Comp 5311 Database Management Systems

5. SQL 3
SQL as Data Definition Language

SQL as Data Definition Language

- Creates the Students relation. The type (domain) of each field is specified, and enforced by the DBMS whenever tuples are added or modified.

```
CREATE TABLE Students
    (sid: CHAR(20),
     name: CHAR(20),
     login: CHAR(10),
     age: INT,
     gpa: REAL)
```

- As another example, the Enrolled table holds information about courses that students take.

```
CREATE TABLE Enrolled
    (sid: CHAR(20),
     cid: CHAR(20),
     grade: CHAR(2))
```

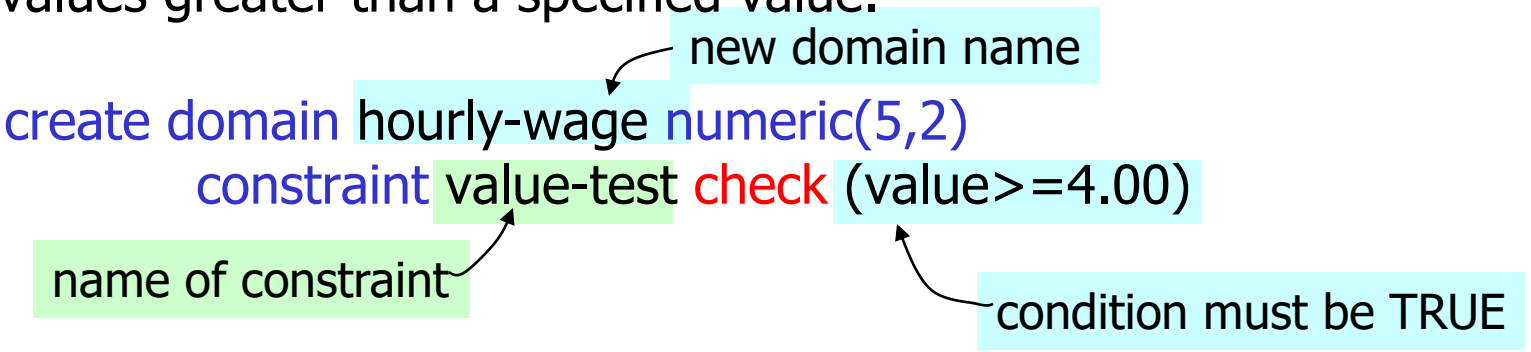
Integrity Constraints (IC)

IC guard against accidental damage to the database, by ensuring that authorized changes to the database do not result in a loss of data consistency.

- Integrity constraints are based upon the semantics of the real-world enterprise that is being described in the database relations.
- We can check a database instance to see if an IC is violated, but we can NEVER infer that an IC is true by looking at an instance.
  - An IC is a statement about *all possible* instances!
  - From example, we know *name* is not a key, but the assertion that *sid* is a key is given to us.

Domain Constraints

- The check clause in SQL-92 permits domains to be restricted
- use check clause to ensure that an hourly-wage domain allows only values greater than a specified value.



- The domain hourly-wage is declared to be a decimal number with 5 digits, 2 of which are after the decimal point
- The domain has a constraint that ensures that the hourly-wage is greater than 4.00.
- constraint value-test is optional; useful to indicate which constraint an update violated.

Primary and Candidate Keys in SQL

- Possibly many *candidate keys* (specified using UNIQUE), one of which is chosen as the *primary key*.

```
CREATE TABLE Enrolled
  (sid CHAR(20)
   cid  CHAR(20),
   grade CHAR(2),
   PRIMARY KEY  (sid,cid) )
```

```
CREATE TABLE Enrolled
  (sid CHAR(20)
   cid  CHAR(20),
   grade CHAR(2),
   PRIMARY KEY  (sid),
   UNIQUE (cid, grade) )
```

- Used carelessly, an IC can prevent the storage of database instances that arise in practice!

