Week 2: Data Model

Creating an Efficient Data Model
for highly-loaded Applications

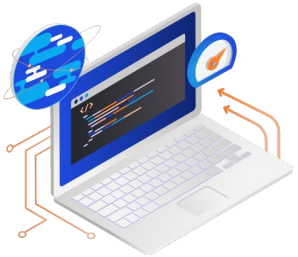
Cassandra Cloud-Native Workshop Series

Building Cloud-Native apps with Cassandra Expertise

~ 10,300 Registrations

https://lime.link/blog/visualizing-crowd-sizes/

The Crew



Your hosts

David Jones-Gilardi 🇺🇸

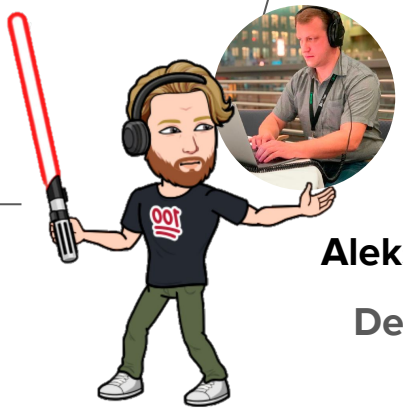
Developer Advocate

Bettina Swynnerton 🇬🇧

Community Engineer

Jack Fryer 🇬🇧

Community Manager

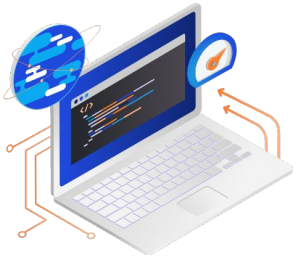


Cédrick Lunven 🇫🇷

Developer Advocate

Aleksandr Volochnev 🇷🇺

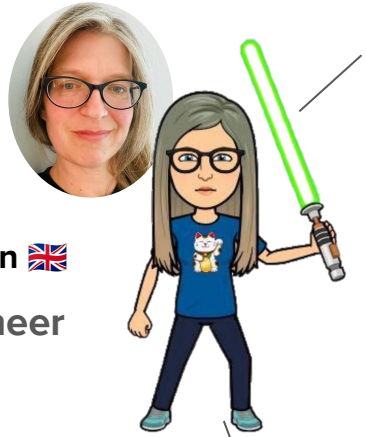
Developer Advocate



Your hosts

Aleksandr Volochnev 🇷🇺

Developer Advocate



Bettina Swynnerton 🇬🇧

Community Engineer

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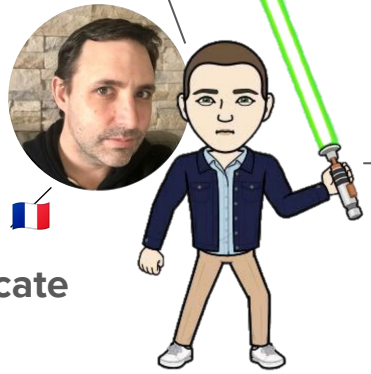
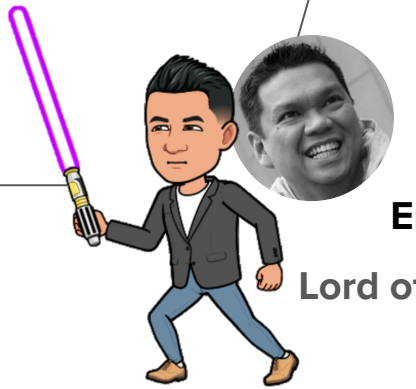




Cédrick Lunven 🇫🇷

Developer Advocate

Erick Ramirez 🇳🇿

Lord of the Cassandra Rings

Cassandra Workshop **SERIES**

PART 1: How to build Applications with Cassandra

- **Week 1 (7/01-7/08) :** Getting Started with Cassandra ✅
- **Week 2 (7/08-7/15) :** Data Modelling for Apache Cassandra™ 🔴
- **Week 3 (7/15-7/22) :** Application Development, Backend Services and CRUD
- **Week 4 (7/22-7/29)** : Application Development, Microservices and REST API

PART 2: Test, Deploy and monitor your clusters and applications

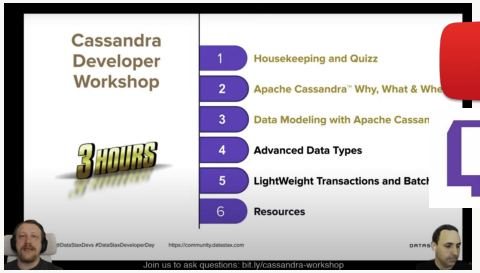
- **Week 5 (7/29-8/05):** Operating your Cassandra clusters
- **Week 6 (8/05-8/12):** Running Cassandra performance tests
- **Week 7 (8/12-8/19):** Testing your deployments and troubleshooting
- **Week 8 (8/19-8/26):** Deploying Cassandra with Kubernetes

How does it work ?

1

Attend one of the 2 LIVE STREAMED workshop (Wednesday or Thursday) Choose the one what matches your timezone.

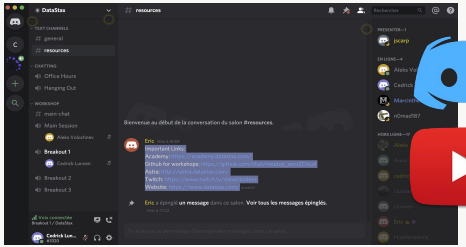
Courses: youtube.com/DataStaxDevs



YouTube

Twitch

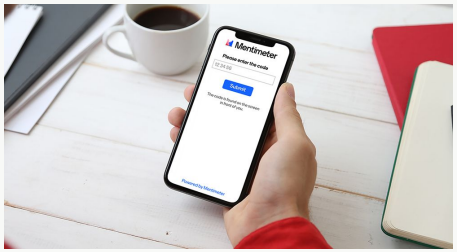
Questions: bit.ly/cassandra-workshop



Discord

YouTube

Quizz: menti.com

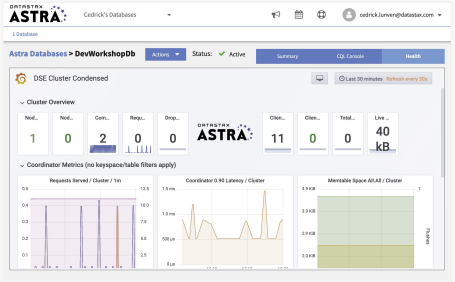


Mentimeter

Available on the iPhone App Store

GET IT ON Google play

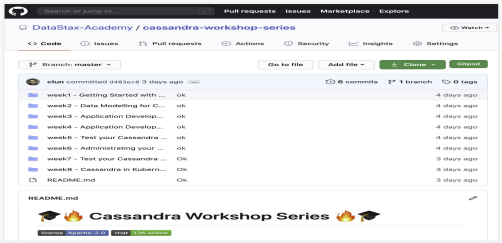
Runtime: dtsx.io/workshop



cassandra

DATASTAX ASTRA

Materials: github.com/DataStax-Academy

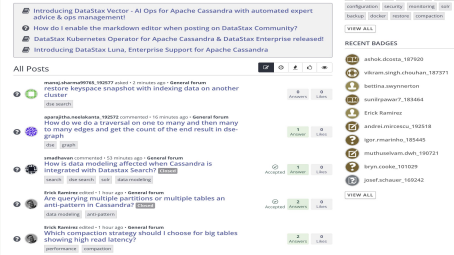


Coding (starting week #3)

How does it work ?

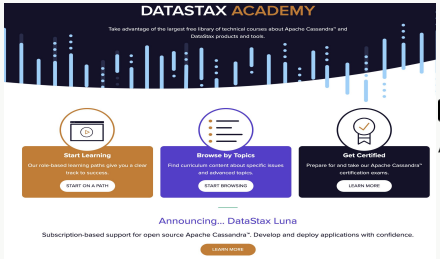
1. **Attend one of the 2 LIVE STREAMED workshop (Wednesday or Thursday) -> They are recorded**
2. **Do Homeworks**

Forum: community.datastax.com



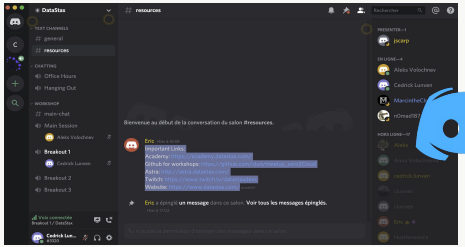
DATASTAX COMMUNITY

Training: academy.datastax.com



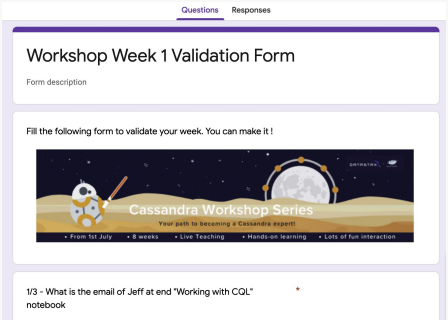
DATASTAX ACADEMY

Chat: bit.ly/cassandra-workshop



Discord

Validate your week:



Google Forms

How does it work ?

1. **Attend one of the 2 LIVE STREAMED workshop (Wednesday or Thursday) -> They are recorded**
2. **Homeworks**
3. **Relax.**

Developer Workshop Series Week II

- ➔ Keyspaces, Tables, Partitions
- ➔ The Art of Data Modelling
- ➔ Data Types
- ➔ What's NEXT?

