NoSQL and MongoDB

NoSQL vs SQL, MongoDB, Mongoose

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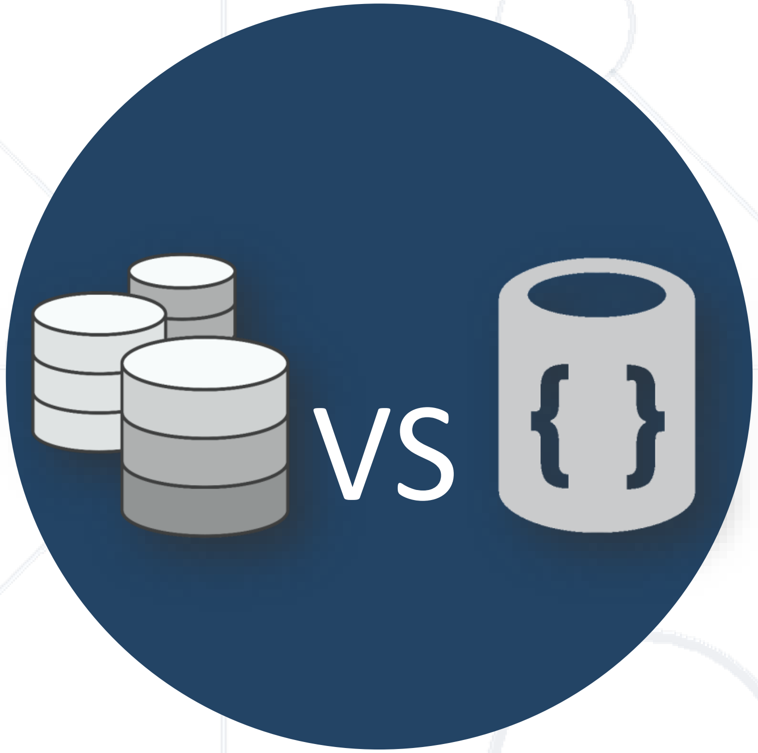


