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Huge and Real-Time Database Systems: A Comparative Study and Review for SQL Server 2016, Oracle 12c & MySQL 5.7 for Personal Computer

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Abstract: Complexity, and Handling of huge data is a crucial target for all management systems. Databases are the backbone, central and core component of a computer application to store data in a logical way, which define the structure and mechanism for manipulation of data. Many Databases are available for handling and saving huge data including commercial and non-commercial like Microsoft SQL Server, Oracle Database, and MYSQL etc. Many vendors are working on modern techniques of databases spatio-temporal, object-relational, parallel databases etc. This novel research evaluates the comparative study and execution performance of top three databases according to their particular scenario and situation, after reading the paper the computer related experts especially developers easily judge, which database is most reliable in particular scenario, choosing the right decision for development of huge computer applications for hospitals, banks, and industries.

Keywords: Microsoft SQL Server, Oracle, MySQL, Huge Databases.

I. INTRODUCTION

The role of database management system becomes an essential part of computer application. The database is the one-way track to save all the information in a logical way. Now databases are widely used in many systems, which include the small and huge management systems like Enterprise Applications for Accounting, Sales, Human Resources, and Manufacturing. In other sectors, databases used in a credit transaction, universities, Airlines, Telecommunication etc. [1]. Databases are core management system of our applications without it application remains meaningless. Many vendors like Microsoft [2], Oracle [3], and MySQL AB [4]. Developing the relational database management system in which some databases are open source and some are licensed based [5]. Choosing the relational database is a good approach when user have a limited amount of data. Developers also take care the good database design because database design plays an active role to execute the data in the database in logical and faster way in particular time all the databases have their own functionalities and features [6]. This research paper concludes the comparatively study and execution performance between the top three databases, which is widely used in the market today known as SQL Server, Oracle, and MySQL Server databases. We are testing different queries with

their level of complexities in well-known DBMS. The execution time of queries is measured in milliseconds, draw the comparison graph to check that which database works faster, and takes minimum execution time. All the experiments are performing on Windows Operating System.

II. BACKGROUND

In this section, we will focus the history, features, and version of databases.

A. Microsoft SQL Server 2016

Microsoft SQL Server is Relational Database Management System which is introduced by Microsoft on June 1, 2016. The language which we follow to perform the operations like database creation, altering, update and delete all the operation are performed in TSQL (Transact-SQL). The T-SQL manages all the operations in SQL Server [7]. The top features are mention below. Data Encryption, Dynamic Data Masking, JSON Support, Multiple TempDB Database, PolyBase, Query Store, Row Level Security, R Support SQL Server, Stretch Database, Temporal Table.

B. Oracle 12c

Oracle Database is referring to RDBMS (Relational Database Management System) is an object-relational database management system which is introduced by Oracle Corporation on 22 July 2013 [9]. Oracle also provides a tool for modeling of UML, data warehousing designing etc Oracle database is a most popular

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database for security purposes. The top features are mention below. Improved Column Defaults, Increase Size Limit, Improved Top N-Queries, Temporary UNDO, Invisible Column, Database Archiving, Online Migration, Transaction Guard, PGA Aggregate Limit Setting

C. MySQL 5.7

MySQL Database is an open source, multithreaded and multi-user Relational Database Management System which is affiliated with Oracle Corporation. The general availability of MySQL Server 5.7 was announced in October 2015. The top features are mention below [10]. The top features are mention below Replication, InnoDB, Optimizer, Security, Performance Schema, OpenGIS Classes, Trigger, Partitioning, SYS Schema JSON Datatype, Client Programs, libmysql Client, Building Changes

