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Scalable data modelling by example

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Jobandtalent

- Revolutionising how people find jobs and how businesses hire employees.
- Leveraging data to produce a unique job matching technology.
- 10M+ users and 150K+ companies worldwide
- @jobandtalentEng / http://jobandtalent.com
- We are hiring!!

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Cassandra Concepts

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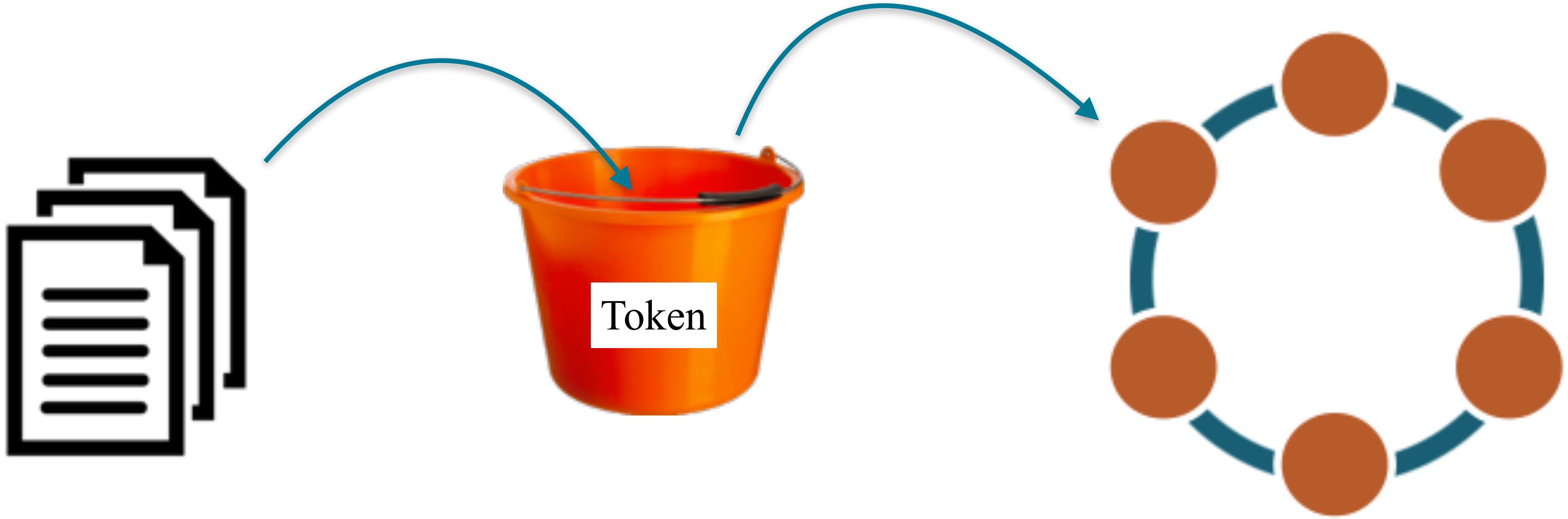
The data model is the only thing you can’t change once in production.

Data organisation



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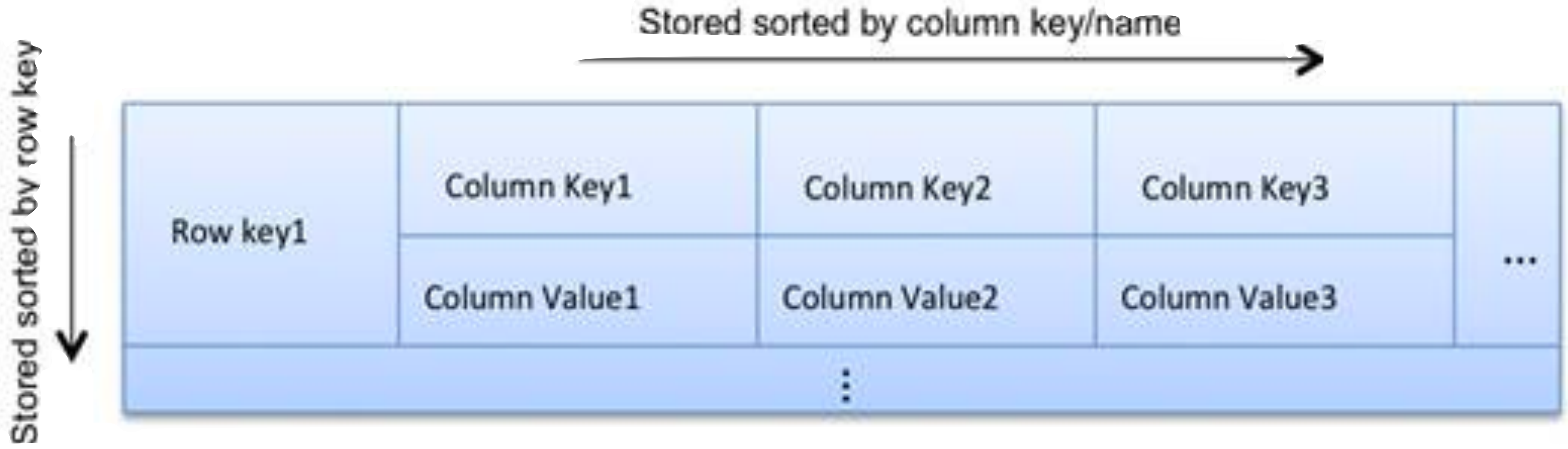
Physical Data Layout