Cassandra Cloud-Native Workshop Series

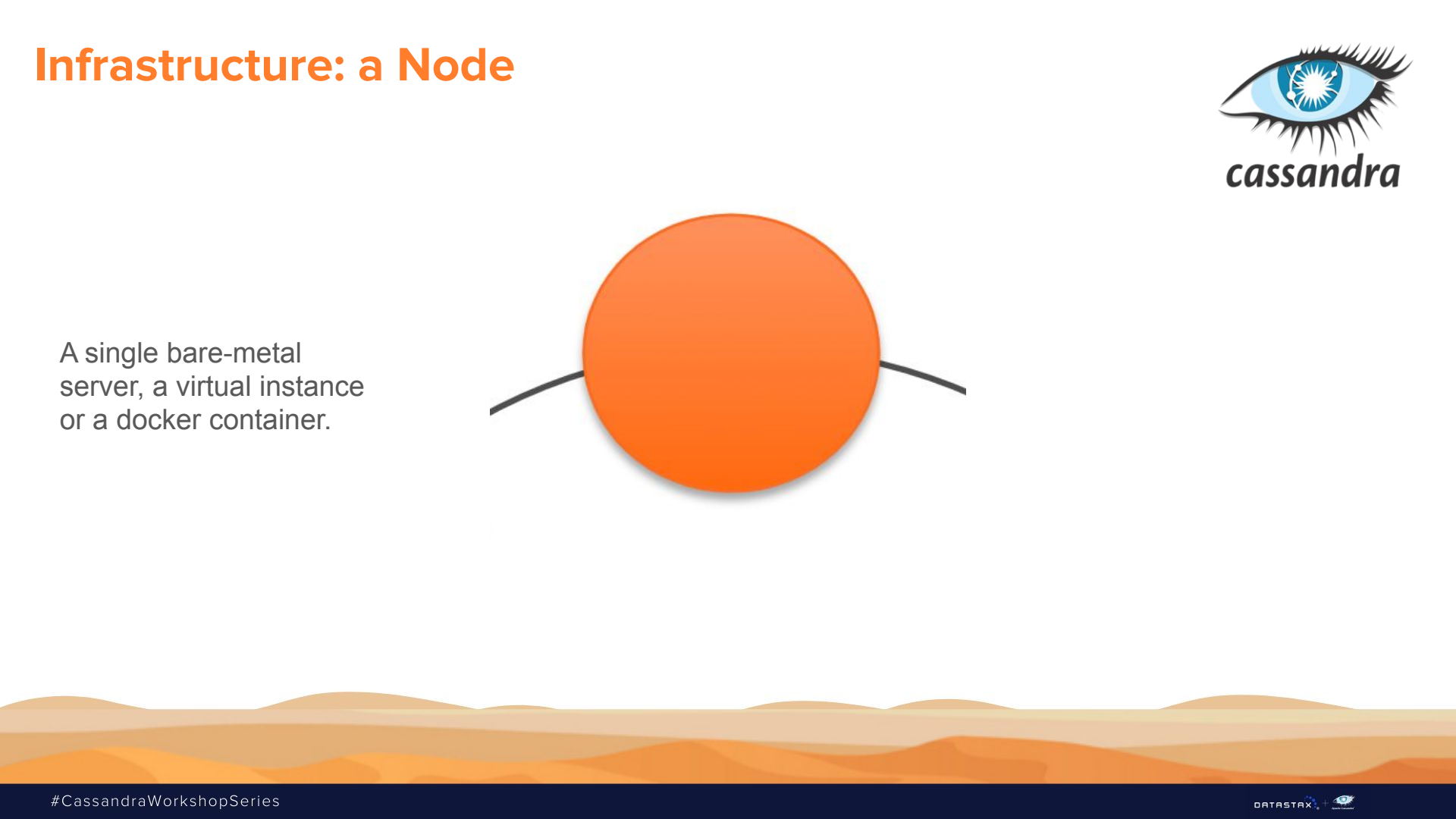

menti.com
89 49 47
Mentimeter
What is the most desirable feature of your ideal workplace?
Flexible time
Social factor
Big paycheck
Available on the iPhone
App Store
GET IT ON
Google play

Developer Workshop Series Week II

- ➔ Keyspaces, Tables, Partitions
- ➔ The Art of Data Modelling
- ➔ Data Types
- ➔ What's NEXT?

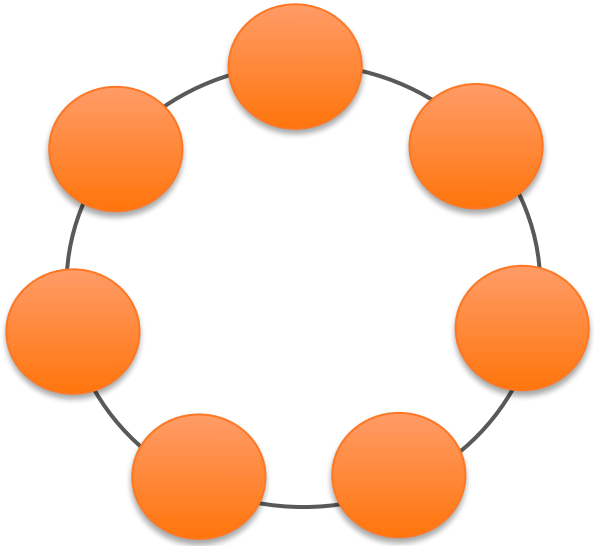
Cassandra Cloud-Native Workshop Series

Infrastructure: a Node



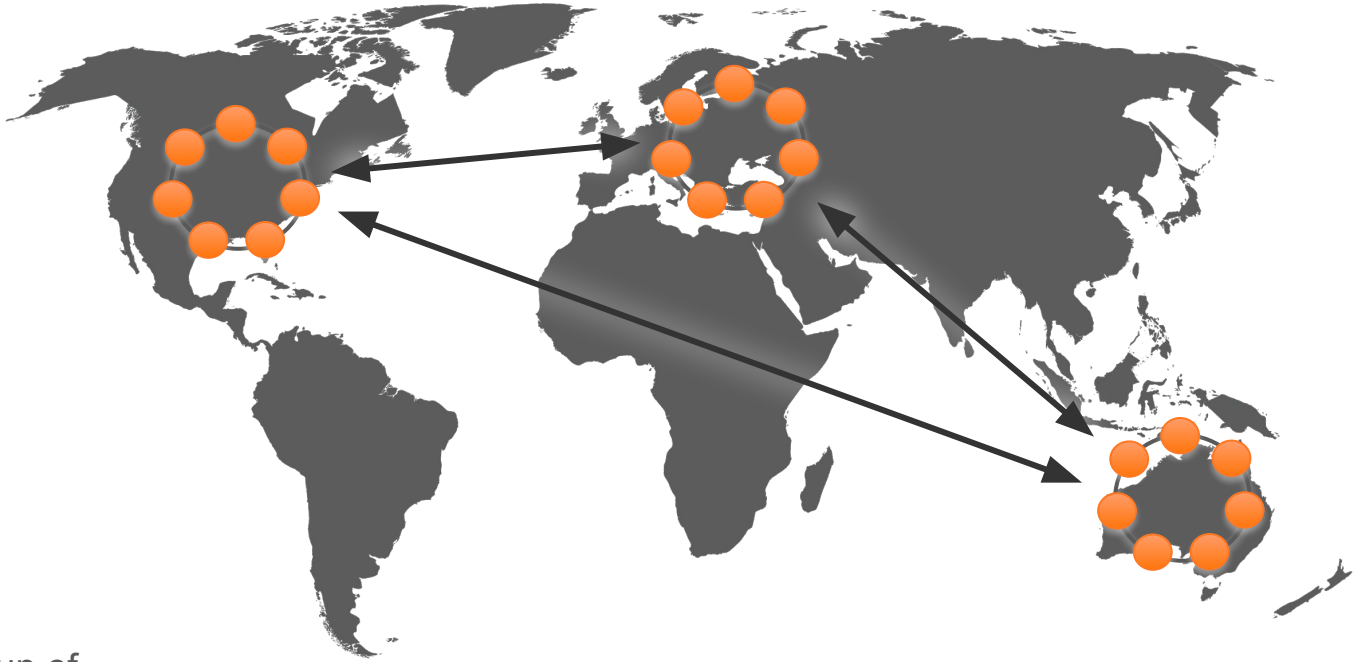
A single bare-metal server, a virtual instance or a docker container.

Infrastructure: a Datacenter (Ring)



A group of nodes located in the same physical location, a cloud datacenter or an availability zone.

Infrastructure: a Cluster



A group of datacenters configured to work together.

Data Structure: a Cell

An intersect of a row and a column, stores data.

Data Structure: a Row

A single, structured data item in a table.

1	John	Doe	Wizardry

Data Structure: a Partition

A group of rows having the same partition token, a base unit of access in Cassandra.

IMPORTANT: stored together, all the rows are guaranteed to be neighbours.

