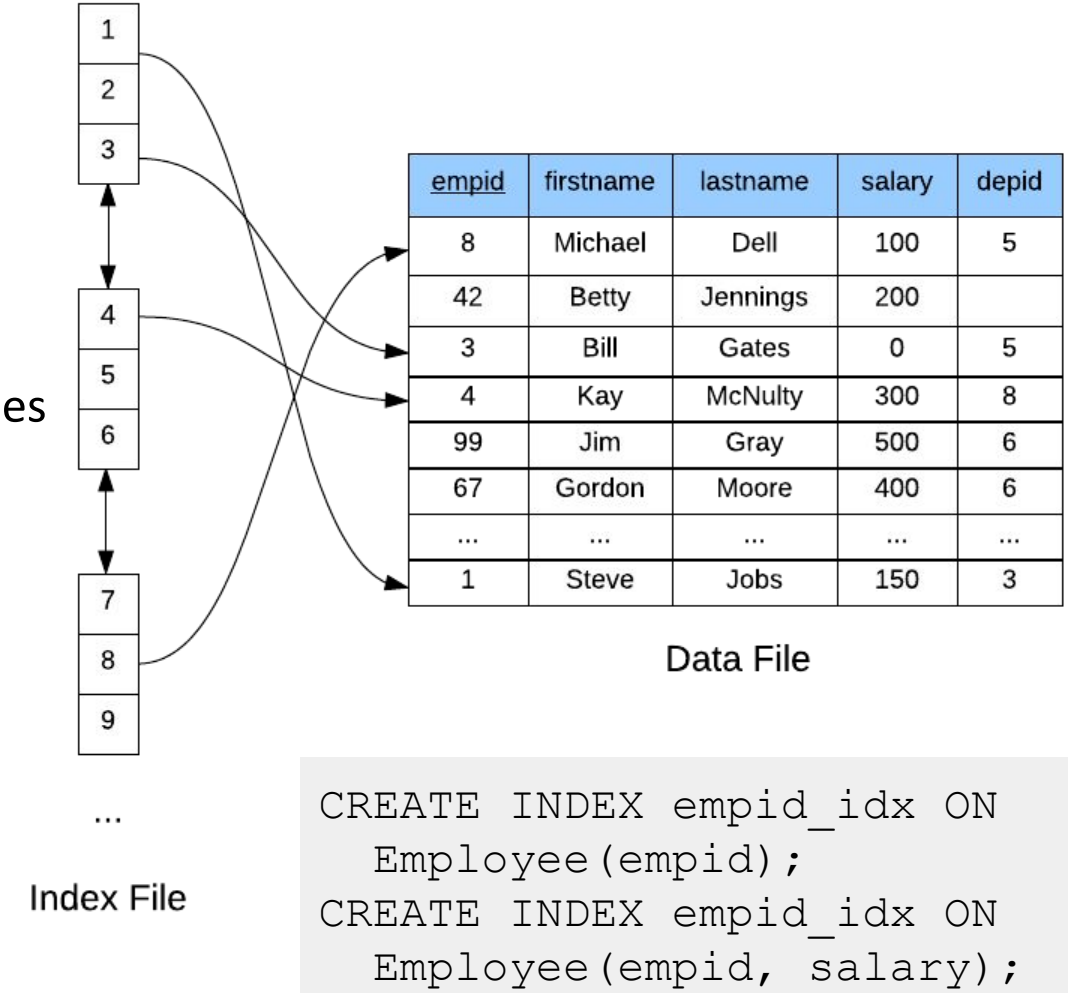
Class 5 BigQuery

Elements of Databases

Feb 25, 2022

Database Indexes

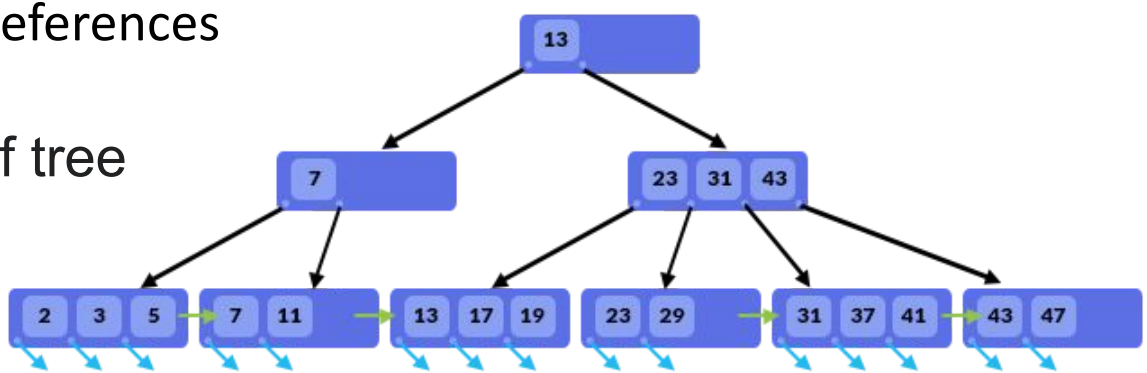
- **Critical** for many databases
- At least one index per table
- DBA analyzes workload and chooses which indexes to create (no easy answers)
- Creating indexes can be an expensive operation
- They work “behind the scenes”
- Query optimizer decides which indexes to use during execution




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

B-Trees

- Standard index implementation in most database systems
- Keep key-value pair sorted by key
- Designed to speed up lookups and range queries
- One tree node maps to one disk page (4KB - 8KB)
- A node is packed with index entries (typically 100+)
