Database Applications
Lecture 8: NoSQL and MongoDB

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Announcements

- Mid-Semester Test – Thursday 22 Sep --
  - Must bring in your laptop (fully charged)
  - Topics covered in Week 1 – 7 are examinable. No PHP coding
  - Multiple-choice and short-answer questions
- Assignment 2 – will be released next week.

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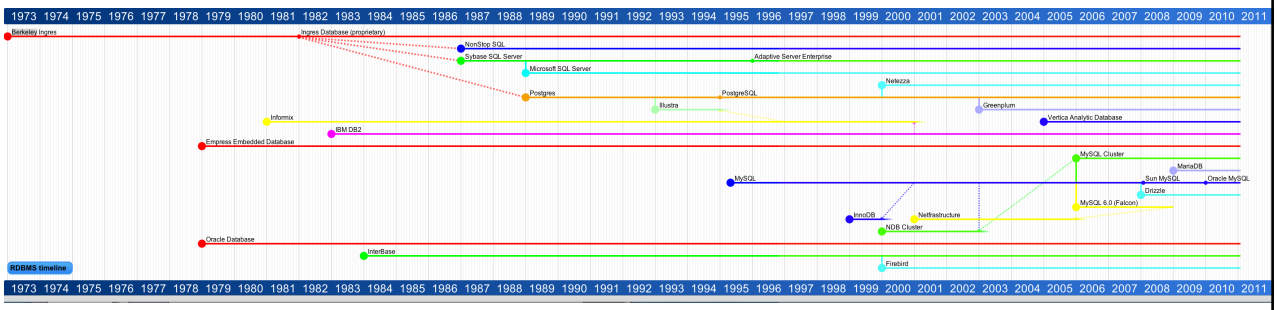
A (not so) short history of DBMS

- http://upload.wikimedia.org/wikipedia/commons/2/22/RDBMS_timeline.svg



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Re-invent the wheel?

- In modern times, there were only very few re-inventions that made a great impact!
  - Propellor engine → Jet engine (in aircraft)
  - Film Camera → Digital Camera
  - …
- Is NoSQL the database equivalent to the jet engine in the aeronautical world?
- Why do you reinvent this new database model?

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Re-invent the wheel?

- Data is everywhere. The digital transformation drives us to the frontiers that never reached.
- The digital transformation demands for rich content and big data!
- The structured database model, that catered the data management needs for almost half a century, has its inherent limitations.

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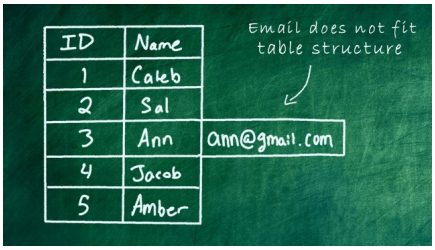
An Example

- Consider the following example: Consider a database schema developed in early 1990s where use of email was not widespread, however, now it has become an essential piece of information required for a student database.



- This is not easily done with a relational database model.

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Another Example

- Consider the following two AirBnB listings:
- https://www.airbnb.com.au/experiences/79594
- https://www.airbnb.com.au/rooms/10082422

- How different are they?
- Can you easily store them in a table in a relational database?

- We will explore these databases in our future labs. (https://docs.atlas.mongodb.com/sample-data/sample-airbnb/#sample-document)

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NoSQL – Not just one model

https://en.wikipedia.org/wiki/NoSQL

NoSQL is a collective noun used for data models other than tabular relations.