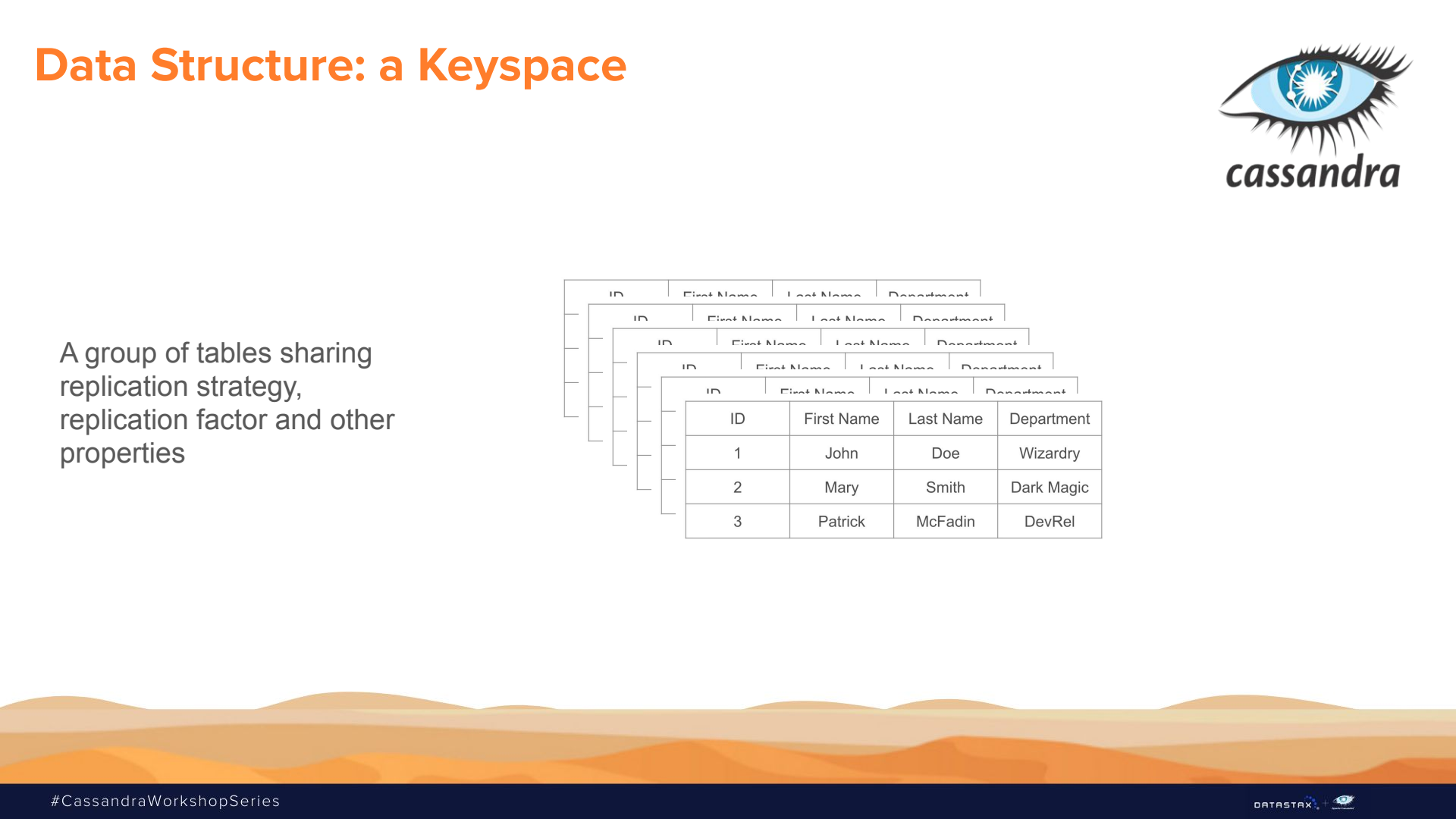
ID	First Name	Last Name	Department
1	John	Doe	Wizardry
399	Marisha	Chapez	Wizardry
415	Maximus	Flavius	Wizardry

Data Structure: a Table

A group of columns and rows storing partitions.

ID	First Name	Last Name	Department
1	John	Doe	Wizardry
2	Mary	Smith	Dark Magic
3	Patrick	McFadin	DevRel

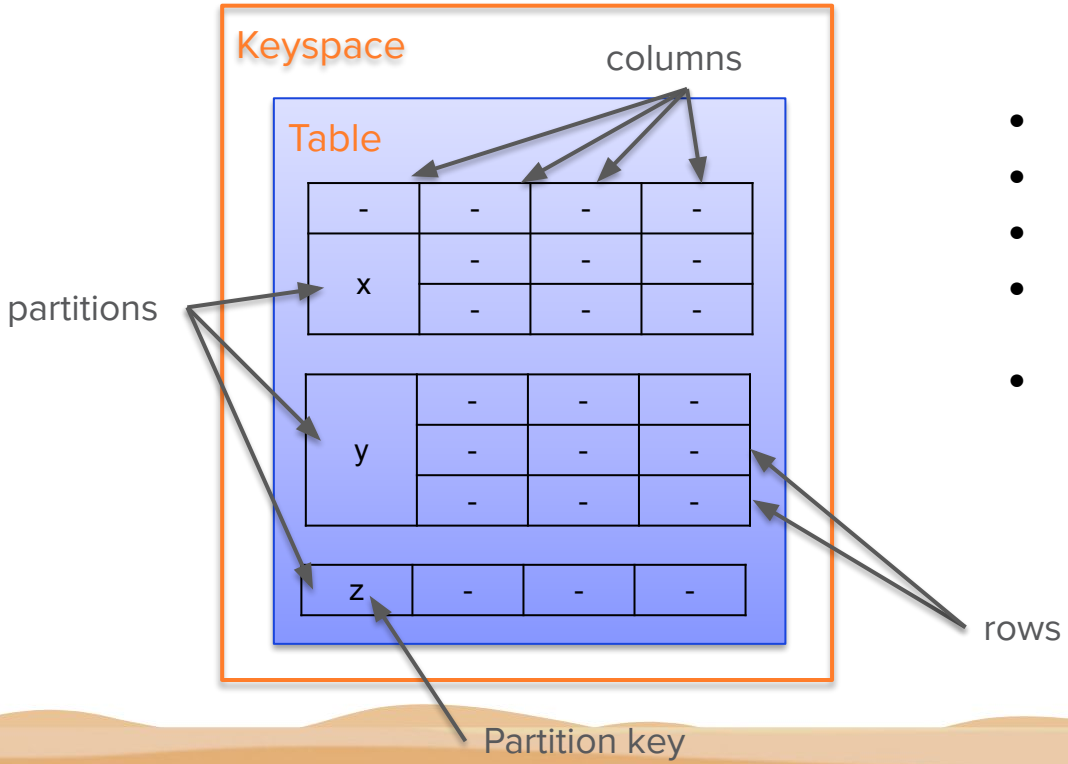
Data Structure: a Keyspace



A group of tables sharing replication strategy, replication factor and other properties

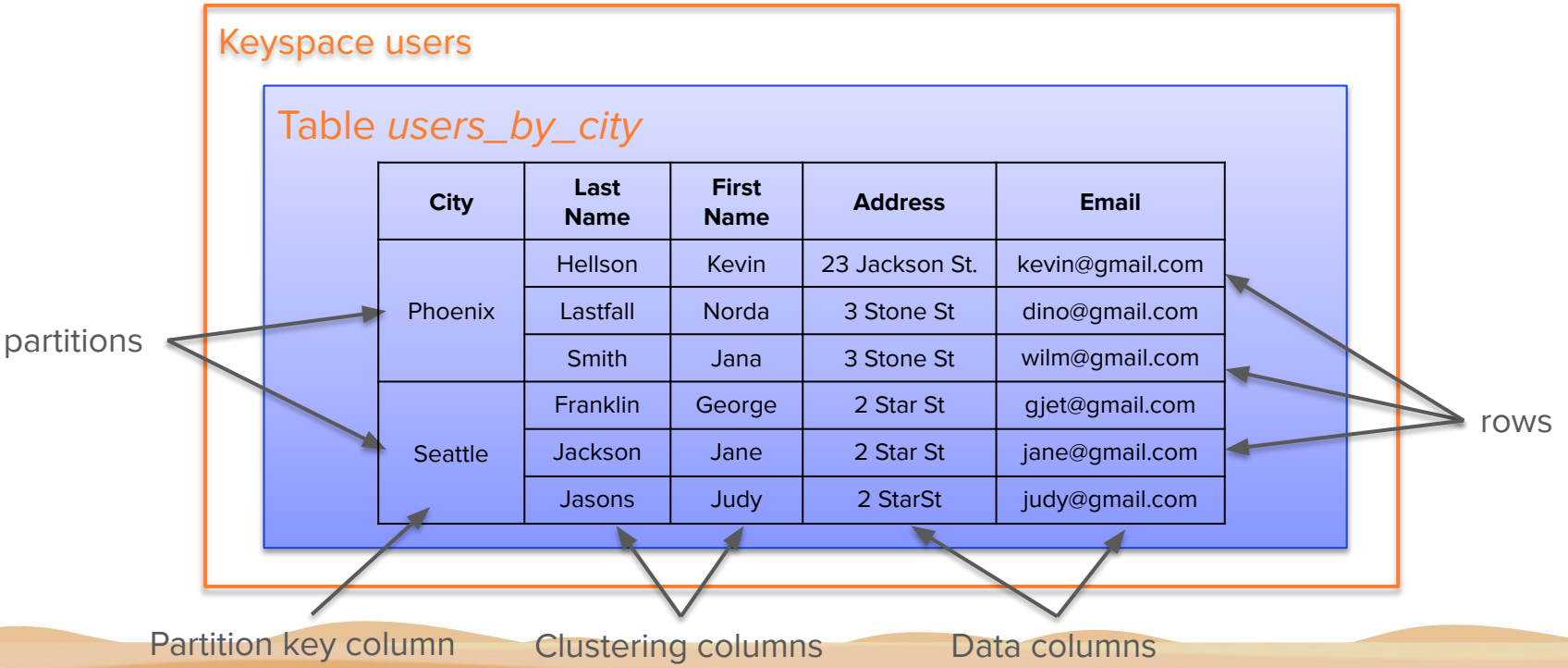
ID	First Name	Last Name	Department
1	John	Doe	Wizardry
2	Mary	Smith	Dark Magic
3	Patrick	McFadin	DevRel

