CS544

LESSON 8
MONGODB

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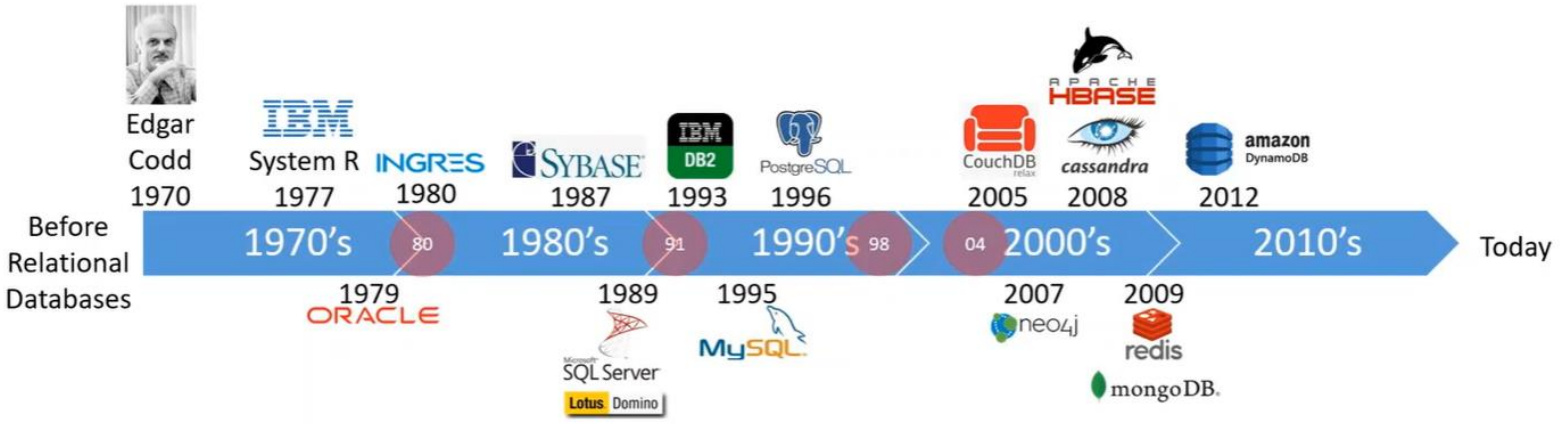
SPRING MONGO

Today's requirements on databases

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



Database problems

- Too much data
  - The data does not fit anymore on one node

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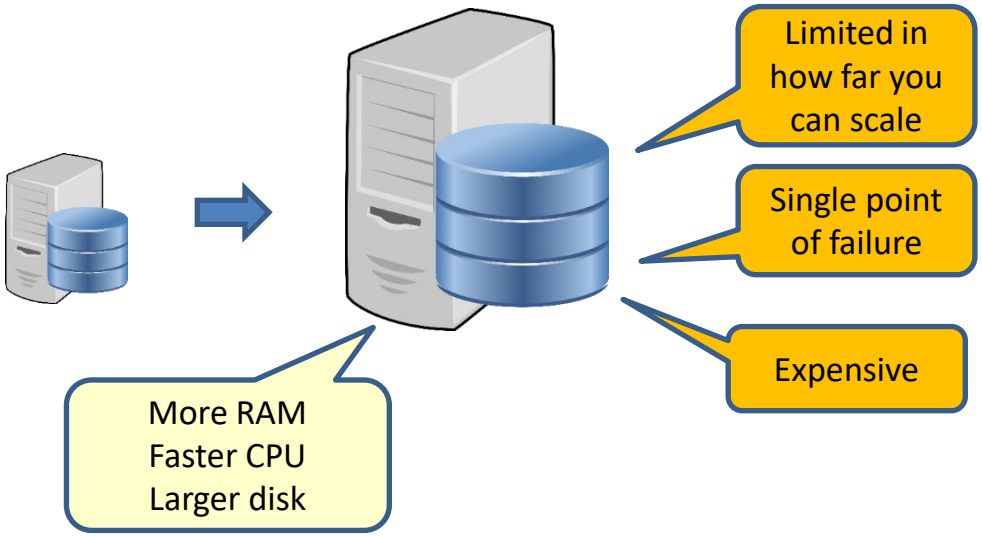
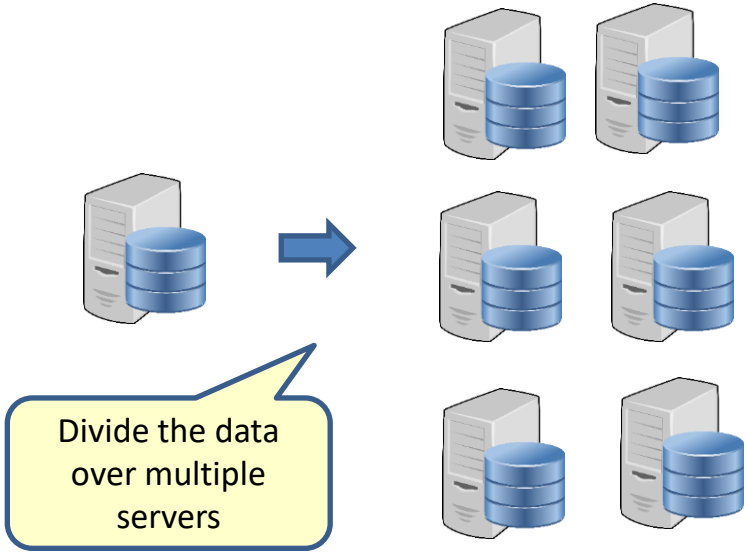
Database Scaling

