



SQL DATABASES IN NODE.JS

Herman Bilous

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AGENDA OF THE LECTURE

- Introduction to Databases;
- Understanding Data Modeling;
- Overview of SQL possibilities;
- Native DB driver;
- ORM concepts;
- Sequelize ORM driver.

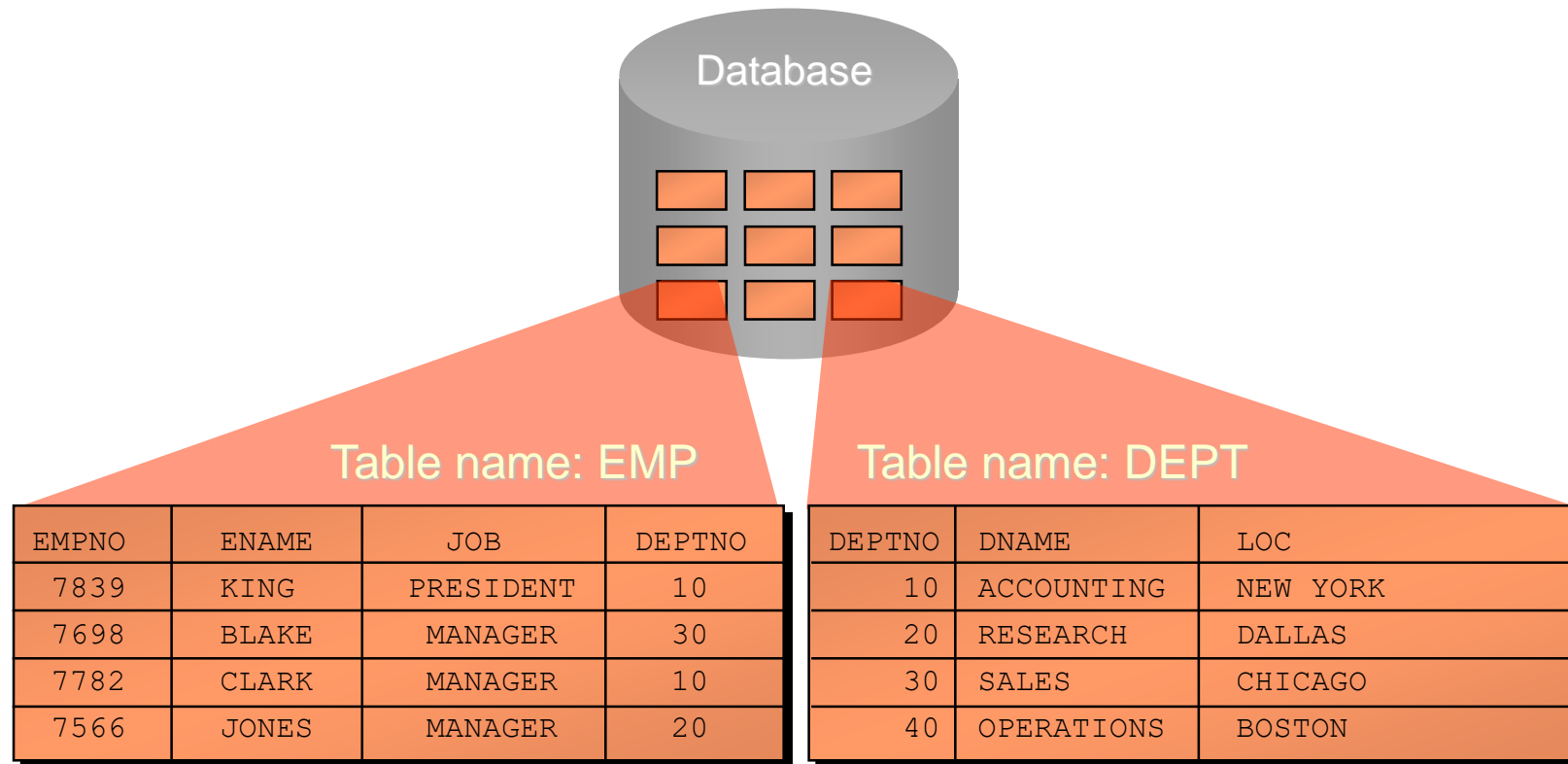




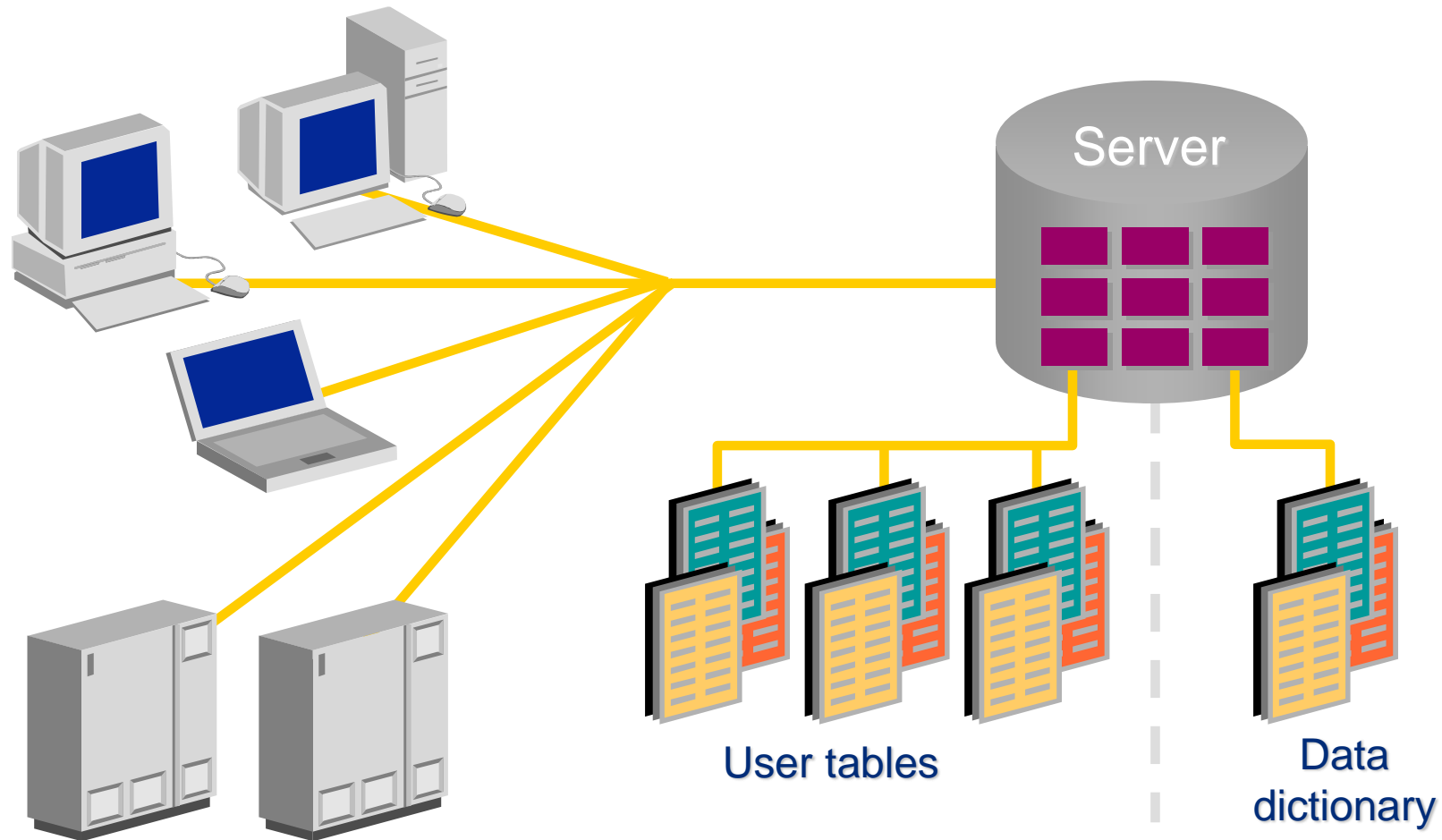
INTRODUCING TO DATABASES