Relational and NoSQL Databases

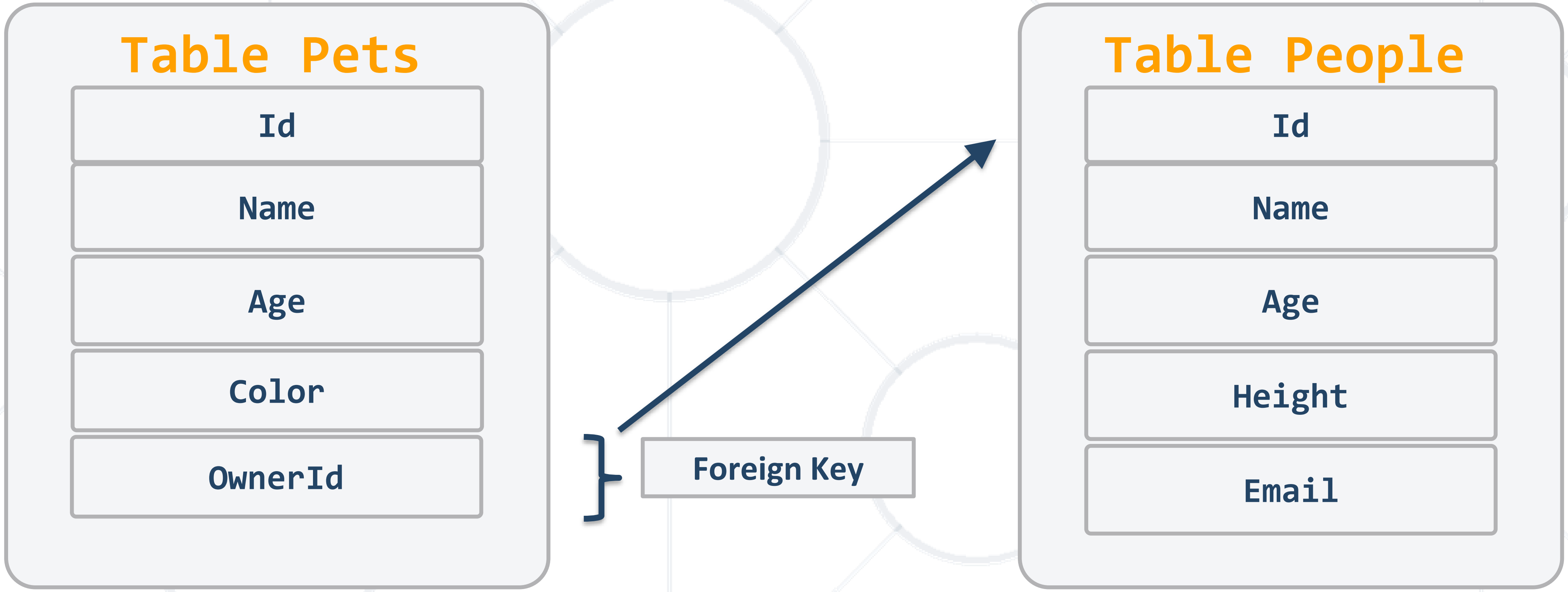
Relational Database

- Organize data into one or more **tables** of **columns** and **rows**
- Unique **key** identifying each **row** of data
- Almost all relational databases use **SQL** to **extract** data

```
SELECT * FROM Students
```

- **Relations** between tables are done using **Foreign Keys (FK)**
- Such databases are **Oracle**, **MariaDB**, **SQL Server**, etc…

Relational Database – Example



Non-relational Database (NoSQL)

- Key-value **stores**

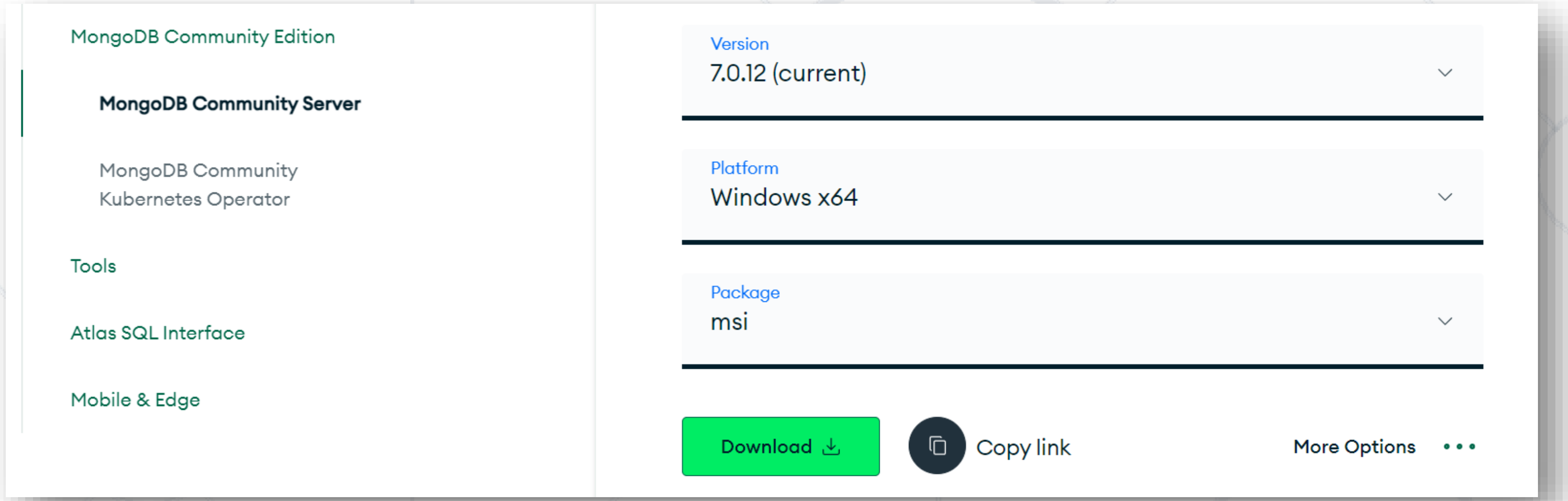
```
{
    "_id": ObjectId("59d3fe7ed81452db0933a871"),
    "email": "peter@gmail.com",
    "age": 22
}
```

- **SQL** query is **not** used in NoSQL systems
- More **scalable** and **provide** superior **performance**
- Such databases are **MongoDB**, **Cassandra**, **Redis**, etc..