Some of the common NoSQL data models are:

- Document databases
- Graph stores
- Key-value stores
- Wide-column stores

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NoSQL Database Types – Document Databases

- **Document databases**: pair each key with a complex data structure known as a document. Documents can contain many different key-value pairs, or key-array pairs, or even nested documents.

```
{
  "_id": "10006546",
  "listing_url": "https://www.airbnb.com/rooms/10006546",
  "name": "Ribeira Charming Duplex",
  "summary": "Fantastic duplex apartment with three bedrooms,
            located in the historic area of Porto, Ribeira (Cube)...",
  "interaction": "Cot - 10 € / night Dog - € 7,5 / night",
  "house_rules": "Make the house your home...",
  "property_type": "House",
  "room_type": "Entire home/apt",
    ...
     ...
```

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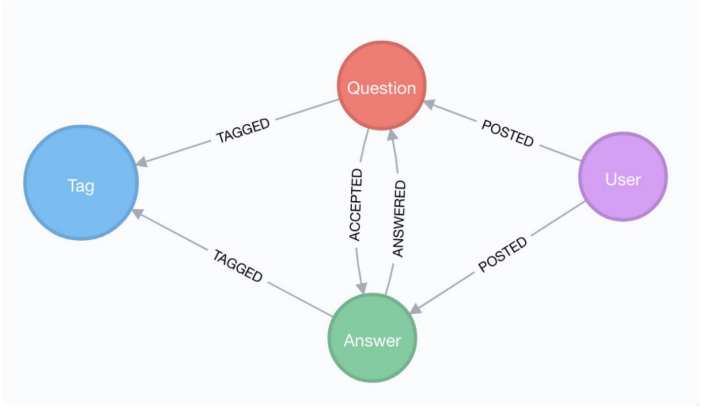
NoSQL Database Types – Graph Stores

- **Graph stores** are used to store information about networks of data, such as social connections. Graph stores include Neo4J and Giraph.



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NoSQL Database Types – Key-value stores

- **Key-value stores** are the simplest NoSQL databases. Every single item in the database is stored as an attribute name (or 'key'), together with its value. Examples of key-value stores are Riak and Berkeley DB. Some key-value stores, such as Redis, allow each value to have a type, such as 'integer', which adds functionality.

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NoSQL Database Types – Wide-column Stores

- **Wide-column stores** such as Cassandra and HBase are optimized for queries over large datasets, and store columns of data together, instead of rows.

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Benefits of NoSQL

- Dynamic Schemas
  - Relational databases require that schemas be defined before you can add data.
  - NoSQL databases are built to allow the insertion of data without a predefined schema.
  - Nicely fits with agile development process.
  - Data validation is delegated to the application.

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Benefits of NoSQL

- Auto-sharding
  - Partitioning can be done in the relational database systems, however, they require quite sophisticated mechanisms to ensure joins etc are executed efficiently.
  - NoSQL databases, on the other hand, usually support auto-sharding, meaning that they natively and automatically spread data across an arbitrary number of servers, without requiring the application to even be aware of the composition of the server pool.

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Benefits of NoSQL

- **Replication**
  - Most NoSQL databases also support automatic database replication to maintain availability in the event of outages or planned maintenance events.
  - Unlike relational databases, NoSQL databases generally have no requirement for separate applications or expensive add-ons to implement replication.

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MongoDB

What a name for a database!

The name of the database was derived from the word *humongous* to support the idea of processing large amount of data.

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MongoDB

- **MongoDB** is a cross-platform document-oriented database
- MongoDB uses JSON-like documents. A document is a record (sort of like a row in a structured table). For example, if we have a database for users, a document would be one individual user.
- A document is made out of a list of key-value pairs.

```
{
name: "sue",
age: 26,
status: "A",
Groups: [ "news", "sports" ]
}
```

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MongoDB – similar but different!

Relational	MongoDB
database	database
table	collection
row	document
column	field
CREATE TABLE people (user_id Varchar(30), age Number, status char(1), PRIMARY KEY (user_id));	db.people.insertOne({ user_id: "abc123", age: 55, status: "A" })

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Demo time!