III. LITERATURE REVIEW

Executing queries on SQL Server 2000 gives a better result and take minimum time comparatively with Oracle 9i [12]. SQL Server gives a better result when we execute the following queries joins, sub-queries, update and delete. Conditional queries having WHERE clause which contain the joins between the two tables execute much faster if the records are first filtered. In Oracle, those queries that contain integer fields work faster instead of floating fields so the recommendation is that as much as possible use integer in primary and foreign keys. Comparing the SQL Server, Oracle 10g, IBM DB2, My SQL 5.0 and MS Access the IBM DB2 is that the fastest DBMS (Database Management System). IBM DB2 database consumes less primary memory and MS Access have lower CPU utilization [13]. Column oriented Database Management System approach is enhanced the way in Business Intelligence where the scalability, performance, transaction etc. are counted. Column-oriented gives user a future- proof of our data management infrastructure. When we need to analyze a huge amount of data, the best approach is to use column-oriented approach, which ensures the capabilities and delivers the faster performances. Compressed column oriented data gives user much better performance instead of directly operating roworiented data [14]. SQL Server gives us best speed in JOIN operations and transactional integrity, where MongoDB gives better performance when we read and update the data. When we normalize our data, normalization requires storing the data in many tables.

The same kind of data structure map in MongoDB database, we completely get rid of the use of JOIN type, which automatically improves the performance and considers faster than the relational database. In the research paper scenario, the data is not normalized, so we easily conclude our point that huge amount of data, MongoDB is the best solution, which always is faster than SQL Server database [15]. When retrieving the data from the database, MongoDB works better but it fails to exceed Oracle speed when it has come to aggregation functions. We cannot replace the relational database to the non-relational database because the need of customer that which database is suited more according to the scenario [16]. We cannot choose the relational database management system for big application because the drawback is that it's time-consuming, queries and execution speed problem. NoSQL (MongoDB) is the best choice instead of MySQL server because easy to use and better timing performance. Huge storage of data storage requirements, Query based on KEY/VALUE pairs NoSQL (MongoDB) is a better choice [17]. MongoDB is work faster when we compare with MySQL Server because it manages the large application on the efficient way. MongoDB removes the ORM (Object Relational Mapping) layer, which helps us to evolve the database according to business requirements. In relational database management system, user can only store those items that contain single attribute but in KEY/VALUE pair, we have the possibility to store related items in one "row" [18]. MongoDB works faster comparatively with MSSQL. MongoDB takes a lower execution time. The basic operation in a database like SELECT, UPDATE and DELETE that is provided in all application. Only the time when MSSQL perform very well is in SELECT query. They also notice that only relational databases are only useful where we manage or handle the limited amount of data. When we want to choose the database, we need to be very careful and measure all factors of databases like data integration, Transaction, Scalability and the Schema of the database. Considering this modern age, choosing the right database on the low process, most of the market chooses the non-relational databases because MongoDB is an open source where is MSSQL is a commercial use in a big significance which makes a clear difference between MongoDB and MSSQL [19]. The non-relational databases have high data through put, relational databases have low data throughput. Non-relational databases are high scalable whereas the relational databases are less scalable. In the non-relational database, user can insert data anytime

without defining a schema and altered at any time if we are facing any issue whereas the relational databases have fixed tables and structure. Non-relational databases support the BASE properties where's the relational database support the ACID properties. Relational databases support key-value storage and single index where's the relational databases have an index on multiple columns [20]. The non-relational databases are a desirable approach for both grid and cloud computing. It provides the quick response, best performance execution in all factors of databases. The thing that makes the difference between non-relational and relational databases is that the different varieties of databases are available for developers outside the legacy applications or systems. The advantage is that developers do not settle the relational model but RDBMS definitely needed. In this modern generation, the storage requirement of a data volume is huge for legacy applications. As the demand of scalability, transaction databases will continue to evolve [21]. It describes the advantages and disadvantages of NOSQL databases. It also describes the pros and cons of data storage in particular cases. The responsibility of the database designer is to consider the query languages, different parameters, redundancy, and consistency and needs to be careful and knowledgeable about the pros and cons of data model when deciding to choose the particular model [21]. It describes the average performance of different versions of MYSQL the reliability of MYSQL 5.1 is faster than the versions of 5.0 and 5.5. On the basis of this research paper, they concluded that MYSQL 5.1 version is fast and better performance and found to be a most reliable way to use [23]. The need for relational databases always remain in the market but today the requirements of companies will not remain same. They need the better performance and faster execution. The MongoDB is better than MYSQL because the reason is two factors, first is easy to use and the second is faster performance [24]. It describes the performance of MYSQL and MongoDB on market application when they inserted or searched the number of records in both MongoDB and MYSQL both databases show the same execution time as compared to MYSQL. We can prefer MongoDB because the performance wise is best. Relational databases have no horizontal scaling when we read or write millions of records. While NOSQL database has high transaction load [25].

