Security and Integrity

Database Systems Lecture 14

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In This Lecture

- Database Security
  - Aspects of security
  - Access to databases
  - Privileges and views
- Database Integrity
  - View updating, Integrity constraints
- For more information
  - Connolly and Begg chapters 6 and 19

Database Security

- Database security is about controlling access to information
  - Some information should be available freely
  - Other information should only be available to certain people or groups
- Many aspects to consider for security
  - Legal issues
  - Physical security
  - OS/Network security
  - Security policies and protocols
  - Encryption and passwords
  - DBMS security

DBMS Security Support

- DBMS can provide some security
  - Each user has an account, username and password
  - These are used to identify a user and control their access to information
- DBMS verifies password and checks a user's permissions when they try to
  - Retrieve data
  - Modify data
  - Modify the database structure

Permissions and Privilege

- SQL uses privileges to control access to tables and other database objects
  - SELECT privilege
  - INSERT privilege
  - UPDATE privilege
  - DELETE privilege
- The owner (creator) of a database has all privileges on all objects in the database, and can grant these to others
- The owner (creator) of an object has all privileges on that object and can pass them on to others

Privileges in SQL

```
GRANT <privileges>
   ON <object>
   TO <users>
[WITH GRANT OPTION]
```

- **`<privileges>`** is a list of **`SELECT <columns>`**, **`INSERT <columns>`**, **`DELETE`**, and **`UPDATE <columns>`**, or simply **`ALL`**
- **`<users>`** is a list of user names or **`PUBLIC`**
- **`<object>`** is the name of a table or view (later)
- **`WITH GRANT OPTION`** means that the users can pass their privileges on to others

Privileges Examples

```
GRANT ALL ON Employee
  TO Manager
  WITH GRANT OPTION
```

The user ‘Manager’ can do anything to the Employee table, and can allow other users to do the same (by using **GRANT** statements)

```
GRANT SELECT,
  UPDATE(Salary) ON
  Employee TO Finance
```

The user ‘Finance’ can view the entire Employee table, and can change Salary values, but cannot change other values or pass on their privilege

Removing Privileges

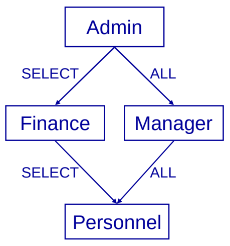
- If you want to remove a privilege you have granted you use

```
REVOKE <privileges>
  ON <object>
  FROM <users>
```

- If a user has the same privilege from other users then they keep it
- All privileges dependent on the revoked one are also revoked

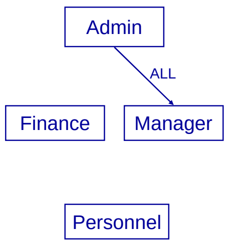
Removing Privileges

- Example
  - ‘Admin’ grants ALL privileges to ‘Manager’, and SELECT to ‘Finance’ with grant option
  - ‘Manager’ grants ALL to Personnel
  - ‘Finance’ grants SELECT to Personnel



Removing Privileges

- Manager’ revokes ALL from ‘Personnel’
  - ‘Personnel’ still has SELECT privileges from ‘Finance’
- ‘Admin’ revokes SELECT from ‘Finance’
  - Personnel loses SELECT also



Views

- Privileges work at the level of tables
  - You can restrict access by column
  - You cannot restrict access by row
- Views, along with privileges, allow for customised access
- Views provide ‘derived’ tables
  - A view is the result of a SELECT statement which is treated like a table
  - You can SELECT from (and sometimes UPDATE etc) views just like tables

Creating Views

```
CREATE VIEW <name>
  AS <select stmt>
```

- **`<name>`** is the name of the new view
- **`<select stmt>`** is a query that returns the rows and columns of the view
- Example
  - We want each user to be able to view the names and phone numbers (only) of those employees in their own department

View Example

- Example
  - We want each user to be able to view the names and phone numbers (only) of those employees in their own department
  - In Oracle, you can refer to the current user as **`USER`**

Employee

ID	Name	Phone	Department	Salary
E158	Mark	x6387	Accounts	£15,000
E159	Mary	x6387	Marketing	£15,000
E160	Jane	x6387	Marketing	£15,000