- Index entry = (key, reference)
- High branching factor = references to child nodes (100+)
- Search speed ≈ height of tree
- Height of tree is O(log *n*) where *n* = index keys



Postgres Code Lab, Part 3

- Clone snippets repo
- Open postgres idx notebook
- Generate an explain plan
- Use \timing
- Create an index to speed up a query

Global Aggregate Queries

```
SELECT <aggregate function>
       [, <aggregate function>]
FROM <single table>
[JOIN <single table>
 ON <join condition>]
[WHERE <boolean condition>]
~~ORDER BY <field(s) to sort on>~~
```

Global Aggregate Queries

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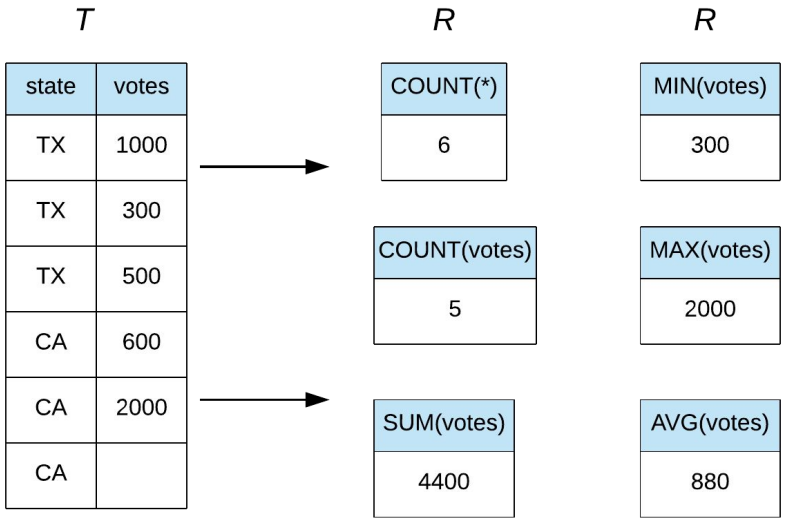
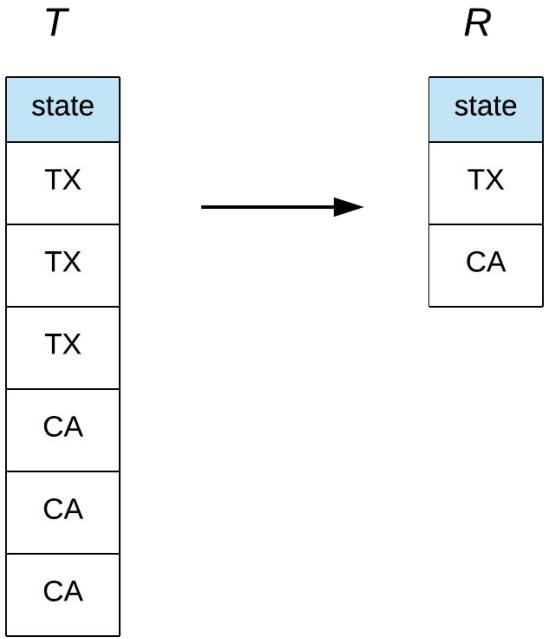


