

COMPUTER ORGANIZATION AND ARCHITECTURE

Lecture 12

Database Administration and Security

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INTRODUCTION

Throughout this lecture series, we have reviewed the history of databases, the ERD diagrams and normalization and finally a review of SQL with some practical cases. This lecture focuses on maintenance and security. We will be reviewing why database security is important including the types of threats that face databases and how to protect databases. We will also do a review of database security goals. Finally, we will review the DBMS approach for security as well as a review of data and data administration.

Learning objectives

By the end of this topic, you should be able to:

1. Describe concepts related to database administration.
2. Identify the technical role of a database administrator
3. Describe the security threats and preventive relating to databases.
4. Understand how MySQL Workbench (DBMS Visual tool) works

OVERVIEW

Throughout this lecture series, we have worked on introducing databases and associated concepts. We have reviewed how to create a database and its elements using SQL. Now part of the database activities includes administration and security. Administration and Security are integral processes of any database and are mainly handled by a database administrator. This lecture focuses on administrative tasks.

INTRODUCTION

What exactly is data? Data is considered raw facts. It is also defined as unprocessed information. Data is the core ingredient of a database. Data is also considered an integral part of any organization. Organizations nowadays collect massive amounts of data that must be stored and retrieved securely. When data is converted into information then it becomes an asset within an organization. Like all assets, data is valuable and must therefore be secured. Loss of data to any organization can result in catastrophic consequences. Database administration arose from the decentralized file system [1]. The database brought a new view on the way data is managed due to the complexities, several users and functionalities [1], [2]. This led to the database administrator (DBA) role whose role was reviewed in lecture 1.

The DBA has various roles including a managerial role. However, of interest to us during this lecture is the technical role of a DBA

Database Administrator Technical Role

Some roles of the database administrator include installation, upgrading, maintenance, and security oversight [1]. We will focus on a couple of the tasks that the DBA oversees.

1. Evaluating, selecting, and installing the DBMS and related utilities [1]

This role involves selecting and installing an appropriate DBMS for an organization. Relooking at the database lifecycle, we recall the stages of development, and the DBA could oversee the planning, design and implementation.

2. Testing and evaluating databases and applications [1]

Once a DBMS has been selected, it is then up to the DBA to test that it is working appropriately and that the applications are all integrated properly.

3. Operating the DBMS, utilities, and applications [1]

This role involves overseeing all the functions of the database. This involves ensuring that data is not lost, that users are assigned appropriate roles with relevant permissions and that the database performs as per the expectations.

4. Training and supporting users [1]

Once the entire setup of the DBMS is concluded, then it is a requirement that the users who will be directly interacting with the database get trained. This could involve the creation of tutorials and walkthroughs of using the database.

5. Maintaining the DBMS, utilities, and applications [1]

Once the database has been implemented within the organization, then the DBA oversees the maintenance of the database, upgrading when needed and installing any additional components.

Data Administration and Database Administration

Data Administration can be defined as the management of the data resource [2], while database administration is defined as the management of the physical realization of a database system [2].

SECURITY

Security in a database refers to the activities and measures that ensure three main security goals: confidentiality, integrity and availability are met [1]. Securing a database involves an entire organization where it is the role of the end-user as it is the management. let us first review the security goals to get a better understanding.

Confidentiality: This involves ensuring that data is protected against unauthorized users. Let us take the example of Bustani college. Students may be allowed to see their grades once they have been released. They have no authorization to see other students' grades nor can they change or manipulate their grades. The same can be said about the kind of data a finance officer within Bustani can access versus what an examinations officer can access. The finance officer can check the student's payment status and can update records relating to finances. On the other hand, the exam officer could easily issue examination cards based on updates by the finance office. However, the exam officer cannot make changes concerning finance.

Integrity: This goal is concerned with keeping records or data that is error-free and does not contain any anomalies [2]. A data anomaly occurs when data changes have to occur in several places. It mainly exists due to data redundancy within a database. Integrity ensures that the data that is captured within the database does not contain any errors and can be updated within a single point. One of the key components of ensuring data integrity is during the design process.