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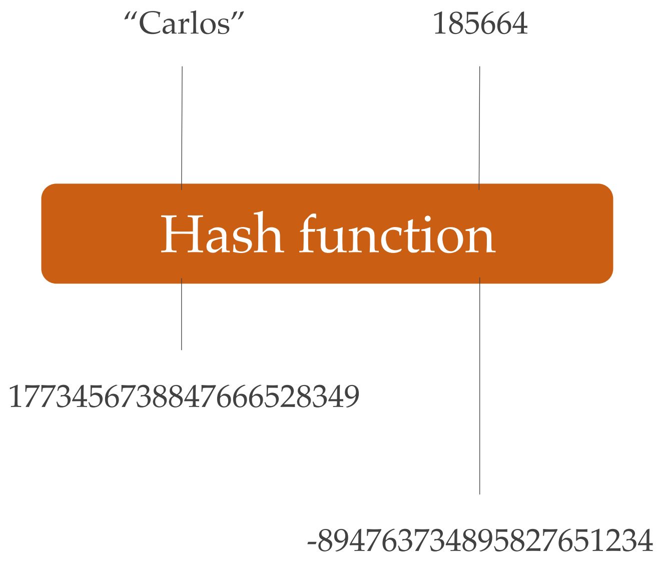
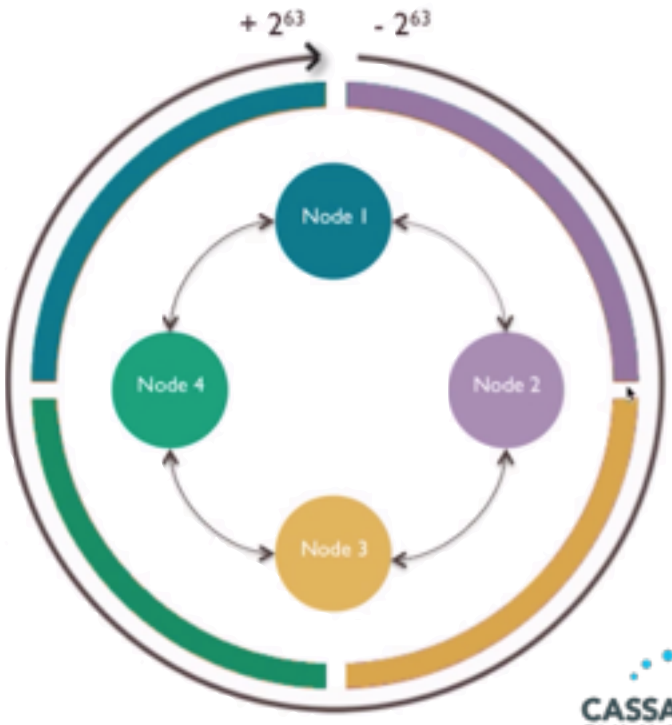
Consistent Hashing





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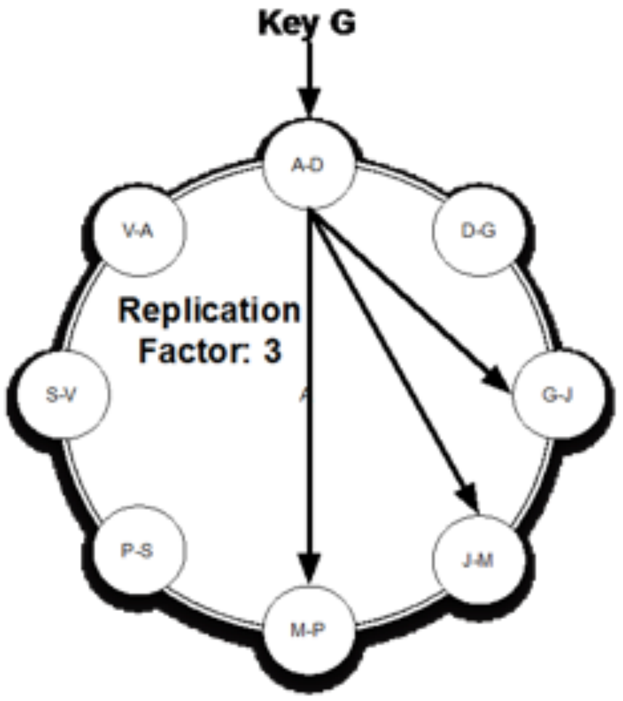
Replication factor

How many copies (replicas) for your data



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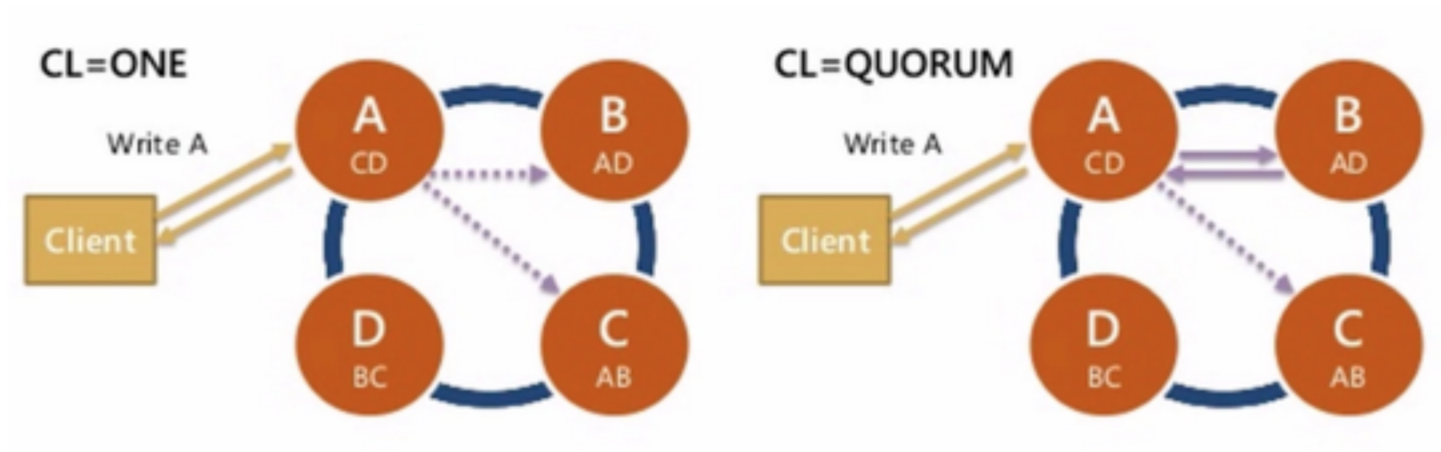
Consistency Level

How many replicas of your data must acknowledge?



