepared backup***. The changes are recorded in the ***ibbackup\_logfile*** file; once the apply step is finished, this file is no longer necessary.

See Also [hot backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_hot_backup), [ibbackup\_logfile](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ibbackup_logfile), [MySQL Enterprise Backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysql_enterprise_backup), [prepared backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_prepared_backup), [raw backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_raw_backup).

AS

A Kerberos authentication server. AS can also refer to the authentication service provided by an authentication server.

See Also [authentication server](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_authentication_server).

ASP.net

A framework for developing web-based applications using ***.NET*** technologies and languages. Such applications can interface with MySQL through the ***Connector/NET*** component.

Another technology for writing server-side web pages with MySQL is ***PHP***.

See Also [.NET](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos__net), [ADO.NET](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ado_net), [Connector/NET](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_net), [Mono](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mono), [PHP](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_php), [Visual Studio](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_visual_studio).

assembly

A library of compiled code in a ***.NET*** system, accessed through ***Connector/NET***. Stored in the ***GAC*** to allow versioning without naming conflicts.

See Also [.NET](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos__net), [GAC](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_gac).

asynchronous I/O

A type of I/O operation that allows other processing to proceed before the I/O is completed. Also known as ***nonblocking I/O*** and abbreviated as ***AIO***. InnoDB uses this type of I/O for certain operations that can run in parallel without affecting the reliability of the database, such as reading pages into the ***buffer pool*** that have not actually been requested, but might be needed soon.

Historically, InnoDB used asynchronous I/O on Windows systems only. Starting with the InnoDB Plugin 1.1 and MySQL 5.5, InnoDB uses asynchronous I/O on Linux systems. This change introduces a dependency on libaio. Asynchronous I/O on Linux systems is configured using the [innodb\_use\_native\_aio](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_use_native_aio) option, which is enabled by default. On other Unix-like systems, InnoDB uses synchronous I/O only.

See Also [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [nonblocking I/O](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_non_blocking_io).

atomic

In the SQL context, ***transactions*** are units of work that either succeed entirely (when ***committed***) or have no effect at all (when ***rolled back***). The indivisible ("atomic") property of transactions is the “A” in the acronym ***ACID***.

See Also [ACID](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_acid), [commit](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_commit), [rollback](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_rollback), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

atomic DDL

An atomic DDL statement is one that combines the data dictionary updates, storage engine operations, and binary log writes associated with a DDL operation into a single, atomic transaction. The transaction is either fully committed or rolled back, even if the server halts during the operation. Atomic DDL support was added in MySQL 8.0. For more information, see [Section 13.1.1, “Atomic Data Definition Statement Support”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/atomic-ddl.html).

See Also [binary log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_binary_log), [data dictionary](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_data_dictionary), [DDL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ddl), [storage engine](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_storage_engine).

atomic instruction

Special instructions provided by the CPU, to ensure that critical low-level operations cannot be interrupted.

authentication server

In Kerberos, a service that provides the initial ticket needed to obtain a ticket-granting ticket (TGT) that is needed to obtain other tickets from the ticket-granting server (TGS). The authentication server (AS) combined with a TGS make up a key distribution center (KDC).

See Also [key distribution center](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_key_distribution_center), [ticket-granting server](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ticket_granting_server).

auto-increment

A property of a table column (specified by the AUTO\_INCREMENT keyword) that automatically adds an ascending sequence of values in the column.

It saves work for the developer, not to have to produce new unique values when inserting new rows. It provides useful information for the query optimizer, because the column is known to be not null and with unique values. The values from such a column can be used as lookup keys in various contexts, and because they are auto-generated there is no reason to ever change them; for this reason, primary key columns are often specified as auto-incrementing.

Auto-increment columns can be problematic with statement-based replication, because replaying the statements on a replica might not produce the same set of column values as on the source, due to timing issues. When you have an auto-incrementing primary key, you can use statement-based replication only with the setting [innodb\_autoinc\_lock\_mode=1](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_autoinc_lock_mode). If you have [innodb\_autoinc\_lock\_mode=2](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_autoinc_lock_mode), which allows higher concurrency for insert operations, use ***row-based replication*** rather than ***statement-based replication***. The setting [innodb\_autoinc\_lock\_mode=0](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_autoinc_lock_mode) should not be used except for compatibility purposes.

Consecutive lock mode ([innodb\_autoinc\_lock\_mode=1](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_autoinc_lock_mode)) is the default setting prior to MySQL 8.0.3. As of MySQL 8.0.3, interleaved lock mode ([innodb\_autoinc\_lock\_mode=2](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_autoinc_lock_mode)) is the default, which reflects the change from statement-based to row-based replication as the default replication type.

See Also [auto-increment locking](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_auto_increment_locking), [innodb\_autoinc\_lock\_mode](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_innodb_autoinc_lock_mode), [primary key](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_primary_key), [row-based replication](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_row_based_replication), [statement-based replication](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_statement_based_replication).

auto-increment locking

The convenience of an ***auto-increment*** primary key involves some tradeoff with concurrency. In the simplest case, if one transaction is inserting values into the table, any other transactions must wait to do their own inserts into that table, so that rows inserted by the first transaction receive consecutive primary key values. InnoDB includes optimizations and the [innodb\_autoinc\_lock\_mode](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_autoinc_lock_mode) option so that you can configure and optimal balance between predictable sequences of auto-increment values and maximum ***concurrency*** for insert operations.

See Also [auto-increment](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_auto_increment), [concurrency](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_concurrency), [innodb\_autoinc\_lock\_mode](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_innodb_autoinc_lock_mode).

autocommit

A setting that causes a ***commit*** operation after each ***SQL*** statement. This mode is not recommended for working with InnoDB tables with ***transactions*** that span several statements. It can help performance for ***read-only transactions*** on InnoDB tables, where it minimizes overhead from ***locking*** and generation of ***undo*** data, especially in MySQL 5.6.4 and up. It is also appropriate for working with [MyISAM](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/myisam-storage-engine.html) tables, where transactions are not applicable.

See Also [commit](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_commit), [locking](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_locking), [read-only transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_read_only_transaction), [SQL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_sql), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction), [undo](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_undo).

availability

The ability to cope with, and if necessary recover from, failures on the host, including failures of MySQL, the operating system, or the hardware and maintenance activity that may otherwise cause downtime. Often paired with ***scalability*** as critical aspects of a large-scale deployment.

See Also [scalability](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_scalability).

### B

B-tree

A tree data structure that is popular for use in database indexes. The structure is kept sorted at all times, enabling fast lookup for exact matches (equals operator) and ranges (for example, greater than, less than, and BETWEEN operators). This type of index is available for most storage engines, such as [InnoDB](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-storage-engine.html) and [MyISAM](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/myisam-storage-engine.html).

Because B-tree nodes can have many children, a B-tree is not the same as a binary tree, which is limited to 2 children per node.

Contrast with ***hash index***, which is only available in the [MEMORY](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/memory-storage-engine.html) storage engine. The MEMORY storage engine can also use B-tree indexes, and you should choose B-tree indexes for MEMORY tables if some queries use range operators.

The use of the term B-tree is intended as a reference to the general class of index design. B-tree structures used by MySQL storage engines may be regarded as variants due to sophistications not present in a classic B-tree design. For related information, refer to the InnoDB Page Structure [Fil Header](https://dev.mysql.com/doc/internals/en/innodb-fil-header.html) section of the [MySQL Internals Manual](https://dev.mysql.com/doc/internals/en/index.html).

See Also [hash index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_hash_index).

backticks

Identifiers within MySQL SQL statements must be quoted using the backtick character (`) if they contain special characters or reserved words. For example, to refer to a table named FOO#BAR or a column named SELECT, you would specify the identifiers as `FOO#BAR` and `SELECT`. Since the backticks provide an extra level of safety, they are used extensively in program-generated SQL statements, where the identifier names might not be known in advance.

Many other database systems use double quotation marks (") around such special names. For portability, you can enable ANSI\_QUOTES mode in MySQL and use double quotation marks instead of backticks to qualify identifier names.

See Also [SQL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_sql).

backup

The process of copying some or all table data and metadata from a MySQL instance, for safekeeping. Can also refer to the set of copied files. This is a crucial task for DBAs. The reverse of this process is the ***restore*** operation.

With MySQL, ***physical backups*** are performed by the ***MySQL Enterprise Backup*** product, and ***logical backups*** are performed by the mysqldump command. These techniques have different characteristics in terms of size and representation of the backup data, and speed (especially speed of the restore operation).

Backups are further classified as ***hot***, ***warm***, or ***cold*** depending on how much they interfere with normal database operation. (Hot backups have the least interference, cold backups the most.)

See Also [cold backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_cold_backup), [hot backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_hot_backup), [logical backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_logical_backup), [MySQL Enterprise Backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysql_enterprise_backup), [mysqldump](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysqldump), [physical backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_physical_backup), [warm backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_warm_backup).

base column

A non-generated table column upon which a stored generated column or virtual generated column is based. In other words, a base column is a non-generated table column that is part of a generated column definition.

See Also [generated column](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_generated_column), [stored generated column](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_stored_generated_column), [virtual generated column](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_virtual_generated_column).

beta

An early stage in the life of a software product, when it is available only for evaluation, typically without a definite release number or a number less than 1. InnoDB does not use the beta designation, preferring an ***early adopter*** phase that can extend over several point releases, leading to a ***GA*** release.

See Also [early adopter](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_early_adopter), [GA](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ga).

binary log

A file containing a record of all statements or row changes that attempt to change table data. The contents of the binary log can be replayed to bring replicas up to date in a ***replication*** scenario, or to bring a database up to date after restoring table data from a backup. The binary logging feature can be turned on and off, although Oracle recommends always enabling it if you use replication or perform backups.

You can examine the contents of the binary log, or replay it during replication or recovery, by using the [**mysqlbinlog**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqlbinlog.html) command. For full information about the binary log, see [Section 5.4.4, “The Binary Log”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/binary-log.html). For MySQL configuration options related to the binary log, see [Section 17.1.6.4, “Binary Logging Options and Variables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-options-binary-log.html).

For the ***MySQL Enterprise Backup*** product, the file name of the binary log and the current position within the file are important details. To record this information for the source when taking a backup in a replication context, you can specify the --slave-info option.

Prior to MySQL 5.0, a similar capability was available, known as the update log. In MySQL 5.0 and higher, the binary log replaces the update log.

See Also [binlog](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_binlog), [MySQL Enterprise Backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysql_enterprise_backup), [replication](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_replication).

binlog

An informal name for the ***binary log*** file. For example, you might see this abbreviation used in e-mail messages or forum discussions.

See Also [binary log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_binary_log).

blind query expansion

A special mode of ***full-text search*** enabled by the WITH QUERY EXPANSION clause. It performs the search twice, where the search phrase for the second search is the original search phrase concatenated with the few most highly relevant documents from the first search. This technique is mainly applicable for short search phrases, perhaps only a single word. It can uncover relevant matches where the precise search term does not occur in the document.

See Also [full-text search](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_full_text_search).

BLOB

An SQL data type ([TINYBLOB](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/blob.html), [BLOB](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/blob.html), [MEDIUMBLOB](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/blob.html), and [LONGBLOB](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/blob.html)) for objects containing any kind of binary data, of arbitrary size. Used for storing documents, images, sound files, and other kinds of information that cannot easily be decomposed to rows and columns within a MySQL table. The techniques for handling BLOBs within a MySQL application vary with each ***Connector*** and ***API***. MySQL Connector/ODBC defines BLOB values as LONGVARBINARY. For large, free-form collections of character data, the industry term is ***CLOB***, represented by the MySQL TEXT data types.

See Also [API](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_api), [CLOB](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_clob), [connector](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector), [Connector/ODBC](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_odbc).

bottleneck

A portion of a system that is constrained in size or capacity, that has the effect of limiting overall throughput. For example, a memory area might be smaller than necessary; access to a single required resource might prevent multiple CPU cores from running simultaneously; or waiting for disk I/O to complete might prevent the CPU from running at full capacity. Removing bottlenecks tends to improve ***concurrency***. For example, the ability to have multiple InnoDB ***buffer pool*** instances reduces contention when multiple sessions read from and write to the buffer pool simultaneously.

See Also [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [concurrency](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_concurrency).

bounce

A ***shutdown*** operation immediately followed by a restart. Ideally with a relatively short ***warmup*** period so that performance and throughput quickly return to a high level.

See Also [shutdown](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_shutdown).

buddy allocator

A mechanism for managing different-sized ***pages*** in the InnoDB ***buffer pool***.

See Also [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_page), [page size](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_page_size).

buffer

A memory or disk area used for temporary storage. Data is buffered in memory so that it can be written to disk efficiently, with a few large I/O operations rather than many small ones. Data is buffered on disk for greater reliability, so that it can be recovered even when a ***crash*** or other failure occurs at the worst possible time. The main types of buffers used by InnoDB are the ***buffer pool***, the ***doublewrite buffer***, and the ***change buffer***.

See Also [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [change buffer](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_change_buffer), [crash](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_crash), [doublewrite buffer](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_doublewrite_buffer).

buffer pool

The memory area that holds cached InnoDB data for both tables and indexes. For efficiency of high-volume read operations, the buffer pool is divided into ***pages*** that can potentially hold multiple rows. For efficiency of cache management, the buffer pool is implemented as a linked list of pages; data that is rarely used is aged out of the cache, using a variation of the ***LRU*** algorithm. On systems with large memory, you can improve concurrency by dividing the buffer pool into multiple ***buffer pool instances***.

Several InnoDB status variables, INFORMATION\_SCHEMA tables, and performance\_schema tables help to monitor the internal workings of the buffer pool. Starting in MySQL 5.6, you can avoid a lengthy warmup period after restarting the server, particularly for instances with large buffer pools, by saving the buffer pool state at server shutdown and restoring the buffer pool to the same state at server startup. See [Section 15.8.3.6, “Saving and Restoring the Buffer Pool State”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-preload-buffer-pool.html).

See Also [buffer pool instance](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool_instance), [LRU](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_lru), [page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_page), [warm up](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_warm_up).

buffer pool instance

Any of the multiple regions into which the ***buffer pool*** can be divided, controlled by the [innodb\_buffer\_pool\_instances](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_buffer_pool_instances) configuration option. The total memory size specified by [innodb\_buffer\_pool\_size](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_buffer_pool_size) is divided among all buffer pool instances. Typically, having multiple buffer pool instances is appropriate for systems that allocate multiple gigabytes to the InnoDB buffer pool, with each instance being one gigabyte or larger. On systems loading or looking up large amounts of data in the buffer pool from many concurrent sessions, having multiple buffer pool instances reduces contention for exclusive access to data structures that manage the buffer pool.

See Also [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool).

built-in

The built-in InnoDB storage engine within MySQL is the original form of distribution for the storage engine. Contrast with the ***InnoDB Plugin***. Starting with MySQL 5.5, the InnoDB Plugin is merged back into the MySQL code base as the built-in InnoDB storage engine (known as InnoDB 1.1).

This distinction is important mainly in MySQL 5.1, where a feature or bug fix might apply to the InnoDB Plugin but not the built-in InnoDB, or vice versa.

See Also [InnoDB](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_innodb).

business rules

The relationships and sequences of actions that form the basis of business software, used to run a commercial company. Sometimes these rules are dictated by law, other times by company policy. Careful planning ensures that the relationships encoded and enforced by the database, and the actions performed through application logic, accurately reflect the real policies of the company and can handle real-life situations.

For example, an employee leaving a company might trigger a sequence of actions from the human resources department. The human resources database might also need the flexibility to represent data about a person who has been hired, but not yet started work. Closing an account at an online service might result in data being removed from a database, or the data might be moved or flagged so that it could be recovered if the account is re-opened. A company might establish policies regarding salary maximums, minimums, and adjustments, in addition to basic sanity checks such as the salary not being a negative number. A retail database might not allow a purchase with the same serial number to be returned more than once, or might not allow credit card purchases above a certain value, while a database used to detect fraud might allow these kinds of things.

See Also [relational](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_relational).

### C

.cfg file

A metadata file used with the InnoDB ***transportable tablespace*** feature. It is produced by the command FLUSH TABLES ... FOR EXPORT, puts one or more tables in a consistent state that can be copied to another server. The .cfg file is copied along with the corresponding ***.ibd file***, and used to adjust the internal values of the .ibd file, such as the ***space ID***, during the ALTER TABLE ... IMPORT TABLESPACE step.

See Also [.ibd file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ibd_file), [space ID](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_space_id), [transportable tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transportable_tablespace).

C

A programming language that combines portability with performance and access to low-level hardware features, making it a popular choice for writing operating systems, drivers, and other kinds of system software. Many complex applications, languages, and reusable modules feature pieces written in C, tied together with high-level components written in other languages. Its core syntax is familiar to ***C++***, ***Java***, and ***C#*** developers.

See Also [C API](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_c_api), [C++](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_cplusplus), [C#](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_csharp), [Java](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_java).

C API

The C ***API*** code is distributed with MySQL. It is included in the ***libmysqlclient*** library and enables ***C*** programs to access a database.

See Also [API](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_api), [C](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_c), [libmysqlclient](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_libmysqlclient).

C#

A programming language combining strong typing and object-oriented features, running within the Microsoft ***.NET*** framework or its open-source counterpart ***Mono***. Often used for creating applications with the ***ASP.net*** framework. Its syntax is familiar to ***C***, ***C++*** and ***Java*** developers.

See Also [.NET](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos__net), [ASP.net](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_asp_net), [C](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_c), [Connector/NET](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_net), [C++](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_cplusplus), [Java](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_java), [Mono](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mono).

C++

A programming language with core syntax familiar to ***C*** developers. Provides access to low-level operations for performance, combined with higher-level data types, object-oriented features, and garbage collection. To write C++ applications for MySQL, you use the ***Connector/C++*** component.

See Also [C](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_c), [Connector/C++](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_c__).

cache

The general term for any memory area that stores copies of data for frequent or high-speed retrieval. In InnoDB, the primary kind of cache structure is the ***buffer pool***.

See Also [buffer](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer), [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool).

cardinality

The number of different values in a table ***column***. When queries refer to columns that have an associated ***index***, the cardinality of each column influences which access method is most efficient. For example, for a column with a ***unique constraint***, the number of different values is equal to the number of rows in the table. If a table has a million rows but only 10 different values for a particular column, each value occurs (on average) 100,000 times. A query such as SELECT c1 FROM t1 WHERE c1 = 50; thus might return 1 row or a huge number of rows, and the database server might process the query differently depending on the cardinality of c1.

If the values in a column have a very uneven distribution, the cardinality might not be a good way to determine the best query plan. For example, SELECT c1 FROM t1 WHERE c1 = x; might return 1 row when x=50 and a million rows when x=30. In such a case, you might need to use ***index hints*** to pass along advice about which lookup method is more efficient for a particular query.

Cardinality can also apply to the number of distinct values present in multiple columns, as in a ***composite index***.

See Also [column](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_column), [composite index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_composite_index), [index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index), [index hint](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index_hint), [persistent statistics](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_persistent_statistics), [random dive](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_random_dive), [selectivity](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_selectivity), [unique constraint](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_unique_constraint).

change buffer

A special data structure that records changes to ***pages*** in ***secondary indexes***. These values could result from SQL [INSERT](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/insert.html), [UPDATE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/update.html), or [DELETE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/delete.html) statements (***DML***). The set of features involving the change buffer is known collectively as ***change buffering***, consisting of ***insert buffering***, ***delete buffering***, and ***purge buffering***.

Changes are only recorded in the change buffer when the relevant page from the secondary index is not in the ***buffer pool***. When the relevant index page is brought into the buffer pool while associated changes are still in the change buffer, the changes for that page are applied in the buffer pool (***merged***) using the data from the change buffer. Periodically, the ***purge*** operation that runs during times when the system is mostly idle, or during a slow shutdown, writes the new index pages to disk. The purge operation can write the disk blocks for a series of index values more efficiently than if each value were written to disk immediately.

Physically, the change buffer is part of the ***system tablespace***, so that the index changes remain buffered across database restarts. The changes are only applied (***merged***) when the pages are brought into the buffer pool due to some other read operation.

The kinds and amount of data stored in the change buffer are governed by the [innodb\_change\_buffering](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_change_buffering) and [innodb\_change\_buffer\_max\_size](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_change_buffer_max_size) configuration options. To see information about the current data in the change buffer, issue the [SHOW ENGINE INNODB STATUS](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/show-engine.html) command.

Formerly known as the ***insert buffer***.

See Also [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [change buffering](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_change_buffering), [delete buffering](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_delete_buffering), [DML](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dml), [insert buffer](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_insert_buffer), [insert buffering](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_insert_buffering), [merge](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_merge), [page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_page), [purge](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_purge), [purge buffering](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_purge_buffering), [secondary index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_secondary_index), [system tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_system_tablespace).

change buffering

The general term for the features involving the ***change buffer***, consisting of ***insert buffering***, ***delete buffering***, and ***purge buffering***. Index changes resulting from SQL statements, which could normally involve random I/O operations, are held back and performed periodically by a background ***thread***. This sequence of operations can write the disk blocks for a series of index values more efficiently than if each value were written to disk immediately. Controlled by the [innodb\_change\_buffering](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_change_buffering) and [innodb\_change\_buffer\_max\_size](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_change_buffer_max_size) configuration options.

See Also [change buffer](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_change_buffer), [delete buffering](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_delete_buffering), [insert buffering](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_insert_buffering), [purge buffering](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_purge_buffering).

checkpoint

As changes are made to data pages that are cached in the ***buffer pool***, those changes are written to the ***data files*** sometime later, a process known as ***flushing***. The checkpoint is a record of the latest changes (represented by an ***LSN*** value) that have been successfully written to the data files.

See Also [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [data files](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_data_files), [flush](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_flush), [fuzzy checkpointing](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_fuzzy_checkpointing), [LSN](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_lsn).

checksum

In InnoDB, a validation mechanism to detect corruption when a ***page*** in a ***tablespace*** is read from disk into the InnoDB ***buffer pool***. This feature is controlled by the [innodb\_checksums](https://docs.oracle.com/cd/E17952_01/mysql-5.7-en/innodb-parameters.html#sysvar_innodb_checksums) configuration option in MySQL 5.5. [innodb\_checksums](https://docs.oracle.com/cd/E17952_01/mysql-5.7-en/innodb-parameters.html#sysvar_innodb_checksums) is deprecated in MySQL 5.6.3, replaced by [innodb\_checksum\_algorithm](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_checksum_algorithm).

The [**innochecksum**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innochecksum.html) command helps diagnose corruption problems by testing the checksum values for a specified ***tablespace*** file while the MySQL server is shut down.

MySQL also uses checksums for replication purposes. For details, see the configuration options [binlog\_checksum](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-options-binary-log.html#sysvar_binlog_checksum), [source\_verify\_checksum](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-options-binary-log.html#sysvar_source_verify_checksum) or [master\_verify\_checksum](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-options-binary-log.html#sysvar_master_verify_checksum), and [replica\_sql\_verify\_checksum](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-options-replica.html#sysvar_replica_sql_verify_checksum) or [slave\_sql\_verify\_checksum](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/replication-options-replica.html#sysvar_slave_sql_verify_checksum).

See Also [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_page), [tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_tablespace).

child table

In a ***foreign key*** relationship, a child table is one whose rows refer (or point) to rows in another table with an identical value for a specific column. This is the table that contains the FOREIGN KEY ... REFERENCES clause and optionally ON UPDATE and ON DELETE clauses. The corresponding row in the ***parent table*** must exist before the row can be created in the child table. The values in the child table can prevent delete or update operations on the parent table, or can cause automatic deletion or updates in the child table, based on the ON CASCADE option used when creating the foreign key.

See Also [foreign key](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_foreign_key), [parent table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_parent_table).

clean page

A ***page*** in the InnoDB ***buffer pool*** where all changes made in memory have also been written (***flushed***) to the [data files](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_data_files). The opposite of a ***dirty page***.

See Also [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [data files](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_data_files), [dirty page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dirty_page), [flush](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_flush), [page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_page).

clean shutdown

A ***shutdown*** that completes without errors and applies all changes to InnoDB tables before finishing, as opposed to a ***crash*** or a ***fast shutdown***. Synonym for ***slow shutdown***.

See Also [crash](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_crash), [fast shutdown](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_fast_shutdown), [shutdown](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_shutdown), [slow shutdown](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_slow_shutdown).

client

A program that runs outside the database server, communicating with the database by sending requests through a ***Connector***, or an ***API*** made available through ***client libraries***. It can run on the same physical machine as the database server, or on a remote machine connected over a network. It can be a special-purpose database application, or a general-purpose program like the [**mysql**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql.html) command-line processor.

See Also [API](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_api), [client libraries](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_client_libraries), [connector](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector), [mysql](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysql), [server](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_server).

client libraries

Files containing collections of functions for working with databases. By compiling your program with these libraries, or installing them on the same system as your application, you can run a database application (known as a ***client***) on a machine that does not have the MySQL server installed; the application accesses the database over a network. With MySQL, you can use the ***libmysqlclient*** library from the MySQL server itself.

See Also [client](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_client), [libmysqlclient](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_libmysqlclient).

client-side prepared statement

A type of ***prepared statement*** where the caching and reuse are managed locally, emulating the functionality of ***server-side prepared statements***. Historically, used by some ***Connector/J***, ***Connector/ODBC***, and ***Connector/PHP*** developers to work around issues with server-side stored procedures. With modern MySQL server versions, server-side prepared statements are recommended for performance, scalability, and memory efficiency.

See Also [Connector/J](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_j), [Connector/ODBC](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_odbc), [Connector/PHP](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_php), [prepared statement](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_prepared_statement).

CLOB

An SQL data type ([TINYTEXT](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/blob.html), [TEXT](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/blob.html), [MEDIUMTEXT](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/blob.html), or [LONGTEXT](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/blob.html)) for objects containing any kind of character data, of arbitrary size. Used for storing text-based documents, with associated character set and collation order. The techniques for handling CLOBs within a MySQL application vary with each ***Connector*** and ***API***. MySQL Connector/ODBC defines TEXT values as LONGVARCHAR. For storing binary data, the equivalent is the ***BLOB*** type.

See Also [API](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_api), [BLOB](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_blob), [connector](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector), [Connector/ODBC](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_odbc).

clustered index

The InnoDB term for a ***primary key*** index. InnoDB table storage is organized based on the values of the primary key columns, to speed up queries and sorts involving the primary key columns. For best performance, choose the primary key columns carefully based on the most performance-critical queries. Because modifying the columns of the clustered index is an expensive operation, choose primary columns that are rarely or never updated.

In the Oracle Database product, this type of table is known as an ***index-organized table***.

See Also [index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index), [primary key](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_primary_key), [secondary index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_secondary_index).

cold backup

A ***backup*** taken while the database is shut down. For busy applications and websites, this might not be practical, and you might prefer a ***warm backup*** or a ***hot backup***.