MongoDB Overview

Install MongoDB

- Download from: *mongodb.com/try/download/community*


MongoDB Community Edition

MongoDB Community Server

MongoDB Community Kubernetes Operator

Tools

Atlas SQL Interface

Mobile & Edge

Version: 7.0.12 (current)

Platform: Windows x64

Package: msi

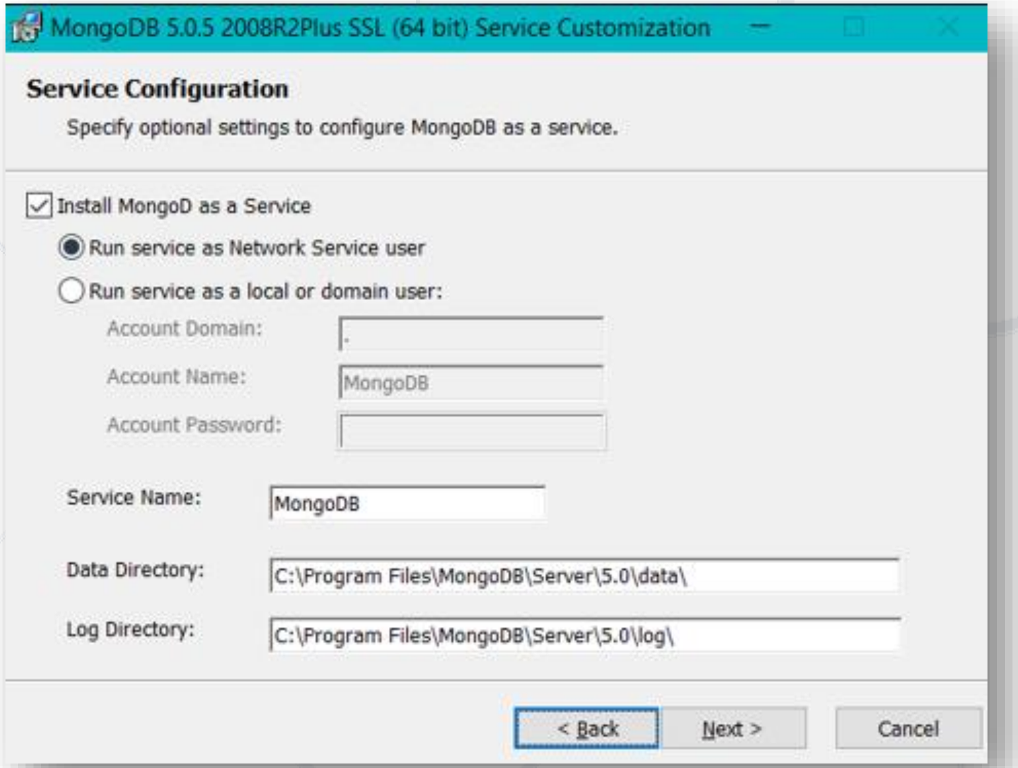
- The package includes **MongoDB Compass**
- When **installed**, MongoDB needs a **driver** (for every project)
  - Install MongoDB **driver** for Node.js

```
npm install mongodb
```

  - We will be using **Mongoose** (includes a driver)

MongoD Windows Service

- During installation, configure the **MongoDB service**:



MongoDB 5.0.5 2008R2Plus SSL (64 bit) Service Customization

Service Configuration

Specify optional settings to configure MongoDB as a service.

- [✓] Install MongoD as a Service
- [●] Run service as Network Service user
- [○] Run service as a local or domain user:

Account Domain:	.
Account Name:	MongoDB
Account Password:	
Service Name:	MongoDB
Data Directory:	C:\Program Files\MongoDB\Server\5.0\data\
Log Directory:	C:\Program Files\MongoDB\Server\5.0\log\

Manual Service Configuration

- Required if you **skipped** the service installation (and for Linux)
  - Go to installation folder and **run** a command prompt as an **administrator**
  - Type the following command

Usually in C:\Program Files\MongoDB\Server\3.4\bin

```
<path to mongod.exe> mongod --dbpath <path to store data>
```

  - Additional information at *https://docs.mongodb.com/manual/tutorial/*

Working with MongoDB Shell Client

- Start the shell from **another** CLI
  - Type the command **mongo**

```
show dbs
```

```
use mytestdb
```

```
db.mycollection.insertOne({"name":"George"})
```

```
db.mycollection.find({"name":" George"})
```

```
db.mycollection.find({})
```

