Chapter 10 Advanced topics in relational databases

- Security and user authorization in SQL
- Recursion in SQL
- Object-relational model
1. User-defined types in SQL
2. Operations on object-relational data
- Online analytic processing & data cubes

Security and user authorization in SQL

Authorization

Aim:

- Make sure users only see the data they're suppose to
- Guard the database against updates by malicious users

How SQL control it?

  - Authorization ID
  - Privileges

Authorization ID

- Authorization ID, typically their name.
- Authorization ID may be granted some particular privileges on objects.
- PUBLIC: a special built-in authorization ID
  - Granting a privilege to PUBLIC makes it available to any authorization ID.

Privileges in SQL

- File systems identify certain access privileges on files, e.g., read,write,execute.
- SQL identifies nine types of privileges:

1. SELECT = the right to query the relation

Privileges in SQL (cont.)

2. INSERT = the right to insert tuples into the relation, may refer to one attribute, in which case the privilege is to specify only one column of the inserted tuple.
3. DELETE = the right to delete tuples from the relation.
4. UPDATE = the right to update tuples of the relation, may refer to one attribute.
5. References = the right to refer to that relation in an integrity constrain.

Privileges in SQL (cont.)

- Usage =the right to use that element in one’s own declarations.
- Trigger = the right to define triggers on that relations
- Execute = the right to execute a piece of code, such as a PSM procedure or function.
- Under=the right to create subtypes of a given type.

Example: What privileges are needed for this statement?

```
INSERT INTO Beers(name)
 SELECT beer FROM Sells
 WHERE NOT EXISTS
      (SELECT * FROM Beers
       WHERE name = beer);
```

beers that do not appear in Beers. We add them to Beers with a NULL manufacturer.

- We require privileges SELECT on Sells and Beers, and INSERT on Beers or Beers.name.

Obtaining Privileges

- How to grant privilege?
- Owner vs. granted user
    - Owner has all privileges and may GRANT them to others

Ownership

- Schema owner: who create the schema and owns all tables, and other schema elements.
- Session owner: who issued a Connect statement.
- Module owner: who create a module.

Authorization-Checking

- Each module, schema, and session has an associated authorization ID.
- A user’s privileges derive from the *current auth. ID* that is either
  - module auth. ID if there is one, or
  - session auth. ID if not.

We may execute the SQL operation only if the current auth. ID possesses all the privileges.

Privilege-Checking

The current authorization ID is:

- the owner of the data, or
- has been granted by the owner or been granted to user PUBLIC.

→ Executing a module.

Granting Privileges

- You have all possible privileges to the relations you create. (owner)
- You may grant privileges to any user if you have those privileges" **with grant option**." You have this option to your own relations. (granted user)

Example

1) Sally can query Sells and can change prices, but cannot pass on this power:

GRANT SELECT ON Sells, UPDATE (price) ON Sells TO *sally*;

2) Sally can also pass these privileges to whom she chooses;

GRANT SELECT ON Sells, UPDATE (price) ON Sells TO sally WITH GRANT OPTION;

Grant diagrams

- An SQL system maintains a representation of this diagram to keep track of both privileges and their origins.
- The nodes of a grant diagram correspond to a user and a privilege.
- A privilege with and without the grant option must be represented by two different nodes.

Grant Diagrams

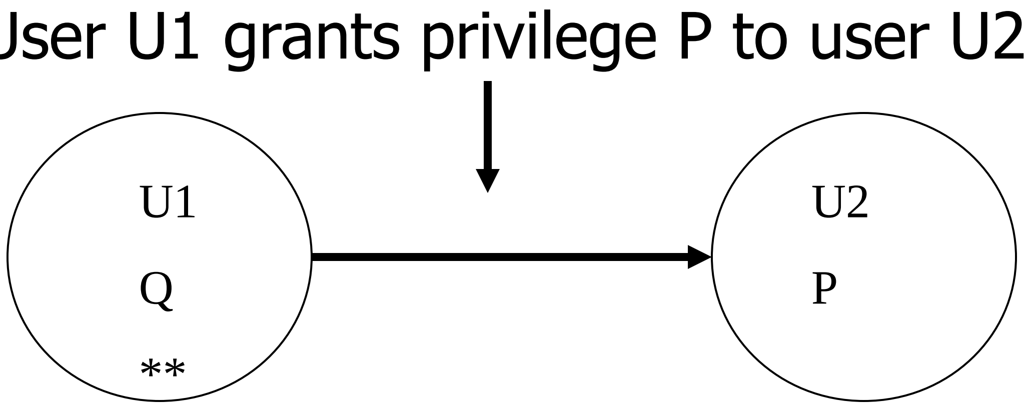
- Node: user/privilege
- Arc: grants
- * = WITH GRANT OPTION

