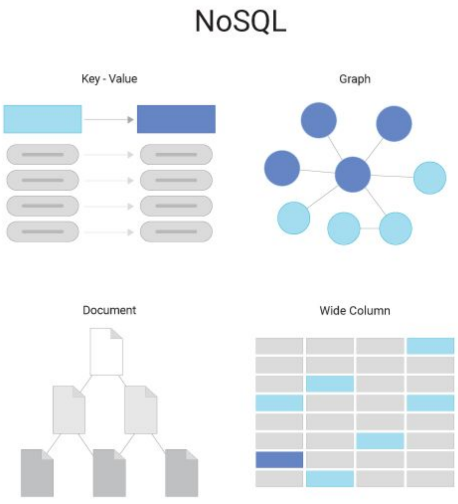
MongoDB

Goal: Build the mental model & write simple MongoDB queries

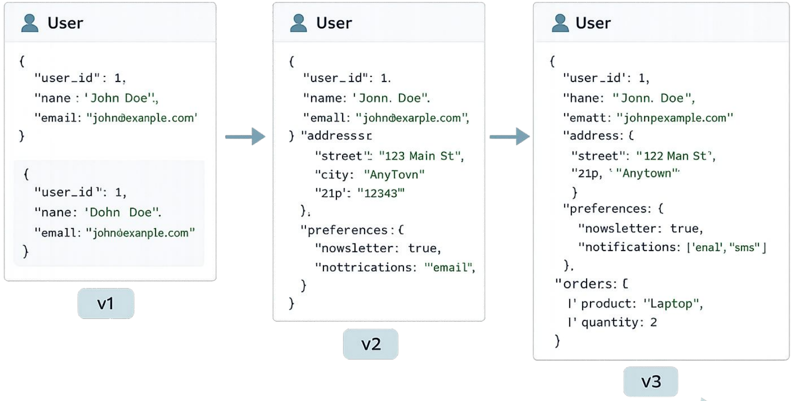
What is NoSQL

- NoSQL is a category of databases that do not rely on relational tables.
- Different NoSQL models exist for different needs, such as document and key value.
- MongoDB is a document database, which means it stores data as documents.



What is MongoDB

- MongoDB is a NoSQL database that stores data as documents.
- A document looks like JSON and can include nested objects and arrays.
- When the shape of the data changes in a system (eg: when your product evolves), MongoDB can be a good choice.



```
{
  "user_id": 1,
  "nane : 'John Doe'',
  "email: "johnⓓexanple.com'
}

{
  "user_id ": 1,
  "nane: 'Dohn  Doe''.
  "emall: "johnⓓexanple.com"
}
```

```
{
  "user_id": 1.
  "name: 'Jonn. Doe''.
  "emall: "johnⓓexarple.com",
} "addresssr
    "street": "123 Main St",
    "city:  "AnyTovn"
    "21p': "12343"'
  }:
  "preferences : {
    "nowsletter:  true,
    "nottrications: '"email",
  }
}
```

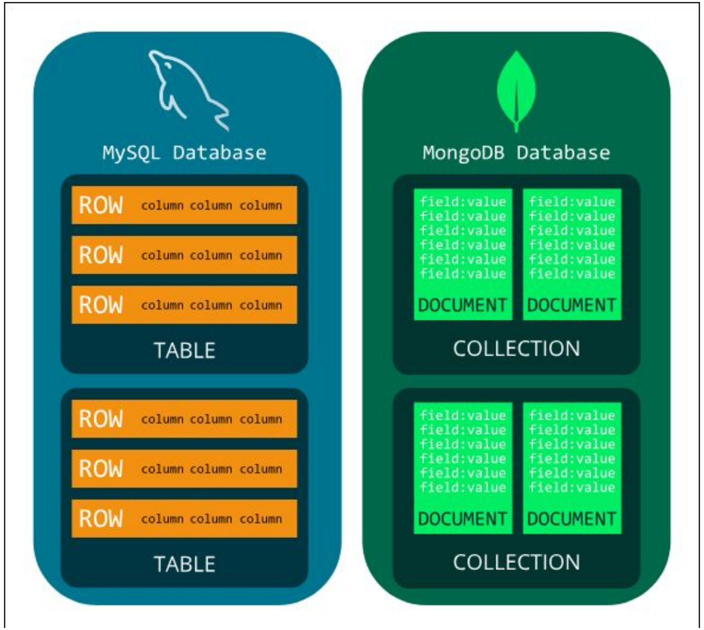
```
{
  "user_id': 1,
  "hane:  "Jonn. Doe",
  "ematt: "johnpexample.com"
  "address: {
   "street": "122 Man St',
   "21p, ' "Anytown"
   }
  "preferences: {
    "nowsletter:  true,
    "notifications: ['enal', "sms" ]
  },
 "orders: [
   I' product: ''Laptop",
   I' quantity: 2
 }
```