See Also [backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_backup), [hot backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_hot_backup), [warm backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_warm_backup).

column

A data item within a ***row***, whose storage and semantics are defined by a data type. Each ***table*** and ***index*** is largely defined by the set of columns it contains.

Each column has a ***cardinality*** value. A column can be the ***primary key*** for its table, or part of the primary key. A column can be subject to a ***unique constraint***, a ***NOT NULL constraint***, or both. Values in different columns, even across different tables, can be linked by a ***foreign key*** relationship.

In discussions of MySQL internal operations, sometimes ***field*** is used as a synonym.

See Also [cardinality](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_cardinality), [foreign key](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_foreign_key), [index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index), [NOT NULL constraint](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_not_null_constraint), [primary key](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_primary_key), [row](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_row), [table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_table), [unique constraint](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_unique_constraint).

column index

An ***index*** on a single column.

See Also [composite index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_composite_index), [index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index).

column prefix

When an ***index*** is created with a length specification, such as CREATE INDEX idx ON t1 (c1(N)), only the first N characters of the column value are stored in the index. Keeping the index prefix small makes the index compact, and the memory and disk I/O savings help performance. (Although making the index prefix too small can hinder query optimization by making rows with different values appear to the query optimizer to be duplicates.)

For columns containing binary values or long text strings, where sorting is not a major consideration and storing the entire value in the index would waste space, the index automatically uses the first N (typically 768) characters of the value to do lookups and sorts.

See Also [index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index).

command interceptor

Synonym for ***statement interceptor***. One aspect of the ***interceptor*** design pattern available for both ***Connector/NET*** and ***Connector/J***. What Connector/NET calls a command, Connector/J refers to as a statement. Contrast with ***exception interceptor***.

See Also [Connector/J](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_j), [Connector/NET](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_net), [exception interceptor](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_exception_interceptor), [interceptor](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_interceptor), [statement interceptor](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_statement_interceptor).

commit

A ***SQL*** statement that ends a ***transaction***, making permanent any changes made by the transaction. It is the opposite of ***rollback***, which undoes any changes made in the transaction.

InnoDB uses an ***optimistic*** mechanism for commits, so that changes can be written to the data files before the commit actually occurs. This technique makes the commit itself faster, with the tradeoff that more work is required in case of a rollback.

By default, MySQL uses the ***autocommit*** setting, which automatically issues a commit following each SQL statement.

See Also [autocommit](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_autocommit), [optimistic](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_optimistic), [rollback](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_rollback), [SQL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_sql), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

compact row format

A ***row format*** for InnoDB tables. It was the default row format from MySQL 5.0.3 to MySQL 5.7.8. In MySQL 8.0, the default row format is defined by the [innodb\_default\_row\_format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_default_row_format) configuration option, which has a default setting of ***DYNAMIC***. The ***COMPACT*** row format provides a more compact representation for nulls and variable-length columns than the ***REDUNDANT*** row format.

For additional information about InnoDB COMPACT row format, see [Section 15.10, “InnoDB Row Formats”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-row-format.html).

See Also [dynamic row format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dynamic_row_format), [file format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_file_format), [redundant row format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_redundant_row_format), [row format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_row_format).

composite index

An ***index*** that includes multiple columns.

See Also [index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index).

compressed backup

The compression feature of the ***MySQL Enterprise Backup*** product makes a compressed copy of each tablespace, changing the extension from .ibd to .ibz. Compressing backup data allows you to keep more backups on hand, and reduces the time to transfer backups to a different server. The data is uncompressed during the restore operation. When a compressed backup operation processes a table that is already compressed, it skips the compression step for that table, because compressing again would result in little or no space savings.

A set of files produced by the ***MySQL Enterprise Backup*** product, where each ***tablespace*** is compressed. The compressed files are renamed with a .ibz file extension.

Applying ***compression*** at the start of the backup process helps to avoid storage overhead during the compression process, and to avoid network overhead when transferring the backup files to another server. The process of ***applying*** the ***binary log*** takes longer, and requires uncompressing the backup files.

See Also [apply](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_apply), [binary log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_binary_log), [compression](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_compression), [hot backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_hot_backup), [MySQL Enterprise Backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysql_enterprise_backup), [tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_tablespace).

compressed row format

A ***row format*** that enables data and index ***compression*** for InnoDB tables. Large fields are stored away from the page that holds the rest of the row data, as in ***dynamic row format***. Both index pages and the large fields are compressed, yielding memory and disk savings. Depending on the structure of the data, the decrease in memory and disk usage might or might not outweigh the performance overhead of uncompressing the data as it is used. See [Section 15.9, “InnoDB Table and Page Compression”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-compression.html) for usage details.

For additional information about InnoDB COMPRESSED row format, see [DYNAMIC Row Format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-row-format.html#innodb-row-format-dynamic).

See Also [compression](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_compression), [dynamic row format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dynamic_row_format), [row format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_row_format).

compressed table

A table for which the data is stored in compressed form. For InnoDB, it is a table created with ROW\_FORMAT=COMPRESSED. See [Section 15.9, “InnoDB Table and Page Compression”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-compression.html) for more information.

See Also [compressed row format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_compressed_row_format), [compression](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_compression).

compression

A feature with wide-ranging benefits from using less disk space, performing less I/O, and using less memory for caching.

InnoDB supports both table-level and page-level compression. InnoDB page compression is also referred to as ***transparent page compression***. For more information about InnoDB compression, see [Section 15.9, “InnoDB Table and Page Compression”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-compression.html).

Another type of compression is the ***compressed backup*** feature of the ***MySQL Enterprise Backup*** product.

See Also [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [compressed backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_compressed_backup), [compressed row format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_compressed_row_format), [DML](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dml), [transparent page compression](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transparent_page_compression).

compression failure

Not actually an error, rather an expensive operation that can occur when using ***compression*** in combination with ***DML*** operations. It occurs when: updates to a compressed ***page*** overflow the area on the page reserved for recording modifications; the page is compressed again, with all changes applied to the table data; the re-compressed data does not fit on the original page, requiring MySQL to split the data into two new pages and compress each one separately. To check the frequency of this condition, query the [INFORMATION\_SCHEMA.INNODB\_CMP](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/information-schema-innodb-cmp-table.html) table and check how much the value of the COMPRESS\_OPS column exceeds the value of the COMPRESS\_OPS\_OK column. Ideally, compression failures do not occur often; when they do, you can adjust the [innodb\_compression\_level](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_compression_level), [innodb\_compression\_failure\_threshold\_pct](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_compression_failure_threshold_pct), and [innodb\_compression\_pad\_pct\_max](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_compression_pad_pct_max) configuration options.

See Also [compression](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_compression), [DML](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dml), [page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_page).

concatenated index

See [composite index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_composite_index).

concurrency

The ability of multiple operations (in database terminology, ***transactions***) to run simultaneously, without interfering with each other. Concurrency is also involved with performance, because ideally the protection for multiple simultaneous transactions works with a minimum of performance overhead, using efficient mechanisms for ***locking***.

See Also [ACID](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_acid), [locking](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_locking), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

configuration file

The file that holds the ***option*** values used by MySQL at startup. Traditionally, on Linux and Unix this file is named my.cnf, and on Windows it is named my.ini. You can set a number of options related to InnoDB under the [mysqld] section of the file.

See [Section 4.2.2.2, “Using Option Files”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/option-files.html) for information about where MySQL searches for configuration files.

When you use the ***MySQL Enterprise Backup*** product, you typically use two configuration files: one that specifies where the data comes from and how it is structured (which could be the original configuration file for your server), and a stripped-down one containing only a small set of options that specify where the backup data goes and how it is structured. The configuration files used with the ***MySQL Enterprise Backup*** product must contain certain options that are typically left out of regular configuration files, so you might need to add options to your existing configuration file for use with ***MySQL Enterprise Backup***.

See Also [my.cnf](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_my_cnf), [MySQL Enterprise Backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysql_enterprise_backup), [option](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_option), [option file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_option_file).

connection

The communication channel between an application and a MySQL server. The performance and scalability of a database applications is influenced by on how quickly a database connection can be established, how many can be made simultaneously, and how long they persist. The parameters such as ***host***, ***port***, and so on are represented as a ***connection string*** in ***Connector/NET***, and as a ***DSN*** in ***Connector/ODBC***. High-traffic systems make use of an optimization known as the ***connection pool***.

See Also [connection pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connection_pool), [connection string](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connection_string), [Connector/NET](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_net), [Connector/ODBC](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_odbc), [DSN](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dsn), [host](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_host), [port](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_port).

connection pool

A cache area that allows database ***connections*** to be reused within the same application or across different applications, rather than setting up and tearing down a new connection for every database operation. This technique is common with ***J2EE*** application servers. ***Java*** applications using ***Connector/J*** can use the connection pool features of ***Tomcat*** and other application servers. The reuse is transparent to applications; the application still opens and closes the connection as usual.

See Also [connection](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connection), [Connector/J](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_j), [J2EE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_j2ee), [Tomcat](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_tomcat).

connection string

A representation of the parameters for a database ***connection***, encoded as a string literal so that it can be used in program code. The parts of the string represent connection parameters such as ***host*** and ***port***. A connection string contains several key-value pairs, separated by semicolons. Each key-value pair is joined with an equal sign. Frequently used with ***Connector/NET*** applications; see [Creating a Connector/NET Connection String](https://docs.oracle.com/cd/E17952_01/connector-net-en/connector-net-connections-string.html) for details.

See Also [connection](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connection), [Connector/NET](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_net), [host](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_host), [port](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_port).

connector

MySQL Connectors provide connectivity to the MySQL server for ***client*** programs. Several programming languages and frameworks each have their own associated Connector. Contrast with the lower-level access provided by an ***API***.

See Also [API](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_api), [client](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_client), [Connector/C++](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_c__), [Connector/J](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_j), [Connector/NET](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_net), [Connector/ODBC](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_odbc).

Connector/C++

Connector/C++ 8.0 can be used to access MySQL servers that implement a [document store](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/document-store.html), or in a traditional way using SQL queries. It enables development of C++ applications using X DevAPI, or plain C applications using X DevAPI for C. It also enables development of C++ applications that use the legacy JDBC-based API from Connector/C++ 1.1. For more information, see [MySQL Connector/C++ 8.0 Developer Guide](https://docs.oracle.com/cd/E17952_01/connector-cpp-8.0-en/).

See Also [client](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_client), [connector](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector), [JDBC](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_jdbc).

Connector/J

A ***JDBC*** driver that provides connectivity for ***client*** applications developed in the ***Java*** programming language. MySQL Connector/J is a JDBC Type 4 driver: a pure-Java implementation of the MySQL protocol that does not rely on the MySQL ***client libraries***. For full details, see [MySQL Connector/J 8.0 Developer Guide](https://docs.oracle.com/cd/E17952_01/connector-j-8.0-en/).

See Also [client](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_client), [client libraries](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_client_libraries), [connector](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector), [Java](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_java), [JDBC](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_jdbc).

Connector/NET

A MySQL ***connector*** for developers writing applications using languages, technologies, and frameworks such as ***C#***, ***.NET***, ***Mono***, ***Visual Studio***, ***ASP.net***, and ***ADO.net***.

See Also [ADO.NET](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ado_net), [ASP.net](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_asp_net), [connector](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector), [C#](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_csharp), [Mono](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mono), [Visual Studio](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_visual_studio).

Connector/ODBC

The family of MySQL ODBC drivers that provide access to a MySQL database using the industry standard Open Database Connectivity (***ODBC***) API. Formerly called MyODBC drivers. For full details, see [MySQL Connector/ODBC Developer Guide](https://docs.oracle.com/cd/E17952_01/connector-odbc-en/).

See Also [connector](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector), [ODBC](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_odbc).

Connector/PHP

A version of the mysql and mysqli ***APIs*** for ***PHP*** optimized for the Windows operating system.

See Also [connector](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector), [PHP](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_php), [PHP API](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_php_api).

consistent read

A read operation that uses ***snapshot*** information to present query results based on a point in time, regardless of changes performed by other transactions running at the same time. If queried data has been changed by another transaction, the original data is reconstructed based on the contents of the ***undo log***. This technique avoids some of the ***locking*** issues that can reduce ***concurrency*** by forcing transactions to wait for other transactions to finish.

With ***REPEATABLE READ*** ***isolation level***, the snapshot is based on the time when the first read operation is performed. With ***READ COMMITTED*** isolation level, the snapshot is reset to the time of each consistent read operation.

Consistent read is the default mode in which InnoDB processes SELECT statements in ***READ COMMITTED*** and ***REPEATABLE READ*** isolation levels. Because a consistent read does not set any locks on the tables it accesses, other sessions are free to modify those tables while a consistent read is being performed on the table.

For technical details about the applicable isolation levels, see [Section 15.7.2.3, “Consistent Nonlocking Reads”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-consistent-read.html).

See Also [concurrency](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_concurrency), [isolation level](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_isolation_level), [locking](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_locking), [READ COMMITTED](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_read_committed), [REPEATABLE READ](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_repeatable_read), [snapshot](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_snapshot), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction), [undo log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_undo_log).

constraint

An automatic test that can block database changes to prevent data from becoming inconsistent. (In computer science terms, a kind of assertion related to an invariant condition.) Constraints are a crucial component of the ***ACID*** philosophy, to maintain data consistency. Constraints supported by MySQL include ***FOREIGN KEY constraints*** and ***unique constraints***.

See Also [ACID](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_acid), [foreign key](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_foreign_key), [unique constraint](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_unique_constraint).

counter

A value that is incremented by a particular kind of InnoDB operation. Useful for measuring how busy a server is, troubleshooting the sources of performance issues, and testing whether changes (for example, to configuration settings or indexes used by queries) have the desired low-level effects. Different kinds of counters are available through ***Performance Schema*** tables and ***INFORMATION\_SCHEMA*** tables, particularly INFORMATION\_SCHEMA.INNODB\_METRICS.

See Also [INFORMATION\_SCHEMA](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_information_schema), [metrics counter](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_metrics_counter), [Performance Schema](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_performance_schema).

covering index

An ***index*** that includes all the columns retrieved by a query. Instead of using the index values as pointers to find the full table rows, the query returns values from the index structure, saving disk I/O. InnoDB can apply this optimization technique to more indexes than MyISAM can, because InnoDB ***secondary indexes*** also include the ***primary key*** columns. InnoDB cannot apply this technique for queries against tables modified by a transaction, until that transaction ends.

Any ***column index*** or ***composite index*** could act as a covering index, given the right query. Design your indexes and queries to take advantage of this optimization technique wherever possible.

See Also [column index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_column_index), [composite index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_composite_index), [index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index), [primary key](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_primary_key), [secondary index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_secondary_index).

CPU-bound

A type of ***workload*** where the primary ***bottleneck*** is CPU operations in memory. Typically involves read-intensive operations where the results can all be cached in the ***buffer pool***.

See Also [bottleneck](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_bottleneck), [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [workload](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_workload).

crash

MySQL uses the term “crash” to refer generally to any unexpected ***shutdown*** operation where the server cannot do its normal cleanup. For example, a crash could happen due to a hardware fault on the database server machine or storage device; a power failure; a potential data mismatch that causes the MySQL server to halt; a ***fast shutdown*** initiated by the DBA; or many other reasons. The robust, automatic ***crash recovery*** for ***InnoDB*** tables ensures that data is made consistent when the server is restarted, without any extra work for the DBA.

See Also [crash recovery](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_crash_recovery), [fast shutdown](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_fast_shutdown), [InnoDB](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_innodb), [shutdown](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_shutdown).

crash recovery

The cleanup activities that occur when MySQL is started again after a ***crash***. For ***InnoDB*** tables, changes from incomplete transactions are replayed using data from the ***redo log***. Changes that were ***committed*** before the crash, but not yet written into the ***data files***, are reconstructed from the ***doublewrite buffer***. When the database is shut down normally, this type of activity is performed during shutdown by the ***purge*** operation.

During normal operation, committed data can be stored in the ***change buffer*** for a period of time before being written to the data files. There is always a tradeoff between keeping the data files up-to-date, which introduces performance overhead during normal operation, and buffering the data, which can make shutdown and crash recovery take longer.

See Also [change buffer](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_change_buffer), [commit](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_commit), [crash](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_crash), [data files](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_data_files), [doublewrite buffer](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_doublewrite_buffer), [InnoDB](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_innodb), [purge](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_purge), [redo log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_redo_log).

CRUD

Acronym for “create, read, update, delete”, a common sequence of operations in database applications. Often denotes a class of applications with relatively simple database usage (basic ***DDL***, ***DML*** and ***query*** statements in ***SQL***) that can be implemented quickly in any language.

See Also [DDL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ddl), [DML](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dml), [query](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_query), [SQL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_sql).

cursor

An internal MySQL data structure that represents the result set of an SQL statement. Often used with ***prepared statements*** and ***dynamic SQL***. It works like an iterator in other high-level languages, producing each value from the result set as requested.

Although SQL usually handles the processing of cursors for you, you might delve into the inner workings when dealing with performance-critical code.

See Also [dynamic SQL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dynamic_sql), [prepared statement](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_prepared_statement), [query](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_query).

### D

data definition language

See [DDL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ddl).

data dictionary

Metadata that keeps track of database objects such as ***tables***, ***indexes***, and table ***columns***. For the MySQL data dictionary, introduced in MySQL 8.0, metadata is physically located in InnoDB ***file-per-table*** tablespace files in the mysql database directory. For the InnoDB data dictionary, metadata is physically located in the InnoDB ***system tablespace***.

Because the ***MySQL Enterprise Backup*** product always backs up the InnoDB system tablespace, all backups include the contents of the InnoDB data dictionary.

See Also [column](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_column), [file-per-table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_file_per_table), [.frm file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_frm_file), [index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index), [MySQL Enterprise Backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysql_enterprise_backup), [system tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_system_tablespace), [table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_table).

data directory

The directory under which each MySQL ***instance*** keeps the ***data files*** for InnoDB and the directories representing individual databases. Controlled by the [datadir](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_datadir) configuration option.

See Also [data files](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_data_files), [instance](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_instance).

data files

The files that physically contain ***table*** and ***index*** data.

The InnoDB ***system tablespace***, which holds the InnoDB ***data dictionary*** and is capable of holding data for multiple InnoDB tables, is represented by one or more .ibdata data files.

File-per-table tablespaces, which hold data for a single InnoDB table, are represented by a .ibd data file.

General tablespaces (introduced in MySQL 5.7.6), which can hold data for multiple InnoDB tables, are also represented by a .ibd data file.

See Also [data dictionary](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_data_dictionary), [file-per-table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_file_per_table), [general tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_general_tablespace), [.ibd file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ibd_file), [ibdata file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ibdata_file), [index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index), [system tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_system_tablespace), [table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_table), [tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_tablespace).

data manipulation language

See [DML](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dml).

data warehouse

A database system or application that primarily runs large ***queries***. The read-only or read-mostly data might be organized in ***denormalized*** form for query efficiency. Can benefit from the optimizations for ***read-only transactions*** in MySQL 5.6 and higher. Contrast with ***OLTP***.

See Also [denormalized](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_denormalized), [OLTP](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_oltp), [query](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_query), [read-only transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_read_only_transaction).

database

Within the MySQL ***data directory***, each database is represented by a separate directory. The InnoDB ***system tablespace***, which can hold table data from multiple databases within a MySQL ***instance***, is kept in ***data files*** that reside outside of individual database directories. When ***file-per-table*** mode is enabled, the ***.ibd files*** representing individual InnoDB tables are stored inside the database directories unless created elsewhere using the DATA DIRECTORY clause. General tablespaces, introduced in MySQL 5.7.6, also hold table data in ***.ibd files***. Unlike file-per-table ***.ibd files***, general tablespace ***.ibd files*** can hold table data from multiple databases within a MySQL ***instance***, and can be assigned to directories relative to or independent of the MySQL data directory.

For long-time MySQL users, a database is a familiar notion. Users coming from an Oracle Database background may find that the MySQL meaning of a database is closer to what Oracle Database calls a ***schema***.

See Also [data files](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_data_files), [file-per-table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_file_per_table), [.ibd file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ibd_file), [instance](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_instance), [schema](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_schema), [system tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_system_tablespace).

DCL

Data control language, a set of ***SQL*** statements for managing privileges. In MySQL, consists of the [GRANT](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/grant.html) and [REVOKE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/revoke.html) statements. Contrast with ***DDL*** and ***DML***.

See Also [DDL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ddl), [DML](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dml), [SQL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_sql).

DDEX provider

A feature that lets you use the data design tools within ***Visual Studio*** to manipulate the schema and objects within a MySQL database. For MySQL applications using ***Connector/NET***, the MySQL Visual Studio Plugin acts as a DDEX provider with MySQL 5.0 and later.

See Also [Visual Studio](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_visual_studio).

DDL

Data definition language, a set of ***SQL*** statements for manipulating the database itself rather than individual table rows. Includes all forms of the CREATE, ALTER, and DROP statements. Also includes the TRUNCATE statement, because it works differently than a DELETE FROM ***table\_name*** statement, even though the ultimate effect is similar.

DDL statements automatically ***commit*** the current ***transaction***; they cannot be ***rolled back***.

The InnoDB [online DDL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_online_ddl) feature enhances performance for [CREATE INDEX](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/create-index.html), [DROP INDEX](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/drop-index.html), and many types of [ALTER TABLE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-table.html) operations. See [Section 15.12, “InnoDB and Online DDL”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-online-ddl.html) for more information. Also, the InnoDB [file-per-table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_file_per_table) setting can affect the behavior of [DROP TABLE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/drop-table.html) and [TRUNCATE TABLE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/truncate-table.html) operations.

Contrast with ***DML*** and ***DCL***.

See Also [commit](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_commit), [DCL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dcl), [DML](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dml), [file-per-table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_file_per_table), [rollback](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_rollback), [SQL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_sql), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

deadlock

A situation where different ***transactions*** are unable to proceed, because each holds a ***lock*** that the other needs. Because both transactions are waiting for a resource to become available, neither one ever releases the locks it holds.

A deadlock can occur when the transactions lock rows in multiple tables (through statements such as UPDATE or SELECT ... FOR UPDATE), but in the opposite order. A deadlock can also occur when such statements lock ranges of index records and ***gaps***, with each transaction acquiring some locks but not others due to a timing issue.

For background information on how deadlocks are automatically detected and handled, see [Section 15.7.5.2, “Deadlock Detection”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-deadlock-detection.html). For tips on avoiding and recovering from deadlock conditions, see [Section 15.7.5.3, “How to Minimize and Handle Deadlocks”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-deadlocks-handling.html).

See Also [gap](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_gap), [lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_lock), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

deadlock detection

A mechanism that automatically detects when a ***deadlock*** occurs, and automatically ***rolls back*** one of the ***transactions*** involved (the ***victim***). Deadlock detection can be disabled using the [innodb\_deadlock\_detect](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_deadlock_detect) configuration option.

See Also [deadlock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_deadlock), [rollback](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_rollback), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction), [victim](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_victim).

delete

When InnoDB processes a DELETE statement, the rows are immediately marked for deletion and no longer are returned by queries. The storage is reclaimed sometime later, during the periodic garbage collection known as the ***purge*** operation. For removing large quantities of data, related operations with their own performance characteristics are ***TRUNCATE*** and ***DROP***.

See Also [drop](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_drop), [purge](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_purge), [truncate](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_truncate).

delete buffering

The technique of storing changes to secondary index pages, resulting from DELETE operations, in the ***change buffer*** rather than writing the changes immediately, so that the physical writes can be performed to minimize random I/O. (Because delete operations are a two-step process, this operation buffers the write that normally marks an index record for deletion.) It is one of the types of ***change buffering***; the others are ***insert buffering*** and ***purge buffering***.

See Also [change buffer](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_change_buffer), [change buffering](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_change_buffering), [insert buffer](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_insert_buffer), [insert buffering](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_insert_buffering), [purge buffering](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_purge_buffering).

denormalized

A data storage strategy that duplicates data across different tables, rather than linking the tables with ***foreign keys*** and ***join*** queries. Typically used in ***data warehouse*** applications, where the data is not updated after loading. In such applications, query performance is more important than making it simple to maintain consistent data during updates. Contrast with ***normalized***.

See Also [data warehouse](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_data_warehouse), [foreign key](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_foreign_key), [join](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_join), [normalized](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_normalized).

descending index

A type of ***index*** where index storage is optimized to process ORDER BY ***column*** DESC clauses.

See Also [index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index).

dictionary object cache

The dictionary object cache stores previously accessed ***data dictionary*** objects in memory to enable object reuse and minimize disk I/O. An ***LRU***-based eviction strategy is used to evict least recently used objects from memory. The cache is comprised of several partitions that store different object types.

For more information, see [Section 14.4, “Dictionary Object Cache”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/data-dictionary-object-cache.html).

See Also [data dictionary](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_data_dictionary), [LRU](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_lru).

dirty page

A ***page*** in the InnoDB ***buffer pool*** that has been updated in memory, where the changes are not yet written (***flushed***) to the ***data files***. The opposite of a ***clean page***.

See Also [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [clean page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_clean_page), [data files](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_data_files), [flush](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_flush), [page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_page).

dirty read

An operation that retrieves unreliable data, data that was updated by another transaction but not yet ***committed***. It is only possible with the ***isolation level*** known as ***read uncommitted***.

This kind of operation does not adhere to the ***ACID*** principle of database design. It is considered very risky, because the data could be ***rolled back***, or updated further before being committed; then, the transaction doing the dirty read would be using data that was never confirmed as accurate.

Its opposite is ***consistent read***, where InnoDB ensures that a transaction does not read information updated by another transaction, even if the other transaction commits in the meantime.

See Also [ACID](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_acid), [commit](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_commit), [consistent read](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_consistent_read), [isolation level](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_isolation_level), [READ UNCOMMITTED](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_read_uncommitted), [rollback](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_rollback).

disk-based

A kind of database that primarily organizes data on disk storage (hard drives or equivalent). Data is brought back and forth between disk and memory to be operated upon. It is the opposite of an ***in-memory database***. Although InnoDB is disk-based, it also contains features such as he ***buffer pool***, multiple buffer pool instances, and the ***adaptive hash index*** that allow certain kinds of workloads to work primarily from memory.

See Also [adaptive hash index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_adaptive_hash_index), [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [in-memory database](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_in_memory_database).

disk-bound

A type of ***workload*** where the primary ***bottleneck*** is disk I/O. (Also known as ***I/O-bound***.) Typically involves frequent writes to disk, or random reads of more data than can fit into the ***buffer pool***.

See Also [bottleneck](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_bottleneck), [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [workload](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_workload).

DML

Data manipulation language, a set of ***SQL*** statements for performing [INSERT](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/insert.html), [UPDATE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/update.html), and [DELETE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/delete.html) operations. The [SELECT](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/select.html) statement is sometimes considered as a DML statement, because the SELECT ... FOR UPDATE form is subject to the same considerations for ***locking*** as [INSERT](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/insert.html), [UPDATE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/update.html), and [DELETE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/delete.html).

