

# Oracle Database 19c: Performance Management and Tuning

Oracle Database

DURATION

**5 Days**

MODULES

**41 Lectures**

COURSE CODE

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## Course Overview

Students learn how to use Oracle Database automatic tuning features such as SQL Tuning Advisor, SQL Access Advisor, Automatic Workload Repository and Automatic Database Diagnostic Monitor, and practice these tuning methods. The course focuses on the tuning tasks expected of a DBA: reactive tuning of SQL statements, maintaining SQL statement and operation performance, and tuning the Oracle Database Instance components.

## What You Will Learn

### Overview

- Objectives
- What Is Performance Management?
- Who Manages Performance?
- What Does the DBA Tune?
- Types of Tuning
- Tuning Methodology
- Effective Tuning Goals
- General Tuning Session
- Tuning a CDB
- Performance Tuning: Diagnostics
- Performance Tuning: Features and Tools
- Tuning Objectives
- Summary
- Practice Overview

### Defining the Scope of Performance Issues

- Objectives
- Defining the Problem
- Limit the Scope
- Determining Tuning Priorities

- Common Tuning Problems
- Tuning Life Cycle Phases
- Tuning During the Life Cycle
- Application Design and Development
- Testing: Database Configuration
- Deployment
- Production
- Migration, Upgrade, and Environment Changes
- ADDM Tuning Session
- Performance Versus Business Requirements
- Monitoring and Tuning Tools: Overview
- Summary
- Practice Overview

## Using the Time Model to Diagnose Performance Issues

- Objectives
- Time Model: Overview
- DB Time
- CPU and Wait Time Tuning Dimensions
- Time Model Statistics Hierarchy
- Time Model: Example
- Top Timed Events
- Summary
- Practice Overview

## Using Statistics and Wait Events to Diagnose Performance Issues

- Objectives
- Dynamic Performance Views
- Dynamic Performance Views: Usage Examples
- Dynamic Performance Views: Considerations
- Statistic Levels
- Instance Activity and Wait Event Statistics
- System Statistic Classes
- Displaying Statistics
- Displaying SGA Statistics
- Wait Events
- Using the V\$EVENT\_NAME View
- Wait Classes
- Displaying Wait Event Statistics
- Commonly Observed Wait Events
- Using the V\$SESSION\_WAIT View
- Precision of System Statistics
- Summary
- Practice Overview

## Using Log and Trace Files to Monitor Performance

- Objectives
- Viewing the Alert Log
- Using Alert Log Information as an Aid in Managing Performance
- Administering the DDL Log File
- Understanding the Debug Log File
- User Trace Files
- Background Processes Trace Files
- Summary
- Practice Overview

## Using Enterprise Manager Cloud Control and SQL Developer to Monitor Performance

- Objectives
- Enterprise Manager: Overview
- Configuring Enterprise Manager Database Express
- Oracle Enterprise Manager Cloud Control Components
- Using Features of the Oracle Management Packs and Options
- Oracle SQL Developer
- SQL Developer Command Line (SQLcl)
- Summary
- Practice Overview

## Using Statspack to View Performance Data

- Objectives
- Introduction to Statspack
- Statspack Scripts
- Installing Statspack
- Capturing Statspack Snapshots
- Configuring Snapshot Data Capture
- Statspack Snapshot Levels
- Statspack Baselines and Purging
- Reporting with Statspack
- Statspack Considerations
- Statspack Reports
- Reading a Statspack Report
- Statspack Report Drilldown Sections
- Report Drilldown Examples
- Load Profile Section
- Time Model Section
- Statspack and AWR
- Summary
- Practice Overview

## Using Automatic Workload Repository

- Objectives
- Automatic Workload Repository: Overview
- Automatic Workload Repository Data
- Workload Repository
- AWR Administration
- AWR Snapshot Purging Policy
- Managing Snapshots with PL/SQL
- AWR Snapshot Settings
- Manual AWR Snapshots
- Managing AWR Data in a Multitenant Environment
- AWR Snapshots and ADDM in a Multitenant Architecture Database
- Generating AWR Reports
- Reading the AWR Report
- AWR Report: Multitenant Data
- Generating AWR Reports by Using SQL\*Plus
- Statspack and AWR Reports
- Reading a Statspack or an AWR Report
- Compare Periods: Benefits
- Snapshots and Periods Comparisons
- Compare Periods: Results
- Compare Periods: Report
- Multitenant AWR Views
- Summary
- Practice Overview

