SQL access control

- The learning objectives for this week are:
  - Knowing what is *discretionary access control*
  - Knowing what is the DBMS access control hierarchy
  - Knowing how to manage users, roles and privileges in the SQL server

Database security

- Database security is accomplished by *verifying the identity of the database users* (authentication) and *controlling what these users are permitted to do* (authorization)
- User authentication is accomplished with either *SQL authentication* (using a username and password registered to the DBMS) or *operating system authentication* (the DBMS trusts the authentication service of the operating system)
- The typical user authorisation mechanism is called *discretionary access control* (DAC)

Discretionary access control (DAC)

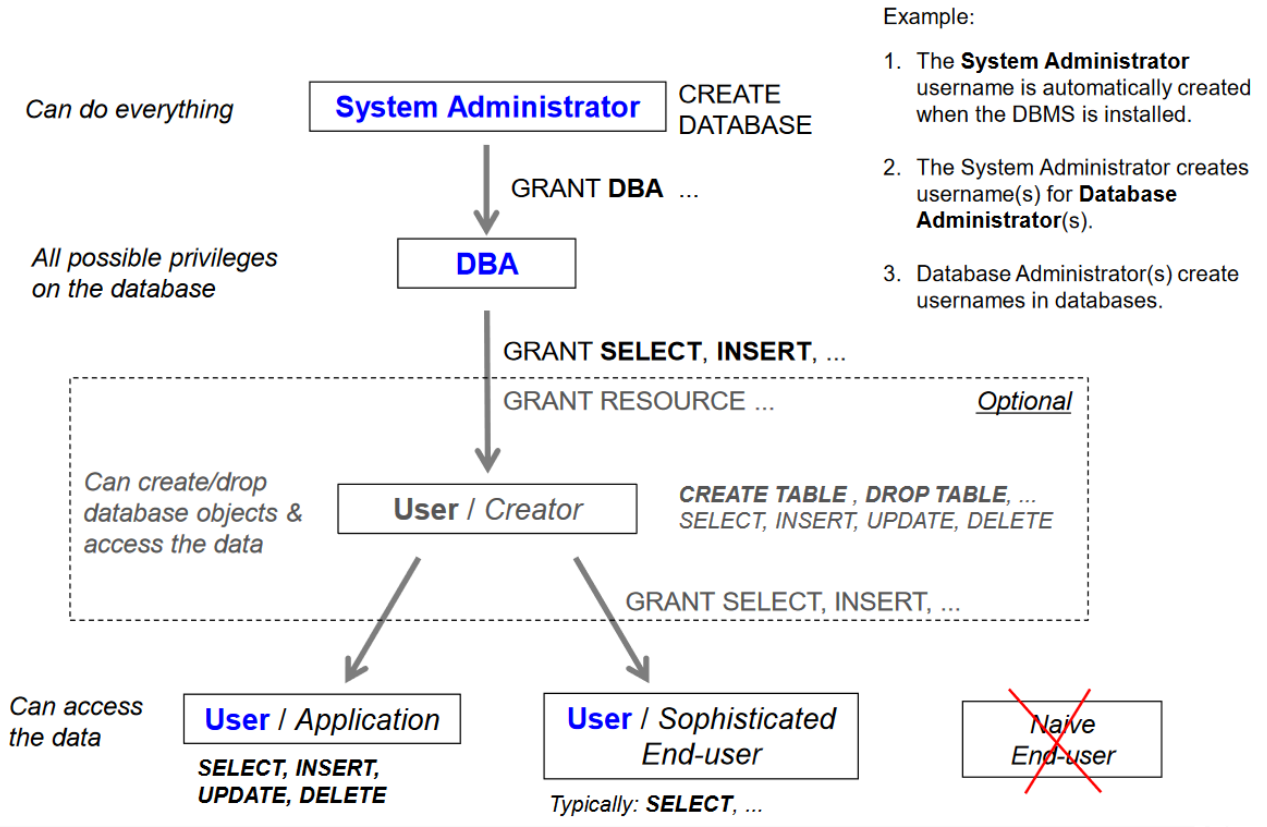
- In *discretionary access control* each user is given appropriate access rights (or privileges) on specific database objects (for example tables)
- Users can obtain certain privileges when they create an object (for example a table) and *they can pass some or all of these privileges to other users* at their discretion
- The ISO SQL Standard leaves many access control details to be *implementation-dependent*
- Different DBMS share many similarities in the access control implementation, but the detailed syntax for specifying access control is *DBMS-specific*
- In the upcoming examples we will learn how to specify access control in the SQL server

