Defining Relational Schema in SQL

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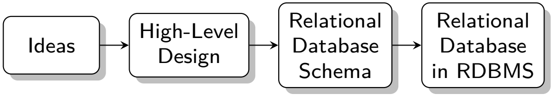
Outline

Overview


Ideas
High-Level Design
Relational Database Schema
Relational Database in RDBMS

Outline

Introduction to SQL

SQL (pronounced as “sequel”) is the principal language used to describe and manipulate relational database, and has several aspects:

- Data definition language (DDL).
  - SQL includes commands to create database objects such as tables, indexes, and views, as well as commands to define access rights to those database objects.
  - Topics of this lecture: SQL commands to create database tables (relations)
- Data manipulation language (DML).
  - SQL includes commands to insert, update, delete, and retrieve data within the database tables.
- Transaction control language (TCL).
  - The DML commands in SQL are executed within the context of a transaction.
- Data control language (DCL).
  - Data control commands are used to control access to data objects.

Relations in SQL

SQL makes a distinction between three kinds of relations:

- Stored relations (also called tables) – a relation that exists in the database and that can be modified by changing its tuples, as well as queried.
- Views – relations defined by a computation, they are not stored, but are constructed, in whole or in part, when needed.
- Temporary tables – constructed by the SQL language processor when it performs its job of executing queries and data modifications, and then thrown away and not stored.

Stored relations or tables are today's topic.

Outline

Data Types

All attributes must have data types

- Character types
- Numeric types
- Datatime types
- Binary types
- National character types
- Interval type
- Boolean
- XML
- JSON

Character Types

Character or string types

SQL Data Type	Description
`CHAR(n)`	a fixed-length string of up to n characters, a typical implementation pads a short string to n characters
`VARCHAR(n)`	a string of up to n characters, a typical implementation may have end-marker or length, but occupies n characters
`VARCHAR2(n)`	no unused spaces, some RDBMS treats (converts) `VARCHAR(n)` to codeVARCHAR2(n)
`NCHAR(n)`	like `CHAR(n)`, in unicode
`NVARCHAR(n)`	like `VARCHAR(n)`, in unicode
`NVARCHAR2(n)`	like `VARCHAR2(n)`, in unicode
`TEXT`	a string (text) of up to $2^{16} - 1 = 65,535$ characters, non-standard with wide support

Numeric Types

SQL Data Type	Description
`INTEGER` or `INT`	whole numbers, typical implementations are signed 32-bit integers
`SMALLINT`	whole numbers, typical implementations are signed 16-bit integers
`DECIMAL(L,D)`	A packed "exact" fixed-point number. L is the total number of digits and D is the number of digits after the decimal point.
`NUMBER(L,D)`	synonym to `DECIMAL(L,D)`
`NUMERIC(L,D)`	synonym to `DECIMAL(L,D)`
`FLOAT`	a single-precision floating point number
`DOUBLE PRECISION`	a double-precision floating point number
`DOUBLE`	synonym to `DOUBLE PRECISION`
`REAL`	a floating point number, some implementations treat it as a synonym to `DOUBLE`

Date and Time Types

SQL Data Type	Description
`Date`	a date, i.e., typically `YYYY-MM-DD`
`Time`	a time, i.e., typically `HH:MM:SS.ssssss`
`DATETIME`	A date and time combination
`TIMESTAMP`	a timestamp, i.e., typically, `YYYY-MM-DD HH:MM:SS.ssssss`

Boolean and Bit String Types

SQL Data Type	Description
`BOOLEAN`	`TRUE, FALSE`
`BIT`	Bit strings are strings of 1's and 0's

Data Types in Example RDBMS

Check out

- MariaDB
- PostgreSQL
- Microsoft SQL Server
- Oracle DBMS
- IBM DB2

and

- SQLite3
- Microsoft Access

Outline

Table Declaration in SQL

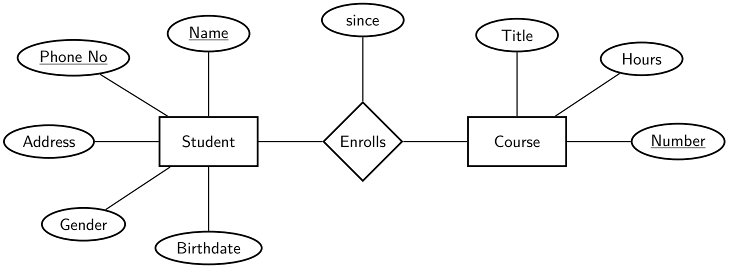
Use CREATE TABLE command

Syntax

```
CREATE TABLE tablename (
column1 datatype [constraint] [,
column2 datatype [constraint] ] [,
PRIMARY KEY (column1 [, column2]) ] [,
FOREIGN KEY (column1 [, column2]) REFERENCES tablename]
CONSTRAINT constraint ] );
```