  - Additional information at
    - https://docs.mongodb.com/manual/reference/mongo-shell/

Working with MongoDB GUI

- Choose one of the many (**Compass** is included in the installer)
- For example
  - Compass - *https://www.mongodb.com/products/compass*
  - Robo 3T - *https://robomongo.org/download*
  - NoSQLBooster - *https://nosqlbooster.com*

Working with MongoDB from Node.js – Example

```
const mongodb = require('mongodb');
const MongoClient = mongodb.MongoClient;
const connectionStr = 'mongodb://localhost:27017';
const client = new MongoClient(connectionStr,
{useUnifiedTopology: true});
client.connect(function(err) {
  const db = client.db('testdb');
  const people = db.collection('people');
  people.insertOne({ 'name': 'Ivan' }, (err, result) => {
    people.find({ name: 'Ivan' }).toArray((err, data) => {
      console.log(data);
    });
  });
});
```

Mongoose Overview

Mongoose Overview

- Mongoose is an object-document **model** module in Node.js for MongoDB
  - It **provides** a straight-forward, **schema-based** solution to **model** your application data
  - Includes build-in type **casting** and **validation**
  - **Extends** the native **queries** (much **easier** to use)
  - To **install** type in terminal/CMD (for every project)

```
npm install mongoose --save
```

Working with Mongoose in Node.js

- Load the following module

```
const mongoose = require('mongoose')
```

- **Connecting** to the database

```
async function main(){
   await mongoose.connect('mongodb://localhost:27017/testdb', {
        useNewUrlParser: true,
        useUnifiedTopology: true
   });
   console.log("Database connected")
}
main();
```

MongoDB Hosting

- Host a **database** in the largest MongoDB **cloud** service
- Go to '**mongo atlas**' and register - *https://www.mongodb.com/cloud/atlas*
- You can **store** up to 500 MB of **content**

Mongoose Models

Mongoose Models

- Mongoose **supports** models
  - Fixed **types** of documents
    - Used like object **constructors**
  - Needs a **mongoose.Schema** call

```
const mongoose = require('mongoose');
const studentSchema = new mongoose.Schema({
   firstName: String,
   lastName: String,
   facultyNumber: { type: String, required: true },
   age: Number
});

const Student= mongoose.model('Student', studentSchema);
```

Mongoose Models - Example

```
const myPerson = new Student({
       firstName: "John",
       lastName: "Peterson",
       facultyNumber: "5014sa",
       age: 25
   });

await myPerson.save();
const data = await Student.find({});
console.log(data); /* [{_id: new ObjectId("6139c6faf79365e5e54645bf"),
                        firstName: 'John',
                        lastName: 'Peterson',
                        facultyNumber: '5014sa',
                        age: 25, __v: 0}] */
```

Model Methods

- Since Mongoose models are just JavaScript **object constructors,** they can have **methods**

```
const studentSchema = new mongoose.Schema({…});

studentSchema.methods.getInfo = function() {
   return `I am ${this.firstName} ${this.lastName}`;
};
```

Do **not** use arrow functions

Model Virtual Properties

- Not all properties **need** to be **persisted** in the **database**
- Mongoose provides a way to **create** properties, that are accessible on all models, but are **not persisted** to the database
  - And they have both **getters** and **setters**

```
studentSchema.virtual('fullName').get(function () {
  return this.firstName + ' ' + this.lastName
});
```

Property Validation

- With Mongoose developers can **define** custom **validation** on their **properties**
  - Validate records when trying to **save**

```
studentSchema.path('firstName')
  .validate(function () {
     return this.firstName.length >= 2
     && this.firstName.length <= 10
}, 'First name must be between 2 and 10 symbols long!')
```

Error message as second param

Property Validation

- Mongoose has several built-in validators
  - All **Schema-**Types have the built-in required validator
  - Numbers have **min** and **max** validators
  - Strings have **enum**, **regex**, **minLength**, and **maxLength** validators

```
facultyNumber: {
   type: String,
   required: [true, 'FacultyNumber is required']
 }
```

Error message

- You can configure the error message for individual validators in your schema

Exemplary Validations

- Mongoose replaces **{VALUE}** with the value being validated

```
const studentSchema = new mongoose.Schema({
  age: {
     type: Number,
     min: [0, 'Must be at least 0, got {VALUE}'],
     max: 50 }
});
```