Data Structure: Overall



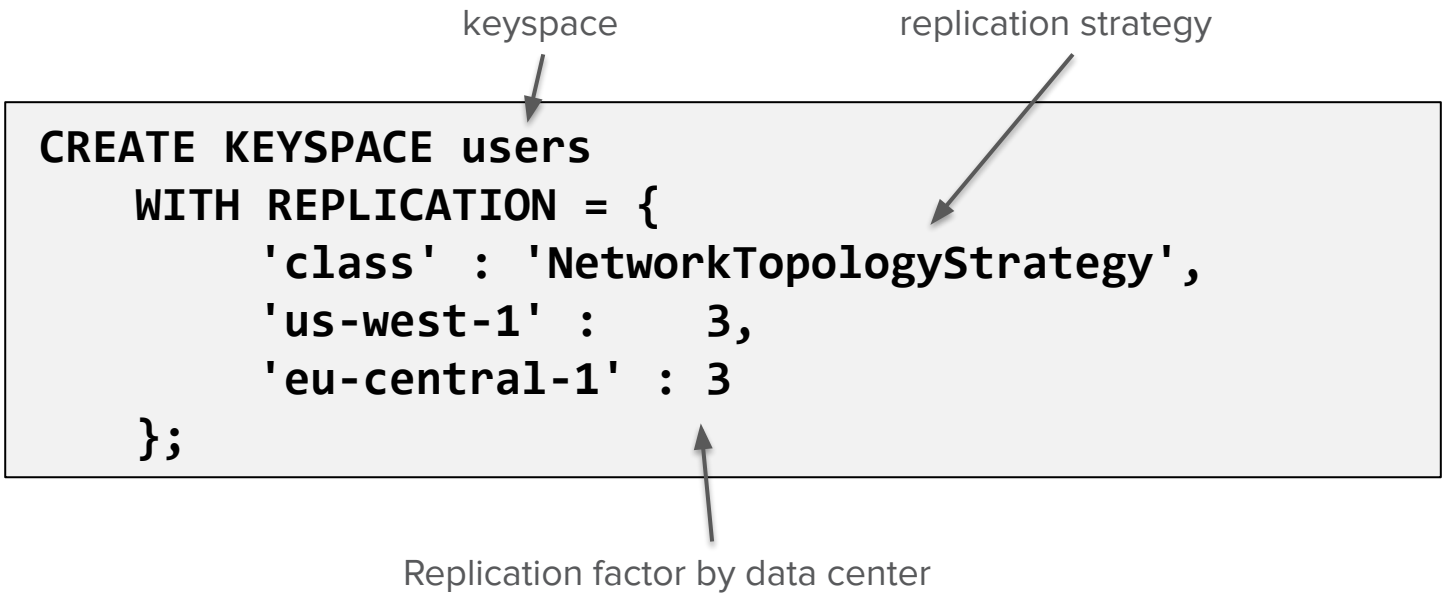
- Tabular data model, with one twist
- *Keyspaces* contain *tables*
- *Tables* are organized in *rows* and *columns*
- Groups of related rows called *partitions* are stored together on the same node (or nodes)
- Each row contains a *partition key*
  - One or more columns that are hashed to determine which node(s) store that data

Example Data: Users organized by city

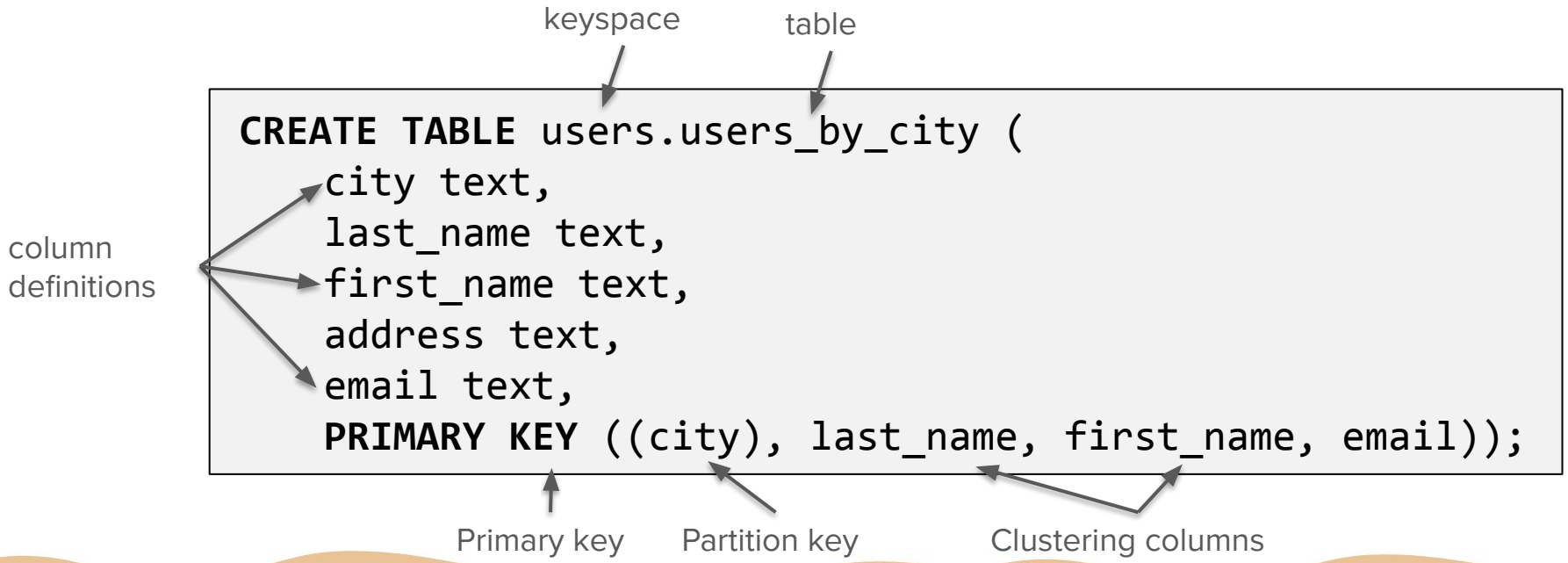


City	Last Name	First Name	Address	Email
Phoenix	Hellson	Kevin	23 Jackson St.	kevin@gmail.com
	Lastfall	Norda	3 Stone St	dino@gmail.com
	Smith	Jana	3 Stone St	wilm@gmail.com
Seattle	Franklin	George	2 Star St	gjet@gmail.com
	Jackson	Jane	2 Star St	jane@gmail.com
	Jasons	Judy	2 StarSt	judy@gmail.com

Creating a Keyspace in CQL



Creating a Table in CQL

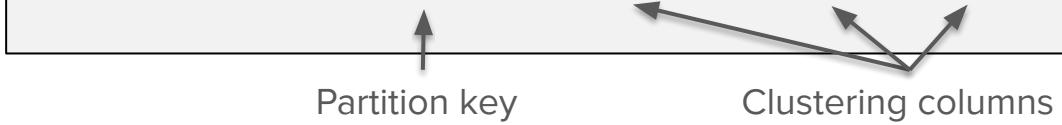


Primary Key

An identifier for a row. Consists of at least one Partition Key and zero or more Clustering Columns.

MUST ENSURE UNIQUENESS.
MAY DEFINE SORTING.

```
CREATE TABLE users.users_by_city (
      city text,
      last_name text,
      first_name text,
      address text,
      email text,
      PRIMARY KEY ((city), last_name, first_name, email));
```



Good Examples:

```
PRIMARY KEY ((city), last_name, first_name, email);
```

```
PRIMARY KEY (user_id);
```

Bad Example:

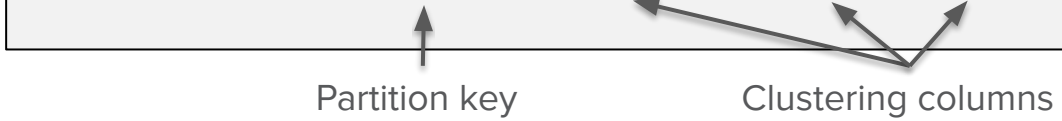
```
PRIMARY KEY ((city), last_name, first_name);
```

Partition Key

An identifier for a partition.
Consists of at least one column, may have more if needed

PARTITIONS ROWS.

```
CREATE TABLE users.users_by_city (
      city text,
      last_name text,
      first_name text,
      address text,
      email text,
      PRIMARY KEY ((city), last_name, first_name, email));
```



Good Examples:

```
PRIMARY KEY (user_id);
```

```
PRIMARY KEY ((video_id), comment_id);
```

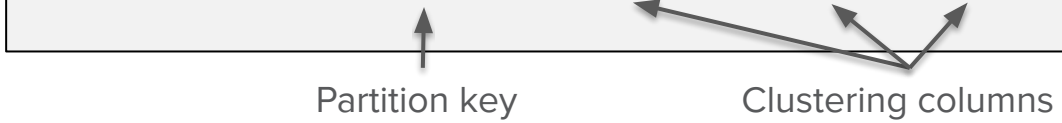
Bad Example:

```
PRIMARY KEY ((sensor_id), logged_at);
```