DML statements for an InnoDB table operate in the context of a ***transaction***, so their effects can be ***committed*** or ***rolled back*** as a single unit.

Contrast with ***DDL*** and ***DCL***.

See Also [commit](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_commit), [DCL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dcl), [DDL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ddl), [locking](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_locking), [rollback](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_rollback), [SQL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_sql), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

document id

In the InnoDB ***full-text search*** feature, a special column in the table containing the ***FULLTEXT index***, to uniquely identify the document associated with each ***ilist*** value. Its name is FTS\_DOC\_ID (uppercase required). The column itself must be of BIGINT UNSIGNED NOT NULL type, with a unique index named FTS\_DOC\_ID\_INDEX. Preferably, you define this column when creating the table. If InnoDB must add the column to the table while creating a FULLTEXT index, the indexing operation is considerably more expensive.

See Also [full-text search](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_full_text_search), [FULLTEXT index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_fulltext_index), [ilist](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ilist).

doublewrite buffer

InnoDB uses a file flush technique called doublewrite. Before writing ***pages*** to the ***data files***, InnoDB first writes them to a storage area called the doublewrite buffer. Only after the write and the flush to the doublewrite buffer have completed, does InnoDB write the pages to their proper positions in the data file. If there is an operating system, storage subsystem, or [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) process crash in the middle of a page write, InnoDB can later find a good copy of the page from the doublewrite buffer during ***crash recovery***.

Although data is always written twice, the doublewrite buffer does not require twice as much I/O overhead or twice as many I/O operations. Data is written to the buffer itself as a large sequential chunk, with a single fsync() call to the operating system.

To turn off the doublewrite buffer, specify the option [innodb\_doublewrite=0](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_doublewrite).

See Also [crash recovery](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_crash_recovery), [data files](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_data_files), [page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_page), [purge](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_purge).

drop

A kind of ***DDL*** operation that removes a schema object, through a statement such as [DROP TABLE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/drop-table.html) or [DROP INDEX](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/drop-index.html). It maps internally to an [ALTER TABLE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-table.html) statement. From an InnoDB perspective, the performance considerations of such operations involve the time that the ***data dictionary*** is locked to ensure that interrelated objects are all updated, and the time to update memory structures such as the ***buffer pool***. For a ***table***, the drop operation has somewhat different characteristics than a ***truncate*** operation ([TRUNCATE TABLE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/truncate-table.html) statement).

See Also [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [data dictionary](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_data_dictionary), [DDL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ddl), [table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_table), [truncate](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_truncate).

DSN

Acronym for “Database Source Name”. It is the encoding for ***connection*** information within ***Connector/ODBC***. See [Configuring a Connector/ODBC DSN on Windows](https://docs.oracle.com/cd/E17952_01/connector-odbc-en/connector-odbc-configuration-dsn-windows.html) for full details. It is the equivalent of the ***connection string*** used by ***Connector/NET***.

See Also [connection](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connection), [connection string](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connection_string), [Connector/NET](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_net), [Connector/ODBC](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_odbc).

dynamic cursor

A type of ***cursor*** supported by ***ODBC*** that can pick up new and changed results when the rows are read again. Whether and how quickly the changes are visible to the cursor depends on the type of table involved (transactional or non-transactional) and the isolation level for transactional tables. Support for dynamic cursors must be explicitly enabled.

See Also [cursor](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_cursor), [ODBC](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_odbc).

dynamic row format

An InnoDB row format. Because long variable-length column values are stored outside of the page that holds the row data, it is very efficient for rows that include large objects. Since the large fields are typically not accessed to evaluate query conditions, they are not brought into the ***buffer pool*** as often, resulting in fewer I/O operations and better utilization of cache memory.

As of MySQL 5.7.9, the default row format is defined by [innodb\_default\_row\_format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_default_row_format), which has a default value of DYNAMIC.

For additional information about InnoDB DYNAMIC row format, see [DYNAMIC Row Format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-row-format.html#innodb-row-format-dynamic).

See Also [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [file format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_file_format), [row format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_row_format).

dynamic SQL

A feature that lets you create and execute ***prepared statements*** using more robust, secure, and efficient methods to substitute parameter values than the naive technique of concatenating the parts of the statement into a string variable.

See Also [prepared statement](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_prepared_statement).

dynamic statement

A ***prepared statement*** created and executed through ***dynamic SQL***.

See Also [dynamic SQL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dynamic_sql), [prepared statement](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_prepared_statement).

### E

early adopter

A stage similar to ***beta***, when a software product is typically evaluated for performance, functionality, and compatibility in a non-mission-critical setting.

See Also [beta](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_beta).

Eiffel

A programming language including many object-oriented features. Some of its concepts are familiar to ***Java*** and ***C#*** developers. For the open-source Eiffel ***API*** for MySQL, see [Section 29.13, “MySQL Eiffel Wrapper”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/apis-eiffel.html).

See Also [API](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_api), [C#](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_csharp), [Java](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_java).

embedded

The embedded MySQL server library (***libmysqld***) makes it possible to run a full-featured MySQL server inside a ***client*** application. The main benefits are increased speed and more simple management for embedded applications.

See Also [client](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_client), [libmysqld](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_libmysqld).

error log

A type of ***log*** showing information about MySQL startup and critical runtime errors and ***crash*** information. For details, see [Section 5.4.2, “The Error Log”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/error-log.html).

See Also [crash](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_crash), [log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_log).

eviction

The process of removing an item from a cache or other temporary storage area, such as the InnoDB ***buffer pool***. Often, but not always, uses the ***LRU*** algorithm to determine which item to remove. When a ***dirty page*** is evicted, its contents are ***flushed*** to disk, and any dirty ***neighbor pages*** might be flushed also.

See Also [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [dirty page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dirty_page), [flush](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_flush), [LRU](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_lru), [neighbor page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_neighbor_page).

exception interceptor

A type of ***interceptor*** for tracing, debugging, or augmenting SQL errors encountered by a database application. For example, the interceptor code could issue a SHOW WARNINGS statement to retrieve additional information, and add descriptive text or even change the type of the exception returned to the application. Because the interceptor code is only called when SQL statements return errors, it does not impose any performance penalty on the application during normal (error-free) operation.

In ***Java*** applications using ***Connector/J***, setting up this type of interceptor involves implementing the com.mysql.jdbc.ExceptionInterceptor interface, and adding a exceptionInterceptors property to the ***connection string***.

In ***Visual Studio*** applications using ***Connector/NET***, setting up this type of interceptor involves defining a class that inherits from the BaseExceptionInterceptor class and specifying that class name as part of the connection string.

See Also [Connector/J](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_j), [Connector/NET](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_net), [interceptor](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_interceptor), [Java](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_java), [Visual Studio](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_visual_studio).

exclusive lock

A kind of ***lock*** that prevents any other ***transaction*** from locking the same row. Depending on the transaction ***isolation level***, this kind of lock might block other transactions from writing to the same row, or might also block other transactions from reading the same row. The default InnoDB isolation level, ***REPEATABLE READ***, enables higher ***concurrency*** by allowing transactions to read rows that have exclusive locks, a technique known as ***consistent read***.

See Also [concurrency](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_concurrency), [consistent read](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_consistent_read), [isolation level](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_isolation_level), [lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_lock), [REPEATABLE READ](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_repeatable_read), [shared lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_shared_lock), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

extent

A group of ***pages*** within a ***tablespace***. For the default ***page size*** of 16KB, an extent contains 64 pages. In MySQL 5.6, the page size for an InnoDB instance can be 4KB, 8KB, or 16KB, controlled by the [innodb\_page\_size](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_page_size) configuration option. For 4KB, 8KB, and 16KB pages sizes, the extent size is always 1MB (or 1048576 bytes).

Support for 32KB and 64KB InnoDB page sizes was added in MySQL 5.7.6. For a 32KB page size, the extent size is 2MB. For a 64KB page size, the extent size is 4MB.

InnoDB features such as ***segments***, ***read-ahead*** requests and the ***doublewrite buffer*** use I/O operations that read, write, allocate, or free data one extent at a time.

See Also [doublewrite buffer](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_doublewrite_buffer), [page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_page), [page size](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_page_size), [read-ahead](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_read_ahead), [segment](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_segment), [tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_tablespace).

### F

.frm file

A file containing the metadata, such as the table definition, of a MySQL table. .frm files were removed in MySQL 8.0 but are still used in earlier MySQL releases. In MySQL 8.0, data previously stored in .frm files is stored in ***data dictionary*** tables.

See Also [data dictionary](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_data_dictionary), [MySQL Enterprise Backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysql_enterprise_backup), [system tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_system_tablespace).

failover

The ability to automatically switch to a standby server in the event of a failure. In the MySQL context, failover involves a standby database server. Often supported within ***J2EE*** environments by the application server or framework.

See Also [Connector/J](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_j), [J2EE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_j2ee).

Fast Index Creation

A capability first introduced in the InnoDB Plugin, now part of MySQL in 5.5 and higher, that speeds up creation of InnoDB ***secondary indexes*** by avoiding the need to completely rewrite the associated table. The speedup applies to dropping secondary indexes also.

Because index maintenance can add performance overhead to many data transfer operations, consider doing operations such as ALTER TABLE ... ENGINE=INNODB or INSERT INTO ... SELECT \* FROM ... without any secondary indexes in place, and creating the indexes afterward.

In MySQL 5.6, this feature becomes more general. You can read and write to tables while an index is being created, and many more kinds of [ALTER TABLE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-table.html) operations can be performed without copying the table, without blocking ***DML*** operations, or both. Thus in MySQL 5.6 and higher, this set of features is referred to as ***online DDL*** rather than Fast Index Creation.

For related information, see [Section 15.12, “InnoDB and Online DDL”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-online-ddl.html).

See Also [DML](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dml), [index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index), [online DDL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_online_ddl), [secondary index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_secondary_index).

fast shutdown

The default ***shutdown*** procedure for InnoDB, based on the configuration setting [innodb\_fast\_shutdown=1](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_fast_shutdown). To save time, certain ***flush*** operations are skipped. This type of shutdown is safe during normal usage, because the flush operations are performed during the next startup, using the same mechanism as in ***crash recovery***. In cases where the database is being shut down for an upgrade or downgrade, do a ***slow shutdown*** instead to ensure that all relevant changes are applied to the ***data files*** during the shutdown.

See Also [crash recovery](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_crash_recovery), [data files](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_data_files), [flush](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_flush), [shutdown](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_shutdown), [slow shutdown](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_slow_shutdown).

file format

The file format for InnoDB tables.

See Also [file-per-table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_file_per_table), [.ibd file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ibd_file), [ibdata file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ibdata_file), [row format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_row_format).

file-per-table

A general name for the setting controlled by the [innodb\_file\_per\_table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_file_per_table) option, which is an important configuration option that affects aspects of InnoDB file storage, availability of features, and I/O characteristics. As of MySQL 5.6.7, [innodb\_file\_per\_table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_file_per_table) is enabled by default.

With the [innodb\_file\_per\_table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_file_per_table) option enabled, you can create a table in its own ***.ibd file*** rather than in the shared ***ibdata files*** of the ***system tablespace***. When table data is stored in an individual ***.ibd file***, you have more flexibility to choose ***row formats*** required for features such as data ***compression***. The TRUNCATE TABLE operation is also faster, and reclaimed space can be used by the operating system rather than remaining reserved for InnoDB.

The ***MySQL Enterprise Backup*** product is more flexible for tables that are in their own files. For example, tables can be excluded from a backup, but only if they are in separate files. Thus, this setting is suitable for tables that are backed up less frequently or on a different schedule.

See Also [compressed row format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_compressed_row_format), [compression](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_compression), [file format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_file_format), [.ibd file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ibd_file), [ibdata file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ibdata_file), [innodb\_file\_per\_table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_innodb_file_per_table), [MySQL Enterprise Backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysql_enterprise_backup), [row format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_row_format), [system tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_system_tablespace).

fill factor

In an InnoDB ***index***, the proportion of a ***page*** that is taken up by index data before the page is split. The unused space when index data is first divided between pages allows for rows to be updated with longer string values without requiring expensive index maintenance operations. If the fill factor is too low, the index consumes more space than needed, causing extra I/O overhead when reading the index. If the fill factor is too high, any update that increases the length of column values can cause extra I/O overhead for index maintenance. See [Section 15.6.2.2, “The Physical Structure of an InnoDB Index”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-physical-structure.html) for more information.

See Also [index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index), [page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_page).

fixed row format

This row format is used by the MyISAM storage engine, not by InnoDB. If you create an InnoDB table with the option ROW\_FORMAT=FIXED in MySQL 5.7.6 or earlier, InnoDB uses the ***compact row format*** instead, although the FIXED value might still show up in output such as SHOW TABLE STATUS reports. As of MySQL 5.7.7, InnoDB returns an error if ROW\_FORMAT=FIXED is specified.

See Also [compact row format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_compact_row_format), [row format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_row_format).

flush

To write changes to the database files, that had been buffered in a memory area or a temporary disk storage area. The InnoDB storage structures that are periodically flushed include the ***redo log***, the ***undo log***, and the ***buffer pool***.

Flushing can happen because a memory area becomes full and the system needs to free some space, because a ***commit*** operation means the changes from a transaction can be finalized, or because a ***slow shutdown*** operation means that all outstanding work should be finalized. When it is not critical to flush all the buffered data at once, InnoDB can use a technique called ***fuzzy checkpointing*** to flush small batches of pages to spread out the I/O overhead.

See Also [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [commit](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_commit), [fuzzy checkpointing](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_fuzzy_checkpointing), [redo log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_redo_log), [slow shutdown](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_slow_shutdown), [undo log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_undo_log).

flush list

An internal InnoDB data structure that tracks ***dirty pages*** in the ***buffer pool***: that is, ***pages*** that have been changed and need to be written back out to disk. This data structure is updated frequently by InnoDB internal ***mini-transactions***, and so is protected by its own ***mutex*** to allow concurrent access to the buffer pool.

See Also [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [dirty page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dirty_page), [LRU](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_lru), [mini-transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mini_transaction), [mutex](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mutex), [page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_page), [page cleaner](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_page_cleaner).

foreign key

A type of pointer relationship, between rows in separate InnoDB tables. The foreign key relationship is defined on one column in both the ***parent table*** and the ***child table***.

In addition to enabling fast lookup of related information, foreign keys help to enforce ***referential integrity***, by preventing any of these pointers from becoming invalid as data is inserted, updated, and deleted. This enforcement mechanism is a type of ***constraint***. A row that points to another table cannot be inserted if the associated foreign key value does not exist in the other table. If a row is deleted or its foreign key value changed, and rows in another table point to that foreign key value, the foreign key can be set up to prevent the deletion, cause the corresponding column values in the other table to become ***null***, or automatically delete the corresponding rows in the other table.

One of the stages in designing a ***normalized*** database is to identify data that is duplicated, separate that data into a new table, and set up a foreign key relationship so that the multiple tables can be queried like a single table, using a ***join*** operation.

See Also [child table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_child_table), [FOREIGN KEY constraint](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_foreign_key_constraint), [join](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_join), [normalized](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_normalized), [NULL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_null), [parent table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_parent_table), [referential integrity](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_referential_integrity), [relational](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_relational).

FOREIGN KEY constraint

The type of ***constraint*** that maintains database consistency through a ***foreign key*** relationship. Like other kinds of constraints, it can prevent data from being inserted or updated if data would become inconsistent; in this case, the inconsistency being prevented is between data in multiple tables. Alternatively, when a ***DML*** operation is performed, FOREIGN KEY constraints can cause data in ***child rows*** to be deleted, changed to different values, or set to ***null***, based on the ON CASCADE option specified when creating the foreign key.

See Also [child table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_child_table), [constraint](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_constraint), [DML](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dml), [foreign key](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_foreign_key), [NULL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_null).

FTS

In most contexts, an acronym for ***full-text search***. Sometimes in performance discussions, an acronym for ***full table scan***.

See Also [full table scan](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_full_table_scan), [full-text search](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_full_text_search).

full backup

A ***backup*** that includes all the ***tables*** in each MySQL ***database***, and all the databases in a MySQL ***instance***. Contrast with ***partial backup***.

See Also [backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_backup), [database](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_database), [instance](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_instance), [partial backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_partial_backup), [table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_table).

full table scan

An operation that requires reading the entire contents of a table, rather than just selected portions using an ***index***. Typically performed either with small lookup tables, or in data warehousing situations with large tables where all available data is aggregated and analyzed. How frequently these operations occur, and the sizes of the tables relative to available memory, have implications for the algorithms used in query optimization and managing the ***buffer pool***.

The purpose of indexes is to allow lookups for specific values or ranges of values within a large table, thus avoiding full table scans when practical.

See Also [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index).

full-text search

The MySQL feature for finding words, phrases, Boolean combinations of words, and so on within table data, in a faster, more convenient, and more flexible way than using the SQL LIKE operator or writing your own application-level search algorithm. It uses the SQL function [MATCH()](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/fulltext-search.html#function_match) and ***FULLTEXT indexes***.

See Also [FULLTEXT index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_fulltext_index).

FULLTEXT index

The special kind of ***index*** that holds the ***search index*** in the MySQL ***full-text search*** mechanism. Represents the words from values of a column, omitting any that are specified as ***stopwords***. Originally, only available for MyISAM tables. Starting in MySQL 5.6.4, it is also available for ***InnoDB*** tables.

See Also [full-text search](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_full_text_search), [index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index), [InnoDB](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_innodb), [search index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_search_index), [stopword](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_stopword).

fuzzy checkpointing

A technique that ***flushes*** small batches of ***dirty pages*** from the ***buffer pool***, rather than flushing all dirty pages at once which would disrupt database processing.

See Also [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [dirty page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dirty_page), [flush](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_flush).

### G

GA

“Generally available”, the stage when a software product leaves ***beta*** and is available for sale, official support, and production use.

See Also [beta](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_beta).

GAC

Acronym for “Global Assembly Cache”. A central area for storing libraries (***assemblies***) on a ***.NET*** system. Physically consists of nested folders, treated as a single virtual folder by the ***.NET*** CLR.

See Also [.NET](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos__net), [assembly](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_assembly).

gap

A place in an InnoDB ***index*** data structure where new values could be inserted. When you lock a set of rows with a statement such as SELECT ... FOR UPDATE, InnoDB can create locks that apply to the gaps as well as the actual values in the index. For example, if you select all values greater than 10 for update, a gap lock prevents another transaction from inserting a new value that is greater than 10. The ***supremum record*** and ***infimum record*** represent the gaps containing all values greater than or less than all the current index values.

See Also [concurrency](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_concurrency), [gap lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_gap_lock), [index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index), [infimum record](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_infimum_record), [isolation level](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_isolation_level), [supremum record](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_supremum_record).

gap lock

A ***lock*** on a ***gap*** between index records, or a lock on the gap before the first or after the last index record. For example, SELECT c1 FROM t WHERE c1 BETWEEN 10 and 20 FOR UPDATE; prevents other transactions from inserting a value of 15 into the column t.c1, whether or not there was already any such value in the column, because the gaps between all existing values in the range are locked. Contrast with ***record lock*** and ***next-key lock***.

Gap locks are part of the tradeoff between performance and ***concurrency***, and are used in some transaction ***isolation levels*** and not others.

See Also [gap](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_gap), [infimum record](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_infimum_record), [lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_lock), [next-key lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_next_key_lock), [record lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_record_lock), [supremum record](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_supremum_record).

general log

See [general query log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_general_query_log).

general query log

A type of ***log*** used for diagnosis and troubleshooting of SQL statements processed by the MySQL server. Can be stored in a file or in a database table. You must enable this feature through the [general\_log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_general_log) configuration option to use it. You can disable it for a specific connection through the [sql\_log\_off](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/server-system-variables.html#sysvar_sql_log_off) configuration option.

Records a broader range of queries than the ***slow query log***. Unlike the ***binary log***, which is used for replication, the general query log contains [SELECT](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/select.html) statements and does not maintain strict ordering. For more information, see [Section 5.4.3, “The General Query Log”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/query-log.html).

See Also [binary log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_binary_log), [log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_log), [slow query log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_slow_query_log).

general tablespace

A shared InnoDB ***tablespace*** created using [CREATE TABLESPACE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/create-tablespace.html) syntax. General tablespaces can be created outside of the MySQL data directory, are capable of holding multiple ***tables***, and support tables of all row formats. General tablespaces were introduced in MySQL 5.7.6.

Tables are added to a general tablespace using [CREATE TABLE ***tbl\_name*** ... TABLESPACE [=] ***tablespace\_name***](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/create-table.html) or [ALTER TABLE ***tbl\_name*** TABLESPACE [=] ***tablespace\_name***](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-table.html) syntax.

Contrast with ***system tablespace*** and ***file-per-table*** tablespace.

For more information, see [Section 15.6.3.3, “General Tablespaces”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/general-tablespaces.html).

See Also [file-per-table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_file_per_table), [system tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_system_tablespace), [table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_table), [tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_tablespace).

generated column

A column whose values are computed from an expression included in the column definition. A generated column can be ***virtual*** or ***stored***.

See Also [base column](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_base_column), [stored generated column](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_stored_generated_column), [virtual generated column](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_virtual_generated_column).

generated stored column

See [stored generated column](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_stored_generated_column).

generated virtual column

See [virtual generated column](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_virtual_generated_column).

Glassfish

See Also [J2EE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_j2ee).

global temporary tablespace

A temporary tablespace that stores rollback segments for changes made to user-created temporary tables.

See Also [temporary tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_temporary_tablespace).

global transaction

A type of ***transaction*** involved in ***XA*** operations. It consists of several actions that are transactional in themselves, but that all must either complete successfully as a group, or all be rolled back as a group. In essence, this extends ***ACID*** properties “up a level” so that multiple ACID transactions can be executed in concert as components of a global operation that also has ACID properties.

See Also [ACID](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_acid), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction), [XA](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_xa).

group commit

An InnoDB optimization that performs some low-level I/O operations (log write) once for a set of ***commit*** operations, rather than flushing and syncing separately for each commit.

See Also [binary log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_binary_log), [commit](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_commit).

GUID

Acronym for “globally unique identifier”, an ID value that can be used to associate data across different databases, languages, operating systems, and so on. (As an alternative to using sequential integers, where the same values could appear in different tables, databases, and so on referring to different data.) Older MySQL versions represented it as BINARY(16). Currently, it is represented as CHAR(36). MySQL has a UUID() function that returns GUID values in character format, and a UUID\_SHORT() function that returns GUID values in integer format. Because successive GUID values are not necessarily in ascending sort order, it is not an efficient value to use as a primary key for large InnoDB tables.

### H

hash index

A type of ***index*** intended for queries that use equality operators, rather than range operators such as greater-than or BETWEEN. It is available for [MEMORY](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/memory-storage-engine.html) tables. Although hash indexes are the default for [MEMORY](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/memory-storage-engine.html) tables for historic reasons, that storage engine also supports ***B-tree*** indexes, which are often a better choice for general-purpose queries.

MySQL includes a variant of this index type, the ***adaptive hash index***, that is constructed automatically for [InnoDB](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-storage-engine.html) tables if needed based on runtime conditions.

See Also [adaptive hash index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_adaptive_hash_index), [B-tree](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_b_tree), [index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index), [InnoDB](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_innodb).

HDD

Acronym for “hard disk drive”. Refers to storage media using spinning platters, usually when comparing and contrasting with ***SSD***. Its performance characteristics can influence the throughput of a ***disk-based*** workload.

See Also [disk-based](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_disk_based), [SSD](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ssd).

heartbeat

A periodic message that is sent to indicate that a system is functioning properly. In a ***replication*** context, if the ***source*** stops sending such messages, one of the ***replicas*** can take its place. Similar techniques can be used between the servers in a cluster environment, to confirm that all of them are operating properly.

See Also [replication](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_replication), [source](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_source).

high-water mark

A value representing an upper limit, either a hard limit that should not be exceeded at runtime, or a record of the maximum value that was actually reached. Contrast with ***low-water mark***.

See Also [low-water mark](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_low_water_mark).

history list

A list of ***transactions*** with delete-marked records scheduled to be processed by the InnoDB ***purge*** operation. Recorded in the ***undo log***. The length of the history list is reported by the command SHOW ENGINE INNODB STATUS. If the history list grows longer than the value of the [innodb\_max\_purge\_lag](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_max_purge_lag) configuration option, each ***DML*** operation is delayed slightly to allow the purge operation to finish ***flushing*** the deleted records.

Also known as ***purge lag***.

See Also [DML](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dml), [flush](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_flush), [purge](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_purge), [purge lag](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_purge_lag), [rollback segment](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_rollback_segment), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction), [undo log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_undo_log).

hole punching

Releasing empty blocks from a page. The InnoDB ***transparent page compression*** feature relies on hole punching support. For more information, see [Section 15.9.2, “InnoDB Page Compression”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-page-compression.html).

See Also [sparse file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_sparse_file), [transparent page compression](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transparent_page_compression).

host

The network name of a database server, used to establish a ***connection***. Often specified in conjunction with a ***port***. In some contexts, the IP address 127.0.0.1 works better than the special name localhost for accessing a database on the same server as the application.

See Also [connection](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connection), [localhost](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_localhost), [port](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_port).

hot

A condition where a row, table, or internal data structure is accessed so frequently, requiring some form of locking or mutual exclusion, that it results in a performance or scalability issue.

Although “hot” typically indicates an undesirable condition, a ***hot backup*** is the preferred type of backup.

See Also [hot backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_hot_backup).

hot backup

A backup taken while the database is running and applications are reading and writing to it. The backup involves more than simply copying data files: it must include any data that was inserted or updated while the backup was in process; it must exclude any data that was deleted while the backup was in process; and it must ignore any changes that were not committed.

The Oracle product that performs hot backups, of InnoDB tables especially but also tables from MyISAM and other storage engines, is known as ***MySQL Enterprise Backup***.

The hot backup process consists of two stages. The initial copying of the data files produces a ***raw backup***. The ***apply*** step incorporates any changes to the database that happened while the backup was running. Applying the changes produces a ***prepared*** backup; these files are ready to be restored whenever necessary.

See Also [apply](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_apply), [MySQL Enterprise Backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysql_enterprise_backup), [prepared backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_prepared_backup), [raw backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_raw_backup).

### I

.ibd file

The data file for ***file-per-table*** tablespaces and general tablespaces. File-per-table tablespace .ibd files contain a single table and associated index data. ***General tablespace*** .ibd files may contain table and index data for multiple tables.

The .ibd file extension does not apply to the ***system tablespace***, which consists of one or more ***ibdata files***.

If a file-per-table tablespace or general tablespace is created with the DATA DIRECTORY = clause, the .ibd file is located at the specified path, outside the normal data directory.

When a .ibd file is included in a compressed backup by the ***MySQL Enterprise Backup*** product, the compressed equivalent is a .ibz file.

