Part IX

Views and Access Control

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1. View Concept

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2. Views in SQL

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3. Updates via Views

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7. Summary

Learning goals for today . . .

- Understanding of the view concept of databases

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- Understanding of the view concept of databases
- Knowledge to formalize and to use views in SQL
- Knowledge of possible problems with updates via views
- Knowledge of data protection aspects in context with aggregated / statistical data

View Concept

Views

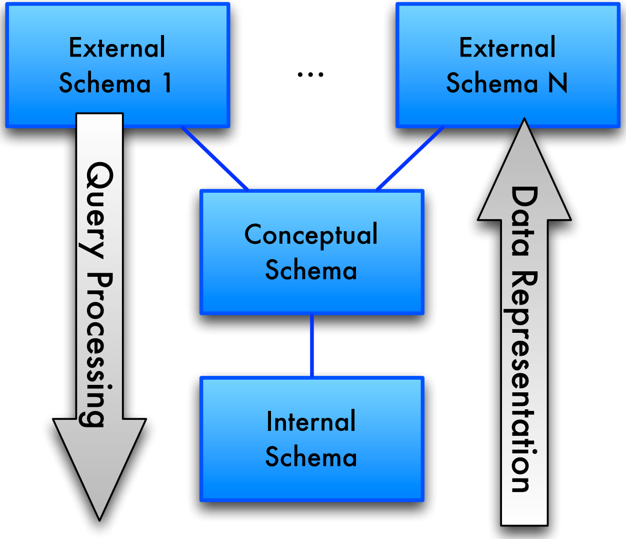
Views: virtual relations (resp. virtual database objects in other data models)

- Views are external DB-schemata that follow the 3-level-schema architecture
- View definition
  - Relation schema (implicit or explicit)
  - Calculation rule for virtual relations, such as SQL-query

Views /2

- Advantages
  - Simplification of queries for the user of the database, e.g. by realization of often required sub-queries
  - Possibility of structuring of the database description, specific to user classes
  - Logical data independence enables robustness of the interface for applications against changes to the database structure (accordingly vice verse)
  - Description of access rights on the database in context with the access control
- Problems
  - Automatic query transformation
  - Execution of updates on views

Three-Level Schema Architecture



Views in SQL

Definition of Views in SQL

```
create view ViewName [ SchemaDeclaration ]
as SQLQuery
[ with check option ]
```

- Schema declaration is optional (could be derived from SQL query)

Views - Example

- all red wines from Bordeaux:

```
create view RedWines as
   select Name, Vintage, WINES.Vineyard
   from WINES natural join PRODUCER
   where Color = ’Red’
         and Region = ’Bordeaux’
```

Problem Areas of Views

- Execution of updates via views
- Automatic query transformation

Updates via Views

Criteria for Updates via Views

- **Effect Conformity**
  User sees effect as if the update was done directly on the view relation.
- **Minimality**
  Basis database should only be changed minimal to preserve the mentioned effect
- **Consistency Preservation**
  Updates of a view must not lead to integrity violations of the basis database
- **Respecting the Database Protection**
  If a view is implemented for data protection purposes, then the consciously faded out part of the basis database must not be effected by changes of the view

Projection View

$$\texttt{WNW} := \pi_{\texttt{WineID},\texttt{Name},\texttt{Vineyard}}(\texttt{WINES})$$

- In SQL with **create view**-statement:

```
create view WNW as
   select WineID, Name, Vineyard from WINES
```

- Update statement for the view WNW:

```
insert into WNW values (3333, 'Dornfelder', 'Mueller')
```

- Corresponding statement on the basis relation WINES:

```
insert into WINES
   values (3333, 'Dornfelder', null, null, 'Mueller')
```

→ Problem of Consistence preservation if Color or Vintage declared as **not null**!