## Using Metrics and Alerts

- Objectives
- Metrics and Alerts
- Limitation of Base Statistics
- Typical Delta Tools
- Oracle Database Metrics
- Benefits of Metrics
- Viewing Metric History Information
- Viewing Metric Details
- Statistic Histograms
- Histogram Views
- Server-Generated Alerts
- Alert Usage Model
- Metric and Alert Views
- Summary
- Practice Overview

## Using Baselines

- Objectives
- Comparative Performance Analysis with AWR Baselines
- Automatic Workload Repository Baselines
- AWR Baselines
- Types of Baselines
- Moving Window Baseline
- Baselines in Performance Page Settings
- Baseline Templates
- Creating AWR Baselines
- Creating a Single AWR Baseline
- Creating a Repeating Baseline and Template
- Managing Baselines by Using the DBMS\_WORKLOAD\_REPOSITORY
- Package
- Generating a Baseline Template for a Single Time Period
- Creating a Repeating Baseline Template
- Baseline Views
- Performance Monitoring and Baselines
- Defining Alert Thresholds by Using a Static Baseline
- Configuring a Basic Set of Thresholds
- Summary
- Practice 3 Overview: Using AWR Baselines

## Managing Automated Maintenance Tasks

- Objectives
- Automated Maintenance Tasks
- Maintenance Windows
- Default Maintenance Plan
- Automated Maintenance Task Priorities
- Configuring Automated Maintenance Tasks
- Summary
- Practice Overview

## Using ADDM to Analyze Performance

- Objectives
- ADDM Performance Monitoring
- ADDM and Database Time
- DB Time-Graph and ADDM Methodology
- Top Performance Issues Detected
- ADDM Recommendations
- Creating a Manual ADDM Task
- ADDM Tasks in a Multitenant Architecture Database
- Changing ADDM Attributes
- Retrieving ADDM Reports by Using SQL

- Compare Periods ADDM: Analysis
- Workload Compatibility
- Configuring Automatic ADDM Analysis at the PDB Level
- Using the DBMS\_ADDM Package to Compare Periods
- Example: Using the DBMS\_ADDM Package to Compare Periods
- Summary
- Practice Overview

## Using Active Session History Data for First Fault System Analysis

- Objectives
- Active Session History: Overview
- Active Session History: Mechanics
- ASH Sampling: Example
- Accessing ASH Data
- Analyzing the ASH Data
- Using Enterprise Manager to Generate ASH Reports
- Using the ASH Report Script to Generate a Report
- ASH Report Structure
- Determining the Source of Data
- Performing Skew Analysis
- Additional Automatic Workload Repository Views
- Summary
- Practice Overview

## Using Emergency Monitoring and Real-Time ADDM to Analyze Performance Issues

- Objectives
- Emergency Monitoring: Challenges
- Emergency Monitoring: Goals
- Using Real-Time ADDM to Perform a Root-Cause Analysis
- Using Real-Time ADDM
- Real-Time ADDM in the Database
- Using Real-Time ADDM
- Viewing Real-Time ADDM Results
- Summary

## Overview of SQL Statement Processing

- Objectives
- SQL Statement Processing Phases
- Parsing
- SQL Cursor Storage
- Session Cursor Cache
- Cursor Usage and Parsing
- SQL Statement Processing Phases: Bind
- SQL Statement Processing Phases: Execute and Fetch

- Processing a DML Statement
- Commit Processing
- Identifying Poorly Performing SQL Statements
- Top SQL Reports
- SQL Monitoring
- Monitored SQL Execution Details
- Summary

## Maintaining Indexes

- Objectives
- Creating Indexes
- Using Invisible and Unusable Indexes
- Dropping Indexes
- Reducing the Cost of SQL Operations
- Index Maintenance
- Using Advanced Index Compression
- Other Index Options
- SQL Access Advisor
- Quiz
- Automatic Indexing Task
- Automatic Index Task Workflow
- Automatic Indexing Task Reporting
- Automatic Indexing Views
- Summary
- Practice Overview

