MySQL 8.0: Performance Tuning

MySQL

DURATION	MODULES	COURSE CODE
4 Days	**13 Lectures**	**—**

Course Overview

After attending this course you will understand performance tuning concepts; be able to benchmark and tune your server; investigate performance metrics with a range of system databases, command-line, and graphical tools; design your schema for optimal performance; identify and optimize slow queries, and troubleshoot common performance problems.

What You Will Learn

Introduction

- Objectives
- Course Goals
- Course Lesson Map
- Introductions
- Classroom Environment
- MySQL Powers the Web
- Database of the Year
- MySQL Enterprise Edition
- MySQL Database Service
- Oracle Premier Support for MySQL
- MySQL and Oracle Integration
- MySQL Websites
- Community Resources
- Oracle University: MySQL Training
- MySQL Certification
- Summary

Performance Tuning Concepts

- Topics
- Objectives
- Topics

- Improving Performance
- Areas to Tune
- Topics
- Performance Tuning Terminology
- Response Time
- Measuring Response Times
- Throughput
- Scalability
- Queuing Theory
- Quiz
- Topics
- Benchmarking
- Benchmarking Best Practices
- More Benchmarking Best Practices
- Benchmarking Bad Practices
- More Benchmarking Bad Practices
- Quiz
- Topics
- Before You Start: Establish a Performance Baseline
- Key Steps in Troubleshooting Performance Issues
- Establishing the Nature of the Problem
- Starting to Troubleshoot
- Identifying Possible Causes of Performance Issues
- Application Profiling
- Localizing Database Problems
- Topics
- Tuning Steps
- General Tuning Procedure
- Topics
- Deploying MySQL
- RAM Requirements
- Maintaining MySQL
- Summary

Performance Tuning Tools

- Topics
- Objectives
- Topics
- MySQL Monitoring Tools
- SHOW [SESSION | GLOBAL] STATUS
- Filtering SHOW STATUS Output
- Status Variables: Handler Operations
- Status Variables: Internal Temporary Tables and Files
- SHOW STATUS: Examples
- SHOW ENGINE INNODB STATUS

- SHOW PROCESSLIST
- Quiz
- mysqladmin
- Information Schema
- Performance Schema
- MySQL Workbench
- MySQL Enterprise Monitor: Overview
- MySQL Enterprise Monitor: Architecture
- MySQL Enterprise Monitor: Global Overview
- MySQL Enterprise Monitor: Query Analyzer
- MySQL Enterprise Monitor: InnoDB Performance
- Topics
- Oracle Enterprise Manager for MySQL
- Oracle SQL Developer
- Quiz
- Topics
- Community Monitoring Tools
- Topics
- Linux Tools
- iostat
- vmstat
- sar
- top
- Topics
- Benchmarking Tools
- MySQL BENCHMARK() Function
- Stress Tools
- mysqlslap Stress Tool
- sysbench
- Using SysBench
- Sample SysBench Output – 1
- Sample SysBench Output – 2
- Summary

Performance Schema

- Topics
- Objectives
- Topics
- Why Use Performance Schema?
- Performance Schema
- How Performance Schema Works
- Instrument Names
- Instrument Prefixes
- Instrument Suffixes
- Instrument Names: Example

- Topics
- Structure of the Performance Schema
- Table Groups
- Topics
- Configuring the Performance Schema
- Setup Tables
- Configuring Instruments
- Configuring Instruments: Examples
- Event Timing
- Configuring Consumers
- Consumer Table Hierarchy
- Configuring Consumers
- Configuring Objects
- Default setup_objects Configuration
- Configuring Actors
- Configuring Thread Monitoring
- Configuring Instruments and Consumers at Startup
- Performance Schema Overhead
- How Performance Schema Uses Memory
- Configuring Performance Schema System Variables
- Quiz
- Topics
- Instance Tables
- cond_instances Table
- file_instances Table
- Read/Write Locks and Mutexes
- mutex_instances Table
- Mutex Life Cycle in the Performance Schema
- rwlock_instances Table
- socket_instances Table
- Identifying Connections in the socket_instances Table
- Connection Tables
- Retrieving Detailed Connection Information
- Quiz
- Topics
- Examining Raw Event Data: Example 1
- Examining Raw Event Data: Example 2
- Examining Raw Event Data: Example 3
- Event Hierarchy
- Nested Events
- Querying Nested Events
- Summary Tables
- Prepared Statements
- Retrieving Statement Summary Information: Example
- Retrieving Wait Summary Information: Example
- Retrieving Memory Summary Information: Example

