

MICROSOFT SQL SERVER AND ORACLE: COMPARATIVE PERFORMANCE ANALYSIS

Miloš Ilić¹ Lazar Kopanja² Dragan Zlatković³ Milica Trajković⁴ Dejana Ćurguz⁵

Abstract: Databases are used to collect and store data, as well as to manipulate that data. In order to properly manage databases and ensure efficient work with data, database management systems (DBMS) are necessary. Microsoft SQL Server, Oracle, IBM Db2, MySQL, SQLite are some of the most known DBMSs. This paper compares the performance of Microsoft SQL Server and Oracle server based on different parameters. The comparison criteria include theoretical differences, basic characteristics, system and hardware requirements, security, as well as query execution time. The aim of the comparison is to point out the advantages and disadvantages of the observed DBMSs so that computer experts, primarily developers, can assess which database is more reliable in which case and make the right choice when developing different computer applications.

Key words: databases, database management systems, Microsoft SQL Server, Oracle, comparison, database queries

1. INTRODUCTION

Digitization processes nowadays take on a significant role in the everyday life of modern man, and with the development of technology, the need for storage and processing of large amounts of data is growing. Databases are used to store this data, and in order to properly manage the databases, database management systems (DBMS) are used, which enable the definition of data, their updating and downloading, as well as user administration, which includes registration and monitoring, strengthening data security, monitoring performance, maintaining data integrity, controlling the competitiveness of transactions, and recovering information damaged by unexpected system crashes. A comparison of the most famous DBMSs, respectively their performances, can often be found in the literature. These comparisons are made with the aim of determining the best, most efficient and most reliable among them. Jangra et al. (2010) perform functionality and security analysis for Oracle, IBM Db2, and Microsoft SQL Server. Bassil (2012) in his work compares the performance of five different DBMSs, including Microsoft SQL Server, Oracle, IBM Db2, MySQL and MS Access. Boacea et al. (2012) compare MongoDB and Oracle. Almeida et al. (2015) have done a performance evaluation for the following three DBMSs MySQL, InnoDB, and Microsoft SQL Server, to determine the most efficient among them for decision support systems. Islam et al. (2017) compare Microsoft SQL Server, Oracle, and MySQL for use on a personal computers. Aluko et al. (2019) compares four major SQL systems: Apache Hive, SPARK SQL, Apache Impala, and PrestoDB, where the performance of these systems is analyzed using three different measures TPC-H, TPC-DS, and TPCx-BB.

Server performance can be affected by various parameters, including hardware, operating system, server configuration, database table structure, query design, indexing, etc. Many authors present various solutions for DBMS optimization or analyze existing techniques in

¹ Teaching assistant, Faculty of Information Technology, Alfa BK University, Belgrade, Serbia, milos.ilic@alfa.edu.rs

² Assistant professor, Faculty of Information Technology, Alfa BK University, Belgrade, Serbia, lazar.kopanja@alfa.edu.rs

³ Teaching assistant, Faculty of Mathematics and Computer Science, Alfa BK University, Belgrade, Serbia, dragan.zlatkovic@alfa.edu.rs

⁴ Student, Faculty of Mathematics and Computer Science, Alfa BK University, Belgrade, Serbia, m.trajkovic963@gmail.com

⁵ Student, Faculty of Mathematics and Computer Science, Alfa BK University, Belgrade, Serbia, dejanacurguz.dc@gmail.com

their papers. Chen (2006) suggests how to set up modern database systems to obtain robust performance optimization. Li (2009) in his work investigates performance optimizations and their application on the Oracle database. Rahman et al. (2010) analyze existing database optimization techniques. Aghav (2010) presents database compression techniques to improve performance. Dehghanimohammadabadi et al. (2017) present a new iterative optimization-based simulation (IOS) framework to improve system's performance, where the performance of this framework is evaluated using a case study in production. Bedo et al. (2018) describe how to optimize similarity searching in DBMS using the Mercurion approach. Samson et al. (2020) analyze automatic optimization in database management systems and emphasize the advantage of this type of optimization over manual tuning.

