CS544

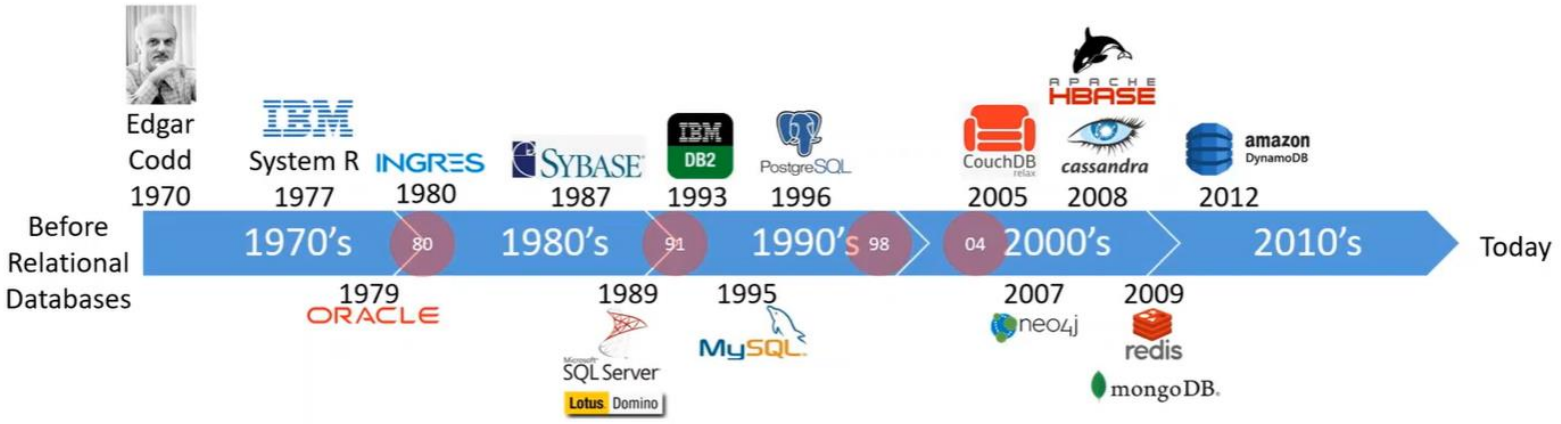
LESSON 8
MONGODB

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
November 28 **Lesson 1** Introduction Spring framework Dependency injection	November 29 **Lesson 2** Spring Boot AOP	November 30 **Lesson 3** JDBC JPA	December 1 **Lesson 4** JPA mapping 1	December 2 **Lesson 5** JPA mapping 2	December 3 **Lesson 6** JPA queries	December 4
December 5 **Lesson 7** Transactions	December 6 **Lesson 8** MongoDB	December 7 **Midterm Review**	December 8 **Midterm exam**	December 9 **Lesson 9** REST webservices	December 10 **Lesson 10** SOAP webservices	December 11
December 12 **Lesson 11** Messaging	December 13 **Lesson 12** Scheduling Events Configuration	December 14 **Lesson 13** Monitoring	December 15 **Lesson 14** Testing your application	December 16 **Final review**	December 17 **Final exam**	December 18
December 19 **Project**	December 20 **Project**	December 21 **Project**	December 22 **Presentations**			

SPRING MONGO

Today's requirements on databases

- Big data (large datasets)
- Agility
- Unstructured/ semi structured data



Problems with relational databases

- Scaling writes are is very difficult and limited
  - Vertical scaling is limited and is expensive
  - Horizontal scaling is limited and is complex
    - Queries work only within shards
    - Strict consistency and partition tolerance leads to availability problems

A relational database is hard to scale

Problems with relational databases

- The schema in a database is fixed
- Schema evolution
  - Adding attributes to an object => have to add columns to table
  - You need to do a migration project
  - Application downtime ...

A relational database is hard to change

Problems with relational databases

- Relational schema doesn‘t easily handle unstructured and semi-structured data
  - Emails
  - Tweets
  - Pictures
  - Audio
  - Movies
  - Text

Unstructured data

The university has 5600 students.
John's ID is number 1, he is 18 years old and already holds a B.Sc. degree.
David's ID is number 2, he is 31 years old and holds a Ph.D. degree. Robert's ID is number 3, he is 51 years old and also holds the same degree as David, a Ph.D. degree.