Selection Views

$$\texttt{WJ} := \sigma_{\texttt{Vintage}>2000}(\pi_{\texttt{WineID,Vintage}}(\texttt{WINES}))$$

```
create view WJ as
select WineID, Vintage
from WINES
where Vintage > 2000
```

- Tuple migration: Tuple $\texttt{WINES}(3456, \text{'Zinfandel'}, \text{'Red'}, 2004, \text{'Helena'})$, gets "moved out" of the view:

```
update WINES
set Vintage = 1998
where WineID = 3456
```

Control of Tuple Migration

```
create view WJ as
select WineID, Vintage
from WINES
where Vintage > 2000
with check option
```

Join Views

$$\mathtt{WE} := \mathtt{WINES} \bowtie \mathtt{PRODUCER}$$

- In SQL:

```
create view WE as
select WineID, Name, Color, Vintage, WINES.Vinyard,
   Area, Region
from WINES, PRODUCER
where WINES.Vineyard = PRODUCER.Vineyard
```

- Update operations usually not clearly translatable:

```
insert into WE
values (3333, ’Dornfelder’, ’Red’, 2002, ’Helena’,
   ’Barossa Valley’, ’South Australia’)
```

Join Views /2

- Update is transformed to

```
insert into WINES
values (3333, 'Dornfelder', 'Red', 2002, 'Helena')
```

- Plus
  1. Insert statement on PRODUCER:

```
insert into PRODUCER
values ('Helena', 'Barossa Valley', 'South Australia')
```

  2. Or alternative:

```
update PRODUCER
set Area = 'Barossa Valley', Region = 'South Australia'
where Vineyard = 'Helena'
```

better regarding minimality requirement, but contradicts effect conformity!

Aggregation Views

```
create view FM (Color, MinVintage) as
select Color, min(Vintage)
from WINES
group by Color
```

- Following update is not clearly realizable:

```
update FM
set MinVintage = 1993
where Color = ’Red’
```

Classification of Problem Areas

1. Violation of the schema definition (e.g. introduction of null values at projection view)
2. Data protection: Avoid side effects on invisible part of the database (tuple migration, selection views)
3. Not always clear transformation: choice problem
4. Aggregation views (among others): no useful transformation possible at all
5. elemental view updates should exactly comply with an atomic change on basis relation: 1:1-Relation between view tuples and tuples of the basis relation (no projection of keys)

Handling of View Updates in SQL

- SQL-92-Standard
  - Integrity-violating view changes are prohibited
  - Data-protection-violating view updates: user control (**`with check option`**)
  - View with unclear transformation: view not update-able (SQL-92 more restrictive than necessary)

Restrictions for View Updates

- Only selection and projection views update-able (join and set operations prohibited)
- 1:1-Relation of view tuples to basis tuples: no **`distinct`** in projection view
- Arithmetic and aggregation functions in the **`select`**-part are prohibited
- Exactly one reference on one relation name in the **`from`**-part permitted (also no self join)
- No sub-queries with "self reference" in the **`where`**-part permitted (use relation name in the top SFW-block not in the **`from`**-parts of sub-queries)
- **`group by`** and **`having`** prohibited

Evaluation of Queries on Views

- Simple syntactical transformation:
  - **`select`**: View attributes, probably renamed resp. replaced by calculation term
  - **`from`**: Names of the original relations
  - Conjunctive linking of the **`where`**-clauses of the view definition and queries (probably renaming)

Problems with Aggregation Views

```
create view FM (Color, MinVintage) as
select Color, min(Vintage)
from WINES
group by Color
```

- Query: *Wine colors with old vintages*

```
select Color
from FM
where MinVintage < 1995
```

Problems with Aggregation Views /2

- After simple syntactic transformation:

```
select Color
from WINES
where min(Vintage) < 1995
group by Color
```

- No syntactic correct SQL-query – correct would be:

```
select Color
from WINES
group by Color
having min(Vintage) < 1995
```

Problems with Aggregation Views /3

- Query

```
select max (MinVintage)
from FM
```

- Should be transformed as follows:

```
select max(min (Vintage))
from WINES
group by Color
```

- But: Nested aggregation functions are prohibited in SQL!

Assignment of Access Rights

Assignment of Access Rights in Databases

- *Access rights*

```
            (AuthorizationID, DB-Excerpt, Operation)
```

- AuthorizationID is internal identification of a "database user"
- Database excerpts: relations and views
- DB-Operations: read, insert, update, remove

Assignment of Rights in SQL

```
grant <Rights>
on <Table>
to <UserList>
[with grant option]
```

Assignment of Rights in SQL /2

- Explanations:
  - In `<Rights>`-List: **`all`** resp. long form **`all privileges`** or list of **`select`**, **`insert`**, **`update`**, **`delete`**
  - After **`on`**: relation and view name
  - After **`to`**: Authorization identifications (also **`public`**, **`group`**)
  - Special right: right on passing of rights (**`with grant option`**)

Authorization for **public**

```
create view MyJobs as
select *
from JOB
where KName = user;

grant select, insert
on MyJobs
to public;
```

"Every user can see her jobs and can insert new jobs (but not remove!)."