Query execution speed is considered as one of the most important measures of DBMS performance, so the representation of query optimization methods is very common in the literature. Kumari (2012) and Corlăţan et al. (2014) in their papers describe query optimization techniques for SQL Server for writing efficient and faster queries. Guo et al. (2017) present a framework for DBMS that is based on energy-aware query optimization and energy-efficient query processing. Zhang et al. (2018) represent a way to optimize recurring queries in big data analysis system using MapReduce. Eslami (2020) proposes a model that can be used to optimize query batching in the DBMS.

In this paper, a comparison of two DBMSs, specifically Microsoft SQL Server and Oracle, is performed to determine their advantages and disadvantages. The parameters on the basis of which the comparison is made include theoretical differences, basic characteristics, system and hardware requirements, security, as well as query execution time. This comparison should facilitate decision-making by computer experts when choosing a DBMS.

2. DATABASE MANAGEMENT SYSTEMS

A database management system is a software system used to create, use, and maintain a database (Post et al., 2001). It serves as an interface between the database and the user, allowing users to enter, modify, delete, and manipulate data (Russell, 1986). Some of the most known DBMSs today are Microsoft SQL Server, Oracle, IBM Db2, MySQL, SQLite and others.

2.1. Microsoft SQL server

SQL Server (Mistry et al., 2014) was developed by Microsoft corporation and represent a system that defines the methods used to manage databases. It manages relational databases and contains a large selection of applications for transaction processing, analytics in corporate IT environments, and business intelligence. SQL Server Management Studio is the main tool used to manage the server and databases. SQL Server serves both the academic needs and the industry-level applications available to us today. There are several different versions: Enterprise, Standard, Web, Developer and Express.

2.2. Oracle

Oracle (Greenwald et al., 2013) was developed by Oracle Corporation and is one of the most reliable and widely used relational database management systems. Because it provides high performance, security and scalability, it is used by companies all around the world. Companies use Oracle mostly for data storage, transaction processing, and business analytics. There are numerous tools for managing Oracle database. The built-in database access tool is called SQL *Plus, Oracle Enterprise Manager Cloud Control is used for administration, while SQL Developer, which is most similar to Microsoft's SQL Server Management Studio, is used for database development and management. In addition, there are many tools developed by

other software companies, among which the most known are Quest Toad and DBeaver. As well as SQL Server, Oracle also has several different versions: Standard Edition One, Standard Edition, Enterprise Edition, Express Edition, and Personal Edition.

3. COMPARISON OF MICROSOFT SQL SERVER AND ORACLE

3.1. Basic characteristics

This subsection will show the basic characteristics of MS SQL Server and Oracle, such as supported operating systems and programming languages, syntax, interface, and supported SQL language, Table 1.

Table 1 – Basic characteristics

Characteristics	Microsoft SQL Server	Oracle
Supported operating systems	Windows and Linux	Windows, Linux, AIX, HP-UX, Solaris, MacOS and z/OS
SQL language	T-SQL	PL-SQL
Syntax	Simpler and easier	More complex and difficult
Interface	Gui and SQL	API, Gui and SQL
Supported programming languages	C#, C++, Delphi, GO, Java, JavaScript, PHP, Python, R, Ruby, Visual Basic	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

Table 1 shows that Microsoft SQL Server and Oracle are quite different in the number of supported operating systems. First one supports only two operating systems, Windows and Linux, while the second one supports multiple, including Windows, Linux, AIX, HP-UX, Solaris, MacOS, and z/OS. The big difference between the two DBMSs is in the language they use. Although both systems use a version of a structured query language, ie. SQL, Microsoft SQL Server uses transact SQL (T-SQL) whose syntax is simpler and easier, while Oracle uses procedural SQL (PL-SQL) whose syntax is more complex and difficult. When it comes to the interface, Microsoft SQL Server supports Gui and SQL, while Oracle in addition to these two interfaces also supports the API. Oracle supports a significantly larger number of programming languages than Microsoft SQL Server, which allows more developers to opt for Oracle.

3.2. System and hardware requirements

A comparison of system and hardware requirements for Microsoft SQL Server 2019 Express and Oracle 18c Express Edition is shown in Table 2. The comparison is done for the purpose of installing both servers on the Windows operating system.