Semi-structured data

```
<University>
  <Student ID="1">
    <Name>John</Name>
    <Age>18</Age>
    <Degree>B.Sc.</Degree>
  </Student>
  <Student ID="2">
    <Name>David</Name>
    <Age>31</Age>
    <Degree>Ph.D. </Degree>
  </Student>
  ....
</University>
```

Structured data

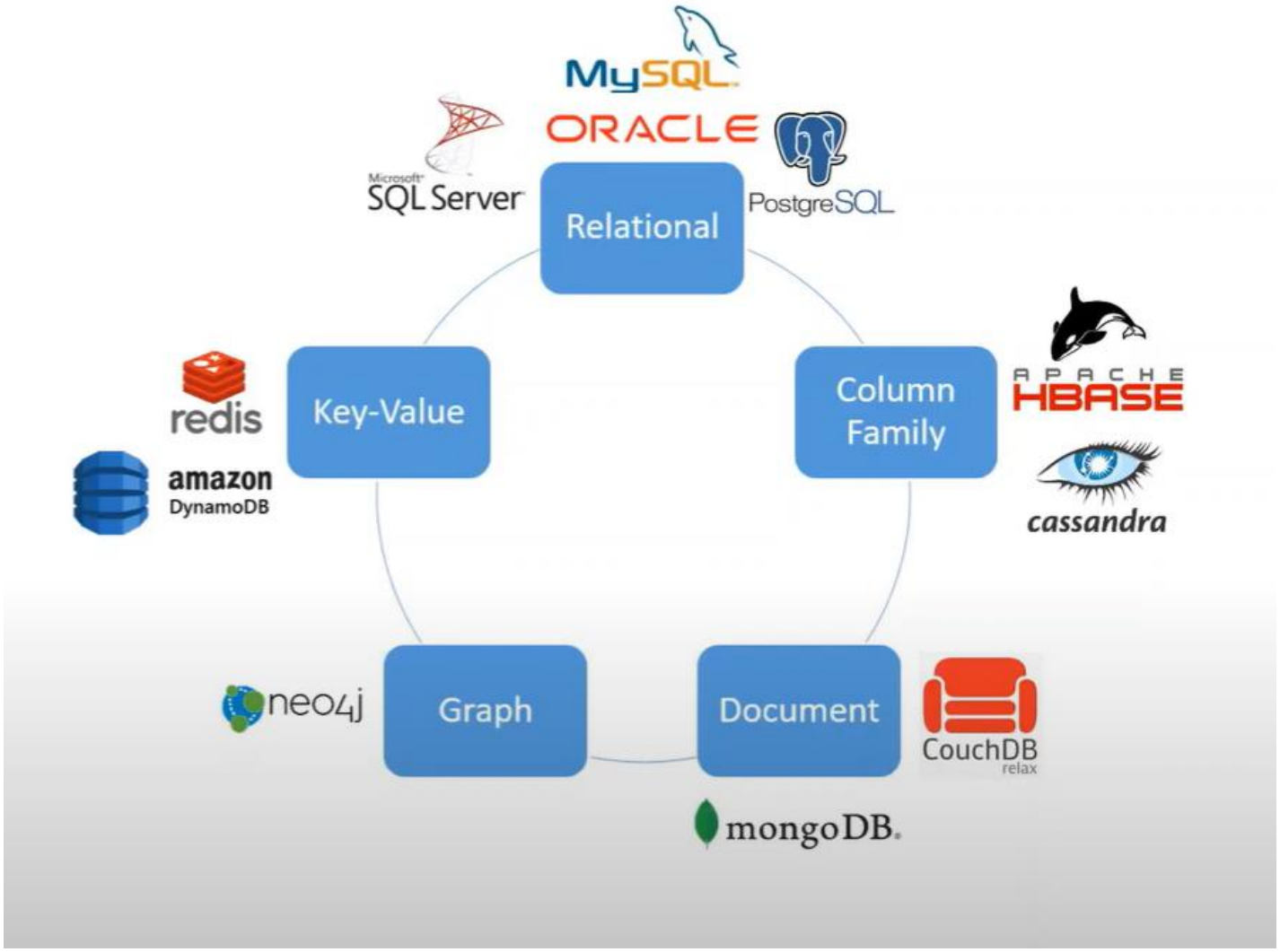
ID	Name	Age	Degree
1	John	18	B.Sc.
2	David	31	Ph.D.
3	Robert	51	Ph.D.
4	Rick	26	M.Sc.
5	Michael	19	B.Sc.