Clustering Column(s)

Used to ensure uniqueness and sorting order. Optional.

```
CREATE TABLE users.users_by_city (
      city text,
      last_name text,
      first_name text,
      address text,
      email text,
      PRIMARY KEY ((city), last_name, first_name, email));
```




```
PRIMARY KEY ((city), last_name, first_name);
```

Not Unique

```
PRIMARY KEY ((city), last_name, first_name, email);
```

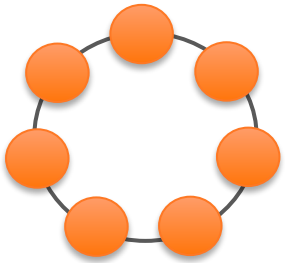
```
PRIMARY KEY ((video_id), comment_id);
```

Not Sorted

```
PRIMARY KEY ((video_id), created_at, comment_id);
```

Partition: The Beginning

```
CREATE TABLE users.users_by_city (
     city text,
     last_name text,
     first_name text,
     address text,
     email text,
     PRIMARY KEY ((city), last_name, first_name, email));
```



- Every node is responsible for a range of tokens (0-100500, 100501-201000...)
- INSERT a new row, we get the value of its Partition Key (can't be null!)
- We hash this value using MurMur3 hasher http://murmurhash.shorelabs.com/
  "Seattle" becomes 2466717130 **Partition Key** = Seattle, **Partition Token** = 2466717130
- This partition belongs to the node[s] responsible for this token
- The INSERT query goes to the nodes storing this partition (Notice Replication Factor)

Rules of a Good Partition

The Slide of the Year Award!

- Store together what you retrieve together
- Avoid big partitions
- Avoid hot partitions

```
PRIMARY KEY (user_id);
```

```
PRIMARY KEY ((video_id), comment_id);
```

```
PRIMARY KEY ((country), user_id);
```

Rules of a Good Partition

The Slide of the Year Award!

- **Store together what you retrieve together**
- Avoid big partitions
- Avoid hot partitions

Example: open a video? Get the comments in a single query!

```
PRIMARY KEY ((video_id), created_at, comment_id);
```

```
PRIMARY KEY ((comment_id), created_at);
```

Rules of a Good Partition

The Slide of the Year Award!

- Store together what you retrieve together
- **Avoid big partitions**
- Avoid hot partitions

```
PRIMARY KEY ((video_id), created_at, comment_id);
```

```
PRIMARY KEY ((country), user_id);
```

- No technical limitations, but…
- Up to ~100k rows in a partition
- Up to ~100MB in a Partition

Rules of a Good Partition

The Slide of the Year Award!

- Store together what you retrieve together
- **Avoid big partitions?**
- Avoid hot partitions

Example: a huge IoT infrastructure, hardware all over the world, different sensors reporting their state every 10 seconds. Every sensor reports its UUID, timestamp of the report, sensor's value.

- Sensor ID: UUID
- Timestamp: Timestamp
- Value: float

```
PRIMARY KEY ((sensor_id), reported_at);
```

Rules of a Good Partition

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- **Avoid big and constantly growing partitions!**
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Example large IoT infrastructure hardware all over the world, different sensors reporting their state every 10 seconds. Every sensor reports its UUID, timestamp of the report, sensor's value

Sensor's UUID
Timestamp:
Value: float

BUCKETING

```
PRIMARY KEY ((sensor_id), reported_at);
```

```
PRIMARY KEY ((sensor_id, _____), reported_at);
```

Rules of a Good Partition

The Slide of the Year Award!

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- **Avoid big and constantly growing partitions!**
- Avoid hot partitions

Example: a huge IoT infrastructure, hardware all over the world, different sensors reporting their state every 10 seconds. Every sensor reports its UUID, timestamp of the report, sensor's value.

```
PRIMARY KEY ((sensor_id), reported_at);
```

```
PRIMARY KEY ((sensor_id, _____), reported_at);
```

```
PRIMARY KEY ((sensor_id, month_year), reported_at);
```

BUCKETING

- Sensor ID: UUID
- **MonthYear**: Integer or String
- Timestamp: Timestamp
- Value: float

Rules of a Good Partition

The Slide of the Year Award!

- Store together what you retrieve together
- Avoid big partitions
- **Avoid hot partitions**

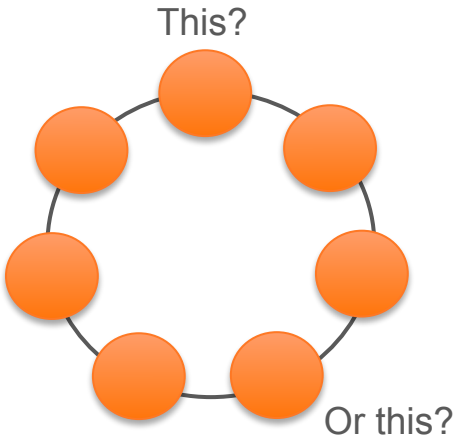
```
PRIMARY KEY (user_id);
```

```
PRIMARY KEY ((video_id), created_at, comment_id);
```

```
PRIMARY KEY ((country), user_id);
```

Always specify the partition key!

If there is no partition key in a query, which node you will ask?



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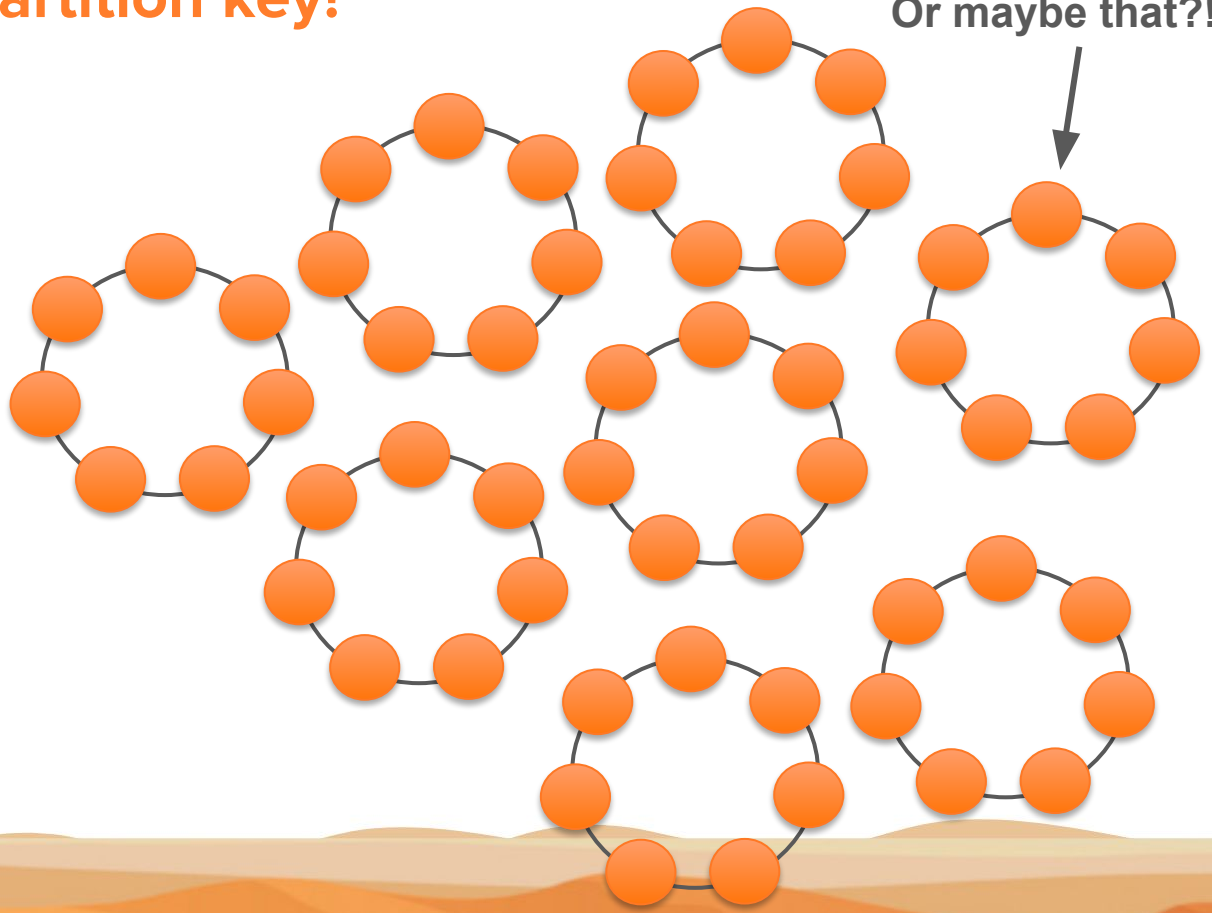

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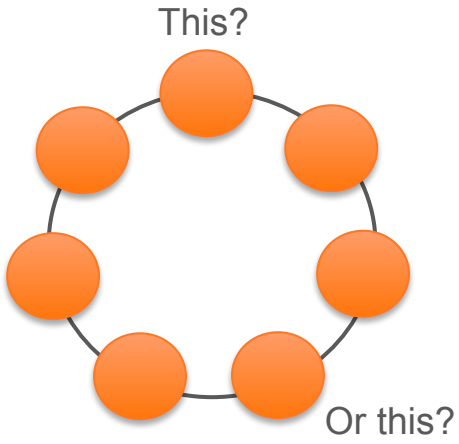



```
CREATE TABLE users.users_by_city (
      city text,
      last_name text,
      first_name text,
      address text,
      email text,
      PRIMARY KEY ((city), last_name, first_name, email));
```

```
SELECT address FROM users_by_city WHERE first_name = “Anna”;
```

```
SELECT address FROM users_by_city WHERE city = “Otterberg” AND last_name = “Koshkina”;
```