A. COMPARISON

After the in-depth search from different research papers we conclude all the research papers in Table 1

with the comparison of their records, nature of databases and execution time of query. The comparison of the database table tells that how much databases takes execution time to perform the basic operations like SELECT, DELETE and UPDATE. While comparing the different research papers we found that in some research paper that the nature of query is same, based on the selection of a record, but some basic queries are not present in different research papers the cross sign in the table tells that the nature of the query is not present in the research papers [13].

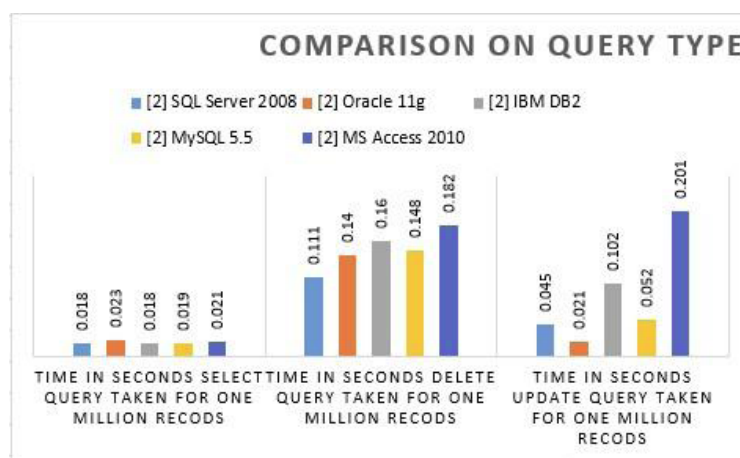
Figure 1 shows the comparison of the execution time of different databases with respect to its query type and their basic operations which have done in all databases like SELECT, DELETE and UPDATE. This chart represents the comparison of the SELECT, DELETE and UPDATE queries of different database, which contain the same record and same system configuration. In SELECT query operation, the IBM DB2 database is work faster comparatively with another database like SQL Server, Oracle, MySQL and MS Access. In DELETE query operation, the SQL Server takes minimum execution time and work faster than another database like IBM DB2, Oracle, MySQL and MS Access. In UPDATE query operation, the Oracle is work faster against another database and takes minimum time. Figure 2 shows the performance of different databases by applying the basic queries like SELECT, UPDATE and DELETE the configuration of the system, nature of queries and the records are same in all databases. When we compare the all databases according to the performance factor, In SELECT query the performance of IBM DB2 is faster. In DELETE query the performance of SQL Server is better compared to the other databases and in UPDATE query operation the performance of Oracle is better than the other databases overall the performance of MS Access is low in DELETE and UPDATE query.

IV. METHODOLOGY

Our methodology is to test the execution time of SQL Server 2016, Oracle 12c and MySQL 5.7 by executing the different types of queries in these experiments. For experiments, we limit our Database rows between 300000 to 400000. We stored 324500 rows in SQL Server 2016, Oracle 12c and MySQL 5.7 using software, which we developed, the work of the software is that this software only inserts the multiple rows in the databases.

