SQL

CPS 216
Advanced Database Systems

Review

SELECT [DISTINCT]…

FROM …

WHERE …

GROUP BY …

HAVING …;

ORDER BY

- SELECT [DISTINCT] E_1, E_2, E_3...
  FROM…WHERE…GROUP BY…HAVING…
  ORDER BY E_{i_1} [ASC | DESC],
  E_{i_2} [ASC | DESC], …;
- ASC = ascending, DESC = descending
- Operational semantics
  - After SELECT list has been computed and optional duplicate elimination has been carried out, sort the output according to ORDER BY specification

ORDER BY example

- List all students, sort them by GPA (descending) and then name (ascending)
  –
  – ASC is the default option
  – Technically, only output columns can appear in ORDER BY clause (some DBMS support more)
  – Can use output index instead

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Data modification: INSERT

- Insert one row

  Example: Student 456 takes CPS 216
  – INSERT INTO Enroll VALUES (456, 'CPS 216');
- Insert the result of a query

  Example: Force everybody to take CPS 216
  – INSERT INTO Enroll
    (SELECT SID, 'CPS 216' FROM Student

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Data modification: DELETE

- Delete everything
  – DELETE FROM Enroll;
- Delete according to a WHERE condition

  Example: Student 456 drops CPS 216
  – DELETE FROM Enroll
    WHERE SID = 456 AND CID = 'CPS 216';

  Example: Drop students with GPA lower than 1.0 from all CPS classes
  –

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Data modification: UPDATE

- Example: Student 142 changes name to “Barney”
  - UPDATE Student
    SET name = ’Barney’
    WHERE SID = 142;
- Example: Let’s be “fair”?
  - UPDATE Student
    SET GPA = (SELECT AVG(GPA) FROM Student);

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Views

- A view is like a virtual table
  - Defined by a query, which describes how to compute the view contents on the fly
  - DBMS stores the view definition query instead of view contents
  - Can be used in queries just like a regular table

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Creating and dropping views

- Example: CPS 216 roster
  - CREATE VIEW CPS216Roster AS
    SELECT SID, name, age, GPA
    FROM Student
    WHERE SID IN (SELECT SID FROM Enroll
    WHERE CID = ’CPS 216’);
- To drop a view (or table)
  - DROP VIEW *view_name*;
  - DROP TABLE *table_name*;

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Using views in queries

- Example: find the average GPA of CPS 216 students
  - SELECT AVG(GPA) FROM CPS216Roster;
  - To process the query, replace the reference to the view by its definition

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Why use views?

- To hide data from users
- To hide complexity from users
- Logical data independence
  - If applications deal with views, we can change the underlying schema without affecting applications
  - Recall physical data independence: change the physical organization of data without affecting applications
- Real database applications use tons of views

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Modifying views

- Doesn't seems to make sense since views are virtual
- But does make sense if that's how users view the database
- Goal: modify the base tables such that the modification would appear to have been accomplished on the view

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A simple case

```
CREATE VIEW StudentGPA AS
  SELECT SID, GPA FROM Student;
DELETE FROM StudentGPA WHERE SID = 123;
```

translates to:

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An impossible case

```
CREATE VIEW HighGPAStudent AS
  SELECT SID, GPA FROM Student
  WHERE GPA > 3.7;
INSERT INTO HighGPAStudent
  VALUES(987, 2.5);
```

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A case with too many possibilities

```
CREATE VIEW AverageGPA(GPA) AS
  SELECT AVG(GPA) FROM Student;
```

– Note that you can rename columns in view definition

```
UPDATE AverageGPA SET GPA = 2.5;
```

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SQL92 updatable views

- Single-table SFW
  - No aggregation
  - No subqueries
- Overly restrictive
- Still gets it wrong in some cases
  - See the slide titled “An impossible case”

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Incomplete information

- Example: Student (SID, name, age, GPA)
- Value unknown
- Value not applicable

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Solution 1

- A dedicated special value for each domain
  - GPA cannot be –1, so use –1 as a special value
  - SELECT AVG(GPA) FROM Student;
  - SELECT AVG(GPA) FROM Student
    WHERE GPA <> 0;
    - Complicates applications
  - Remember the pre-Y2K bug?
    - 09/09/99 was used as an invalid or missing date value
    - It’s tricky to make these assumptions!

