



Review

Data
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Request
Coordination

Cassandra
Query
Language

Terms

Start
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Keyspaces

Inserting
Data

Shutting
Down

Consider this

Introduction to Database Systems: CS312

Cassandra

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Quiz 2

Let's Review a Bit

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Time to Review

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Consider this

Theory of NoSQL

- The CAP Theorem
- The theory behind MongoDB and Cassandra
- Shards and scaling in MongoDB
- Schemas: NoSQL versus RDBMS

Compare and contrast

- Tools: Sqlite3 versus MongoDB
- Database Language Guide: terminologies of RDBMS compared to those of MongoDB
- *Sharding* and *scaling* in MongoDB
- Schemas: MongoDB versus Sqlite3
- The CAP theory (Capacity, Availability and Partition tolerance)

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Consider this

Simple answers

- Provide short answers or basic code. (Review your sandbox files!)
 - Placing simple data into JSON format (i.e., a person's "name", "age", etc)
 - Inserting json data in MongoDB
 - Queries in MongoDB (see the *employee* data and its queries)
 - Comparing values in MongoDB queries
 - Queries in Cassandra

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Consider this

Nodes

- All the nodes in a cluster play the same role.
 - Each node is independent and at the same time interconnected to other nodes.
- Each node in a cluster can accept read and write requests, regardless of where the data is actually located in the cluster.
- When a node goes down, read/write requests can be served from other nodes in the network.

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Consider this

Nodes

- One or more of the nodes in a cluster act as *replicas* (i.e., cloning) for a given piece of data
- If out-of-date values return from a node, Cassandra will return the most recent value to the client.
- After returning the most recent value, Cassandra performs a read repair in the background to update the stale values.

Replication of Data

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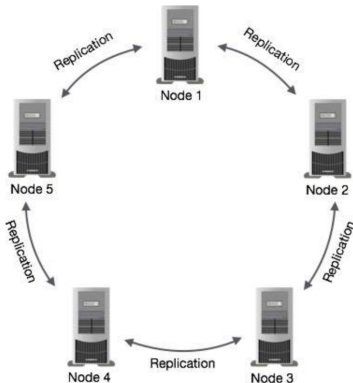
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Consider this



Nodes

- Nodes are updated in the background using a *Gossip Protocol*
- Nodes communicate: detection of faulty nodes within cluster

Request Coordination

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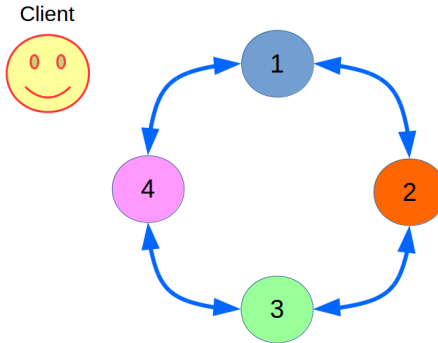
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Consider this



- Coordinator: the node chosen by the client to receive a particular read or write to its cluster
- No single point of Failure

Request Coordination

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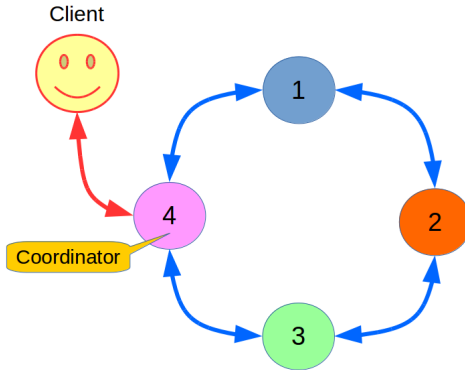
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Consider this



- The client connects to the closest node to run a query
- Each client request may be coordinated by a different node

Request Coordination

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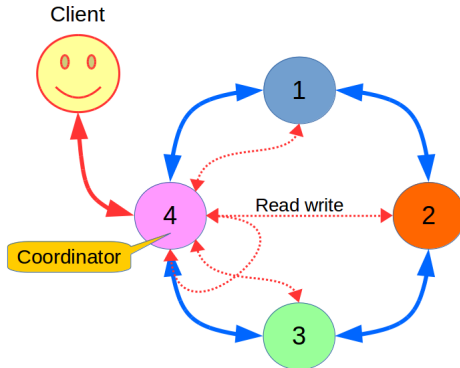
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Consider this



- The request is immediately sent to all other nodes where updates occur (if a write) or the query is performed (if a read)