Where MongoDB Fits

- User profiles and settings often change over time and can be stored as flexible documents.
- Activity and event data can arrive in high volume and often gains new fields as features are added.
- Content and product metadata often benefits from nested structures, such as tags, variants, and attributes.
- Systems at companies like Google, Netflix, and Stripe often deal with profiles, catalogs, and event streams at scale, where NoSQL storage models are a common fit.

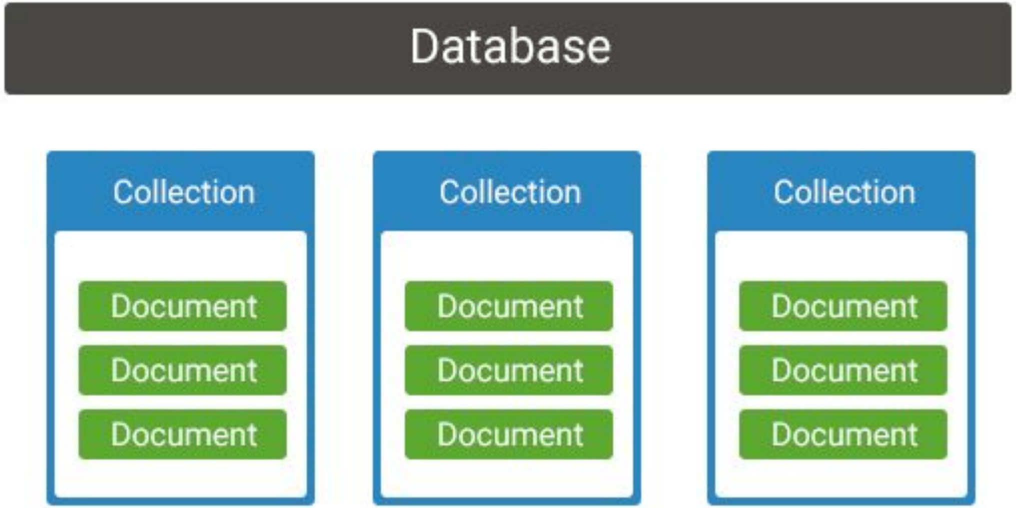
MongoDB and MySQL Vocabulary

- A MySQL table is similar to a MongoDB **collection**.
- A MySQL row is similar to a MongoDB **document**.
- A MySQL column is similar to a **field** inside a document.
- Note: both systems store databases, but they organize data differently.