Error message as second param

```
const studentSchema = new mongoose.Schema({
  facultyNumber: {
     type: String,
     enum: {
      values: ['50121', '50122', '50123'],
      message: '{VALUE} is not valid'
    } }
});
```

Exporting Modules

- Having all model definitions in the **main** module is **no** good
  - That is the reason Node.js has **modules** in the first place
  - In folder **models**, file **Student.js**

```
const mongoose = require('mongoose');
const studentSchema = new mongoose.Schema({
    firstName: { type: String, required: true },
    age: { type: Number }
});

module.exports = mongoose.model('Student', studentSchema);
```

Exporting and Using Modules

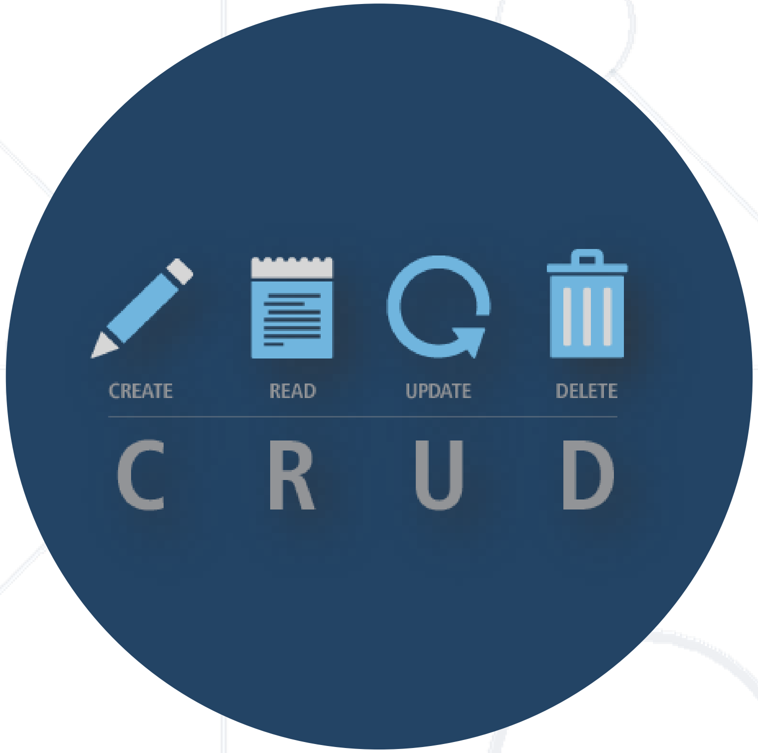
- Export the model definition:

```
const mongoose = require('mongoose');
const studentSchema = new mongoose.Schema({ /* … */ });

module.exports = mongoose.model('Student', studentSchema);
```

- We can put each **model** in a different **module**, and **load** all models where they are needed

```
const Student = require('./models/Student');
```



CRUD with Mongoose

CRUD with Mongoose

- Mongoose supports **all** CRUD operations
  - Create (Persist data)

```
new Student({}).save(callback)
```

  - Read (Extract data)

```
Student.find({})
Student.findOne({conditions}, {options}, callback)
Student.findById(id, {options}, callback)
```

CRUD with Mongoose

- Update (Modify data)

```
Student
  .findByIdAndUpdate(id, {$set: {prop: newVal}}, callback)
Student
  .updateOne({filter}, {$set: {prop: newVal}}, callback)
Student
  .updateMany({filter}, {$set: {prop: newVal}}, callback)
```

- Delete (Remove data)

```
Student.findByIdAndDelete(id, callback)
Student.deleteOne({conditions}, {options}, callback)
Student.deleteMany({conditions}, {options}, callback)
```

Create Example

```
const mongoose = require('mongoose');
const connectionStr = 'mongodb://localhost:27017/unidb';
const studentSchema = new mongoose.Schema({
  name: { type: String, required: true, minlength: 3 },
  age: Number
});
const Student = mongoose.model('Student', studentSchema);
mongoose.connect(connectionStr).then(() => {
  new Student({ name: 'Petar', age: 21 })
    .save()
    .then(student => {
      console.log(student._id)
    });
});
```

You can also use Student.create()