DEFINITION OF A RELATION DATABASE

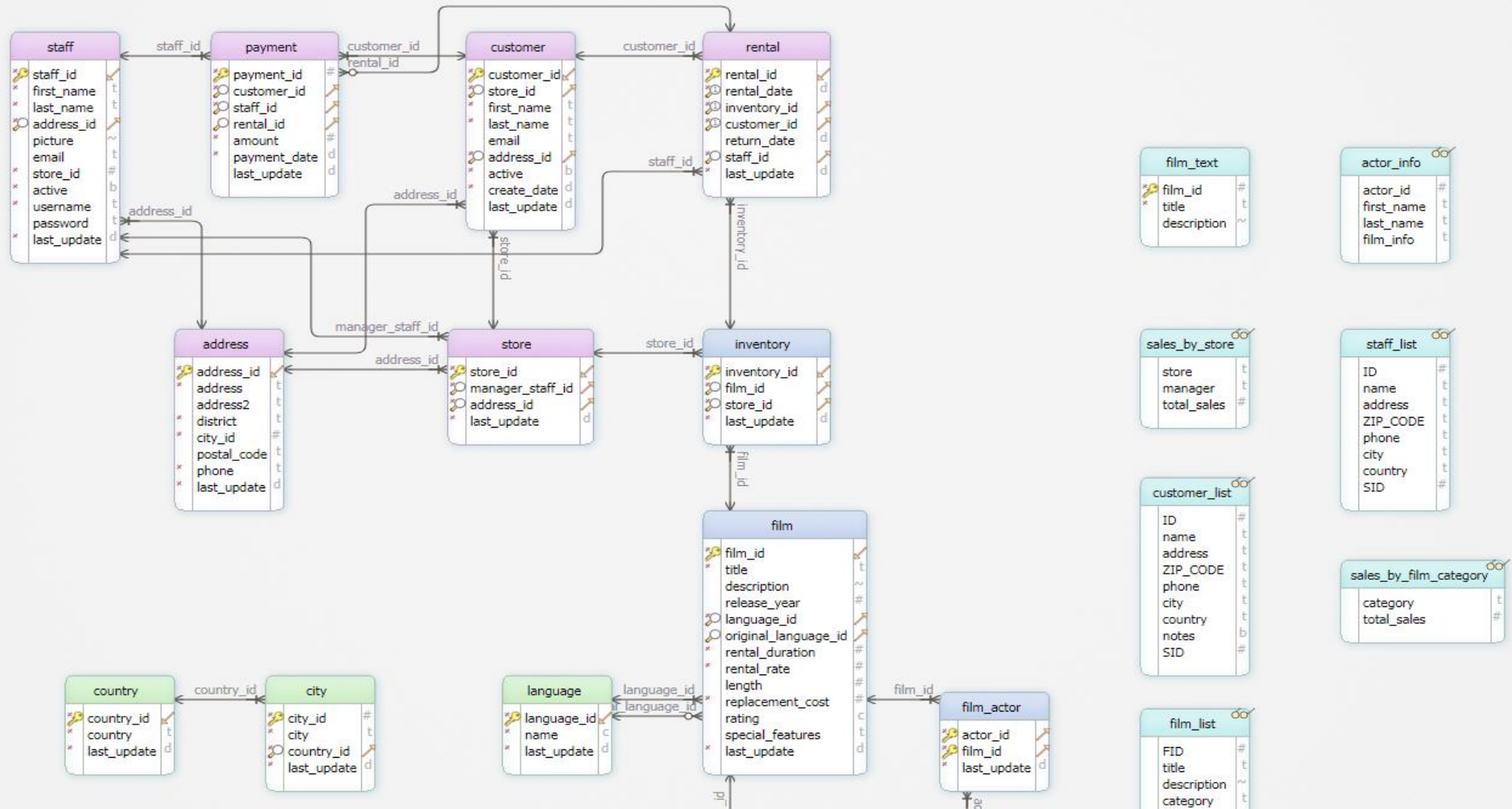
A relational database is a digital database of relations or two-dimensional tables.



RELATION DATABASE MANAGEMENT SYSTEM (RDBMS)



DATA STRUCTURE EXAMPLE



RELATING MULTIPLE TABLES

- Each row of data in a table is uniquely identified by a primary key (PK).
- You can logically relate data from multiple tables using foreign keys (FK).

