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Structured Query Language (SQL)

CS 272 Software Development

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Introduction

- **Structured Query Language (SQL)**
  - Often pronounced "sequel" or spelled out "S-Q-L"
  - Standard language for relational databases
- **Relational Database Management System (RDBMS)**
  - MySQL or MariaDB, PostgreSQL, SQL Server, Oracle, IBM DB2, SQLite, ...

SQL Statements

- **Keywords**
  - Traditionally UPPERCASE (optional)
  - Includes operators (e.g. =, >, etc.)
- **Identifiers**
  - Traditionally lowercase
- **Literal values**

https://dev.mysql.com/doc/refman/8.0/en/language-structure.html

Example SQL Statement

```
SELECT name FROM teams WHERE id=9;
```

Example Keywords

```
SELECT name FROM teams WHERE id=9;
```

Example Identifiers

```
SELECT name FROM teams WHERE id=9;
```

Example Literal

```
SELECT name FROM teams WHERE id=9;
```

Example Clause

```
SELECT name FROM teams WHERE id=9;
```

FROM Clause of a SELECT Statement

Data Definition Language (DDL)

Data Definition Language (DDL)

- Create and Manipulate Structure
  - e.g. tables, databases, schemas, etc.
- Example Statements
  - **CREATE**: Add new database object
  - **ALTER**: Manipulate existing database object
  - **DROP**: Remove database object

https://mariadb.com/kb/en/data-definition/

Data Definition Language (DDL)

```
CREATE TABLE [tab_name] (
  [col_name] [DATA_TYPE] [CONSTRAINTS], ...
);

CREATE TABLE students (
  id INTEGER NOT NULL PRIMARY KEY,
  name VARCHAR(50) NOT NULL,
  Program VARCHAR(50));
```

https://mariadb.com/kb/en/create-table/

Column Data Types

- Numeric Data Types
  - e.g. TINYINT, INTEGER, DECIMAL, FLOAT, etc.
- Character Data Types
  - e.g. CHAR, VARCHAR, BLOB, ENUM, etc.
- Temporal Data Types
  - e.g. DATE, TIME, DATETIME, TIMESTAMP, etc.

https://mariadb.com/kb/en/data-types/

Numeric Data Types

Type	Bytes	Minimum	Maximum
TINYINT	1	–128 or 0	127 or 255
SMALLINT	2	–32,768	32,767
MEDIUMINT	3	–8,388,608	8,388,607
INTEGER	4	–2,147,483,648	2,147,483,647
BIGINT	8	–9,223,372,036,854,775,808 ...	

https://mariadb.com/kb/en/numeric-data-type-overview/

Numeric Data Types

- DECIMAL(precision[, scale]) for "exact" floating types
  - precision: total number of digits
  - scale: digits after decimal point
- FLOAT or DOUBLE for "approximate" floating types for really large or really small numbers

https://mariadb.com/kb/en/data-types-numeric-data-types/

Character Data Types

- CHAR(width) for fixed width text
- VARCHAR(maxwidth) for variable width text
- BLOB (binary large object) for images, files, etc.
- TEXT for large variable-sized text (e.g. articles)
- ENUM for fixed text values (e.g. types of fruit)

https://mariadb.com/kb/en/string-data-types/

Temporal Data Types

- DATE, TIME, DATETIME, TIMESTAMP, etc.
- Different input, storage, and display formats
- Input format depends on database system
  - e.g. usually YYYY-MM-DD date input format
- Display format controlled by query
  - e.g. MM/DD/YYYY

https://mariadb.com/kb/en/date-and-time-data-types/

Column Constraints

- **`PRIMARY KEY`**
  - Indicates column values can be used to uniquely identify each row
- **`AUTO_INCREMENT`**
  - Automatically increments value for each row (useful for primary keys)

https://mariadb.com/kb/en/create-table/#column-definitions

Column Constraints

- **`UNIQUE`**
  - Indicates column values must be unique
- **`NULL`** or **`NOT NULL`**
  - Indicates column values may (or may not) be null
- **`DEFAULT`**
  - Uses a default value if no value provided

https://mariadb.com/kb/en/create-table/#column-definitions

Data Manipulation Language (DML)

Data Manipulation Language (DML)