Group By Queries

```
SELECT <unaggregated field(s)>
FROM <single table>
[JOIN <single table>
ON <join condition>]
[WHERE <boolean condition>]
GROUP BY <unaggregated field(s)>
```



Aggregate Group By Queries

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SELECT <unaggregated field(s)>,
       <aggregate function(s)>
FROM <single table>
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[WHERE <boolean condition>]
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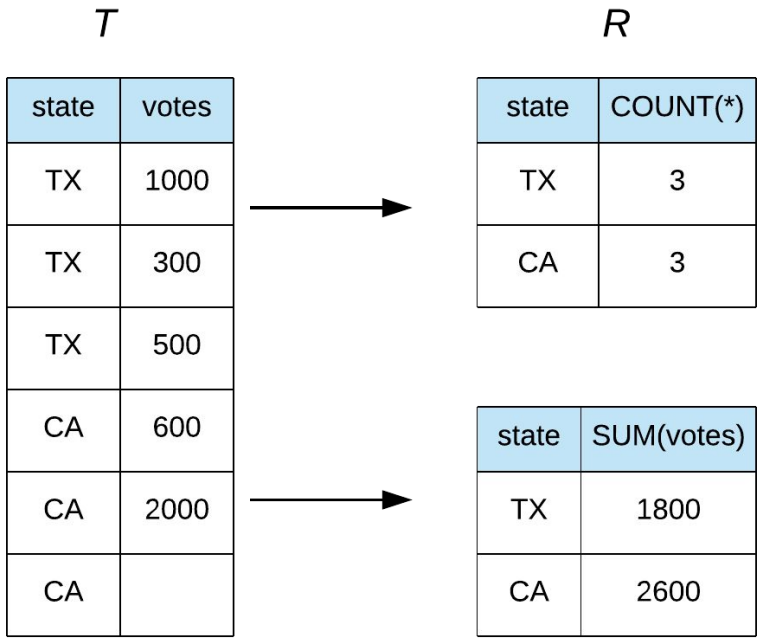


The semantics of `COUNT()`

```
SELECT COUNT(*)
FROM Employee

SELECT COUNT(department)
FROM Employee

SELECT DISTINCT department
FROM Employee

SELECT COUNT(DISTINCT department)
FROM Employee
```

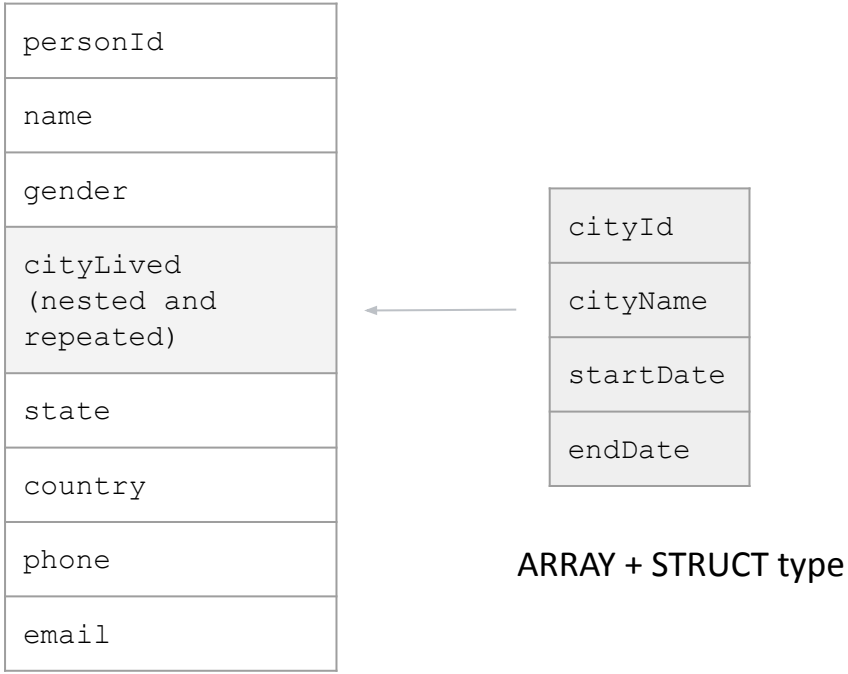
Employee

row	employee	department
1	Sunil	ENG
2	Morgan	ENG
3	Rama	Product
4	Drew	
5	Jeff	Research
6	Danielle	HR
7	Grace	ENG