Table name: EMP

EMPNO	ENAME	JOB	DEPTNO
7839	KING	PRESIDENT	10
7698	BLAKE	MANAGER	30
7782	CLARK	MANAGER	10
7566	JONES	MANAGER	20



Primary key



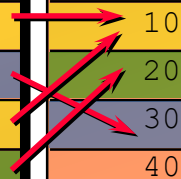
Foreign key

Table name: DEPT

DEPTNO	DNAME	LOC
10	ACCOUNTING	NEW YORK
20	RESEARCH	DALLAS
30	SALES	CHICAGO
40	OPERATIONS	BOSTON

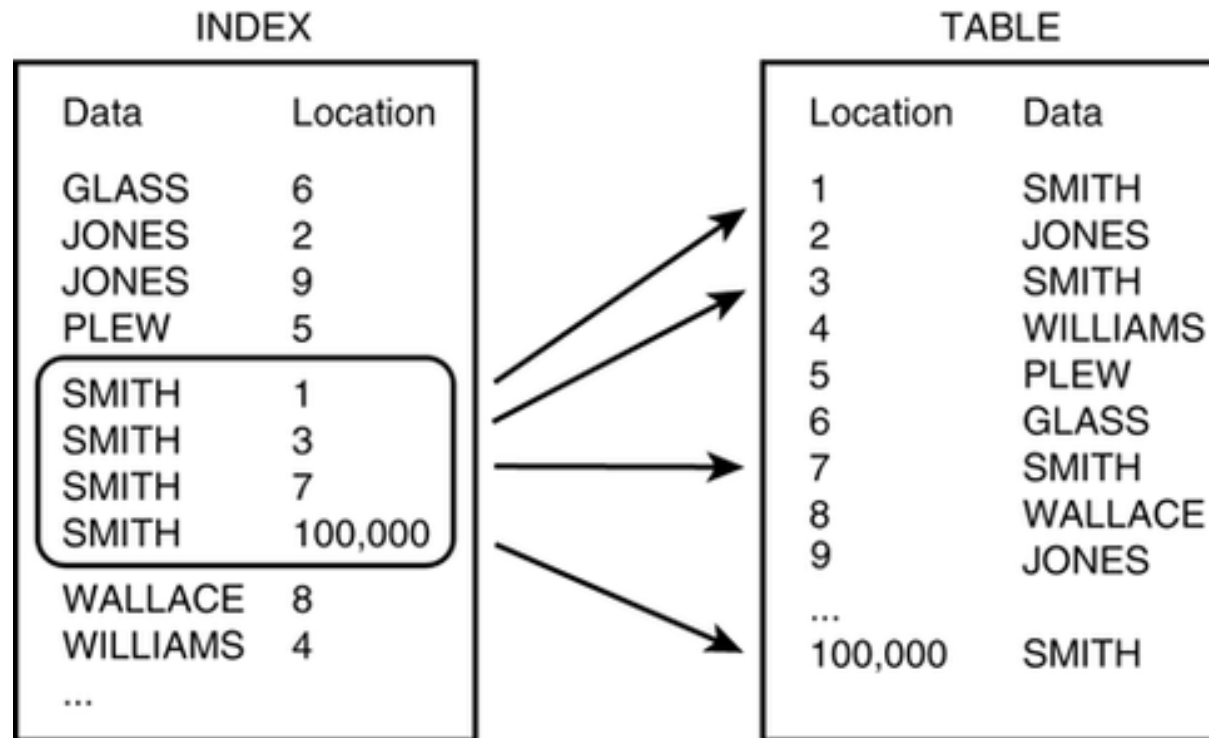


Primary key



INDEXING

When to Create an index



SQL BASICS

What is SQL?

SQL is an abbreviation for “Structured Query Language”.

SQL is a language used to build database applications that need to query relational databases.

SQL has statements such as CREATE, SELECT, INSERT, UPDATE, DELETE, etc., just like there are statements such as assignment statement, if statement, while statement, etc., in general purpose programming languages such as C, C++ and Java.

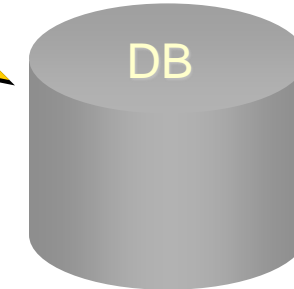
SQL is a language for databases just like C, C++ and Java are languages for general purpose programming.