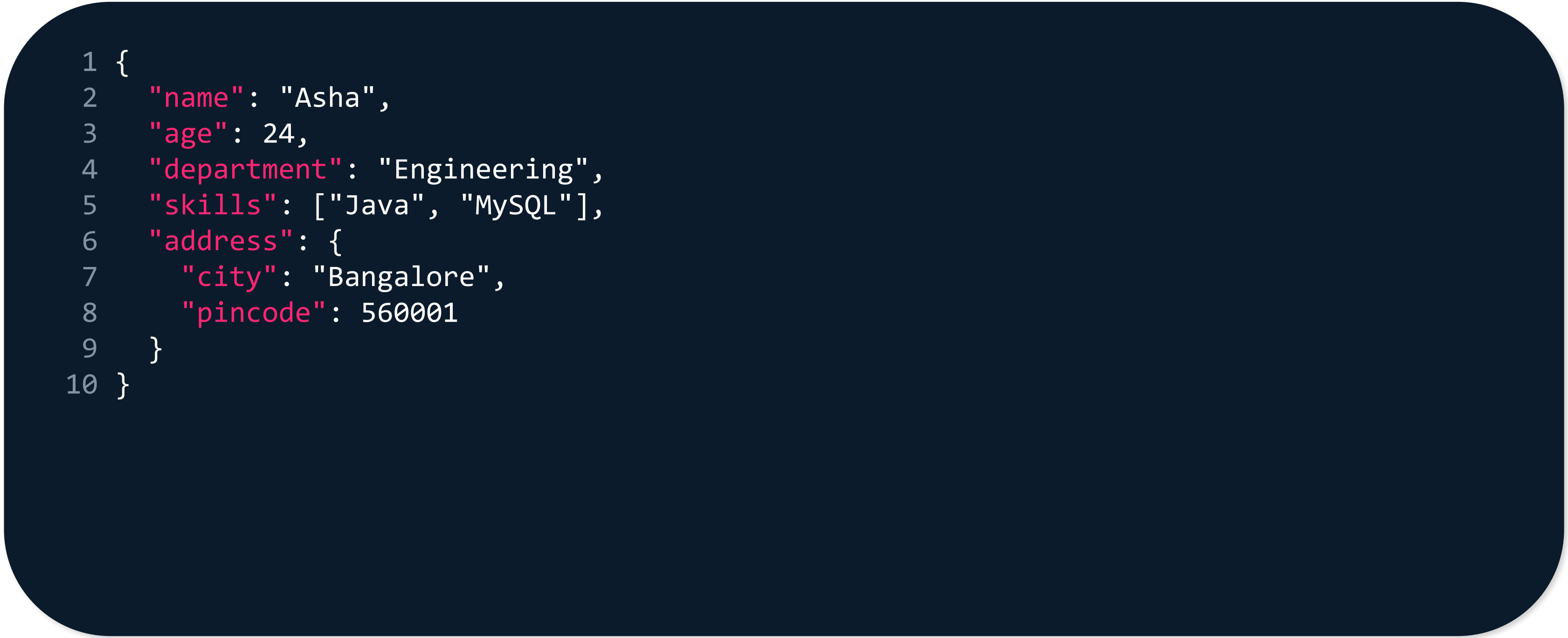
Documents and Collections in MongoDB

- A **document** is one record stored as key value pairs.
- A **collection** is a group of documents of a similar type.
- Every document has an _id field that uniquely identifies it.



Nested Data in a Document

- An employee document can store address as an object and skills as an array.
- This makes it natural to fetch related details together in one read.
- The goal is to model data in the shape your application uses.



```json
{
  "name": "Asha",
  "age": 24,
  "department": "Engineering",
  "skills": ["Java", "MySQL"],
  "address": {
    "city": "Bangalore",
    "pincode": 560001
  }
}
```