- Topics
- sys Schema
- Setting sys Schema Privileges
- sys Views
- Using sys for Statement Analysis: Example
- Using sys to Identify Queries with Full Table Scans: Example
- Using sys to Identify the Slowest Queries: Example
- Using sys to Identify Unused Indexes: Example
- Using sys as a Non-Blocking SHOW PROCESSLIST: Example
- sys Stored Routines
- Configuring Performance Schema by Using sys: Example
- Using sys Functions to Format Output: Example
- Quiz
- Topics
- MySQL Workbench Performance Dashboard
- MySQL Workbench Performance Reports
- MySQL Workbench Performance Schema Setup
- Summary

General Server Tuning

- Topics
- Objectives
- Topics
- Major Components of the MySQL Server
- Quiz
- MySQL Memory Usage
- Tuning the MySQL Server
- CPU and I/O Saturation
- Global Buffers
- Dictionary Object Cache
- MySQL Thread Handling
- Per-Thread Buffers
- Quiz
- Topics
- Displaying Memory Usage by Using sys
- Topics
- Simultaneous Connections in MySQL
- Administrative Connections in MySQL
- Connection Status Variables
- Monitoring Idle Connections with Performance Schema
- Scenario: Users Unable to Connect
- Diagnosing Network Problems
- Topics
- Reusing Threads
- Quiz

- Other Thread Status Variables
- Scenario: Calculating Thread Cache Effectiveness
- Scenario: Setting thread_cache_size
- The MySQL Enterprise Thread Pool
- Summary

Tuning Tables, Files, and Logs

- Topics
- Objectives
- Topics
- Reusing Tables
- How MySQL Caches Tables
- Setting table_open_cache
- Sizing the Table Cache
- Setting table_definition_cache
- Setting table_open_cache: Scenario 1
- Setting table_open_cache: Scenario 2
- Setting table_open_cache: Scenario 3
- Quiz
- Topics
- Tables and Files
- Managing the Number of Open Files
- Setting File Descriptors in the Operating System
- Quiz
- Topics
- Binary Logs
- ACID and Database Transactions
- Transactions and the Binary Log
- Sizing the Binary Log Caches
- Monitoring Binary Logs
- Binary Log Group Commit Settings
- Improving Binary Log Performance
- Scenario: Binary Log File Cache Effectiveness
- Quiz
- Summary

Tuning InnoDB

- Topics
- Objectives
- Topics
- InnoDB Storage Engine
- Topics
- Operating System Buffers
- How InnoDB Reads Data
- How InnoDB Writes Data

- Topics
- Sizing the InnoDB Buffer Pool
- Dumping and Restoring the Buffer Pool
- Sizing the InnoDB Redo Log Files
- Other InnoDB Redo Log Settings
- Disabling Redo Logging
- InnoDB Tablespace Settings
- Thread Concurrency
- InnoDB Buffer and Log File Flushing
- Adaptive Flushing
- Purge Behavior
- Undo Logs
- Recommended InnoDB Settings for OLTP and Benchmarking
- Recommended InnoDB Settings for Replication
- Linux Filesystem Recommendations
- Topics
- InnoDB Support in the Information Schema
- Information Schema InnoDB Metrics
- Example: Enabling InnoDB Monitoring
- Example: Displaying InnoDB Metrics
- Example: Resetting InnoDB Counters and Disabling Monitoring
- InnoDB Support in the Performance Schema
- Monitoring InnoDB Performance in MySQL Workbench
- SHOW ENGINE INNODB STATUS
- SHOW ENGINE INNODB STATUS: Semaphores and Transactions
- SHOW ENGINE INNODB STATUS: File I/O
- SHOW ENGINE INNODB STATUS: Insert Buffer and Adaptive Hash Index
- SHOW ENGINE INNODB STATUS: Log
- SHOW ENGINE INNODB STATUS: Buffer Pool and Memory
- SHOW ENGINE INNODB STATUS: Row Operations
- SHOW ENGINE INNODB STATUS: Latest Foreign Key Error
- SHOW ENGINE INNODB STATUS: Latest Detected Deadlock
- Quiz
- Summary

Optimizing Your Schema

- Topics
- Objectives
- Topics
- Schema Design Considerations
- Schema Design Tasks
- Normalization and Performance
- Denormalizing Specific Data for Performance
- Quiz
- Data Types

- Topics
- Indexes
- Indexing
- Optimizing Indexes
- Index Types
- B+TREE Index
- Quiz
- Topics
- InnoDB Table Compression
- Tuning Compression for InnoDB Tables
- Topics
- Partitioning
- Partitioning Types
- RANGE Partitioning: Example
- LIST Partitioning: Example
- HASH Partitioning: Example
- KEY Partitioning: Example
- Partitioning and Performance
- Partitioning Limitations
- Retrieving Partition Information
- Quiz
- Summary

