Data Definition Language (DDL), Views and Indexes

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Reference:
A First Course in Database Systems,
3rd edition, Chapter 2.3 and 8.1-8.4

Important Notices

- Lab2 assignment is due by **Sunday, Feb 5, 11:59pm** on Canvas (zip file).
  - Lab2 answer will be posted on Monday, Feb 6.
- Lab3 assignment will be posted by Monday, Feb 6.
  - Due by Sunday, Feb 26, 11:59pm (3 weeks)
- Gradiance 2 was posted was posted Tuesday, Jan 31
  - Due by Friday, Feb 10, 11:59pm
- **Reminder:** Midterm is on **Monday, Feb 13**; no make-ups
  - You may bring a **single two-sided 8.5" x 11" sheet of paper** with as much info written (or printed) on it as you can fit and read unassisted.
    - No sharing of these sheets will be permitted.
  - For DSC accommodation, please submit forms to me well in advance.

HAVING Example

```
SELECT e.name, SUM(m.length)
FROM MovieExec e, Movies m
WHERE m.producerC# = e.cert#
GROUP BY e.name
HAVING MIN(m.year) < 1930;
```

Find the total film length for just those producers who made at least one film prior to 1930.

Another HAVING Example

```
SELECT e.name, SUM(m.length), MAX(m.year)
FROM MovieExec e, Movies m
WHERE m.producerC# = e.cert#
GROUP BY e.name
HAVING COUNT(DISTINCT m.year) >=3
    AND MIN(m.year) < 1930;
```

Find the total film length and the latest movie year, for just those producers who made movies in at least 3 different years, and made at least one film prior to 1930.

SQL Language

- Data Manipulation Language (DML)
  - Access and modify data
  - SELECT, INSERT, DELETE, UPDATE
- Data Definition Language (DDL)
  - Modify structure of data
  - CREATE, DROP, ALTER
- Data Control Language (DCL)
  - Control access to the data (security)
  - GRANT, REVOKE
- Databases also have Utilities, such as Backup/Restore
  - Syntax not specified in the SQL standard

CREATE TABLE

```
CREATE TABLE MovieStar (
    name            CHAR(30) ,
    address         VARCHAR(255)  DEFAULT ‘Hollywood’,
    gender          CHAR(1),
    birthdate       DATE NOT NULL DEFAULT ‘2001-12-30’
    PRIMARY KEY (name)
    );
```

- PRIMARY KEY
- DEFAULT
- NOT NULL

Reminder: Some Facts About Nulls

- Almost all comparisons with NULL will evaluate to unknown. If Salary is NULL, then the following will be unknown (treated like false):
  - Salary = 10
  - Salary <> 10
  - 90 > Salary OR 90 <= Salary
  - Salary = NULL
  - Salary <> NULL

- Use of IS NULL and IS NOT NULL
  - Salary IS NULL will be true if Salary is NULL, false otherwise
  - Salary IS NOT NULL will be true if Salary isn't NULL, false otherwise

- ORDER BY works with attributes that can have NULL values
  - NULL will probably be smallest or largest value
  - Not specified by SQL standard, so it depends on the implementation

- GROUP BY also works with attributes that can have NULL values

DROP TABLE

- Dropping a table:

```
DROP TABLE MovieStar;
```

- Don’t assume that rolling back transaction will bring back the table!
  - Interaction of DDL and transactions may depend on implementation.

ALTER TABLE

- Adding a column to a table:
  - ALTER TABLE MovieStar ADD phone CHAR(16) DEFAULT ‘unlisted’;
- Dropping a column from a table:
  - ALTER TABLE MovieStar DROP birthdate;
  - In some systems:
    ALTER TABLE MovieStar DROP **COLUMN** birthdate;
  - In some SQL systems, dropping a column isn’t allowed.
- Changing the type of a column:
  - Some implementations let you change type of column in limited ways.

What Can You CREATE/DROP in SQL DDL?

- TABLE
- **VIEW**
- **INDEX**
- ASSERTION
- TRIGGER
- SCHEMA
- PROCEDURE/FUNCTION/TYPE
  - SQL2003 standard, but there are significant variations in implementations in different systems
- …

Views

- Views help with logical data independence, allowing you to retrieve data as if it matched the description in the view.

  CREATE VIEW < view-name> AS < view-definition> ;

  CREATE VIEW ParamountMovies AS
  SELECT title, year
  FROM Movies
  WHERE studioName = ‘Paramount ' ;

- You may now ask queries on ParamountMovies as if it were a table:
  SELECT title FROM ParamountMovies WHERE year=1976;
  - Composition in SQL is powerful: Tables, Queries, Views

More Views

Movies (title , year , length , genre , studioName , producerC#)

MovieExec (name , address , cert# , netWorth)

```
CREATE VIEW MovieProd AS
        SELECT m.title, e.name, e.genre
        FROM Movies m, MovieExec e
         WHERE m.producerC# = e.cert# ;

       SELECT DISTINCT genre
        FROM MovieProd
        WHERE name = ‘George Lucas’;
```

Renaming Attributes in CREATE VIEW

Movies (title , year , length , genre , studioName , producerC#)

MovieExec (name , address , cert# , netWorth)

```
CREATE VIEW MovieProd(movie_title, prod_name, movie_genre) AS
        SELECT m.title, e.name, e.genre
        FROM Movies m , MovieExec e
         WHERE m.producerC# = e.cert# ;

       SELECT DISTINCT movie_genre
        FROM MovieProd
        WHERE prod_name = ‘George Lucas’;
```

What is a View?

