Class 4 Spanner

Elements of Databases

Sept 17, 2021

Announcements

Preparing for Midterm 1:

- End-of-chapter exercises (requires Sakila sample database)
- Practice SQL on Hacker Rank
- Practice SQL on Leetcode

On the horizon:

- BigQuery starting next week (no setup needed)
- Review session for Midterm 1 (week of the 4th)

Instapoll on your Spanner setup

https://github.com/cs327e-fall2021/snippets/wiki/Spanner-Setup-Guide

1. Connect to the span database you created during the setup (either from UI or spanner-cli).

2. Run this query: `SELECT count(*) FROM information_schema.tables;`

3. How many tables are in the output?

A World without Transactions

Time

	Client 1	Client 2

t_0	`UPDATE account`
	`SET balance = balance - 100`
	`WHERE name = 'Alice';`	

t_1		`SELECT name, balance`
		`FROM account`
		`WHERE name IN ('Alice', 'Bob');`

t_2	`UPDATE account`
	`SET balance = balance + 100`
	`WHERE name = 'Bob';`	

A World without Transactions

Time

	Client 1	Client 2

t_0	`UPDATE playlist`
	`SET count = count + 1`
	`WHERE user = 'Alice';`
		`UPDATE playlist`
		`SET count = count + 1`
		`WHERE user = 'Alice';`

t_1	`SELECT count`
	`FROM playlist`
	`WHERE user = 'Alice';`
		`SELECT count`
		`FROM playlist`
		`WHERE user = 'Alice';`

Transaction Guarantees

- Atomicity
- Consistency
- Isolation
- Durability

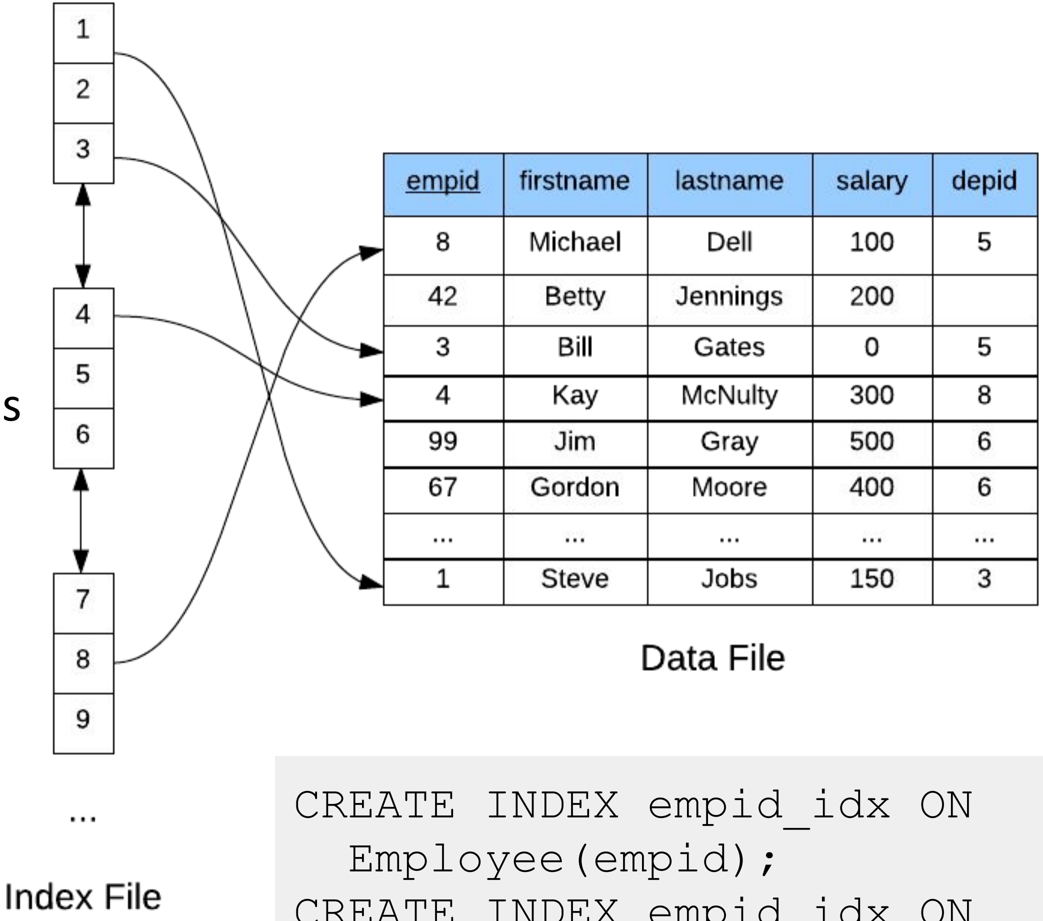
Transaction Blocks

```
BEGIN TRANSACTION;
  {some SQL statement 1}
  {some SQL statement 2}
  {some SQL statement n}
COMMIT;
```

```
BEGIN TRANSACTION;
  {some SQL statement 1}
  {some SQL statement 2}
  {some SQL statement n}
ROLLBACK;
```

Database Indexes

- **Critical** for many databases
- At least one index per table
- DBA analyzes workload and chooses which indexes to create (no easy answers)
- Creating indexes can be an expensive operation
- They work “behind the scenes”
- Query optimizer decides which indexes to use during execution

