INFS3202/7202 – Web Information Systems

Lecture Week 4: MVC – Databases and CI Models

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Contents

Course Updates

Issue/Feedback	Change
Sharing Frequent Questions in Labs (Request via Forum Post)	• Great idea – thank you for posting • Demonstrators will add to an FAQ on the Blackboard site (just below the link to the Lab html file)
Questions regarding Database Diagram style	• Again thanks for asking via the forum • Will discuss the ERD today

What is a Relational Database Server

What is a Relational Database Server?

- **Stores Data Efficiently**:
  A database organizes and stores data in a manner that makes it easily accessible and manageable. Indexes data so that results are returned fast.

- **Multiple Related Tables**:
  It can consist of several related tables, allowing for the organization of different types of information in a structured way.

- **Scales with Needs**:
  Databases are designed to scale, meaning they can handle an increasing amount of work or data as the need grows.

- **Search, Add, Update via SQL**:
  Utilizes Structured Query Language (SQL) for searching, adding, and updating data, providing a powerful tool for managing the database.

What Database Servers are Available?

- **SQLite**: A lightweight database filesystem database. Ideal for development, small applications, and situations where simplicity and minimal setup are advantageous.
- **MySQL**: A popular open-source relational database management system known for its reliability and ease of use. It's widely used for web applications and supports a variety of programming languages.
- **PostgreSQL**: An advanced open-source relational database system, offering strong compliance to SQL standards, and known for its robustness, scalability, and support for advanced data types and functionalities.
- **MS SQL Server**: A comprehensive, enterprise-level database management system developed by Microsoft. Known for its high performance, robust security features, data integration, and analysis tools.
- **Oracle Database**: A comprehensive, enterprise-grade database solution that provides robust support for large-scale databases, complex applications, and data warehousing needs. Known for its performance, security, and scalability.

- **Local and UQCloud Options**: SQLite can be used locally, providing an easy-to-manage database environment without the need for a server. Both MySQL and PostgreSQL are available on UQCloud.

Why are Databases Essential for Web Development?

- **Data Management**:
  Databases provide a structured and efficient way to store, manage, and retrieve data, which is crucial for dynamic websites and applications.

- **User Interaction**:
  They enable personalized user experiences by storing user preferences, orders, and account information, enhancing engagement and satisfaction.

- **Scalability**:
  Databases can handle increasing amounts of data and user requests, allowing websites to grow and accommodate more traffic seamlessly.

- **Data Integrity**:
  Ensure consistency and accuracy of the data through constraints, transactions, and relational database design, minimizing errors and data duplication.

- **Security**:
  Databases offer robust security features to protect sensitive information, such as user data and financial transactions, from unauthorized access and breaches.

Web Servers vs Database Servers

- **On your UQCloud Zone the Web Server and Database are on the same server**

- **For Scalability we usually separate the Web Server and the Database**
- This just means that the database server software is installed on a separate server