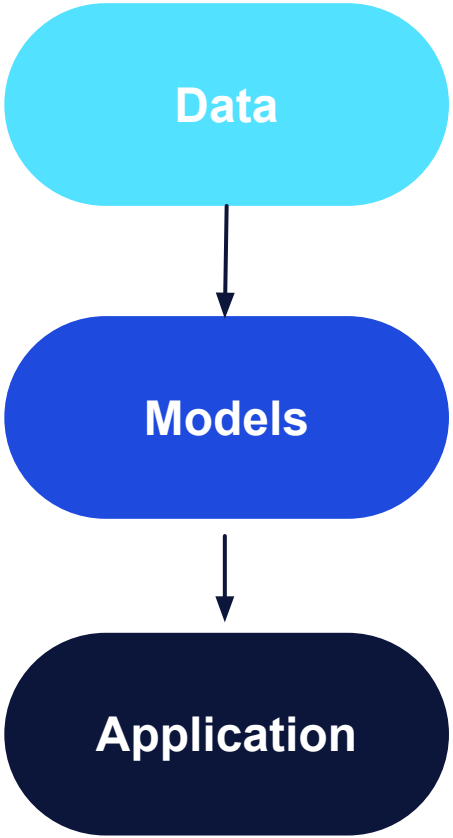
Developer Workshop Series Week II

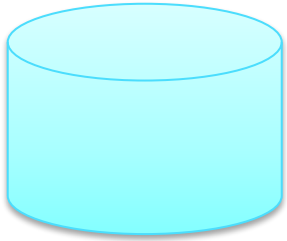
- ➔ Keyspaces, Tables, Partitions
- ➔ The Art of Data Modelling
- ➔ Data Types
- ➔ What's NEXT?

Cassandra Cloud-Native Workshop Series

Relational Data Modelling

1. Analyze raw data
2. Identify entities, their properties and relations
3. Design tables, using normalization and foreign keys.
4. Use JOIN when doing queries to join denormalized data from multiple tables





Employees

userId	firstName	lastName
1	Edgar	Codd
2	Raymond	Boyce

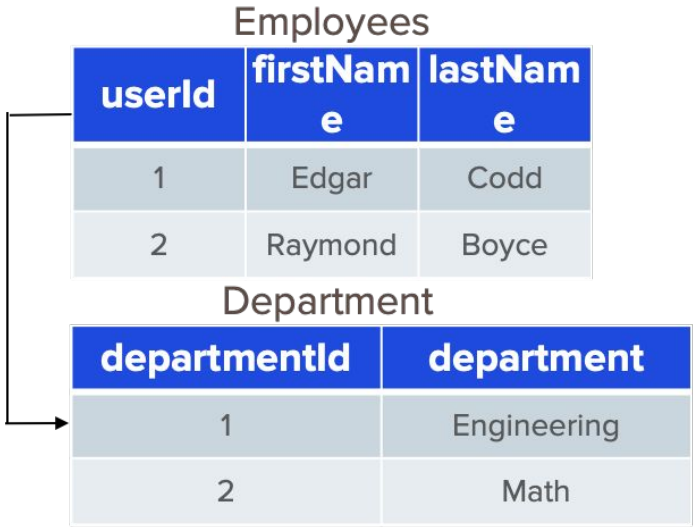
Department

departmentId	department
1	Engineering
2	Math

Normalization

“Database normalization is the process of structuring a relational database in accordance with a series of so-called normal forms in order to reduce data redundancy and improve data integrity. It was first proposed by Edgar F. Codd as part of his relational model.”

PROS: Simple write, Data Integrity
CONS: Slow read, Complex Queries



Denormalization

“Denormalization is a strategy used on a database to increase performance. In computing, denormalization is the process of trying to improve the read performance of a database, at the expense of losing some write performance, by adding redundant copies of data”

PROS: Quick Read, Simple Queries
CONS: Multiple Writes, Manual Integrity

Employees

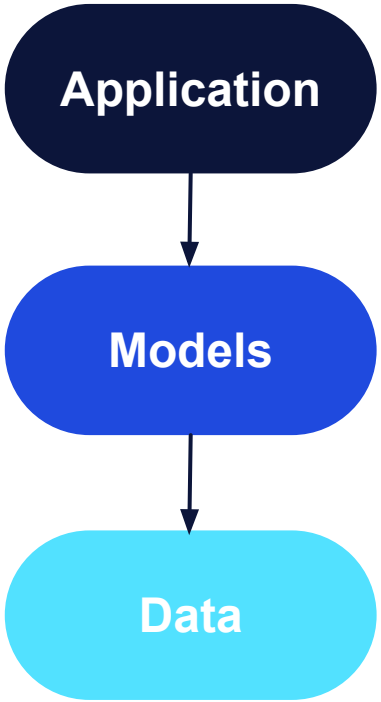
userId	firstName	lastName	department
1	Edgar	Codd	Engineering
2	Raymond	Boyce	Math

Department

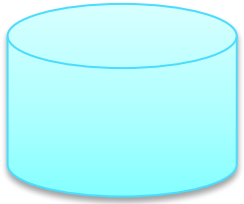
departmentId	department
1	Engineering
2	Math

NoSQL Data Modelling

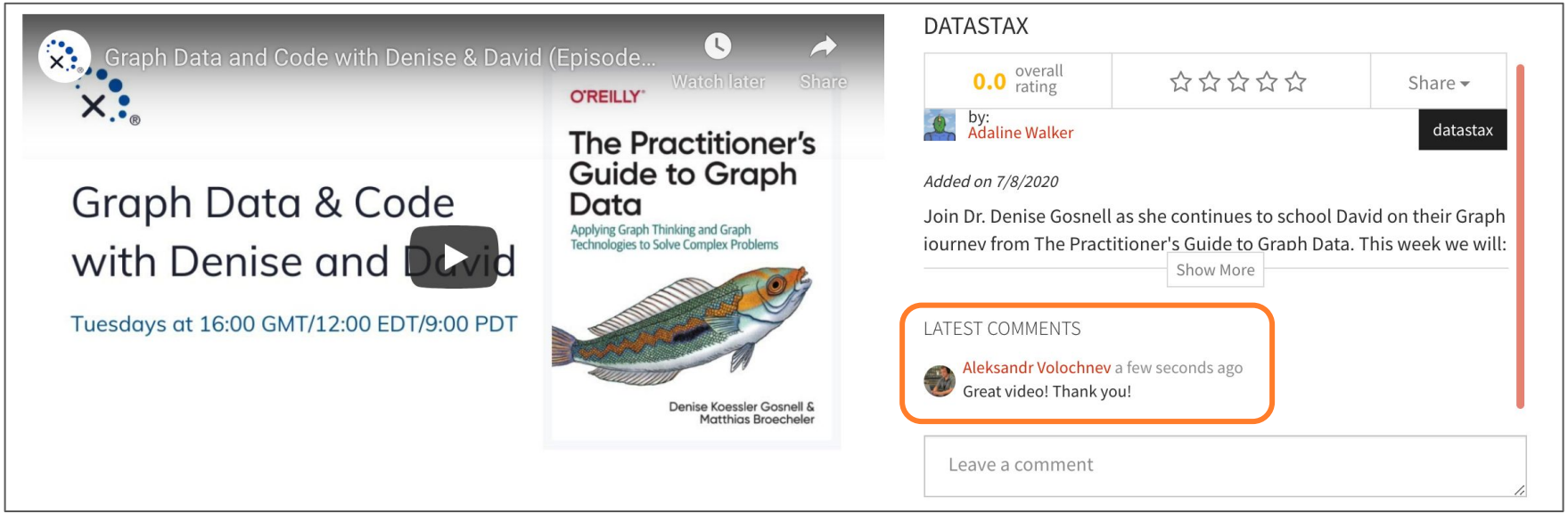
1. Analyze user behaviour (customer first!)
2. Identify workflows, their dependencies and needs
3. Define Queries to fulfill these workflows
4. Knowing the queries, design tables, using denormalization.
5. Use BATCH when inserting or updating denormalized data of multiple tables



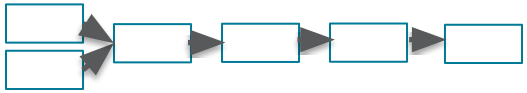
id	firstName	lastName	department
1	Edgar	Codd	Engineering
2	Raymond	Boyce	Math