Accessibility: This refers to the availability of data whenever a user requires it [1]. Of course, this means that a user would need to have the correct authorizations before data can be availed to them. This means that security has to be factored in to ensure that the database is free or protected from internal and external attacks.

Types of vulnerability

A security vulnerability can be defined as a weakness within a system component that can be exploited to allow unauthorized access that may then cause severe disruptions [1]. Vulnerabilities are considered as either technical, managerial, cultural or procedural. A **technical vulnerability** happens due to a flaw in the system while a **managerial vulnerability** happens due to user errors within the organization [1]. **Cultural vulnerabilities** arise due to user ignorance while **procedural vulnerabilities** occur due to a lax in company policies [1].

TYPES OF THREATS

There are several areas that which any organization should aim to reduce risk or prevent the possibility of loss and damage [2]

- Theft and fraud
- Loss of confidentiality
- Loss of privacy
- Loss of integrity
- Loss of availability

We will now give examples of specific threats and ways in which to protect a database.

Theft and fraud

A student at Bustani college uses another student's account without their knowledge to access an online system.

Measures: Ensure that a student is required to change their password from the system default as soon as they log in.

Loss of confidentiality

A disgruntled former employee who was an IT technician at Bustani college hacks into the college system intending to access and make unauthorized changes.

Measures: Ensure security authorization updates to ensure no unauthorized access. Ensure that policies are in place to retract permission of former employees.

Loss of privacy

A malicious employee views data regarding other employees and discloses the information to the public.

Measures: Ensuring that there are separate levels of access and audits to ensure data is secure from unauthorized access.

Loss of integrity

A student logs into the exams system and makes changes to different students' grades

Measures: Ensuring that there are separate levels of access and audits to ensure data is secure from unauthorized access. Ensuring file system security is implemented.

Loss of availability

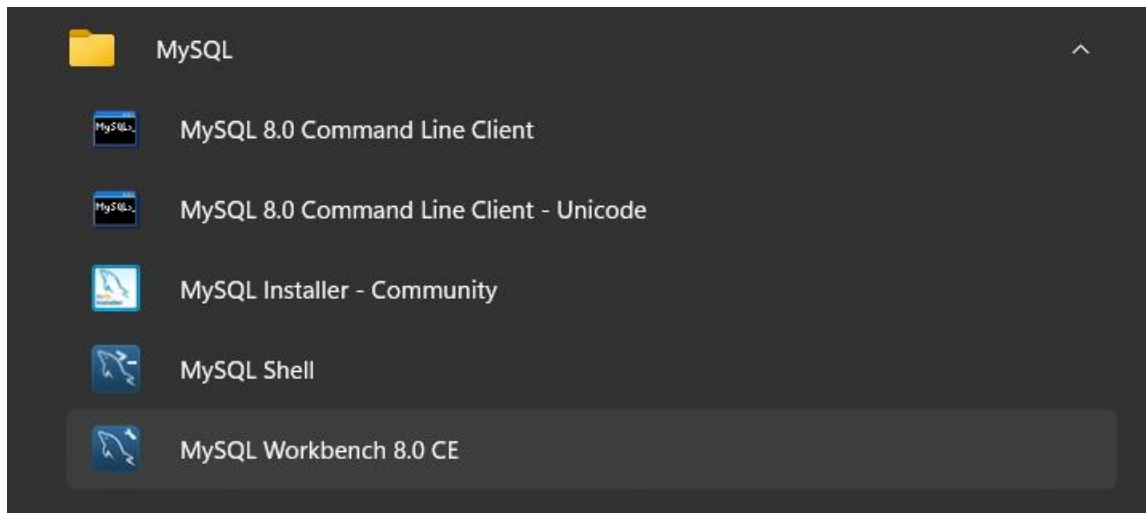
The Bustani database is attacked by a virus leading to the loss of critical information.

Measures: Use of antiviruses and firewalls to prevent attacks. Performing regular backup and recovery procedures to ensure continuity.