- Vertical scaling



- Horizontal scaling



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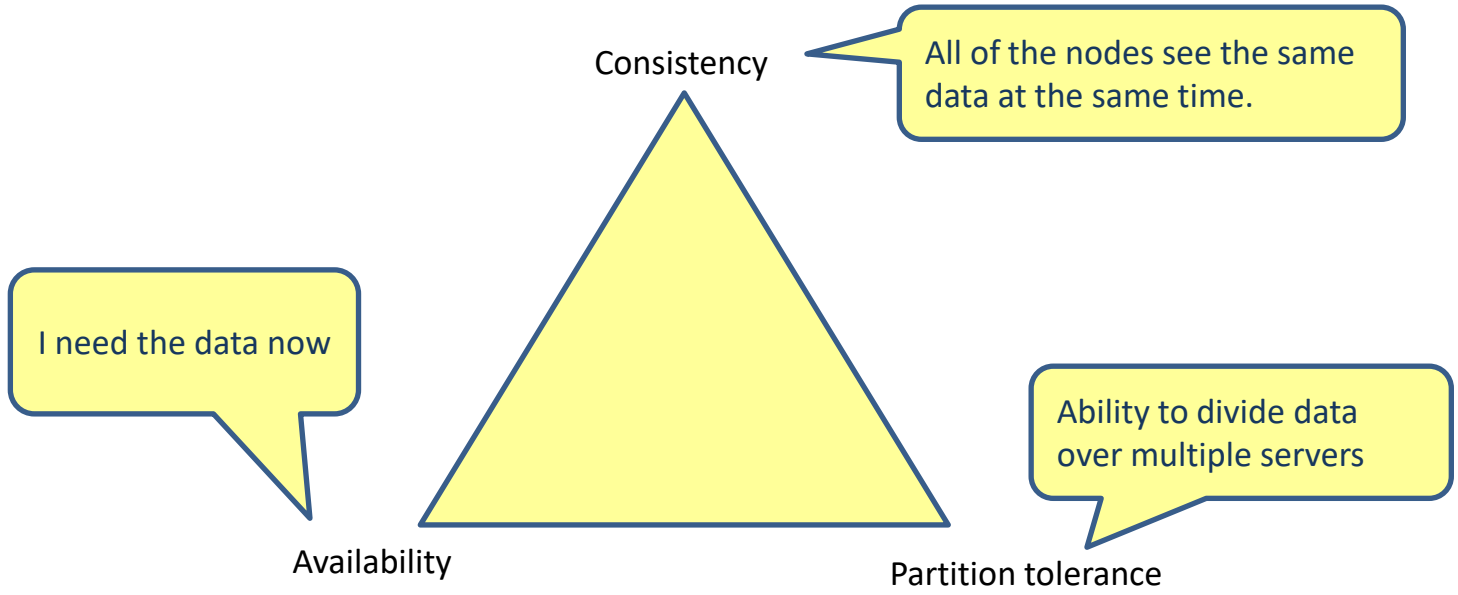
Brewer‘s CAP Theorem

- A distributed system can support only two of the following characteristics



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Consistency

- Strict consistency
  - The data that I read is always correct
  - You never loose data
- Eventual consistency
  - The data might not be correct
    - But will eventually become correct

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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

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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