## Maintaining Tables

- Objectives
- Reducing the Cost of SQL Operations
- Table Maintenance for Performance
- Table Reorganization Methods
- Space Management
- Extent Management
- Locally Managed Extents
- Large Extents: Considerations
- How Table Data Is Stored
- Anatomy of a Database Block
- Minimize Block Visits
- Block Allocation
- Free Lists
- Block Space Management
- Block Space Management with Free Lists
- Automatic Segment Space Management
- Automatic Segment Space Management at Work
- Block Space Management with ASSM

- Creating an Automatic Segment Space Management Segment
- Migration and Chaining
- Guidelines for PCTFREE and PCTUSED
- Detecting Migration and Chaining
- Selecting Migrated Rows
- Eliminating Migrated Rows
- Shrinking Segments: Overview
- Shrinking Segments: Considerations
- Shrinking Segments by Using SQL
- Segment Shrink: Basic Execution
- Segment Shrink: Execution Considerations
- Data Compression
- Advanced Row Compression: Overview
- Advanced Row Compression: Concepts
- Using Advanced Row Compression
- Advanced Row Compression for DML Operations
- Advanced Index Compression
- How Does Hybrid Columnar Compression Work?
- Using the Compression Advisor
- Using the Compression Advisor for Indexes
- Viewing Table Compression Information
- Quiz
- Summary
- Practice Overview

## Introduction to Query Optimizer

- Objectives
- Role of the Oracle Optimizer
- Functions of the Query Optimizer
- Selectivity
- Cardinality and Cost
- Changing Optimizer Behavior
- Setting and Viewing Optimizer Parameters
- Using Initialization Parameters to Control Optimizer Behavior
- Enabling Query Optimizer Features
- Influencing the Optimizer Approach
- Optimizing SQL Statements
- Access Paths
- Choosing an Access Path
- Summary

## Understanding Execution Plans

- Objectives
- What Is an Execution Plan?
- Methods for Viewing Execution Plans

- Uses of Execution Plans
- DBMS\_XPLAN Package: Overview
- EXPLAIN PLAN Command
- EXPLAIN PLAN Command: Example
- EXPLAIN PLAN Command: Output
- Reading an Execution Plan
- Using the V\$SQL\_PLAN View
- Querying V\$SQL\_PLAN
- V\$SQL\_PLAN\_STATISTICS View
- Querying the AWR
- SQL\*Plus AUTOTRACE
- Using SQL\*Plus AUTOTRACE
- SQL\*Plus AUTOTRACE: Statistics
- Quiz
- Adaptive Execution Plans
- Dynamic Plans
- Dynamic Plan: Adaptive Process
- Dynamic Plans: Example
- Continuous Adaptive Query Plans
- Automatic Re-Optimization
- Comparing Execution Plans
- Summary
- Practice Overview

## Viewing Execution Plans by Using SQL Trace and TKPROF

- Objectives
- SQL Trace Facility
- How to Use the SQL Trace Facility
- Initialization Parameters
- Enabling SQL Trace
- Disabling SQL Trace
- Formatting Your Trace Files
- TKPROF Command Options
- Output of the TKPROF Command
- TKPROF Output with No Index: Example
- TKPROF Output with Index: Example
- Generating an Optimizer Trace
- Summary
- Practice Overview

## Managing Optimizer Statistics

- Objectives
- Optimizer Statistics
- Types of Optimizer Statistics
- Optimizer Statistics Collection

- Dynamic Statistics
- Gathering Statistics and Setting Optimizer Statistics Preferences
- Setting Statistic Preferences
- Viewing and Managing Optimizer Statistics Preferences
- Extended Statistics
- Maintaining Optimizer Statistics
- Automated Maintenance Tasks
- Optimizer Statistics Advisor
- Optimizer Statistics Advisor Report
- Executing Optimizer Statistics Advisor Tasks
- Restoring Statistics
- Deferred Statistics Publishing: Overview
- Deferred Statistics Publishing: Example
- Managing Real-Time Statistics
- Configuring High-Frequency Automatic Optimizer Statistics Collection
- Summary
- Practice Overview

