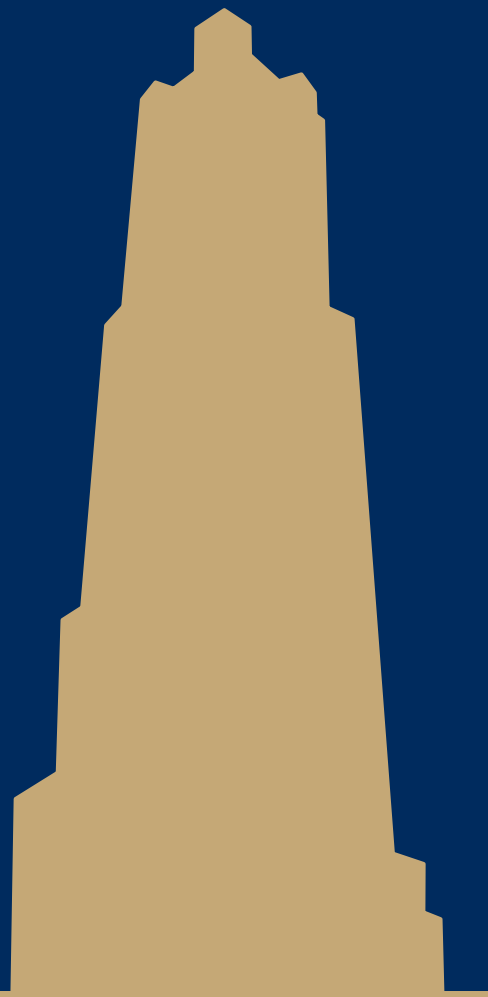
CS 1555

www.cs.pitt.edu/~nlf4/cs1555/

Using SQL as a DDL



SQL

- Declarative query language
- Originally developed for System R
  - First presented in 1974
- Current incarnation is the result of a very successful standardization effort by both ANSI and ISO
  - SQL-86 (SQL)
  - SQL-89 (SQL1)
  - SQL-92 (SQL2)
  - SQL:1999, SQL:2003, SQL:2006, SQL:2008, SQL:2011
- De-facto language for RDBMS
  - DDL, DML and VDL

The database schema

- Describes the data stored in the database
- Specifically:
  - Base relations
    - (tbl_name, creator, #tuples, tuple_length, #attributes...)
  - Attributes of relations (columns)
    - (tbl_name, atrb_name, type, format, order, key_no, ...)
  - Indexes
    - (tbl_name, index_name, key_attribute,...)!
  - Authorizations
  - Integrity constraints
- All of this information is stored in the *catalog*
- SQL-92 and later allow multiple database schemas
  - Tables are named as SchemaName.TableName

Creating and deleting schemas

- `CREATE SCHEMA name AUTHORIZATION user;`
- `DROP SCHEMA name [RESTRICT|CASCADE];`
  - RESTRICT: removes schema if it doesn't contain any elements
  - CASCADE: remove schema and everything it contains

Creating database tables

- `CREATE TABLE tname (attribute list ...);`
  - Need to specify a name and a data type for each attribute

Numerical data types

- C-style integers
  - `SMALLINT`
  - `INT`
- Floating point types
  - `FLOAT[(p)]`
    - *p* sets the precision of the float, in bytes, max of 8
    - Allows custom precision floating point types
  - `REAL` and `DOUBLE PRECISION`
    - Set precision floating point types
    - 4 bytes and 8 bytes, respectively
- `DECIMAL(i, j)` or `NUMERIC(i, j)`
  - i: total number of digits (precision)
  - j: digits after a decimal point (scale)

Very few DBMSs "speak" standard SQL

- In reality, most will speak its own SQL dialect
  - Integer data type example:
    - PostgreSQL:
      - SMALLINT (16 bit)
      - INTEGER (32 bit)
      - BIGINT (64 bit)
    - My SQL:
      - SMALLINT (16 bit)
      - INT (32 bit)
      - BIGINT (64 bit)
    - Oracle:
      - SHORTINTEGER (16 bit)
      - INTEGER (32 bit)
      - LONGINTEGER (64 bit)
- Always consult the documentation for your DBMS!