See Also [database](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_database), [file-per-table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_file_per_table), [general tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_general_tablespace), [ibdata file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ibdata_file), [.ibz file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ibz_file), [innodb\_file\_per\_table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_innodb_file_per_table), [MySQL Enterprise Backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysql_enterprise_backup), [system tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_system_tablespace).

.ibz file

When the ***MySQL Enterprise Backup*** product performs a ***compressed backup***, it transforms each ***tablespace*** file that is created using the ***file-per-table*** setting from a .ibd extension to a .ibz extension.

The compression applied during backup is distinct from the ***compressed row format*** that keeps table data compressed during normal operation. A compressed backup operation skips the compression step for a tablespace that is already in compressed row format, as compressing a second time would slow down the backup but produce little or no space savings.

See Also [compressed backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_compressed_backup), [compressed row format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_compressed_row_format), [file-per-table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_file_per_table), [.ibd file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ibd_file), [MySQL Enterprise Backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysql_enterprise_backup), [tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_tablespace).

I/O-bound

See [disk-bound](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_disk_bound).

ib-file set

The set of files managed by InnoDB within a MySQL database: the ***system tablespace***, ***file-per-table*** tablespace files, and ***redo log*** files. Depending on MySQL version and InnoDB configuration, may also include ***general tablespace***, ***temporary tablespace***, and ***undo tablespace*** files. This term is sometimes used in detailed discussions of InnoDB file structures and formats to refer to the set of files managed by InnoDB within a MySQL database.

See Also [database](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_database), [file-per-table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_file_per_table), [general tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_general_tablespace), [redo log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_redo_log), [system tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_system_tablespace), [temporary tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_temporary_tablespace), [undo tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_undo_tablespace).

ibbackup\_logfile

A supplemental backup file created by the ***MySQL Enterprise Backup*** product during a ***hot backup*** operation. It contains information about any data changes that occurred while the backup was running. The initial backup files, including ibbackup\_logfile, are known as a ***raw backup***, because the changes that occurred during the backup operation are not yet incorporated. After you perform the ***apply*** step to the raw backup files, the resulting files do include those final data changes, and are known as a ***prepared backup***. At this stage, the ibbackup\_logfile file is no longer necessary.

See Also [apply](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_apply), [hot backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_hot_backup), [MySQL Enterprise Backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysql_enterprise_backup), [prepared backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_prepared_backup), [raw backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_raw_backup).

ibdata file

A set of files with names such as ibdata1, ibdata2, and so on, that make up the InnoDB ***system tablespace***. For information about the structures and data that reside in the system tablespace ibdata files, see [Section 15.6.3.1, “The System Tablespace”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-system-tablespace.html).

Growth of the ibdata files is influenced by the [innodb\_autoextend\_increment](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_autoextend_increment) configuration option.

See Also [change buffer](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_change_buffer), [data dictionary](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_data_dictionary), [doublewrite buffer](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_doublewrite_buffer), [file-per-table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_file_per_table), [.ibd file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ibd_file), [innodb\_file\_per\_table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_innodb_file_per_table), [system tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_system_tablespace), [undo log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_undo_log).

ibtmp file

The InnoDB ***temporary tablespace*** ***data file*** for non-compressed InnoDB ***temporary tables*** and related objects. The configuration file option, [innodb\_temp\_data\_file\_path](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_temp_data_file_path), allows users to define a relative path for the temporary tablespace data file. If [innodb\_temp\_data\_file\_path](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_temp_data_file_path) is not specified, the default behavior is to create a single auto-extending 12MB data file named ibtmp1 in the data directory, alongside ibdata1.

See Also [data files](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_data_files), [temporary table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_temporary_table), [temporary tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_temporary_tablespace).

ib\_logfile

A set of files, typically named ib\_logfile0 and ib\_logfile1, that form the ***redo log***. Also sometimes referred to as the ***log group***. These files record statements that attempt to change data in InnoDB tables. These statements are replayed automatically to correct data written by incomplete transactions, on startup following a crash.

This data cannot be used for manual recovery; for that type of operation, use the ***binary log***.

See Also [binary log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_binary_log), [log group](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_log_group), [redo log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_redo_log).

ilist

Within an InnoDB ***FULLTEXT index***, the data structure consisting of a document ID and positional information for a token (that is, a particular word).

See Also [FULLTEXT index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_fulltext_index).

implicit row lock

A row lock that InnoDB acquires to ensure consistency, without you specifically requesting it.

See Also [row lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_row_lock).

in-memory database

A type of database system that maintains data in memory, to avoid overhead due to disk I/O and translation between disk blocks and memory areas. Some in-memory databases sacrifice durability (the “D” in the ***ACID*** design philosophy) and are vulnerable to hardware, power, and other types of failures, making them more suitable for read-only operations. Other in-memory databases do use durability mechanisms such as logging changes to disk or using non-volatile memory.

MySQL features that address the same kinds of memory-intensive processing include the InnoDB ***buffer pool***, ***adaptive hash index***, and ***read-only transaction*** optimization, the [MEMORY](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/memory-storage-engine.html) storage engine, the MyISAM key cache, and the MySQL query cache.

See Also [ACID](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_acid), [adaptive hash index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_adaptive_hash_index), [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [disk-based](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_disk_based), [read-only transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_read_only_transaction).

incremental backup

A type of ***hot backup***, performed by the ***MySQL Enterprise Backup*** product, that only saves data changed since some point in time. Having a full backup and a succession of incremental backups lets you reconstruct backup data over a long period, without the storage overhead of keeping several full backups on hand. You can restore the full backup and then apply each of the incremental backups in succession, or you can keep the full backup up-to-date by applying each incremental backup to it, then perform a single restore operation.

The granularity of changed data is at the ***page*** level. A page might actually cover more than one row. Each changed page is included in the backup.

See Also [hot backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_hot_backup), [MySQL Enterprise Backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysql_enterprise_backup), [page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_page).

index

A data structure that provides a fast lookup capability for ***rows*** of a ***table***, typically by forming a tree structure (***B-tree)*** representing all the values of a particular ***column*** or set of columns.

InnoDB tables always have a ***clustered index*** representing the ***primary key***. They can also have one or more ***secondary indexes*** defined on one or more columns. Depending on their structure, secondary indexes can be classified as ***partial***, ***column***, or ***composite*** indexes.

Indexes are a crucial aspect of ***query*** performance. Database architects design tables, queries, and indexes to allow fast lookups for data needed by applications. The ideal database design uses a ***covering index*** where practical; the query results are computed entirely from the index, without reading the actual table data. Each ***foreign key*** constraint also requires an index, to efficiently check whether values exist in both the ***parent*** and ***child*** tables.

Although a B-tree index is the most common, a different kind of data structure is used for ***hash indexes***, as in the MEMORY storage engine and the InnoDB ***adaptive hash index***. ***R-tree*** indexes are used for spatial indexing of multi-dimensional information.

See Also [adaptive hash index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_adaptive_hash_index), [B-tree](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_b_tree), [child table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_child_table), [clustered index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_clustered_index), [column index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_column_index), [composite index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_composite_index), [covering index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_covering_index), [foreign key](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_foreign_key), [hash index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_hash_index), [parent table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_parent_table), [partial index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_partial_index), [primary key](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_primary_key), [query](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_query), [R-tree](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_r_tree), [row](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_row), [secondary index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_secondary_index), [table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_table).

index cache

A memory area that holds the token data for InnoDB ***full-text search***. It buffers the data to minimize disk I/O when data is inserted or updated in columns that are part of a ***FULLTEXT index***. The token data is written to disk when the index cache becomes full. Each InnoDB FULLTEXT index has its own separate index cache, whose size is controlled by the configuration option [innodb\_ft\_cache\_size](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_ft_cache_size).

See Also [full-text search](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_full_text_search), [FULLTEXT index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_fulltext_index).

index condition pushdown

Index condition pushdown (ICP) is an optimization that pushes part of a WHERE condition down to the storage engine if parts of the condition can be evaluated using fields from the ***index***. ICP can reduce the number of times the ***storage engine*** must access the base table and the number of times the MySQL server must access the storage engine. For more information, see [Section 8.2.1.6, “Index Condition Pushdown Optimization”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/index-condition-pushdown-optimization.html).

See Also [index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index), [storage engine](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_storage_engine).

index hint

Extended SQL syntax for overriding the ***indexes*** recommended by the optimizer. For example, the FORCE INDEX, USE INDEX, and IGNORE INDEX clauses. Typically used when indexed columns have unevenly distributed values, resulting in inaccurate ***cardinality*** estimates.

See Also [cardinality](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_cardinality), [index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index).

index prefix

In an ***index*** that applies to multiple columns (known as a ***composite index***), the initial or leading columns of the index. A query that references the first 1, 2, 3, and so on columns of a composite index can use the index, even if the query does not reference all the columns in the index.

See Also [composite index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_composite_index), [index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index).

index statistics

See [statistics](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_statistics).

infimum record

A ***pseudo-record*** in an ***index***, representing the ***gap*** below the smallest value in that index. If a transaction has a statement such as SELECT ... FROM ... WHERE col < 10 FOR UPDATE;, and the smallest value in the column is 5, it is a lock on the infimum record that prevents other transactions from inserting even smaller values such as 0, -10, and so on.

See Also [gap](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_gap), [index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index), [pseudo-record](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_pseudo_record), [supremum record](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_supremum_record).

INFORMATION\_SCHEMA

The name of the ***database*** that provides a query interface to the MySQL ***data dictionary***. (This name is defined by the ANSI SQL standard.) To examine information (metadata) about the database, you can query tables such as INFORMATION\_SCHEMA.TABLES and INFORMATION\_SCHEMA.COLUMNS, rather than using SHOW commands that produce unstructured output.

The INFORMATION\_SCHEMA database also contains tables specific to ***InnoDB*** that provide a query interface to the InnoDB data dictionary. You use these tables not to see how the database is structured, but to get real-time information about the workings of InnoDB tables to help with performance monitoring, tuning, and troubleshooting.

See Also [data dictionary](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_data_dictionary), [database](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_database), [InnoDB](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_innodb).

InnoDB

A MySQL component that combines high performance with ***transactional*** capability for reliability, robustness, and concurrent access. It embodies the ***ACID*** design philosophy. Represented as a ***storage engine***; it handles tables created or altered with the ENGINE=INNODB clause. See [Chapter 15, The InnoDB Storage Engine](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-storage-engine.html) for architectural details and administration procedures, and [Section 8.5, “Optimizing for InnoDB Tables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/optimizing-innodb.html) for performance advice.

In MySQL 5.5 and higher, InnoDB is the default storage engine for new tables and the ENGINE=INNODB clause is not required.

InnoDB tables are ideally suited for ***hot backups***. See [Section 30.2, “MySQL Enterprise Backup Overview”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-enterprise-backup.html) for information about the ***MySQL Enterprise Backup*** product for backing up MySQL servers without interrupting normal processing.

See Also [ACID](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_acid), [hot backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_hot_backup), [MySQL Enterprise Backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysql_enterprise_backup), [storage engine](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_storage_engine), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

innodb\_autoinc\_lock\_mode

The [innodb\_autoinc\_lock\_mode](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_autoinc_lock_mode) option controls the algorithm used for ***auto-increment locking***. When you have an auto-incrementing ***primary key***, you can use statement-based replication only with the setting [innodb\_autoinc\_lock\_mode=1](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_autoinc_lock_mode). This setting is known as consecutive lock mode, because multi-row inserts within a transaction receive consecutive auto-increment values. If you have [innodb\_autoinc\_lock\_mode=2](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_autoinc_lock_mode), which allows higher concurrency for insert operations, use row-based replication rather than statement-based replication. This setting is known as interleaved lock mode, because multiple multi-row insert statements running at the same time can receive ***auto-increment*** values that are interleaved. The setting [innodb\_autoinc\_lock\_mode=0](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_autoinc_lock_mode) should not be used except for compatibility purposes.

Consecutive lock mode ([innodb\_autoinc\_lock\_mode=1](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_autoinc_lock_mode)) is the default setting prior to MySQL 8.0.3. As of MySQL 8.0.3, interleaved lock mode ([innodb\_autoinc\_lock\_mode=2](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_autoinc_lock_mode)) is the default, which reflects the change from statement-based to row-based replication as the default replication type.

See Also [auto-increment](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_auto_increment), [auto-increment locking](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_auto_increment_locking), [mixed-mode insert](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mixed_mode_insert), [primary key](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_primary_key).

innodb\_file\_per\_table

An important configuration option that affects many aspects of InnoDB file storage, availability of features, and I/O characteristics. In MySQL 5.6.7 and higher, it is enabled by default. The [innodb\_file\_per\_table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_file_per_table) option turns on ***file-per-table*** mode. With this mode enabled, a newly created InnoDB table and associated indexes can be stored in a file-per-table ***.ibd file***, outside the ***system tablespace***.

This option affects the performance and storage considerations for a number of SQL statements, such as [DROP TABLE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/drop-table.html) and [TRUNCATE TABLE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/truncate-table.html).

Enabling the [innodb\_file\_per\_table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_file_per_table) option allows you to take advantage of features such as table ***compression*** and named-table backups in ***MySQL Enterprise Backup***.

For more information, see [innodb\_file\_per\_table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_file_per_table), and [Section 15.6.3.2, “File-Per-Table Tablespaces”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-file-per-table-tablespaces.html).

See Also [compression](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_compression), [file-per-table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_file_per_table), [.ibd file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ibd_file), [MySQL Enterprise Backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysql_enterprise_backup), [system tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_system_tablespace).

innodb\_lock\_wait\_timeout

The [innodb\_lock\_wait\_timeout](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_lock_wait_timeout) option sets the balance between ***waiting*** for shared resources to become available, or giving up and handling the error, retrying, or doing alternative processing in your application. Rolls back any InnoDB transaction that waits more than a specified time to acquire a ***lock***. Especially useful if ***deadlocks*** are caused by updates to multiple tables controlled by different storage engines; such deadlocks are not ***detected*** automatically.

See Also [deadlock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_deadlock), [deadlock detection](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_deadlock_detection), [lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_lock), [wait](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_wait).

innodb\_strict\_mode

The [innodb\_strict\_mode](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_strict_mode) option controls whether InnoDB operates in ***strict mode***, where conditions that are normally treated as warnings, cause errors instead (and the underlying statements fail).

See Also [strict mode](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_strict_mode).

insert

One of the primary ***DML*** operations in ***SQL***. The performance of inserts is a key factor in ***data warehouse*** systems that load millions of rows into tables, and ***OLTP*** systems where many concurrent connections might insert rows into the same table, in arbitrary order. If insert performance is important to you, you should learn about ***InnoDB*** features such as the ***insert buffer*** used in ***change buffering***, and ***auto-increment*** columns.

See Also [auto-increment](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_auto_increment), [change buffering](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_change_buffering), [data warehouse](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_data_warehouse), [DML](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dml), [InnoDB](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_innodb), [insert buffer](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_insert_buffer), [OLTP](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_oltp), [SQL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_sql).

insert buffer

The former name of the ***change buffer***. In MySQL 5.5, support was added for buffering changes to secondary index pages for [DELETE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/delete.html) and [UPDATE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/update.html) operations. Previously, only changes resulting from [INSERT](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/insert.html) operations were buffered. The preferred term is now change buffer.

See Also [change buffer](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_change_buffer), [change buffering](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_change_buffering).

insert buffering

The technique of storing changes to secondary index pages, resulting from [INSERT](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/insert.html) operations, in the ***change buffer*** rather than writing the changes immediately, so that the physical writes can be performed to minimize random I/O. It is one of the types of ***change buffering***; the others are ***delete buffering*** and ***purge buffering***.

Insert buffering is not used if the secondary index is ***unique***, because the uniqueness of new values cannot be verified before the new entries are written out. Other kinds of change buffering do work for unique indexes.

See Also [change buffer](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_change_buffer), [change buffering](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_change_buffering), [delete buffering](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_delete_buffering), [insert buffer](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_insert_buffer), [purge buffering](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_purge_buffering), [unique index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_unique_index).

insert intention lock

A type of ***gap lock*** that is set by [INSERT](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/insert.html) operations prior to row insertion. This type of ***lock*** signals the intent to insert in such a way that multiple transactions inserting into the same index gap need not wait for each other if they are not inserting at the same position within the gap. For more information, see [Section 15.7.1, “InnoDB Locking”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-locking.html).

See Also [gap lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_gap_lock), [lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_lock), [next-key lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_next_key_lock).

instance

A single ***mysqld*** daemon managing a ***data directory*** representing one or more ***databases*** with a set of ***tables***. It is common in development, testing, and some ***replication*** scenarios to have multiple instances on the same ***server*** machine, each managing its own data directory and listening on its own port or socket. With one instance running a ***disk-bound*** workload, the server might still have extra CPU and memory capacity to run additional instances.

See Also [data directory](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_data_directory), [database](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_database), [disk-bound](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_disk_bound), [mysqld](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysqld), [replication](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_replication), [server](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_server), [table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_table).

instrumentation

Modifications at the source code level to collect performance data for tuning and debugging. In MySQL, data collected by instrumentation is exposed through an SQL interface using the INFORMATION\_SCHEMA and PERFORMANCE\_SCHEMA databases.

See Also [INFORMATION\_SCHEMA](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_information_schema), [Performance Schema](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_performance_schema).

intention exclusive lock

See [intention lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_intention_lock).

intention lock

A kind of ***lock*** that applies to the table, used to indicate the kind of lock the ***transaction*** intends to acquire on rows in the table. Different transactions can acquire different kinds of intention locks on the same table, but the first transaction to acquire an intention exclusive (IX) lock on a table prevents other transactions from acquiring any S or X locks on the table. Conversely, the first transaction to acquire an intention shared (IS) lock on a table prevents other transactions from acquiring any X locks on the table. The two-phase process allows the lock requests to be resolved in order, without blocking locks and corresponding operations that are compatible. For more information about this locking mechanism, see [Section 15.7.1, “InnoDB Locking”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-locking.html).

See Also [lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_lock), [lock mode](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_lock_mode), [locking](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_locking), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

intention shared lock

See [intention lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_intention_lock).

interceptor

Code for instrumenting or debugging some aspect of an application, which can be enabled without recompiling or changing the source of the application itself.

See Also [command interceptor](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_command_interceptor), [Connector/J](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_j), [Connector/NET](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_net), [exception interceptor](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_exception_interceptor).

intrinsic temporary table

An optimized internal InnoDB temporary table used by the optimizer.

See Also [optimizer](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_optimizer).

inverted index

A data structure optimized for document retrieval systems, used in the implementation of InnoDB ***full-text search***. The InnoDB ***FULLTEXT index***, implemented as an inverted index, records the position of each word within a document, rather than the location of a table row. A single column value (a document stored as a text string) is represented by many entries in the inverted index.

See Also [full-text search](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_full_text_search), [FULLTEXT index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_fulltext_index), [ilist](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ilist).

IOPS

Acronym for ***I/O operations per second***. A common measurement for busy systems, particularly ***OLTP*** applications. If this value is near the maximum that the storage devices can handle, the application can become ***disk-bound***, limiting ***scalability***.

See Also [disk-bound](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_disk_bound), [OLTP](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_oltp), [scalability](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_scalability).

isolation level

One of the foundations of database processing. Isolation is the ***I*** in the acronym ***ACID***; the isolation level is the setting that fine-tunes the balance between performance and reliability, consistency, and reproducibility of results when multiple ***transactions*** are making changes and performing queries at the same time.

From highest amount of consistency and protection to the least, the isolation levels supported by InnoDB are: ***SERIALIZABLE***, ***REPEATABLE READ***, ***READ COMMITTED***, and ***READ UNCOMMITTED***.

With InnoDB tables, many users can keep the default isolation level (REPEATABLE READ) for all operations. Expert users might choose the ***READ COMMITTED*** level as they push the boundaries of scalability with ***OLTP*** processing, or during data warehousing operations where minor inconsistencies do not affect the aggregate results of large amounts of data. The levels on the edges (***SERIALIZABLE*** and ***READ UNCOMMITTED***) change the processing behavior to such an extent that they are rarely used.

See Also [ACID](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_acid), [OLTP](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_oltp), [READ COMMITTED](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_read_committed), [READ UNCOMMITTED](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_read_uncommitted), [REPEATABLE READ](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_repeatable_read), [SERIALIZABLE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_serializable), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

### J

J2EE

Java Platform, Enterprise Edition: Oracle's enterprise Java platform. It consists of an API and a runtime environment for enterprise-class Java applications. For full details, see <http://www.oracle.com/technetwork/java/javaee/overview/index.html>. With MySQL applications, you typically use ***Connector/J*** for database access, and an application server such as ***Tomcat*** or ***JBoss*** to handle the middle-tier work, and optionally a framework such as ***Spring***. Database-related features often offered within a J2EE stack include a ***connection pool*** and ***failover*** support.

See Also [connection pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connection_pool), [Connector/J](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_j), [failover](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_failover), [Java](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_java), [JBoss](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_jboss), [Spring](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_spring), [Tomcat](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_tomcat).

Java

A programming language combining high performance, rich built-in features and data types, object-oriented mechanisms, extensive standard library, and wide range of reusable third-party modules. Enterprise development is supported by many frameworks, application servers, and other technologies. Much of its syntax is familiar to ***C*** and ***C++*** developers. To write Java applications with MySQL, you use the ***JDBC*** driver known as ***Connector/J***.

See Also [C](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_c), [Connector/J](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_j), [C++](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_cplusplus), [JDBC](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_jdbc).

JBoss

See Also [J2EE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_j2ee).

JDBC

Abbreviation for “Java Database Connectivity”, an ***API*** for database access from ***Java*** applications. Java developers writing MySQL applications use the ***Connector/J*** component as their JDBC driver.

See Also [API](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_api), [Connector/J](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_j), [J2EE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_j2ee), [Java](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_java).

JNDI

See Also [Java](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_java).

join

A ***query*** that retrieves data from more than one table, by referencing columns in the tables that hold identical values. Ideally, these columns are part of an InnoDB ***foreign key*** relationship, which ensures ***referential integrity*** and that the join columns are ***indexed***. Often used to save space and improve query performance by replacing repeated strings with numeric IDs, in a ***normalized*** data design.

See Also [foreign key](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_foreign_key), [index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index), [normalized](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_normalized), [query](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_query), [referential integrity](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_referential_integrity).

### K

KDC

See [key distribution center](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_key_distribution_center).

key distribution center

In Kerberos, the key distribution center comprises an authentication server (AS) and a ticket-granting server (TGS).

See Also [authentication server](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_authentication_server), [ticket-granting ticket](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ticket_granting_ticket).

keystore

See Also [SSL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ssl).

KEY\_BLOCK\_SIZE

An option to specify the size of data pages within an InnoDB table that uses ***compressed row format***. The default is 8 kilobytes. Lower values risk hitting internal limits that depend on the combination of row size and compression percentage.

For [MyISAM](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/myisam-storage-engine.html) tables, KEY\_BLOCK\_SIZE optionally specifies the size in bytes to use for index key blocks. The value is treated as a hint; a different size could be used if necessary. A KEY\_BLOCK\_SIZE value specified for an individual index definition overrides a table-level KEY\_BLOCK\_SIZE value.

See Also [compressed row format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_compressed_row_format).

### L

latch

A lightweight structure used by InnoDB to implement a ***lock*** for its own internal memory structures, typically held for a brief time measured in milliseconds or microseconds. A general term that includes both ***mutexes*** (for exclusive access) and ***rw-locks*** (for shared access). Certain latches are the focus of InnoDB performance tuning. Statistics about latch use and contention are available through the ***Performance Schema*** interface.

See Also [lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_lock), [locking](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_locking), [mutex](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mutex), [Performance Schema](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_performance_schema), [rw-lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_rw_lock).

libmysql

Informal name for the ***libmysqlclient*** library.

See Also [libmysqlclient](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_libmysqlclient).

libmysqlclient

The library file, named libmysqlclient.a or libmysqlclient.so, that is typically linked into ***client*** programs written in ***C***. Sometimes known informally as ***libmysql*** or the ***mysqlclient*** library.

See Also [client](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_client), [libmysql](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_libmysql), [mysqlclient](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysqlclient).

libmysqld

This ***embedded*** MySQL server library makes it possible to run a full-featured MySQL server inside a ***client*** application. The main benefits are increased speed and more simple management for embedded applications. You link with the libmysqld library rather than ***libmysqlclient***. The API is identical between all three of these libraries.

See Also [client](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_client), [embedded](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_embedded), [libmysql](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_libmysql), [libmysqlclient](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_libmysqlclient).

lifecycle interceptor

A type of ***interceptor*** supported by ***Connector/J***. It involves implementing the interface com.mysql.jdbc.ConnectionLifecycleInterceptor.

See Also [Connector/J](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_j), [interceptor](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_interceptor).

list

The InnoDB ***buffer pool*** is represented as a list of memory ***pages***. The list is reordered as new pages are accessed and enter the buffer pool, as pages within the buffer pool are accessed again and are considered newer, and as pages that are not accessed for a long time are ***evicted*** from the buffer pool. The buffer pool is divided into ***sublists***, and the replacement policy is a variation of the familiar ***LRU*** technique.

See Also [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [eviction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_eviction), [LRU](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_lru), [page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_page), [sublist](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_sublist).

load balancing

A technique for scaling read-only connections by sending query requests to different slave servers in a replication or Cluster configuration. With ***Connector/J***, load balancing is enabled through the com.mysql.jdbc.ReplicationDriver class and controlled by the configuration property loadBalanceStrategy.

See Also [Connector/J](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_j), [J2EE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_j2ee).

localhost

See Also [connection](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connection).

lock

The high-level notion of an object that controls access to a resource, such as a table, row, or internal data structure, as part of a ***locking*** strategy. For intensive performance tuning, you might delve into the actual structures that implement locks, such as ***mutexes*** and ***latches***.

See Also [latch](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_latch), [lock mode](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_lock_mode), [locking](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_locking), [mutex](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mutex).

lock escalation

An operation used in some database systems that converts many ***row locks*** into a single ***table lock***, saving memory space but reducing concurrent access to the table. InnoDB uses a space-efficient representation for row locks, so that ***lock*** escalation is not needed.

See Also [locking](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_locking), [row lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_row_lock), [table lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_table_lock).

lock mode

A shared (S) ***lock*** allows a ***transaction*** to read a row. Multiple transactions can acquire an S lock on that same row at the same time.

An exclusive (X) lock allows a transaction to update or delete a row. No other transaction can acquire any kind of lock on that same row at the same time.

***Intention locks*** apply to the table, and are used to indicate what kind of lock the transaction intends to acquire on rows in the table. Different transactions can acquire different kinds of intention locks on the same table, but the first transaction to acquire an intention exclusive (IX) lock on a table prevents other transactions from acquiring any S or X locks on the table. Conversely, the first transaction to acquire an intention shared (IS) lock on a table prevents other transactions from acquiring any X locks on the table. The two-phase process allows the lock requests to be resolved in order, without blocking locks and corresponding operations that are compatible.

