Databases

Advanced SQL

Other Constraints: check

- "check" specifies constraints over tuples (and possibly, even more complex ones that aren't always supported in all SQL implementations)

```
CHECK ( Predicate )
```

Check, Example (1)

```
create table Employee
(
Number integer primary key,
Surname character(20),
Name character(20),
Sex character not null CHECK (Gender in ('M','F')) ,
Salary integer CHECK (Salary >= 0) ,
Supervisor integer,
CHECK (Salary <= (select Salary
                  from Employee J
                  where Supervisor = J.Number) )
)
```

A **select** clause within the **CHECK** constraint is not fully supported in every SQL implementation.

Check, Example (2)

```
create table Employee
(
Number character(6),
Surname character(20),
Name character(20),
Sex character not null CHECK (Sex in ('M','F'))
Salary integer,
Withholding integer,
Net integer,
Supervisor character(6),
check (Net = Salary - Withholding )
)
```

ok

Check, Example (3)

```
insert into Employee values
(1 , 'Doe', 'John', '', 100, 20,
  80);
```

Sex is neither ‘M’ nor ‘F’

```
insert into Employee values
(2 , 'Smith', 'Jimmy', 'M', 100,
  10, 80);
```

Net (80) is not 100-10

```
insert into Employee values
(3 , 'Rossini', 'Luca', 'M', 70,
  20, 50);
```

This update is allowed

Other constraints: Assertion

- Defines constraints at the schema level

```
create ASSERTION NameAs check ( Predicate )

create ASSERTION AtLeastOneEmployee
      check (1 <= ( select count(*)
                    from Employee ))
```

A **select** clause within the **check** constraint is not fully supported in every SQL implementation.

View

```
create view ViewName [ ( AttList ) ] as
  SelectStatement
[ with [ local | cascaded ] check option ]
```

```
create view AdminEmployees
      (Name, Surname, Salary) as
select Name, Surname, Salary
from Employee
where Dept = 'Administration' and
      Salary > 10
```

Querying a view

- Views could be queried like any other relation within the database. e.g.:

```
select * from AdminEmployees
```

is like performing the following query (and it is run as):

```
select Name, Surname, Salary
from Employee
where Dept = 'Administration' and
      Salary > 10
```

View Update

- Usually, such updates are allowed for views defined on a single relation
- We can force the DB to perform some checks

View Update: check option

```
create view PoorAdminEmployees as
   select *
   from AdminEmployees
   where Salary < 50
with check option
```

- **check option** allows to update the view, but only if the inserted tuple belongs to the view (the user cannot have a salary greater than 50)

Not allowed operation, Example

```
create view PoorAdminEmployees as
   select *
   from AdminEmployees
   where Salary < 50
with check option

update PoorAdminEmployees
   set Salary = 60
   where Name = 'Ann'
```

Altering a View: local and cascaded

- `local` (in the case of views over views): the tuple update has to be performed only at the last level of the view
- `cascaded` (in the case of views over views): the tuple update has to be performed over all the underlying views and relations

A wrong SQL query (1)

- Provide the average number of offices per department.

- Wrong query:

```
select avg(count(distinct Office))
from Employee
group by Dept
```

- The query is wrong because the SQL syntax does not allow to nest aggregating operators

A correct SQL query (1)

- Provide the average number of offices per department.

- Using an intermediate view:

```
create view DeptOffices(NameDept,OffNo) as
select Dept, count(distinct Office)
from Employee
group by Dept;

select avg(OffNo)
from DeptOffices
```

A wrong SQL query (2)

- Provide the Dept. having the greatest employee's salary sum
- A solution wrong for some systems

```
select Dept
from Employee
group by Dept
having sum(Salary) >= all (select sum(Salary)
                           from Employee
                           group by Dept)
```

- A nested **having** is not allowed in some SQL implementations

A correct SQL query (2)

```
create view BudgetSalary(Dep,TotalSalary) as
select Dept, sum(Salary)
from Employee
group by Dept

select Dep
from BudgetSalary
where TotalSalary =(select max(TotalSalary)
                    from BudgetSalary)
```