- A view can include any SQL SELECT statement
  - Including UNION, Aggregates, GROUP BY, HAVING, ORDER BY, etc.
- A view is not stored as a table
  - The tables underlying the view are stored in the database, but only the description of the view is in the database
  - … although some systems support MATERIALIZED VIEWS
- But a view can be used in many (not all) of the same ways as tables
  - Views can be queried
  - Views can be defined on views, as well as on tables!

Queries on Views and Tables

```
CREATE VIEW ParamountMovies AS
        SELECT title , year
        FROM Movies
        WHERE studioName = ’Paramount ' ;

SELECT DISTINCT s.starName
FROM ParamountMovies p , StarsIn s
WHERE p.title = s.movieTitle AND p.year = s.movieYear ;

CREATE VIEW ParamountStars AS
       SELECT DISTINCT starName
       FROM ParamountMovies , StarsIn
       WHERE title = movieTitle AND year = movieYear ;
```

DROP VIEW

```
CREATE VIEW ParamountMovies AS
        SELECT title , year
        FROM Movies
        WHERE studioName = ’Paramount ' ;

DROP View ParamountMovies;
```

- What happens if you execute the following after dropping that view?
  - SELECT * FROM ParamountMovies;
  - SELECT * FROM Movies;

View Updates

- Some modification operations on views work, but others do not, generally failing either because:
  - Constraint on underlying table would be violated, or
  - The effects of the View modification is not well-defined on the underlying tables.

- This is a complex topic, which we'll only discuss briefly.
  - See book, section 8.2 for more info.

View Update Problems

Movies(title, year, length, genre, studioName , producerC#)

```
CREATE VIEW ParamountMovies AS
    SELECT title , year
    FROM Movies
    WHERE studioName = ‘Paramount ' ;

INSERT INTO ParamountMovies VALUES (‘StarTrek’, 1979);
```

The INSERT will fail if the other columns of Movies (besides title and year) don’t have defaults, and also don’t allow NULL values.

View Update Problems (continued)

Ambiguous View Update example with Employees and Departments

<< We'll draw this on the board >>

Motivation for Indexes

- Searching an entire table may take a long time:

```
SELECT *
FROM Movies
WHERE studioName = 'Disney' AND year = 1990;
```

If there were 100 Million movies, searching them might take a while. An index (e.g., a B-Tree) would allow faster access to matching movies.

If a table is updated, all Indexes on that table are immediately automatically updated within the same transaction.

- Which indexes do you need to change on INSERT and DELETE?
- What about UPDATE?

CREATE INDEX

```
SELECT *
FROM Movies
WHERE studioName = 'Disney' AND year = 1990;
```

How much would each of these indexes help?

```
CREATE INDEX YearIndex ON Movies(year);

CREATE INDEX StudioIndex ON Movies(studioName);

CREATE INDEX YSIndex ON Movies(year,studioName);

CREATE INDEX SYIndex ON Movies(studioName,year);
```

How much would each of the indexes help if the WHERE clause was just year = 1990?

Indexes and Ordering

```
SELECT *
FROM Movies
WHERE studioName = 'Disney' AND year < 1990;
```

How much would each of these indexes help?

```
CREATE INDEX YearIndex ON Movies(year);

CREATE INDEX StudioIndex ON Movies(studioName);

CREATE INDEX YSIndex ON Movies(year,studioName);

CREATE INDEX SYIndex ON Movies(studioName,year);
```

How much would each of the indexes help if the WHERE clause was just year < 1990?

Disadvantages of Indexes?

- Why not put indexes on every attributes, or even on every combination of attributes you might query on?
  - Huge number of indexes
  - Space for indexes
  - Cache impact of searching indexes
  - Update time for indexes when table is modified

Index Design

- Most Database Administrators (DBAs) pick a set of indexes that work well on expected workload, and there are tools that help pick good indexes
  - But workloads change, so choice of indexes may need to change
    - DROP INDEX YearIndex;

- Keys are indexed (automatically in many database systems) to:
  - Help maintain uniqueness (primary key, unique)
  - Check Foreign Key references to Primary Keys (Referential Integrity)

Index Utilization

- SQL statements don't have to be modified to specify use of indexes.
  - Database Optimizer tries to figure out "best"/good way to execute SQL query.
  - Tables can be scanned entirely, as well as accessed via indexes.
  - Some systems have ways that you can tell the optimizer what to do. This has advantages and disadvantages. (What are they?)

- Many SQL systems (including PostgreSQL) have an EXPLAIN PLAN statement, so that you can see what plan the optimizer chooses for a SQL statement.