Table Declaration for a Database in SQL: Example

Consider the following database model



whose relational database schemas are,

`Students(`<u>`name`</u>`:string, `<u>`phone`</u>`:string, address:string, gender:string, birthdate:date)`

`Courses(name:string, title:string, `<u>`number`</u>`, hours:integer)`

`Enrollment(`<u>`sname`</u>`:string, `<u>`sphone`</u>`:string, `<u>`cnumber`</u>`:string, since:datetime)`

Declarations in SQL: Example

```
CREATE TABLE Students (
  name CHAR(30),
  phone CHAR(10),
  address VARCHAR(255),
  gender CHAR(1),
  birthdate DATE,
  -- primary key constraint
  PRIMARY KEY (name, phone)
);

CREATE TABLE Courses (
  title VARCHAR(255),
  -- also primary key constraint
  idnum CHAR(5) PRIMARY KEY,
  hours integer
);
```

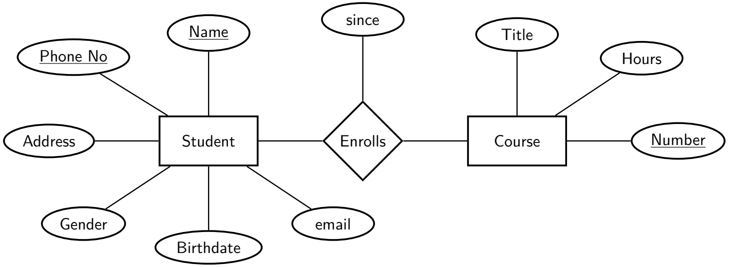
Declarations in SQL: Example

```sql
CREATE TABLE Enrollment(
  sname CHAR(30),
  sphone CHAR(10),
  -- foreign key constraint
  cidnum CHAR(5) REFERENCES Courses ( idnum ),
  since DATETIME,
  -- primary key constraint
  PRIMARY KEY(sname, sphone, cidnum),
  -- also foreign key constraint
  FOREIGN KEY(sname, sphone)
            REFERENCES Students (name, phone));
```

In SQL, -- leads a comment

Table Declaration for a Database in SQL: Revisiting the Example

Let's revisit our example database and consider that we add an attribute to `Students` enttity set.



where the business rule indicates that email addresses must be unique.

Declaration of Students in SQL: Example

```
CREATE TABLE Students (
  name CHAR(30),
  phone CHAR(10),
  address VARCHAR(255),
  gender CHAR(1),
  email VARCHAR(255),
  birthdate DATE,
  -- primary key constraint
  PRIMARY KEY (name, phone),
  UNIQUE (email)
);
```

Declaration of Students in SQL: Example

Since the alternate key has a single attribute, alternatively we can declare it as,

```
CREATE TABLE Students (
  name CHAR(30),
  phone CHAR(10),
  address VARCHAR(255),
  gender CHAR(1),
  email VARCHAR(255) UNIQUE,
  birthdate DATE,
  -- primary key constraint
  PRIMARY KEY (name, phone)
);
```

Describing Table Definition

This is MariaDB specific. To show a table definition, use "`DESCRIBE table_name`," for example,

```
DESCRIBE Students;
```

Constraints in the Example

- Primary Key constraint
  - Single-attribute key?
  - Multi-attribute key?
- Unique constraint (alternate key)
  - Single-attribute key?
  - Multi-attribute key?
- Foreign Key constraint
  - Single-attribute key?
  - Multi-attribute key?

Outline

Removing Tables

To remove tables and the data, use "`DROP TABLE table_name`."

```
DROP TABLE Enrollment;
```

What would happen if we attempted to remove `Students`? Why?

Change Structure of Existing Tables

To change the structure of an existing table, use "`ALTERNATE TABLE` . . . ."

- Add or delete columns
- Change the type of existing columns
- Rename columns or the table itself
- More . . .

Adding or Deleting Columns

To delete a column, use “ALTER TABLE table_name DROP column_name.”

```
ALTER TABLE Students DROP gender;
```

To add a column, use “ALTER TABLE table_name ADD column_name data_type.”

```
ALTER TABLE Students ADD gender CHAR(1);
```

Changing Type of Existing Columns

To change the type of existing column, use "`ALTER TABLE table_name MODIFY column_name data_type`"

```
ALTER TABLE Students MODIFY gender VARCHAR(10);
```

Renaming Existing Columns

To rename an existing column, use “`ALTER TABLE table_name CHANGE old_column_name new_column_name data_type`”

```
ALTER TABLE Students CHANGE birthdate birthday DATE;
```

Renaming Existing Tables

To rename an existing table, use "`ALTER TABLE table_name RENAME TO new_table_name`"

```
ALTER TABLE Students RENAME TO Students2;
```

Outline

Getting Help

Other than looking up the documentation online or from a book, we can use the "`help`" command – this is MariaDB specific.

```
HELP ALTER TABLE;
```

```
HELP CREATE TABLE;
```

Outline

Assignment

Let's work on an assignment using paper and pencil/pen ...