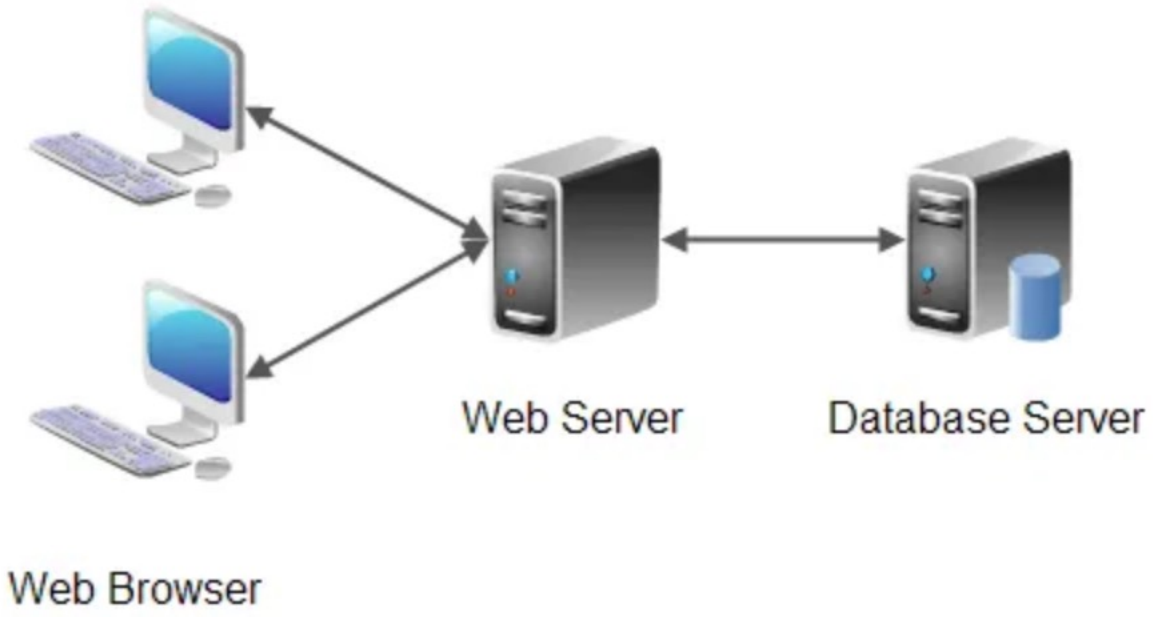


Image from: https://medium.com/@skariel3/your-db-and-web-server-belong-physically-together-b267747f4230

A Simple View of a Database

So… What exactly is inside a Relational Database Management System?

- A collection of tables or entities
- Each table is assigned a unique name
- Each table consists of a set of attributes or fields or columns
- Each attributes or field or column must have a specific data type
- Each table can store many records or rows of data
- Tables can be related via a common id