- Create and Manipulate Data
  - e.g. create or modify row in table
- Example Statements
  - **INSERT**: Creates new row(s) in a table
  - **UPDATE**: Updates value(s) in a table
  - **DELETE**: Removes rows from a table

https://mariadb.com/kb/en/data-manipulation/

Data Manipulation Language (DML)

```
INSERT INTO [tab_name]
([column_order])
VALUES ([column_values]);
```

```
INSERT INTO students
(name, degree)
VALUES ('Yasmin', 'CS');
```

https://mariadb.com/kb/en/insert/

SQL SELECT Statements

- Retrieves information from database
- Common clauses
  - `FROM [tab_name]`
  - `WHERE [condition]`, `HAVING [condition]`
  - `GROUP BY [col_name]`, `ORDER BY [col_name]`

https://mariadb.com/kb/en/selecting-data/

SQL SELECT JOIN Clauses

- Combines results together from multiple tables
- Multiple types of JOINs
  - e.g. INNER JOIN, LEFT OUTER JOIN, RIGHT OUTER JOIN, NATURAL JOIN, etc.
- Critical component of SELECT statements

https://mariadb.com/kb/en/joins/

INNER JOIN

upper

1	A
2	B
3	C

lower

b	2
c	3
d	4

LEFT OUTER JOIN

upper

1	A
2	B
3	C

lower

b	2
c	3
d	4

LEFT OUTER JOIN

upper

1	A
2	B
3	C

lower

b	2
c	3
d	4

RIGHT OUTER JOIN

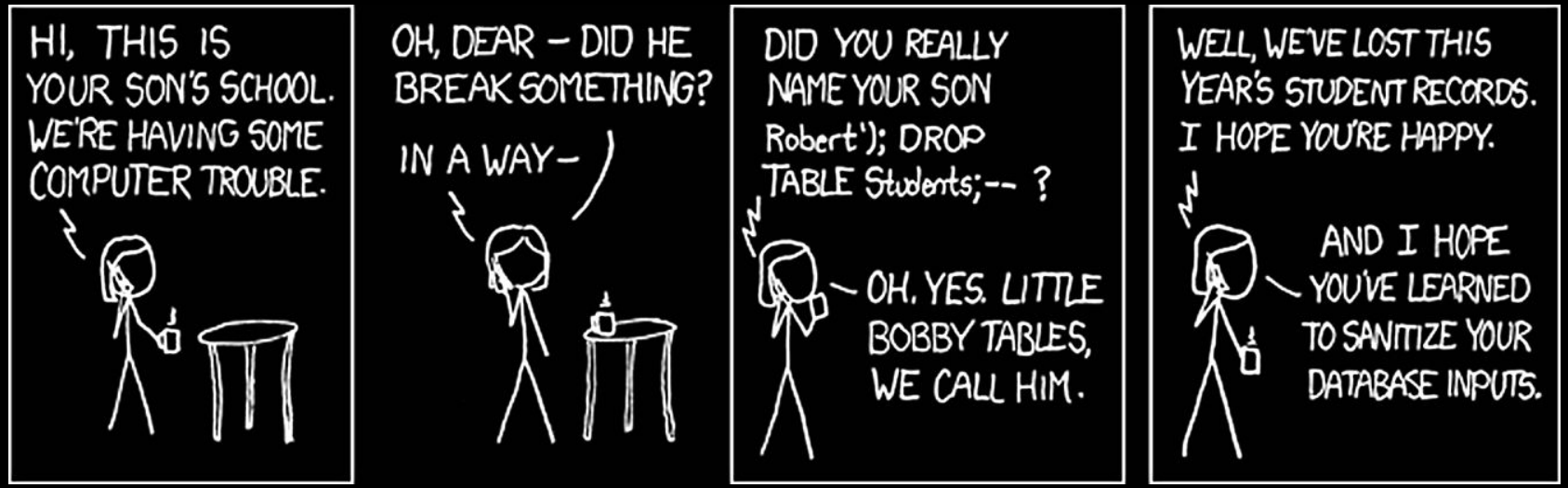
upper

1	A
2	B
3	C

lower

b	2
c	3
d	4

Bobby Tables



https://xkcd.com/327/

Questions?