A relational database does not handle unstructured and semi structured data very well

NoSQL characteristics

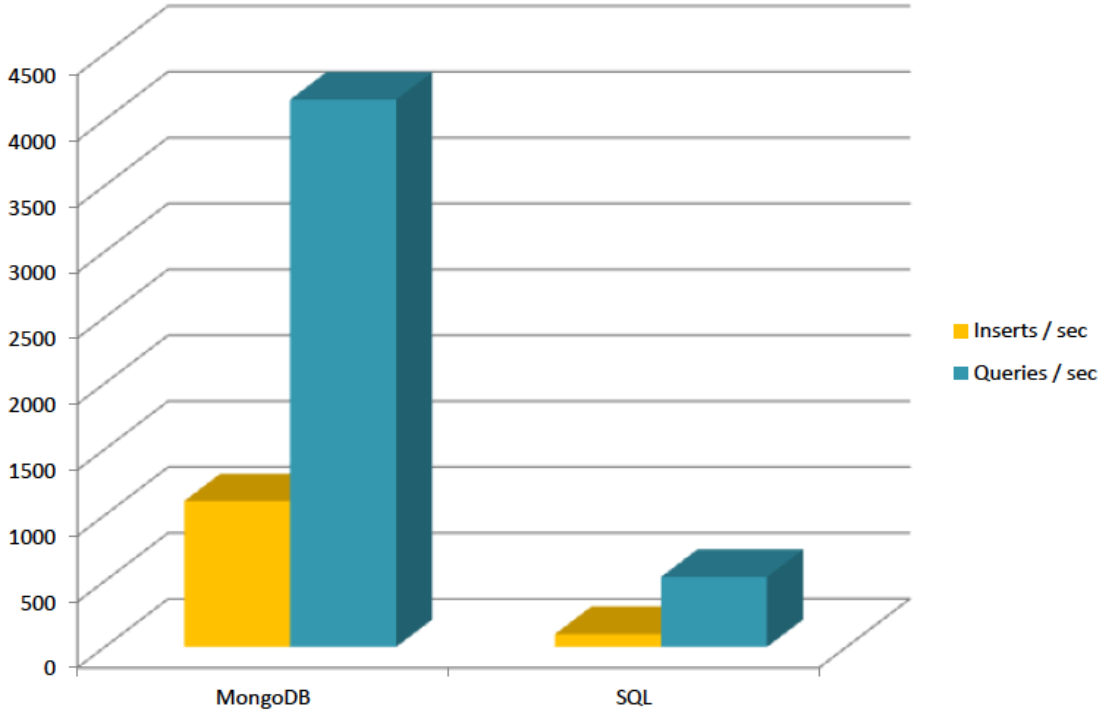
- Key-value store
- No fixed schema
- Can scale (almost) unlimited
  - Eventual consistency

Different types of databases



MongoDB

- Document database
- Fast
- Can handle large datasets



MongoDB

RDBMS		MongoDB
Database	→	Database
Table	→	Collection
Row	→	Document
Index	→	Index
Join	→	Embedded Document
Foreign Key	→	Reference

Document data model (JSON)

Relational - Tables

Customer ID	First Name	Last Name	City
0	John	Doe	New York
1	Mark	Smith	San Francisco
2	Jay	Black	Newark
3	Meagan	White	London
4	Edward	Daniels	Boston

Account Number	Branch ID	Account Type	Customer ID
10	100	Checking	0
11	101	Savings	0
12	101	IRA	0
13	200	Checking	1
14	200	Savings	1
15	201	IRA	2

Document - Collections

```
{   customer_id : 1,
    first_name : "Mark",
    last_name : "Smith",
    city : "San Francisco",
    accounts : [   {
        account_number : 13,
        branch_ID : 200,
        account_type : "Checking"
    },
    {   account_number : 14,
        branch_ID : 200,
        account_type : ”IRA”,
        beneficiaries: […]
    } ]
}
```

Documents are rich structures

```
{
        category: “glove”,
        model: “PRO112PT”,
        name: “Air Elite”,
        brand: “Rawlings”,
        price: 229.99,
        available: Date(“2013-03-31”),
        position: [“infield”, “outfield”, “pitcher”]
}
```