Table 2 – System and hardware requirements

Requirements	Microsoft SQL Server 2019 Express	Oracle 18c Express Edition
Operating system versions	Windows 10	Windows 7 and later
	Windows Server 2016 and later	Windows Server 2012 and later
Free space on Hard disk	6 GB minimum	8,5 GB minimum
RAM	512 MB minimum	1 GB minimum
Processor type	AMD Opteron, AMD Athlon 64, Intel Xeon with Intel EM64T support, Intel Pentium IV with EM64T support	AMD64 and Intel EM64T
Screen resolution	800x600 minimum	1024x768 minimum

On the basis of system and hardware requirements from Table 2, it can be concluded that, unlike SQL Server, Oracle supports older versions of Windows, and is therefore available to a larger number of users. Compared to Oracle, SQL Server takes up less hard disk space and requires less RAM to function. However, it should be noted that the amount of memory that will take up space on the hard disk also depends on the number of options that the user chooses during installation. By comparing the processors, it can be said that the requirements for both DBMSs are equal. When it comes to screen resolution, SQL Server can run at a lower resolution than Oracle.

3.3. Security

A comparison of security features for Microsoft SQL Server and Oracle is shown in Table 3.

Table 3 – Security

Security features	Microsoft SQL Server	Oracle
Security type	Simple security	Multi-layer security
Authentication	User authentication at the instance level and at the database level	Confirmation of user identity at the database level and based on OS roles
Database sharing	Users cannot share databases	Users can share databases
Prone to errors and data corruption	Chances are high	Chances are low
Types of backup	Full, partial and incremental	Full, partial, incremental and differential

When considering the security of the observed DBMSs, Oracle has a great advantage as it provides multi-layer security, while with Microsoft SQL Server it is at a simpler level and offers fewer options. User authentication in SQL Server is performed at the instance and database level, while in Oracle it is performed at the database level and based on the roles of the operating system. Oracle users can share databases, while SQL Server does not have this capability, thus having better protection. SQL Server has a much higher propensity for errors

and data corruption, so Oracle is considered far more reliable in that regard. When it comes to backing up databases, SQL Server supports full, partial and incremental backup, while Oracle in addition to these three backups also allows differential backup.

3.4. Query execution time

Query execution time is the best way to analyze the performance of a DBMS. In this subsection, query execution speed have been tested and compared for Microsoft SQL Server 2019 Express and Oracle 18c Express Edition.

The computer used for testing has a Windows 10 Pro (x64) operating system, an i7-9700K processor and 32 GB of RAM. Query execution time measurement has been done on the same database for both DBMSs. The database consists of 10 tables with 102356 records in total. Testing has been performed in two groups. The first group represents queries from single table, while the second group uses queries for merging multiple tables (inner join). In both groups there are queries with unfiltered table/tables contents, with *Where* clause and with *Order by* clause.

Because the execution time of the same code may vary (Илић et al., 2020), queries have been tested several times and then their average execution time was calculated, which is shown as a result. The query execution time in Figure 1 and Figure 2 is shown in seconds. Figure 1 shows a graph representing the execution time of a query from single table (first group). In all three cases, Microsoft SQL Server has better results than Oracle, as it requires less time to execute queries. The difference in the time required for queries to execute is far more evident in the case of unfiltered table content and with *Order by* clause, while in the case of queries with the *Where* clause the difference exists but is not so evident.