DBMS access control hierarchy

- Privileges are granted to an user by another user in a higher *access control hierarchy level*
- At the top of the hierarchy there's is the *system administrator* user who has access to *everything*
- The system administrator's username is automatically created when the DBMS is installed
- The system administrator creates databases and usernames for *database administrators*
- Database administrators have all possible privileges on the database they are granted access to

DBMS access control hierarchy

- Database administrators create usernames in databases and grant them different privileges
- For example certain users can be granted privileges to create database tables and grant privileges to other users for the created tables
- In contrast, certain users can be granted privileges to only retrieve data from the database (`SELECT`)



Users, database roles, and privileges

- *Database users* can be added to *database roles*, inheriting any privileges associated with those roles
- A user *privilege* is a right to execute a particular type of SQL statement (for example `SELECT`, `INSERT`, `UPDATE`), or a right to access another user's database object
- A privilege can be granted to directly a user or database role
- Database roles make it easier to manage privileges to be granted to a group of users of the same type
- The built-in *PUBLIC* role is contained in every database. Permissions granted to this role are inherited by all other users and roles

Granting privileges

- This is the simplified syntax of the `GRANT` statement in SQL Server:

```
GRANT privilegeList ON objectName
TO { authorizationIdList | PUBLIC }
[ WITH GRANT OPTION ]
```

- `privilegeList` consists of one or more of the following privileges separated by commas: `SELECT`, `INSERT`, `UPDATE`, `DELETE`, ...
- `objectName` can be any a base table, view etc.
- `authorizationIdList` consists of one or more of following separated by commas: user, role
- `WITH GRANT OPTION` allows privileges to be passed on to other users

Example of granting privileges

- Here is an example, how we can grant `SELECT`, `INSERT`, and `UPDATE` privileges for the user `kalle` on a `Course` table:

```
-- user "kalle" is granted privilege to connect to the database
GRANT CONNECT TO kalle
-- user "kalle" is granted privilege
-- to perform SELECT, INSERT and UPDATE statements on the Course table
GRANT SELECT, INSERT, UPDATE ON Course TO kalle
```

Example of users, roles and privileges

- Here is an example, how we can create roles and grant privileges to roles:

```
-- Change the database context to the specified database
USE UniversityDatabase
-- 1. Create database roles in the current database
CREATE ROLE student_role
CREATE ROLE teacher_role
-- 2. Grant privileges to database roles
-- Allow the user to connect to the database
GRANT CONNECT TO student_role
GRANT CONNECT TO teacher_role
-- Allow the user to create tables
-- and grant privileges on their own tables to other users/roles
GRANT CREATE TABLE TO student_role WITH GRANT OPTION
-- Grant different privileges on existing tables to different roles
GRANT SELECT, INSERT, UPDATE, DELETE ON Course TO teacher_role
GRANT SELECT ON Course TO student_role
```

Example of users, roles and privileges

- Here is an example, how we can create username and password logins for users and add them to roles:

```
-- 3. Create DBMS-instance-level login names for the DBMS instance
CREATE LOGIN s001 WITH PASSWORD = 'wekPkuO-52'
CREATE LOGIN h1234 WITH PASSWORD = 'fhhFkhw-12'
-- 4. Create database-level user names based on existing logins
-- Create a new user in the current database
CREATE USER s001 FOR LOGIN s001
CREATE USER kalle FOR LOGIN h1234
-- 5. Add members to database roles
ALTER ROLE student_role ADD MEMBER s001
ALTER ROLE teacher_role ADD MEMBER kalle
```

Modifying database roles and privileges

- Here is an example, how we can remove members and privileges from a role:

```
-- Remove member from a database role
ALTER ROLE student_role DROP MEMBER s001
-- Revoke a privilege from a database user or role
REVOKE DELETE ON Course FROM teacher_role
-- Drop a database role
DROP ROLE teacher_role
```

Summary

- In *discretionary access control* each user is given appropriate access rights (or privileges) on specific database objects
- Users can obtain certain privileges when they create an object and they can pass some or all of these privileges to other users at their discretion
- Privileges are granted to an user by another user in a higher *access control hierarchy level*
- The *system administrator* has access to everything and they grant database access to *database administrators*
- *Database users* can be added to *database roles*, inheriting any privileges associated with those roles
- A privilege can be granted with the `GRANT` statement directly to a user or a database role