Course_id	Student_id
3202	4132335
3204	4052922

Course_list

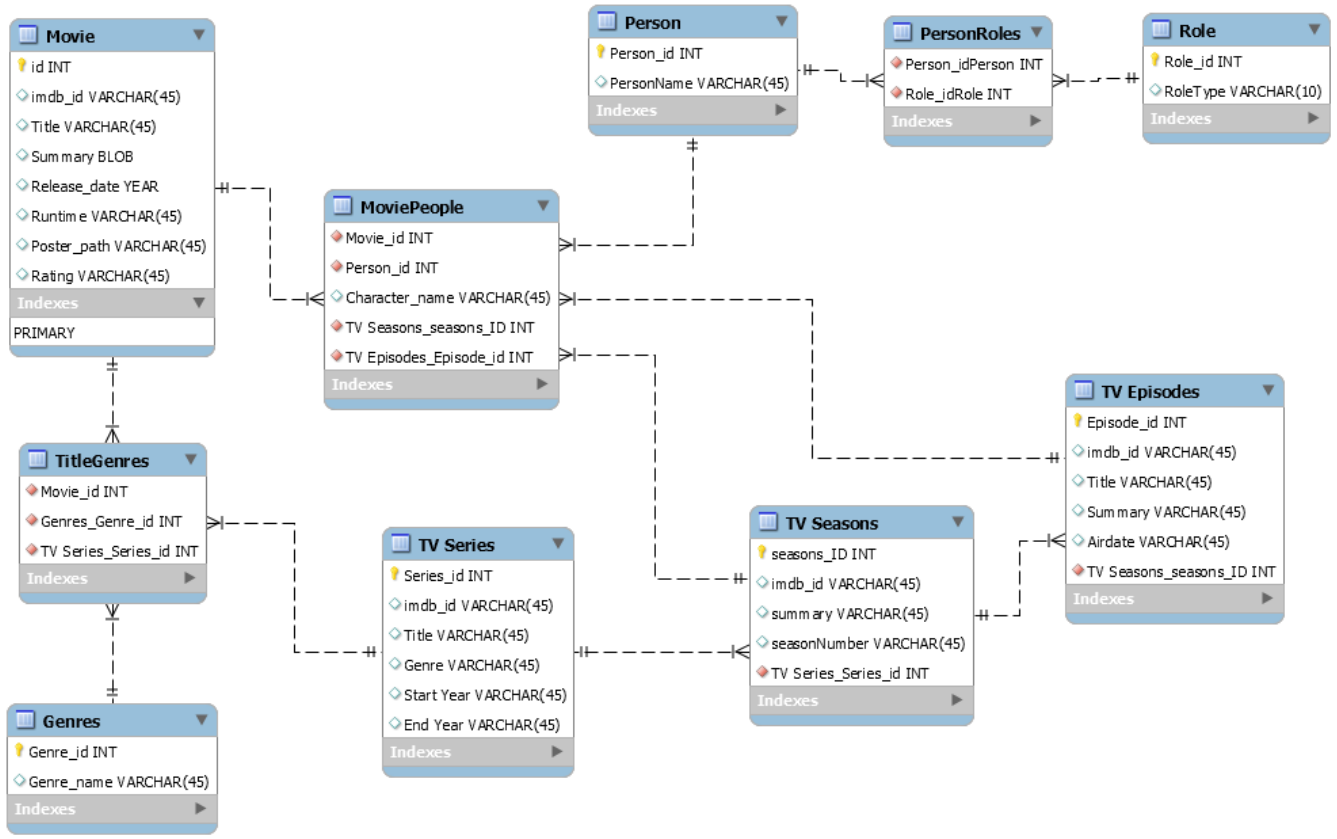
attributes

Student_id	First name	Last name
4044151	Jack	Smith
4052922	Zoe	Lee
4132335	John	Hunter

Student_list

Database Schema and Entity Relationship Diagrams (ERD)

- The database schema of a database system is its **structure** described in a formal language supported by the database management system (DBMS).
- The term "schema" refers to the organization of data as a **blueprint** of how the database is constructed (divided into database tables in the case of relational databases).
- An ERD is used to visually display tables and their relationships



https://stackoverflow.com/questions/45135485/creating-a-database-schema-from-the-movie-database

You are required to create an ERD for the Design Document Assessment

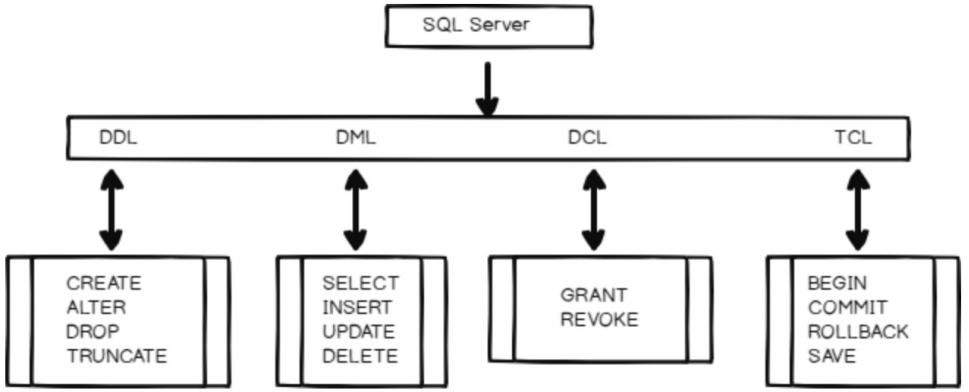
Structured Query Language (SQL)

What is SQL?

- **Structured Query Language**:
  SQL stands for Structured Query Language, a standardized programming language specifically designed for managing and manipulating relational databases.

- **Data Operations**:
  It is used to perform various data operations such as querying, inserting, updating, and deleting data within a database.

