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A Non-Parametric Analogy between Oracle & MySQL

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Abstract:

Database Servers store, manipulate and retrieve critical information. In current computing era these database servers are often exercise unauthorized access, security breaches and violation. A sub field of digital forensic called Database Forensic deals with the study of database and about their data. Oracle server and SQL Server are two database server actively used by digital industry for their data store. This research paper is a detailed non parametric comparison between oracle server and SQL Server that helps forensic investigators in DB tool selection for the sake of forensic analysis and investigation of databases. According to findings oracle is more secure than SQL, oracle data types are more flexible than SQL. Both tools are good at query optimization but oracle is more expensive than SQL. This comparison is made with the expectation of escalating research in database forensic analysis and investigation areas.

Keyword: Data Model (DM), Data Definition Language (DDL), Entity Relationship Diagram (ERD), Database Administration (DBA), Query Execution Plan (QEP), Automatic Workload Repository (AWR), configuration management pack (CMP), Oracle Manager Console (OMC), Oracle Real Application Cluster (Oracle RAC)

1. Introduction

In the modern computing world, databases expanded quickly and have been used in computer applications and information technology development. Database development is the process of a problem specification and requirement analysis; provides a mechanism for data's logical structure. Data constraints, needs, requirements, and purpose are covers in the problem-solving definition in some organizational operations. Firstly, logical structure is built by some simple language or plain text, like simple finite series of statements, and later these statements trans-

formed into a complex model known as "Data Model" (DM). DM will provide the directions towards the conceptual view or level and then mapped it as metadata (data schema), which is known as "Data Definition Language" (DDL).

SQL statements created in the form of tables, indexes, and views within systems of a relational database such as DDL. DM expressed as "Entity Relationship Diagram" (ERD) and these diagrams are transformed into metadata through a database tool. Some tools are also available in the market to perform reverse operation (reverse transformation) means from metadata to ERD.

When we talk about the database, our main concern is how logical data designs are generalized into "physical database", which means our concern is about physical design. Database scientists said that logical data design is an art more than a science concept. In the database, we treat an independent presence of real-world thing as an entity. Entity and entity type are terms used interchangeably in many situations. Simply, consider entity type as a class notion (as we used in "object-oriented" design). Entities collection is known as entity type (entity instances) and object collection is known as class instances.

In physical database, tables are treated as entity types and tables records (rows) are known as entity instances. For example, company, person, department, location, students are entity types. Attributes are the descriptive property of an entity (Elmasri at al., 2004). They are used as entities with relevant characteristics and they have their own types. For example, a person is an entity then person age is an attribute of that entity. Each entity type has a key which is actually a subset of entity attributes and used to uniquely identify the entity instances (many keys are used in databases like primary key and foreign key). The next thing that comes is the relationships of logical data. Relationships R is types of relations among data entities. For example, STUDENT is an entity and REGISTRATION is the entity instance, then relationship type is considered as COMPLETE. For any problem-solving technique, entities and their relationships are the main ingredients in the analysis.

2. Oracle Database:

Database Oracle gives new directions in several major areas of innovations like storage management, performance management, data warehousing, change management, data guard administration, and many others. The latest version of Oracle is more secure and robust, user friendly in terms of easiness gives better performance. All the function of DB is fully supported by the ODB such as storage management, memory management, get back up and solve recovery; performed by its administration known as "Database Administration" (DBA). The difficult task of DBMS in real-time systems are testing, tuning, and managing.

When we talk about environmental efficiency related to the task, self-optimization is the way to improve efficiency (Deari et, al. 2018). Query optimization, automatic Database diagnostic monitoring, automatic statistic collection, and automatic workload repository are the four components through which Oracle performs self-optimization.

2.1. Query Optimization:

Query optimization is done in four steps. Firstly, the Oracle database identifies load queries that have higher priorities and have a higher rank, secondly, it made a plan which is

optimal to load queries. At the third step, it generates an improved version of "Query Execution Plan" (QEP) and in the fourth step it generates the best execution plan for the query (Dageville et al., 2004). Query optimizer utilized the user-selected setting/recommendations (which are stored in the SQL profile) and then generate the best execution plan (Padhyet al., 2011). The heuristic-based approach is used by the query optimizer to perform optimization, and even the user can set response time or throughput as optimization goals (Barlowet al.,2003, Elnaffaret al.,2003,Clarenceet al.,2012).

2.2. Automatic Database Diagnostic Monitor:

The database provides a central intelligence (Diaset al.,2005,Wei-Pinget al.,2011) such as high load execution request, concurrency and configuration issues, memory structure, the bottleneck of CPU, fragmentation analysis of space, and SQL tuning. In Oracle last version (Oracle 10g) management of monitoring was done through observe, diagnose, and resolve phases. All these phases have performed these functionalities in iterative nature.