Table 1: Comparison of various databases [12, 14, 16-18, 24]

Reference. NO	Databases Name/ Approach	Relational Database	Records	NON-Relational Database	SELECT QUERY TIME In Sec	DELETE QUERY TIME In Sec	UPDATE QUERY TIME In Sec	Client / Personal Computer
Tudose, C. and Odubăşteanu, C., [12]	SQL Server	√	500,000	X	1	4	13	YES
	Oracle				2	1	2	
Bajaj P., and Dhindsa Kaur, [14]	Column Oriented DBMS, Row Oriented Database	√	X	√	X	X	X	YES
K. Sanobar. and Vanita M., [24]	SQL Server	√	50,000	√	150	X	3	YES
	MongoDB				130		1	
Faraj A., Shareef T., and Rashid B, [16]	Oracle	√	5000	√	3.45	X	X	YES
	MongoDB				0.633			
Kumar L., Rajawat S. and Joshi K., [17]	MongoDB	√	50,000	√	10	X	X	YES
	MySQL				28			
B Damodaran D., Salim S. and Varghese M S., [18]	MongoDB	√	25000	√	0.025	X	X	YES
	MySQL				0.03			

**Figure 1:** Comparison of the execution time [13].

1. Experiment 1

The key objective of this experiment consists of 324500 rows; the main purpose of this query is to only fetch the number of rows in the table instead of applying any condition. The table consists of basic columns and where the ID is PRIMARY KEY. The following Figure 3 shows the execution time and result of the experiment.

Figure 3 shows that we can already be inserting 324500 rows in the database using the software, which inserts the rows into the database. This experiment clearly shows that, when we retrieve the rows from SQL Server 2016, Oracle 12c and MySQL Server 5.7. MySQL server is work faster and its execution time is minimum comparatively with SQL Server 2016 and Oracle 12c takes maximum time to execute the result.

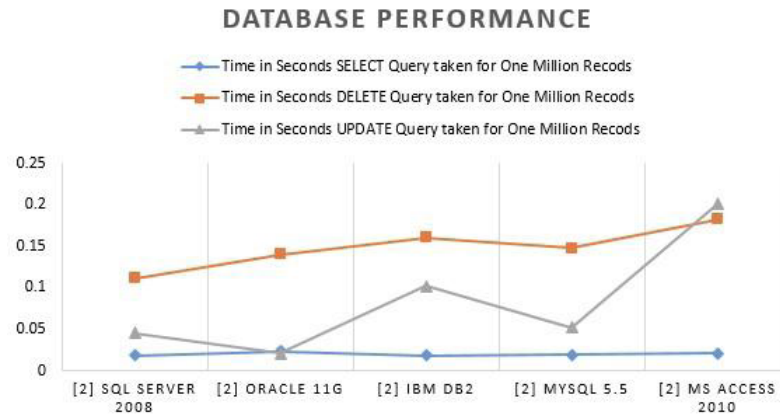


Figure 2: Performance of the execution time [13].

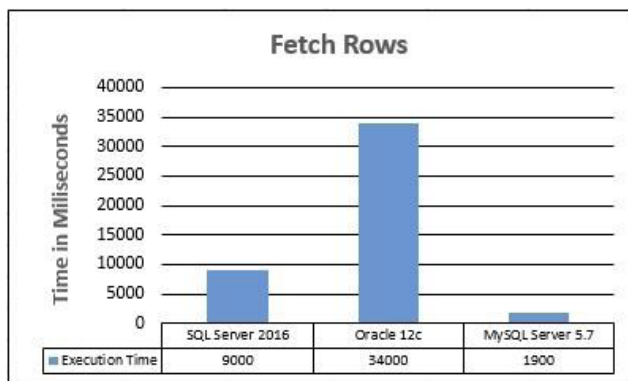


Figure 3: The execution time for selecting records.

2. Experiment 2

In this experiment, we searched random IDs from Table using the Conditional query (WHERE clause) on query based execution. As previously, mention that the ID on the SQL Server 2016, Oracle 12c and MySQL Server 5.7 database is a PRIMARY KEY. Figure 4 show the execution time and result of the experiment.