MongoDB
MongoDB Compass

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Insert a document

- In SQL:

```
INSERT INTO people (user_id, age, status)
    VALUES ('A1234',23,'A');
```

- In MongoDB Shell:

```
db.people.insertOne(
   { user_id: "A1234", age: 23, status: "A" }
)
```

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Insert a document

- In SQL:

```
INSERT INTO people (user_id, age, status)
    VALUES ('A1234',23,'A');
```

- In MongoDB Compass:

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A complex insertion

- In SQL: We **cannot** insert composite objects or arrays into tables

```
INSERT INTO people (user_id, name, address, age, sports)
    VALUES ('A1234','Sam', {1}{Happy St}{Happyville}{3999},
              23,['AFL', 'Cricket', 'Rugby']);
```

- In MongoDB Shell:

```
db.people.insertOne(
   { user_id: "A1234", name: "Sam",
     address: { no: 28, street: "Happy St",
                suburb: "Happyville"},
     age: 23, sports: ["AFL", "Cricket", "Rugby"] }
)
```

Address is a composite object. Sports is an array.

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A complex insertion

- In MongoDB Compass:

Address is a composite object. Sports is an array.

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Find a document

- In SQL we use SELECT to find/ retrieve data. In MongoDB, we use find() method.

```
db.<<collection-name>>.find (<<query>>, <<projection>>)
```

This specifies the conditions. Similar to WHERE clause in SQL

- Next few slides demonstrate how queries and projections are formed.

This specifies which fields to display. Similar to SELECT clause in SQL.

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Find a document

- In SQL:

```
SELECT *
    FROM people;
```

- In MongoDB Shell:

```
db.people.find()
```

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Find some fields in a document

- In SQL:

```
SELECT ROWID, user_id, status
    FROM people;
```

- In MongoDB Shell:

```
db.people.find(
    { },
    { user_id: 1, status: 1 }
)
```

Leave this empty, as there isn't any filtering condition.

If you do not want to see the document ID, add _id: 0 to the projection (field list).

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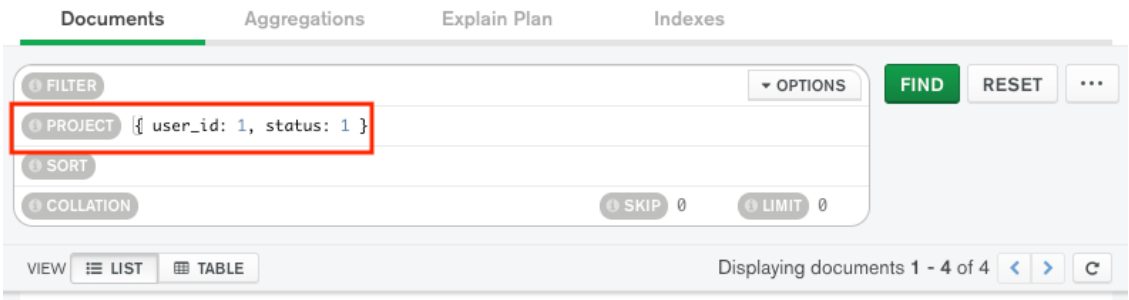
Find a document

- In SQL:

```
SELECT ROWID, user_id, status
    FROM people;
```

- In MongoDB Compass:



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Filter a document

filtering condition.

- In SQL:

```
SELECT user_id, status
    FROM people
    WHERE status = 'A';
```

- In MongoDB Shell:

```
db.people.find(
    { status: "A" },
    { user_id: 1, status: 1, _id: 0 }
)
```

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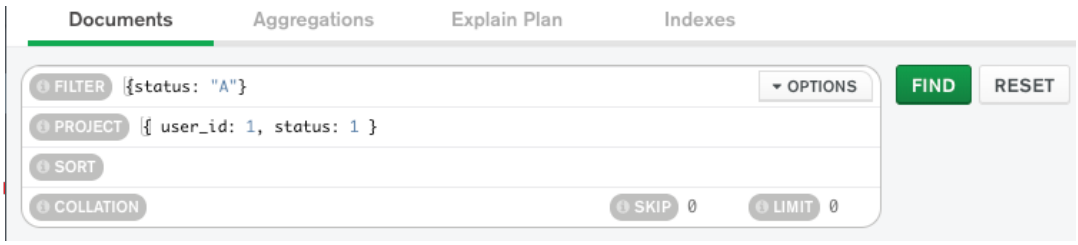
Filter a document