## Using Automatic SQL Tuning

- Objectives
- Automatic SQL Tuning: Overview
- SQL Statement Profiling
- Plan Tuning Flow and SQL Profile Creation
- SQL Tuning Loop
- Using SQL Profiles
- Summary

## Using the SQL Plan Management Feature

- Objectives
- SQL Plan Management: Overview
- SQL Plan Baseline: Architecture
- Loading SQL Plan Baselines
- Loading SQL Plan Baselines from AWR
- Evolving SQL Plan Baselines
- Adaptive SQL Plan Management
- Automatically Evolving SQL Plan Baseline
- Including Alternate Plans in the SPM Evolve Advisor List
- Important Baseline SQL Plan Attributes
- SQL Plan Selection
- Possible SQL Plan Manageability Scenarios
- SQL Performance Analyzer and SQL Plan Baseline Scenario
- Loading a SQL Plan Baseline Automatically
- Purging SQL Management Base Policy
- Enterprise Manager and SQL Plan Baselines
- Quiz

- Summary
- Practice Overview

## Overview of the SQL Advisors

- Objectives
- SQL Tuning Process
- SQL Tuning Advisor: Overview
- SQL Access Advisor: Overview
- SQL Performance Analyzer: Overview
- Summary

## Using the SQL Tuning Advisor

- Objectives
- SQL Tuning Advisor: Overview
- SQL Tuning Advisor Architecture
- Automatic Tuning Optimizer
- Using the SQL Tuning Advisor
- SQL Tuning Advisor Options
- SQL Tuning Advisor Recommendations
- Alternative Execution Plans
- Summary
- Practice Overview

## Using the SQL Access Advisor

- Objectives
- SQL Access Advisor: Overview
- Using the SQL Access Advisor
- Viewing Recommendations
- Viewing Recommendation Details
- Summary
- Practice Overview

## Overview of Real Application Testing Components

- Objectives
- Real Application Testing: Overview
- Real Application Testing: Use Cases
- Summary

## Using SQL Performance Analyzer to Determine the Impact of Changes

- Objectives
- SQL Performance Analyzer: Process
- Steps 6-7: Comparing/Analyzing Performance and Tuning Regressed SQL
- Capturing the SQL Workload

- Creating a SQL Performance Analyzer Task
- SQL Performance Analyzer Task Page
- SQL Performance Analyzer: PL/SQL Example
- Tuning Regressed SQL Statements
- SQL Performance Analyzer: Data Dictionary Views
- Quiz
- Summary
- Practice Overview

## Using Database Replay to Test System Performance

- Objectives
- Using Database Replay
- The Big Picture
- System Architecture: Capture
- System Architecture: Processing the Workload
- System Architecture: Replay
- Database Replay Workflow in Enterprise Manager
- Accessing Database Replay in Enterprise Manager
- Capture Considerations
- Replay Considerations: Preparation
- Replay Considerations
- Replay Customized Options
- Replay Analysis
- Quiz
- Database Replay Packages
- Data Dictionary Views: Database Replay
- Database Replay: PL/SQL Example
- Calibrating Replay Clients
- Capturing and Replaying in a CDB and PDBs
- Reporting
- Quiz
- Summary
- Practice Overview

## Implementing Real-Time Database Operation Monitoring

- Objectives
- Overview
- Use Cases
- Defining a DB Operation
- Scope of a Composite DB Operation
- Database Operation Concepts
- Identifying a Database Operation
- Enabling Monitoring of Database Operations
- Identifying, Starting, and Completing a Database Operation
- Monitoring Database Operations in Sessions

- Monitoring the Progress of a Database Operation
- Monitoring Load Database Operations
- Monitoring Load Database Operation Details
- Database Operation View: V\$SQL\_MONITOR
- Database Operation Views
- Reporting Database Operations by Using Functions
- Database Operation Tuning
- Summary
- Practice Overview