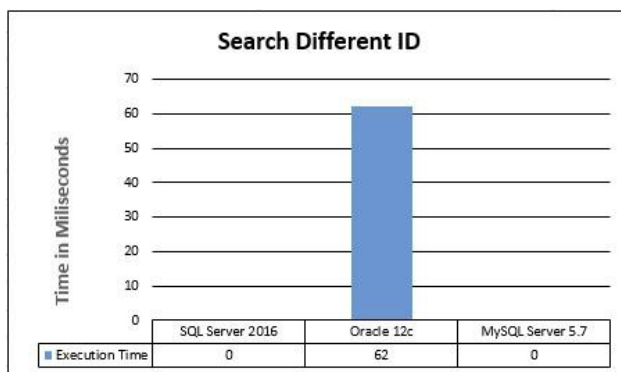


Figure 4: The execution time of search IDs.

Figure 4 pointing towards the conclusion that, when we search the different IDs that are consists of PRIMARY KEY from three databases SQL Server

2016, Oracle 12c and MySQL Server 5.7, the execution time of SQL Server 2016 and MySQL Server 5.7 are same, both of them takes no execution time both are faster and efficient. The execution time of Oracle 12c takes a little bit time. SQL Server 2016 and MySQL Server 5.7 both are efficient.

3. Experiment 3

The purpose of this experiment is to update the single column, which consists of 324500 fields in a table. As we previous mention that the table consists of different attributes, ID is the PRIMARY KEY in the table. Figure 5 clearly shows the execution time of SQL Server 2016, Oracle 12c and MySQL Server 5.7.

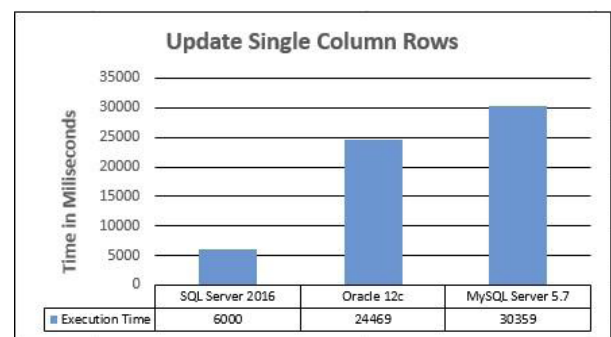


Figure 5: The execution time to update records.

The method chosen to update the single column is same in all databases SQL Server 2016, Oracle 12c and MySQL Server 5.7. We update this column using the simple SQL Query and apply this query on three databases with a little bit change in the query. This conclusion of this experiment is clearly show the result that when we update the single column which consists of 324500 rows on SQL Server 2016, Oracle 12c and MySQL Server 5.7, the execution time of SQL Server is faster than Oracle 12c and MySQL Server 5.7, it takes

minimum time over the Oracle 12c and MySQL Server 5.7.

4. Experiment 4

The objective of this experiment is to copy the 324500 rows from one table and paste it into another table. The first table consists of different attributes; ID is the PRIMARY KEY attribute in the first table. The structure of the second table is same as the first table but the second table is not consisting the PRIMARY KEY attribute. All the attributes in the first table and the second table are same and their data type and column names are also same but the table name is different. The Figure 6 shows that the rows transfer from one to table to another table.

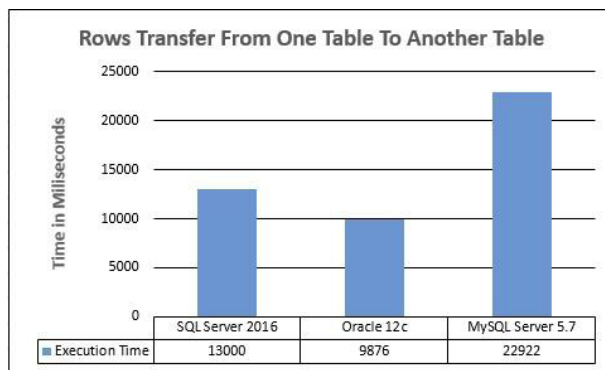


Figure 6: The execution time of rows transfer.