See Also [intention lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_intention_lock), [lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_lock), [locking](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_locking), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

locking

The system of protecting a ***transaction*** from seeing or changing data that is being queried or changed by other transactions. The ***locking*** strategy must balance reliability and consistency of database operations (the principles of the ***ACID*** philosophy) against the performance needed for good ***concurrency***. Fine-tuning the locking strategy often involves choosing an ***isolation level*** and ensuring all your database operations are safe and reliable for that isolation level.

See Also [ACID](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_acid), [concurrency](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_concurrency), [isolation level](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_isolation_level), [locking](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_locking), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

locking read

A [SELECT](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/select.html) statement that also performs a ***locking*** operation on an InnoDB table. Either SELECT ... FOR UPDATE or SELECT ... LOCK IN SHARE MODE. It has the potential to produce a ***deadlock***, depending on the ***isolation level*** of the transaction. The opposite of a ***non-locking read***. Not allowed for global tables in a ***read-only transaction***.

SELECT ... FOR SHARE replaces SELECT ... LOCK IN SHARE MODE in MySQL 8.0.1, but LOCK IN SHARE MODE remains available for backward compatibility.

See [Section 15.7.2.4, “Locking Reads”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-locking-reads.html).

See Also [deadlock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_deadlock), [isolation level](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_isolation_level), [locking](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_locking), [non-locking read](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_non_locking_read), [read-only transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_read_only_transaction).

log

In the InnoDB context, “log” or “log files” typically refers to the ***redo log*** represented by the ***ib\_logfileN*** files. Another type of InnoDB log is the ***undo log***, which is a storage area that holds copies of data modified by active transactions.

Other kinds of logs that are important in MySQL are the ***error log*** (for diagnosing startup and runtime problems), ***binary log*** (for working with replication and performing point-in-time restores), the ***general query log*** (for diagnosing application problems), and the ***slow query log*** (for diagnosing performance problems).

See Also [binary log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_binary_log), [error log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_error_log), [general query log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_general_query_log), [ib\_logfile](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ib_logfile), [redo log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_redo_log), [slow query log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_slow_query_log), [undo log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_undo_log).

log buffer

The memory area that holds data to be written to the ***log files*** that make up the ***redo log***. It is controlled by the [innodb\_log\_buffer\_size](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_log_buffer_size) configuration option.

See Also [log file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_log_file), [redo log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_redo_log).

log file

One of the ***ib\_logfileN*** files that make up the ***redo log***. Data is written to these files from the ***log buffer*** memory area.

See Also [ib\_logfile](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ib_logfile), [log buffer](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_log_buffer), [redo log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_redo_log).

log group

The set of files that make up the ***redo log***, typically named ib\_logfile0 and ib\_logfile1. (For that reason, sometimes referred to collectively as ***ib\_logfile***.)

See Also [ib\_logfile](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ib_logfile), [redo log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_redo_log).

logical

A type of operation that involves high-level, abstract aspects such as tables, queries, indexes, and other SQL concepts. Typically, logical aspects are important to make database administration and application development convenient and usable. Contrast with ***physical***.

See Also [logical backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_logical_backup), [physical](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_physical).

logical backup

A ***backup*** that reproduces table structure and data, without copying the actual data files. For example, the *mysqldump* command produces a logical backup, because its output contains statements such as [CREATE TABLE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/create-table.html) and [INSERT](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/insert.html) that can re-create the data. Contrast with ***physical backup***. A logical backup offers flexibility (for example, you could edit table definitions or insert statements before restoring), but can take substantially longer to ***restore*** than a physical backup.

See Also [backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_backup), [mysqldump](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysqldump), [physical backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_physical_backup), [restore](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_restore).

loose\_

A prefix added to InnoDB configuration options after server ***startup***, so any new configuration options not recognized by the current level of MySQL do not cause a startup failure. MySQL processes configuration options that start with this prefix, but gives a warning rather than a failure if the part after the prefix is not a recognized option.

See Also [startup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_startup).

low-water mark

A value representing a lower limit, typically a threshold value at which some corrective action begins or becomes more aggressive. Contrast with ***high-water mark***.

See Also [high-water mark](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_high_water_mark).

LRU

An acronym for “least recently used”, a common method for managing storage areas. The items that have not been used recently are ***evicted*** when space is needed to cache newer items. InnoDB uses the LRU mechanism by default to manage the ***pages*** within the ***buffer pool***, but makes exceptions in cases where a page might be read only a single time, such as during a ***full table scan***. This variation of the LRU algorithm is called the ***midpoint insertion strategy***. For more information, see [Section 15.5.1, “Buffer Pool”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-buffer-pool.html).

See Also [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [eviction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_eviction), [full table scan](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_full_table_scan), [midpoint insertion strategy](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_midpoint_insertion_strategy), [page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_page).

LSN

Acronym for “log sequence number”. This arbitrary, ever-increasing value represents a point in time corresponding to operations recorded in the ***redo log***. (This point in time is regardless of ***transaction*** boundaries; it can fall in the middle of one or more transactions.) It is used internally by InnoDB during ***crash recovery*** and for managing the ***buffer pool***.

Prior to MySQL 5.6.3, the LSN was a 4-byte unsigned integer. The LSN became an 8-byte unsigned integer in MySQL 5.6.3 when the redo log file size limit increased from 4GB to 512GB, as additional bytes were required to store extra size information. Applications built on MySQL 5.6.3 or later that use LSN values should use 64-bit rather than 32-bit variables to store and compare LSN values.

In the ***MySQL Enterprise Backup*** product, you can specify an LSN to represent the point in time from which to take an ***incremental backup***. The relevant LSN is displayed by the output of the **mysqlbackup** command. Once you have the LSN corresponding to the time of a full backup, you can specify that value to take a subsequent incremental backup, whose output contains another LSN for the next incremental backup.

See Also [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [crash recovery](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_crash_recovery), [incremental backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_incremental_backup), [MySQL Enterprise Backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysql_enterprise_backup), [redo log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_redo_log), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

### M

.MRG file

A file containing references to other tables, used by the MERGE storage engine. Files with this extension are always included in backups produced by the **mysqlbackup** command of the ***MySQL Enterprise Backup*** product.

See Also [MySQL Enterprise Backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysql_enterprise_backup), [mysqlbackup command](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysqlbackup_command).

.MYD file

A file that MySQL uses to store data for a [MyISAM](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/myisam-storage-engine.html) table.

See Also [.MYI file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_myi_file), [MySQL Enterprise Backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysql_enterprise_backup), [mysqlbackup command](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysqlbackup_command).

.MYI file

A file that MySQL uses to store indexes for a [MyISAM](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/myisam-storage-engine.html) table.

See Also [.MYD file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_myd_file), [MySQL Enterprise Backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysql_enterprise_backup), [mysqlbackup command](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysqlbackup_command).

master

See [source](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_source).

master thread

An InnoDB ***thread*** that performs various tasks in the background. Most of these tasks are I/O related, such as writing changes from the ***change buffer*** to the appropriate secondary indexes.

To improve ***concurrency***, sometimes actions are moved from the master thread to separate background threads. For example, in MySQL 5.6 and higher, ***dirty pages*** are ***flushed*** from the ***buffer pool*** by the ***page cleaner*** thread rather than the master thread.

See Also [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [change buffer](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_change_buffer), [concurrency](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_concurrency), [dirty page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dirty_page), [flush](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_flush), [page cleaner](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_page_cleaner), [thread](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_thread).

MDL

Acronym for “metadata lock”.

See Also [metadata lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_metadata_lock).

medium trust

Synonym for ***partial trust***. Because the range of trust settings is so broad, “partial trust” is preferred, to avoid the implication that there are only three levels (low, medium, and full).

See Also [Connector/NET](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_net), [partial trust](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_partial_trust).

memcached

A popular component of many MySQL and ***NoSQL*** software stacks, allowing fast reads and writes for single values and caching the results entirely in memory. Traditionally, applications required extra logic to write the same data to a MySQL database for permanent storage, or to read data from a MySQL database when it was not cached yet in memory. Now, applications can use the simple **memcached** protocol, supported by client libraries for many languages, to communicate directly with MySQL servers using InnoDB or NDB tables. These NoSQL interfaces to MySQL tables allow applications to achieve higher read and write performance than by issuing SQL statements directly, and can simplify application logic and deployment configurations for systems that already incorporate **memcached** for in-memory caching.

The **memcached** interface to InnoDB tables is available in MySQL 5.6 and higher; see [Section 15.20, “InnoDB memcached Plugin”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-memcached.html) for details. The **memcached** interface to NDB tables is available in NDB Cluster 7.2 and later; see <http://dev.mysql.com/doc/ndbapi/en/ndbmemcache.html> for details.

See Also [InnoDB](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_innodb), [NoSQL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_nosql).

merge

To apply changes to data cached in memory, such as when a page is brought into the ***buffer pool***, and any applicable changes recorded in the ***change buffer*** are incorporated into the page in the buffer pool. The updated data is eventually written to the ***tablespace*** by the ***flush*** mechanism.

See Also [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [change buffer](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_change_buffer), [flush](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_flush), [tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_tablespace).

metadata lock

A type of ***lock*** that prevents ***DDL*** operations on a table that is being used at the same time by another ***transaction***. For details, see [Section 8.11.4, “Metadata Locking”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/metadata-locking.html).

Enhancements to ***online*** operations, particularly in MySQL 5.6 and higher, are focused on reducing the amount of metadata locking. The objective is for DDL operations that do not change the table structure (such as [CREATE INDEX](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/create-index.html) and [DROP INDEX](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/drop-index.html) for InnoDB tables) to proceed while the table is being queried, updated, and so on by other transactions.

See Also [DDL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ddl), [lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_lock), [online](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_online), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

metrics counter

A feature implemented by the [INNODB\_METRICS](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/information-schema-innodb-metrics-table.html) table in the ***INFORMATION\_SCHEMA***, in MySQL 5.6 and higher. You can query ***counts*** and totals for low-level InnoDB operations, and use the results for performance tuning in combination with data from the ***Performance Schema***.

See Also [counter](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_counter), [INFORMATION\_SCHEMA](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_information_schema), [Performance Schema](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_performance_schema).

midpoint insertion strategy

The technique of initially bringing ***pages*** into the InnoDB ***buffer pool*** not at the “newest” end of the list, but instead somewhere in the middle. The exact location of this point can vary, based on the setting of the [innodb\_old\_blocks\_pct](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_old_blocks_pct) option. The intent is that pages that are only read once, such as during a ***full table scan***, can be aged out of the buffer pool sooner than with a strict ***LRU*** algorithm. For more information, see [Section 15.5.1, “Buffer Pool”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-buffer-pool.html).

See Also [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [full table scan](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_full_table_scan), [LRU](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_lru), [page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_page).

mini-transaction

An internal phase of InnoDB processing, when making changes at the ***physical*** level to internal data structures during ***DML*** operations. A mini-transaction (mtr) has no notion of ***rollback***; multiple mini-transactions can occur within a single ***transaction***. Mini-transactions write information to the ***redo log*** that is used during ***crash recovery***. A mini-transaction can also happen outside the context of a regular transaction, for example during ***purge*** processing by background threads.

See Also [commit](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_commit), [crash recovery](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_crash_recovery), [DML](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dml), [physical](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_physical), [purge](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_purge), [redo log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_redo_log), [rollback](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_rollback), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

mixed-mode insert

An [INSERT](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/insert.html) statement where ***auto-increment*** values are specified for some but not all of the new rows. For example, a multi-value INSERT could specify a value for the auto-increment column in some cases and NULL in other cases. InnoDB generates auto-increment values for the rows where the column value was specified as NULL. Another example is an [INSERT ... ON DUPLICATE KEY UPDATE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/insert-on-duplicate.html) statement, where auto-increment values might be generated but not used, for any duplicate rows that are processed as UPDATE rather than INSERT statements.

Can cause consistency issues between ***source*** and ***replica*** servers in a ***replication*** configuration. Can require adjusting the value of the ***innodb\_autoinc\_lock\_mode*** configuration option.

See Also [auto-increment](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_auto_increment), [innodb\_autoinc\_lock\_mode](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_innodb_autoinc_lock_mode), [replica](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_replica), [replication](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_replication), [source](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_source).

MM.MySQL

An older JDBC driver for MySQL that evolved into ***Connector/J*** when it was integrated with the MySQL product.

See Also [Connector/J](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_j).

Mono

An Open Source framework developed by Novell, that works with ***Connector/NET*** and ***C#*** applications on Linux platforms.

See Also [Connector/NET](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_net), [C#](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_csharp).

mtr

See [mini-transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mini_transaction).

multi-core

A type of processor that can take advantage of multithreaded programs, such as the MySQL server.

multiversion concurrency control

See [MVCC](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mvcc).

mutex

Informal abbreviation for “mutex variable”. (Mutex itself is short for “mutual exclusion”.) The low-level object that InnoDB uses to represent and enforce exclusive-access ***locks*** to internal in-memory data structures. Once the lock is acquired, any other process, thread, and so on is prevented from acquiring the same lock. Contrast with ***rw-locks***, which InnoDB uses to represent and enforce shared-access ***locks*** to internal in-memory data structures. Mutexes and rw-locks are known collectively as ***latches***.

See Also [latch](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_latch), [lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_lock), [Performance Schema](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_performance_schema), [Pthreads](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_pthreads), [rw-lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_rw_lock).

MVCC

Acronym for “multiversion concurrency control”. This technique lets InnoDB ***transactions*** with certain ***isolation levels*** perform ***consistent read*** operations; that is, to query rows that are being updated by other transactions, and see the values from before those updates occurred. This is a powerful technique to increase ***concurrency***, by allowing queries to proceed without waiting due to ***locks*** held by the other transactions.

This technique is not universal in the database world. Some other database products, and some other MySQL storage engines, do not support it.

See Also [ACID](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_acid), [concurrency](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_concurrency), [consistent read](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_consistent_read), [isolation level](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_isolation_level), [lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_lock), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

my.cnf

The name, on Unix or Linux systems, of the MySQL ***option file***.

See Also [my.ini](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_my_ini), [option file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_option_file).

my.ini

The name, on Windows systems, of the MySQL ***option file***.

See Also [my.cnf](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_my_cnf), [option file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_option_file).

MyODBC drivers

Obsolete name for ***Connector/ODBC***.

See Also [Connector/ODBC](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_odbc).

mysql

The [**mysql**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql.html) program is the command-line interpreter for the MySQL database. It processes ***SQL*** statements, and also MySQL-specific commands such as [SHOW TABLES](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/show-tables.html), by passing requests to the [**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) daemon.

See Also [mysqld](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysqld), [SQL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_sql).

MySQL Enterprise Backup

A licensed product that performs ***hot backups*** of MySQL databases. It offers the most efficiency and flexibility when backing up [InnoDB](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-storage-engine.html) tables, but can also back up [MyISAM](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/myisam-storage-engine.html) and other kinds of tables.

See Also [hot backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_hot_backup), [InnoDB](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_innodb).

mysqlbackup command

A command-line tool of the ***MySQL Enterprise Backup*** product. It performs a ***hot backup*** operation for [InnoDB](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-storage-engine.html) tables, and a [warm backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_warm_backup) for [MyISAM](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/myisam-storage-engine.html) and other kinds of tables. See [Section 30.2, “MySQL Enterprise Backup Overview”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-enterprise-backup.html) for more information about this command.

See Also [hot backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_hot_backup), [MySQL Enterprise Backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysql_enterprise_backup), [warm backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_warm_backup).

mysqlclient

The informal name for the library that is implemented by the file ***libmysqlclient***, with extension .a or .so.

See Also [libmysqlclient](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_libmysqlclient).

mysqld

[**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html), also known as MySQL Server, is a single multithreaded program that does most of the work in a MySQL installation. It does not spawn additional processes. MySQL Server manages access to the MySQL data directory that contains databases, tables, and other information such as log files and status files.

[**mysqld**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysqld.html) runs as a Unix daemon or Windows service, constantly waiting for requests and performing maintenance work in the background.

See Also [instance](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_instance), [mysql](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysql).

MySQLdb

The name of the open-source ***Python*** module that forms the basis of the MySQL ***Python API***.

See Also [Python](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_python), [Python API](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_python_api).

mysqldump

A command that performs a ***logical backup*** of some combination of databases, tables, and table data. The results are SQL statements that reproduce the original schema objects, data, or both. For substantial amounts of data, a ***physical backup*** solution such as ***MySQL Enterprise Backup*** is faster, particularly for the ***restore*** operation.

See Also [logical backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_logical_backup), [MySQL Enterprise Backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysql_enterprise_backup), [physical backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_physical_backup), [restore](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_restore).

### N

.NET

See Also [ADO.NET](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ado_net), [ASP.net](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_asp_net), [Connector/NET](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_net), [Mono](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mono), [Visual Studio](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_visual_studio).

native C API

Synonym for ***libmysqlclient***.

See Also [libmysql](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_libmysql).

natural key

An indexed column, typically a ***primary key***, where the values have some real-world significance. Usually advised against because:

* If the value should ever change, there is potentially a lot of index maintenance to re-sort the ***clustered index*** and update the copies of the primary key value that are repeated in each ***secondary index***.
* Even seemingly stable values can change in unpredictable ways that are difficult to represent correctly in the database. For example, one country can change into two or several, making the original country code obsolete. Or, rules about unique values might have exceptions. For example, even if taxpayer IDs are intended to be unique to a single person, a database might have to handle records that violate that rule, such as in cases of identity theft. Taxpayer IDs and other sensitive ID numbers also make poor primary keys, because they may need to be secured, encrypted, and otherwise treated differently than other columns.

Thus, it is typically better to use arbitrary numeric values to form a ***synthetic key***, for example using an ***auto-increment*** column.

See Also [auto-increment](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_auto_increment), [clustered index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_clustered_index), [primary key](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_primary_key), [secondary index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_secondary_index), [synthetic key](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_synthetic_key).

neighbor page

Any ***page*** in the same ***extent*** as a particular page. When a page is selected to be ***flushed***, any neighbor pages that are ***dirty*** are typically flushed as well, as an I/O optimization for traditional hard disks. In MySQL 5.6 and up, this behavior can be controlled by the configuration variable [innodb\_flush\_neighbors](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_flush_neighbors); you might turn that setting off for SSD drives, which do not have the same overhead for writing smaller batches of data at random locations.

See Also [dirty page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dirty_page), [extent](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_extent), [flush](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_flush), [page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_page).

next-key lock

A combination of a ***record lock*** on the index record and a [gap lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_gap_lock) on the gap before the index record.

See Also [gap lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_gap_lock), [locking](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_locking), [record lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_record_lock).

non-locking read

A ***query*** that does not use the SELECT ... FOR UPDATE or SELECT ... LOCK IN SHARE MODE clauses. The only kind of query allowed for global tables in a ***read-only transaction***. The opposite of a ***locking read***. See [Section 15.7.2.3, “Consistent Nonlocking Reads”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-consistent-read.html).

SELECT ... FOR SHARE replaces SELECT ... LOCK IN SHARE MODE in MySQL 8.0.1, but LOCK IN SHARE MODE remains available for backward compatibility.

See Also [locking read](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_locking_read), [query](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_query), [read-only transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_read_only_transaction).

non-repeatable read

The situation when a query retrieves data, and a later query within the same ***transaction*** retrieves what should be the same data, but the queries return different results (changed by another transaction committing in the meantime).

This kind of operation goes against the ***ACID*** principle of database design. Within a transaction, data should be consistent, with predictable and stable relationships.

Among different ***isolation levels***, non-repeatable reads are prevented by the ***serializable read*** and ***repeatable read*** levels, and allowed by the ***consistent read***, and ***read uncommitted*** levels.

See Also [ACID](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_acid), [consistent read](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_consistent_read), [isolation level](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_isolation_level), [READ UNCOMMITTED](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_read_uncommitted), [REPEATABLE READ](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_repeatable_read), [SERIALIZABLE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_serializable), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

nonblocking I/O

An industry term that means the same as ***asynchronous I/O***.

See Also [asynchronous I/O](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_asynchronous_io).

normalized

A database design strategy where data is split into multiple tables, and duplicate values condensed into single rows represented by an ID, to avoid storing, querying, and updating redundant or lengthy values. It is typically used in ***OLTP*** applications.

For example, an address might be given a unique ID, so that a census database could represent the relationship ***lives at this address*** by associating that ID with each member of a family, rather than storing multiple copies of a complex value such as ***123 Main Street, Anytown, USA***.

For another example, although a simple address book application might store each phone number in the same table as a person's name and address, a phone company database might give each phone number a special ID, and store the numbers and IDs in a separate table. This normalized representation could simplify large-scale updates when area codes split apart.

Normalization is not always recommended. Data that is primarily queried, and only updated by deleting entirely and reloading, is often kept in fewer, larger tables with redundant copies of duplicate values. This data representation is referred to as ***denormalized***, and is frequently found in data warehousing applications.

See Also [denormalized](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_denormalized), [foreign key](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_foreign_key), [OLTP](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_oltp), [relational](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_relational).

NoSQL

A broad term for a set of data access technologies that do not use the ***SQL*** language as their primary mechanism for reading and writing data. Some NoSQL technologies act as key-value stores, only accepting single-value reads and writes; some relax the restrictions of the ***ACID*** methodology; still others do not require a pre-planned ***schema***. MySQL users can combine NoSQL-style processing for speed and simplicity with SQL operations for flexibility and convenience, by using the ***memcached*** API to directly access some kinds of MySQL tables. The **memcached** interface to InnoDB tables is available in MySQL 5.6 and higher; see [Section 15.20, “InnoDB memcached Plugin”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-memcached.html) for details. The **memcached** interface to NDB tables is available in NDB Cluster 7.2 and later; see [ndbmemcache—Memcache API for NDB Cluster (NO LONGER SUPPORTED)](https://docs.oracle.com/cd/E17952_01/ndbapi-en/ndbmemcache.html).

See Also [ACID](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_acid), [InnoDB](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_innodb), [memcached](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_memcached), [schema](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_schema), [SQL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_sql).

NOT NULL constraint

A type of ***constraint*** that specifies that a ***column*** cannot contain any ***NULL*** values. It helps to preserve ***referential integrity***, as the database server can identify data with erroneous missing values. It also helps in the arithmetic involved in query optimization, allowing the optimizer to predict the number of entries in an index on that column.

See Also [column](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_column), [constraint](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_constraint), [NULL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_null), [primary key](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_primary_key), [referential integrity](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_referential_integrity).

NULL

A special value in ***SQL***, indicating the absence of data. Any arithmetic operation or equality test involving a NULL value, in turn produces a NULL result. (Thus it is similar to the IEEE floating-point concept of NaN, “not a number”.) Any aggregate calculation such as AVG() ignores rows with NULL values, when determining how many rows to divide by. The only test that works with NULL values uses the SQL idioms IS NULL or IS NOT NULL.

NULL values play a part in ***index*** operations, because for performance a database must minimize the overhead of keeping track of missing data values. Typically, NULL values are not stored in an index, because a query that tests an indexed column using a standard comparison operator could never match a row with a NULL value for that column. For the same reason, unique indexes do not prevent NULL values; those values simply are not represented in the index. Declaring a NOT NULL constraint on a column provides reassurance that there are no rows left out of the index, allowing for better query optimization (accurate counting of rows and estimation of whether to use the index).

Because the ***primary key*** must be able to uniquely identify every row in the table, a single-column primary key cannot contain any NULL values, and a multi-column primary key cannot contain any rows with NULL values in all columns.

Although the Oracle database allows a NULL value to be concatenated with a string, InnoDB treats the result of such an operation as NULL.

See Also [index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index), [primary key](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_primary_key), [SQL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_sql).

### O

.OPT file

A file containing database configuration information. Files with this extension are included in backups produced by the **mysqlbackup** command of the ***MySQL Enterprise Backup*** product.

See Also [MySQL Enterprise Backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysql_enterprise_backup), [mysqlbackup command](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysqlbackup_command).

ODBC

Acronym for Open Database Connectivity, an industry-standard API. Typically used with Windows-based servers, or applications that require ODBC to communicate with MySQL. The MySQL ODBC driver is called ***Connector/ODBC***.

See Also [Connector/ODBC](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_odbc).

off-page column

A column containing variable-length data (such as [BLOB](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/blob.html) and [VARCHAR](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/char.html)) that is too long to fit on a ***B-tree*** page. The data is stored in ***overflow pages***. The ***DYNAMIC*** row format is more efficient for such storage than the older ***COMPACT*** row format.

See Also [B-tree](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_b_tree), [compact row format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_compact_row_format), [dynamic row format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dynamic_row_format), [overflow page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_overflow_page).

OLTP

Acronym for “Online Transaction Processing”. A database system, or a database application, that runs a workload with many ***transactions***, with frequent writes as well as reads, typically affecting small amounts of data at a time. For example, an airline reservation system or an application that processes bank deposits. The data might be organized in ***normalized*** form for a balance between ***DML*** (insert/update/delete) efficiency and ***query*** efficiency. Contrast with ***data warehouse***.

With its ***row-level locking*** and ***transactional*** capability, ***InnoDB*** is the ideal storage engine for MySQL tables used in OLTP applications.

See Also [data warehouse](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_data_warehouse), [DML](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dml), [InnoDB](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_innodb), [query](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_query), [row lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_row_lock), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

online

A type of operation that involves no downtime, blocking, or restricted operation for the database. Typically applied to ***DDL***. Operations that shorten the periods of restricted operation, such as ***fast index creation***, have evolved into a wider set of ***online DDL*** operations in MySQL 5.6.

In the context of backups, a ***hot backup*** is an online operation and a ***warm backup*** is partially an online operation.

See Also [DDL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ddl), [Fast Index Creation](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_fast_index_creation), [hot backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_hot_backup), [online DDL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_online_ddl), [warm backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_warm_backup).

online DDL

A feature that improves the performance, concurrency, and availability of InnoDB tables during ***DDL*** (primarily [ALTER TABLE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-table.html)) operations. See [Section 15.12, “InnoDB and Online DDL”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-online-ddl.html) for details.

The details vary according to the type of operation. In some cases, the table can be modified concurrently while the [ALTER TABLE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-table.html) is in progress. The operation might be able to be performed without a table copy, or using a specially optimized type of table copy. DML log space usage for in-place operations is controlled by the [innodb\_online\_alter\_log\_max\_size](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_online_alter_log_max_size) configuration option.

This feature is an enhancement of the ***Fast Index Creation*** feature in MySQL 5.5.

See Also [DDL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ddl), [Fast Index Creation](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_fast_index_creation), [online](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_online).

optimistic

A methodology that guides low-level implementation decisions for a relational database system. The requirements of performance and ***concurrency*** in a relational database mean that operations must be started or dispatched quickly. The requirements of consistency and ***referential integrity*** mean that any operation could fail: a transaction might be rolled back, a ***DML*** operation could violate a constraint, a request for a lock could cause a deadlock, a network error could cause a timeout. An optimistic strategy is one that assumes most requests or attempts succeed, so that relatively little work is done to prepare for the failure case. When this assumption is true, the database does little unnecessary work; when requests do fail, extra work must be done to clean up and undo changes.