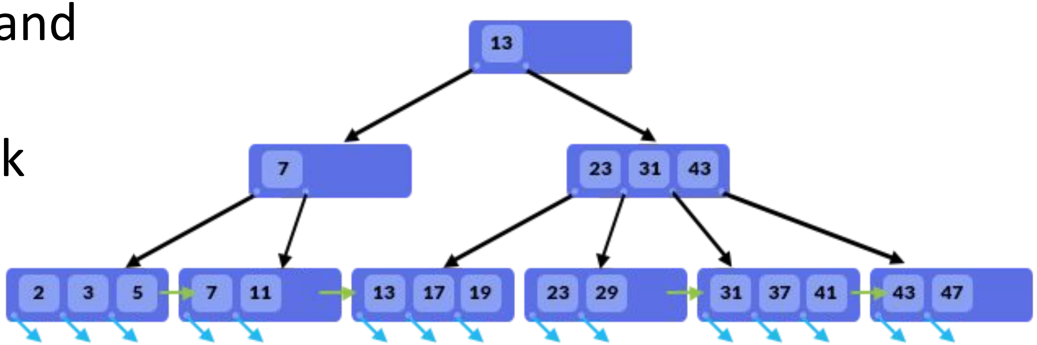


empid	firstname	lastname	salary	depid
8	Michael	Dell	100	5
42	Betty	Jennings	200	
3	Bill	Gates	0	5
4	Kay	McNulty	300	8
99	Jim	Gray	500	6
67	Gordon	Moore	400	6
...	...	...	...	...
1	Steve	Jobs	150	3

```
CREATE INDEX empid_idx ON
  Employee(empid);
CREATE INDEX empid_idx ON
  Employee(empid, salary);
```

B-Trees

- Standard index implementation in relational databases
- Designed to speed up lookups and range queries
- One tree node maps to one disk page
- Nodes store index entries
- Index entry = (key, ref)
- Branching factor 100+
- Height is O(log *n*)
- Search speed ≈ height of tree

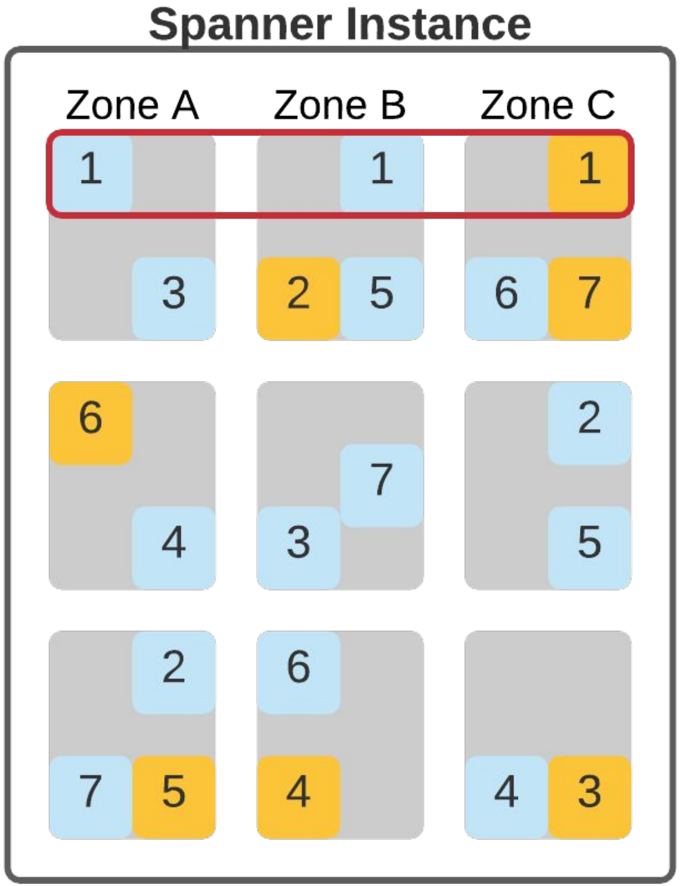


Spanner Overview

- Distributed database system:

  1 Spanner instance == 1...1000’s nodes

- Regional and multi-regional configurations
- Implements relational model
- Standard SQL (+ table hierarchies)
- Implements ACID transactions
- TrueTime assigns globally consistent time
- Compute and storage are decoupled
- Data is split based based on load and volume
- Dynamic split assignments to nodes
- Massive scale (PBs, 1000+ nodes)
- Higher latency per QPS than MySQL, etc.



Spanner Code Lab

- Clone snippets repo
- Open spanner notebook
- Create shopify database
- Populate shopify tables
- Run transactions
- Create foreign key
- Create index

Practice Problem 1

Debug this query and create an index to try to speed up its runtime.

```
SELECT *, c.title
WHERE c.title = 'Productivity'
FROM categories c JOIN apps_categories
ON c.id = category_id
AND reviews_count >= 50
AND rating >= 4.0
JOIN apps ON id = app_id;
```

Practice Problem 2

1. Write a query that returns all records in `pricing_plans` whose app_id values don’t exist in the table `apps.id`.

2. If the above query returns NULL, create a Foreign Key on `pricing_plans.app_id` which references `apps.id.`

Project 3

http://www.cs.utexas.edu/~scohen/projects/Project3.pdf