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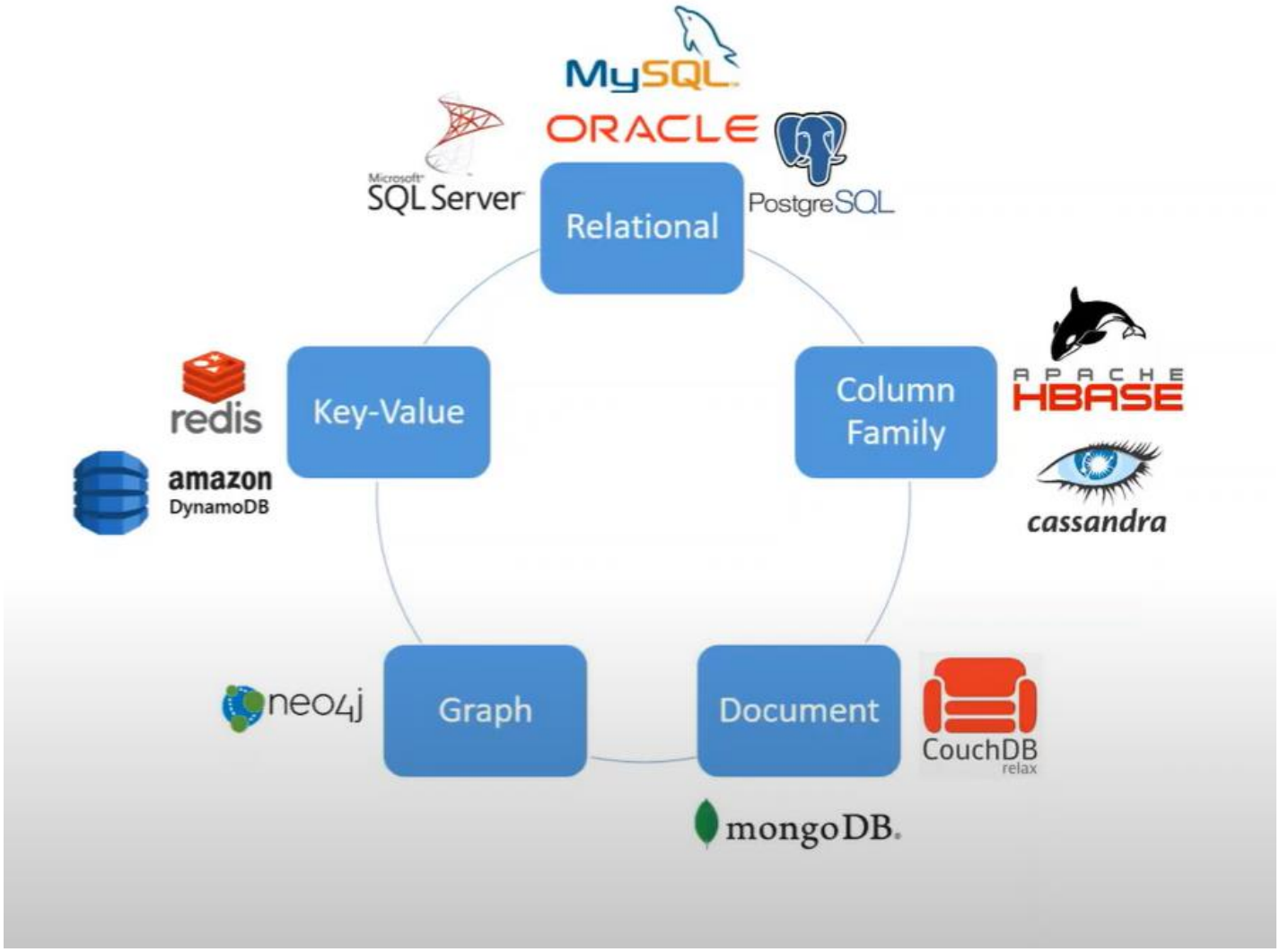
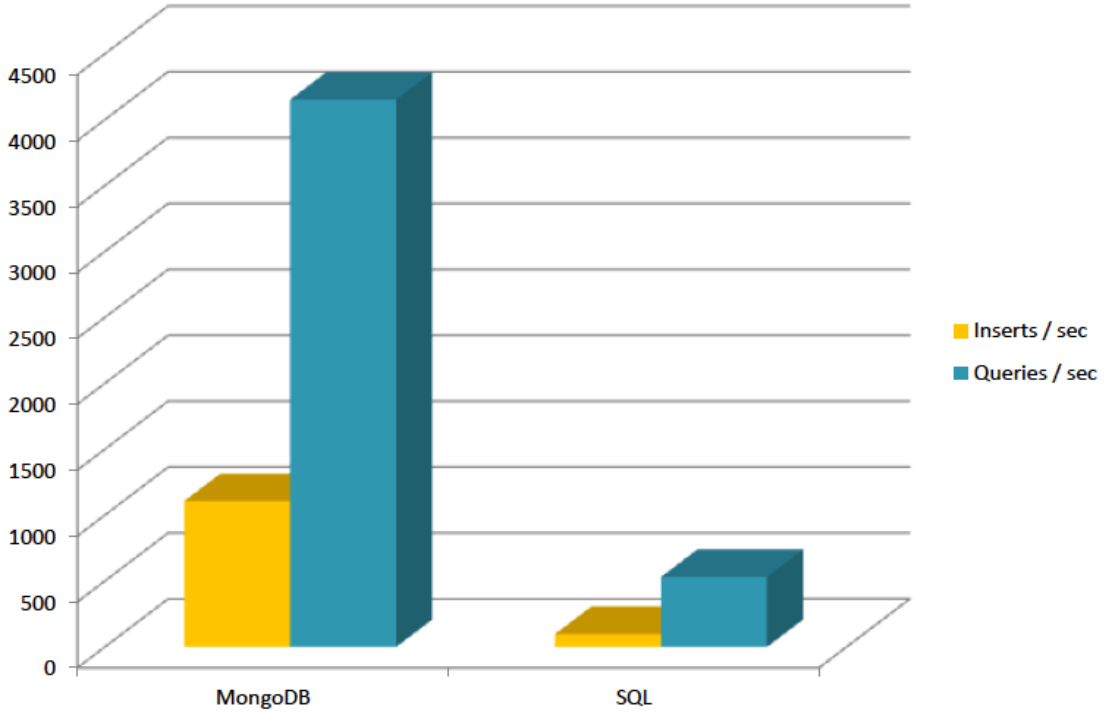
Different types of databases