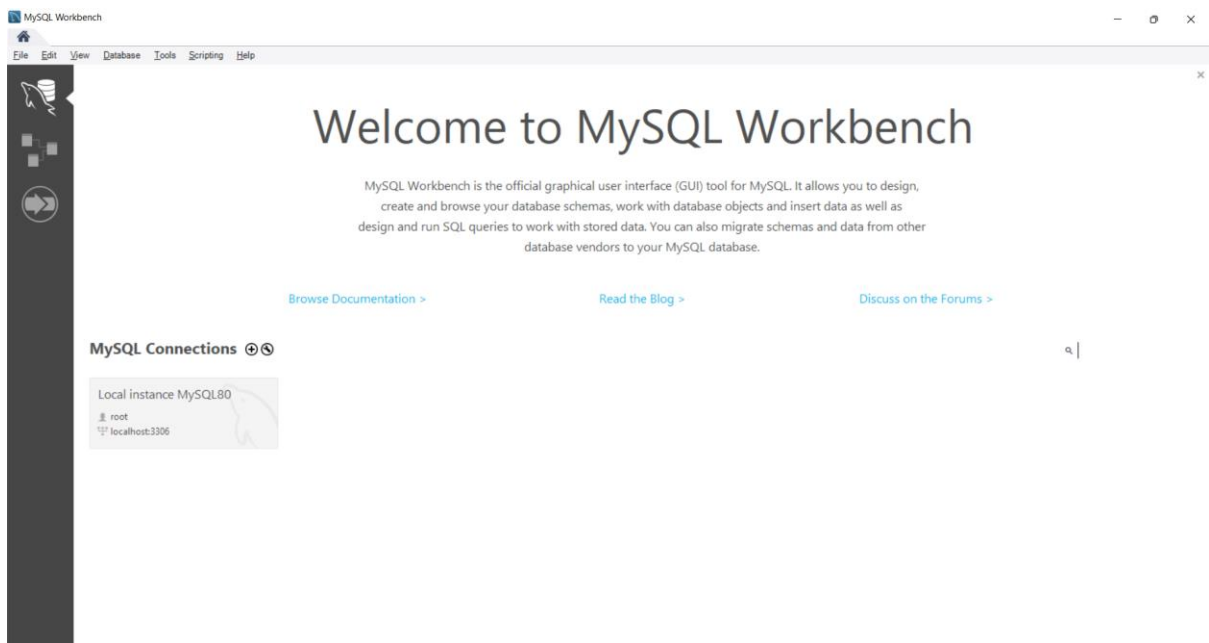
MYSQL Workbench DBMS visual review

We have come a long way from learning the history of databases to creating and querying a database and its elements. This section is devoted to conducting a review of MySQL Workbench is a visual IDE. We will work toward reviewing different administrative procedures of a database using a visual tool.

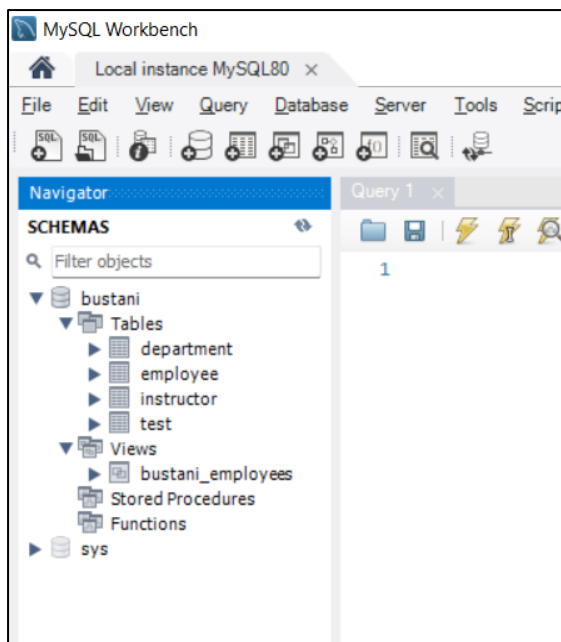
You open the MySQL workbench by selecting the MySQL Workbench 8.0 CE from all apps under the Start Menu.