- **Database Schema Creation and Modification**:
  SQL is also used for creating and modifying the structure of database systems, including tables, schemas, and indexes.



https://www.sqlshack.com/what-is-sql-in-sql-server/

The Structured Query Language (SQL)

- **D**ata **D**efinition **L**anguage (**DDL**) - Defines and modifies a schema e.g. CREATE / DROP / ALTER **table**; does not manipulate data

- **D**ata **M**anipulation **L**anguage (**DML**) - Language used to retrieve (SELECT), add (INSERT), modify (UPDATE) and DELETE **data**

- **D**ata **C**ontrol **L**anguage (**DCL**) statements. Used for providing (GRANT) / withdrawing (REVOKE) **access privileges**

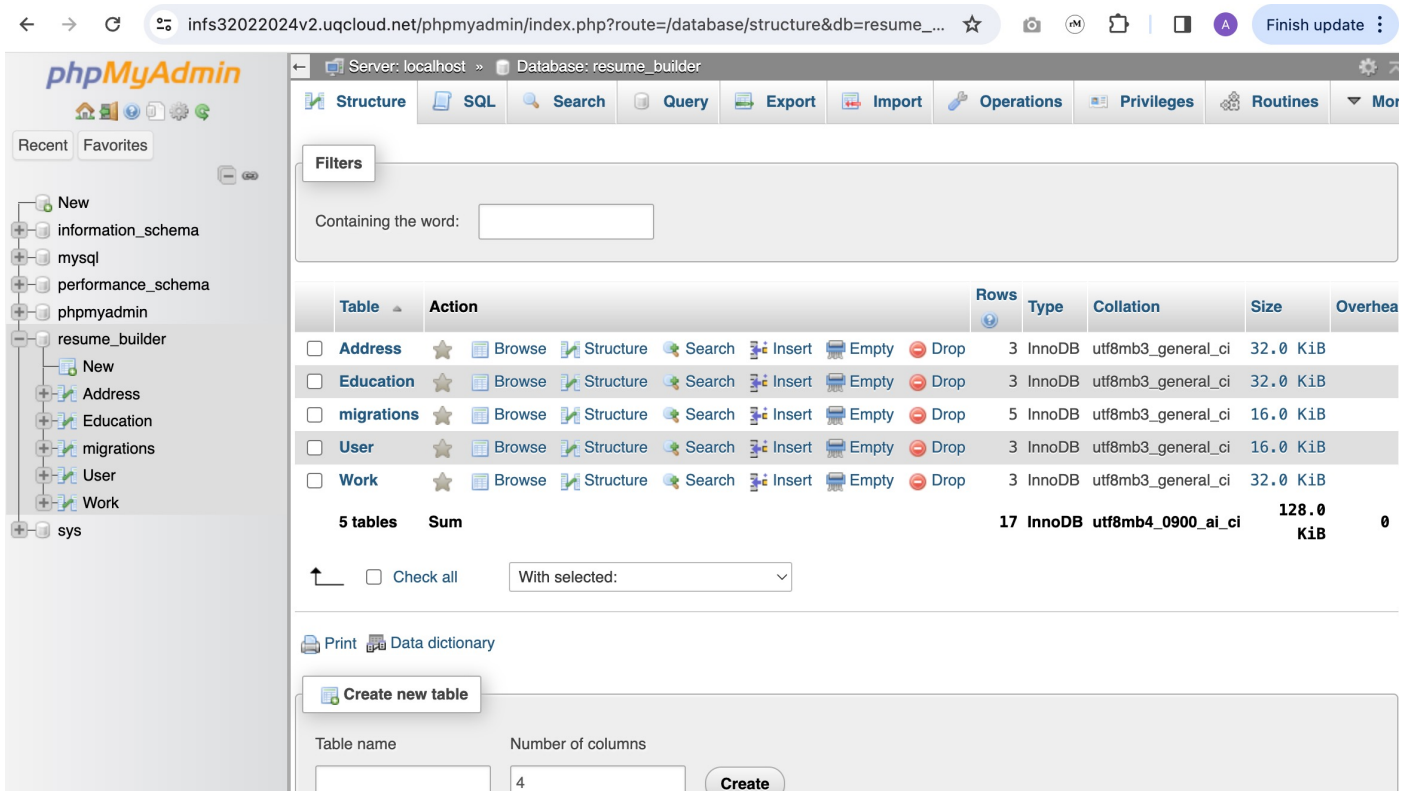
- **T**ransaction **C**ontrol **L**anguage (**TCL**) statements are used to manage the changes made by DML statements. It allows statements to be grouped together into **logical transactions**. Example: COMMIT, ROLLBACK, etc.