Fields can contain arrays

Documents are rich structures

```
{
        category: “glove”,
        model: “PRO112PT”,
        name: “Air Elite”,
        brand: “Rawlings”,
        price: 229.99,
        available: Date(“2013-03-31”),
        position: [“infield”, “outfield”, “pitcher”],
        endorsed: {name: “Ryan Howard”,
                   team: “Phillies”,
                   position: “first base”},
}
```

Fields can contain sub-documents

Documents are rich structures

```
{
        category: “glove”,
        model: “PRO112PT”,
        name: “Air Elite”,
        brand: “Rawlings”,
        price: 229.99,
        available: Date(“2013-03-31”),
        position: [“infield”, “outfield”, “pitcher”],
        endorsed: {name: “Ryan Howard”,
                   team: “Phillies”,
                   position: “first base”},
        history: [{date: Date(“2013-03-31”),  price: 279.99},
                  {date: Date(“2013-06-01”), price: 259.79},
                  {date: Date(“2013-08-15”), price: 229.99}]
}
```

Fields can contain an array of sub-documents

Documents are flexible

```
{
        category: bat,
        model: B1403E,
        name: Air Elite,
        brand: “Rip-IT”,
        price: 399.99

        diameter: “2 5/8”,
        barrel: R2 Alloy,
        handle: R2
}
```

```
{
        category: glove,
        model: PRO112PT,
        name: Air Elite,
        brand: “Rawlings”,
        price: “229.99”

        size: 11.25,
        position: outfield,
        pattern: “Pro taper”,
        material: leather,
        color: black
}
```

BSON

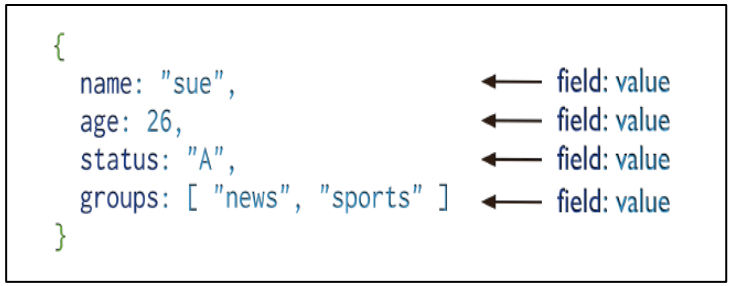
```
{ author: 'joe',
  created : new Date('03/28/2009'),
  title : 'Yet another blog post',
  text : 'Here is the text...',
  tags : [ 'example', 'joe' ],
  comments : [
              { author: 'jim',
                comment: 'I disagree'
              },
              { author: 'nancy',
                comment: 'Good post'
              }
  ]
}
```

Remember it is stored in binary formats (BSON)

```
"\x16\x00\x00\x00\x02hello\x00
 \x06\x00\x00\x00world\x00\x00"

"1\x00\x00\x00\x04BSON\x00&\x00
 \x00\x00\x020\x00\x08\x00\x00
 \x00awesome\x00\x011\x00333333
 \x14@\x102\x00\xc2\x07\x00\x00
 \x00\x00"
```

MongoDB model

document (e.g., one tuple in RDBMS)



- The field names **cannot** start with the **$** character
- The field names **cannot** contain the **.** character
- Max size of single document 16MB

Find() method

SQL SELECT Statements	MongoDB find() Statements
`SELECT * FROM users`	`db.users.find()`
`SELECT id, user_id, status FROM users`	`db.users.find( { }, { user_id: 1, status: 1 } )`
`SELECT user_id, status FROM users`	`db.users.find( { }, { user_id: 1, status: 1, _id: 0 } )`
`SELECT * FROM users WHERE status = "A"`	`db.users.find( { status: "A" } )`
`SELECT user_id, status FROM users WHERE status = "A"`	`db.users.find( { status: "A" }, { user_id: 1, status: 1, _id: 0 } )`
`SELECT * FROM users WHERE status != "A"`	`db.users.find( { status: { $ne: "A" } } )`
`SELECT * FROM users WHERE status = "A" AND age = 50`	`db.users.find( { status: "A", age: 50 } )`
`SELECT * FROM users WHERE status = "A" OR age = 50`	`db.users.find( { $or: [ { status: "A" } , { age: 50 } ] } )`
`SELECT * FROM users WHERE age > 25`	`db.users.find( { age: { $gt: 25 } } )`