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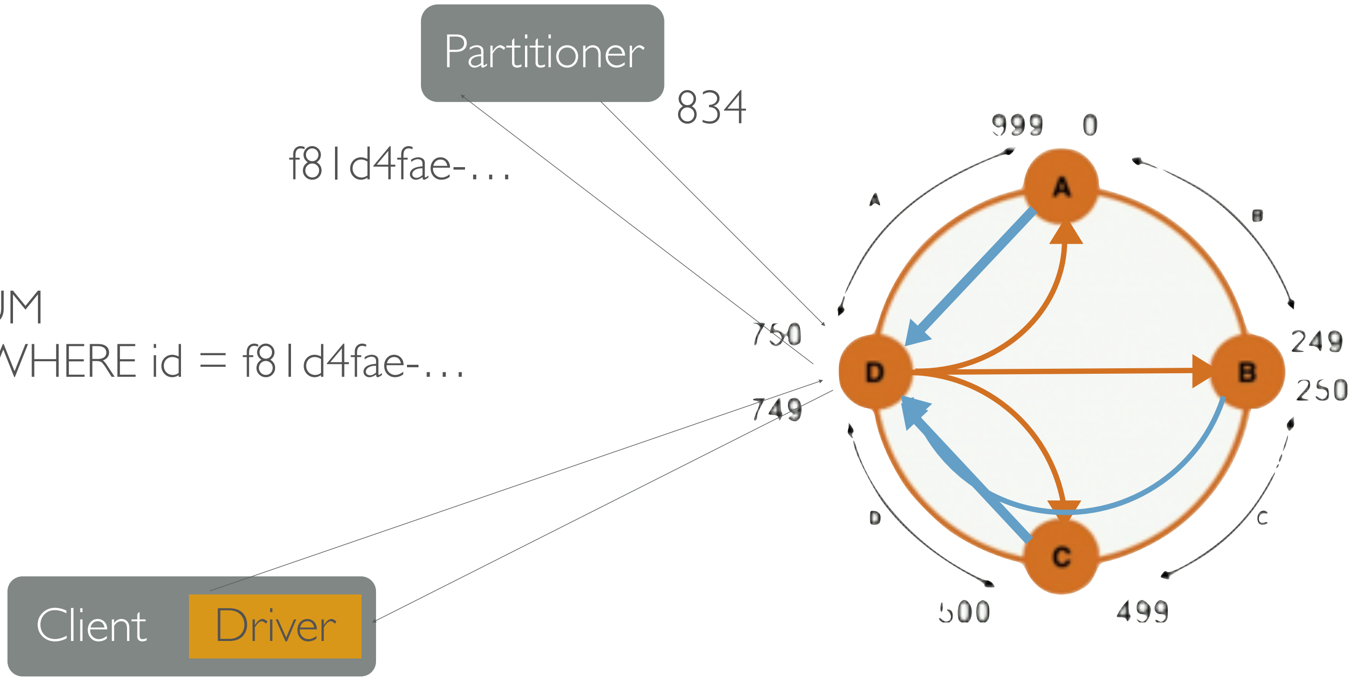
A complete read/write example

- RF = 3
- CL = QUORUM
- SELECT * … WHERE id = f81d4fae-…



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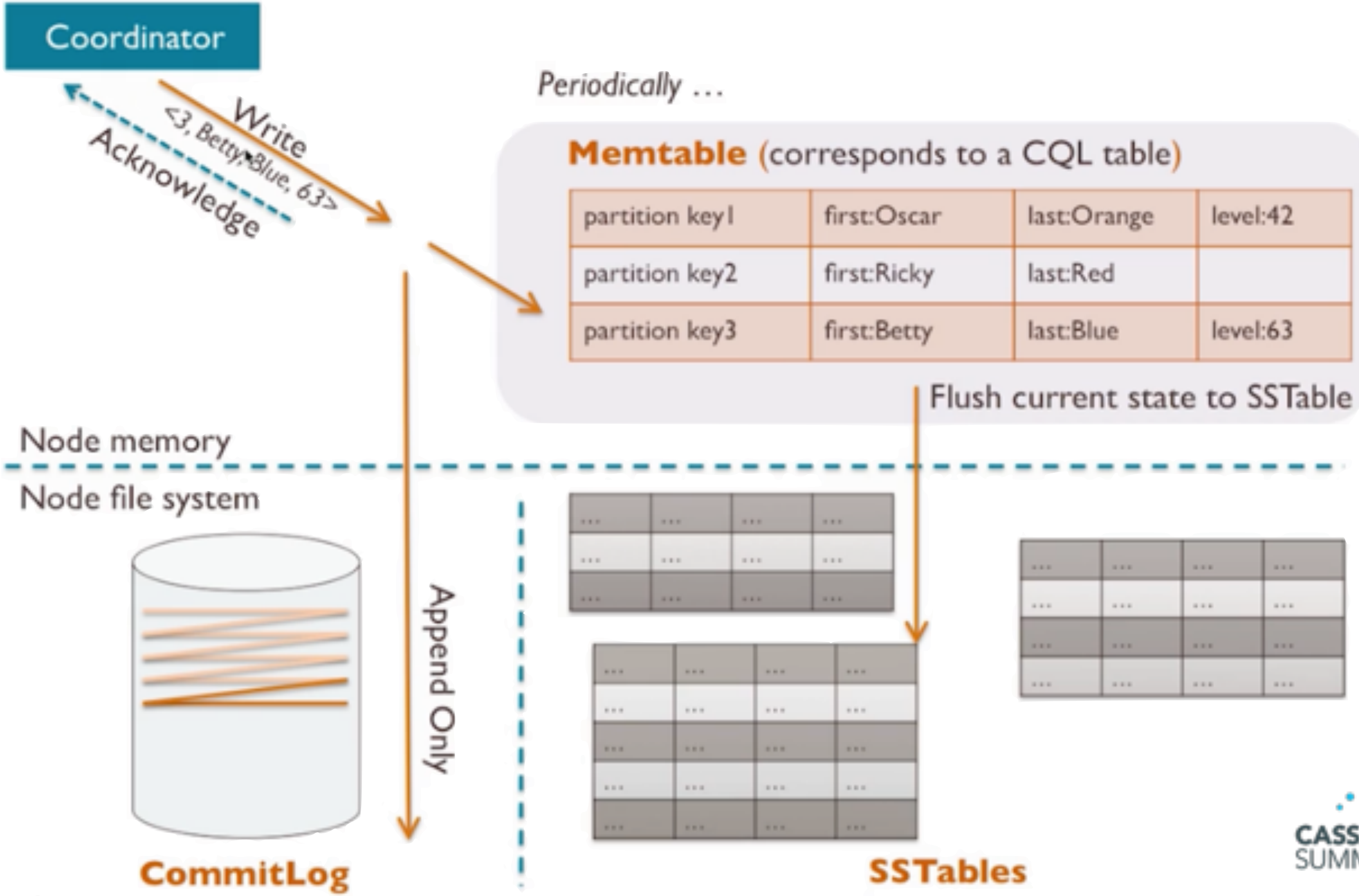

partition key1	first:Oscar	last:Orange	level:42
partition key2	first:Ricky	last:Red	
partition key3	first:Betty	last:Blue	level:63