Foreign Keys in SQL

- Only students listed in the Students relation should be allowed to enroll for courses.

```
CREATE TABLE Enrolled
  (sid CHAR(20), cid CHAR(20), grade CHAR(2),
   PRIMARY KEY (sid,cid),
   FOREIGN KEY (sid) REFERENCES Students )
```

Enrolled

sid	cid	grade
53666	Carnatic101	C
53666	Reggae203	B
53650	Topology112	A
53666	History105	B

Students

sid	name	login	age	gpa
53666	Jones	jones@cs	18	3.4
53688	Smith	smith@eecs	18	3.2
53650	Smith	smith@math	19	3.8

Enforcing Referential Integrity

- Consider Students and Enrolled; *sid* in Enrolled is a foreign key that references Students.
- What should be done if an Enrolled tuple with a non-existent student id is inserted? (*Reject it!*)
- What should be done if a Students tuple is deleted?
  - Also delete all Enrolled tuples that refer to it (cascading deletion).
  - Disallow deletion of a Student tuple that is referred to by an Enrolled tuple.
  - Set sid in Enrolled tuples that refer to it to a *default sid*.
  - Set sid in Enrolled tuples that refer to it to a special value *null* (not applicable in this example because sid is part of the primary key).
- If primary key of Students tuple is updated, you must also update the classes taken by the student

Referential Integrity in SQL/92

- SQL/92 supports all 4 options on deletes and updates.
  - Default is NO ACTION (*delete is rejected*)
  - CASCADE (also delete all tuples that refer to deleted tuple)
  - SET NULL / SET DEFAULT (sets foreign key value of referencing tuple)

```
CREATE TABLE Enrolled
   (sid CHAR(20),
    cid CHAR(20),
    grade CHAR(2),
    PRIMARY KEY  (sid,cid),
    FOREIGN KEY (sid)
      REFERENCES Students
            ON DELETE CASCADE
            ON UPDATE CASCADE)
```

Participation Constraints in SQL

We can capture total participation constraints using NOT NULL.

```
CREATE TABLE Dept_Mgr(
  did INTEGER,
  dname CHAR(20),
  budget REAL,
  HKID CHAR(11) NOT NULL,
  since DATE,
  PRIMARY KEY (did),
  FOREIGN KEY (HKID) REFERENCES Employees,
    ON DELETE NO ACTION)
```

Destroying and Altering Relations

DROP TABLE Students

Destroys the relation Students. The schema information *and* the tuples are deleted.

ALTER TABLE Students
ADD COLUMN firstYear: integer

The schema of Students is altered by adding a new field; every tuple in the current instance is extended with a *null* value in the new field.

Views

Provide a mechanism to hide certain data from the view of certain users. To create a view we use the command:

create view view-name as <query expression>

where: <query expression> is any legal SQL query

EXAMPLE: Create a view from loan(loan-number, branch-name, amount) that hides the amount.

```
create view branch-loan as
        select branch-name, loan-number
        from loan
```

QUERY: Find all loans in the Perryridge branch

```
select loan-number
from branch-loan
where branch-name = "Perryridge"
```

A user who has access to the view, but not the loan table, cannot see the amount.

General Constraints

Useful when more general ICs than keys are involved.

Are created in the definition of table - checked whenever there is an update within the table

```
CREATE TABLE  Loan
( loan-number  INTEGER,
amount  INTEGER,
branch-name CHAR(20),
PRIMARY KEY  (loan-number ),
FOREIGN KEY  (branch-name) REFERENCES Branch,
     ON DELETE CASCADE
CHECK  ( amount >= 1 AND amount <= 10000)
CHECK ( branch-name <> "Choi Hung"))
```

Assertions

- An assertion is a complex constraint that the database must always satisfy.
- An assertion in SQL-92 takes the form
  create assertion <assertion-name> check <predicate>
- Difference from general constraints:
  - A constraint is associated with a single table and checked when there is an update on this specific table
  - An assertion may be associated with several tables, and is checked every time there is an update anywhere.
- Assertion testing may introduce a significant amount of overhead; hence assertions should be used with great care.
- Any predicate allowed in SQL can be used.

Assertion Example

- The sum of all loan amounts for each branch must be less than the sum of all account balances at the branch.

```
create assertion sum-constraint check
    (not exists (select * from branch
                    where (select sum(amount) from loan
                              where loan.branch-name=branch.branch-name)
                          >=
                          (select sum(amount) from account
                            where loan.number-name=branch.branch-name) ))
```

- Note that the assertion refers to multiple tables. Therefore it cannot be included as a constraint in the definition of loan or amount.