Distributed Database in Go

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May 18, 2025

Abstract

This report presents the design and implementation of a simple distributed database system using the Go programming language and SQLite. The system follows a master-slave architecture where nodes communicate via HTTP to ensure replication and consistency of data. The project is intended for educational use and demonstrates key principles of distributed systems.

1 Introduction

Distributed systems are essential in building scalable, fault-tolerant applications. This project simulates a distributed database setup with a central master node and multiple slave nodes. Each node runs independently and communicates over HTTP to replicate changes and maintain data consistency.

2 System Architecture

The system consists of:

- **Master Node:** Handles privileged operations like creating or deleting tables. It replicates these changes to all slave nodes.
- **Slave Nodes:** Handle regular SQL operations. They replicate queries to the master and other slaves.
- **SQLite Database:** Embedded database engine used by all nodes.

Each node listens for HTTP POST requests and processes them based on the role (master or slave).

3 Features

- Master-slave architecture
- SQLite storage engine

- HTTP communication between nodes
- Query replication for consistency
- Command-line runnable nodes

4 How to Run

Install Dependencies

```
go mod tidy
```

Run Slave Node

```
go run node/main.go <slave_id> <num_slaves>
```

Run Master Node

```
go run master/main.go <num_slaves>
```

5 Usage Example

To create a table via the master node, send the following JSON to `http://localhost:8080`:

```
{
  "command": "exec",
  "query": "CREATE TABLE IF NOT EXISTS users (
      id INTEGER PRIMARY KEY,
      username TEXT UNIQUE,
      email TEXT,
      created_at TIMESTAMP DEFAULT CURRENT_TIMESTAMP
  )",
  "is_master": false
}
```

6 File Structure

```
distributed-database/
          master/main.go        # Master node logic
          node/main.go          # Slave node logic
          show_all/main.go      # Helper to view databases
          send_dummy.go         # Helper to send test requests
          go.mod, go.sum        # Go modules
```

7 System Logic

Privileged Operations

Only the master can execute table or schema-related queries. It then replicates the query to slaves.

Query Replication

- Master replicates queries to all slaves.
- Slaves replicate to the master and remaining slaves.
- A flag prevents recursive replication.

8 Technologies Used

- Go (Golang)
- SQLite
- HTTP/REST for inter-node communication

9 Authors

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