COMMUNICATING WITH A RDBMS USING SQL

SQL statement is entered

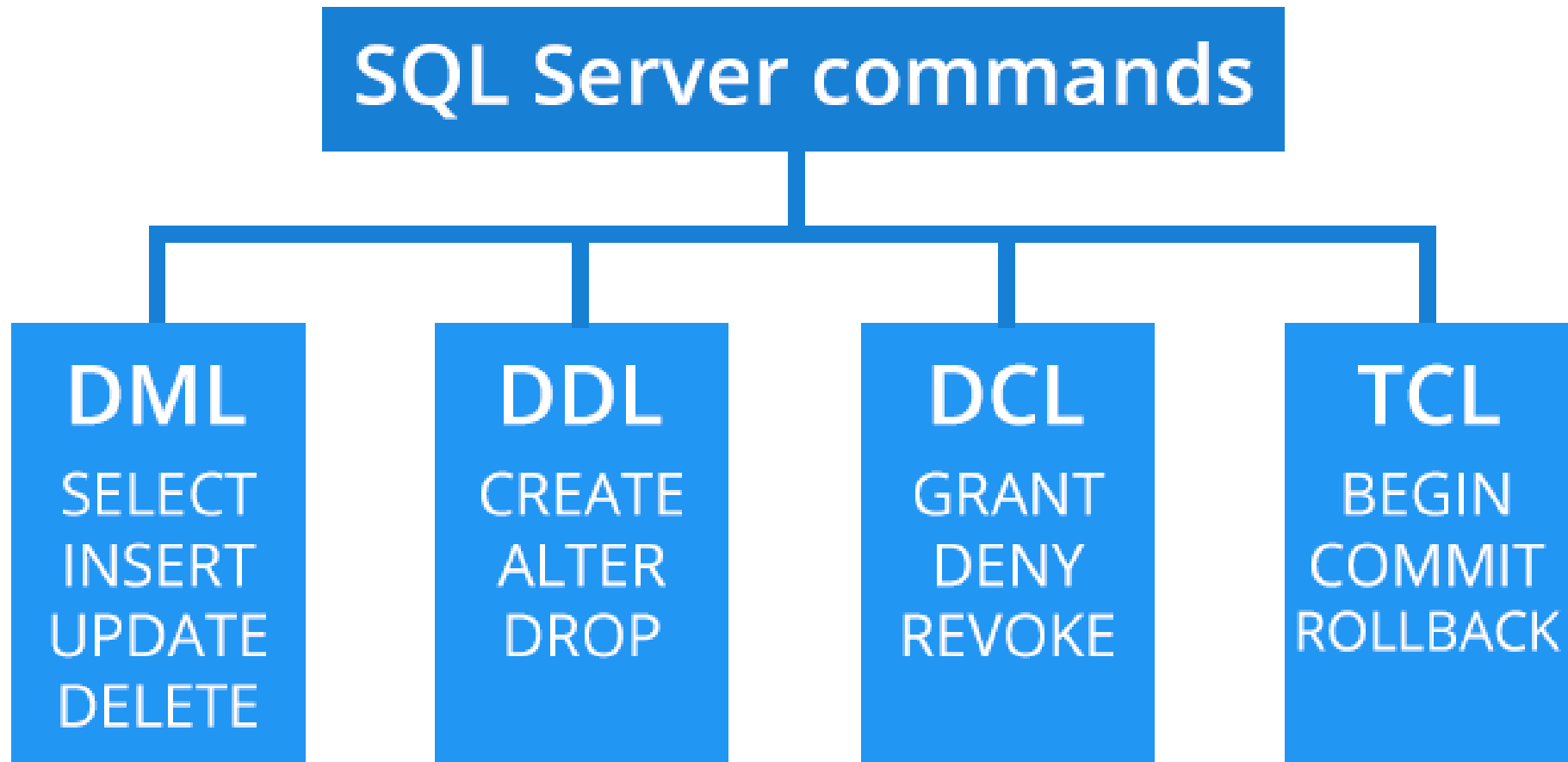
```
SQL> SELECT loc  
      2 FROM dept;
```

Statement is sent to DB



Data is displayed

```
LOC  
-----  
NEW YORK  
DALLAS  
CHICAGO  
BOSTON
```



SQL SELECT

Syntax

```
SELECT [DISTINCT|ALL] { * | column | column_expression [AS new_name] [, ...] }  
  FROM   table_name [alias] [, ... ]  
    [WHERE condition]  
    [GROUP BY column_list]  
    [HAVING condition]  
    [ORDER BY column_list [ASC|DESC]] ;
```

- *column* represents a column name.
- *column_expression* represents an expression on a column.
- *table_name* is the name of an existing database table or view.
- FROM specifies the table(s) to be used.
- WHERE filters the rows subject to some condition.
- GROUP BY forms groups of rows with the same column name.
- SELECT specifies which column are to appear in the output.
- ORDER BY specifies the order of the output.
- Order of the clauses in the SELECT statement can not be changed.
- The result of a query is another table.

SQL SELECT EXAMPLES

```
SELECT sno, fname, lname, position, sex, dob, salary, bno  
FROM staff;
```

OR

```
SELECT *  
FROM staff;
```

Sno	FName	LName	position	Sex	DOB	Salary	bno
SL21	John	White	Manager	M	1-Oct-45	30000	B005
SG37	Ann	Beech	Assistant	F	10-Nov-60	12000	B003
SG14	David	Ford	Supervisor	M	24-Mar-58	18000	B003

```
SELECT sno, fname, lname, salary  
FROM staff  
WHERE salary > 10000;
```

Sno	FName	LName	Salary
SL21	John	White	30000
SG37	Ann	Beech	12000
SG14	David	Ford	18000
SG5	Susan	Brand	24000

```
SELECT propertyNo, type, rooms, rent  
FROM property  
ORDER BY type, rent DESC;
```

PropertyNo	Type	Rooms	Rent
PG16	Flat	4	450
PL94	Flat	4	400
PG36	Flat	3	370
PG4	House	3	650
PA14	House	6	600

Syntax

```
INSERT INTO table_name [(column (,...))]  
    { VALUES (data_value (,...)) | subquery };
```

- *table_name* may be either a base table or an updatable view.
- *column_list* represents a list of one or more column names separated by commas.
- If omitted, SQL assumes a list of all columns in their original CREATE TABLE order.
- If specified, then any columns that are omitted from the list must have been declared as NULL column.
- *data_value* must match the *column_list* as follows:
 - The number of items in each list must be same.
 - There must be a direct correspondence in the position of items in the two lists, so that the first item in the *data_value_list* applies to the first item in the *column_list*, and so on.
 - The data type of each item in the *data_value_list* must be compatible with the data type of the corresponding column.

SQL INSERT EXAMPLE

Example:

Insert a new row into the staff table supplying data for all mandatory columns, knowing that the sex and birth date are optional fields.

```
INSERT INTO staff (Sno, fname, lname, position, salary, bno)
VALUES ('SG16', 'Alan', 'Brown', 'Assistant', 8300, 'B003');
```

Alternative:

```
INSERT INTO staff
VALUES ('SG16', 'Alan', 'Brown', 'Assistant', NULL, NULL, 8300,
      'B003');
```

SQL UPDATE

Syntax

```
UPDATE table_name
    SET column_name1 = data_value1 [, column_namei =
data_valuei ...]
    [WHERE search_condition]
```

- *table_name* may be either a base table or an updatable view.
- The SET clause specifies the names of one or more columns that are updated for all rows in the table.
- Only rows that satisfy the *search_condition* are updated.
- *data_values* must be compatible with the data types for the corresponding columns.