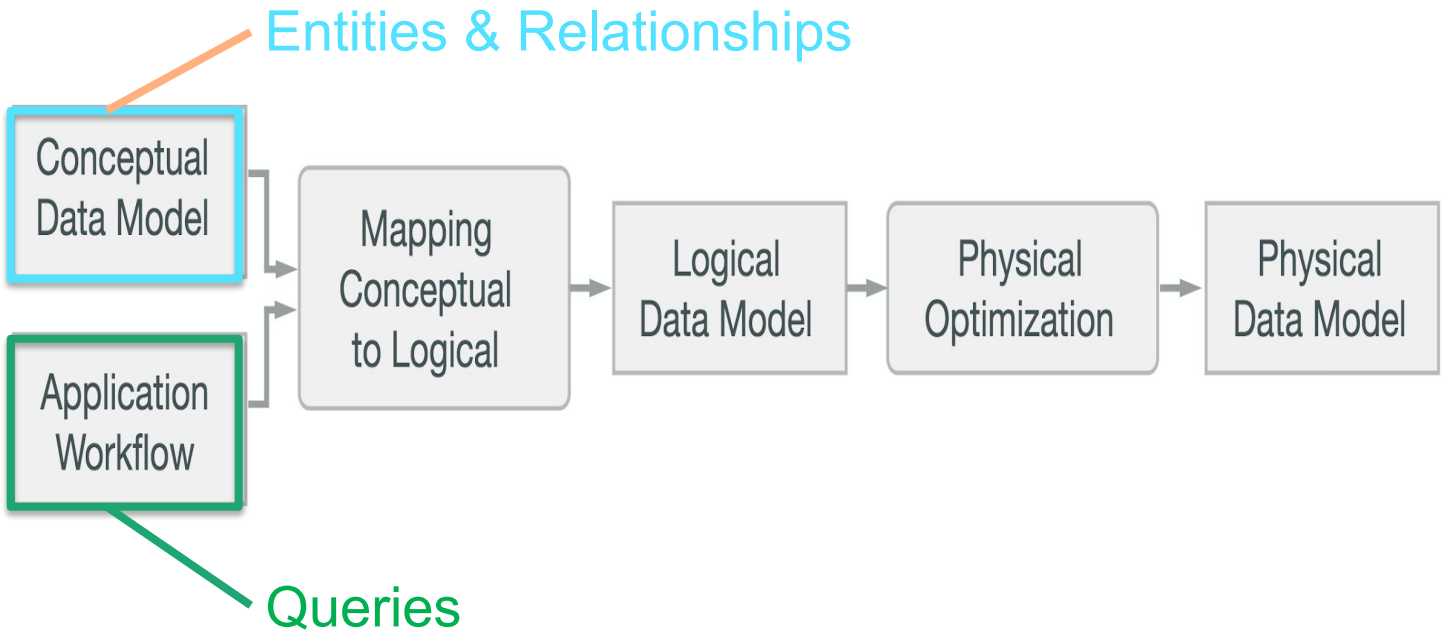


Let’s go practical!

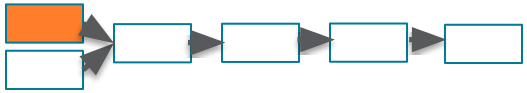


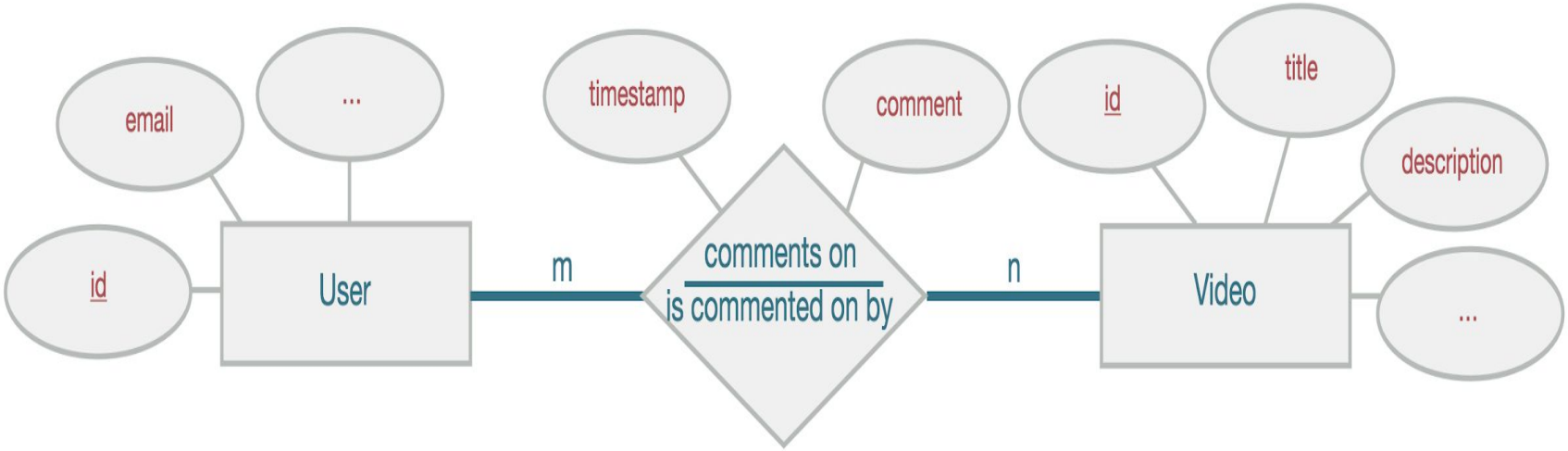
Designing Process: Step by Step



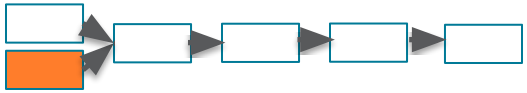


Designing Process: Conceptual Data Model





Designing Process: Application Workflow



Use-Case I:

- A User opens a Video Page

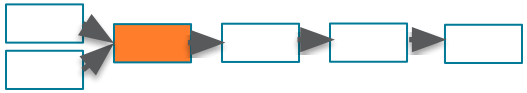
WF1: Find comments related to target video using its identifier, most recent first

Use-Case II + III:

- A User opens a Profile
- A Moderator verifies a User if spammer or not

WF2: Find comments related to target user using its identifier, get most recent first

Designing Process: Mapping



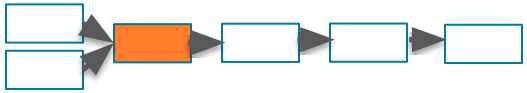
Query I: Find comments posted for a user with a known id (show most recent first)

→ comments_by_user

Query II: Find comments for a video with a known id (show most recent first)

→ comments_by_video

Designing Process: Mapping



```
SELECT * FROM comments_by_user
WHERE userid = <some UUID>
```

→ comments_by_user

```
SELECT * FROM comments_by_video
WHERE videoid = <some UUID>
```

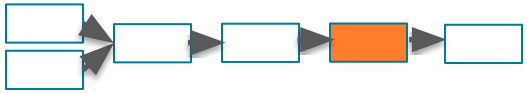
→ comments_by_video

Designing Process: Logical Data Model

comments_by_user	
userid	K
creationdate	C ↓
commentid	C ↑
videoid	
comment	

comments_by_video	
videoid	K
creationdate	C ↓
commentid	C ↑
userid	
comment	

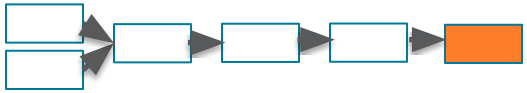
Designing Process: Physical Data Model



comments_by_user			
userid	UUID	K	
commentid	TIMEUUID	C	↓
videoid	UUID		
comment	TEXT		

comments_by_video			
videoid	UUID	K	
commentid	TIMEUUID	C	↓
userid	UUID		
comment	TEXT		

Designing Process: Schema DDL



```
CREATE TABLE IF NOT EXISTS comments_by_user (
    userid uuid,
    commentid timeuuid,
    videoid uuid,
    comment text,
    PRIMARY KEY ((userid), commentid)
) WITH CLUSTERING ORDER BY (commentid DESC);

CREATE TABLE IF NOT EXISTS comments_by_video (
    videoid   uuid,
    commentid timeuuid,
    userid    uuid,
    comment   text,
    PRIMARY KEY ((videoid), commentid)
) WITH CLUSTERING ORDER BY (commentid DESC);
```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Flexible time
Social factor
Big paycheck
Available on the iPhone
App Store
GET IT ON
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Developer Workshop Series Week II

- ➔ Keyspaces, Tables, Partitions
- ➔ The Art of Data Modelling
- ➔ Data Types
- ➔ What's NEXT?