Monitoring Queries

- Topics
- Objectives
- Topics
- Query Monitoring
- Identifying Queries That Require Optimization
- Identifying Frequent Queries
- Topics
- General Query Log
- Slow Query Log
- Using mysqldumpslow to View Slow Query Log Entries
- mysqldumpslow Output: Example
- Topics
- General Statement Status Variables
- SELECT Statement Status Variables
- Quiz
- Topics
- Finding Slow Queries with Performance Schema
- Example: Querying events_statements_current
- Example: Querying events_statements_summary_by_digest
- Identifying Slow Queries with the sys Schema
- Investigating Aggregated Statement Metrics with the sys.statement_analysis View

- Topics
- MySQL Enterprise Monitor Query Analyzer
- Query Analyzer Tab
- Query Analyzer Detailed Query View
- MySQL Workbench Query Statistics
- MySQL Workbench Visual EXPLAIN
- Summary

Query Optimization

- Topics
- Objectives
- Topics
- MySQL Query Processing
- Optimizer Main Stages
- Logical Transformations
- Example: Logical Transformation
- Cost-Based Optimization
- Cost Model Inputs
- Access Method
- Join Order
- Subquery Optimizations
- Plan Refinement
- Index Condition Pushdown Optimization
- Quiz
- Topics
- Understanding the Query Plan
- Example: EXPLAIN Output
- EXPLAIN Output
- EXPLAIN Output: select_type Column
- EXPLAIN Output: type Column
- EXPLAIN Output: key Column and Index Hints
- EXPLAIN Output: Extra Column
- EXPLAIN Output: Extra column
- Structured EXPLAIN
- Example: Standard EXPLAIN
- Example: EXPLAIN FORMAT=JSON
- Visual EXPLAIN in MySQL Workbench
- Tree Structured EXPLAIN
- EXPLAIN ANALYZE
- Quiz
- Optimizer Trace
- Topics
- Improving Query Performance
- Data Retrieval: Best Practices
- Filtering Data with WHERE

- Indexing for Query Performance
- Query Using WHERE Clause
- Query Using Covering Index
- Query Using Index Condition Pushdown
- Costs of Indexing
- Indexing: Best Practices
- Leftmost Prefixes
- Improving the Performance of SELECT Statements
- Optimizing Table Joins
- Optimizing Sorting Operations
- Order of Sort Operations
- Optimizing Bulk DML Statements
- Creating Summary Tables
- Quiz
- Summary

Optimizing Locking Operations

- Topics
- Objectives
- Topics
- Locks in MySQL
- Implicit Locks
- Explicit Locks
- Avoiding Locks with InnoDB Multiversion Concurrency Control
- Topics
- InnoDB Table Locks
- InnoDB Row Locks
- Topics
- Metadata Locks
- Metadata Lock Example
- Topics
- Identifying Locks in the Process List
- Example: Table Lock Information in SHOW PROCESSLIST
- Displaying InnoDB Lock Information with SHOW ENGINE INNODB STATUS
- Topics
- Viewing Metadata Lock Information
- Interpreting LOCK_STATUS
- Example: Querying the metadata_locks Table
- Viewing Table Lock Information
- Example: Querying the table_handles Table
- Viewing Table Lock Information in sys.innodb_lock_waits
- Quiz
- Summary

Tuning Replication

- Topics
- Objectives
- Topics
- MySQL Replication
- Replication Use Cases
- Replication Logs
- Replication Log Events
- Role of the Source Server
- Role of the Replica Server
- Topics
- What Is Replication Lag?
- Common Causes of Replication Lag
- Quiz
- Topics
- Diagnosing Replication Lag
- Binary Log File Name and Position of the Source Server
- Binary Log File and Position of the Replica Server
- Comparing Binary Log File Name and Position
- Timing Replication Lag
- Comparing GTID Sets
- Executed GTIDs
- Retrieved GTIDs
- Manipulating GTIDs
- Example: I/O Thread Lag
- Example: SQL Thread Lag
- Example: SQL Thread Lagging Behind I/O Thread
- Performance Schema Replication Table Hierarchy
- Performance Schema Replication Tables
- Replication Support in MySQL Enterprise Monitor
- Quiz
- Topics
- Resolving I/O Thread Lag
- Resolving SQL Thread Lag
- Summary

Conclusion

- Course Goals
- Oracle University: MySQL Training
- MySQL Websites
- Your Evaluation
- Thank You
- Q&A Session