Recursive Queries (1)

- For each person provide his/her ancestors, having:
  Fatherhood (Father, Child)

Fatherhood

Father	Child
Carl	Frank
Louis	Olga
Louis	Bob
Frank	Alex
Frank	Alfred

Recursive Queries (2)

- We have to use recursion; in Datalog:

Ancestors (Ancestor: p, Descendant: f) ←
Fatherhood (Father: p, Child: f)

Ancestors (Ancestor: a, Descendant: d) ←
Fatherhood (Father: a, Child: f) ,
Ancestors (Ancestor: f, Descendant: d)

Recursive Queries in SQL:1999

```
with recursive Ancestors(Ancestor,Descendant) AS
(   select Father, Son
    from Fatherhood
  union all
    select Ancestor, Son
    from Ancestors, Fatherhood
    where Descendant = Father
)
select *
from Ancestors
```

- `with` defines the `Ancestors` view, which is built up recursively using `Fatherhood`.

Example

Return all John Doe's supervisors

```
with recursive InCharge (No, Supervisor) AS
(   select No, Supervisor
    from Employee
union
    select Employee.No, InCharge.Supervisor
    from Employee, InCharge
    where Employee.Supervisor = InCharge.No
)
select Name, Surname, InCharge.Supervisor
from Employee join InCharge
    on (Employee.No = InCharge.No)
where Name = 'John' and Surname = 'Doe'
```

Scalar Functions (1)

- Functions at tuple level providing one single value per tuple

- Temporal
  - `current_date` Returns the present date
  - `extract(yearExpression)`, extracts part of a date from a given expression (e.g. month, day, hour, etc.)

- Return the order year from the orders that were issued today

```
SELECT EXTRACT(YEAR from OrderDate) AS
  OrderYear,
FROM Orders
WHERE DATE(OrderDate)=current_date()
```

Scalar Functions (2)

- String editing
  - `char_length`, returns the string's length
  - `lower` , converts the string to lower case

- Casting
  - `Cast` allows the casting of a value into another domain;

- Conditional
  - ...

Conditional Expression: coalesce (1)

`coalesce` takes several expressions as an input and returns the first of them which is not `NULL`.

- Given the following relation
  Employee (Number, Dept, Mobile, PhoneHome)

  For each employee return either a valid Mobile phone number, or its phone number.

```
Select number, coalesce(Mobile, PhoneHome)
from Employee
```

Conditional Expression: coalesce (2)

coalesce could be used to provide a default value for replacing null values. In the following example, a NULL department is replaced with “None”

```
select Name, Surname, coalesce(Dept, ‘None’)
from Employee
```

Conditional Expression: nullif

`nullif` compares the first argument (e.g. an Attribute of a given relation) with the second one (e.g. a constant value). It returns NULL if the two arguments match, otherwise it returns the value from the first argument.

Example: Extract the surnames and departments to which the employees belong, returning a NULL value for the department when the Dept attribute has the value ‘Unknown’

```
select Surname, nullif(Dept, 'Unknow')
from Employee
```

Conditional Expression: case (1)

The case function allows to specify conditional structures, whose results depends on the evaluation of the tables' content.

It is used to provide an "if-then-else" kind of logic to the SQL language.

Conditional Expression: case (2)

Evaluate the vehicle taxes by its type and registration year (since 1975).

```
select PlateNo,
   (case Type
      when 'Car' then 2.58 * KWatt
      when 'Moto' then (22.00 + 1.00 * KWatt)
      else null
   end) as Tax
from Vehicle
where RegistrationYear > 1975
```

Database Security

- SQL allows to grant for each user specific privileges (reading, writing, …) for either the whole DB or part of it.
- Privileges could be granted to either relations, attributes, views or domains.
- There is at least one default admin (e.g. _system) for which all the privileges are granted.
- Any user creating a specific “resource” automatically grants every privilege on it

Privileges

A privilege is described by:

- a specific *resource*
- the user *granting* the privilege
- the user *to which* the privilege is granted
- a specific *operation*
- whether the user can *propagate* the privilege or not