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Solution 2

- A valid-bit column for every real column
  - Student (SID, name, name_is_valid,
    age, age_is_valid,
    GPA, GPA_is_valid)
  - Too much overhead
  - SELECT AVG(GPA) FROM Student
    WHERE GPA_valid;
    - Still complicates applications

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SQL's solution

- A special value NULL
  - Same for every domain
  - Special rules for dealing with NULLs
- Example: Student (SID, name, age, GPA)
  - <789, 'Nelson', NULL, NULL>

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Computing with NULLs

- When we operate on a NULL and another value (including another NULL) using +, –, etc., the result is NULL
- Aggregate functions ignore NULL, except COUNT(*)

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Three-valued logic

- TRUE = 1, FALSE = 0, UNKNOWN = 0.5
- *x* AND *y* = min(*x*, *y*)
  x OR *y* = max(*x*, *y*)
  NOT(*x*) = 1 – *x*
- When we compare a NULL with another value (including another NULL) using =, >, etc., the result is UNKNOWN
- WHERE and HAVING clauses only select tuples if the condition evaluates to TRUE
  - UNKNOWN is insufficient

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Unfortunate consequences

- select avg(GPA) from Student;
  select sum(GPA) / count(*) from Student;
- select * from Student;
  select * from Student
  where GPA > 3.0 or GPA <= 3.0;
- Be careful: NULL breaks many equivalences

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Another problem

- Example: Who has NULL GPA values?
  - New built-in predicates IS NULL and IS NOT NULL
    select * from Student where GPA is null;

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Recap

- Covered
  - ORDER BY
  - Data modification statements
  - Views
  - NULLs
- Skipped
  - Outerjoin
  - Alternative join syntax
  - Schema modification statements
- Next
  - Constraints

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Constraints

- Restrictions on allowable data in a database
  - In addition to the simple structure and type restrictions imposed by the table definitions
  - Declared as part of the schema
  - Enforced by the DBMS
- Why use constraints?
  - Protect data integrity
  - Tell the DBMS about the data

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Types of constraints

- NOT NULL
- Key
- Referential integrity
- General assertion
- Tuple- and attribute-based CHECKs

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NOT NULL constraint example

- create table Student
  (SID integer not null,
  name varchar(30) not null,
  email varchar(30),
  age integer, GPA float);
- create table Course
  (CID char(10) not null,
  title varchar(100) not null);
- create table Enroll
  (SID integer not null, CID char(10) not null);

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Key declaration

- At most one PRIMARY KEY per table
  - Typically implies a primary index
  - Rows are stored inside the index, typically sorted by primary key value
- Any number of UNIQUE keys per table
  - Typically implies a secondary index
  - Pointers to rows are stored inside the index

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Key declaration examples

- create table Student
  (SID integer not null primary key,
  name varchar(30) not null,
  email varchar(30) unique,
  age integer, GPA float);
- create table Course
  (CID char(10) not null primary key,
  title varchar(100) not null);
- create table Enroll
  (SID integer not null, CID char(10) not null,
  primary key(SID, CID));

Works on Oracle but not DB2: DB2 requires UNIQUE key columns to be NOT NULL

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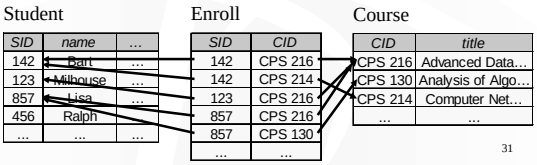
Referential integrity example

- Enroll.SID references Student.SID
- Enroll.CID references Course.SID
- If an SID appears in Enroll, it must appear in Student
- If a CID appears in Enroll, it must appear in Course
- That is, no "dangling pointers"



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Referential integrity in SQL

- Referenced column must be PRIMARY KEY
- Referencing column is called FOREIGN KEY
- Example declaration
  - create table Enroll
    (SID integer not null references Student(SID),
    CID char(10) not null,
    primary key(SID, CID),
    foreign key CID references Course(CID));

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Enforcing referential integrity

Example: Enroll.SID references Student.SID

- Insert or update a Enroll tuple so it refers to a non-existent SID
  - Reject
- Delete or update a Student tuple whose SID is referenced by some Enroll tuple
  - All three options can be specified in SQL

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Deferred constraint checking

- No-chicken-no-egg problem
  - create table Dept
    (name char(20) not null primary key,
    chair char(30) not null references Prof(name));
    create table Prof
    (name char(30) not null primary key,
    dept char(20) not null references Dept(name));
- Deferred constraint checking is necessary
  - Check only at the end of a transaction
  - Allowed in SQL as an option

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General assertion

- CREATE ASSERTION *assertion_name* CHECK *assertion_condition*;
- *assertion_condition* is checked for each modification that could potentially violate it
- Example: Enroll.SID references Student.SID
  - CREATE ASSERTION EnrollStudentRefIntegrity
    CHECK (

    );
- SQL3, but not all (perhaps no) DBMS supports it

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Tuple- and attribute-based CHECKs

- Associated with a single table
- Only checked when a tuple or an attribute is inserted or updated
- Example:
  - CREATE TABLE Enroll
    (SID integer not null
    CHECK (SID IN (SELECT SID FROM Student)),
    CID …);
  - Is it a referential integrity constraint?

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Next time

Transactions!

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