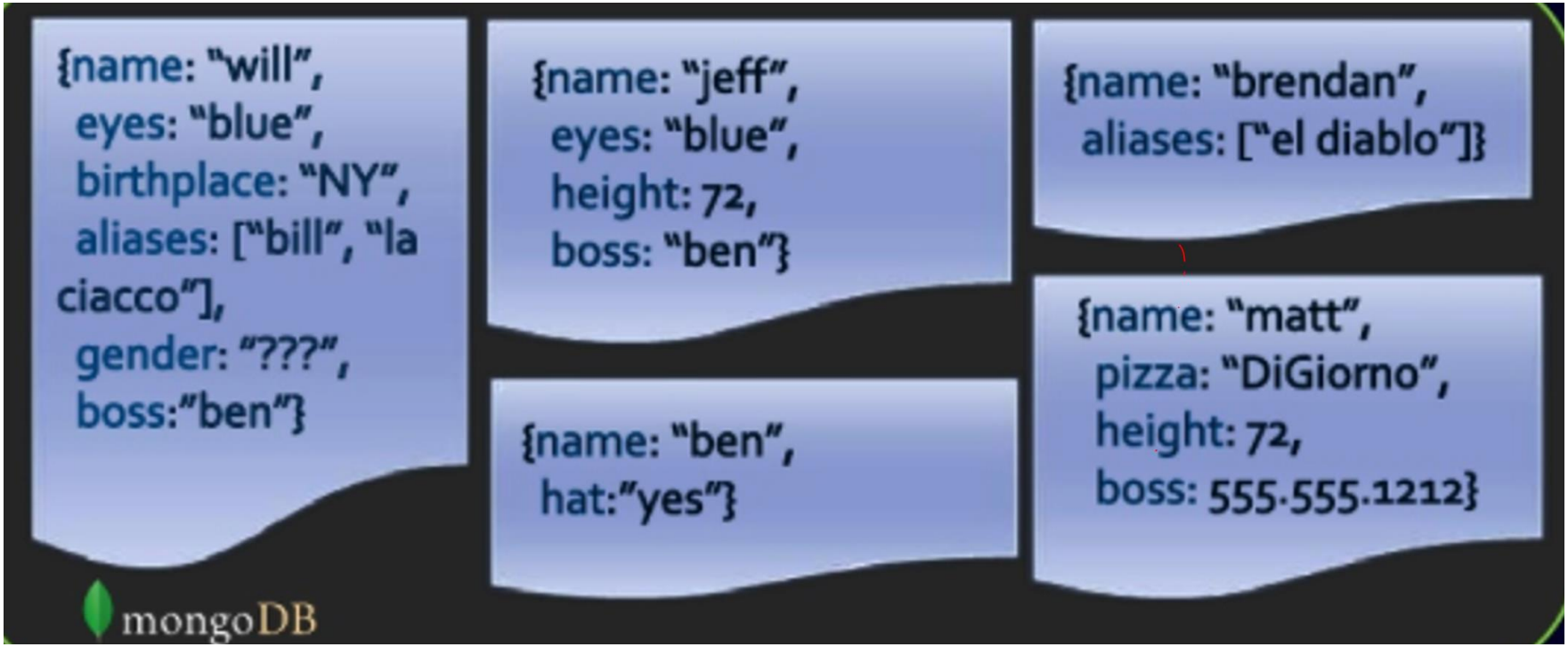
Find() method

`SELECT * FROM users WHERE age < 25`	`db.users.find( { age: { $lt: 25 } } )`
`SELECT * FROM users WHERE age > 25 AND age <= 50`	`db.users.find( { age: { $gt: 25, $lte: 50 } } )`
`SELECT * FROM users WHERE user_id like "%bc%"`	`db.users.find( { user_id: /bc/ } )`
`SELECT * FROM users WHERE user_id like "bc%"`	`db.users.find( { user_id: /^bc/ } )`
`SELECT * FROM users WHERE status = "A" ORDER BY user_id ASC`	`db.users.find( { status: "A" } ).sort( { user_id: 1 } )`
`SELECT * FROM users WHERE status = "A" ORDER BY user_id DESC`	`db.users.find( { status: "A" } ).sort( { user_id: -1 } )`