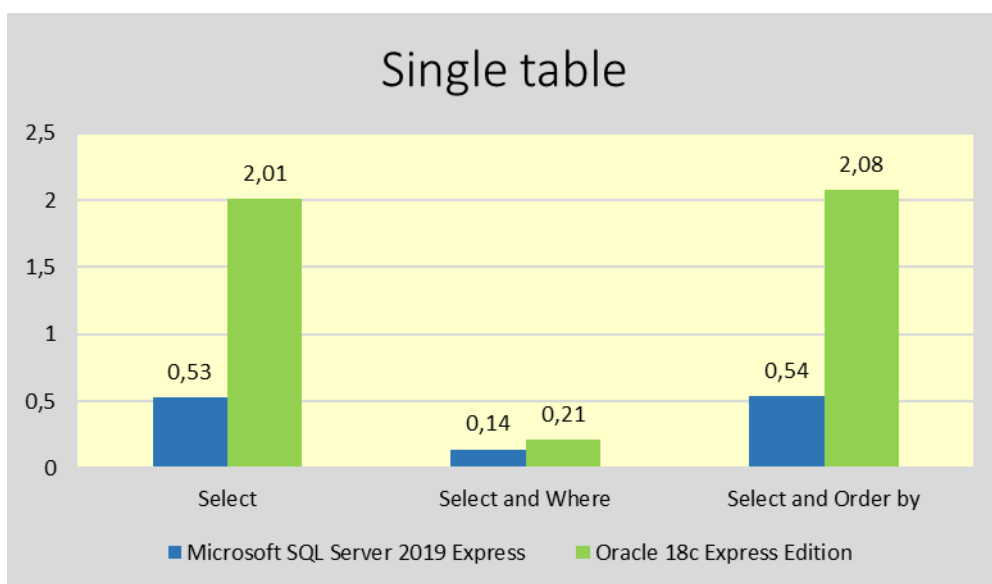


Figure 1 – Query execution time from single table

Figure 2 shows a graph representing the query execution time from three tables (second group), which shows that Microsoft SQL Server requires less time for query execution than Oracle. The difference is more evident in queries with unfiltered table content and with *Order by* clause than in the case with the *Where* clause.

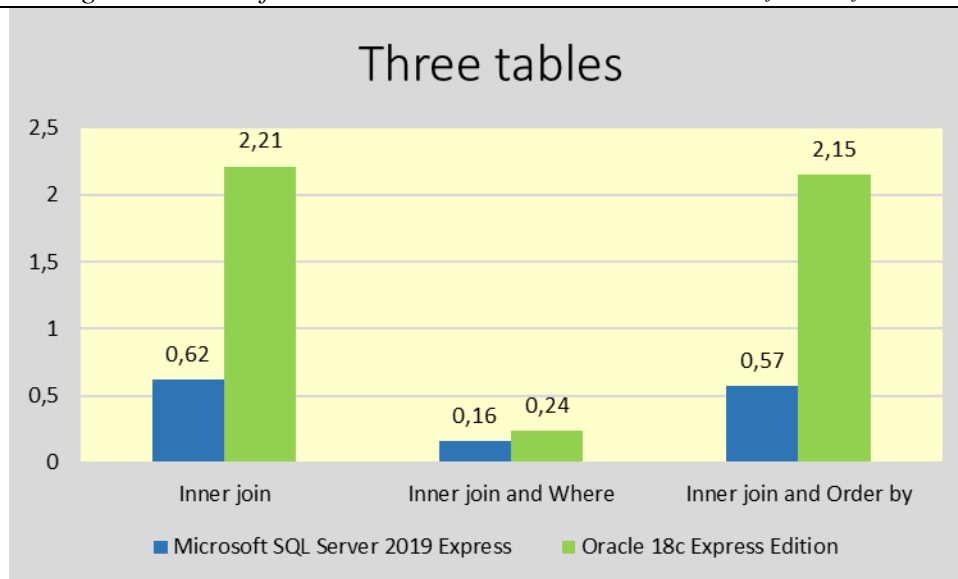


Figure 2 – Query execution time from three tables

4. CONCLUSION

In this paper, a comparison of two DBMSs Microsoft SQL Server and Oracle was conducted. The comparison has been made on the basis of theoretical differences, basic characteristics, system and hardware requirements, security and query execution time. Observing the basic features of the two DBMSs, Oracle has an advantage as it allows more people to install the server, due to the number of supported operating systems, and the fact that it supports multiple programming languages leads to more developers opting for it. The only advantage of Microsoft SQL Server in this part is the simpler syntax. If we look at system and hardware requirements, for the installation of both servers on the Windows operating system, besides the fact that Oracle allows installation on older versions of operating systems and that the situation around the processor is similar, everything else goes in favor of Microsoft SQL Server whose requirements are less demanding for the installation and normal operation of the server. When it comes to security features, Oracle is the one that contains multi-layered security and is less prone to errors and data corruption. In this part of comparison, Microsoft SQL Server is more secure only with regards to database sharing, since sharing is not possible between users. When looking at the results of query execution time, which is one of the most important measures of performance, Microsoft SQL Server shows far better results in both cases, queries from a single table, as well as queries for merging tables. This research can help in making a choice between the two observed DBMSs.

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