2.3. Automatic Statistics Collection:

Oracle has the ability to generate several statistical types such as operating system (OS) and Database interpreting statistics. If we further expand OS statistics it handles virtual memory, CPU, network and disk statistics, and in-database statistics active session and events wait are being handled.

2.4. Automatic Workload Repository:

Oracle has the ability to stores the snapshot (on the hourly basis) and performance data. In a repository known as "automatic workload repository" (AWR). It used to collect the data from statistics and send this information to other components (like SQL Tuning Advisor) to enhance the overall performance.

2.5. Self-Configuration:

The property of configuration itself but according to the objectives and goals are known as self-configuration. Firstly, Oracle has a "Configuration Management Pack" (CMP) which contain all the configuration related issues. The main aim of this CMP is to minimize the tedious tasks and heavy labor of DBA to provide an efficient environment. Through this pack, Oracle achieves standardization and scalability. Secondly, it used SQL Access Advisor (SQL AA) to support various workload types. Through evaluation mode and problem-solving mode, it enhances the partitions and index structure and provides efficient access recommendations. Thirdly, Oracle has a shared memory management concept (Kumaret al.,2006,Gornshteinet al., 2004) in which it handles the memory distribution according to object and workload requirements (Sanobaret al.,2013). It provides the best possibility of available resource utilization through which we can get much reduction in expenditure.

2.6. Self-inspection:

Self-inspection is the Oracle property in which it can make intelligent decisions based on self-awareness. For that purpose, Oracle uses a "manager console" (OMC) to automatically examine all the time system health. If any sign of un-health occurs it generates alerts and stores systems performance. OMC observes application concurrency, memory consumption, logging, and storage issues.

3. MySQL:

MYSQL has been widely used due to its open-source database nature. MySQL is a "Relational Database Management System" RDMS provides the functionality of an access database to the multi-users and runs as a server. "My" at the beginning of MySQL took from the Finnish developer (Oracle 12c Database 2016) daughters name. SQL is designed to serve data as a relational model in databases. It stores data in "tabular" representation and for data access it uses structured query language (SQL).

MySQL has several types of storage engines through which it provides different indexing mechanisms, storage technique capabilities, and several features. the essential function of a database is to provide managing and storing data to its end users with better performance (Laurence Goasduff, 2020).

3.1. MySQL Storage Engines:

MySQL has different techniques to store data files. These techniques provide better functions and high speed for data execution through which overall application functionality will increase. These mechanisms and their functions are treated as "storage engine".

3.2. Database Security:

MySQL provides security features to authenticate its users with user name and password and also used an additional security parameter known as "Location". Location parameter contains user/host IP address and name. another feature in terms of security used in MySQL known as "Privileges". MySQL privileges system is a hierarchical structure system that operates as an inheritance. Through privileges MySQL performs five different levels of security known as 1) global, 2) pre-host basis, 3) database level, 4) table-specific, and 5) column-specific. Each of the above mention levels has a grant table in a particular database. At each step it performs privilege check by checking the privileged scope.

4. Comparison:

The above sections provide detail about the Oracle and the MySQL components and their functionalities. This section provides a summary of both the Oracle and MySQL comparison and through comparison, we try to evaluate both the database approaches. In our applications, databases are the core element for the management system. Some vendors such as MySQL AB (MySQL Database 2016), Oracle (Oracle Database 2016), and Microsoft (MS SQL Server 2016) develop RDMS and made some databases licensed based and some are open-source (Oracle 12c Database Features 2016). To check the performance of the database, each execution time is measured (in milliseconds) and build a graph (to perform comparison graph with other approaches) to check whether the database execute faster or not and which execution time is taken for the queries. The detailed comparison is shown in table 1 to 11.

Oracle	**MySQL**
RDMS	RDMS
Oracle corporation	Affiliated with Oracle corporation
22 July 2013 (Kumar.,2006)	MySQL server 5.7 October 2015
	(Gornshteinet al.,2004)

Features (Mateenet al.,2009)	
Provide tools for UML	Optimizer
Popular for security purposes	Provide security
Perform optimization	Open GIS classes
Improved column defaults	Partitioning
Increase size limit	Client program
Improved top-N-Queries	Building changes
Database archiving	
Online migration	
Transaction Guard	

4.1. Schema Migration:

This schema contains the data related to table definitions, users, indexes, views, stored procedures, constrains and other specific objects related to database.
Schema object similarities in Oracle and MySQL

Functions	**Oracle**	**MySQL**
Trigger	Yes	Yes
Check constraint	Yes	Yes
Column default	Yes	Yes
Database	Yes	Yes
Foreign key	Yes	Yes
Index	Yes	Yes
Package	Yes	Not available
PL/SQL function	Yes	Routine
PL/SQL procedure	Yes	Routine
Primary Key	Yes	Yes
Role	Yes	Not available
Schema	Yes	Yes
Snapshot	Yes	Not available
Table	Yes	Yes
Unique key	Yes	Yes
User	Yes	Yes

MySQL use some reserved words like TIME-STAMP and DATE but Oracle don't allow them.