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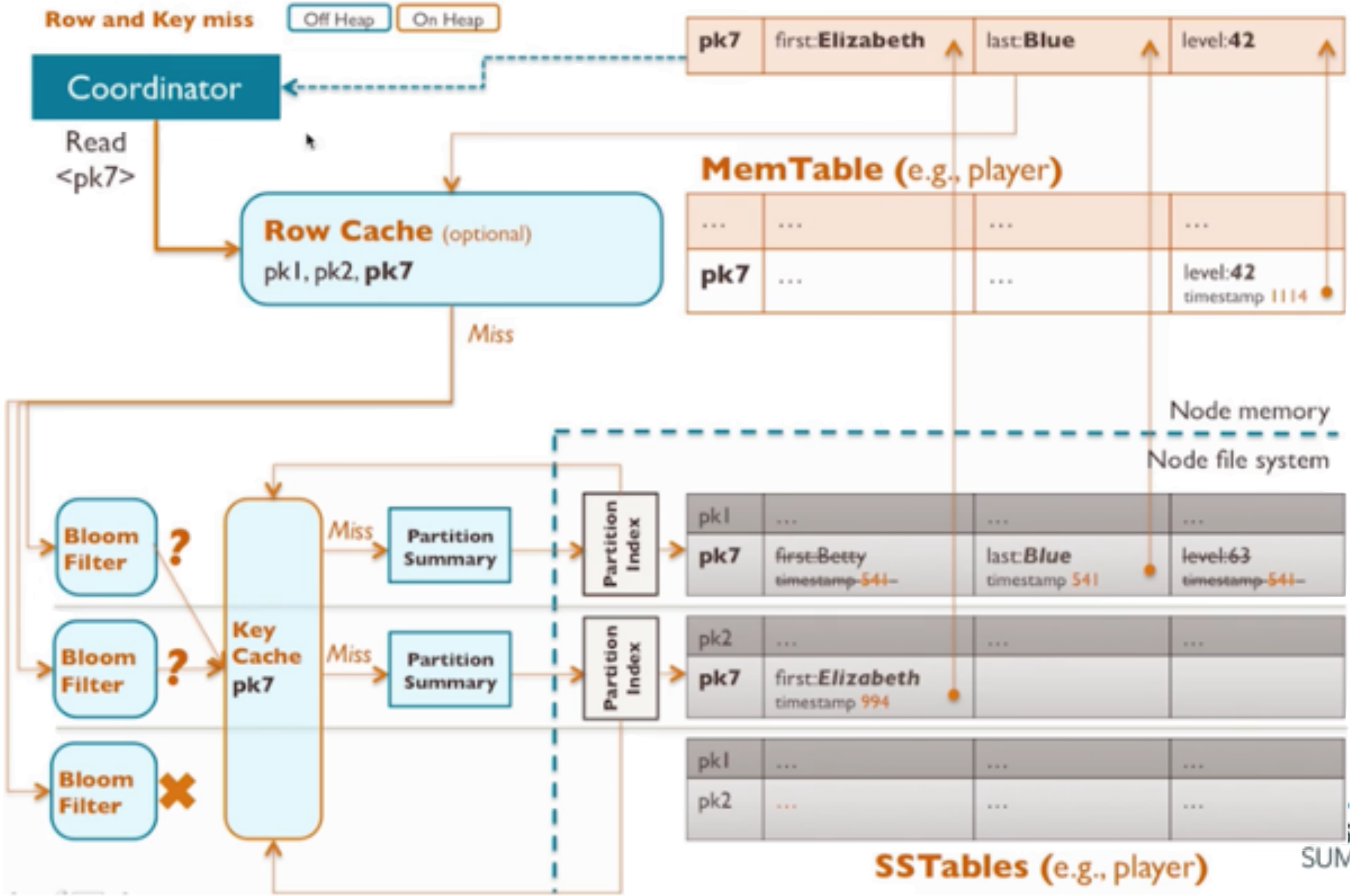
Row and Key miss



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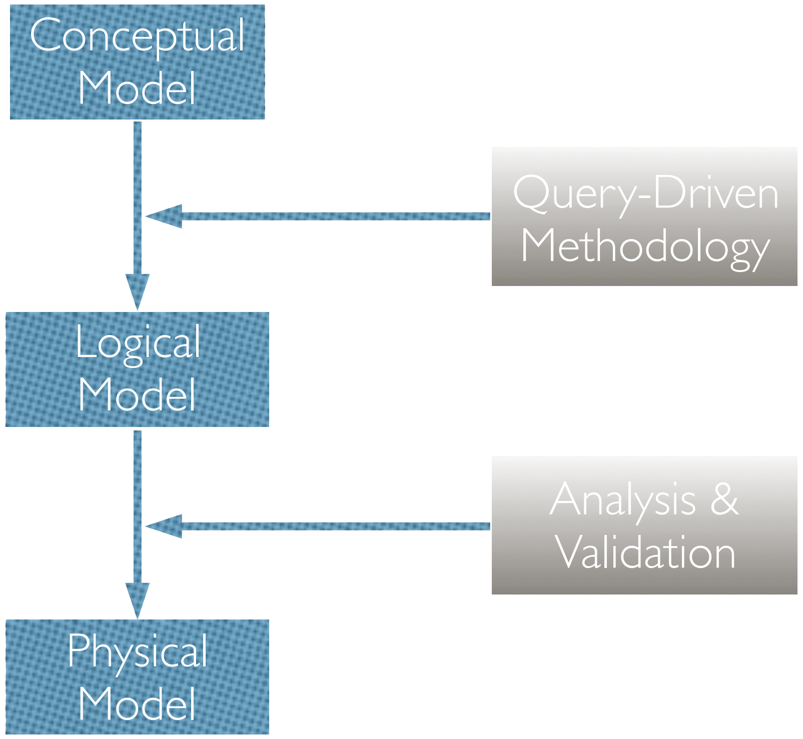
Data Modelling