`SELECT COUNT(*) FROM users`	`db.users.count()`
	or
	`db.users.find().count()`

`SELECT COUNT(user_id) FROM users`	`db.users.count( { user_id: { $exists: true } } )`
	or
	`db.users.find( { user_id: { $exists: true } } ).count()`

Schema free



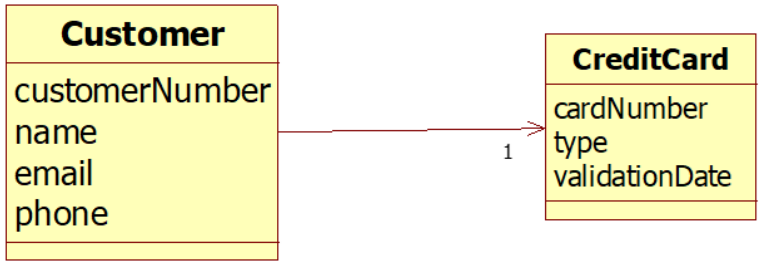
Spring Mongo libraries

```
<dependency>
  <groupId>org.springframework.boot</groupId>
  <artifactId>spring-boot-starter-data-mongodb</artifactId>
</dependency>
```

The Mongo Documents

```
@Document
public class Customer {
  @Id
  private int customerNumber;
  private String name;
  private String email;
  private String phone;
  private CreditCard creditCard;
```

```
public class CreditCard {
   private String cardNumber;
   private String type;
   private String validationDate;
```



The repository

```
@Repository
public interface CustomerRepository extends MongoRepository<Customer, Integer> {
   Customer findByPhone(String phone);
   Customer findByEmail(String email);

   @Query("{email : :#{#email}}")
   Customer findCustomerWithEmail(@Param("email") String email);

   @Query("{'creditCard.type' : :#{#cctype}}")
   List<Customer>  findCustomerWithCreditCardType(@Param("cctype") String cctype);

}
```

Find in an Object

application.properties

```
spring.data.mongodb.host=localhost
spring.data.mongodb.port=27017
spring.data.mongodb.database=testdb
```

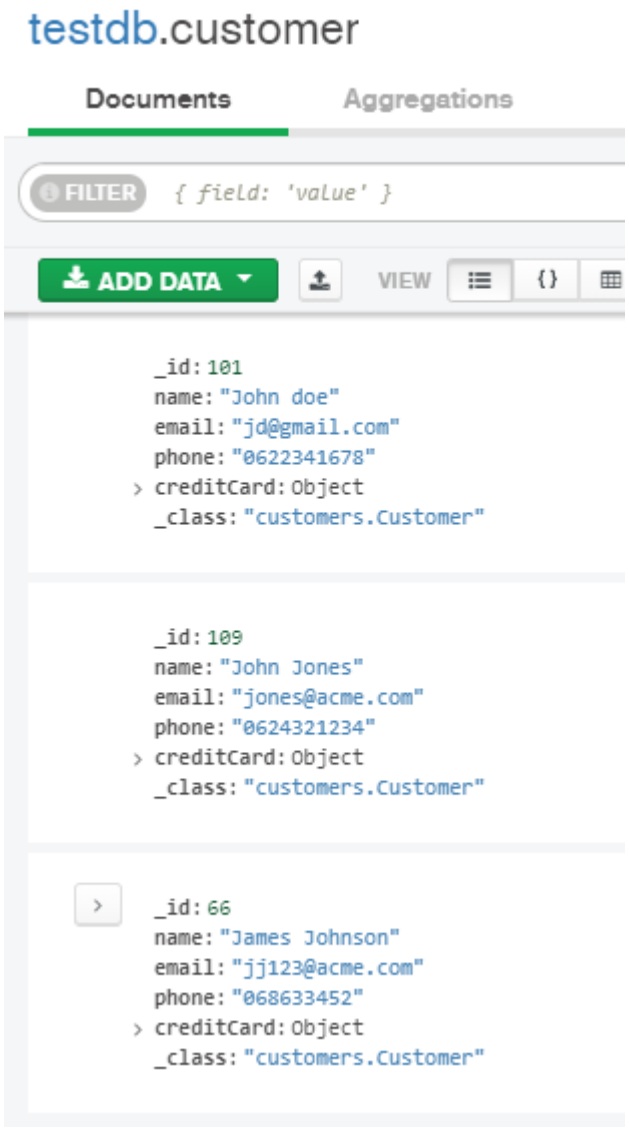
The application(1/2)

```
public class Application implements CommandLineRunner {

  @Autowired
  private CustomerRepository customerRepository;

  public static void main(String[] args) {
    SpringApplication.run(Application.class, args);
  }

  @Override
  public void run(String... args) throws Exception {
     // create customer
    Customer customer = new Customer(101,"John doe", "johnd@acme.com", "0622341678");
    CreditCard creditCard = new CreditCard("12324564321", "Visa", "11/23");
    customer.setCreditCard(creditCard);
    customerRepository.save(customer);
    customer = new Customer(109,"John Jones", "jones@acme.com", "0624321234");
    creditCard = new CreditCard("657483342", "Visa", "09/23");
    customer.setCreditCard(creditCard);
    customerRepository.save(customer);
    customer = new Customer(66,"James Johnson", "jj123@acme.com", "068633452");
    creditCard = new CreditCard("99876549876", "MasterCard", "01/24");
    customer.setCreditCard(creditCard);
    customerRepository.save(customer);
```