Read Example

```
Student
    .find({})
    .then(students => console.log(students))
    .catch(err => console.error(err))
Student
    .find({name: 'Petar'})
    .then(students => console.log(students))
Student
    .findOne({name: 'Petar'})
    .then(student => console.log(student))
```

Always handle errors

Update Example

```
Student
    .findById('57fb9fe1853ab747b0f692d1')
    .then((student) => {
      student.name = 'Stamat'
      student.save()
    });
Student
    .findByIdAndUpdate('57fb9fe1853ab747b0f692d1', {
      $set: { name: 'Petar' }
    }).then(students => console.log(students))
Student
    .updateOne(
      { name: 'Petar' },
      { $set: { name: 'Kiril' } }). then(students =>
console.log(students))
```

Remove and Count Example

```
Student
    .findByIdAndDelete('57fb9fe1853ab747b0f692d1').then()
Student
    .deleteOne({ name: 'Stamat' }).then()
Student
    .countDocuments()
    .then(console.log)
Student
    . countDocuments({ age: { $gt: 19 } })
    .then(console.log)
```

Remove by criteria

Get the count by criteria

Mongoose Queries

Mongoose Queries

- Mongoose defines **all** queries of the native MongoDB driver in a more **clear** and **useful** way
  - Instead of

```
{
  $or: [
    {conditionOne: true},
    {conditionTwo: true}
  ]
}
```

  - Do

```
.where({ conditionOne: true })
.or({ conditionTwo: true })
```

Mongoose Queries Example

- Mongoose supports **many** queries
  - For equality / non-equality

```
Student.findOne({'lastName':'Petrov'})
```

```
Student.find({}).where('age').gt(7).lt(14)
```

```
Student.find({}).where('facultyNumber').equals('12399')
```

  - Selection of some properties

```
Student.findOne({'lastName':'Kirilov'}).select('name age')
```

Mongoose Queries Example 2

- Sorting

```
Student.find({}).sort({age:-1})
```

- Limit & skip

```
Student.find({}).sort({age:-1}).skip(10).limit(10)
```

- Different methods could be **stacked** one upon the other

```
Student.find({})
      .where('firstName').equals('gosho')
      .where('age').gt(18).lt(65)
      .sort({age:-1})
      .skip(10)
      .limit(10)
```

Model Population

Population Definition

- Population is the process of **automatically replacing** the **specified paths** in the document with document(s) from **other** collection(s)
- We may **populate** a single document, multiple documents, plain object, multiple plain objects, or all objects returned from a query

Example

- We create **two models** that **reference** each other

```
const studentSchema = new mongoose.Schema({
  name: String,
  age: Number,
  facultyNumber: String,
  teacher: { type: Schema.Types.ObjectId, ref: 'Teacher' },
  subjects: [{ type: Schema.Types.ObjectId, ref: 'Subject' }]
});
const subjectSchema = new mongoose.Schema({
  title: String,
  students: [{ type: Schema.Types.ObjectId, ref: 'Student' }]
});
const Student = mongoose.model('Student', studentSchema);
const Subject = mongoose.model('Subject', subjectSchema);
```

Population

- To load all the data **referenced** with the entity use **populate()**

```
Student.findOne({ name: 'Peter' })
  .populate('subjects')
  .then(student => {
     console.log(student.subjects)
   })
```

Will return an array of **objects** and **NOT** Id's

- You can also load **multiple** paths

```
Student.findOne({ name: 'Peter' })
   .populate('subjects')
   .populate('teacher')
   .then(student => {
      console.log(student.teacher)
      console.log(student.subjects)
   })
```

Query Conditions

- Populate based on a **condition**

```
Subject.
  find({})
  .populate({
    path: 'students',
    match: { age: { $gte: 19 }},
    select: 'name facultyNumber',
    options: { limit: 3 }
  })
```

- More on populate here - *mongoosejs.com/docs/populate.html*

Summary

- NoSQL databases provide superior performance
- Mongoose gives us a schema-based solution

```
const modelSchema = new mongoose.Schema({
   propString: String
});
```

- Mongoose supports all CRUD operations
- Chaining queries with Mongoose is possible

```
Student.find({}).where('firstName').equals('gosho')
.where('age').gt(18).lt(65).sort({age:1}).skip(10)
.limit(10)
```

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