- In SQL:

```
SELECT user_id, status
    FROM people
    WHERE status = 'A';
```

- In MongoDB Compass:



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Filter a document – with multiple conditions

- In SQL:

```
SELECT *
    FROM people
    WHERE status = 'A' AND
          age = 25;
```

AND is the default.

- In MongoDB Shell:

```
db.people.find(
    { status: "A",
      age: 25 }
)
```

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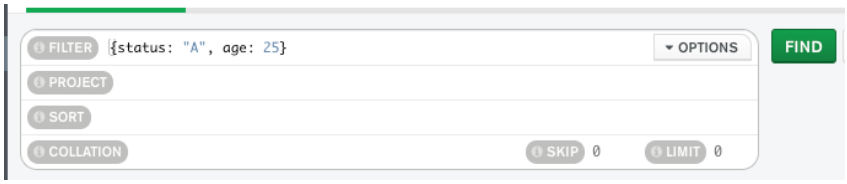
Filter a document

- In SQL:

```
SELECT *
    FROM people
    WHERE status = 'A' AND
          age = 25;
```

- In MongoDB Compass:



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Filter a document – with OR conditions

- In SQL:

```
SELECT *
    FROM people
    WHERE status = 'A' OR
          age = 25;
```

OR is applied to an array of conditions. [ ] denotes an array.

- In MongoDB Shell:

```
db.people.find(
    { $or: [ { status: "A" } , { age: 25 } ] }
)
```

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Filter a document – with OR conditions

- In SQL:

```
SELECT *
    FROM people
    WHERE status = 'A' OR
          age = 25;
```

- In MongoDB Compass:

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Filter a document – with "Not Equal"

$ne means "not equal"

- In SQL:

```
SELECT *
    FROM people
    WHERE  age <> 25;
```

- In MongoDB Shell:

```
db.people.find(
     { age: { $ne: 25 } }
)
```

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Filter a document – middle-aged people!

- In SQL:

```
SELECT *
    FROM people
    WHERE  age > 35 AND age <= 60;
```

- In MongoDB Shell:

```
db.people.find(
     { age: { $gt: 35, $lte: 60 }}
)
```

$gt: greater than
$gte: greater than or equal
$lt: less than
$lte: less than or equal

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Filter a document – Partial Matches

- In SQL:

```
SELECT *
    FROM people
    WHERE  name LIKE '%Sam%;
```

- In MongoDB Shell:

```
db.people.find(
     {name: /Sam/}
)
```

More complex regular expressions are possible. To be discussed later. E.g.
`{name: {$regex: /Sam/ } }`

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Filter a document – Using Composite Fields

- In SQL: Cannot be done!

```
SELECT *
    FROM people
    WHERE  address.suburb = 'Happyville';
```

- In MongoDB Shell:

```
db.people.find(
     {"address.suburb": "Happyville"}
)
```

Make sure to use double quotes.

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Filter a document – Using Array Values

- In SQL: Cannot be done!

```
SELECT *
    FROM people
    WHERE  sport = ['AFL', 'Cricket']
```

- In MongoDB Shell:

```
db.people.find(
    {sports:"AFL", "Cricket"}
)
```

Return documents that exactly contain this array.