Data Modelling

- Understand your data
- Decide (know) how you'll query the data
- Define column families to satisfy those queries
- Implement and optimise

Data Modelling



Query Driven Methodology: goals

- Spread data evenly around the cluster
- Minimise the number of partitions read
- Keep partitions manageable

Query Driven Methodology: process

- Entities and relationships: map to tables
- Key attributes: map to primary key columns
- Equality search attributes: must be at the beginning of the primary key
- Inequality search attributes: become clustering columns
- Ordering attributes: become clustering columns

The Primary Key

PARTITION KEY + CLUSTERING COLUMN(S)

```
CREATE TABLE . . .(
  fields . . .
  PRIMARY KEY (part_key, clust1, . . .)
);
```

Analysis & Validation

- Data evenly spread?
- 1 Partition per read?
- Are write conflicts (overwrites) possible?
- How large are partitions?
  - Ncells = Nrow X (Ncols – Npk – Nstatic) + Nstatic < 1M
- How much data duplication? (batches)

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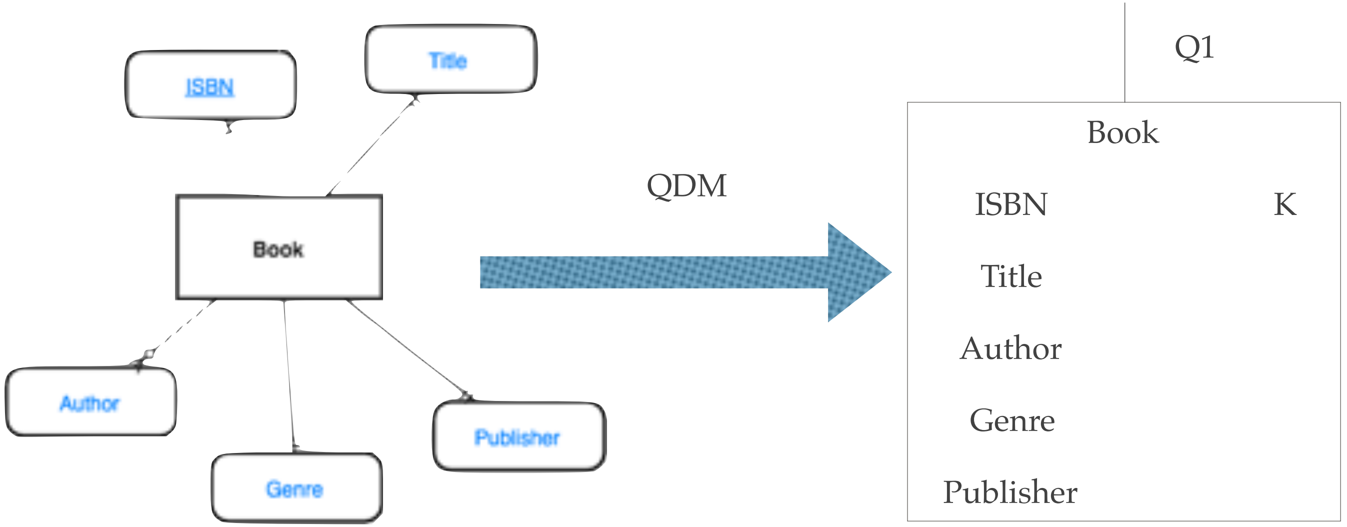
An E-Library project.

Requirement: 1

Books can be uniquely identified and accessed by ISBN, we also need a title, genre, author and publisher.

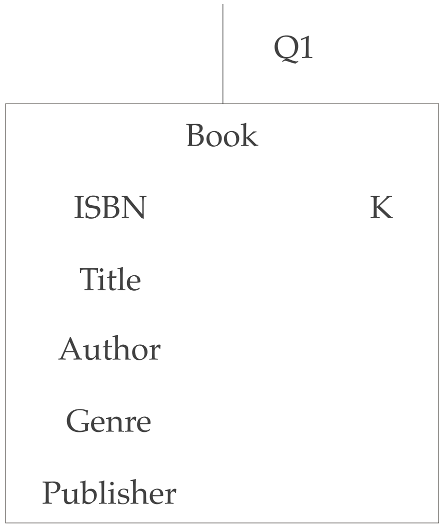


Q1: Find books by ISBN

Analysis & Validation

- Data evenly spread? ✓
- 1 Partition per read? ✓
- Are write conflicts (overwrites) possible? ✓
- How large are partitions? ✓
  - Ncells = Nrow X (Ncols – Npk – Nstatic) + Nstatic < 1M
  - 1 X (5 - 1 - 0) + 0 < 1M
- How much data duplication? 0 ✓

Q1: Find books by ISBN

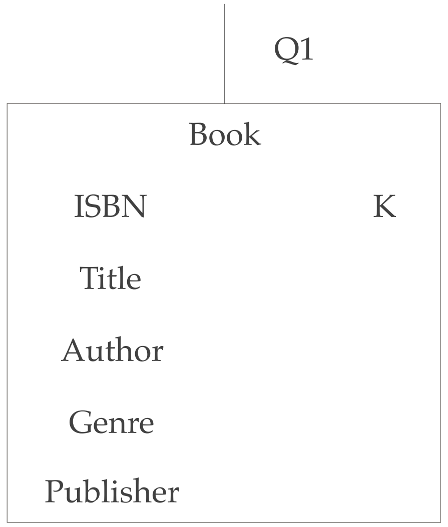


Physical data model

```
CREATE TABLE books (
  ISBN VARCHAR PRIMARY KEY,
  title VARCHAR,
  author VARCHAR,
  genre VARCHAR,
  publisher VARCHAR
);
```