Character string data types

- Strings of *printable* characters
- Enclosed in `'single quotes'`
- **`CHARACTER`**`(`*n*`)` or **`CHAR`**`(`*n*`)`
  - Fixed length n strings
- **`CHARACTER VARYING`**`(`*n*`)` or **`VARCHAR`**`(`*n*`)`
  - Variable length string (max of *n*)
- Concatenation operator: `||`
  - `'abc' || 'XYZ'` results in `'abcXYZ'`
- **`CLOB`**`(`*size*`)`
  - Character Large OBject
  - size specified in kilobytes (K), megabytes (M), or gigabytes (G)

Bit string data types

- Sequences of bits
- Enclosed in single quotes with a leading `B`
  - `B'001100101'`
- **`BIT`**(*`n`*)
  - Fixed length of n bit
- **`BIT VARYING`**(*`n`*)
  - Variable length (max of *`n`*)
- **`BLOB`**(*`size`*)
  - Binary Large OBject
  - size specified in kilobytes (K), megabytes (M), or gigabytes (G)

Boolean values

- Valued TRUE or FALSE

NULL values

- Several reasons to store a `NULL` value in a tuple:
  - Unknown value
    - A person's date of birth is not known, so it is represented by `NULL` in the database.
  - Unavailable or withheld value
    - A person has a home phone but does not want it to be listed, so it is withheld and represented as `NULL` in the database.
  - Not applicable attribute
    - An attribute LastCollegeDegree would be `NULL` for a person who has no college degrees because it does not apply to that person.

Three-valued logic

- `TRUE`, `FALSE`, or `UNKNOWN`
- Consider:
  - Storing a `NULL` value for a **`BOOLEAN`** attribute
    - How should this be treated in a logical expression?
  - Evaluating a condition on a `NULL` value
    - Consider the partial condition:
      - `Students.Name = 'SUSAN' AND Students.GPA > 2.0`
        - If a row in the students table has a value of 3.0 for the GPA attribute and a `NULL` value for the Name attribute, should this condition be `TRUE` or `FALSE`?
        - What about `NULL` name, but a 1.0 for GPA?

Date and time data types

- **DATE**
  - E.g., YYYY-MM-DD
- **TIME** [(*p*)] [**WITH TIME ZONE**]
  - HH:MM:SS.dddddd{+,-}hhmm
  - If not specified, default is local timezone
- **TIMESTAMP** [(*p*)] [**WITH TIME ZONE**]
  - Complete date and time with up to 6 fractional seconds and optional time zone
- Dates and times must be valid!

Date and time implementations

- PostgreSQL sticks pretty close to SQL standard
- MySQL implements both TIMESTAMP and DATETIME
  - DATETIME is not a valid ANSI type
  - DATETIME range:
    - '1000-01-01 00:00:00' to '9999-12-31 23:59:59’
  - TIMESTAMP range in MySQL:
    - '1970-01-01 00:00:01' UTC to '2038-01-19 03:14:07' UTC
- Oracle DATE is not equivalent to ANSI DATE, it instead functions like ANSI TIMESTAMP

Intervals

- Represent periods of time and are used in operations on date and time data types
- DATE {+,-} INTERVAL results in TIMESTAMP
- DATE - DATE results in INTERVAL
- INTERVAL {*,/} number results in INTERVAL
- INTERVAL {+,-} INTERVAL results in INTERVAL
- Examples
  - `(CURRENT_DATE + INTERVAL '1 MONTH')`
  - `(CURRENT_DATE + INTERVAL '18 DAYS')`
  - `(CURRENT_DATE - BirthDate)`