InnoDB uses optimistic strategies for operations such as ***locking*** and ***commits***. For example, data changed by a transaction can be written to the data files before the commit occurs, making the commit itself very fast, but requiring more work to undo the changes if the transaction is rolled back.

The opposite of an optimistic strategy is a ***pessimistic*** one, where a system is optimized to deal with operations that are unreliable and frequently unsuccessful. This methodology is rare in a database system, because so much care goes into choosing reliable hardware, networks, and algorithms.

See Also [commit](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_commit), [concurrency](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_concurrency), [DML](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dml), [locking](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_locking), [pessimistic](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_pessimistic), [referential integrity](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_referential_integrity).

optimizer

The MySQL component that determines the best ***indexes*** and ***join*** order to use for a ***query***, based on characteristics and data distribution of the relevant ***tables***.

See Also [index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index), [join](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_join), [query](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_query), [table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_table).

option

A configuration parameter for MySQL, either stored in the ***option file*** or passed on the command line.

For the ***options*** that apply to ***InnoDB*** tables, each option name starts with the prefix innodb\_.

See Also [InnoDB](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_innodb), [option](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_option), [option file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_option_file).

option file

The file that holds the configuration ***options*** for the MySQL instance. Traditionally, on Linux and Unix this file is named my.cnf, and on Windows it is named my.ini.

See Also [configuration file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_configuration_file), [my.cnf](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_my_cnf), [my.ini](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_my_ini), [option](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_option).

overflow page

Separately allocated disk ***pages*** that hold variable-length columns (such as BLOB and VARCHAR) that are too long to fit on a ***B-tree*** page. The associated columns are known as ***off-page columns***.

See Also [B-tree](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_b_tree), [off-page column](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_off_page_column), [page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_page).

### P

.par file

A file containing partition definitions. Files with this extension are included in backups produced by the mysqlbackup command of the ***MySQL Enterprise Backup*** product.

With the introduction of native partitioning support for InnoDB tables in MySQL 5.7.6, .par files are no longer created for partitioned InnoDB tables. Partitioned MyISAM tables continue to use .par files in MySQL 5.7. In MySQL 8.0, partitioning support is only provided by the InnoDB storage engine. As such, .par files are no longer used as of MySQL 8.0.

See Also [MySQL Enterprise Backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysql_enterprise_backup), [mysqlbackup command](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysqlbackup_command).

page

A unit representing how much data InnoDB transfers at any one time between disk (the ***data files***) and memory (the ***buffer pool***). A page can contain one or more ***rows***, depending on how much data is in each row. If a row does not fit entirely into a single page, InnoDB sets up additional pointer-style data structures so that the information about the row can be stored in one page.

One way to fit more data in each page is to use ***compressed row format***. For tables that use BLOBs or large text fields, ***compact row format*** allows those large columns to be stored separately from the rest of the row, reducing I/O overhead and memory usage for queries that do not reference those columns.

When InnoDB reads or writes sets of pages as a batch to increase I/O throughput, it reads or writes an ***extent*** at a time.

All the InnoDB disk data structures within a MySQL instance share the same ***page size***.

See Also [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [compact row format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_compact_row_format), [compressed row format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_compressed_row_format), [data files](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_data_files), [extent](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_extent), [page size](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_page_size), [row](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_row).

page cleaner

An InnoDB background ***thread*** that ***flushes*** ***dirty pages*** from the ***buffer pool***. Prior to MySQL 5.6, this activity was performed by the ***master thread***. The number of page cleaner threads is controlled by the [innodb\_page\_cleaners](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_page_cleaners) configuration option, introduced in MySQL 5.7.4.

See Also [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [dirty page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dirty_page), [flush](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_flush), [master thread](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_master_thread), [thread](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_thread).

page size

For releases up to and including MySQL 5.5, the size of each InnoDB ***page*** is fixed at 16 kilobytes. This value represents a balance: large enough to hold the data for most rows, yet small enough to minimize the performance overhead of transferring unneeded data to memory. Other values are not tested or supported.

Starting in MySQL 5.6, the page size for an InnoDB ***instance*** can be either 4KB, 8KB, or 16KB, controlled by the [innodb\_page\_size](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_page_size) configuration option. As of MySQL 5.7.6, InnoDB also supports 32KB and 64KB page sizes. For 32KB and 64KB page sizes, ROW\_FORMAT=COMPRESSED is not supported and the maximum record size is 16KB.

Page size is set when creating the MySQL instance, and it remains constant afterward. The same page size applies to all InnoDB ***tablespaces***, including the ***system tablespace***, ***file-per-table*** tablespaces, and ***general tablespaces***.

Smaller page sizes can help performance with storage devices that use small block sizes, particularly for ***SSD*** devices in ***disk-bound*** workloads, such as for ***OLTP*** applications. As individual rows are updated, less data is copied into memory, written to disk, reorganized, locked, and so on.

See Also [disk-bound](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_disk_bound), [file-per-table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_file_per_table), [general tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_general_tablespace), [instance](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_instance), [OLTP](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_oltp), [page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_page), [SSD](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ssd), [system tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_system_tablespace), [tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_tablespace).

parent table

The table in a ***foreign key*** relationship that holds the initial column values pointed to from the ***child table***. The consequences of deleting, or updating rows in the parent table depend on the ON UPDATE and ON DELETE clauses in the foreign key definition. Rows with corresponding values in the child table could be automatically deleted or updated in turn, or those columns could be set to NULL, or the operation could be prevented.

See Also [child table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_child_table), [foreign key](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_foreign_key).

partial backup

A ***backup*** that contains some of the ***tables*** in a MySQL database, or some of the databases in a MySQL instance. Contrast with ***full backup***.

See Also [backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_backup), [full backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_full_backup), [table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_table).

partial index

An ***index*** that represents only part of a column value, typically the first N characters (the ***prefix***) of a long VARCHAR value.

See Also [index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index), [index prefix](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index_prefix).

partial trust

An execution environment typically used by hosting providers, where applications have some permissions but not others. For example, applications might be able to access a database server over a network, but be “sandboxed” with regard to reading and writing local files.

See Also [Connector/NET](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_net).

Performance Schema

The performance\_schema schema, in MySQL 5.5 and up, presents a set of tables that you can query to get detailed information about the performance characteristics of many internal parts of the MySQL server. See [Chapter 27, MySQL Performance Schema](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/performance-schema.html).

See Also [INFORMATION\_SCHEMA](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_information_schema), [latch](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_latch), [mutex](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mutex), [rw-lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_rw_lock).

Perl

A programming language with roots in Unix scripting and report generation. Incorporates high-performance regular expressions and file I/O. Large collection of reusable modules available through repositories such as CPAN.

See Also [Perl API](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_perl_api).

Perl API

An open-source ***API*** for MySQL applications written in the ***Perl*** language. Implemented through the DBI and DBD::mysql modules. For details, see [Section 29.9, “MySQL Perl API”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/apis-perl.html).

See Also [API](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_api), [Perl](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_perl).

persistent statistics

A feature that stores ***index*** statistics for InnoDB ***tables*** on disk, providing better ***plan stability*** for ***queries***. For more information, see [Section 15.8.10.1, “Configuring Persistent Optimizer Statistics Parameters”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-persistent-stats.html).

See Also [index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index), [optimizer](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_optimizer), [plan stability](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_plan_stability), [query](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_query), [table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_table).

pessimistic

A methodology that sacrifices performance or concurrency in favor of safety. It is appropriate if a high proportion of requests or attempts might fail, or if the consequences of a failed request are severe. InnoDB uses what is known as a pessimistic ***locking*** strategy, to minimize the chance of ***deadlocks***. At the application level, you might avoid deadlocks by using a pessimistic strategy of acquiring all locks needed by a transaction at the very beginning.

Many built-in database mechanisms use the opposite ***optimistic*** methodology.

See Also [deadlock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_deadlock), [locking](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_locking), [optimistic](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_optimistic).

phantom

A row that appears in the result set of a query, but not in the result set of an earlier query. For example, if a query is run twice within a ***transaction***, and in the meantime, another transaction commits after inserting a new row or updating a row so that it matches the WHERE clause of the query.

This occurrence is known as a phantom read. It is harder to guard against than a ***non-repeatable read***, because locking all the rows from the first query result set does not prevent the changes that cause the phantom to appear.

Among different ***isolation levels***, phantom reads are prevented by the ***serializable read*** level, and allowed by the ***repeatable read***, ***consistent read***, and ***read uncommitted*** levels.

See Also [consistent read](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_consistent_read), [isolation level](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_isolation_level), [non-repeatable read](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_non_repeatable_read), [READ UNCOMMITTED](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_read_uncommitted), [REPEATABLE READ](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_repeatable_read), [SERIALIZABLE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_serializable), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

PHP

A programming language originating with web applications. The code is typically embedded as blocks within the source of a web page, with the output substituted into the page as it is transmitted by the web server. This is in contrast to applications such as CGI scripts that print output in the form of an entire web page. The PHP style of coding is used for highly interactive and dynamic web pages. Modern PHP programs can also be run as command-line or GUI applications.

MySQL applications are written using one of the ***PHP APIs***. Reusable modules can be written in ***C*** and called from PHP.

Another technology for writing server-side web pages with MySQL is ***ASP.net***.

See Also [ASP.net](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_asp_net), [C](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_c), [PHP API](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_php_api).

PHP API

Several ***APIs*** are available for writing MySQL applications in the ***PHP*** language: the original MySQL API (Mysql) the MySQL Improved Extension (Mysqli) the MySQL Native Driver (Mysqlnd) the MySQL functions (PDO\_MYSQL), and Connector/PHP. For details, see [MySQL and PHP](https://docs.oracle.com/cd/E17952_01/apis-php-en/).

See Also [API](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_api), [PHP](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_php).

physical

A type of operation that involves hardware-related aspects such as disk blocks, memory pages, files, bits, disk reads, and so on. Typically, physical aspects are important during expert-level performance tuning and problem diagnosis. Contrast with ***logical***.

See Also [logical](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_logical), [physical backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_physical_backup).

physical backup

A ***backup*** that copies the actual data files. For example, the *mysqlbackup* command of the ***MySQL Enterprise Backup*** product produces a physical backup, because its output contains data files that can be used directly by the mysqld server, resulting in a faster ***restore*** operation. Contrast with ***logical backup***.

See Also [backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_backup), [logical backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_logical_backup), [MySQL Enterprise Backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysql_enterprise_backup), [restore](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_restore).

PITR

Acronym for ***point-in-time recovery***.

See Also [point-in-time recovery](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_point_in_time_recovery).

plan stability

A property of a ***query execution plan***, where the optimizer makes the same choices each time for a given ***query***, so that performance is consistent and predictable.

See Also [query](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_query), [query execution plan](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_query_execution_plan).

point-in-time recovery

The process of restoring a ***backup*** to recreate the state of the database at a specific date and time. Commonly abbreviated “PITR”. Because it is unlikely that the specified time corresponds exactly to the time of a backup, this technique usually requires a combination of a ***physical backup*** and a ***logical backup***. For example, with the ***MySQL Enterprise Backup*** product, you restore the last backup that you took before the specified point in time, then replay changes from the ***binary log*** between the time of the backup and the PITR time.

See Also [backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_backup), [binary log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_binary_log), [logical backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_logical_backup), [MySQL Enterprise Backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysql_enterprise_backup), [physical backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_physical_backup).

port

The number of the TCP/IP socket the database server listens on, used to establish a ***connection***. Often specified in conjunction with a ***host***. Depending on your use of network encryption, there might be one port for unencrypted traffic and another port for ***SSL*** connections.

See Also [connection](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connection), [host](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_host), [SSL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ssl).

prefix

See [index prefix](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index_prefix).

prepared backup

A set of backup files, produced by the ***MySQL Enterprise Backup*** product, after all the stages of applying ***binary logs*** and ***incremental backups*** are finished. The resulting files are ready to be ***restored***. Prior to the apply steps, the files are known as a ***raw backup***.

See Also [binary log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_binary_log), [hot backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_hot_backup), [incremental backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_incremental_backup), [MySQL Enterprise Backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysql_enterprise_backup), [raw backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_raw_backup), [restore](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_restore).

prepared statement

An SQL statement that is analyzed in advance to determine an efficient execution plan. It can be executed multiple times, without the overhead for parsing and analysis each time. Different values can be substituted for literals in the WHERE clause each time, through the use of placeholders. This substitution technique improves security, protecting against some kinds of SQL injection attacks. You can also reduce the overhead for converting and copying return values to program variables.

Although you can use prepared statements directly through SQL syntax, the various ***Connectors*** have programming interfaces for manipulating prepared statements, and these APIs are more efficient than going through SQL.

See Also [client-side prepared statement](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_client_side_prepared_statement), [connector](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector), [server-side prepared statement](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_server_side_prepared_statement).

primary key

A set of columns—and by implication, the index based on this set of columns—that can uniquely identify every row in a table. As such, it must be a unique index that does not contain any NULL values.

InnoDB requires that every table has such an index (also called the ***clustered index*** or ***cluster index***), and organizes the table storage based on the column values of the primary key.

When choosing primary key values, consider using arbitrary values (a ***synthetic key***) rather than relying on values derived from some other source (a ***natural key***).

See Also [clustered index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_clustered_index), [index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index), [natural key](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_natural_key), [synthetic key](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_synthetic_key).

principal

The Kerberos term for a named entity, such as a user or server.

See Also [service principal name](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_service_principal_name), [user principal name](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_user_principal_name).

process

An instance of an executing program. The operating system switches between multiple running processes, allowing for a certain degree of ***concurrency***. On most operating systems, processes can contain multiple ***threads*** of execution that share resources. Context-switching between threads is faster than the equivalent switching between processes.

See Also [concurrency](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_concurrency), [thread](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_thread).

pseudo-record

An artificial record in an index, used for ***locking*** key values or ranges that do not currently exist.

See Also [infimum record](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_infimum_record), [locking](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_locking), [supremum record](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_supremum_record).

Pthreads

The POSIX threads standard, which defines an API for threading and locking operations on Unix and Linux systems. On Unix and Linux systems, InnoDB uses this implementation for ***mutexes***.

See Also [mutex](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mutex).

purge

A type of garbage collection performed by one or more separate background threads (controlled by [innodb\_purge\_threads](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_purge_threads)) that runs on a periodic schedule. Purge parses and processes ***undo log*** pages from the ***history list*** for the purpose of removing clustered and secondary index records that were marked for deletion (by previous [DELETE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/delete.html) statements) and are no longer required for ***MVCC*** or ***rollback***. Purge frees undo log pages from the history list after processing them.

See Also [history list](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_history_list), [MVCC](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mvcc), [rollback](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_rollback), [undo log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_undo_log).

purge buffering

The technique of storing changes to secondary index pages, resulting from DELETE operations, in the ***change buffer*** rather than writing the changes immediately, so that the physical writes can be performed to minimize random I/O. (Because delete operations are a two-step process, this operation buffers the write that normally purges an index record that was previously marked for deletion.) It is one of the types of ***change buffering***; the others are ***insert buffering*** and ***delete buffering***.

See Also [change buffer](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_change_buffer), [change buffering](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_change_buffering), [delete buffering](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_delete_buffering), [insert buffer](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_insert_buffer), [insert buffering](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_insert_buffering).

purge lag

Another name for the InnoDB ***history list***. Related to the [innodb\_max\_purge\_lag](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_max_purge_lag) configuration option.

See Also [history list](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_history_list), [purge](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_purge).

purge thread

A ***thread*** within the InnoDB process that is dedicated to performing the periodic ***purge*** operation. In MySQL 5.6 and higher, multiple purge threads are enabled by the [innodb\_purge\_threads](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_purge_threads) configuration option.

See Also [purge](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_purge), [thread](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_thread).

Python

A programming language used in a broad range of fields, from Unix scripting to large-scale applications. Includes runtime typing, built-in high-level data types, object-oriented features, and an extensive standard library. Often used as a “glue” language between components written in other languages. The MySQL ***Python API*** is the open-source ***MySQLdb*** module.

See Also [MySQLdb](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysqldb), [Python API](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_python_api).

Python API

See Also [API](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_api), [Python](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_python).

### Q

query

In ***SQL***, an operation that reads information from one or more ***tables***. Depending on the organization of data and the parameters of the query, the lookup might be optimized by consulting an ***index***. If multiple tables are involved, the query is known as a ***join***.

For historical reasons, sometimes discussions of internal processing for statements use “query” in a broader sense, including other types of MySQL statements such as ***DDL*** and ***DML*** statements.

See Also [DDL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ddl), [DML](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dml), [index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index), [join](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_join), [SQL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_sql), [table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_table).

query execution plan

The set of decisions made by the optimizer about how to perform a ***query*** most efficiently, including which ***index*** or indexes to use, and the order in which to ***join*** tables. ***Plan stability*** involves the same choices being made consistently for a given query.

See Also [index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index), [join](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_join), [plan stability](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_plan_stability), [query](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_query).

query log

See [general query log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_general_query_log).

quiesce

To reduce the amount of database activity, often in preparation for an operation such as an [ALTER TABLE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-table.html), a ***backup***, or a ***shutdown***. Might or might not involve doing as much ***flushing*** as possible, so that ***InnoDB*** does not continue doing background I/O.

In MySQL 5.6 and higher, the syntax FLUSH TABLES ... FOR EXPORT writes some data to disk for InnoDB tables that make it simpler to back up those tables by copying the data files.

See Also [backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_backup), [flush](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_flush), [InnoDB](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_innodb), [shutdown](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_shutdown).

### R

R-tree

A tree data structure used for spatial indexing of multi-dimensional data such as geographical coordinates, rectangles or polygons.

See Also [B-tree](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_b_tree).

RAID

Acronym for “Redundant Array of Inexpensive Drives”. Spreading I/O operations across multiple drives enables greater ***concurrency*** at the hardware level, and improves the efficiency of low-level write operations that otherwise would be performed in sequence.

See Also [concurrency](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_concurrency).

random dive

A technique for quickly estimating the number of different values in a column (the column's ***cardinality***). InnoDB samples pages at random from the index and uses that data to estimate the number of different values.

See Also [cardinality](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_cardinality).

raw backup

The initial set of backup files produced by the ***MySQL Enterprise Backup*** product, before the changes reflected in the ***binary log*** and any ***incremental backups*** are applied. At this stage, the files are not ready to ***restore***. After these changes are applied, the files are known as a ***prepared backup***.

See Also [binary log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_binary_log), [hot backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_hot_backup), [ibbackup\_logfile](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ibbackup_logfile), [incremental backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_incremental_backup), [MySQL Enterprise Backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysql_enterprise_backup), [prepared backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_prepared_backup), [restore](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_restore).

READ COMMITTED

An ***isolation level*** that uses a ***locking*** strategy that relaxes some of the protection between ***transactions***, in the interest of performance. Transactions cannot see uncommitted data from other transactions, but they can see data that is committed by another transaction after the current transaction started. Thus, a transaction never sees any bad data, but the data that it does see may depend to some extent on the timing of other transactions.

When a transaction with this isolation level performs UPDATE ... WHERE or DELETE ... WHERE operations, other transactions might have to wait. The transaction can perform SELECT ... FOR UPDATE, and LOCK IN SHARE MODE operations without making other transactions wait.

SELECT ... FOR SHARE replaces SELECT ... LOCK IN SHARE MODE in MySQL 8.0.1, but LOCK IN SHARE MODE remains available for backward compatibility.

See Also [ACID](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_acid), [isolation level](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_isolation_level), [locking](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_locking), [REPEATABLE READ](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_repeatable_read), [SERIALIZABLE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_serializable), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

read phenomena

Phenomena such as ***dirty reads***, ***non-repeatable reads***, and ***phantom*** reads which can occur when a transaction reads data that another transaction has modified.

See Also [dirty read](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dirty_read), [non-repeatable read](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_non_repeatable_read), [phantom](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_phantom).

READ UNCOMMITTED

The ***isolation level*** that provides the least amount of protection between transactions. Queries employ a ***locking*** strategy that allows them to proceed in situations where they would normally wait for another transaction. However, this extra performance comes at the cost of less reliable results, including data that has been changed by other transactions and not committed yet (known as ***dirty read***). Use this isolation level with great caution, and be aware that the results might not be consistent or reproducible, depending on what other transactions are doing at the same time. Typically, transactions with this isolation level only do queries, not insert, update, or delete operations.

See Also [ACID](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_acid), [dirty read](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dirty_read), [isolation level](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_isolation_level), [locking](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_locking), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

read view

An internal snapshot used by the ***MVCC*** mechanism of InnoDB. Certain ***transactions***, depending on their ***isolation level***, see the data values as they were at the time the transaction (or in some cases, the statement) started. Isolation levels that use a read view are ***REPEATABLE READ***, ***READ COMMITTED***, and ***READ UNCOMMITTED***.

See Also [isolation level](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_isolation_level), [MVCC](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mvcc), [READ COMMITTED](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_read_committed), [READ UNCOMMITTED](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_read_uncommitted), [REPEATABLE READ](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_repeatable_read), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

read-ahead

A type of I/O request that prefetches a group of ***pages*** (an entire ***extent***) into the ***buffer pool*** asynchronously, in case these pages are needed soon. The linear read-ahead technique prefetches all the pages of one extent based on access patterns for pages in the preceding extent. The random read-ahead technique prefetches all the pages for an extent once a certain number of pages from the same extent are in the buffer pool. Random read-ahead is not part of MySQL 5.5, but is re-introduced in MySQL 5.6 under the control of the [innodb\_random\_read\_ahead](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_random_read_ahead) configuration option.

See Also [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [extent](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_extent), [page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_page).

read-only transaction

A type of ***transaction*** that can be optimized for InnoDB tables by eliminating some of the bookkeeping involved with creating a ***read view*** for each transaction. Can only perform ***non-locking read*** queries. It can be started explicitly with the syntax [START TRANSACTION READ ONLY](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/commit.html), or automatically under certain conditions. See [Section 8.5.3, “Optimizing InnoDB Read-Only Transactions”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-performance-ro-txn.html) for details.

See Also [non-locking read](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_non_locking_read), [read view](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_read_view), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

record lock

A [lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_lock) on an index record. For example, SELECT c1 FROM t WHERE c1 = 10 FOR UPDATE; prevents any other transaction from inserting, updating, or deleting rows where the value of t.c1 is 10. Contrast with ***gap lock*** and ***next-key lock***.

See Also [gap lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_gap_lock), [lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_lock), [next-key lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_next_key_lock).

redo

The data, in units of records, recorded in the ***redo log*** when [DML](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dml) statements make changes to InnoDB tables. It is used during ***crash recovery*** to correct data written by incomplete ***transactions***. The ever-increasing ***LSN*** value represents the cumulative amount of redo data that has passed through the redo log.

See Also [crash recovery](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_crash_recovery), [DML](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dml), [LSN](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_lsn), [redo log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_redo_log), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

redo log

A disk-based data structure used during ***crash recovery***, to correct data written by incomplete ***transactions***. During normal operation, it encodes requests to change InnoDB table data, which result from SQL statements or low-level API calls through NoSQL interfaces. Modifications that did not finish updating the ***data files*** before an unexpected ***shutdown*** are replayed automatically.

The redo log is physically represented as a set of files, typically named ib\_logfile0 and ib\_logfile1. The data in the redo log is encoded in terms of records affected; this data is collectively referred to as ***redo***. The passage of data through the redo logs is represented by the ever-increasing ***LSN*** value. The original 4GB limit on maximum size for the redo log is raised to 512GB in MySQL 5.6.3.

The disk layout of the redo log is influenced by the configuration options [innodb\_log\_file\_size](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_log_file_size), [innodb\_log\_group\_home\_dir](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_log_group_home_dir), and (rarely) [innodb\_log\_files\_in\_group](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_log_files_in_group). The performance of redo log operations is also affected by the ***log buffer***, which is controlled by the [innodb\_log\_buffer\_size](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_log_buffer_size) configuration option.

See Also [crash recovery](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_crash_recovery), [data files](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_data_files), [ib\_logfile](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ib_logfile), [log buffer](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_log_buffer), [LSN](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_lsn), [redo](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_redo), [shutdown](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_shutdown), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

redo log archiving

An InnoDB feature that, when enabled, sequentially writes redo log records to an archive file to avoid potential loss of data than can occur when a backup utility fails to keep pace with redo log generation while a backup operation is in progress. For more information, see [Redo Log Archiving](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-redo-log.html#innodb-redo-log-archiving).

See Also [redo log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_redo_log).

redundant row format

The oldest InnoDB ***row format***. Prior to MySQL 5.0.3, it was the only row format available in InnoDB. From MySQL 5.0.3 to MySQL 5.7.8, the default row format is ***COMPACT***. As of MySQL 5.7.9, the default row format is defined by the [innodb\_default\_row\_format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_default_row_format) configuration option, which has a default setting of ***DYNAMIC***. You can still specify the ***REDUNDANT*** row format for compatibility with older InnoDB tables.

For more information, see [Section 15.10, “InnoDB Row Formats”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-row-format.html).

See Also [compact row format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_compact_row_format), [dynamic row format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dynamic_row_format), [row format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_row_format).

referential integrity

The technique of maintaining data always in a consistent format, part of the ***ACID*** philosophy. In particular, data in different tables is kept consistent through the use of ***foreign key constraints***, which can prevent changes from happening or automatically propagate those changes to all related tables. Related mechanisms include the ***unique constraint***, which prevents duplicate values from being inserted by mistake, and the ***NOT NULL constraint***, which prevents blank values from being inserted by mistake.

See Also [ACID](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_acid), [FOREIGN KEY constraint](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_foreign_key_constraint), [NOT NULL constraint](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_not_null_constraint), [unique constraint](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_unique_constraint).

relational

An important aspect of modern database systems. The database server encodes and enforces relationships such as one-to-one, one-to-many, many-to-one, and uniqueness. For example, a person might have zero, one, or many phone numbers in an address database; a single phone number might be associated with several family members. In a financial database, a person might be required to have exactly one taxpayer ID, and any taxpayer ID could only be associated with one person.

The database server can use these relationships to prevent bad data from being inserted, and to find efficient ways to look up information. For example, if a value is declared to be unique, the server can stop searching as soon as the first match is found, and it can reject attempts to insert a second copy of the same value.

At the database level, these relationships are expressed through SQL features such as ***columns*** within a table, unique and NOT NULL ***constraints***, ***foreign keys***, and different kinds of join operations. Complex relationships typically involve data split between more than one table. Often, the data is ***normalized***, so that duplicate values in one-to-many relationships are stored only once.

In a mathematical context, the relations within a database are derived from set theory. For example, the OR and AND operators of a WHERE clause represent the notions of union and intersection.