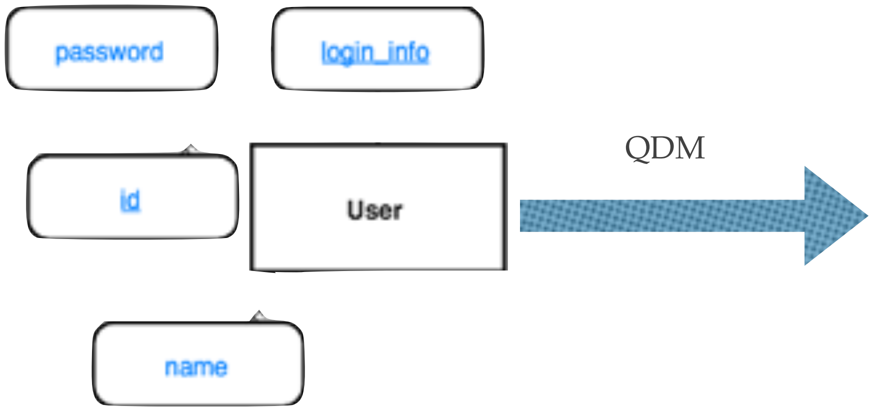
```
SELECT * FROM books WHERE ISBN = '…';
```

Q1: Find books by ISBN



Requirement 2

Users register into the system uniquely identified by an email and a password. We also want their full name. They will be accessed by email and password or internal unique ID.



Q1

Users_by_ID	
ID	K
full_name	

Q2 | Q3

Users_by_login_info	
email	K
password	C
full_name	
ID	

Q1: Find users by ID

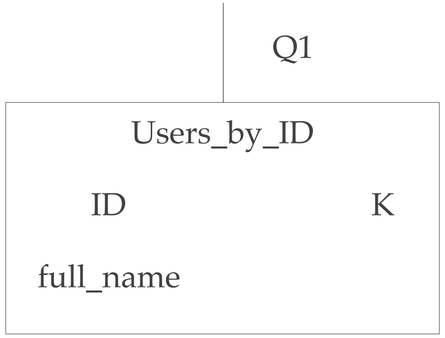
Q2: Find users by login info

Q3: Find users by email
(to guarantee uniqueness)

Analysis & Validation

- Data evenly spread? ✓
- 1 Partition per read? ✓
- Are write conflicts (overwrites) possible? ✓
- How large are partitions? ✓
  - Ncells = Nrow X (Ncols – Npk – Nstatic) + Nstatic < 1M
  - 1 X (2 - 1 - 0) + 0 < 1M
- How much data duplication? 0 ✓

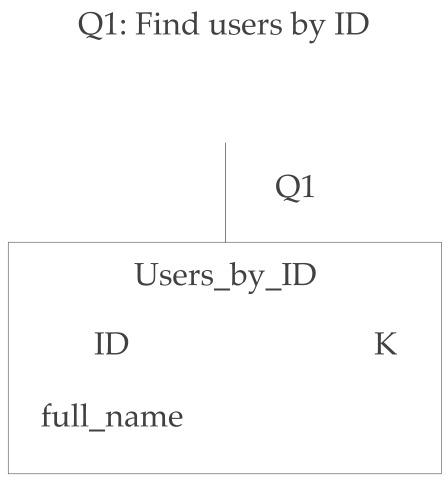
Q1: Find users by ID



Physical Data Model

```
CREATE TABLE users_by_id (
   ID TIMEUUID PRIMARY KEY,
   full_name VARCHAR
);
```

```
SELECT * FROM users_by_id WHERE ID = …;
```



Analysis & Validation

- Data evenly spread? ✓
- 1 Partition per read? ✓
- Are write conflicts (overwrites) possible? ✓
- How large are partitions? ✓
  - Ncells = Nrow X (Ncols – Npk – Nstatic) + Nstatic < 1M
  - 1 X (4 - 1 - 0) + 0 < 1M
- How much data duplication? 1 ✓

Q2: Find users by login info

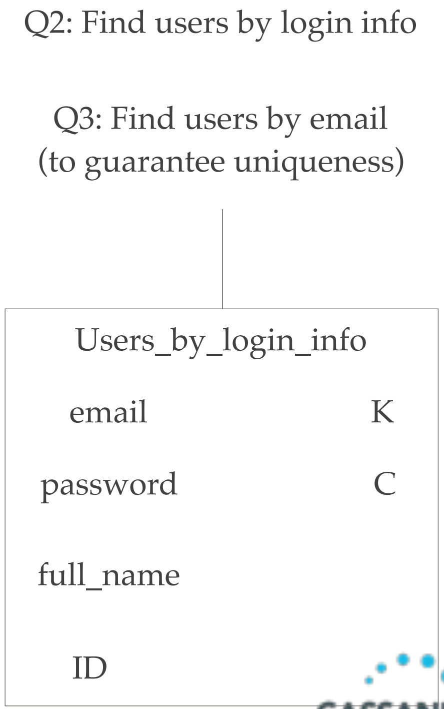
Q3: Find users by email
(to guarantee uniqueness)

Users_by_login_info	
email	K
password	C
full_name	
ID	

Physical Data Model

```
CREATE TABLE users_by_login_info (
   email VARCHAR,
   password VARCHAR,
   full_name VARCHAR,
   ID TIMEUUID,
   PRIMARY KEY (email, password)
);
```

```
SELECT * FROM users_by_login_info
WHERE email = '…' [AND password = '…'];
```



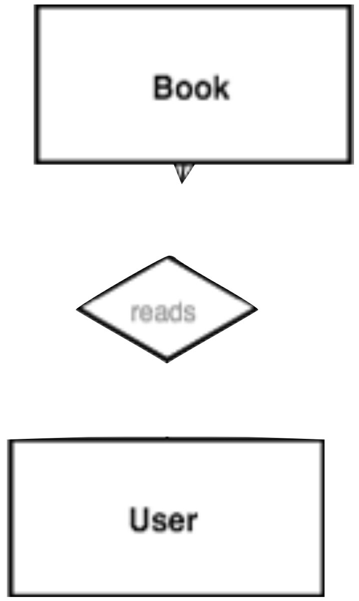
Physical Data Model

```
BEGIN BATCH
  INSERT INTO users_by_id (ID, full_name) VALUES (…) IF NOT EXISTS;
  INSERT INTO users_by_login_info (email, password, full_name, ID) VALUES (…);
APPLY BATCH;
```

Requirement 3

Users read books.
We want to know which books has a user read and show them sorted by title and author