The application(2/2)

```
    //get customers
    System.out.println(customerRepository.findById(66).get());
    System.out.println(customerRepository.findById(101).get());
    System.out.println("----------All customers ----------");
    System.out.println(customerRepository.findAll());
    //update customer
    customer = customerRepository.findById(101).get();
    customer.setEmail("jd@gmail.com");
    customerRepository.save(customer);
    System.out.println("----------find by phone ----------");
    System.out.println(customerRepository.findByPhone("0622341678"));
    System.out.println("----------find by email ----------");
    System.out.println(customerRepository.findCustomerWithEmail("jj123@acme.com"));
    System.out.println("----------find customers with a certain type of creditcard ----------");
    List<Customer> customers = customerRepository.findCustomerWithCreditCardType("Visa");
    for (Customer cust : customers){
      System.out.println(cust);
    }

}
```

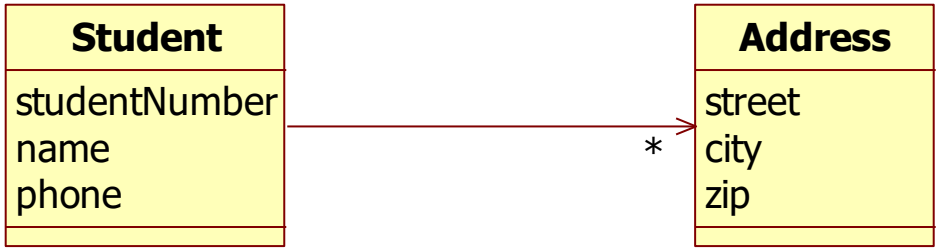
The database



One to many relations

```java
public class Customer {
  @Id
  private int customerNumber;
  private String name;
  private String email;
  private String phone;
  private List<CreditCard> creditCards = new ArrayList<CreditCard>();
```

```java
public class CreditCard {
    private String cardNumber;
    private String type;
    private String validationDate;
```



The repository

```
@Repository
public interface CustomerRepository extends MongoRepository<Customer, Integer> {
   Customer findByPhone(String phone);
   Customer findByEmail(String email);

   @Query("{email : :#{#email}}")
   Customer findCustomerWithEmail(@Param("email") String email);

   @Query("{ 'creditCards': { $elemMatch: { 'type' : :#{#cctype} } }}")
   List<Customer>  findCustomerWithCreditCardType(@Param("cctype") String cctype);

}
```

Find in an Array

Main point

- MongoDB is a document database that stores whole documents (including embedded data) in a collection. This gives data redundancy, but makes the data access very fast.

  Science of Consciousness: The Unified Field is the source of all relative creation where there is no redundancy or loss of performance.

Connecting the parts of knowledge with the wholeness of knowledge

1. MongoDB is a document database where we store documents instead of relational data
2. Spring Boot Mongo makes it very easy to use the MongoDB in your application

3. **Transcendental consciousness** is the field where all intelligence resides.
4. **Wholeness moving within itself:** In unity consciousness, one experiences that everything is an expression of one's own Self.