BigQuery Overview

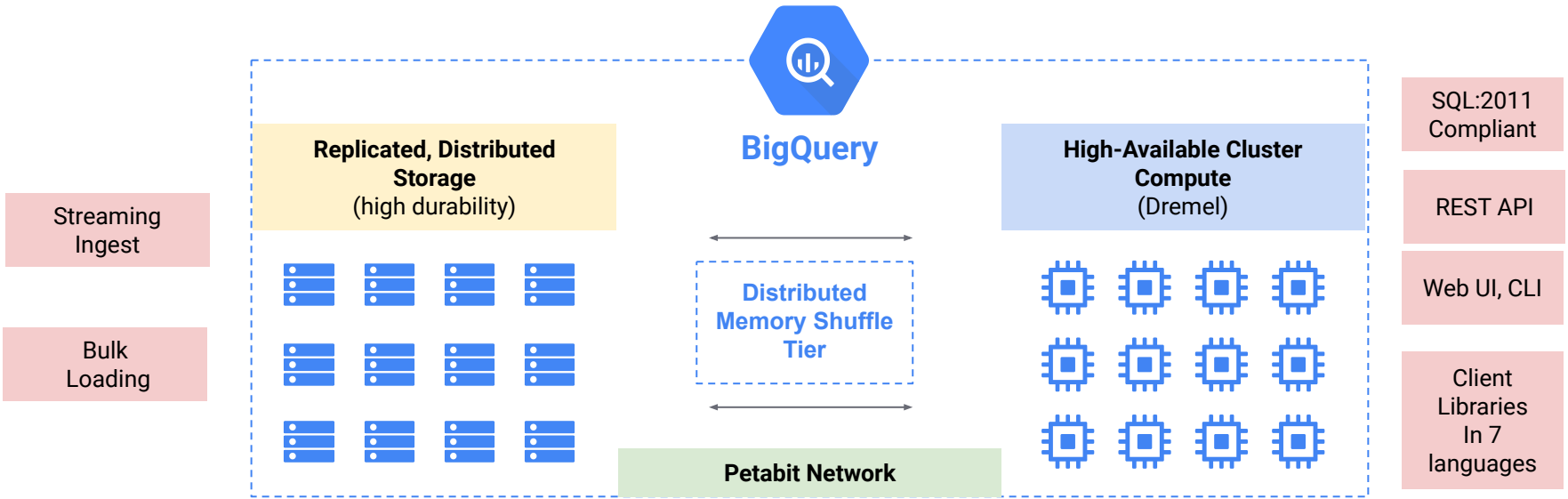
- Data warehouse / analytics database service
- Distributed database system
- Optimized for large data (petabyte-scale)
- Data model: tables with optional nesting
- Query language: standard SQL
- Data Types:
  - Primitive: BOOL, BYTES, FLOAT64, INT64, NUMERIC, STRING
  - Temporal: DATE, DATETIME, TIME, TIMESTAMP
  - Geospatial: GEOGRAPHY
  - Complex: ARRAY, STRUCT
- No provisioning needed, easy to use
- Not an operational database, no referential integrity