  ** = derived from ownership

For example:

Q: is UPDATE ON R

P: UPDATE(a) on R



Q is more general than P

Revoking Privileges

- Syntax

  REVOKE *privileges* ON *relation* FROM *users*

  [CASCADE | RESTRICT]

  - CASCADE: transitively revoking.
  - RESTRICT: Revoke not allowed if it would cause any node unreachable from an owner.

Revoking Privileges (cont.)

a) If you have been given a privilege by several different people, then all of them have to revoke in order for you to lose the privilege.

b) Revocation is transitive （传递的）. If A granted P to B, who granted P to C, and then A revokes P from B, it is as if B also revoked P from C.

Revoking Privileges (cont.)

c) Revoke with RESTRICT： the revoke statement cannot be executed if the cascading rule would result in the revoking of any privileges due to the revoked privileges having been passed on to others.

Revoking GRANT OPTION

- Syntax

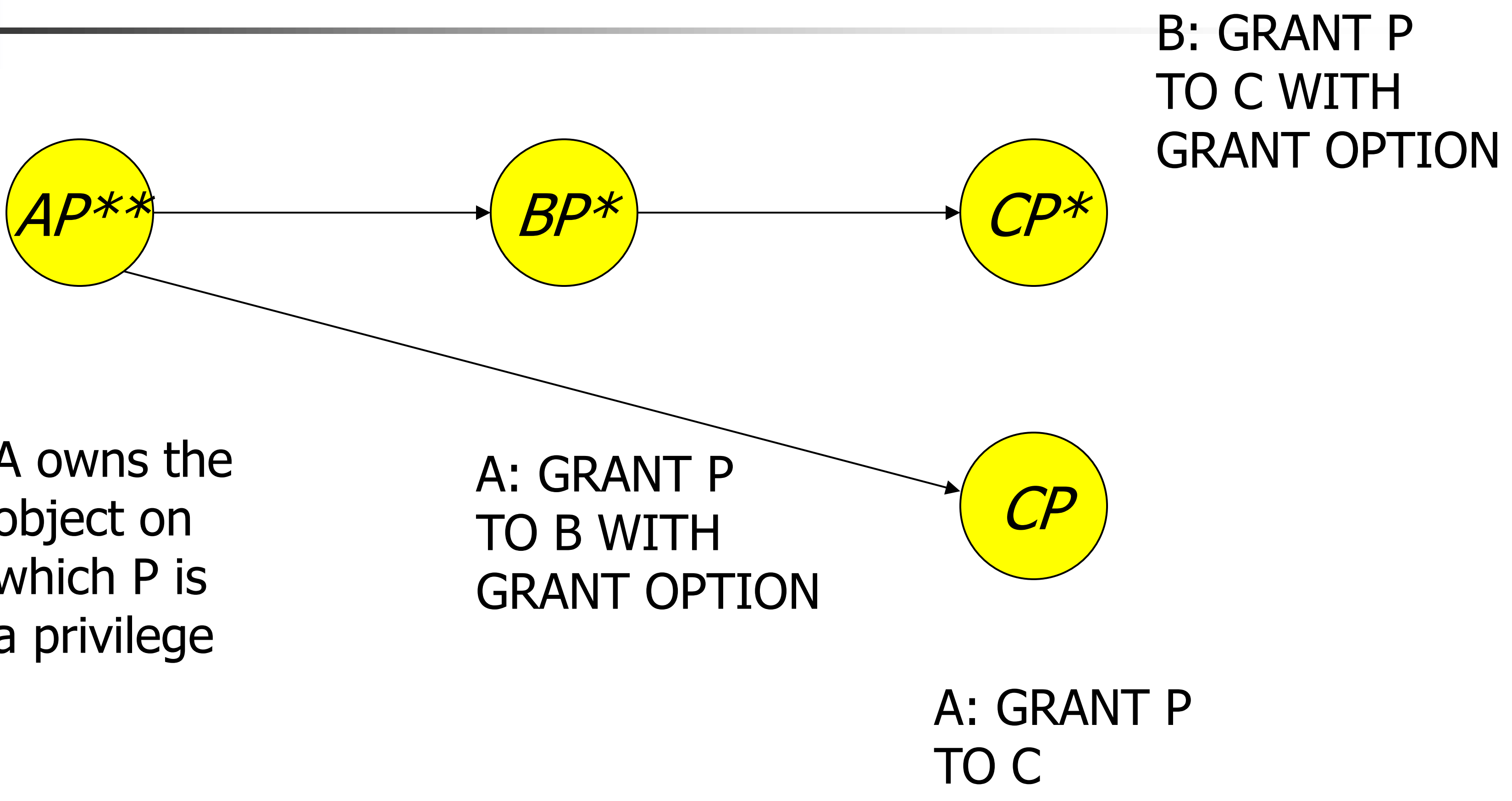
  REVOKE GRANT OPTION FOR *privilege*

  ON *relation* FROM *users*

  [CASCADE | RESTRICT]

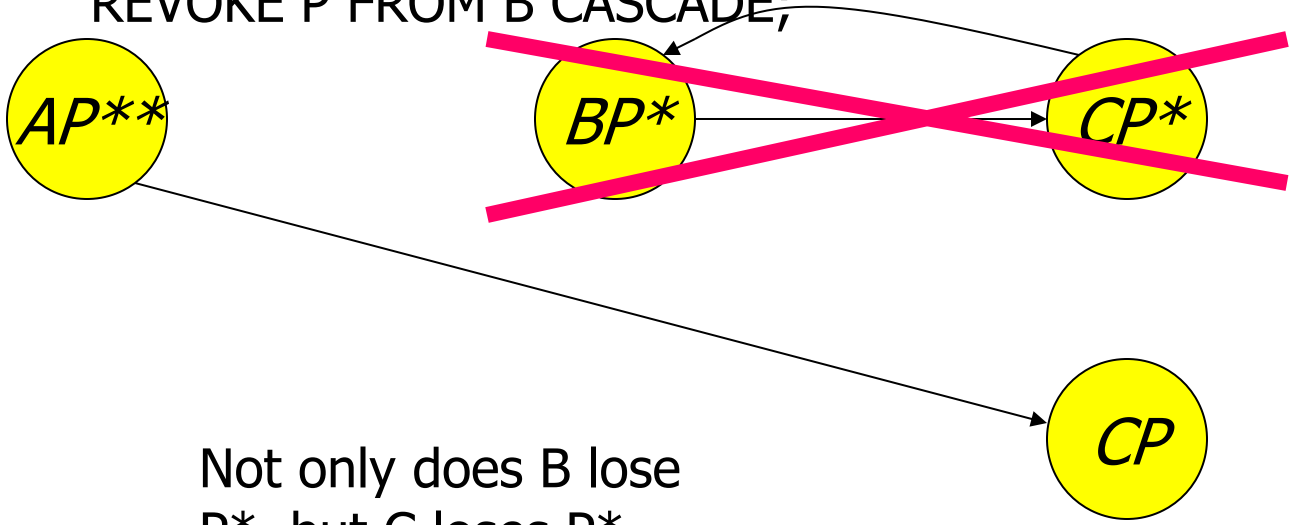
  - Only revoking the grant option, not the privilege itself.

Example: Grant Diagram


B: GRANT P TO C WITH GRANT OPTION
AP**
BP*
CP*
A owns the object on which P is a privilege
A: GRANT P TO B WITH GRANT OPTION
CP
A: GRANT P TO C

Example: Grant Diagram

A executes
REVOKE P FROM B CASCADE;



Even had C passed P to B, both nodes are still cut off.

Not only does B lose P*, but C loses P*. Delete BP* and CP*.

However, C still has P without grant option because of the direct grant.

If A executes

REVOKE P FROM B RESTRICT ??

Summary

- Privileges: select, update, grant privilege, and so on.
- How to grant or revoke privileges?
- Grant diagrams.