See Also [ACID](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_acid), [column](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_column), [constraint](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_constraint), [foreign key](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_foreign_key), [normalized](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_normalized).

relevance

In the ***full-text search*** feature, a number signifying the similarity between the search string and the data in the ***FULLTEXT index***. For example, when you search for a single word, that word is typically more relevant for a row where it occurs several times in the text than a row where it appears only once.

See Also [full-text search](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_full_text_search), [FULLTEXT index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_fulltext_index).

REPEATABLE READ

The default ***isolation level*** for InnoDB. It prevents any rows that are queried from being changed by other ***transactions***, thus blocking ***non-repeatable reads*** but not ***phantom*** reads. It uses a moderately strict ***locking*** strategy so that all queries within a transaction see data from the same snapshot, that is, the data as it was at the time the transaction started.

When a transaction with this isolation level performs UPDATE ... WHERE, DELETE ... WHERE, SELECT ... FOR UPDATE, and LOCK IN SHARE MODE operations, other transactions might have to wait.

SELECT ... FOR SHARE replaces SELECT ... LOCK IN SHARE MODE in MySQL 8.0.1, but LOCK IN SHARE MODE remains available for backward compatibility.

See Also [ACID](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_acid), [consistent read](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_consistent_read), [isolation level](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_isolation_level), [locking](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_locking), [phantom](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_phantom), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

repertoire

Repertoire is a term applied to character sets. A character set repertoire is the collection of characters in the set. See [Section 10.2.1, “Character Set Repertoire”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/charset-repertoire.html).

replica

A database ***server*** machine in a ***replication*** topology that receives changes from another server (the ***source***) and applies those same changes. Thus it maintains the same contents as the source, although it might lag somewhat behind.

In MySQL, replicas are commonly used in disaster recovery, to take the place of a source that fails. They are also commonly used for testing software upgrades and new settings, to ensure that database configuration changes do not cause problems with performance or reliability.

Replicas typically have high workloads, because they process all the ***DML*** (write) operations relayed from the source, as well as user queries. To ensure that replicas can apply changes from the source fast enough, they frequently have fast I/O devices and sufficient CPU and memory to run multiple database instances on the same server. For example, the source might use hard drive storage while the replicas use ***SSD***s.

See Also [DML](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dml), [replication](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_replication), [server](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_server), [source](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_source), [SSD](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ssd).

replication

The practice of sending changes from a ***source***, to one or more ***replicas***, so that all databases have the same data. This technique has a wide range of uses, such as load-balancing for better scalability, disaster recovery, and testing software upgrades and configuration changes. The changes can be sent between the databases by methods called ***row-based replication*** and ***statement-based replication***.

See Also [replica](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_replica), [row-based replication](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_row_based_replication), [source](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_source), [statement-based replication](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_statement_based_replication).

restore

The process of putting a set of backup files from the ***MySQL Enterprise Backup*** product in place for use by MySQL. This operation can be performed to fix a corrupted database, to return to some earlier point in time, or (in a ***replication*** context) to set up a new ***replica***. In the ***MySQL Enterprise Backup*** product, this operation is performed by the copy-back option of the mysqlbackup command.

See Also [hot backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_hot_backup), [MySQL Enterprise Backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysql_enterprise_backup), [mysqlbackup command](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysqlbackup_command), [prepared backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_prepared_backup), [replica](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_replica), [replication](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_replication).

rollback

A ***SQL*** statement that ends a ***transaction***, undoing any changes made by the transaction. It is the opposite of ***commit***, which makes permanent any changes made in the transaction.

By default, MySQL uses the ***autocommit*** setting, which automatically issues a commit following each SQL statement. You must change this setting before you can use the rollback technique.

See Also [ACID](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_acid), [autocommit](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_autocommit), [commit](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_commit), [SQL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_sql), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

rollback segment

The storage area containing the ***undo logs***. Rollback segments have traditionally resided in the ***system tablespace***. As of MySQL 5.6, rollback segments can reside in ***undo tablespaces***. As of MySQL 5.7, rollback segments are also allocated to the global temporary tablespace.

See Also [global temporary tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_global_temporary_tablespace), [system tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_system_tablespace), [undo log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_undo_log), [undo tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_undo_tablespace).

row

The logical data structure defined by a set of ***columns***. A set of rows makes up a ***table***. Within InnoDB ***data files***, each ***page*** can contain one or more rows.

Although InnoDB uses the term ***row format*** for consistency with MySQL syntax, the row format is a property of each table and applies to all rows in that table.

See Also [column](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_column), [data files](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_data_files), [page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_page), [row format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_row_format), [table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_table).

row format

The disk storage format for ***rows*** of an InnoDB ***table***. As InnoDB gains new capabilities such as ***compression***, new row formats are introduced to support the resulting improvements in storage efficiency and performance.

The row format of an InnoDB table is specified by the ROW\_FORMAT option or by the [innodb\_default\_row\_format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_default_row_format) configuration option (introduced in MySQL 5.7.9). Row formats include REDUNDANT, COMPACT, COMPRESSED, and DYNAMIC. To view the row format of an InnoDB table, issue the [SHOW TABLE STATUS](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/show-table-status.html) statement or query InnoDB table metadata in the [INFORMATION\_SCHEMA](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/information-schema.html).

See Also [compact row format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_compact_row_format), [compressed row format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_compressed_row_format), [compression](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_compression), [dynamic row format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dynamic_row_format), [redundant row format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_redundant_row_format), [row](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_row), [table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_table).

row lock

A ***lock*** that prevents a row from being accessed in an incompatible way by another ***transaction***. Other rows in the same table can be freely written to by other transactions. This is the type of ***locking*** done by ***DML*** operations on ***InnoDB*** tables.

Contrast with ***table locks*** used by [MyISAM](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/myisam-storage-engine.html), or during ***DDL*** operations on InnoDB tables that cannot be done with ***online DDL***; those locks block concurrent access to the table.

See Also [DDL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ddl), [DML](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dml), [InnoDB](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_innodb), [lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_lock), [locking](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_locking), [online DDL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_online_ddl), [table lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_table_lock), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

row-based replication

A form of ***replication*** where events are propagated from the ***source*** specifying how to change individual rows on the ***replica***. It is safe to use for all settings of the [innodb\_autoinc\_lock\_mode](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_autoinc_lock_mode) option.

See Also [auto-increment locking](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_auto_increment_locking), [innodb\_autoinc\_lock\_mode](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_innodb_autoinc_lock_mode), [replica](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_replica), [replication](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_replication), [source](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_source), [statement-based replication](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_statement_based_replication).

row-level locking

The ***locking*** mechanism used for ***InnoDB*** tables, relying on ***row locks*** rather than ***table locks***. Multiple ***transactions*** can modify the same table concurrently. Only if two transactions try to modify the same row does one of the transactions wait for the other to complete (and release its row locks).

See Also [InnoDB](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_innodb), [locking](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_locking), [row lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_row_lock), [table lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_table_lock), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

Ruby

A programming language that emphasizes dynamic typing and object-oriented programming. Some syntax is familiar to ***Perl*** developers.

See Also [API](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_api), [Perl](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_perl), [Ruby API](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ruby_api).

Ruby API

mysql2, based based on the ***libmysqlclient*** API library, is available for Ruby programmers developing MySQL applications. For more information, see [Section 29.11, “MySQL Ruby APIs”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/apis-ruby.html).

See Also [libmysql](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_libmysql), [Ruby](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ruby).

rw-lock

The low-level object that InnoDB uses to represent and enforce shared-access ***locks*** to internal in-memory data structures following certain rules. Contrast with ***mutexes***, which InnoDB uses to represent and enforce exclusive access to internal in-memory data structures. Mutexes and rw-locks are known collectively as ***latches***.

rw-lock types include s-locks (shared locks), x-locks (exclusive locks), and sx-locks (shared-exclusive locks).

* An s-lock provides read access to a common resource.
* An x-lock provides write access to a common resource while not permitting inconsistent reads by other threads.
* An sx-lock provides write access to a common resource while permitting inconsistent reads by other threads. sx-locks were introduced in MySQL 5.7 to optimize concurrency and improve scalability for read-write workloads.

The following matrix summarizes rw-lock type compatibility.

|  | ***S*** | ***SX*** | ***X*** |
| --- | --- | --- | --- |
| ***S*** | Compatible | Compatible | Conflict |
| ***SX*** | Compatible | Conflict | Conflict |
| ***X*** | Conflict | Conflict | Conflict |

See Also [latch](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_latch), [lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_lock), [mutex](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mutex), [Performance Schema](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_performance_schema).

### S

savepoint

Savepoints help to implement nested ***transactions***. They can be used to provide scope to operations on tables that are part of a larger transaction. For example, scheduling a trip in a reservation system might involve booking several different flights; if a desired flight is unavailable, you might ***roll back*** the changes involved in booking that one leg, without rolling back the earlier flights that were successfully booked.

See Also [rollback](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_rollback), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

scalability

The ability to add more work and issue more simultaneous requests to a system, without a sudden drop in performance due to exceeding the limits of system capacity. Software architecture, hardware configuration, application coding, and type of workload all play a part in scalability. When the system reaches its maximum capacity, popular techniques for increasing scalability are ***scale up*** (increasing the capacity of existing hardware or software) and ***scale out*** (adding new servers and more instances of MySQL). Often paired with ***availability*** as critical aspects of a large-scale deployment.

See Also [availability](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_availability), [scale out](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_scale_out), [scale up](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_scale_up).

scale out

A technique for increasing ***scalability*** by adding new servers and more instances of MySQL. For example, setting up replication, NDB Cluster, connection pooling, or other features that spread work across a group of servers. Contrast with ***scale up***.

See Also [scalability](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_scalability), [scale up](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_scale_up).

scale up

A technique for increasing ***scalability*** by increasing the capacity of existing hardware or software. For example, increasing the memory on a server and adjusting memory-related parameters such as [innodb\_buffer\_pool\_size](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_buffer_pool_size) and [innodb\_buffer\_pool\_instances](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_buffer_pool_instances). Contrast with ***scale out***.

See Also [scalability](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_scalability), [scale out](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_scale_out).

schema

Conceptually, a schema is a set of interrelated database objects, such as tables, table columns, data types of the columns, indexes, foreign keys, and so on. These objects are connected through SQL syntax, because the columns make up the tables, the foreign keys refer to tables and columns, and so on. Ideally, they are also connected logically, working together as part of a unified application or flexible framework. For example, the ***INFORMATION\_SCHEMA*** and ***performance\_schema*** databases use “schema” in their names to emphasize the close relationships between the tables and columns they contain.

In MySQL, physically, a ***schema*** is synonymous with a ***database***. You can substitute the keyword SCHEMA instead of DATABASE in MySQL SQL syntax, for example using CREATE SCHEMA instead of CREATE DATABASE.

Some other database products draw a distinction. For example, in the Oracle Database product, a ***schema*** represents only a part of a database: the tables and other objects owned by a single user.

See Also [database](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_database), [INFORMATION\_SCHEMA](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_information_schema), [Performance Schema](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_performance_schema).

SDI

Acronym for “serialized dictionary information”.

See Also [serialized dictionary information (SDI)](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_serialized_dictionary_information).

search index

In MySQL, ***full-text search*** queries use a special kind of index, the ***FULLTEXT index***. In MySQL 5.6.4 and up, InnoDB and MyISAM tables both support FULLTEXT indexes; formerly, these indexes were only available for MyISAM tables.

See Also [full-text search](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_full_text_search), [FULLTEXT index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_fulltext_index).

secondary index

A type of InnoDB ***index*** that represents a subset of table columns. An InnoDB table can have zero, one, or many secondary indexes. (Contrast with the ***clustered index***, which is required for each InnoDB table, and stores the data for all the table columns.)

A secondary index can be used to satisfy queries that only require values from the indexed columns. For more complex queries, it can be used to identify the relevant rows in the table, which are then retrieved through lookups using the clustered index.

Creating and dropping secondary indexes has traditionally involved significant overhead from copying all the data in the InnoDB table. The ***fast index creation*** feature makes both CREATE INDEX and DROP INDEX statements much faster for InnoDB secondary indexes.

See Also [clustered index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_clustered_index), [Fast Index Creation](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_fast_index_creation), [index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index).

segment

A division within an InnoDB ***tablespace***. If a tablespace is analogous to a directory, the segments are analogous to files within that directory. A segment can grow. New segments can be created.

For example, within a ***file-per-table*** tablespace, table data is in one segment and each associated index is in its own segment. The ***system tablespace*** contains many different segments, because it can hold many tables and their associated indexes. Prior to MySQL 8.0, the system tablespace also includes one or more ***rollback segments*** used for ***undo logs***.

Segments grow and shrink as data is inserted and deleted. When a segment needs more room, it is extended by one ***extent*** (1 megabyte) at a time. Similarly, a segment releases one extent's worth of space when all the data in that extent is no longer needed.

See Also [extent](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_extent), [file-per-table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_file_per_table), [rollback segment](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_rollback_segment), [system tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_system_tablespace), [tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_tablespace), [undo log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_undo_log).

selectivity

A property of data distribution, the number of distinct values in a column (its ***cardinality***) divided by the number of records in the table. High selectivity means that the column values are relatively unique, and can retrieved efficiently through an index. If you (or the query optimizer) can predict that a test in a WHERE clause only matches a small number (or proportion) of rows in a table, the overall ***query*** tends to be efficient if it evaluates that test first, using an index.

See Also [cardinality](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_cardinality), [query](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_query).

semi-consistent read

A type of read operation used for UPDATE statements, that is a combination of ***READ COMMITTED*** and ***consistent read***. When an UPDATE statement examines a row that is already locked, InnoDB returns the latest committed version to MySQL so that MySQL can determine whether the row matches the WHERE condition of the UPDATE. If the row matches (must be updated), MySQL reads the row again, and this time InnoDB either locks it or waits for a lock on it. This type of read operation can only happen when the transaction has the READ COMMITTED ***isolation level***.

See Also [consistent read](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_consistent_read), [isolation level](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_isolation_level), [READ COMMITTED](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_read_committed).

SERIALIZABLE

The ***isolation level*** that uses the most conservative locking strategy, to prevent any other ***transactions*** from inserting or changing data that was read by this transaction, until it is finished. This way, the same query can be run over and over within a transaction, and be certain to retrieve the same set of results each time. Any attempt to change data that was committed by another transaction since the start of the current transaction, cause the current transaction to wait.

This is the default isolation level specified by the SQL standard. In practice, this degree of strictness is rarely needed, so the default isolation level for InnoDB is the next most strict, ***REPEATABLE READ***.

See Also [ACID](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_acid), [consistent read](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_consistent_read), [isolation level](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_isolation_level), [locking](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_locking), [REPEATABLE READ](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_repeatable_read), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

serialized dictionary information (SDI)

Dictionary object metadata in serialized form. SDI is stored in JSON format.

As of MySQL 8.0.3, SDI is present in all InnoDB tablespace files except for temporary tablespace and undo tablespace files. The presence of SDI in tablespace files provides metadata redundancy. For example, dictionary object metadata can be extracted from tablespace files using the [**ibd2sdi**](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/ibd2sdi.html) utility if the data dictionary becomes unavailable.

For a MyISAM table, SDI is stored in a .sdi metadata file in the schema directory. An SDI metadata file is required to perform an [IMPORT TABLE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/import-table.html) operation.

See Also [file-per-table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_file_per_table), [general tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_general_tablespace), [system tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_system_tablespace), [tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_tablespace).

server

A type of program that runs continuously, waiting to receive and act upon requests from another program (the ***client***). Because often an entire computer is dedicated to running one or more server programs (such as a database server, a web server, an application server, or some combination of these), the term ***server*** can also refer to the computer that runs the server software.

See Also [client](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_client), [mysqld](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysqld).

server-side prepared statement

A ***prepared statement*** managed by the MySQL server. Historically, issues with server-side prepared statements led ***Connector/J*** and ***Connector/PHP*** developers to sometimes use ***client-side prepared statements*** instead. With modern MySQL server versions, server-side prepared statements are recommended for performance, scalability, and memory efficiency.

See Also [client-side prepared statement](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_client_side_prepared_statement), [Connector/J](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_j), [Connector/PHP](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_php), [prepared statement](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_prepared_statement).

service principal name

The name for a Kerberos named entity that represents a service.

See Also [principal](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_principal).

service ticket

A Kerberos ticket that provides access to an application service, such as the service provided by a web or database server.

servlet

See Also [Connector/J](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_j).

session temporary tablespace

A temporary tablespace that stores user-created temporary tables and internal temporary tables created by the optimizer when InnoDB is configured as the on-disk storage engine for internal temporary tables.

See Also [optimizer](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_optimizer), [temporary table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_temporary_table), [temporary tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_temporary_tablespace).

shared lock

A kind of ***lock*** that allows other ***transactions*** to read the locked object, and to also acquire other shared locks on it, but not to write to it. The opposite of ***exclusive lock***.

See Also [exclusive lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_exclusive_lock), [lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_lock), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

shared tablespace

Another way of referring to the ***system tablespace*** or a ***general tablespace***. General tablespaces were introduced in MySQL 5.7. More than one table can reside in a shared tablespace. Only a single table can reside in a file-per-table tablespace.

See Also [general tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_general_tablespace), [system tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_system_tablespace).

sharp checkpoint

The process of ***flushing*** to disk all ***dirty*** buffer pool pages whose redo entries are contained in certain portion of the ***redo log***. Occurs before InnoDB reuses a portion of a log file; the log files are used in a circular fashion. Typically occurs with write-intensive ***workloads***.

See Also [dirty page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dirty_page), [flush](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_flush), [redo log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_redo_log), [workload](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_workload).

shutdown

The process of stopping the MySQL server. By default, this process cleans up operations for ***InnoDB*** tables, so InnoDB can be ***slow*** to shut down, but fast to start up later. If you skip the cleanup operations, it is ***fast*** to shut down but the cleanup must be performed during the next restart.

The shutdown mode for InnoDB is controlled by the [innodb\_fast\_shutdown](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_fast_shutdown) option.

See Also [fast shutdown](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_fast_shutdown), [InnoDB](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_innodb), [slow shutdown](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_slow_shutdown), [startup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_startup).

slave

See [replica](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_replica).

slow query log

A type of ***log*** used for performance tuning of SQL statements processed by the MySQL server. The log information is stored in a file. You must enable this feature to use it. You control which categories of “slow” SQL statements are logged. For more information, see [Section 5.4.5, “The Slow Query Log”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/slow-query-log.html).

See Also [general query log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_general_query_log), [log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_log).

slow shutdown

A type of ***shutdown*** that does additional InnoDB flushing operations before completing. Also known as a ***clean shutdown***. Specified by the configuration parameter [innodb\_fast\_shutdown=0](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_fast_shutdown) or the command SET GLOBAL innodb\_fast\_shutdown=0;. Although the shutdown itself can take longer, that time should be saved on the subsequent startup.

See Also [clean shutdown](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_clean_shutdown), [fast shutdown](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_fast_shutdown), [shutdown](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_shutdown).

snapshot

A representation of data at a particular time, which remains the same even as changes are ***committed*** by other ***transactions***. Used by certain ***isolation levels*** to allow ***consistent reads***.

See Also [commit](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_commit), [consistent read](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_consistent_read), [isolation level](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_isolation_level), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

sort buffer

The buffer used for sorting data during creation of an InnoDB index. Sort buffer size is configured using the [innodb\_sort\_buffer\_size](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_sort_buffer_size) configuration option.

source

A database server machine in a ***replication*** scenario that processes the initial insert, update, and delete requests for data. These changes are propagated to, and repeated on, other servers known as ***replicas***.

See Also [replica](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_replica), [replication](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_replication).

space ID

An identifier used to uniquely identify an InnoDB ***tablespace*** within a MySQL instance. The space ID for the ***system tablespace*** is always zero; this same ID applies to all tables within the system tablespace or within a general tablespace. Each ***file-per-table*** tablespace and ***general tablespace*** has its own space ID.

Prior to MySQL 5.6, this hardcoded value presented difficulties in moving InnoDB tablespace files between MySQL instances. Starting in MySQL 5.6, you can copy tablespace files between instances by using the ***transportable tablespace*** feature involving the statements FLUSH TABLES ... FOR EXPORT, ALTER TABLE ... DISCARD TABLESPACE, and ALTER TABLE ... IMPORT TABLESPACE. The information needed to adjust the space ID is conveyed in the ***.cfg file*** which you copy along with the tablespace. See [Section 15.6.1.3, “Importing InnoDB Tables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-table-import.html) for details.

See Also [.cfg file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_cfg_file), [file-per-table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_file_per_table), [general tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_general_tablespace), [.ibd file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ibd_file), [system tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_system_tablespace), [tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_tablespace), [transportable tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transportable_tablespace).

sparse file

A type of file that uses file system space more efficiently by writing metadata representing empty blocks to disk instead of writing the actual empty space. The InnoDB ***transparent page compression*** feature relies on sparse file support. For more information, see [Section 15.9.2, “InnoDB Page Compression”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-page-compression.html).

See Also [hole punching](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_hole_punching), [transparent page compression](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transparent_page_compression).

spin

A type of ***wait*** operation that continuously tests whether a resource becomes available. This technique is used for resources that are typically held only for brief periods, where it is more efficient to wait in a “busy loop” than to put the thread to sleep and perform a context switch. If the resource does not become available within a short time, the spin loop ceases and another wait technique is used.

See Also [latch](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_latch), [lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_lock), [mutex](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mutex), [wait](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_wait).

SPN

See [service principal name](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_service_principal_name).

Spring

A Java-based application framework designed for assisting in application design by providing a way to configure components.

See Also [J2EE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_j2ee).

SQL

The Structured Query Language that is standard for performing database operations. Often divided into the categories ***DDL***, ***DML***, and ***queries***. MySQL includes some additional statement categories such as ***replication***. See [Chapter 9, Language Structure](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/language-structure.html) for the building blocks of SQL syntax, [Chapter 11, Data Types](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/data-types.html) for the data types to use for MySQL table columns, [Chapter 13, SQL Statements](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/sql-statements.html) for details about SQL statements and their associated categories, and [Chapter 12, Functions and Operators](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/functions.html) for standard and MySQL-specific functions to use in queries.

See Also [DDL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ddl), [DML](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dml), [query](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_query), [replication](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_replication).

SQLState

An error code defined by the ***JDBC*** standard, for exception handling by applications using ***Connector/J***.

See Also [Connector/J](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_j), [JDBC](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_jdbc).

SSD

Acronym for “solid-state drive”. A type of storage device with different performance characteristics than a traditional hard disk drive (***HDD***): smaller storage capacity, faster for random reads, no moving parts, and with a number of considerations affecting write performance. Its performance characteristics can influence the throughput of a ***disk-bound*** workload.

See Also [disk-bound](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_disk_bound), [HDD](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_hdd).

SSL

Acronym for “secure sockets layer”. Provides the encryption layer for network communication between an application and a MySQL database server.

See Also [keystore](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_keystore), [truststore](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_truststore).

ST

See [service ticket](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_service_ticket).

startup

The process of starting the MySQL server. Typically done by one of the programs listed in [Section 4.3, “Server and Server-Startup Programs”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/programs-server.html). The opposite of ***shutdown***.

See Also [shutdown](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_shutdown).

statement interceptor

A type of ***interceptor*** for tracing, debugging, or augmenting SQL statements issued by a database application. Sometimes also known as a ***command interceptor***.

In ***Java*** applications using ***Connector/J***, setting up this type of interceptor involves implementing the com.mysql.jdbc.StatementInterceptorV2 interface, and adding a statementInterceptors property to the ***connection string***.

In ***Visual Studio*** applications using ***Connector/NET***, setting up this type of interceptor involves defining a class that inherits from the BaseCommandInterceptor class and specifying that class name as part of the connection string.

See Also [command interceptor](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_command_interceptor), [connection string](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connection_string), [Connector/J](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_j), [Connector/NET](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_net), [interceptor](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_interceptor), [Java](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_java), [Visual Studio](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_visual_studio).

statement-based replication

A form of ***replication*** where SQL statements are sent from the ***source*** and replayed on the ***replica***. It requires some care with the setting for the [innodb\_autoinc\_lock\_mode](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_autoinc_lock_mode) option, to avoid potential timing problems with ***auto-increment locking***.

See Also [auto-increment locking](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_auto_increment_locking), [innodb\_autoinc\_lock\_mode](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_innodb_autoinc_lock_mode), [replica](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_replica), [replication](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_replication), [row-based replication](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_row_based_replication), [source](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_source).

statistics

Estimated values relating to each InnoDB ***table*** and ***index***, used to construct an efficient ***query execution plan***. The main values are the ***cardinality*** (number of distinct values) and the total number of table rows or index entries. The statistics for the table represent the data in its ***primary key*** index. The statistics for a ***secondary index*** represent the rows covered by that index.

The values are estimated rather than counted precisely because at any moment, different ***transactions*** can be inserting and deleting rows from the same table. To keep the values from being recalculated frequently, you can enable ***persistent statistics***, where the values are stored in InnoDB system tables, and refreshed only when you issue an [ANALYZE TABLE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/analyze-table.html) statement.

You can control how ***NULL*** values are treated when calculating statistics through the [innodb\_stats\_method](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_stats_method) configuration option.

Other types of statistics are available for database objects and database activity through the ***INFORMATION\_SCHEMA*** and ***PERFORMANCE\_SCHEMA*** tables.

See Also [cardinality](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_cardinality), [index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index), [INFORMATION\_SCHEMA](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_information_schema), [NULL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_null), [Performance Schema](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_performance_schema), [persistent statistics](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_persistent_statistics), [primary key](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_primary_key), [query execution plan](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_query_execution_plan), [secondary index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_secondary_index), [table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_table), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

stemming

The ability to search for different variations of a word based on a common root word, such as singular and plural, or past, present, and future verb tense. This feature is currently supported in MyISAM ***full-text search*** feature but not in ***FULLTEXT indexes*** for InnoDB tables.

See Also [full-text search](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_full_text_search), [FULLTEXT index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_fulltext_index).

stopword

In a ***FULLTEXT index***, a word that is considered common or trivial enough that it is omitted from the ***search index*** and ignored in search queries. Different configuration settings control stopword processing for InnoDB and MyISAM tables. See [Section 12.10.4, “Full-Text Stopwords”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/fulltext-stopwords.html) for details.

See Also [FULLTEXT index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_fulltext_index), [search index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_search_index).

storage engine

A component of the MySQL database that performs the low-level work of storing, updating, and querying data. In MySQL 5.5 and higher, ***InnoDB*** is the default storage engine for new tables, superceding MyISAM. Different storage engines are designed with different tradeoffs between factors such as memory usage versus disk usage, read speed versus write speed, and speed versus robustness. Each storage engine manages specific tables, so we refer to [InnoDB](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-storage-engine.html) tables, [MyISAM](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/myisam-storage-engine.html) tables, and so on.

The ***MySQL Enterprise Backup*** product is optimized for backing up InnoDB tables. It can also back up tables handled by MyISAM and other storage engines.