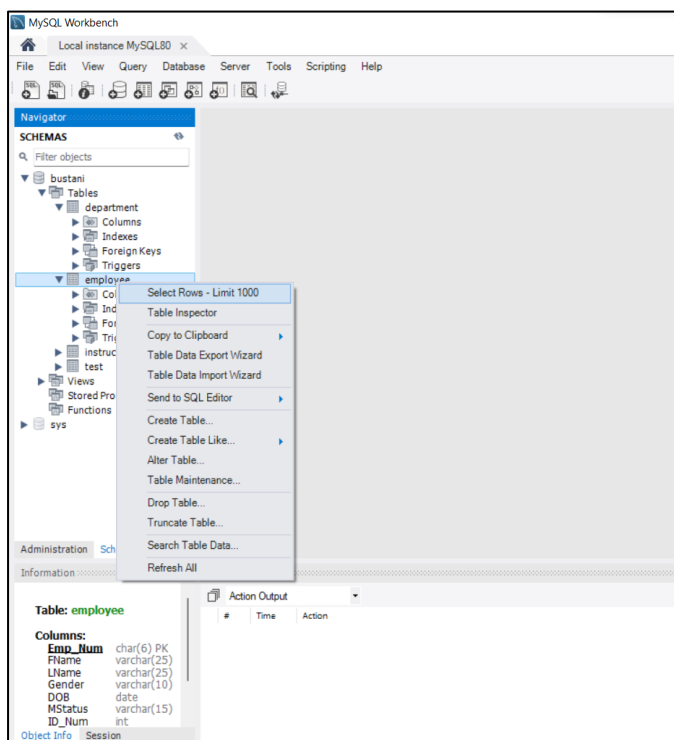
Once you open the program, you will get the screen below.



By default, there is a root account that you can log in with to see the Bustani database that we created. Once we log in, then we will go ahead and review the databases created.



As shown on the screen above, we can see the Bustani databases, the tables and the views. You can right-click on the employee table and select Rows – Limit 1000 then you can review the details in the table.



You will notice at the bottom that the information contains the details of the table including the datatypes.

The screenshot shows the MySQL Workbench interface. The Navigator on the left displays the database structure for 'bustani', including tables like 'department', 'employee', 'instructor', and 'test'. The SQL Editor in the center contains the query: `SELECT * FROM bustani.employee;`. The Result Grid below the editor displays the following data:

Emp_Num	FName	LName	Gender	DOB	MStatus	ID_Num
EMP001	Agnes	Njue	Female	1997-09-12	Single	17584692
EMP002	Will	Omondi	Male	1989-08-24	Married	0
EMP003	Carol	Njagi	Female	1993-09-01	Married	12346598
EMP004	Mary	Munene	Female	1998-08-06	Married	0
EMP005	Cathy	Resley	Male	1989-04-16	Married	0
EMP006	Abdul	Muita	Male	1988-07-30	Single	0
EMP007	Steve	Kimuri	Male	1999-03-02	Married	0
EMP008	Ruth	Kimuli	Female	1996-04-07	Single	0
NULL	NULL	NULL	NULL	NULL	NULL	NULL

The Information panel at the bottom left shows the table structure for 'employee':