The aim of this experiment is to check the execution speed that when we copy the 324500 rows and paste it into another table. This action is performing with the help of query. The experiment of this result pointing toward the conclusion that when we copy the 324500 rows from one table that consists of PRIMARY KEY attribute and transfer it into another table that cannot consist of the PRIMARY KEY attribute. We examine that the Oracle 12c work faster and the execution time of Oracle 12c is minimum and comparatively with SQL Server 2016 and MySQL Server 5.7.

5. Experiment 5

The purpose of this experiment is to select 324500 rows from the table using Conditional query (ORDER BY) clause we select all the rows and column without neglecting the specific column or row. As we know that the table is, consist of the PRIMARY KEY attribute.

The Figure 7 show that the experiment moving towards the conclusion is that, when we execute this query on SQL Server 2016, Oracle 12c and MySQL Server 5.7 the execution time of MySQL Server 5.7 is faster than the SQL Server 2016 and Oracle 12c. SQL

Server 2016 is much better but the execution time of Oracle 12c is maximum. The Figure 7 show that the rows are selected using ORDER BY clause.

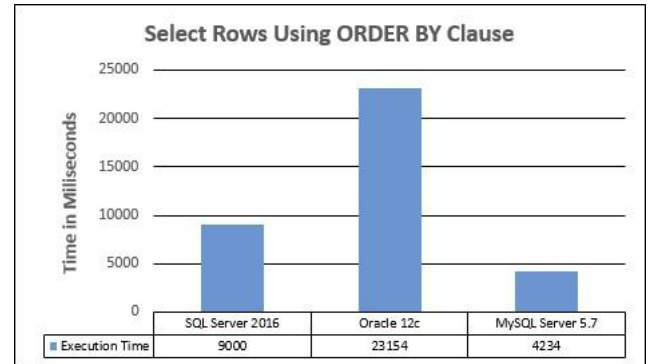


Figure 7: The execution time of rows selection.

6. Experiment 6

The purpose of this experiment is to select multiple rows from the table using Conditional query (GROUP BY) clause we select some attributes, like ID, Contact_Name from table Contact and apply the GROUP BY clause on Contact_Name. As we know that the table is, consist of the PRIMARY KEY attribute. The Figure 8 concludes our result that when we apply the query on the databases, SQL Server 2016, Oracle 12c and MySQL Server 5.7, MySQL Server 5.7 works faster and take little bit execution time and it is faster than Oracle 12c and SQL Server 2016.

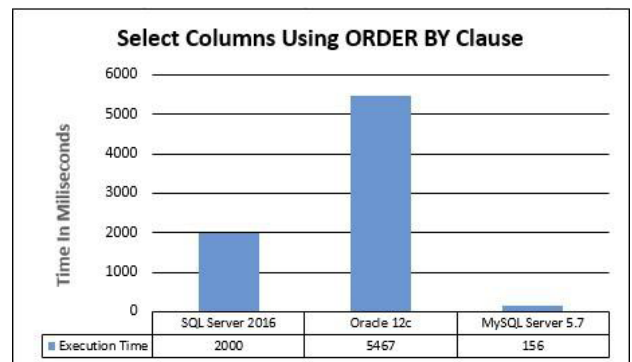


Figure 8: The execution time Columns Selection.

7. Experiment 7

The purpose of this experiment is to perform multiple joins between two tables using SELECT query that select different attributes from table Contacts table and joins with New Contacts table through ID. Both tables consists of the PRIMARY KEY attribute. The Figure 9 concludes our result that when we apply the query on the databases, SQL Server 2016, Oracle 12c and MySQL Server 5.7, MySQL Server 5.7 works faster and take little execution time and joins table through ID

attribute, SQL Server 2016 takes some times and Oracle 12c takes a long time in joining tables.

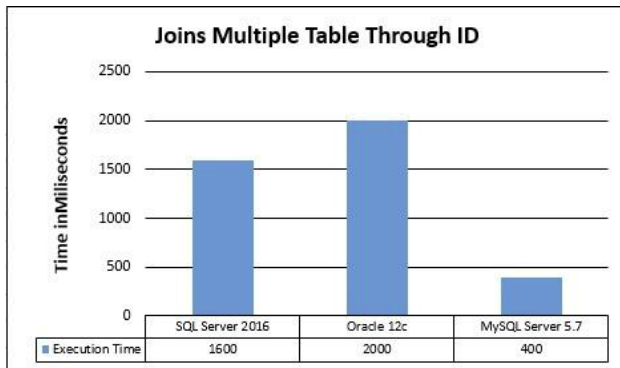


Figure 9: The execution time of Table Joins.