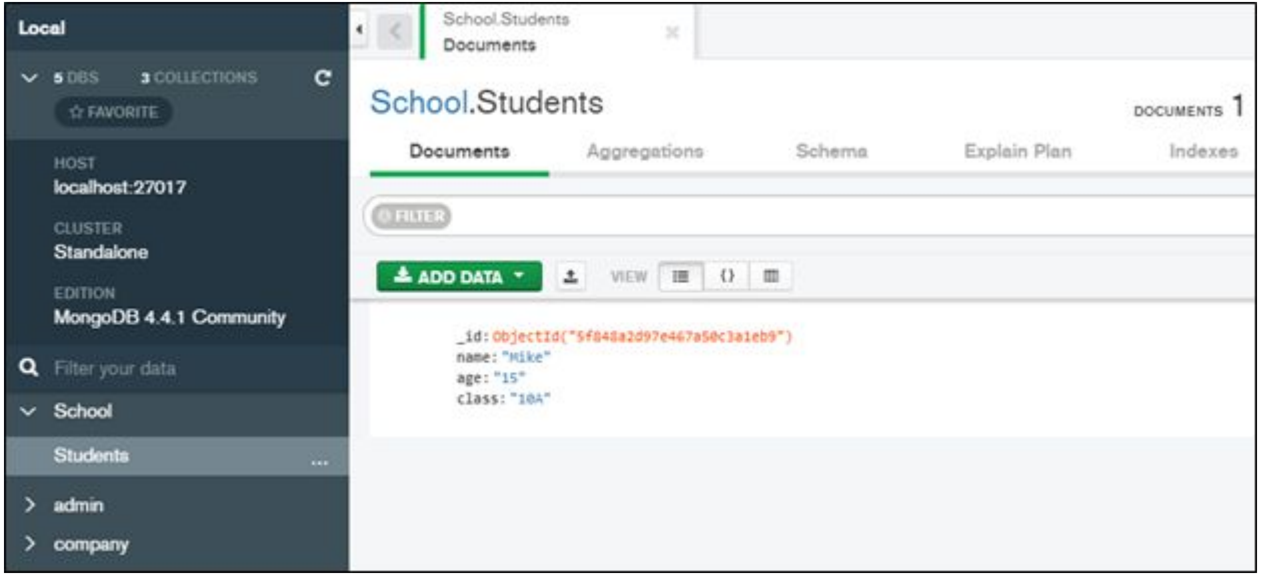
Tools and Connection

MongoDB Server

- MongoDB Server is the database engine that stores data and runs queries.
- When you connect from Compass or Shell, you are connecting to the MongoDB Server.
- Download link

MongoDB Compass

- MongoDB Compass is a graphical tool to browse databases, collections, and documents.
- It lets you run queries and aggregation pipelines using MQL and view results immediately.
- [Download link]()



HOST
localhost:27017

CLUSTER
Standalone

EDITION
MongoDB 4.4.1 Community

```
_id: ObjectId("5f848a2d97e467a50c3a1eb9")
name: "Mike"
age: "15"
class: "10A"
```

Mongo Shell

- Mongo Shell is a command line tool for MongoDB.
- It is useful for running commands quickly and repeating them reliably.
- Download link (Note: this is an optional tool for our course)

MongoDB Query Language

- MongoDB Query Language, or MQL, is the syntax used to work with documents.
- MQL is used for for inserting, finding, updating, deleting, and aggregating data.
- You can write MQL inside MongoDB Compass and inside Mongo Shell.

Connecting to MongoDB

- Install MongoDB Server and ensure the service is running.
- Open MongoDB Compass and connect using your connection string.
- After connecting, you can create a database and start inserting documents.

CRUD Operations

CRUD

- CRUD describes the four actions you perform on stored data.
- **C**reate adds new data,
- **R**ead fetches data,
- **U**pdate changes data, and
- **D**elete removes data.

CRUD in MongoDB

- Create is done with **insert** operations.
- Read is done with **find** operations.
- Update is done with **update** operations.
- Delete is done with **delete** operations.

Data Model We’ll Use

- We will use one database, **company_db**.
- We will use one collection, **employees**.
- Employees will have the following fields: **name, age, department, skills, and address**.

Create

- Create means inserting a new document into a collection.

```
db.employees.insertOne({
  name: "Asha",
  age: 24,
  department: "Engineering",
  skills: ["Java", "MySQL"],
  address: { city: "Bangalore", pincode: 560001 }
});
```

Read

- Read means finding documents that match a filter.

```
db.employees.find({ department: "Engineering" });
```

- This returns all employee documents where the department field matches Engineering.

Update

- Update means changing fields in matching documents.
- A common pattern is to add an item to an array field such as skills. Alternatively, an update may simply update the age of an employee.

```
db.employees.updateOne(
  { name: "Asha" },
  { $addToSet: { skills: "MongoDB" } }
);
```

- $addToSet adds the value only if it is not already present in the array.
  - $addToSet is an update operator, which is a special keyword used inside an update command to modify document(s).

Delete

- Delete means removing documents that match a filter.

```
db.employees.deleteMany({ age: { $lt: 25 } });
```

- This removes all employee documents where age is less than 25.
- In order to delete a single document matching a condition, you may use deleteOne(...)