Q1: Find all books a logged user has read



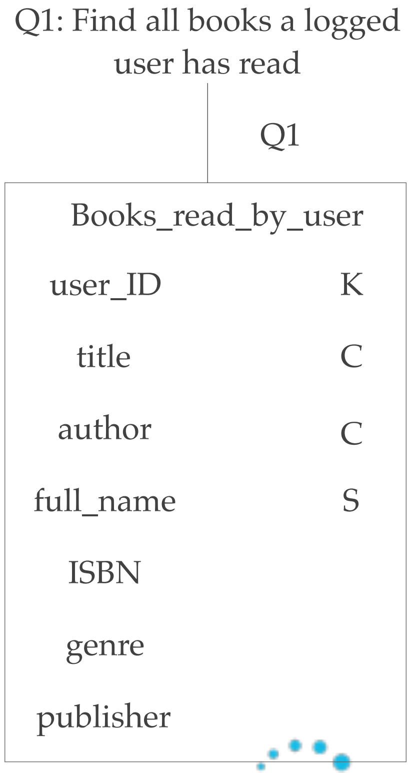
QDM

Q1

Books_read_by_user	
user_ID	K
title	C
author	C
full_name	S
ISBN	
genre	
publisher	

Analysis & Validation

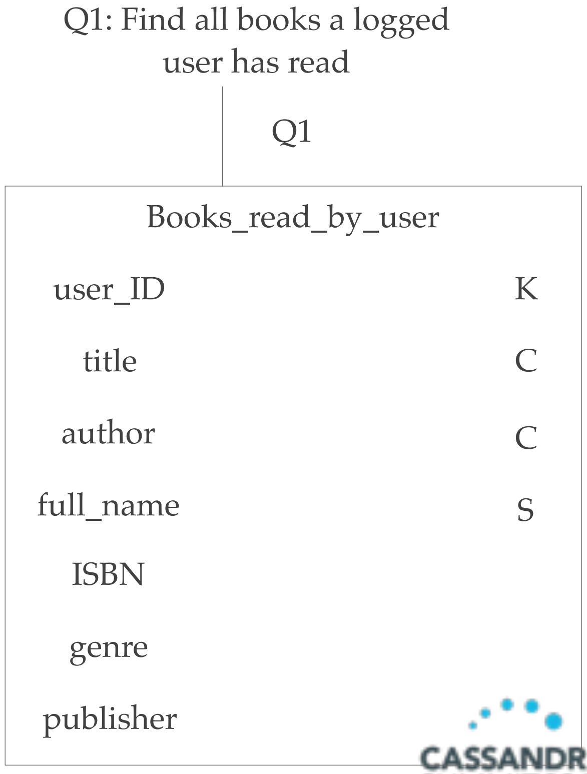
- Data evenly spread? ✓
- 1 Partition per read? ✓
- Are write conflicts (overwrites) possible? ✓
- How large are partitions? ✓
  - Ncells = Nrow X (Ncols – Npk – Nstatic) + Nstatic < 1M
  - Books X (7 - 1 - 1) + 1 < 1M => 200,000 books per user
- How much data duplication? 0 ✓



Physical Data Model

```
CREATE TABLE books_read_by_user (
  user_id TIMEUUID,
  title VARCHAR,
  author VARCHAR,
  full_name VARCHAR STATIC,
  ISBN VARCHAR,
  genre VARCHAR,
  publisher VARCHAR,
  PRIMARY KEY (user_id, title, author)
);
```

```
SELECT * FROM books_read_by_user
WHERE user_ID = …;
```



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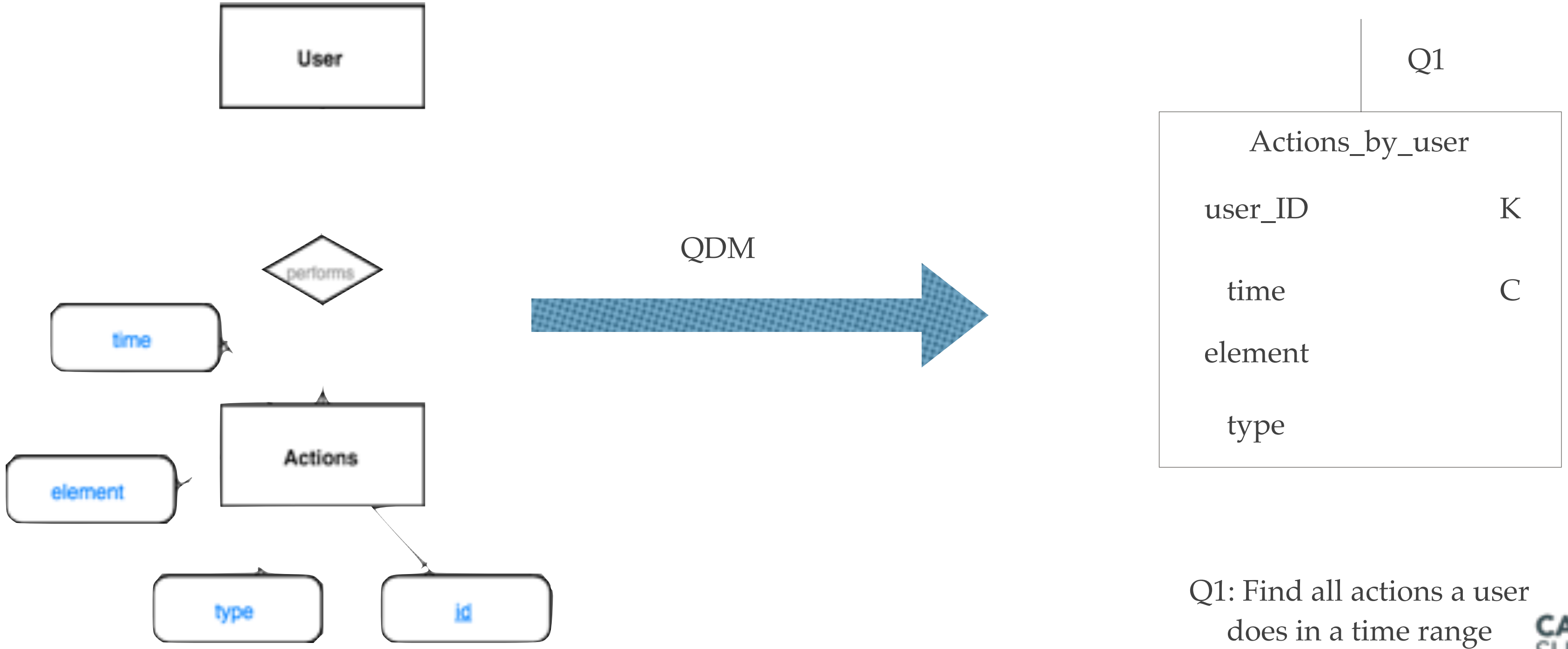
Requirement 4

In order to improve our site's usability we need to understand how our users use it by tracking every interaction they have with our site.