Table 2 is comparing the different parameters of the SQL Server 2016, MySQL 5.7 and Oracle 12c databases. This table shows that which database has more features and functionalities in the manner of their usage and system support configurations and platforms. This table clearly shows that the Oracle database has huge supports of the platform including

Windows, MacOS, and Linux while SQL Server only supports the Windows platforms. Oracle database has a huge support of different programming languages while SQL Server and MySQL Server have less support. MySQL Server is free and open source database while Oracle and SQL Server are used as commercial way.

Figure 10 shows that According to [27] the trend wise, Oracle database is the top most popular database, at second, the MySQL Server is popular database our experiment clearly show that the performance and execution time of MySQL Server is faster.

V. DISCUSSION & ANALYSIS

In order to perform the different experiments, the software developer developed C# Application using a C# programming language and the IDE (Integrated Development Environment) is Visual Studio 2013 under the Entity Framework 6. The application performs the one task. This task is that it inserts the records into the database by just giving the total number of records in

Table 2: Comparison of Different Parameters [26]

Parameters	SQL Server 2016	MySQL 5.7	Oracle 12c
Supported Platforms	Windows Operating System	Oracle Linux Oracle, Solaris Red Hat Various Linux FreeBSD Apple, IBM Microsoft Debian, SUSE Canonical	AIX HP-UX Linux OSX Solaris Windows z/OS
Supported Programming Languages	.Net C++ Delphi Go Java JavaScript (Node.js) PHP Python R Ruby Visual Basic	Ada, C C#, C++ D, Delphi Eiffel Erlang Haskell Java JavaScript (Node.js) Objective-C OCaml Perl PHP Python Ruby Scheme Tcl	C, C#, C++ Clojure Cobol Delphi Eiffel Erlang Fortran, Groovy Haskell, Java JavaScript Lisp Objective C OCaml, Perl PHP, Python R, Ruby Scala, TCL Visual Basic
License	Commercial	Open Source	Commercial
Durability	✓	✓	✓
Concurrency	✓	✓	✓
Transaction concepts	✓	✓	✓
Triggers	✓	✓	✓
Memory Capabilities	✓	✓	✓
MapReduce	✓	✓	✓
Data scheme	✓	✓	✓

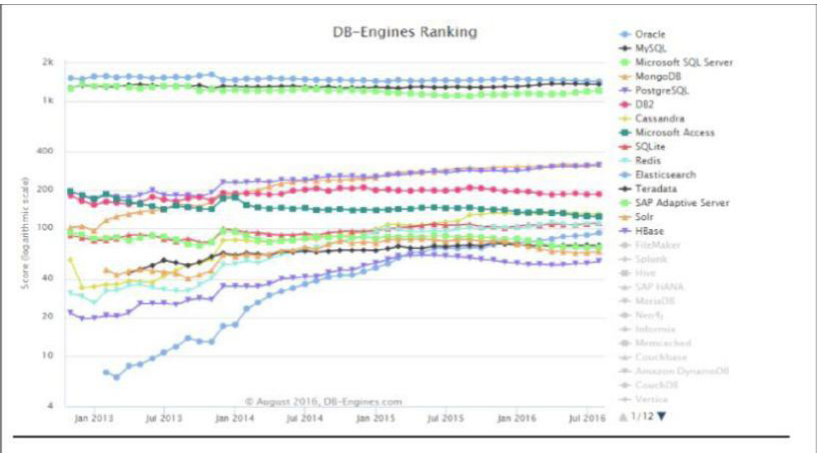


Figure 10: August 2016 Ranking of DB-Engines [27].

