COS 316
Precept: SQL
History

  • definitive model for relational database management systems (RDBMS).
• 1970s. Structured English Query Language (SEQUEL)
  • IBM Corporation based on Codd's model
  • Called SEQUEL later became SQL (still pronounced "sequel")
  • Structured Query Language
• 1979. Relational Software, Inc. (now Oracle) introduced the first commercially available implementation of SQL
• 1986. ANSI Standard
• Today. ANSI/ISO Standard
  • Although many vendors have their own variations
Relational Database

- What really is relational? ~**tables**
  - Present data as a collection of tables
  - Use “relational” operators to manipulate data in tabular form
- A table represents one “entity type”
- A row represents an instance of that type
  - Rows are called **records**
  - Unique key to identify each row.
- Columns are called **attributes**
- Link to rows in other tables by adding a column for unique keys of the linked row in other tables
  - Foreign keys
### Tables, Tuples and Attributes

Each column has an attribute / type

<table>
<thead>
<tr>
<th>ID</th>
<th>TITLE</th>
<th>YEAR</th>
<th>AUTHOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>198</td>
<td>Harry Potter and the Philosopher's Stone</td>
<td>1997</td>
<td>ROWLING</td>
</tr>
<tr>
<td>090</td>
<td>Game of Thrones</td>
<td>1991</td>
<td>MARTIN</td>
</tr>
<tr>
<td>134</td>
<td>A Clash of Kings</td>
<td>1992</td>
<td>MARTIN</td>
</tr>
</tbody>
</table>

**BOOKS**

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**tuples/records**

**primary key**

**tables / relations**
## Tables, Tuples and Attributes

### BOOKS

<table>
<thead>
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<th>TITLE</th>
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<th>AUTHOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>198</td>
<td>Lord of the Rings</td>
<td>1954</td>
<td>1712</td>
</tr>
<tr>
<td>090</td>
<td>Game of Thrones</td>
<td>1991</td>
<td>2000</td>
</tr>
<tr>
<td>134</td>
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<td>2000</td>
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</tbody>
</table>

### AUTHORS

<table>
<thead>
<tr>
<th>KEY</th>
<th>FIRST</th>
<th>LAST</th>
<th>YEAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1712</td>
<td>J RR</td>
<td>Tolkien</td>
<td>1892</td>
</tr>
<tr>
<td>2000</td>
<td>George RR</td>
<td>Martin</td>
<td>1948</td>
</tr>
<tr>
<td>1311</td>
<td>Charles</td>
<td>Dickens</td>
<td>1812</td>
</tr>
</tbody>
</table>
Popular RDBMS

- MySQL – https://www.mysql.com
- Postgres – https://www.postgresql.org
- SQLite – https://www.sqlite.org

- lightweight in terms of setup, database administration, and required resource
- features: self-contained, serverless, zero-configuration, transactional
RDBMS Architectures

MySQL, Postres, etc.

Client

Application
Connector

Server
Server Process
SQL DB

SQLite

Application
Connector
SQL DB
SQLite Storage Classes*

• **NULL**
  - Value is a NULL value

• **INTEGER**
  - Value is a signed integer, stored in 1, 2, 3, 4, 6, or 8 bytes depending on the magnitude of the value

• **REAL**
  - Value is a floating point value, stored as an 8-byte IEEE floating point number

• **TEXT**
  - Value is a text string, stored using the database encoding (UTF-8, UTF-16BE or UTF-16LE)

• **BLOB.**
  - The value is a blob of data, stored exactly as it was input

* [https://www.sqlite.org/datatype3.html](https://www.sqlite.org/datatype3.html)
Using SQLite - Setup

> cd <Precepts repo>

> git pull # update with precept6

> cd precept6

> go get github.com/mattn/go-sqlite3
Using SQLite - Windows

- Start the X server on their host machine.
  - Windows key to open search, then type `XLaunch`
- In the command prompt on the host machine, before running `vagrant ssh`, set the environment variable `DISPLAY` to `localhost:0.0`
  - In a cmd shell, type: `set DISPLAY=localhost:0.0`
  - In a bash shell, type: `export DISPLAY=localhost:0.0`
  - Run `vagrant ssh` as normal
Using SQLite - Locally

• SQLite 3 should already be installed
• Optional: download DB Browser for SQLite

https://sqlitebrowser.org/dl
Exercise Dataset

- MovieLens –
  https://grouplens.org/datasets/movielens/
MovieLens

4 different tables contained in the MovieLens database:

- **Movies**
  - movielId: represent the movie id
  - title: represent the full movie title
  - year: year of release
  - genre: a pipe-separated list of genres associated with the movie