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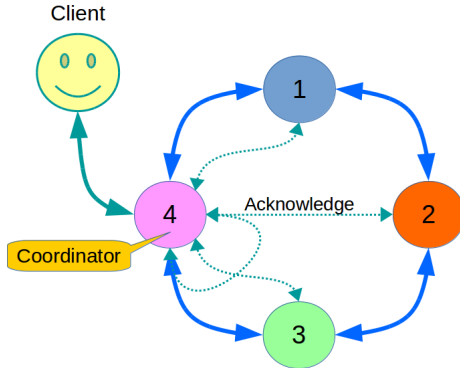
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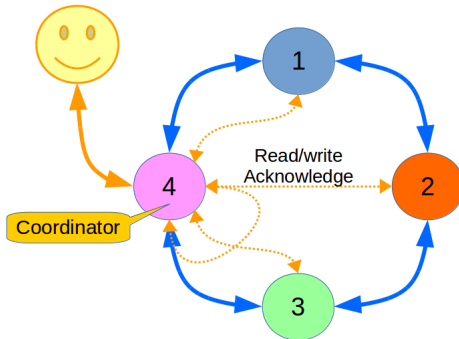
Consider this



- By the node responses, the coordinator node may also learn of any connectivity issues.

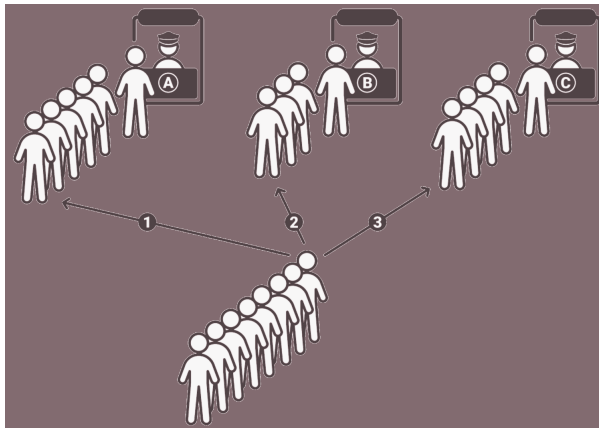
Request Coordination

Client: **Cassandra Driver**



- The Cassandra driver chooses the coordinator node
- Round-Robin pattern, token-aware pattern: nodes attempt contact with others using different connection attempts each time and service is received from different nodes each time to help distribute load on the network.

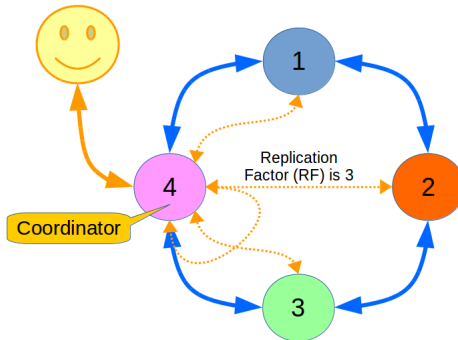
Round Robin?



- Signalling nodes use different orders to contact others each time to distribute the load across network

Request Coordination

Client: **Cassandra Driver**



- The coordinator manages the replication process
- Replication Factor (RF): num of nodes to share with
- The write will occur on the nodes responsible for that partition
- Each write has been time-stamped

Access to Cassandra

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Consider this

cqlsh

- Access Cassandra through its nodes using Cassandra Query Language (CQL).
- CQL treats the database (Keyspace) as a container of tables.
- Note: Programmers use `cqlsh`: a prompt to work with CQL or use separate application language drivers to access the base.
- Clients approach any of the nodes for their read-write operations.
- That node (coordinator) plays a proxy between the client and the nodes holding the data.

Reading and Writing

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Consider this

Read Operations

During read operations, Cassandra gets values from the mem-table and checks the bloom filter to find the appropriate SSTable that holds the required data.

Write Operations

- Write activities of nodes are captured by the commit logs written in the nodes.
- This data will eventually be captured and stored in the mem-table.
- Whenever the mem-table is full, data will be written into the SSTable data file.
- All writes are automatically partitioned and replicated throughout the cluster.
- Garbage Collection: Cassandra periodically consolidates the SSTables, discarding unnecessary data.

Terms and Definitions

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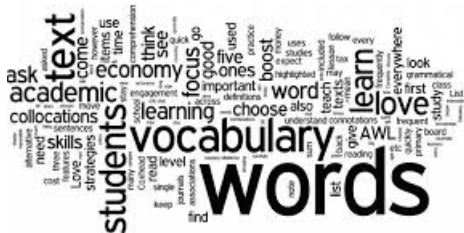
Start Cassandra

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Consider this



Term	Definition
Node	The place where data is stored.
Data center	A collection of related nodes.
Cluster	A cluster is a component that contains one or more data centers.
Commit log	A crash-recovery mechanism in Cassandra. Every write operation is written to the commit log to recover in case of a crash.

Terms and Definitions

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Term	Definition
Mem-table	A mem-table is a memory-resident data structure. After commit is logged, the data will be written to the mem-table.
SSTable	A disk file to which the data is flushed from the mem-table when its contents reach a threshold value.
Bloom filter	A collection of quick, nondeterministic, algorithms for testing whether an element is a member of a set. A cache; bloom filters are accessed after every query.