4.2. Character datatype:

Both databases have different character type values.

	Oracle	MySQL
Character datatype	CHAR, NCHAR, NVARCHAR2, VARCHAR2	CHAR, VARCHAR

4.3. Column Default Value

Oracle differs from MySQL in the way it doesn't handle default value for a column that does not allow NULL value. Means MySQL doesn't allow null values in the column, and no data is provided to the table for the null contain column. In Oracle, data must be given for all the columns that don't allow the A NULL value (when inserting the data value in the table)

4.4. Times and date types

The date and time types of MySQL to Oracle

Size in bytes	**MySQL**	**Oracle**
03	DATE	DATE
04	TIMESTAMP	DATE
08	DATETIME	DATE
03	TIME	DATE
01	YEAR	NUMBER

4.5. Database Deploy:

MySQL	Oracle
Written in C, C++	Written in C, C++, Assembly Language
Support following Languages	
• C • C++ • JAVA • NET • Python • PHP • Go • R • Lua • Perl • Erlang • Node.js • LISP • D • Delphi	• C • CC++ • CJAVA • CNET • CPython • CPHP • CGo • CCR • CRuby • CPerl • CErlang • CNode.js • CRust • CCOBOL • CFORTRAN

4.6. Type of replications and Clusters:

Replication is known as the process of allowing multiple data copies which are automatically copied from MASTER database to SLAVE database. Whereas clustering is referred as a shared storage and allow front-ends of multiple databases.

MySQL	Oracle
Replication	
One way asynchronous	Enables data integration and replication
One server performs its duties as MASTER and another act as a SLAVE	Allow propagation of data, data streaming (within a database or one database to another database)
Cluster	
Allow share nothing clustering (no single point of failure)	Use a "Oracle Real Application Cluster" (Oracle RAC) to allow interconnection of servers and computers. For this it uses Oracle Cluster ware (an infrastructure to tie up multiple computers)

4.7. Community Support:

MySQL	Oracle
Support community options	Support community options
Support commercial ones	Also allow paid support options (web - based support)

4.8. Documentation Maintainers:

MySQL	Oracle
Community-based and official documentation available	Help center available with feature guides

4.9. Queries

Usually, MySQL and Oracle quires are exactly the same in context.

Creating a student database	
MySQL	**Oracle**
CREATE DATABASE students	CREATE DATABASE students;
Creating a student table	
MySQL	**Oracle**
CREATE TABLE student (	CREATE TABLE student (
Stu_id int PRIMARY KEY,	Stu_id int PRIMARY KEY,
Branch varchar (255),	branch varchar (255),
Status varchar (255));	status varchar (255),
	CONSTRAINT student_pk PRIMARY KEY (Stu_id));

4.10. Database Organizations:

MySQL	Oracle
• Facebook • YouTube • NASA • BBC News • Apple Inc. • US Navy	• Airtel • Apple • Amazon • LinkedIn • Sony Corporation

Parameters	Oracle	MySQL
Hardware requirements	1GHz processor, 1 GB RAM, 2GB Disk space	200 MHz processor,64 MB RAM, 100 MB Disk space
Operating System	Windows, Linux, MAC OS	Any windows, Linux, Unix, MAC OS
Max Database size	OS limited	OS limited
Query optimization	Yes	Yes
Auto tuning	Yes	Yes
Password Management	Yes	Yes
Price	$180	Free
Works with	works with both dynamic and static systems	only works with static
Provides	only provides Forums support	provides on-site and phone support

Conclusion:

The ever-growing need of preserving and manipulating data stored in databases highlights the need for in-depth understanding and forensic investigation of databases. At the end user schema/level most Database Management System (DBMS) are similar to each other. According to former said level most DBMS contain relation, relationships, degree of relationship, cardinality of relationship, a structured query language, primary key, entity integrity, foreign key, referential integrity, and data about data. With respect to external/physical schema file structures, concurrency methods, security methods, query optimization and data warehouse techniques, database tools may be drastically different from each other. To serve the purpose of database forensic analysis and investigation, we carry out the detailed comparison between conventional database tools e.g., SQL Server and Oracle server. According to findings oracle is more secure than SQL, oracle data types are more flexible than SQL. Both tools are good at query optimization but oracle is more expensive than SQL. We find both tools to be helpful to perform database forensic analysis and investigation but there is a tradeoff as the oracle tool is much more expensive than SQL.

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