## Using Services to Monitor Applications

- Objectives
- What is a service?
- Service Attributes
- Service Types
- Creating Services
- Using the DBMS\_SERVICE Package to Manage Services
- Where are services used?
- Using Services with Client Applications
- Using Services with the Resource Manager
- Using Enterprise Manager to Manage Consumer Group Mappings
- Services and the Resource Manager: Example
- Using Enterprise Manager to Create a Job Class
- Using Enterprise Manager to Create a Job
- Services and the Scheduler: Example
- Using Services with Metric Thresholds
- Using Enterprise Manager to Change Service Thresholds
- Services and Metric Thresholds: Example
- Service Aggregation and Tracing
- Top Services Performance Page
- Service Aggregation Configuration
- Service Aggregation: Example
- Client Identifier Aggregation and Tracing
- Using the TRCSESS Utility
- Service Performance Views
- Summary
- Practice Overview

## Overview of Memory Structures

- Objectives
- Managing Memory Caches and Structures
- Guidelines for Efficient Memory Usage
- Summary
- Practice Overview

- Objectives
- Shared Pool Architecture
- Shared Pool Operation
- Library Cache
- Latch and Mutex
- Latch and Mutex: Views and Statistics
- Diagnostic Tools for Tuning the Shared Pool
- AWR/Statspack Indicators
- Top Timed Events
- Time Model
- Load Profile
- Instance Efficiencies
- Library Cache Activity
- Avoid Hard Parses
- Are Cursors Being Shared?
- Candidate Cursors for Sharing
- Sharing Cursors
- Adaptive Cursor Sharing: Example
- Adaptive Cursor Sharing Views
- Interacting with Adaptive Cursor Sharing
- Reduce the Cost of Soft Parses
- Quiz
- Sizing the Shared Pool
- Shared Pool Advisory
- Shared Pool Advisory in an AWR Report
- Shared Pool Advisor
- Avoiding Fragmentation
- Large Memory Requirements
- Tuning the Shared Pool Reserved Pool
- Keeping Large Objects
- Data Dictionary Cache
- Dictionary Cache Misses
- SQL Query Result Cache: Overview
- Managing the SQL Query Result Cache
- Using the RESULT\_CACHE Hint
- Using Table Annotation to Control Result Caching
- Using the DBMS\_RESULT\_CACHE Package
- Viewing SQL Result Cache Dictionary Information
- SQL Query Result Cache: Considerations
- Summary
- Practice Overview

- Objectives
- Buffer Cache: Highlights
- Database Buffers
- Buffer Hash Table for Lookups
- Working Sets
- Tuning Goals and Techniques
- Symptoms of a Buffer Cache Issue
- Cache Buffer Chains Latch Contention
- Finding Hot Segments
- Buffer Busy Waits
- Buffer Cache Hit Ratio
- Buffer Cache Hit Ratio is Not Everything
- Interpreting Buffer Cache Hit Ratio
- Read Waits
- Free Buffer Waits
- Solutions for Buffer Cache Issues
- Sizing the Buffer Cache
- Buffer Cache Size Parameters
- Dynamic Buffer Cache Advisory Parameter
- Buffer Cache Advisory View
- Using the V\$DB\_CACHE\_ADVICE View
- Using the Buffer Cache Advisor
- Caching Tables
- Automatic Big Table Caching
- Configuring Automatic Big Table Caching
- Using Automatic Big Table Caching
- Monitoring Automatic Big Table Caching
- Memoptimized Rowstore
- In-Memory Hash Index
- Multiple Buffer Pools
- Enabling Multiple Buffer Pools
- Calculating the Hit Ratio for Multiple Pools
- Multiple Block Sizes
- Multiple Database Writers
- Multiple I/O Slaves
- Using Multiple Writers and I/O Slaves
- Private Pool for I/O-Intensive Operations
- Automatically Tuned Multiblock Reads
- Database Smart Flash Cache Overview
- Using Database Smart Flash Cache
- Database Smart Flash Cache Architecture Overview
- Configuring Database Smart Flash Cache
- Sizing Database Smart Flash Cache
- Enabling and Disabling Flash Devices

- Specifying Database Smart Flash Cache for a Table
- Full Database In-Memory Caching
- Setting Up Force Full Database Caching
- Monitoring Full Database In-Memory Caching
- Flushing the Buffer Cache (for Testing Only)
- Summary
- Practice Overview