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Aggregations -- count()

- In SQL:

```
SELECT COUNT(*)
    FROM people;
```

- In MongoDB Shell:

```
db.people.find().count()
```

Object-oriented. Two ways to do it:
`db.collection.find().count()`
`db.collection.count()`

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Sorting

- In SQL:

```
SELECT *
    FROM people
    ORDER BY name;
```

- In MongoDB Shell:

```
db.people.find().sort({name: 1})
```

```
db.people.find().sort({name: -1})
```

Descending order

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Sorting

- In SQL:

```
SELECT *
    FROM people
    ORDER BY name;
```

- In MongoDB Compass:

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Further Readings

- https://docs.mongodb.com/manual/reference/sql-comparison/
- https://docs.mongodb.com/manual/tutorial/insert-documents/
- https://docs.mongodb.com/manual/tutorial/query-documents/

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Next Week

- Mid-semester Test
- We will continue MongoDB discussion in Week 9. We discuss further on aggregations, etc.

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Menti-time!

Menti.com
Code: to be supplied

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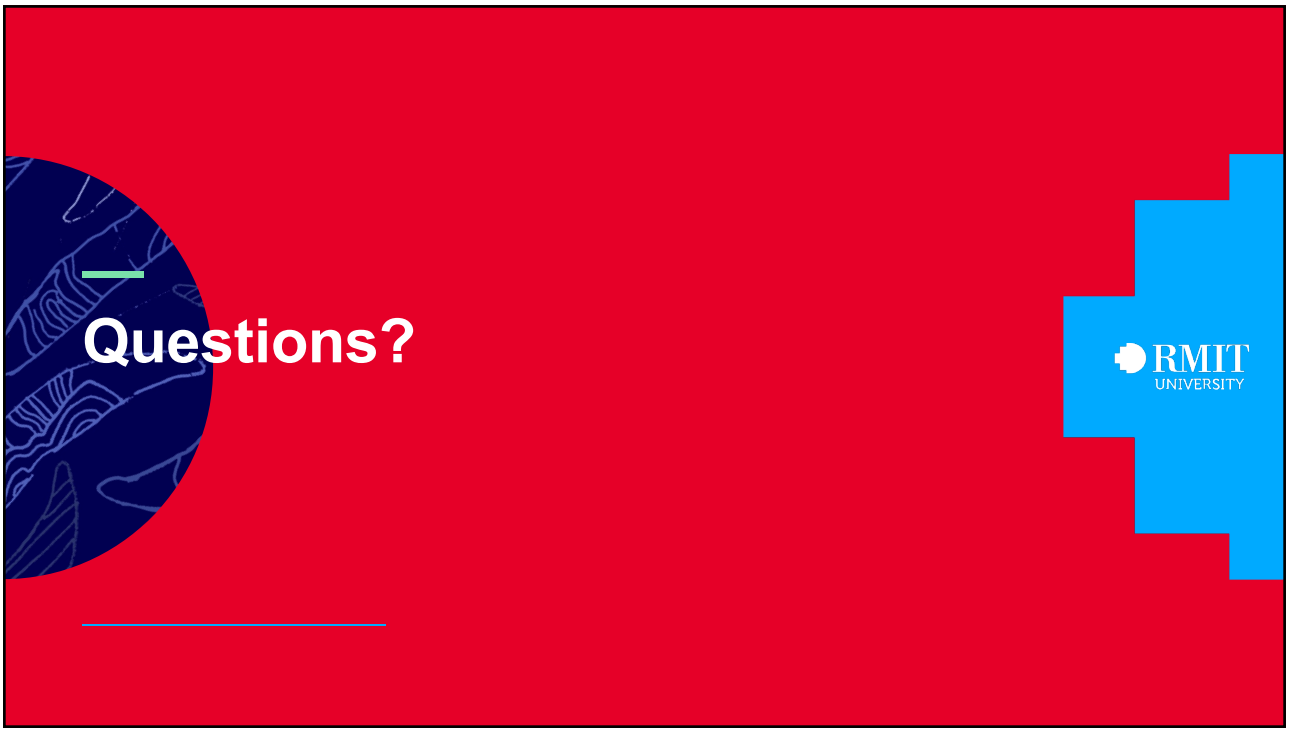

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