MongoDB

- Document database
- Fast
- Can handle large datasets



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MongoDB

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

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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: […]
    } ]
}
```

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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

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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

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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
}
```

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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"
```

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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 } } )`

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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()`

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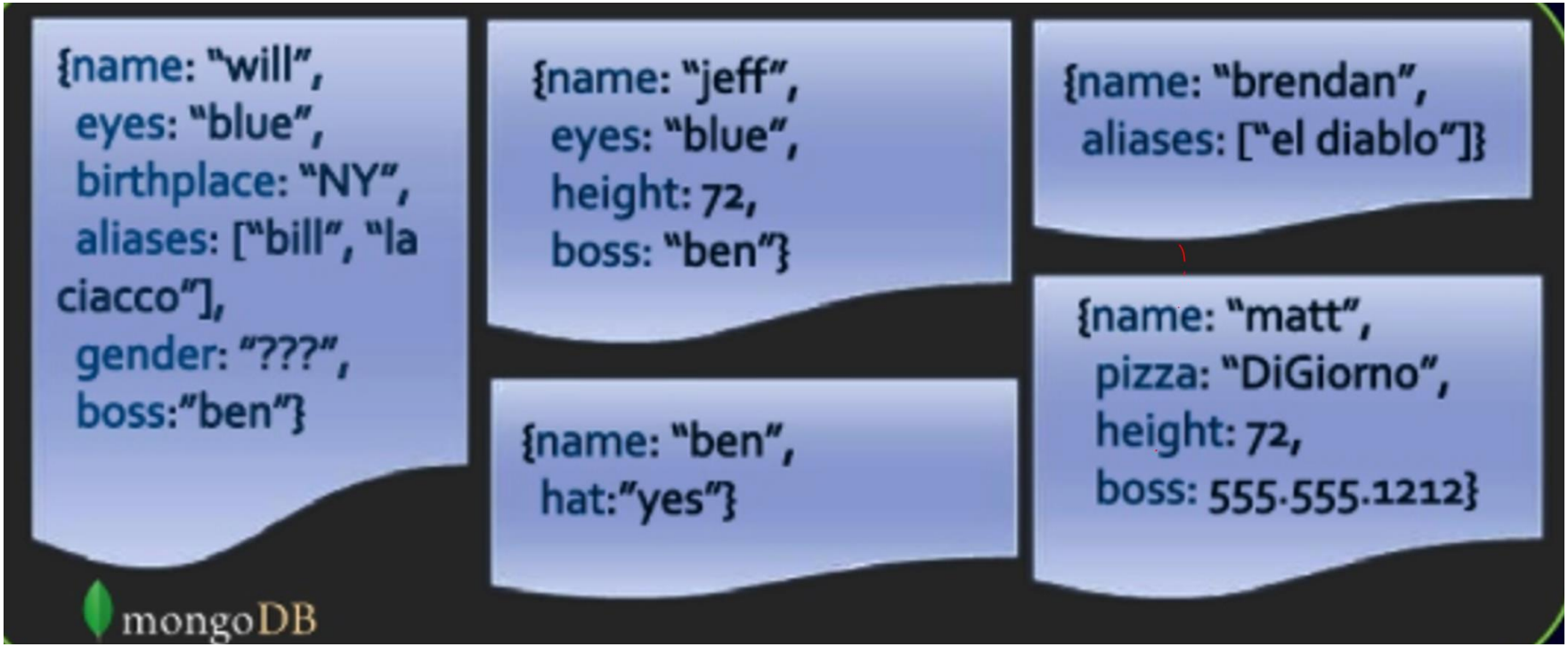
Schema free



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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.

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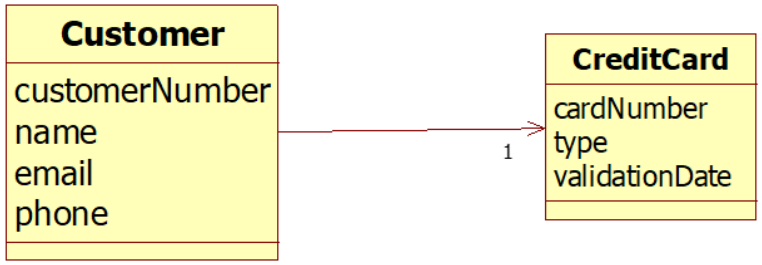
Spring Mongo libraries

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

The Mongo Documents

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

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



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The repository

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

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

}
```