## Managing PGA and Temporary Space Performance

- Objectives
- SQL Memory Usage
- Performance Impact
- Automatic PGA Memory
- SQL Memory Manager
- Configuring Automatic PGA Memory
- Setting PGA\_AGGREGATE\_TARGET Initially
- Limiting the Size of the Program Global Area
- Managing the PGA for PDBs
- Monitoring SQL Memory Usage
- Monitoring SQL Memory Usage: Examples
- Tuning SQL Memory Usage
- PGA Target Advice Statistics
- PGA Target Advice Histograms
- Automatic PGA and Enterprise Manager
- Automatic PGA and AWR Reports
- Temporary Tablespace Management: Overview
- Temporary Tablespace: Locally Managed
- Configuring Temporary Tablespace
- Temporary Tablespace Group: Overview
- Temporary Tablespace Group: Benefits
- Creating Temporary Tablespace Groups
- Maintaining Temporary Tablespace Groups
- Viewing Tablespace Groups
- Monitoring Temporary Tablespace
- Shrinking a Temporary Tablespace
- Using the Tablespace Option When Creating a Temporary Table
- Quiz
- Summary
- Practice Overview

## Configuring the Large Pool

- Objectives
- Large Pool Overview
- Tuning the Large Pool
- Summary

## Using Automatic Shared Memory Management

- Objectives
- Oracle Database Architecture
- Granules
- Automatic Shared Memory Management: Overview
- SGA Sizing Parameters: Overview
- Dynamic SGA Transfer Modes
- Memory Broker Architecture
- Manually Resizing Dynamic SGA Parameters
- Behavior of Auto-Tuned SGA Parameters
- Behavior of Manually Tuned SGA Components
- Using the V\$SYSTEM\_PARAMETER View
- Resizing SGA\_TARGET
- Disabling Automatic Shared Memory Management
- Using the SGA Advisor
- Monitoring ASMM
- Managing SGA for PDBs
- Summary
- Practice Overview

## Introduction to In-Memory Column Store

- Objectives
- Database In-Memory Feature Set
- Goals of In-Memory Column Store
- Benefits
- Overview
- Row Store Versus Column Store: 2D Vision
- In-Memory Column Unit
- Compare: In-Memory Column Store Cache and Buffer Cache
- Dual Format In-Memory
- Indexes Issues
- Process
- In-Memory Column Store: Dual Format of Segments in SGA
- Summary

## Configuring the In-Memory Column Store Feature

- Objectives
- Deploying IM Column Store
- Deploying IM Column Store: Objects Setting
- Deploying IM Column Store: Columns Setting
- Defining IM Column Store Compression
- In-Memory Advisor
- IM Advisor or Compression Advisor?
- Computing Compression Ratio

- IM FastStart
- Automatic In-Memory: Overview
- AIM Action
- Configuring Automatic In-Memory
- Diagnostic Views
- Summary
- Practice Overview

## Using the In-Memory Column Store Feature to Improve SQL Performance

- Objectives
- Query Benefits
- Testing and Comparing Query Performance
- Queries on In-Memory Tables: Simple Predicate
- MINMAX Pruning Statistics
- IM Column Store Statistics
- Execution Plan: TABLE ACCESS IN MEMORY FULL
- Queries on In-Memory Tables: Join
- Execution Plan: JOIN FILTER CREATE / USE
- Queries on In-Memory Tables: Join Groups
- Population of Expressions and Virtual Columns Results
- In-Memory Expression Unit (IMEU)
- Populating In-Memory Expression Results
- Populating In-Memory Expression Results Within a Window
- Waiting for In-Memory Segments to be Populated
- Views
- Summary
- Practice Overview

## Using In-Memory Column Store with Oracle Database Features

- Objectives
- Interaction with Other Products
- Optimizer
- IM Column Store and Real Application Clusters
- IM Column Store and Data Pump
- Data Pump TRANSFORM Names
- Automatic Data Optimization Interaction
- Managing Heat Map and Automatic Data Optimization Policies
- Creating ADO In-Memory Policies
- Summary
- Practice Overview