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Basic Data Types

type	constants supported	description
`ascii`	`string`	ASCII character string
`bigint`	`integer`	64-bit signed long
`blob`	`blob`	Arbitrary bytes (no validation)
`boolean`	`boolean`	Either `true` or `false`
`counter`	`integer`	Counter column (64-bit signed value). See Counters for details
`date`	`integer`, `string`	A date (with no corresponding time value). See Working with dates below for details
`decimal`	`integer`, `float`	Variable-precision decimal
`double`	`integer` `float`	64-bit IEEE-754 floating point
`duration`	`duration`,	A duration with nanosecond precision. See Working with durations below for details
`float`	`integer`, `float`	32-bit IEEE-754 floating point
`inet`	`string`	An IP address, either IPv4 (4 bytes long) or IPv6 (16 bytes long). Note that there is no `inet` constant, IP address should be input as strings
`int`	`integer`	32-bit signed int
`smallint`	`integer`	16-bit signed int
`text`	`string`	UTF8 encoded string
`time`	`integer`, `string`	A time (with no corresponding date value) with nanosecond precision. See Working with times below for details
`timestamp`	`integer`, `string`	A timestamp (date and time) with millisecond precision. See Working with timestamps below for details
`timeuuid`	`uuid`	Version 1 UUID, generally used as a “conflict-free” timestamp. Also see Timeuuid functions
`tinyint`	`integer`	8-bit signed int
`uuid`	`uuid`	A UUID (of any version)
`varchar`	`string`	UTF8 encoded string
`varint`	`integer`	Arbitrary-precision integer

Collections

I'm a SET with a bunch of unordered things

I'm an ordered LIST

I'm a MAP of key/value pairs

Key	Value
K1	V1
K2	V2
K3	V3
K4	V4
K5	V5

Collection: Set

```
CREATE killrvideo.videos (
  videoid                 uuid,
  userid                  uuid,
  name                    text,
  description             text,
  location                text,
  location_type           int,
  preview_image_location  text,
  tags                    set<text>,
  added_date              timestamp,
  PRIMARY KEY (videoid)
);
```

{‘Family’, ‘Disney’, ‘Princess’}

{‘Thriller’, ‘Short’}

{‘Tragicomedy’, ‘Western’}

Collection: Set

```
INSERT INTO killrvideo.videos (videoid, tags)
  VALUES(12345678-1234-1234-1234-123456789012,
  {'Side-splitter', 'Short'});
```

Insert

```
UPDATE killrvideo.videos
  SET tags = {'Dark', 'Sad'}
  WHERE videoid = 12345678-1234-1234-1234-123456789012;
```

Replace entire set

```
UPDATE killrvideo.videos
  SET tags = tags + {'Enthralling'}
  WHERE videoid = 12345678-1234-1234-1234-123456789012;
```

Add to set

Collection: List

```
CREATE killrvideo.actors_by_video (
  videoid  uuid,
  actors   list<text>, // alphabetical list of actors
  PRIMARY KEY (videoid)
);
```

Collection: List

```
INSERT INTO killrvideo.actors_by_video (videoid, actors)
  VALUES(12345678-1234-1234-1234-123456789012,
  ['Adams', 'Baker', 'Cox']);
```

Insert

```
UPDATE killrvideo.actors_by_video
  SET actors = ['Arthur', 'Beverly']
  WHERE videoid = 12345678-1234-1234-1234-123456789012;
```

Replace entire list

```
UPDATE killrvideo.actors_by_video
  SET actors = actors + ['Crawford']
  WHERE videoid = 12345678-1234-1234-1234-123456789012;
```

Append

Collection: List

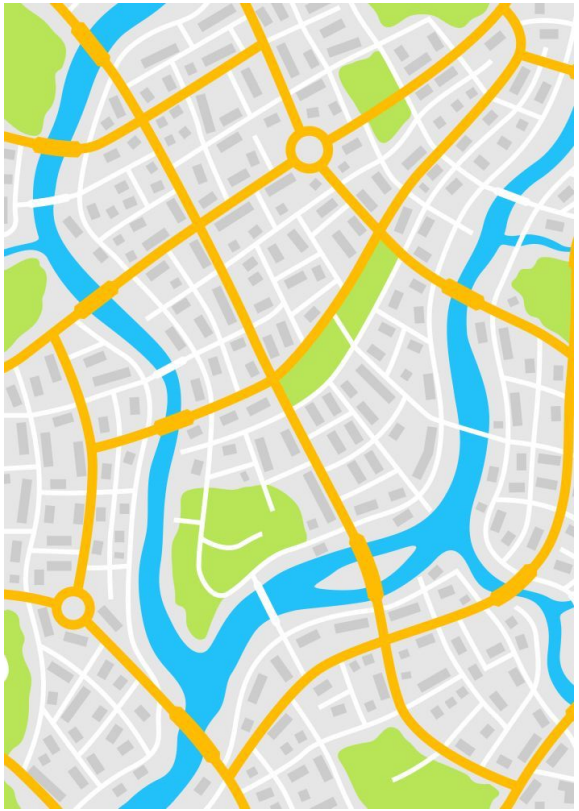
```
UPDATE killrvideo.actors_by_video
  SET actors[1] = 'Brown'
  WHERE videoid = 12345678-1234-1234-1234-123456789012;
```

Replace an element

Note: replacing an element requires a read-before-write, which implies performance penalty.

Collection: Map

```
CREATE TABLE killrvideo.users(
  userid       uuid,
  phone_nos    map<text, text>,
  PRIMARY KEY (userid)
);
```



Collection: Map

```
INSERT INTO killrvideo.users (userid, phone_nos)
  VALUES(12345678-1234-1234-1234-123456789012,
  {'cell':'867-5309', 'home':'555-1212',
  'busi':'800-555-1212'});
```

Insert

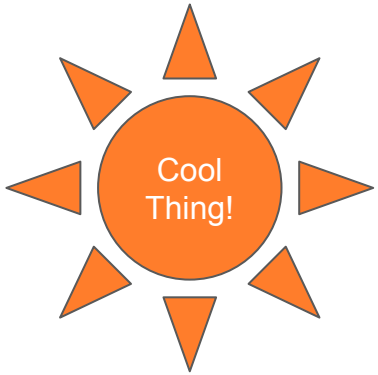
```
UPDATE killrvideo.users
  SET phone_nos = {'cell':'867-5310', 'office':'555-1212'}
  WHERE userid = 12345678-1234-1234-1234-123456789012;
```

Replace entire map

```
UPDATE killrvideo.users
  SET phone_nos = phone_nos + {'desk': '270-555-1213'}
  WHERE userid = 12345678-1234-1234-1234-123456789012;
```

Add to map

User Defined Types




```
CREATE TYPE killrvideo.address(
  street text,
  city   text,
  state  text,
);
```

```
CREATE TABLE killrvideo.users(
  userid       uuid,
  location     address,
  PRIMARY KEY (userid)
);
```

User Defined Types

Insert

```
INSERT INTO killrvideo.users (userid, location)
  VALUES(12345678-1234-1234-1234-123456789012,
  {street:'123 Main', city:'Metropolis', state:'CA'});
```

Replace entire UDT

```
UPDATE killrvideo.users
  SET location = {street:'234 Elm', city:'NYC', state:'NY'}
  WHERE userid = 12345678-1234-1234-1234-123456789012;
```

Replace one UDT field

```
UPDATE killrvideo.users
  SET location.city = 'Albany'
  WHERE userid = 12345678-1234-1234-1234-123456789012;
```

User Defined Types

```
SELECT location.city FROM killrvideo.users
  WHERE userid = 12345678-1234-1234-1234-123456789012;
```

Select field

Counters

- 64-bit signed integer
- Use-case:
  - Imprecise values such as likes, views, etc.
- Two operations:
  - Increment
  - Decrement
  - First op assumes the value is zero

Counters

- Cannot be part of primary key
- Counters not mixed with other types in table
- Value cannot be set
- Rows with counters cannot be inserted
- Updates are not idempotent
  - Counters should *not* be used for precise values

Counters

```
CREATE TABLE killrvideo.video_playback_stats (
    videoid uuid,
    views counter,
    PRIMARY KEY (videoid)
);
```

Counters

Incrementing a counter:

This format must be observed

This can be an integer value

```
UPDATE killrvideo.videos SET views = views + 1
  WHERE videoid = 12345678-1234-1234-1234-123456789012;
```

Decrementing a counter:

Just change the sign

```
UPDATE killrvideo.videos SET views = views - 1
  WHERE videoid = 12345678-1234-1234-1234-123456789012;
```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Developer Workshop Series Week II

- ➔ Keyspaces, Tables, Partitions
- ➔ The Art of Data Modelling
- ➔ Data Types
- ➔ What's NEXT?

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Homework Week II

1. Do notebooks: **Data Modelling and Advanced Data Types**
   https://github.com/DataStax-Academy/cassandra-workshop-series/tree/master/week2-DataModel

2. Watch the **DS220 Course** (videos only)
   https://academy.datastax.com/resources/ds220

3. Validate your participation, fill **the form** (5 questions)
   https://forms.gle/YYZcZti4r3JgCLtV9

Bonus Week II

- Single-Row Partitions
  https://katacoda.com/datastax/courses/cassandra-intro/tables-single-row-partitions
- Multi-Row Partitions
  https://katacoda.com/datastax/courses/cassandra-intro/tables-multi-row-partitions
- Advanced Data Types
  https://katacoda.com/datastax/courses/cassandra-intro/advanced-data-types

Training Courses at DataStax Academy

- DS201: Foundations of Apache Cassandra™
- DS220: Practical Application Data Modeling with Apache Cassandra™

Developer Resources

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MATERIALS

Slides and code for this course are available at https://github.com/DataStax-Academy/cassandra-workshop-series

Part 1 - How to build Applications with Cassandra

Every Wednesday (NAM/LATAM) - 9am PDT / 12pm EDT / 5pm BST / 6pm CEST / 21:30pm IST
Every Thursday (APAC/EMEA) - 8am BST / 9am CEST / 12:30 pm IST / 15 pm SGT / 17pm ACT

July 1	Getting Started with Cassandra	✅
July 8	Data Modelling for Apache Cassandra™	✅
July 15	Application Development with Cassandra part 1	
July 22	Application Development with Cassandra part 2	

Part 2 - Test, Deploy and Monitor

Every Wednesday (NAM/LATAM) - 9am PDT / 12pm EDT / 5pm BST / 6pm CEST / 21:30pm IST
Every Thursday (APAC/EMEA) - 8am BST / 9am CEST / 12:30 pm IST / 15 pm SGT / 17pm ACT

July 29	Operating your Cassandra clusters
Aug 5	Running Cassandra performance tests
Aug 12	Testing your deployments and troubleshooting
Aug 19	Deploying Cassandra with Kubernetes


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