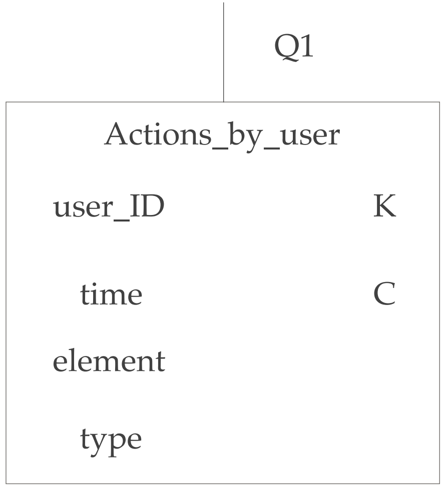


Q1: Find all actions a user does in a time range

Analysis & Validation

- Data evenly spread? ✓
- 1 Partition per read? ✓
- Are write conflicts (overwrites) possible? ✓
- How large are partitions? ✗
  - Ncells = Nrow X (Ncols – Npk – Nstatic) + Nstatic < 1M
  - Actions X (4 - 1 - 0) + 0 < 1M => 333.333
- How much data duplication? 0

Q1: Find all actions a user does in a time range



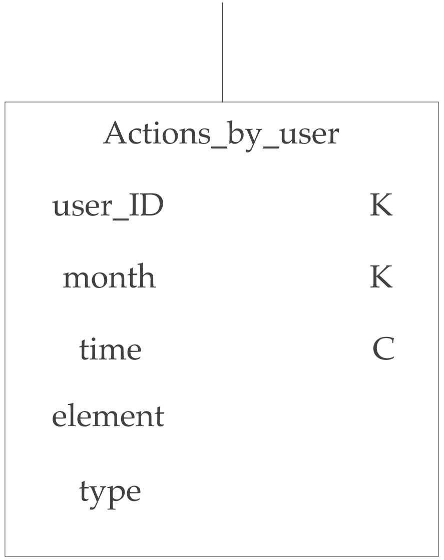
Requirement 4: Bucketing

- Ncells = Nrow X (Ncols – Npk – Nstatic) + Nstatic < 1M
- Actions X (5 - 2 - 0) + 0 < 1M => 333.333
  per user every <bucket_size>

bucket_size = 1 year => 38 actions / h

bucket_size = 1 month => 462 actions / h

bucket_size = 1 week => 1984 actions / h

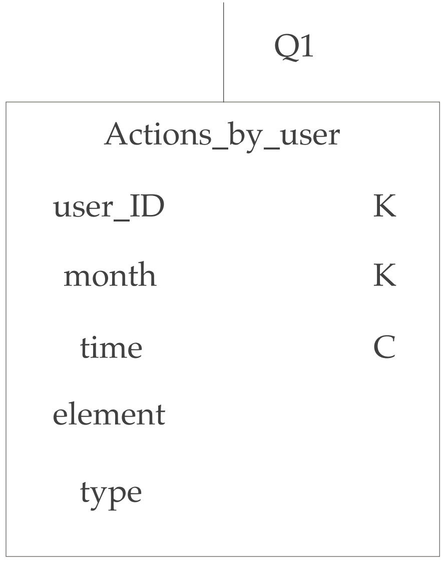


Actions_by_user	
user_ID	K
month	K
time	C
element	
type	

Analysis & Validation

- Data evenly spread? ✓
- 1 Partition per read? ✓
- Are write conflicts (overwrites) possible? ✓
- How large are partitions? ✓
  - Ncells = Nrow X (Ncols – Npk – Nstatic) + Nstatic < 1M
  - Actions X (5 - 2 - 0) + 0 < 1M => 333.333 / month
- How much data duplication? 0 ✓

Q1: Find all actions a user does in a time range

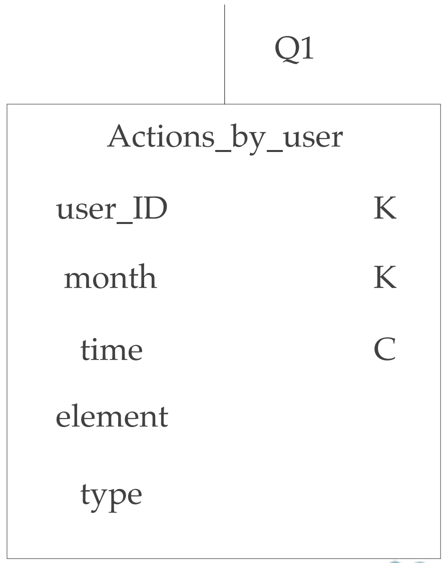


Physical Data Model

```
CREATE TABLE actions_by_user (
  user_ID TIMEUUID,
  month INT,
  time TIMESTAMP,
  element VARCHAR,
  type VARCHAR,
  PRIMARY KEY ((user_ID, month), time)
);
```

```
SELECT * FROM actions_by_user
WHERE user_ID = … AND month = … AND time < … AND time > …;
```

Q1: Find all actions a user does in a time range



Further validation

$$\sum sizeOf(pk) + \sum sizeOf(sc) + Nr \times \sum(sizeOf(rc) + \sum sizeOf(clc)) + 8 \times Nv < 200\ MB$$

- pk = Partition Key column
- sc = Static column
- Nr = Number of rows
- rc = Regular column
- clc = Clustering column
- Nv = Number of values

Next Steps

- Test your models against your hardware setup
  - cassandra-stress
  - http://www.sestevez.com/sestevez/CassandraDataModeler/ (kudos Sebastian Estevez)
- Monitor everything
  - DataStax OpsCenter
  - Graphite
  - Datadog
  - . . .

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Thanks!

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