Table: employee

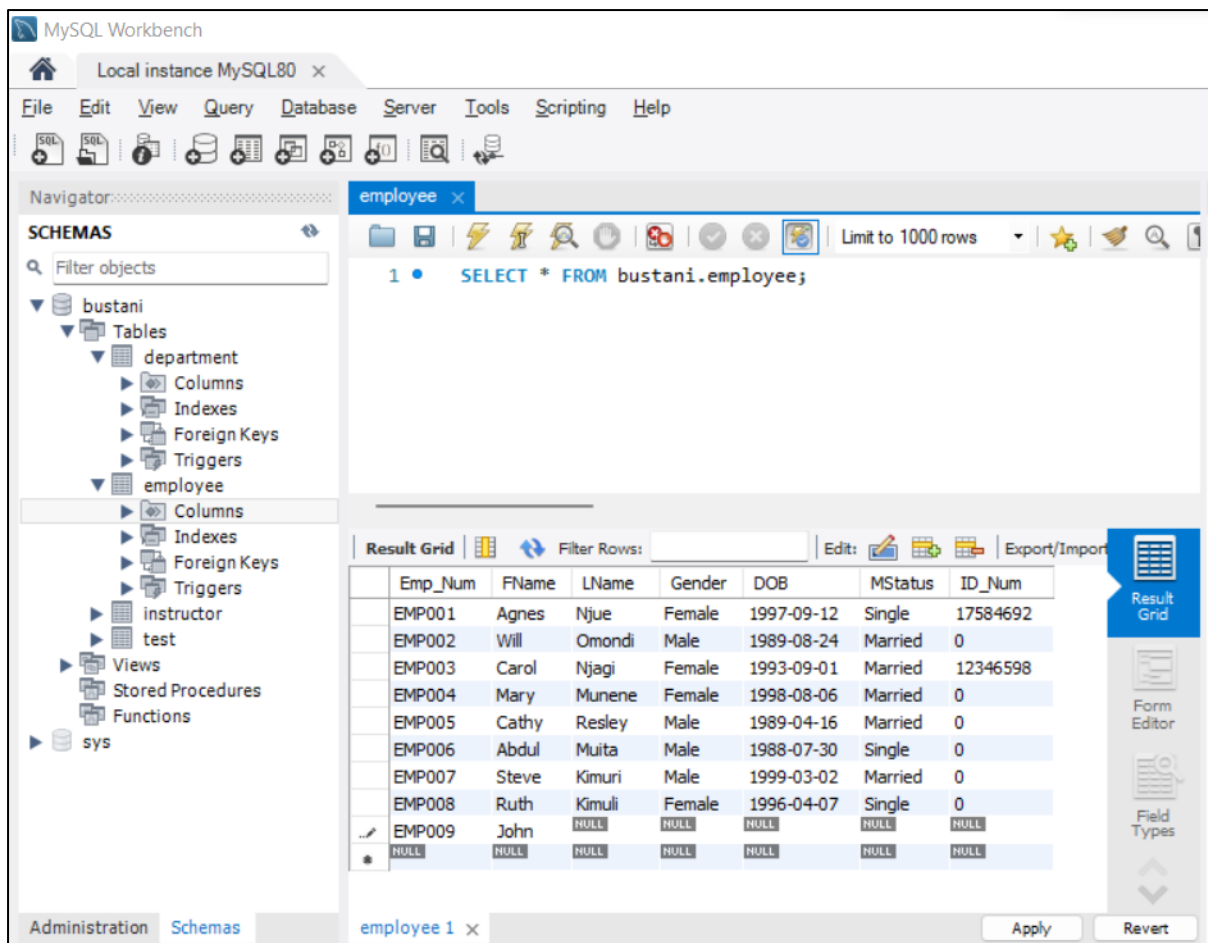
Columns:

- Emp_Num: char(6) PK
- FName: varchar(25)
- LName: varchar(25)
- Gender: varchar(10)
- DOB: date
- MStatus: varchar(15)
- ID_Num: int

The Output panel at the bottom right shows the execution of the query:

#	Time	Action
1	22:38:57	SELECT * FROM bustani.employee LIMIT 0, 1000

The data from the Employee table is shown above. This allows for various activities to be done using the user interface and using simple commands. For instance, to add a new record, you would add the record by clicking on the null row directly under EMP008 and typing in as shown below.



With this example of MySQL Workbench, one understands the need for a graphical interface especially when the database to be designed is a large corporate one that requires a lot of complex relationships.

SUMMARY

Throughout this lecture topic, we have reviewed the role of security and database management. We started by reviewing the database administrator role, especially their technical role. The difference between data administration and database administration was highlighted as well. An introduction to security was conducted with an overview of the security goals. Next, the types of vulnerability were reviewed. The types of threats that databases were reviewed including measures for each threat. Finally, a review of the MySQL Workbench was done, showing the graphical side of the MySQL client.

DISCUSSION TOPIC

We have come a long way since we first started the discussion topic involving the land office database. For the final lecture, we will review the land database we created from the MySQL Command Line Client. Review the database tables and the views as well as the data within each table.

REFERENCES

- [1] Database systems: design, implementation, and management, Coronel, C., & Morris, S, Cengage Learning, 2019.
- [2] Database Systems: A Practical Approach to Design, Implementation, and Management, Connolly, T., & Begg, C., Pearson, 2015.
- [3] Fundamentals of database systems, Elmasri, R., & Navathe, S. B., Pearson Education Limited, 2016.