Taking Back of Rights

```
revoke <Rights>
on <Table>
from <UserList>
[restrict | cascade ]
```

- **restrict**: If rights already passed to thirds: abort of **revoke**
- **cascade**: Propagate revocation of the rights with **revoke** to all users that received them from this user with **grant**

Privacy-Aspects

Privacy: Term and Areas of Application

Privacy: The right of each individual on a save and private room, that can only be violated by others in exceptional cases.

- Electronic highway toll system: Monitoring of vehicles
- Credit card activities and diverse payback resp. discount cards: buying behavior of customers
- Mobile communication systems: movement profiles of users
- RFID-technology: e.g. in retail trade the customer behavior, flow of goods, etc.

Statistic Databases

- Databases in which single entries are subject to data protection, but statistic information about all users is accessible
- Statistic information = aggregated data (average income etc.)
- Problem: Extraction of single information with indirect queries

Statistic Databases: Example

- Example: User X can query data about the account holder as well as statistic data, but no single account balances

1. Simplification of search criterion (only one customer gets selected)

```
select count (∗) from ACCOUNT
where Place = ’Manebach’ and Age = 24 and ...
```

2. Name of the account holder

```
select Name from ACCOUNT
where Place = ’Manebach’ and Age = 24 and ...
```

3. Statistic query, that actually gives a single entry

```
select sum(Balance) from ACCOUNT
where Place = ’Manebach’ and Age = 24 and ...
```

- Remedy: no query that select less than n tuples

Statistic Database: Example /2

- X wants to find out balance of Y
- X knows, that Y does not live in Ilmenau
- X has queried, that more than n account holders live in Ilmenau
  1. Sum of the balances of customers from Ilmenau

     ```
     select sum(Balance) from Account
     where Place = ’Ilmenau’
     ```

  2. Sum of the balances of customers from Ilmenau + Customer Y

     ```
     select sum(Balance) from Account
     where Name = :Y or Place = ’Ilmenau’
     ```

  3. Difference of the results gives balance of Y
- Remedy: prohibition of statistic queries that affect pairwise an average of more than m given tuples

Statistic Databases: Conclusion

- Critical parameters
  - Result size n
  - Size of the overlapping of the result sets m

If only results of aggregate functions are permitted, than a person needs $1 + (n-2)/m$ queries to determine a single attribute value.

k-Anonymity

k-Anonymity

- For many purposes (clinical studies etc.) detail data (micro data) is required

Name	Age	ZIP	Gender	MaritalState	Disease
*****	38	98693	male	married	cold
*****	29	39114	female	single	fever
*****	29	39114	female	single	anemia
*****	34	98693	male	married	cough
*****	34	98693	male	married	broken bone
*****	27	18055	male	single	fever
*****	27	18055	female	single	cold

k-Anonymity: Problem

- Is for a person of this relation known that he is:
  - male
  - 38 years old
  - married
  - living in 98693 Ilmenau
- $\rightsquigarrow$ cold
- Further relation (Name etc.), e.g. by join with other data
- Solution: Data Swapping (??)

k-Anonymity

k-Anonymity: a certain fact cannot be differentiated among a given amount of k tuples

- A query for an arbitrary combination of age, gender, marital state and ZIP code gives either an empty relation or at least k tuples

k-Anonymity: Approaches

- **Generalization**: Replace attribute values by more general values that are gathered from a generalization hierarchy
  - Generalization of the age of the person to age classes: {35, 39} $\rightsquigarrow$ 30-40
  - Leave off digits of the ZIP code: { 39106, 39114 } $\rightsquigarrow$ 39***
- **Suppression of tuples**: Removing of tuples that violate the k-anonymity and thus are identifiable

Summary

Control Questions

- What is a database view? How are views defined?

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- What is a database view? How are views defined?
- Are views update-able? Under which conditions?
- How can data protection be achieved in databases?

Summary

- Views to structure databases
- Problems with updates via views
- Access right system in SQL-DBS
- Privacy aspects