Getting started with Cassandra

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Consider this

- Copy your Cassandra setup tar file (apache-cassandra-3.11.2-bin.tar.gz) to a desktop directory. Do not copy this file or open it in your submission directory!!!
- Click on this file to unpack its contents
- Locate the bin directory and then locate file: `cassandra` and file: `cqlsh`

Lab PCs: Setup Java 8 in the path from the terminal

```
JAVA_HOME=/usr/lib/jvm/java-8-openjdk-amd64/
```

Start the Cassandra server

Note: Control-C to exit.

```
./cassandra -f
```

With new another terminal, start the `cqlsh` client

```
./cqlsh
```

Keyspaces

Similar to a schema

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Consider this

Checking your database

```
describe keyspaces;  
describe schema;  
describe tables;  
describe table tableName;
```

Start a new keyspaces

```
create keyspace mydb with replication =  
{ 'class':'SimpleStrategy', 'replication_factor':1 };
```

Use a keyspace

```
use mydb;
```

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Consider this

Build Tables

```
CREATE TABLE songs (  
    id uuid PRIMARY KEY,  
    title text,  
    album text,  
    artist text,  
    data blob  
);
```

```
CREATE TABLE playlists (  
    id uuid,  
    song_order int,  
    song_id uuid,  
    title text,  
    album text,  
    artist text,  
    PRIMARY KEY (id, song_order ) );
```

```
describe tables;
```

Example Music DB

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Consider this

Enter playlists Data

```
INSERT INTO playlists (id, song_order, song_id, title, artist, album)
VALUES (62c36092-82a1-3a00-93d1-46196ee77204, 4,
7db1a490-5878-11e2-bcfd-0800200c9a66,
'Ojo Rojo', 'Fu Manchu', 'No One Rides for Free');
```

```
INSERT INTO playlists (id, song_order, song_id, title, artist, album)
VALUES (62c36092-82a1-3a00-93d1-46196ee77206, 3,
7db1a490-5878-11e2-bcfd-0800200c9a68,
'Green and The Other Colors in the Rainbow', 'Kermit the Frog', 'Funky Lilly Pad');
```

```
INSERT INTO playlists (id, song_order, song_id, title, artist, album)
VALUES (62c36092-82a1-3a00-93d1-46196ee77207, 1,
7db1a490-5878-11e2-bcfd-0800200c9a69,
'Shovin the Lovin -- cookies in my mouth', 'Cookie Monster', 'Blue Carpet Disaster');
```

```
INSERT INTO playlists (id, song_order, song_id, title, artist, album)
VALUES (62c36092-82a1-3a00-93d1-46196ee77205, 2,
7db1a490-5878-11e2-bcfd-0800200c9a67,
'Singin With Lovin', 'Roy Ray Robinson', 'The Sun Shine on Your Shoulders');
```

```
INSERT INTO playlists (id, song_order, song_id, title, artist, album)
VALUES (62c36092-82a1-3a00-93d1-46196ee77207, 1,
7db1a490-5878-11e2-bcfd-0800200c9a69,
'Dance to me', 'Dance Floor Dolls', 'Electric Motion');
```

Example Music DB

We will only enter one row, *just for show*

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Consider this

Enter songs Data

```
INSERT INTO songs (id, title, album, artist, data)
VALUES
  (62c36092-82a1-3a00-93d1-46196ee77204,
   'Fu_title',
   'Fu_album',
   'Fu_artist',
   textAsBlob('Fu_blob'));
```

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Consider this

Simple queries

```
select * from playlists;  
select album from playlists;
```

Simple queries with conditions

```
select * from playlists  
  where id = 62c36092-82a1-3a00-93d1-46196ee77205;  
  
select album from playlists  
  where id = 62c36092-82a1-3a00-93d1-46196ee77205;  
  
select  album, title from playlists  
  where id = 62c36092-82a1-3a00-93d1-46196ee77205;
```


Conditional Queries

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Consider this

- In Cassandra, if you want to query columns other than the primary key, you need to create a secondary index on them

Simple queries with conditions

```
CREATE INDEX ON playlists( artist );  
/*Now, you can query the playlists for songs by Fu Manchu. */
```

Index membership code

```
select * from playlists where artist = 'Fu Manchu';  
select * from playlists where artist = 'Kermit the Frog';
```

Study the schema and index memberships (i.e., *query-able* columns)

```
describe schema
```

How to Shut Down a Session

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Consider this

Remove a keyspace; destroy data

```
/*Drop the "mydb" keyspace*/  
DROP KEYSPACE mydb;
```

Remove a table; destroy data

```
/*Drop the "emp" table*/  
DROP TABLE emp;
```

Closing down

- exit in the client terminal
- Control-C in the server terminal

Consider this...



THINK

- Can you query other columns in the `playlists` table?
- Can you write index membership code to allow for the query of other columns?