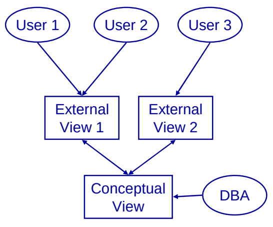
View Example

```
CREATE VIEW OwnDept AS
SELECT Name, Phone FROM Employee
  WHERE Department =
    (SELECT Department FROM Employee
      WHERE name = USER)

GRANT SELECT ON OwnDept TO PUBLIC
```

Using Views and Privileges

- Views and privileges are used together to control access
  - A view is made which contains the information needed
  - Privileges are granted to that view, rather than the underlying tables



View Updating

- Views are like virtual tables
  - Their value depends on the 'base' tables that they are defined from
  - You can select from views just like a table
  - What about update, insert, and delete?
- Updating views
  - Updates to the base tables change the views and vice-versa
  - It is often not clear how to change the base tables to make the desired change to the view

View Updating

- For a view to be updatable, the defining query of the view should satisfy certain conditions:
  - Every element in SELECT is a column name
  - Should not use DISTINCT
  - View should be defined on a single table (no join, union, etc. used in FROM)
  - WHERE should not have nested SELECTs
  - Should not use GROUP BY or HAVING

Using Views and Privileges

To restrict someone's access to a table
- Create a view of that table that shows only the information they need to see
- Grant them privileges on the view
- Revoke any privileges they have on the original table

Employee

ID	Name	Salary	Department

- We want to let the user 'John' read the department and name, and be able to update the department (only)

Using Views and Privileges

Create a view

```
CREATE VIEW forJohn
AS SELECT Name,
          Department
  FROM Employee
```

Set the privileges

```
GRANT SELECT,
UPDATE (Department)
ON forJohn
TO John

REVOKE ALL ON
Employee FROM John
```

Database Integrity

- Security vs Integrity
  - Database security makes sure that the user is authorised to access information
  - Database integrity makes sure that (authorised) users use that information correctly
- Integrity constraints
  - Domain constraints apply to data types
  - Attribute constraints apply to columns
  - Relation constraints apply to rows in a single table
  - Database constraints apply between tables

Domains and Attributes

- Domains constraints are data types
  - SQL: CREATE DOMAIN (not in Oracle)

```
CREATE DOMAIN
  Colour VARCHAR(15)
CONSTRAINT checkCol
  CHECK
  (VALUE IN
   (‘RED’,‘Blue’…))
```

- Attributes are constrained by their domains

```
CREATE TABLE
  Rainbow (
    Rorder Int,
    Rcolour Colour)
```

Assertions

- Provide a way to give relation and database constraints
  - Give a boolean condition that must always be true
  - No action is permitted that would make the condition false
  - Again, not supported in Oracle

```
CREATE ASSERTION
  <name>
CHECK (
  <condition>
)
```

- The condition can refer to one or several tables
- Often use **EXISTS** or **NOT EXISTS**

Relation Constraints

- To create a relation constraint
  - We simply make an assertion that checks the constraint
  - Example: in an Employee table, no employee’s bonus should be more than 15% of their salary

```
CREATE ASSERTION
  checkSalaryBonus
CHECK (
  NOT EXISTS (
    SELECT *
    FROM EMPLOYEE
    WHERE (Bonus >
       0.15*Salary)
  )
)
```

Database Constraints

- Database constraints are similar but refer to several tables
  - Example: Given tables student and enrolment, make sure no CS student takes more than 12 modules

Student

ID	Name	Department

Enrolment

ID	Code

Database Constraints

```
CREATE ASSERTION CSEnrolment CHECK
  (NOT EXISTS (
    SELECT * FROM Student AS S
     WHERE S.Department = ‘CS’ AND
      ((SELECT COUNT(*) FROM
         Enrolment AS E
         WHERE S.ID = E.ID) > 12)))
```

Constraints in Oracle

- Oracle does not support domains or assertions
- It does, however, support row-level constraints using CHECK constraints
- These are declared like other constraints

```
CONSTRAINT <name>
  CHECK
  (<condition>)
```

- This is less general than an assertion since the condition refers to a single row of a single table

CHECK Example

- To add a check on the Employee table to make sure no employee’s bonus is more than 15% of their salary

```
ALTER TABLE Employee
  ADD CONSTRAINT checkSalaryBonus
CHECK (Bonus < 0.15*Salary)
```

Next Lecture

- Transactions
  - ACID properties
  - The transaction manager
- Recovery
  - System and Media Failures
- Concurrency
  - Concurrency problems
- For more information
  - Connolly and Begg chapter 20
  - Ullman and Widom chapter 8.6