Querying with Filters and Projection

Querying

- Querying means selecting documents that match conditions.
- A filter defines the condition that documents must match.
- An equality filter matches an exact value in a field.
- Comparison operators such as $gt and $lt match a range of values.

```
db.employees.find({ department: "Engineering" });

db.employees.find({ age: { $gt: 25 } });

db.employees.find({ age: { $lt: 25 } });
```

Combining Conditions

- You can combine multiple conditions in a single filter object.
- The below query matches employees in Engineering who are older than 25.

```
db.employees.find({
  department: "Engineering",
  age: { $gt: 25 }
});
```

Projection

- Projection controls which fields come back in the result.
- This helps you fetch only what you need, such as name and department.
- The query below returns only name and department and hides _id.

```
db.employees.find(
  { department: "Engineering" },
  { name: 1, department: 1, _id: 0 }
);
```

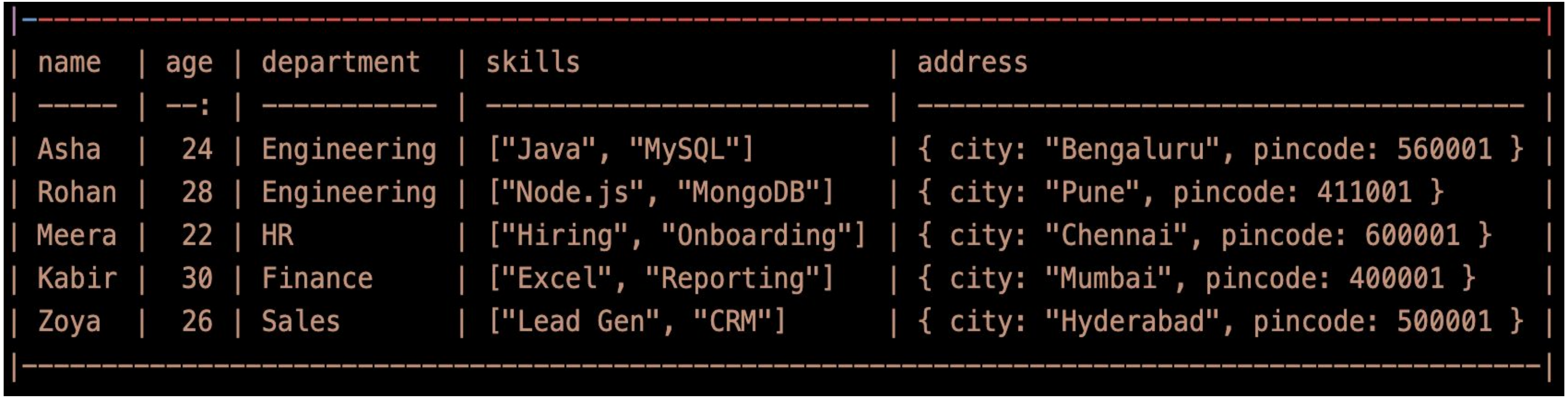
Aggregation Framework

Aggregation

- **Aggregation** summarizes many documents into fewer results.
- It answers questions like counts and averages by group.
- In MySQL, we use COUNT and AVG with GROUP BY.
- In MongoDB, we use an aggregation pipeline to produce similar summaries.
    - An aggregation pipeline is a sequence of stages.
    - Each stage transforms the data and passes results to the next stage.

Stages We’ll Cover

- **$match** filters documents before grouping.
- **$group** groups documents and computes summary values.
- **$project** shapes the final output fields.
- Table we’ll use:



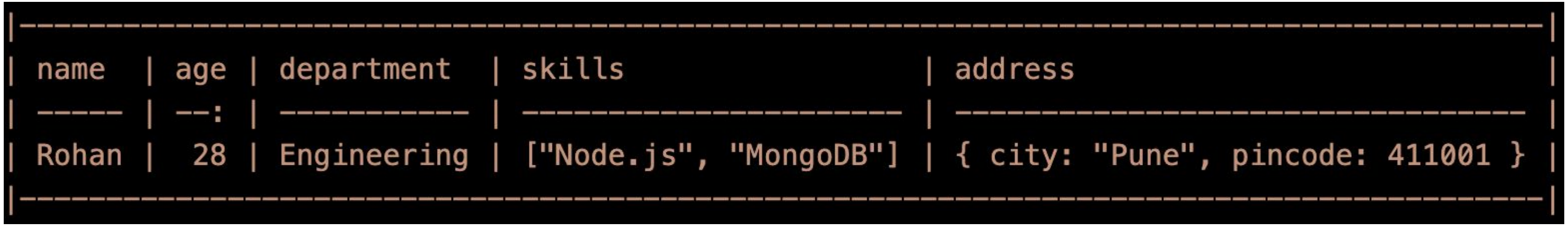
```
|-------------------------------------------------------------------------------------------------|
| name  | age | department  | skills                     | address                                |
| ----- | --: | ----------- | -------------------------- | -------------------------------------- |
| Asha  |  24 | Engineering | ["Java", "MySQL"]          | { city: "Bengaluru", pincode: 560001 } |
| Rohan |  28 | Engineering | ["Node.js", "MongoDB"]     | { city: "Pune", pincode: 411001 }      |
| Meera |  22 | HR          | ["Hiring", "Onboarding"]   | { city: "Chennai", pincode: 600001 }   |
| Kabir |  30 | Finance     | ["Excel", "Reporting"]     | { city: "Mumbai", pincode: 400001 }    |
| Zoya  |  26 | Sales       | ["Lead Gen", "CRM"]        | { city: "Hyderabad", pincode: 500001 } |
|-------------------------------------------------------------------------------------------------|
```

Aggregation: $match

- This single pipeline matches employees by skills

```
db.employees.aggregate([
  { $match: { skills: "MongoDB" } }
]);
```

Output:



```
|---------------------------------------------------------------------------------------|
| name  | age | department  | skills                 | address                          |
| ----- | --: | ----------- | ---------------------- | -------------------------------- |
| Rohan |  28 | Engineering | ["Node.js", "MongoDB"] | { city: "Pune", pincode: 411001 } |
|---------------------------------------------------------------------------------------|
```

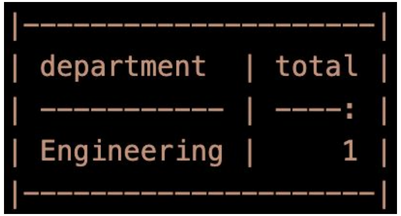
Aggregation: $match + $group

- The pipeline below first selects employees whose skills include "MongoDB".
- Then it groups the matching employees by department.
- For each department, it outputs the number of matching employees as total.
- How?
  - _id: "$department" creates one bucket per department (Engineering, Sales, etc)
  - total: { $sum: 1 } adds 1 for each matching employee in that bucket, so total becomes the count per department

Pipeline:

```
db.employees.aggregate([
  { $match: { skills: "MongoDB" } }
  { $group: { _id: "$department", total: { $sum: 1 } } }
]);
```

Output:



```
|---------------------|
| department  | total |
| ----------- | ----: |
| Engineering |     1 |
|---------------------|
```

Indexing Basics

What is an Index

- An index is a data structure that helps MongoDB search faster on a field.
- Indexes matter most when collections grow large and queries repeat frequently.
- Trade Offs
  - Indexes improve read performance for common queries.
  - They consume storage and can make writes (inserts, updates) slower because the index must be maintained
- When do we create an index?
  - Fields that you filter on frequently (Eg: filter by department)
  - Fields that you sort on frequently (Eg: sort by name)
  - Note: Avoid indexing every field unless you have a clear reason

Creating an Index

- This creates an index on department, which helps queries that filter by department.

```
db.employees.createIndex({ department: 1 });
```

- The impact is faster reads for matching queries, with a small cost on insert and update operations.

Your turn!

Activity

- Create database library_db and collection members
- Insert 5 member documents with fields:
  - name, age, membershipType, borrowedBooks (array), address (object)
- Update one member by adding a new book to borrowedBooks
- Delete members where age < 18
- Fetch only name and membershipType using projection
- Aggregation: count members per membershipType