SQL UPDATE EXAMPLE

STAFF(sno, fname, lname, position, sex, DOB, salary, bno)

Example:

Give all staff a 3% pay increase.

```
UPDATE  staff
      SET  salary = salary * 1.03;
```

Example:

Give all managers a 3% pay increase.

```
UPDATE  staff
      SET  salary = salary * 1.03
      WHERE position = 'Manager';
```


SQL DELETE

Syntax

```
DELETE FROM table_name  
        [WHERE search_condition];
```

- *table_name* may be either a base table or an updatable view.
- Only rows that satisfy the *search_condition* are deleted.
- If no *search_condition* is omitted, all rows are deleted from the table.
- DELETE does not delete the table itself, only rows in the table.

SQL DELETE EXAMPLE

STAFF(sno, fname, lname, position, sex, DOB, salary, bno)

Example:

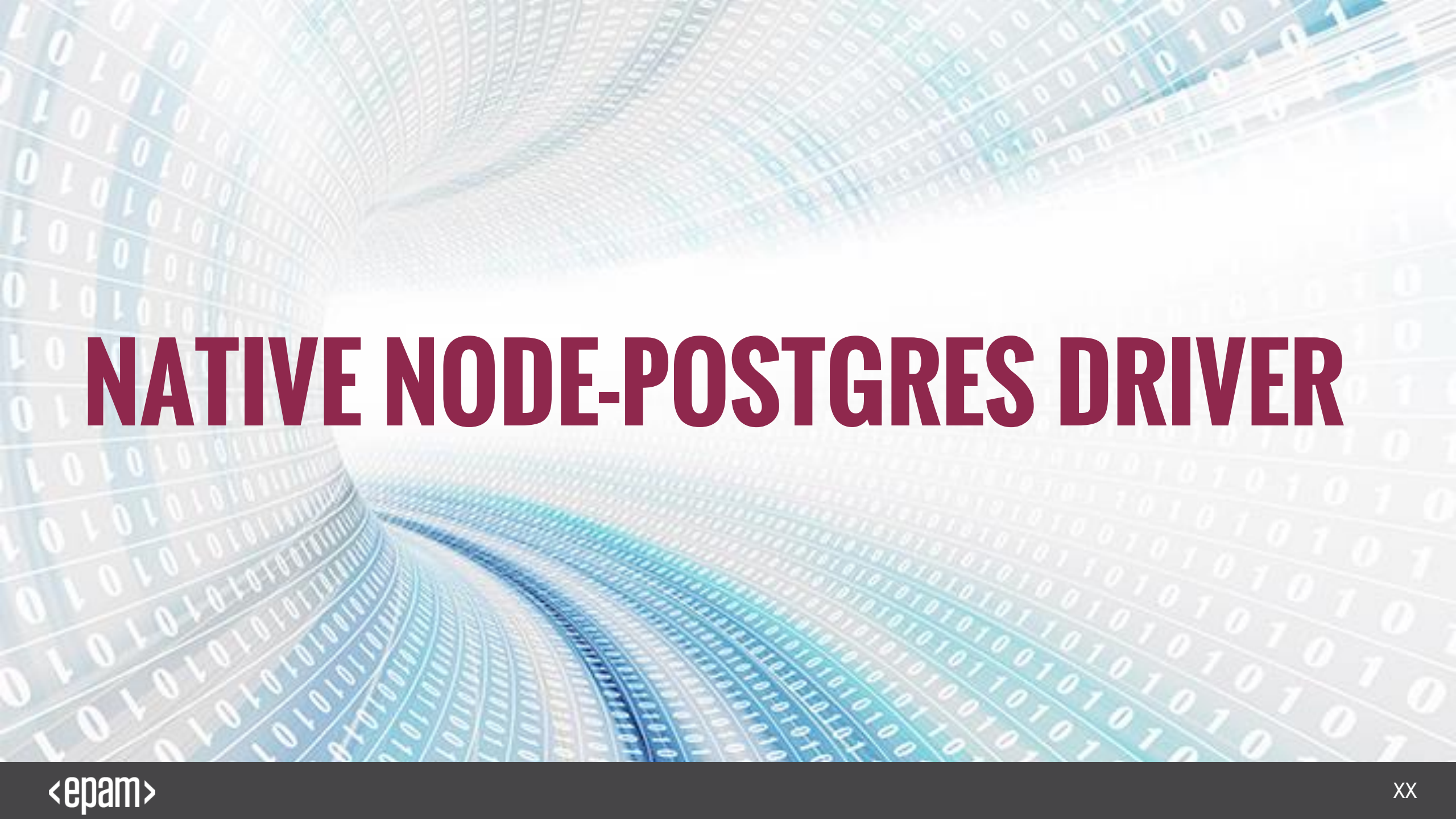
Delete all staff in branch B003.

```
DELETE FROM staff
WHERE bno = 'B003';
```

Example:

Delete all staff.

```
DELETE FROM staff;
```



NATIVE NODE-POSTGRES DRIVER

SETTING UP A CONNECTION

Getting started

This is the simplest possible way to connect, query, and disconnect with async/await:

```
const { Client } = require('pg')
const client = new Client()

await client.connect()

const res = await client.query('SELECT $1::text as message', ['Hello world!'])
console.log(res.rows[0].message) // Hello world!
await client.end()
```

SETTING UP A CONNECTION

Getting started

And here's the same thing with callbacks:

```
var Pg = require('pg').Client;
var conString = "postgres://postgres:123456@domain.com/nodejs";

var pg = new Pg(conString);
pg.connect();

var query = pg.query("select * from node.users order by id", function(err, result){
    var json = JSON.stringify(result.rows);
    console.log(json);
});
```


Parameterized query

With callback and promise

```
const text = 'INSERT INTO users(name, email) VALUES($1, $2) RETURNING *'
const values = ['brianc', 'brian.m.carlson@gmail.com']

client.query(text, values, (err, res) => {
  if (err) {
    console.log(err.stack)
  } else {
    console.log(res.rows[0])
    // { name: 'brianc', email: 'brian.m.carlson@gmail.com' }
  }
})

client.query(text, values)
  .then(res => {
    console.log(res.rows[0])
    // { name: 'brianc', email: 'brian.m.carlson@gmail.com' }
  })
  .catch(e => console.error(e.stack))
```