SQL's privileges

- `insert`: allows to insert new tuples
- `update`: allows to edit pre-existing tuples
- `delete`: allows to delete tuples
- `select`: allows to read a resource
- `references`: allows to define referential integrity constraints
- `usage`: allows to use a definition (e.g. a custom data type)

Granting privileges

- granting privileges:

```
grant < Privileges | all privileges > on
  Resource
  to Users  [ with grant option ]
```

- `grant option` allows the user to propagate his/her privilege to other users

```
grant select on Department to Jack
```

Revoking privileges

- Revoking privileges

```
revoke Privileges on Resource from Users
  [ restrict | cascade ]
```

The privileges have to be revoked by the same user that granted them in the first place.

  - `restrict` (default) the revoke does not involve other users that received the grant from the current user
  - `cascade` the revoke is extended to the other users

Be careful: `cascade` causes a “chain reaction”

Privileges, discussion (1)

- The SQL implementation has to hide (without giving a clue) the part of the database that are not accessible to the user. E.g., either:
  - Table `Employees` doesn't exist, or
  - Table `Employees` does exist, but the user cannot access it,

  the user has to receive the same message from the system

Privileges, discussion (2)

- We could use a view for showing only specific tuples to a user:
  - The view is defined with a selection predicate
  - The privilege is granted for the specific view

Authorizations: RBAC (1)

SQL-3 has introduced RBAC for the first time (Role-Based Access Control, **RBAC**).

- Each role acts as a container of several privileges that can be granted via the `grant` command.

- At any moment, each user has both “individual” granted privileges, associated directly to him, and the privileges granted to its role through RBAC.

Authorizations: RBAC(2)

- The following command creates a new role

```
create role Name
```

- This other one grants *Name* to the current user

```
set role Name
```

RBAC, Example

- Grant `create table` to a specific user through the role `Employee`:

Create the new role:

```
create role Employee;
```

Grant the privilege to the previously defined role:

```
grant create table to Employee;
```

Grant the privilege to a specific user:

```
grant Employee to user1;
```

Revoke the previously granted privilege:

```
revoke create table from Employee;
```

Transactions

- A transaction is an executing program that forms a logical unit of database processing (atomic operation)
- Properties:
  - **A**tomicity
  - **C**onsistency preservation
  - **I**solation
  - **D**urability (permanency)

Transactions are … Atomic

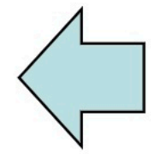
- A transaction is an atomic unit of processing: it should either be performed or not performed at all.
  - Money transfer from a bank account A to B: either the money is withdrawn from A and transferred to B, or no operation at all is performed.

Transactions are … consistent

- A transaction should be consistency preserving: if it is completely executed from beginning to end with no interference, the database moves between two consistent states.
- During the execution of a transaction some violations may occur, but they cannot stay when the transaction ends: if in the end of a transaction there are still violations, the transaction must be cancelled (abort) completely.

Transactions are … isolated

- Even if many transactions are executed concurrently, the execution of the current transaction should not be interfered with others that are currently running.
  - E.g.: the case of two money transfers over the same bank account happening at the “same” time.



Transactions have durable effects

- The changes applied to the database by a correct (committed) transaction must persist and must not be lost, even when serious faults (hardware or software) occur and in parallel execution.

Transaction Support in SQL

- Once the connection to the database is established, the first transaction starts with `start transaction`, either before the first operation, or after the last one (the command is optional in most RDBMSs)
- After the first transaction it could terminate
  - `commit [work]`: the operations are saved within the database
  - `rollback [work]`: the operations are discarded and the DB returns to a previous safe state.
- Most RDBMSs have `autocommit`, where each statement is a different transaction.

Transaction Support in SQL, Example

- Withdraw 10€ from the account 42177 and transfer it to the account 12202.

```
start transaction                    (optional)
update BankAccount
       set Balance = Balance - 10
       where AccountNumber = 42177;
 update BankAccount
       set Balance = Balance + 10
       where AccountNumber = 12202;
 commit work;
```