application.properties

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

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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.findByCreditCardType("Visa");
    for (Customer cust : customers){
      System.out.println(cust);
    }

}
```

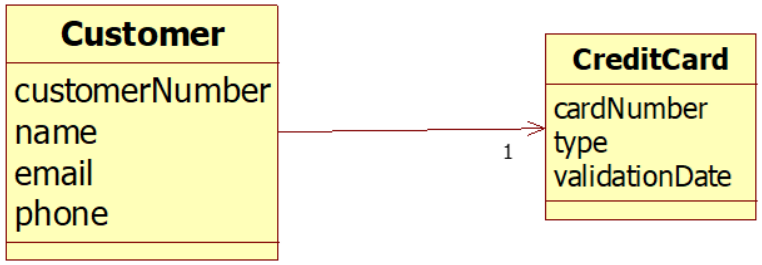
Embedded


testdb.customer
Documents
Aggregations
FILTER
{ field: 'value' }
ADD DATA
VIEW
{}
_id: 101
name: "John doe"
email: "jd@gmail.com"
phone: "0622341678"
creditCard: Object
cardNumber: "12324564321"
type: "Visa"
validationDate: "11/23"
_class: "embedded.domain.Customer"
_id: 109
name: "John Jones"
email: "jones@acme.com"
phone: "0624321234"
creditCard: Object
cardNumber: "657483342"
type: "Visa"
validationDate: "09/23"
_class: "embedded.domain.Customer"
_id: 66
name: "James Johnson"
email: "jj123@acme.com"
phone: "068633452"
creditCard: Object
cardNumber: "99876549876"
type: "MasterCard"
validationDate: "01/24"
_class: "embedded.domain.Customer"

The Mongo Documents

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

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



Reference

testdb.customer

Documents Aggregations Schema

FILTER { field: 'value' }

ADD DATA VIEW

```
_id: 101
name: "John doe"
email: "jd@gmail.com"
phone: "0622341678"
creditCard: DBRef(creditCard, 12324564321, undefined)
_class: "reference.domain.Customer"
```

```
_id: 109
name: "John Jones"
email: "jones@acme.com"
phone: "0624321234"
creditCard: DBRef(creditCard, 657483342, undefined)
_class: "reference.domain.Customer"
```

```
_id: 66
name: "James Johnson"
email: "jj123@acme.com"
phone: "068633452"
creditCard: DBRef(creditCard, 99876549876, undefined)
_class: "reference.domain.Customer"
```

testdb.creditCard

Documents Aggregations

FILTER { field: 'value' }

ADD DATA VIEW

```
_id: "12324564321"
type: "Visa"
validationDate: "11/23"
_class: "reference.domain.CreditCard"
```

```
_id: "657483342"
type: "Visa"
validationDate: "09/23"
_class: "reference.domain.CreditCard"
```

```
_id: "99876549876"
type: "MasterCard"
validationDate: "01/24"
_class: "reference.domain.CreditCard"
```

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One to many relations

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

}
```

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.

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