Row mode with callback and promise

```
const query = {
  text: 'SELECT $1::text as first_name, select $2::text as last_name',
  values: ['Brian', 'Carlson'],
  rowMode: 'array',
};

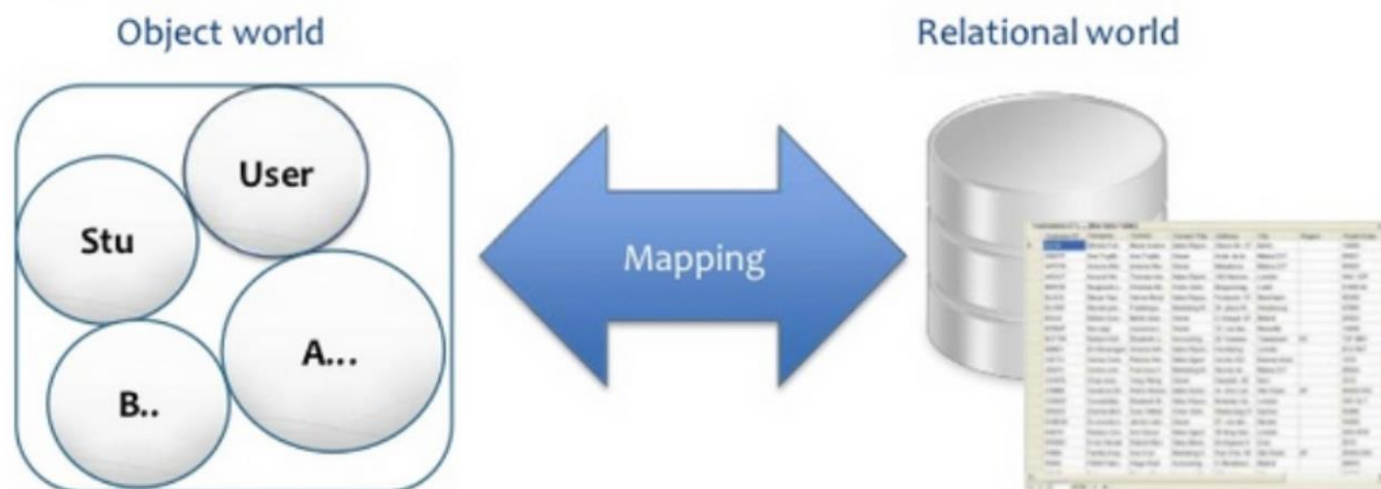
client.query(query, (err, res) => {
  if (err) {
    console.log(err.stack)
  } else {
    console.log(res.fields.map(f => field.name)) // ['first_name', 'last_name']
    console.log(res.rows[0]) // ['Brian', 'Carlson']
  }
})

client.query(query)
  .then(res => {
    console.log(res.fields.map(f => field.name)) // ['first_name', 'last_name']
    console.log(res.rows[0]) // ['Brian', 'Carlson']
  })
  .catch(e => console.error(e.stack))
```

ORM: WHAT IS IT?

What is ORM?

- Relational Database
- Objects
- Mapping between Objects & Relational Database



Why ORM?

- Leverages existing knowledge and skills related to OOP
- Level of abstraction
- Saves programmer time

CRUD

1. Create

- `User.create(:name => 'asd', :email => 'asd@wer.com')`

2. Read

- `@user = User.find(1)`

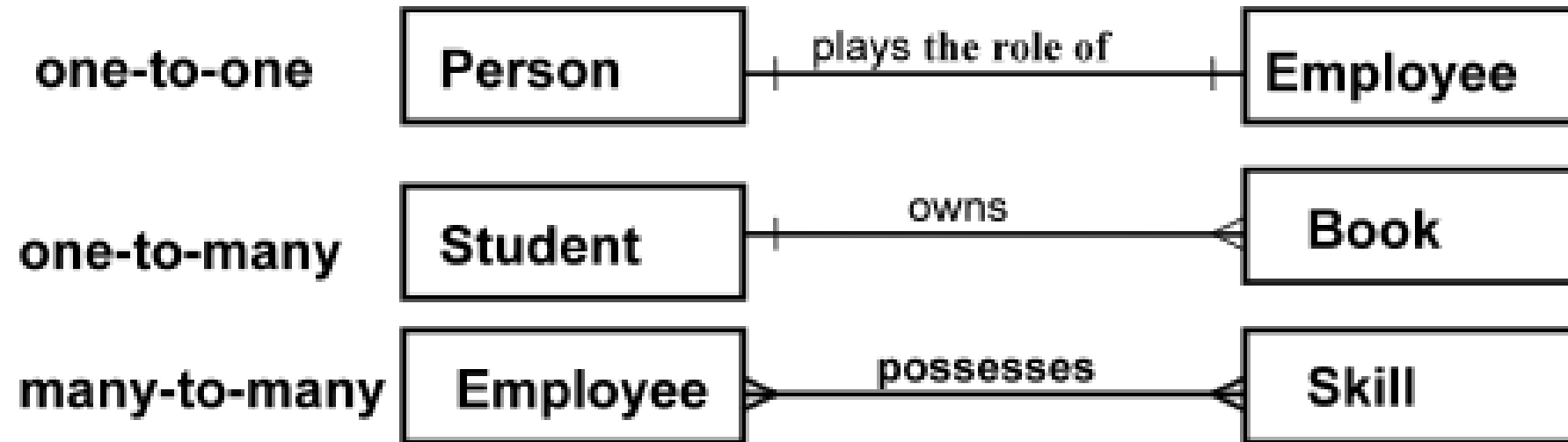
3. Update

- `@user.name = 'new name'`
- `@user.save`

4. Delete

- `@user.delete`

ASSOCIATIONS



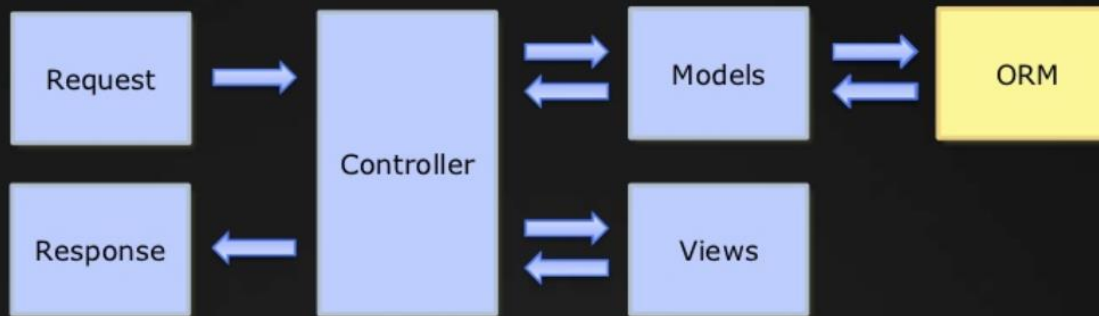
Advantages of ORM

- ORM frees the programmer from dealing with simple repetitive database queries;
- Automatically mapping the database to business objects lets programmers focus more on business problems and less with data storage;
- ORM can provide a caching layer above the database;
- Lazy loading.