- **Links**
  - movielId: represent the movie id
  - imdbId: can be used to generate a link to the IMDb site
  - tmdbId: can be used to generate a link to the The Movie DB site

- **Ratings (made by users)**
  - userId & movielId: represent the user id and movie id
  - rating: uses a 5-star scale, with 0.5 star increments
  - timestamp: use the epoch format (seconds since midnight of January 1, 1970 on UTC time zone)

- **Tags (added by users)**
  - userId & movielId: represent the user id and movie id
  - tag: represent user-generated textual metadata
  - timestamp: use the epoch format (seconds since midnight of January 1, 1970 on UTC time zone)
import (
    "database/sql"
    _ "github.com/mattn/go-sqlite3"
)

- Load database driver anonymously, aliasing its package qualifier to _
  - none of its exported names are visible
- Driver registers itself as being available to the database/sql package, but in general nothing else happens with the exception that the init function is run.
Go and SQL (2) - Opening a Database

```go
conn, err := sql.Open("sqlite3",
    "file:MovieLens.db")
```

- Create a sql.DB using sql.Open()
- First argument: driver name - driver uses to register itself with database/sql
- Second argument: driver-specific syntax that tells the driver how to access the underlying datastore
  - See [https://github.com/mattn/go-sqlite3](https://github.com/mattn/go-sqlite3)
<table>
<thead>
<tr>
<th>Go</th>
<th>SQLite</th>
</tr>
</thead>
<tbody>
<tr>
<td>nil</td>
<td>null</td>
</tr>
<tr>
<td>int</td>
<td>integer</td>
</tr>
<tr>
<td>int64</td>
<td>integer</td>
</tr>
<tr>
<td>float64</td>
<td>real</td>
</tr>
<tr>
<td>bool</td>
<td>integer</td>
</tr>
<tr>
<td>[]byte</td>
<td>blob</td>
</tr>
<tr>
<td>string</td>
<td>text</td>
</tr>
<tr>
<td>time.Time</td>
<td>timestamp/datetime</td>
</tr>
</tbody>
</table>
Go and SQL (4) - Queries

```go
var (
    title  string
    genres string
)
rows, err := db.Query("select title, genres from Movies where year = 1933;")
if err != nil {
    log.Fatal(err)
}
defer rows.Close()
for rows.Next() {
    err := rows.Scan(&title, &genres)
    if err != nil {
        log.Fatal(err)
    }
    log.Println(title, genres)
}
err = rows.Err()
if err != nil {
    log.Fatal(err)
}
```
Go and SQL (5) - More Queries

```go
err = db.QueryRow("select title from Movies where movieId = ?", 1).Scan(&title)
if err != nil {
    log.Fatal(err)
}
fmt.Println(title)
```
stmt, err := db.Prepare("select title from Movies where year = ?")
if err != nil {
    log.Fatal(err)
}
defer stmt.Close()
if err != nil {
    log.Fatal(err)
}
defer rows.Close()
for rows.Next() {
    err := rows.Scan(&title)
    if err != nil {
        log.Fatal(err)
    }
    log.Println(title)
}
if err = rows.Err(); err != nil {
    log.Fatal(err)
}
Go and SQL (7) - Updates

```go
cstmt, err = db.Prepare("INSERT INTO movies(movieId,title, year, genres) VALUES(?,?,?,?)")
if err != nil {
    log.Fatal(err)
}
if err != nil {
    log.Fatal(err)
}
lastId, err := res.LastInsertId()
if err != nil {
    log.Fatal(err)
}
rowCnt, err := res.RowsAffected()
if err != nil {
    log.Fatal(err)
}
log.Printf("ID = %d, affected = %d\n", lastId, rowCnt)
```
Go and SQL Exercise

1. Write a function to find and print the oldest movies in the database

2. Write a function to find and print a movie by name

3. Use JOIN (https://www.sqlitetutorial.net/sqlite-join/) to list movie titles alongside their ratings
1. Write a function to find and print the oldest movies in the database:
   a. `rows, err := db.Query("select * from Movies order by year asc")`

2. Write a function to find and print a movie by name:
   a. `rows, err := db.Query("select * from Movies where title = ?", title)`

3. Use JOIN ([https://www.sqlitetutorial.net/sqlite-join/](https://www.sqlitetutorial.net/sqlite-join/)) to list movie titles alongside their ratings:
   a. `rows, err := db.Query("select title, rating from Movies as t1 INNER JOIN Ratings as t2 on t1.movieId = t2.movieId")`