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

Security and Integrity

Database System Lecture 14
Natasha Alechina

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

- 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
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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.

<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>Phone</th>
<th>Department</th>
<th>Salary</th>
</tr>
</thead>
<tbody>
<tr>
<td>E158</td>
<td>Mark</td>
<td>x6387</td>
<td>Accounts</td>
<td>£15,000</td>
</tr>
<tr>
<td>E159</td>
<td>Mary</td>
<td>x6387</td>
<td>Marketing</td>
<td>£15,000</td>
</tr>
<tr>
<td></td>
<td>Jane</td>
<td>x6387</td>
<td>Marketing</td>
<td>£15,000</td>
</tr>
</tbody>
</table>

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

GRANT SELECT ON OwnDept TO PUBLIC

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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

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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

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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

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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

Security and Integrity
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
- Integrity constraints
- Database security makes sure that the user is authorised to access information
- Database integrity makes sure that (authorised) users use that information correctly
- 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>
)
```

 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

```
<table>
<thead>
<tr>
<th>Student ID</th>
<th>Name</th>
<th>Department</th>
<th>Enrolment ID</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```
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