Disadvantages of ORM

- ORM adds a small layer of application code, increasing processing overhead and amount of moving parts;
- Lazy loading;
- An ORM system's design might dictate certain database design decisions.

Using an ORM in an MVC framework



- The ORM is your data abstraction layer
- The Model contains your business logic
- What not to do:
 - have the business logic in the controller and use the ORM as your model
 - Some ORM's allow you to merge the functionality of the Model and the ORM
 - but think carefully about the complexity...

SEQUELIZE ORM DRIVER



Sequelize

[Sequelize](#) is a promise-based ORM for Node.js and io.js. It supports PostgreSQL, MySQL, MariaDB, SQLite and MSSQL and features transaction support, relations, read replication and more. Starting from 4.0.0 Sequelize will only support Node v4 and above to use ES6 features.

SETTING UP A CONNECTION

Getting started

you can simply use a connection uri

```
const Sequelize = require('sequelize');  
const sequelize = new Sequelize('postgres://user:pass@example.com:5432/dbname');
```

SETTING UP A CONNECTION

Getting started

Setup with parameters

```
const Sequelize = require('sequelize');
const sequelize = new Sequelize('database', 'username', 'password', {
  host: 'localhost',
  dialect: 'mysql' | 'sqlite' | 'postgres' | 'mssql',

  pool: {
    max: 5,
    min: 0,
    idle: 10000
  },

  // SQLite only
  storage: 'path/to/database.sqlite'
});
```

TEST CONNECTION

You can use the `.authenticate()` function like this to test the connection.

```
sequelize
  .authenticate()
  .then(() => {
    console.log('Connection has been established successfully.');
```

```
  })
```

```
  .catch(err => {
```

```
    console.error('Unable to connect to the database:', err);
```

```
  });
```


MODEL DEFINITION

To define mappings between a model and a table, use the `define` method.

```
const Project = sequelize.define('project', {  
  title: Sequelize.STRING,  
  description: Sequelize.TEXT  
});
```

```
const Task = sequelize.define('task', {  
  title: Sequelize.STRING,  
  description: Sequelize.TEXT,  
  deadline: Sequelize.DATE  
});
```

GETTERS & SETTERS

It is possible to define 'object-property' getters and setter functions on your models, these can be used both for 'protecting' properties that map to database fields and for defining 'pseudo' properties.

```
const Employee = sequelize.define('employee', {
  name: {
    type: Sequelize.STRING,
    allowNull: false,
    get() {
      const title = this.getDataValue('title');
      // 'this' allows you to access attributes of the instance
      return this.getDataValue('name') + ' (' + title + ')';
    },
  },
  title: {
    type: Sequelize.STRING,
    allowNull: false,
    set(val) {
      this.setDataValue('title', val.toUpperCase());
    }
  }
});
```

DATA TYPES

Below are some of the datatypes supported by sequelize:

<code>Sequelize.STRING</code>	<code>// VARCHAR(255)</code>
<code>Sequelize.TEXT</code>	<code>// TEXT</code>
<code>Sequelize.INTEGER</code>	<code>// INTEGER</code>
<code>Sequelize.BIGINT</code>	<code>// BIGINT</code>
<code>Sequelize.FLOAT</code>	<code>// FLOAT</code>
<code>Sequelize.REAL</code>	<code>// REAL PostgreSQL only.</code>
<code>Sequelize.DOUBLE</code>	<code>// DOUBLE</code>
<code>Sequelize.DECIMAL</code>	<code>// DECIMAL</code>
<code>Sequelize.DATE</code>	<code>// DATETIME for mysql/sqlite, TIMESTAMP WITH TIME ZONE for postgres</code>
<code>Sequelize.DATEONLY</code>	<code>// DATE without time.</code>
<code>Sequelize.BOOLEAN</code>	<code>// TINYINT(1)</code>
<code>Sequelize.ENUM('value 1', 'value 2')</code>	<code>// An ENUM with allowed values 'value 1' and 'value 2'</code>
<code>Sequelize.ARRAY(Sequelize.TEXT)</code>	<code>// Defines an array. PostgreSQL only.</code>
<code>Sequelize.JSON</code>	<code>// JSON column. PostgreSQL, SQLite and MySQL only.</code>
<code>Sequelize.JSONB</code>	<code>// JSONB column. PostgreSQL only.</code>
<code>Sequelize.BLOB</code>	<code>// BLOB (bytea for PostgreSQL)</code>
<code>Sequelize.UUID</code>	<code>// UUID datatype for PostgreSQL and SQLite, CHAR(36)</code>

VALIDATIONS

Model validations allow you to specify format/content/inheritance validations for each attribute of the model.