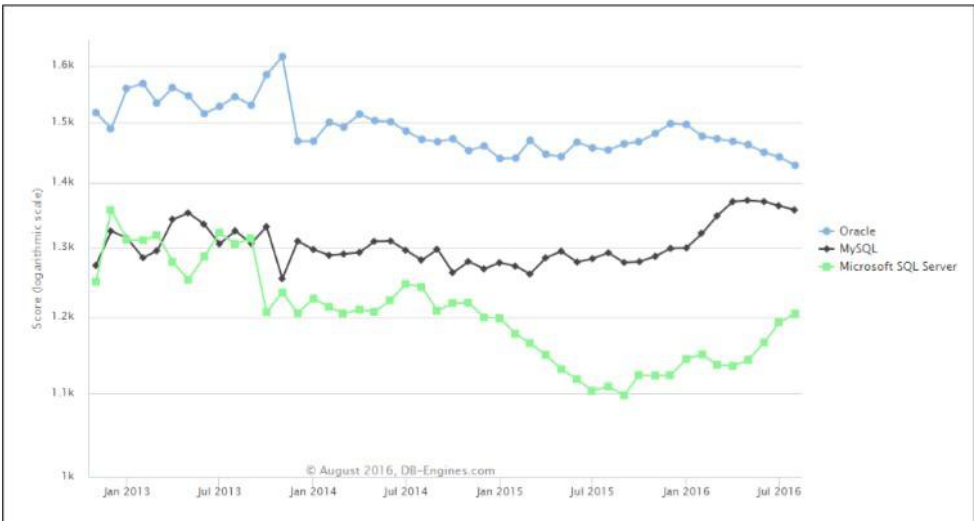


Figure 11: DB-Engines Ranking - Trend of Microsoft SQL Server vs. MySQL vs. Oracle Popularity [28].

the text box user want to insert into the database. Moreover, computer configuration used to execute experiments is illustrated in Table 3.

Table 3: Computer Configuration Used to Execute

Item	Description
Operating System	Windows 8
Processor Clocked Speed	Intel Core i3-1.5GHz
Ram (Random Access Memory)	4 GB
Storage Disk	Seagate 500GB

All the queries all executed on two tables Contact and New Contacts. Initially, the Contact table contains 324500 records and the New Contacts table is empty. Both tables Contacts and New Contacts have the same structure as illustrated in Table 4.

Table 4: Schema & Database Design

Field Name	Field Type	Length	Notes
c_id	Integer		PRIMARY KEY
c_name	Varchar		
c_phonenumber	Integer	25	
c_email	Varchar	25	
c_address	Varchar	25	
c_city	Varchar	25	
c_identitynumber	Integer		
c_date	Date		
c_gender	Char		
c_region	varchar		

Table 5: Schema & Database Design of Table 2

Field Name	Field Type	Length	Notes
id	Integer		PRIMARY KEY
name	Varchar		
phonenummer	Integer	25	
email	Varchar	25	
address	Varchar	25	
city	Varchar	25	
identitynumber	Integer		
date	Date		
gender	Char		
region	varchar		

CONCLUSION

In this paper, we showed some operations based on queries that have applied on the top three databases MS SQL, Oracle and MYSQL and we evaluate that measuring the performance factor and execution performance of three databases MYSQL work faster and give best execution time. Choosing MYSQL is the best decision but when database designer creating a database they may take much consideration like load transaction, the different operation applied on a database according to requirement. Generally, for the small and medium size of the management system, a relational database is a good choice but we cannot say that it is best criteria it also depends on the purpose of the company. Considering MYSQL is the best decision because most of the companies need open source database that complete their needs MS SQL Server and Oracle database are available at a high price while MYSQL is open source, which is the big advantage for companies.

In end, choosing right database is not only depend upon the execution performance but also depend upon particular situation according to their factors that are dependent upon the database.

The scope of the paper is limited to personal Computer for evaluating the performance of Database. In future, we will perform these experiments on the server machine. We will discuss some organization for providing server machine for evaluating Database performance.

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