SQL Data Definition and Data Manipulation Languages
(DDL and DML)

Note: This handout introduces both the ANSI SQL syntax for the SQL
DDL and DML commands, as well as discusses the MySQL extensions to
the syntax that are of importance to the course. As a general note, MySQL
has a very rich syntax for the statements discussed in this handout, with
many advanced features specifiable in addition to the standard ANSI SQL
syntax. We only cover the features that are of immediate interest to us.

Data Definition Language.

Creating a Relation

CREATE TABLE Name (attribute-declarations
constraint-declarations)

Attribute declarations:

\textit{AttName AttType [ default expression ] [ ColConstraints ]}

Constraints

Column constraints:

\texttt{[NOT] NULL : Not null constraint.}

\texttt{PRIMARY KEY: Primary key constraint (when the primary key consists of}
exactly one attribute, otherwise, use constraint declaration).

\texttt{UNIQUE: Key constraint (when the key consists of exactly one attribute,}
otherwise, use constraint declaration).
REFERENCES <Table>[(<AttName>))] [ON DELETE CASCADE]: Foreign key constraint (when the foreign key consists of exactly one attribute, otherwise, use constraint declaration). ON DELETE CASCADE specifies that all rows containing a no longer existing value for must be deleted.

**AUTO_INCREMENT**: the values in the column (integer type) are incremented automatically as new tuples are added to the table.

Constraint declarations:

[constraint <ConstName>] PRIMARY KEY (<AttNames>): Primary key constraint. Use when the primary key includes multiple attributes.

[constraint <ConstName>] UNIQUE (<AttNames>): Key constraint. Use when the key includes multiple attributes.

[constraint <ConstName>] FOREIGN KEY (<AttNames>) REFERENCES <Table> [(<AttNames>)]: Foreign key constraint. Use when the foreign key involves multiple attributes.

All column constraints except for not null constraint can only be used if the appropriate constraint (e.g., primary key) is associated with exactly one attribute. (i.e., if your primary key is two attributes, use the constraint declaration, rather than column constraint).

**Types**

<table>
<thead>
<tr>
<th>Type</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integer</td>
<td>INTEGER or INT, SMALLINT, TINYINT, MEDIUMINT, BIGINT</td>
</tr>
<tr>
<td>Real</td>
<td>FLOAT or REAL, DOUBLE</td>
</tr>
<tr>
<td>Fixed Point</td>
<td>DECIMAL(n, d)</td>
</tr>
<tr>
<td></td>
<td>n - number of digits</td>
</tr>
<tr>
<td></td>
<td>d - number of decimals</td>
</tr>
<tr>
<td></td>
<td>NUMERIC(n, d) (Oracle)</td>
</tr>
<tr>
<td>Strings</td>
<td>CHAR(n)</td>
</tr>
<tr>
<td></td>
<td>n - length of string, max=255</td>
</tr>
<tr>
<td></td>
<td>VARCHAR(n), n - length of string</td>
</tr>
<tr>
<td>Bit Strings</td>
<td>BIT(n)</td>
</tr>
<tr>
<td>Dates</td>
<td>DATE, TIME, TIMESTAMP, DATETIME, YEAR</td>
</tr>
</tbody>
</table>
Examples

CREATE TABLE Books (  
    LibCode INT,  
    ISBN CHAR(20),  
    Title CHAR(80),  
    Authors CHAR(60),  
    Year INT,  
    Publisher CHAR(20),  
    PurchPrice REAL,  
    TakeHome BOOLEAN,  
    PRIMARY KEY (LibCode),  
    UNIQUE (ISBN)  
);  

CREATE TABLE Employees (  
    SSN INT PRIMARY KEY,  
    Name CHAR(30) NOT NULL,  
    Department INT REFERENCES Departments,  
    Salary FLOAT NOT NULL  
    Position CHAR(30) DEFAULT 'Not Specified',  
    StartYear INT CHECK(StartYear > 1992)  
);  

CREATE TABLE Departments (  
    DeptID INT PRIMARY KEY AUTO_INCREMENT,  
    Name CHAR(30) UNIQUE,  
    Head INT,  
    FOREIGN KEY(Head) REFERENCES Employees  
);  

Deleting a Table  

DROP TABLE Name [RESTRICT | CASCADE]  

Example:  

DROP TABLE Books;  

DROP TABLE Departments CASCADE;  

In the latter case, all referential integrity constraints (foreign keys) are dropped from their respective tables, after Departments table is deleted.  

DROP TABLE Employees RESTRICT;  

The use of RESTRICT in the DROP TABLE command directs the DBMS server to drop the table only if doing so does not affect the constraints in other tables. Otherwise, the table is not deleted.  

Modifying a Table  

• Adding an attribute
ALTER TABLE Name
ADD [COLUMN] ( [AttName Type [FIRST | AFTER AttName]]+ )
Examples:

ALTER TABLE Books
ADD (Genre CHAR(10),
    NumPages INT);

ALTER TABLE Employees
ADD COLUMN (TransferredFrom INT AFTER Department);

The FIRST and AFTER AttName modifiers specify the position of the new column in the table. The default position (when both modifiers are omitted) is at the end of the table.

- Deleting an attribute
  ALTER TABLE Name
  DROP [COLUMN] (AttName+)
  Example:

  ALTER TABLE Books
  DROP (Year);

- Modifying an attribute
  ALTER TABLE Name
  MODIFY ( [AttName Type [FIRST | AFTER AttName] ]+ )
  Example:

  ALTER TABLE Books
  MODIFY (Genre VARCHAR2(30));

- Renaming a table (MySQL only)
  ALTER TABLE Name
  RENAME [TO | AS] NewName;

Note: ALTER TABLE command can be used for a wide range of other changes to the database (manipulation of constraints, for example). These are covered later.

Data Manipulation Language

Inserting a Tuple

INSERT INTO TableName(AttNames)
VALUES(values)[,(values)]*

values — comma-separated list of values. The number of values must match the number attribute names in AttNames, and the types must be compatible.

INSERT INTO TableName
VALUES(values)[,(values)]*
Values for all attributes must be given and in the order in which attributes were defined in `CREATE TABLE` command.

In both cases, in MySQL (but not in ANSI SQL), a single `INSERT INTO` command can insert multiple tuples.

Examples:

```sql
INSERT INTO Books(LibCode,Title,Year)
VALUES (12349, 'Database Management Systems', 2000);

INSERT INTO Books
VALUES (15923, '1-56592-000-7', 'Lex \& Yacc', 
       'J. Levine, T. Mason, D. Brown', 1990, 
       'O'Reily', 29.95, True);

INSERT INTO Departments(
VALUES ('Sales', 3), ('HR',11),
       ('IT', 76);
```

(Note that in the latter example, `DeptID` is an auto incrementing attribute and does not need to be inserted into the table.)

Deleting Tuples

```sql
DELETE FROM TableName
[WHERE Expression];
```

Expression identifies the properties of tuples to be removed from the table.

Examples:

```sql
DELETE FROM Books;

DELETE FROM Books
WHERE LibCode = 12349;

DELETE FROM Books
WHERE PurchPrice > 100.00 AND Year < 1950;
```

Updating Tuples

```sql
UPDATE TableName
SET Assignments
WHERE Expression;
```

Expression identifies tuples to be updated. Assignments specifies modifications.

Examples:

```sql
UPDATE Books
SET Year = 2003
WHERE Year > 2003;
```
UPDATE Books
SET Year = Year - 1,
    PurchPrice = PurchPrice * 1.05;
WHERE Year > 2000;

UPDATE Books
SET TakeHome = True;