It runs on create, update and save. You can also call `validate()` to manually validate an instance

```
const Pub = Sequelize.define('pub', {
  name: { type: Sequelize.STRING },
  address: { type: Sequelize.STRING },
  latitude: {
    type: Sequelize.INTEGER,
    allowNull: true,
    defaultValue: null,
    validate: { min: -90, max: 90 }
  },
  longitude: {
    type: Sequelize.INTEGER,
    allowNull: true,
    defaultValue: null,
    validate: { min: -180, max: 180 }
  },
}, {
  validate: {
    bothCoordsOrNone() {
      if ((this.latitude === null) !== (this.longitude === null)) {
        throw new Error('Require either both latitude and longitude or neither')
      }
    }
  }
})
```

find - Search for one specific element in the database

```
// search for known ids
Project.findById(123).then(project => {
  // project will be an instance of Project and stores the content of the table entry
  // with id 123. if such an entry is not defined you will get null
})

// search for attributes
Project.findOne({ where: { title: 'aProject' } }).then(project => {
  // project will be the first entry of the Projects table with the title 'aProject' || null
})

Project.findOne({
  where: { title: 'aProject' },
  attributes: ['id', ['name', 'title']]
}).then(project => {
  // project will be the first entry of the Projects table with the title 'aProject' || null
  // project.title will contain the name of the project
})

// limit the results of the query
Project.findAll({ limit: 10 })
```


- **findOrCreate** - Search for a specific element or create it if not available
- **findAndCountAll** - Search for multiple elements in the database, returns both data and total count
- **findAll** - Search for multiple elements in the database

Manipulating the dataset with limit, offset, order and group

To get more relevant data, you can use limit, offset, order and grouping:

// limit the results of the query

```
Project.findAll({ limit: 10 })
```

// step over the first 10 elements

```
Project.findAll({ offset: 10 })
```

// step over the first 10 elements, and take 2

```
Project.findAll({ offset: 10, limit: 2 })
```

QUERYING

Attributes:

list all the attributes of the model if you only want to add an aggregation

// This is a tiresome way of getting the number of hats...

```
Model.findAll({  
  attributes: ['id', 'foo', 'bar', 'baz', 'quz', [sequelize.fn('COUNT', sequelize.col('hats')), 'no_hats']]  
});
```

// This is shorter, and less error prone because it still works if you add / remove attributes

```
Model.findAll({  
  attributes: { include: [[sequelize.fn('COUNT', sequelize.col('hats')), 'no_hats']] }  
});
```

```
SELECT id, foo, bar, baz, quz, COUNT(hats) AS no_hats ...
```

- Attributes
- Where
 - Basics
 - Operators
 - Range Operators
 - Combinations
 - Operators Aliases
 - Operators security
 - JSONB
 - Nested object
 - Nested key
 - Containment
 - Relations / Associations
- Pagination / Limiting
- Ordering

```
where: { authorId: 2 }  
[Op.or]: [{a: 5}, {a: 6}] // (a = 5 OR a = 6)  
[Op.notBetween]: [11, 15], // NOT BETWEEN 11 AND 15  
rank: { [Op.or]: { [Op.lt]: 1000, [Op.eq]: null } }  
const operatorsAliases = { $gt: Op.gt } // $gt: 6  
operatorsAliases: { $and: Op.and }
```

```
{  
  meta: {  
    video: {  
      url: {  
        [Op.ne]: null  
      }  
    }  
  },  
  {  
    "meta.audio.length": {  
      [Op.gt]: 20  
    }  
  },  
  {  
    "meta": {  
      [Op.contains]: {  
        site: {  
          url: 'http://google.com'  
        }  
      }  
    }  
  }  
}
```

```
where: { state: Sequelize.col('project.state')}
```

```
Project.findAll({ offset: 5, limit: 5 })
```

```
order: ['title', 'DESC']
```

ASSOCIATIONS

One-To-One associations

```
const Player = this.sequelize.define('player', { /* attributes */ });  
const Team   = this.sequelize.define('team', { /* attributes */ });
```

```
Player.belongsTo(Team); // Will add a teamId attribute to Player to hold the primary key value for Team
```

```
const User = this.sequelize.define('user', { /* attributes */ })  
const UserRole = this.sequelize.define('userRole', { /* attributes */ });
```

```
User.belongsTo(UserRole, { as: 'role' }); // Adds roleId to user rather than userRoleId
```


ASSOCIATIONS

One-To-Many associations

```
const User = sequelize.define('user', { /* ... */ })
const Project = sequelize.define('project', { /* ... */ })

// OK. Now things get more complicated (not really visible to the user :)).
// First let's define a hasMany association
Project.hasMany(User, { as: 'Workers' })

const City = sequelize.define('city', { countryCode: Sequelize.STRING });
const Country = sequelize.define('country', { isoCode: Sequelize.STRING });

// Here we can connect countries and cities base on country code
Country.hasMany(City, { foreignKey: 'countryCode', sourceKey: 'isoCode' });
City.belongsTo(Country, { foreignKey: 'countryCode', targetKey: 'isoCode' });
```

Managed transaction (auto-callback)

```
return sequelize.transaction(function (t) {  
  
    // chain all your queries here. make sure you return them.  
    return User.create({  
        firstName: 'Abraham',  
        lastName: 'Lincoln'  
    }, {transaction: t}).then(function (user) {  
        return user.setShooter({  
            firstName: 'John',  
            lastName: 'Boothe'  
        }, {transaction: t});  
    });  
  
}).then(function (result) {  
    // Transaction has been committed  
    // result is whatever the result of the promise chain returned to the transaction callback  
}).catch(function (err) {  
    // Transaction has been rolled back  
    // err is whatever rejected the promise chain returned to the transaction callback  
});
```

TRANSACTIONS

Concurrent/Partial transactions

```
sequelize.transaction(function (t1) {  
  return sequelize.transaction(function (t2) {  
    // Pass in the `transaction` option to define/alter the transaction they belong to.  
    return Promise.all([  
      User.create({ name: 'Bob' }, { transaction: null }),  
      User.create({ name: 'Mallory' }, { transaction: t1 }),  
      User.create({ name: 'John' }) // this would default to t2  
    ]);  
  });  
});
```

Hooks (also known as lifecycle events), are functions which are called before and after calls in sequelize are executed

```
User.hook('beforeValidate', (user, options) => {  
    user.mood = 'happy';  
});
```

```
User.addHook('afterValidate', 'someCustomName', (user, options) => {  
    return sequelize.Promise.reject(new Error("I'm afraid I can't let you do that!"));  
});
```

Only a hook with name param can be removed:

```
Book.addHook('afterCreate', 'notifyUsers', (book, options) => {  
    // ...  
});
```

```
Book.removeHook('afterCreate', 'notifyUsers');
```

CONCLUSION



Questions?





THANKS!

Herman Bilous

JANUARY 20, 2020