See Also [InnoDB](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_innodb), [MySQL Enterprise Backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysql_enterprise_backup), [table type](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_table_type).

stored generated column

A column whose values are computed from an expression included in the column definition. Column values are evaluated and stored when rows are inserted or updated. A stored generated column requires storage space and can be indexed.

Contrast with ***virtual generated column***.

See Also [base column](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_base_column), [generated column](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_generated_column), [virtual generated column](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_virtual_generated_column).

stored object

A stored program or view.

stored program

A stored routine (procedure or function), trigger, or Event Scheduler event.

stored routine

A stored procedure or function.

strict mode

The general name for the setting controlled by the [innodb\_strict\_mode](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_strict_mode) option. Turning on this setting causes certain conditions that are normally treated as warnings, to be considered errors. For example, certain invalid combinations of options related to ***file format*** and ***row format***, that normally produce a warning and continue with default values, now cause the CREATE TABLE operation to fail. [innodb\_strict\_mode](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_strict_mode) is enabled by default in MySQL 5.7.

MySQL also has something called strict mode. See [Section 5.1.11, “Server SQL Modes”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/sql-mode.html).

See Also [file format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_file_format), [innodb\_strict\_mode](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_innodb_strict_mode), [row format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_row_format).

sublist

Within the list structure that represents the ***buffer pool***, pages that are relatively old and relatively new are represented by different portions of the ***list***. A set of parameters control the size of these portions and the dividing point between the new and old pages.

See Also [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [eviction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_eviction), [list](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_list), [LRU](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_lru).

supremum record

A ***pseudo-record*** in an index, representing the ***gap*** above the largest value in that index. If a transaction has a statement such as SELECT ... FROM ... WHERE col > 10 FOR UPDATE;, and the largest value in the column is 20, it is a lock on the supremum record that prevents other transactions from inserting even larger values such as 50, 100, and so on.

See Also [gap](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_gap), [infimum record](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_infimum_record), [pseudo-record](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_pseudo_record).

surrogate key

Synonym name for ***synthetic key***.

See Also [synthetic key](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_synthetic_key).

synthetic key

An indexed column, typically a ***primary key***, where the values are assigned arbitrarily. Often done using an ***auto-increment*** column. By treating the value as completely arbitrary, you can avoid overly restrictive rules and faulty application assumptions. For example, a numeric sequence representing employee numbers might have a gap if an employee was approved for hiring but never actually joined. Or employee number 100 might have a later hiring date than employee number 500, if they left the company and later rejoined. Numeric values also produce shorter values of predictable length. For example, storing numeric codes meaning “Road”, “Boulevard”, “Expressway”, and so on is more space-efficient than repeating those strings over and over.

Also known as a ***surrogate key***. Contrast with ***natural key***.

See Also [auto-increment](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_auto_increment), [natural key](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_natural_key), [primary key](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_primary_key), [surrogate key](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_surrogate_key).

system tablespace

One or more data files (***ibdata files***) containing the metadata for InnoDB-related objects, and the storage areas for the ***change buffer***, and the ***doublewrite buffer***. It may also contain table and index data for InnoDB tables if tables were created in the system tablespace instead of ***file-per-table*** or ***general tablespaces***. The data and metadata in the system tablespace apply to all ***databases*** in a MySQL ***instance***.

Prior to MySQL 5.6.7, the default was to keep all InnoDB tables and indexes inside the system tablespace, often causing this file to become very large. Because the system tablespace never shrinks, storage problems could arise if large amounts of temporary data were loaded and then deleted. In MySQL 8.0, the default is ***file-per-table*** mode, where each table and its associated indexes are stored in a separate ***.ibd file***. This default makes it easier to use InnoDB features that rely on DYNAMIC and COMPRESSED row formats, such as table ***compression***, efficient storage of ***off-page columns***, and large index key prefixes.

Keeping all table data in the system tablespace or in separate .ibd files has implications for storage management in general. The ***MySQL Enterprise Backup*** product might back up a small set of large files, or many smaller files. On systems with thousands of tables, the file system operations to process thousands of .ibd files can cause bottlenecks.

InnoDB introduced general tablespaces in MySQL 5.7.6, which are also represented by .ibd files. General tablespaces are shared tablespaces created using [CREATE TABLESPACE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/create-tablespace.html) syntax. They can be created outside of the data directory, are capable of holding multiple tables, and support tables of all row formats.

See Also [change buffer](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_change_buffer), [compression](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_compression), [data dictionary](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_data_dictionary), [database](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_database), [doublewrite buffer](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_doublewrite_buffer), [dynamic row format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dynamic_row_format), [file-per-table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_file_per_table), [general tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_general_tablespace), [.ibd file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ibd_file), [ibdata file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ibdata_file), [innodb\_file\_per\_table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_innodb_file_per_table), [instance](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_instance), [MySQL Enterprise Backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mysql_enterprise_backup), [off-page column](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_off_page_column), [tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_tablespace), [undo log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_undo_log).

### T

table

Each MySQL table is associated with a particular ***storage engine***. ***InnoDB*** tables have particular ***physical*** and ***logical*** characteristics that affect performance, ***scalability***, ***backup***, administration, and application development.

In terms of file storage, an InnoDB table belongs to one of the following tablespace types:

* The shared InnoDB ***system tablespace***, which is comprised of one or more ***ibdata files***.
* A ***file-per-table*** tablespace, comprised of an individual ***.ibd file***.
* A shared ***general tablespace***, comprised of an individual .ibd file. General tablespaces were introduced in MySQL 5.7.6.

*.ibd* data files contain both table and ***index*** data.

InnoDB tables created in file-per-table tablespaces can use ***DYNAMIC*** or ***COMPRESSED*** row format. These row formats enable InnoDB features such as ***compression***, efficient storage of ***off-page columns***, and large index key prefixes. General tablespaces support all row formats.

The system tablespace supports tables that use ***REDUNDANT***, ***COMPACT***, and ***DYNAMIC*** row formats. System tablespace support for the ***DYNAMIC*** row format was added in MySQL 5.7.6.

The ***rows*** of an InnoDB table are organized into an index structure known as the ***clustered index***, with entries sorted based on the ***primary key*** columns of the table. Data access is optimized for queries that filter and sort on the primary key columns, and each index contains a copy of the associated primary key columns for each entry. Modifying values for any of the primary key columns is an expensive operation. Thus an important aspect of InnoDB table design is choosing a primary key with columns that are used in the most important queries, and keeping the primary key short, with rarely changing values.

See Also [backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_backup), [clustered index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_clustered_index), [compact row format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_compact_row_format), [compressed row format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_compressed_row_format), [compression](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_compression), [dynamic row format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dynamic_row_format), [Fast Index Creation](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_fast_index_creation), [file-per-table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_file_per_table), [.ibd file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ibd_file), [index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index), [off-page column](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_off_page_column), [primary key](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_primary_key), [redundant row format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_redundant_row_format), [row](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_row), [system tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_system_tablespace), [tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_tablespace).

table lock

A lock that prevents any other ***transaction*** from accessing a table. InnoDB makes considerable effort to make such locks unnecessary, by using techniques such as ***online DDL***, ***row locks*** and ***consistent reads*** for processing ***DML*** statements and ***queries***. You can create such a lock through SQL using the LOCK TABLE statement; one of the steps in migrating from other database systems or MySQL storage engines is to remove such statements wherever practical.

See Also [consistent read](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_consistent_read), [DML](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dml), [lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_lock), [locking](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_locking), [online DDL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_online_ddl), [query](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_query), [row lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_row_lock), [table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_table), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

table scan

See [full table scan](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_full_table_scan).

table statistics

See [statistics](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_statistics).

table type

Obsolete synonym for ***storage engine***. We refer to [InnoDB](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-storage-engine.html) tables, [MyISAM](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/myisam-storage-engine.html) tables, and so on.

See Also [InnoDB](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_innodb), [storage engine](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_storage_engine).

tablespace

A data file that can hold data for one or more InnoDB ***tables*** and associated ***indexes***.

The ***system tablespace*** contains the InnoDB ***data dictionary***, and prior to MySQL 5.6 holds all other InnoDB tables by default.

The [innodb\_file\_per\_table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_file_per_table) option, enabled by default in MySQL 5.6 and higher, allows tables to be created in their own tablespaces. File-per-table tablespaces support features such as efficient storage of ***off-page columns***, table compression, and transportable tablespaces. See [Section 15.6.3.2, “File-Per-Table Tablespaces”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-file-per-table-tablespaces.html) for details.

InnoDB introduced general tablespaces in MySQL 5.7.6. General tablespaces are shared tablespaces created using [CREATE TABLESPACE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/create-tablespace.html) syntax. They can be created outside of the MySQL data directory, are capable of holding multiple tables, and support tables of all row formats.

MySQL NDB Cluster also groups its tables into tablespaces. See [Section 23.6.10.1, “NDB Cluster Disk Data Objects”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/mysql-cluster-disk-data-objects.html) for details.

See Also [compressed row format](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_compressed_row_format), [data dictionary](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_data_dictionary), [data files](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_data_files), [file-per-table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_file_per_table), [general tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_general_tablespace), [index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_index), [innodb\_file\_per\_table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_innodb_file_per_table), [system tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_system_tablespace), [table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_table).

Tcl

A programming language originating in the Unix scripting world. Sometimes extended by code written in ***C***, ***C++***, or ***Java***. For the open-source Tcl ***API*** for MySQL, see [Section 29.12, “MySQL Tcl API”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/apis-tcl.html).

See Also [API](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_api).

temporary table

A ***table*** whose data does not need to be truly permanent. For example, temporary tables might be used as storage areas for intermediate results in complicated calculations or transformations; this intermediate data would not need to be recovered after a crash. Database products can take various shortcuts to improve the performance of operations on temporary tables, by being less scrupulous about writing data to disk and other measures to protect the data across restarts.

Sometimes, the data itself is removed automatically at a set time, such as when the transaction ends or when the session ends. With some database products, the table itself is removed automatically too.

See Also [table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_table).

temporary tablespace

InnoDB uses two types of temporary tablespace. Session temporary tablespaces store user-created temporary tables and internal temporary tables created by the optimizer. The global temporary tablespace stores rollback segments for changes made to user-created temporary tables.

See Also [global temporary tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_global_temporary_tablespace), [session temporary tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_session_temporary_tablespace), [temporary table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_temporary_table).

text collection

The set of columns included in a ***FULLTEXT index***.

See Also [FULLTEXT index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_fulltext_index).

TGS

A Kerberos ticket-granting server. TGS can also refer to the ticket-granting service provided by a ticket-granting server.

See Also [ticket-granting server](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ticket_granting_server).

TGT

See [ticket-granting ticket](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ticket_granting_ticket).

thread

A unit of processing that is typically more lightweight than a ***process***, allowing for greater ***concurrency***.

See Also [concurrency](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_concurrency), [master thread](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_master_thread), [process](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_process), [Pthreads](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_pthreads).

ticket-granting server

In Kerberos, a server that provides tickets. The ticket-granting server (TGS) combined with an authentication server (AS) make up a key distribution center (KDC).

TGS can also refer to the ticket-granting service provided by the ticket-granting server.

See Also [authentication server](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_authentication_server), [key distribution center](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_key_distribution_center).

ticket-granting ticket

In Kerberos, a ticket-granting ticket is presented to the ticket-granting server (TGS) to obtain service tickets for service access.

See Also [ticket-granting server](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ticket_granting_server).

Tomcat

An open source ***J2EE*** application server, implementing the Java Servlet and JavaServer Pages programming technologies. Consists of a web server and Java servlet container. With MySQL, typically used in conjunction with ***Connector/J***.

See Also [J2EE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_j2ee).

torn page

An error condition that can occur due to a combination of I/O device configuration and hardware failure. If data is written out in chunks smaller than the InnoDB ***page size*** (by default, 16KB), a hardware failure while writing could result in only part of a page being stored to disk. The InnoDB ***doublewrite buffer*** guards against this possibility.

See Also [doublewrite buffer](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_doublewrite_buffer).

TPS

Acronym for “***transactions*** per second”, a unit of measurement sometimes used in benchmarks. Its value depends on the ***workload*** represented by a particular benchmark test, combined with factors that you control such as the hardware capacity and database configuration.

See Also [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction), [workload](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_workload).

transaction

Transactions are atomic units of work that can be ***committed*** or ***rolled back***. When a transaction makes multiple changes to the database, either all the changes succeed when the transaction is committed, or all the changes are undone when the transaction is rolled back.

Database transactions, as implemented by InnoDB, have properties that are collectively known by the acronym ***ACID***, for atomicity, consistency, isolation, and durability.

See Also [ACID](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_acid), [commit](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_commit), [isolation level](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_isolation_level), [lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_lock), [rollback](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_rollback).

transaction ID

An internal field associated with each ***row***. This field is physically changed by [INSERT](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/insert.html), [UPDATE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/update.html), and [DELETE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/delete.html) operations to record which ***transaction*** has locked the row.

See Also [implicit row lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_implicit_row_lock), [row](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_row), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

transparent page compression

A feature added in MySQL 5.7.8 that permits page-level compression for InnoDB tables that reside in ***file-per-table*** tablespaces. Page compression is enabled by specifying the COMPRESSION attribute with [CREATE TABLE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/create-table.html) or [ALTER TABLE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-table.html). For more information, see [Section 15.9.2, “InnoDB Page Compression”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-page-compression.html).

See Also [file-per-table](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_file_per_table), [hole punching](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_hole_punching), [sparse file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_sparse_file).

transportable tablespace

A feature that allows a ***tablespace*** to be moved from one instance to another. Traditionally, this has not been possible for InnoDB tablespaces because all table data was part of the ***system tablespace***. In MySQL 5.6 and higher, the [FLUSH TABLES ... FOR EXPORT](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/flush.html#flush-tables-for-export-with-list) syntax prepares an InnoDB table for copying to another server; running [ALTER TABLE ... DISCARD TABLESPACE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-table.html) and [ALTER TABLE ... IMPORT TABLESPACE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/alter-table.html) on the other server brings the copied data file into the other instance. A separate ***.cfg file***, copied along with the ***.ibd file***, is used to update the table metadata (for example the ***space ID***) as the tablespace is imported. See [Section 15.6.1.3, “Importing InnoDB Tables”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-table-import.html) for usage information.

See Also [.cfg file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_cfg_file), [.ibd file](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ibd_file), [space ID](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_space_id), [system tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_system_tablespace), [tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_tablespace).

troubleshooting

The process of determining the source of a problem. Some of the resources for troubleshooting MySQL problems include:

* [Section 2.10.2.1, “Troubleshooting Problems Starting the MySQL Server”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/starting-server-troubleshooting.html)
* [Section 6.2.22, “Troubleshooting Problems Connecting to MySQL”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/problems-connecting.html)
* [Section B.3.3.2, “How to Reset the Root Password”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/resetting-permissions.html)
* [Section B.3.2, “Common Errors When Using MySQL Programs”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/common-errors.html)
* [Section 15.21, “InnoDB Troubleshooting”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-troubleshooting.html).

truncate

A ***DDL*** operation that removes the entire contents of a table, while leaving the table and related indexes intact. Contrast with ***drop***. Although conceptually it has the same result as a DELETE statement with no WHERE clause, it operates differently behind the scenes: InnoDB creates a new empty table, drops the old table, then renames the new table to take the place of the old one. Because this is a DDL operation, it cannot be ***rolled back***.

If the table being truncated contains ***foreign keys*** that reference another table, the truncation operation uses a slower method of operation, deleting one row at a time so that corresponding rows in the referenced table can be deleted as needed by any ON DELETE CASCADE clause. (MySQL 5.5 and higher do not allow this slower form of truncate, and return an error instead if foreign keys are involved. In this case, use a DELETE statement instead.

See Also [DDL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ddl), [drop](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_drop), [foreign key](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_foreign_key), [rollback](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_rollback).

truststore

See Also [SSL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ssl).

tuple

A technical term designating an ordered set of elements. It is an abstract notion, used in formal discussions of database theory. In the database field, tuples are usually represented by the columns of a table row. They could also be represented by the result sets of queries, for example, queries that retrieved only some columns of a table, or columns from joined tables.

See Also [cursor](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_cursor).

two-phase commit

An operation that is part of a distributed ***transaction***, under the ***XA*** specification. (Sometimes abbreviated as 2PC.) When multiple databases participate in the transaction, either all databases ***commit*** the changes, or all databases ***roll back*** the changes.

See Also [commit](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_commit), [rollback](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_rollback), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction), [XA](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_xa).

### U

undo

Data that is maintained throughout the life of a ***transaction***, recording all changes so that they can be undone in case of a ***rollback*** operation. It is stored in ***undo logs*** either within the ***system tablespace*** (in MySQL 5.7 or earlier) or in separate ***undo tablespaces***. As of MySQL 8.0, undo logs reside in undo tablespaces by default.

See Also [rollback](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_rollback), [rollback segment](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_rollback_segment), [system tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_system_tablespace), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction), [undo log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_undo_log), [undo tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_undo_tablespace).

undo buffer

See [undo log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_undo_log).

undo log

A storage area that holds copies of data modified by active ***transactions***. If another transaction needs to see the original data (as part of a ***consistent read*** operation), the unmodified data is retrieved from this storage area.

In MySQL 5.6 and MySQL 5.7, you can use the [innodb\_undo\_tablespaces](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_undo_tablespaces) variable have undo logs reside in ***undo tablespaces***, which can be placed on another storage device such as an ***SSD***. In MySQL 8.0, undo logs reside in two default undo tablespaces that are created when MySQL is initialized, and additional undo tablespaces can be created using [CREATE UNDO TABLESPACE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/create-tablespace.html) syntax.

The undo log is split into separate portions, the ***insert undo buffer*** and the ***update undo buffer***.

See Also [consistent read](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_consistent_read), [rollback segment](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_rollback_segment), [SSD](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ssd), [system tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_system_tablespace), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction), [undo tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_undo_tablespace).

undo log segment

A collection of ***undo logs***. Undo log segments exists within ***rollback segments***. An undo log segment might contain undo logs from multiple transactions. An undo log segment can only be used by one transaction at a time but can be reused after it is released at transaction ***commit*** or ***rollback***. May also be referred to as an “undo segment”.

See Also [commit](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_commit), [rollback](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_rollback), [rollback segment](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_rollback_segment), [undo log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_undo_log).

undo tablespace

An undo tablespace contains ***undo logs***. Undo logs exist within ***undo log segments***, which are contained within ***rollback segments***. Rollback segments have traditionally resided in the system tablespace. As of MySQL 5.6, rollback segments can reside in undo tablespaces. In MySQL 5.6 and MySQL 5.7, the number of undo tablespaces is controlled by the [innodb\_undo\_tablespaces](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_undo_tablespaces) configuration option. In MySQL 8.0, two default undo tablespaces are created when the MySQL instance is initialized, and additional undo tablespaces can be created using [CREATE UNDO TABLESPACE](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/create-tablespace.html) syntax.

For more information, see [Section 15.6.3.4, “Undo Tablespaces”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-undo-tablespaces.html).

See Also [rollback segment](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_rollback_segment), [system tablespace](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_system_tablespace), [undo log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_undo_log), [undo log segment](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_undo_log_segment).

Unicode

A system for supporting national characters, character sets, code pages, and other internationalization aspects in a flexible and standardized way.

Unicode support is an important aspect of the ***ODBC*** standard. ***Connector/ODBC*** 5.1 is a Unicode driver, as opposed to Connector/ODBC 3.51, which is an ***ANSI*** driver.

See Also [ANSI](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_ansi), [Connector/ODBC](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_odbc), [ODBC](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_odbc).

unique constraint

A kind of ***constraint*** that asserts that a column cannot contain any duplicate values. In terms of ***relational*** algebra, it is used to specify 1-to-1 relationships. For efficiency in checking whether a value can be inserted (that is, the value does not already exist in the column), a unique constraint is supported by an underlying ***unique index***.

See Also [constraint](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_constraint), [relational](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_relational), [unique index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_unique_index).

unique index

An index on a column or set of columns that have a ***unique constraint***. Because the index is known not to contain any duplicate values, certain kinds of lookups and count operations are more efficient than in the normal kind of index. Most of the lookups against this type of index are simply to determine if a certain value exists or not. The number of values in the index is the same as the number of rows in the table, or at least the number of rows with non-null values for the associated columns.

***Change buffering*** optimization does not apply to unique indexes. As a workaround, you can temporarily set unique\_checks=0 while doing a bulk data load into an InnoDB table.

See Also [cardinality](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_cardinality), [change buffering](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_change_buffering), [unique constraint](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_unique_constraint), [unique key](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_unique_key).

unique key

The set of columns (one or more) comprising a ***unique index***. When you can define a WHERE condition that matches exactly one row, and the query can use an associated unique index, the lookup and error handling can be performed very efficiently.

See Also [cardinality](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_cardinality), [unique constraint](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_unique_constraint), [unique index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_unique_index).

UPN

See [user principal name](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_user_principal_name).

user principal name

The name for a Kerberos named entity that represents a user.

See Also [principal](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_principal).

### V

variable-length type

A data type of variable length. [VARCHAR](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/char.html), [VARBINARY](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/binary-varbinary.html), and [BLOB](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/blob.html) and [TEXT](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/blob.html) types are variable-length types.

InnoDB treats fixed-length fields greater than or equal to 768 bytes in length as variable-length fields, which can be stored ***off-page***. For example, a CHAR(255) column can exceed 768 bytes if the maximum byte length of the character set is greater than 3, as it is with utf8mb4.

See Also [off-page column](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_off_page_column), [overflow page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_overflow_page).

victim

The ***transaction*** that is automatically chosen to be ***rolled back*** when a ***deadlock*** is detected. InnoDB rolls back the transaction that has updated the fewest rows.

***Deadlock detection*** can be disabled using the [innodb\_deadlock\_detect](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_deadlock_detect) configuration option.

See Also [deadlock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_deadlock), [deadlock detection](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_deadlock_detection), [innodb\_lock\_wait\_timeout](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_innodb_lock_wait_timeout), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction).

view

A stored query that when invoked produces a result set. A view acts as a virtual table.

virtual column

See [virtual generated column](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_virtual_generated_column).

virtual generated column

A column whose values are computed from an expression included in the column definition. Column values are not stored, but are evaluated when rows are read, immediately after any BEFORE triggers. A virtual generated column takes no storage. InnoDB supports secondary indexes on virtual generated columns.

Contrast with ***stored generated column***.

See Also [base column](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_base_column), [generated column](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_generated_column), [stored generated column](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_stored_generated_column).

virtual index

A virtual index is a ***secondary index*** on one or more ***virtual generated columns*** or on a combination of virtual generated columns and regular columns or stored generated columns. For more information, see [Section 13.1.20.9, “Secondary Indexes and Generated Columns”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/create-table-secondary-indexes.html).

See Also [secondary index](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_secondary_index), [stored generated column](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_stored_generated_column), [virtual generated column](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_virtual_generated_column).

Visual Studio

For supported versions of Visual Studio, see the following references:

* Connector/NET: [Connector/NET Versions](https://docs.oracle.com/cd/E17952_01/connector-net-en/connector-net-versions.html)
* Connector/C++ 8.0: [Platform Support and Prerequisites](https://docs.oracle.com/cd/E17952_01/connector-cpp-8.0-en/connector-cpp-introduction.html#connector-cpp-prerequisites)

See Also [Connector/C++](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_c__), [Connector/NET](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_connector_net).

### W

wait

When an operation, such as acquiring a ***lock***, ***mutex***, or ***latch***, cannot be completed immediately, InnoDB pauses and tries again. The mechanism for pausing is elaborate enough that this operation has its own name, the ***wait***. Individual threads are paused using a combination of internal InnoDB scheduling, operating system wait() calls, and short-duration ***spin*** loops.

On systems with heavy load and many transactions, you might use the output from the SHOW INNODB STATUS command or ***Performance Schema*** to determine whether threads are spending too much time waiting, and if so, how you can improve ***concurrency***.

See Also [concurrency](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_concurrency), [latch](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_latch), [lock](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_lock), [mutex](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_mutex), [Performance Schema](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_performance_schema), [spin](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_spin).

warm backup

A ***backup*** taken while the database is running, but that restricts some database operations during the backup process. For example, tables might become read-only. For busy applications and websites, you might prefer a ***hot backup***.

See Also [backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_backup), [cold backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_cold_backup), [hot backup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_hot_backup).

warm up

To run a system under a typical ***workload*** for some time after startup, so that the ***buffer pool*** and other memory regions are filled as they would be under normal conditions. This process happens naturally over time when a MySQL server is restarted or subjected to a new workload.

Typically, you run a workload for some time to warm up the buffer pool before running performance tests, to ensure consistent results across multiple runs; otherwise, performance might be artificially low during the first run.

In MySQL 5.6, you can speed up the warmup process by enabling the [innodb\_buffer\_pool\_dump\_at\_shutdown](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_buffer_pool_dump_at_shutdown) and [innodb\_buffer\_pool\_load\_at\_startup](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-parameters.html#sysvar_innodb_buffer_pool_load_at_startup) configuration options, to bring the contents of the buffer pool back into memory after a restart. These options are enabled by default in MySQL 5.7. See [Section 15.8.3.6, “Saving and Restoring the Buffer Pool State”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/innodb-preload-buffer-pool.html).

See Also [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [workload](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_workload).

workload

The combination and volume of ***SQL*** and other database operations, performed by a database application during typical or peak usage. You can subject the database to a particular workload during performance testing to identify ***bottlenecks***, or during capacity planning.

See Also [bottleneck](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_bottleneck), [CPU-bound](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_cpu_bound), [disk-bound](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_disk_bound), [SQL](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_sql).

write combining

An optimization technique that reduces write operations when ***dirty pages*** are ***flushed*** from the InnoDB ***buffer pool***. If a row in a page is updated multiple times, or multiple rows on the same page are updated, all of those changes are stored to the data files in a single write operation rather than one write for each change.

See Also [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [dirty page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_dirty_page), [flush](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_flush).

### X

XA

A standard interface for coordinating distributed ***transactions***, allowing multiple databases to participate in a transaction while maintaining ***ACID*** compliance. For full details, see [Section 13.3.8, “XA Transactions”](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/xa.html).

XA Distributed Transaction support is enabled by default.

See Also [ACID](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_acid), [binary log](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_binary_log), [commit](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_commit), [transaction](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_transaction), [two-phase commit](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_two_phase_commit).

### Y

young

A characteristic of a ***page*** in the InnoDB ***buffer pool*** meaning that it has been accessed recently, and so is moved within the buffer pool data structure, so that it is not ***flushed*** too soon by the ***LRU*** algorithm. This term is used in some ***INFORMATION\_SCHEMA*** column names of tables related to the buffer pool.

See Also [buffer pool](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_buffer_pool), [flush](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_flush), [INFORMATION\_SCHEMA](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_information_schema), [LRU](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_lru), [page](https://docs.oracle.com/cd/E17952_01/mysql-8.0-en/glossary.html#glos_page).