Note

- Different DBMSs tend to use specialized DATE and TIME functions to manipulate DATE, TIME, and INTERVAL data
- Be sure to check the documentation of your DBMS

Interval specification

- **`INTERVAL`** `[`*`fields`*`] [(`*`p`*`)]`
- Possible fields:
  - YEAR
  - MONTH
  - DAY
  - HOUR
  - MINUTE
  - SECOND
  - YEAR TO MONTH
  - DAY TO HOUR
  - DAY TO MINUTE
  - DAY TO SECOND
  - HOUR TO MINUTE
  - HOUR TO SECOND
  - MINUTE TO SECOND
- Precision only applies to intervals with second field

All the data types you could want!

- DOMAIN defines datatype macros in a schema
  - Basic datatype
  - DEFAULT value
  - CHECK (validity conditions)
- **DROP DOMAIN** *dname* [**RESTRICT**|**CASCADE**];
  - RESTRICT drops domain if it is unused
  - CASCADE drops domain and replaces it with underlying type
- Examples:
  - `CREATE DOMAIN sectno_dom AS SMALLINT;`
  - `CREATE DOMAIN section_dom VARCHAR(20) DEFAULT 'none';`
  - `CREATE DOMAIN gpa_dom DECIMAL(3,2) DEFAULT 0.00;`
  -
```
CREATE DOMAIN valid_date DATE
CONSTRAINT valid_date_range
CHECK (VALUE BETWEEN '2017-01-01' AND '2018-01-01');
```

Constraints on table attributes

- Constraints:
  - **NOT NULL**
  - **DEFAULT** *value*
    - without the **DEFAULT** clause, the default value is NULL
  - **PRIMARY KEY**(*attribute list*)
  - **UNIQUE**(*attribute list*)
    - allows the specification of alternative key
  - **FOREIGN KEY**(*key*) **REFERENCES** table(*key*)

CREATE TABLE example 1

```
CREATE TABLE Students
(
  ID          INTEGER,
  Name        VARCHAR(20),
  Major       VARCHAR(10),
  GPA         DECIMAL(3,2),
  CONSTRAINT Students_PK
    PRIMARY KEY (ID)
);
```

CREATE TABLE example 2

```
CREATE TABLE Enrollment
(
  Stud_ID INTEGER,
  Course  VARCHAR(15),
  CONSTRAINT Enrollment_FK
    FOREIGN KEY (Stud_ID) REFERENCES Students(ID)
);
```

CREATE TABLE example 3

```
CREATE TABLE Students
(
  ID          INTEGER,
  Name        VARCHAR(20),
  Ssn         CHAR(9) NOT NULL,
  Major       VARCHAR(10),
  GPA         DECIMAL(3,2),
  CONSTRAINT Students_PK
    PRIMARY KEY (ID),
  CONSTRAINT Students_AK
    UNIQUE (Ssn)
);
```

Modifying tables after creation

- **ALTER TABLE** *tname* **ALTER COLUMN** *cname options*;
  - **ALTER TABLE** Students **ALTER COLUMN** GPA **DECIMAL**(4,2);
  - **ALTER TABLE** Students **ALTER COLUMN** GPA **SET DEFAULT NULL**;
  - **ALTER TABLE** Students **ALTER COLUMN** GPA **DROP DEFAULT**;
- **ALTER TABLE** *tname* **ADD COLUMN** *cname type*;
- **ALTER TABLE** *tname* **DROP COLUMN** *cname* [**RESTRICT**|**CASCADE**];
- **ALTER TABLE** *tname* **ADD CONSTRAINT** *con_name description*;
- **ALTER TABLE** *tname* **DROP CONSTRAINT** *con_name*;

Dropping tables

- **`DROP TABLE`** *`tname`* **`[RESTRICT|CASCADE];`**
  - RESTRICT drops the table only if it is not referenced
    - E.g., by constraints or views
  - CASCADE drops the table and items that reference it