Nested Columns



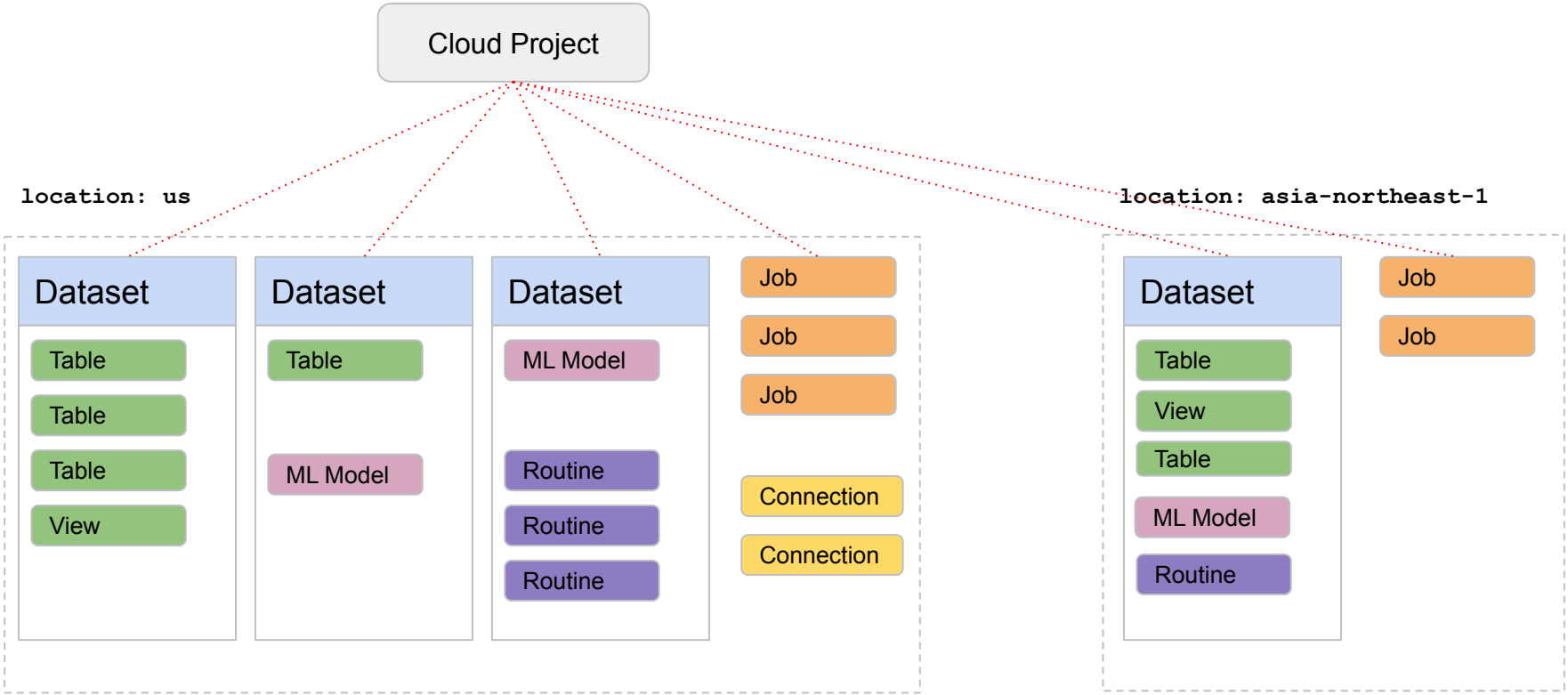
ARRAY + STRUCT type

BQ Architecture*



* Very approximate

Resource Model



BigQuery Code Lab

- Clone snippets repo
- Open bigquery notebook
- Create college dataset
- Populate college tables
- Explore the data
- Write aggregate queries

Exercise 1: Group-by queries

For each class in the database, obtain the number of students taking the class.

Return the cno for the class along with its enrollment count.

Sort the results by enrollment in descending order.

Database Schema:

Student(sid, fname, lname, dob, status)

Class(cno, cname, credits)

Instructor(tid, name, dept)

Takes(sid, cno, grade)

Teaches(tid, cno)

Exercise 2: Group-by queries

For each class in the database which has at least two students enrolled, how many students are taking the class?

Return the cno for the class along with its enrollment count.

Sort the results by enrollment in descending order.

Database Schema:

Student(sid, fname, lname, dob, status)

Class(cno, cname, credits)

Instructor(tid, name, dept)

Takes(sid, cno, grade)

Teaches(tid, cno)

Project 4: explore K-12 enrollment data

Assignment sheet

- Open project4 notebook
- Run starter code:
  - Create and populate tables
  - Explore the data
  - Write aggregate query
  - Create database view
  - Created data visualization