Running SQL

- Multiple ways to run SQL
  - Use a GUI tool
    e.g. PHPMyAdmin
  - Use a command line tool
    e.g. MySQL command line
  - Use a CodeIgniter Migration
    (In this course we'll mainly focus on using Migrations but it is good to see how the create statement works)

Using PHPMyAdmin on UQCloud

- Main steps
  - Setup the mysql service
    - `sudo webprojctl enable mysql`
  - Go to https://youruqzoneurl/phpmyadmin



- Provides a good first place to:
  - Create a database
  - Create tables
  - Run SQL select statements

Using PHPMyAdmin on UQCloud

- We will now setup a database with 2 related tables and run some queries using PHPMyAdmin

Table 1: `customers`

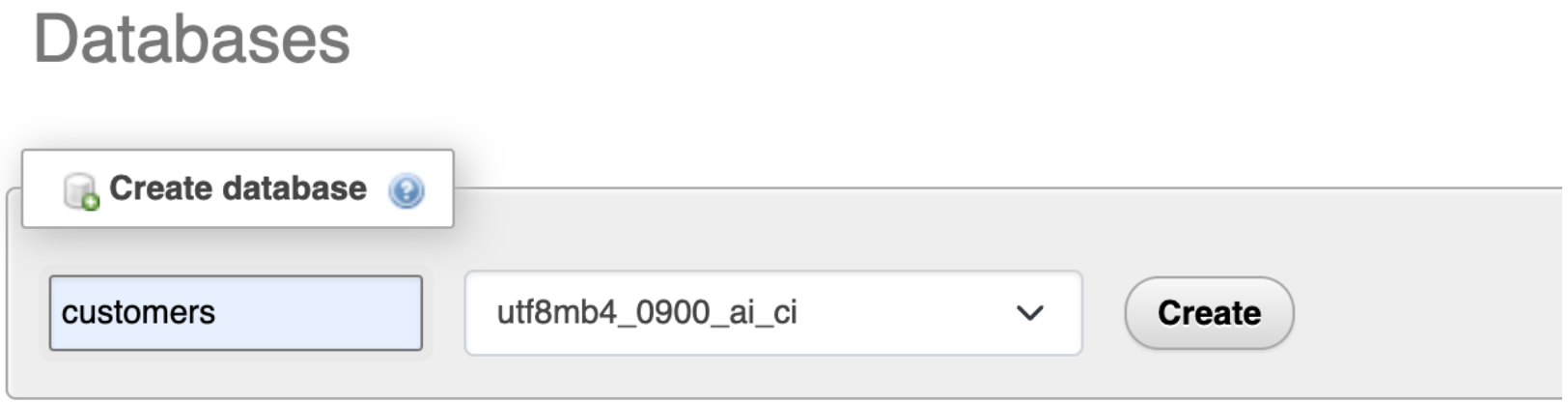
Field Name	Data Type
id	INT
name	VARCHAR(255)
email	VARCHAR(255)

Table 2: `orders`

Field Name	Data Type
id	INT
customer_id	INT
order_date	DATE
total_amount	DECIMAL(10,2)

Creating the Database

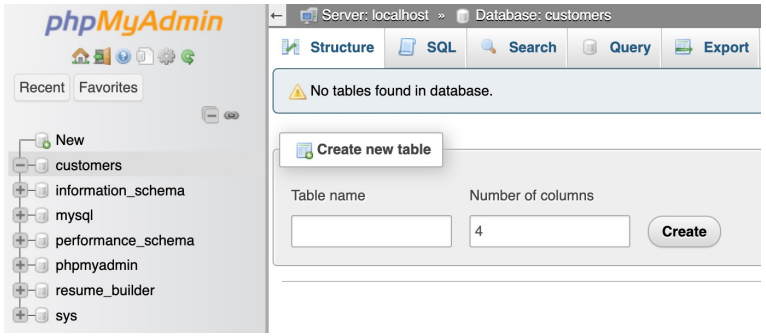
- You can create a database via the GUI
- Enter the name of the database and choose the charset



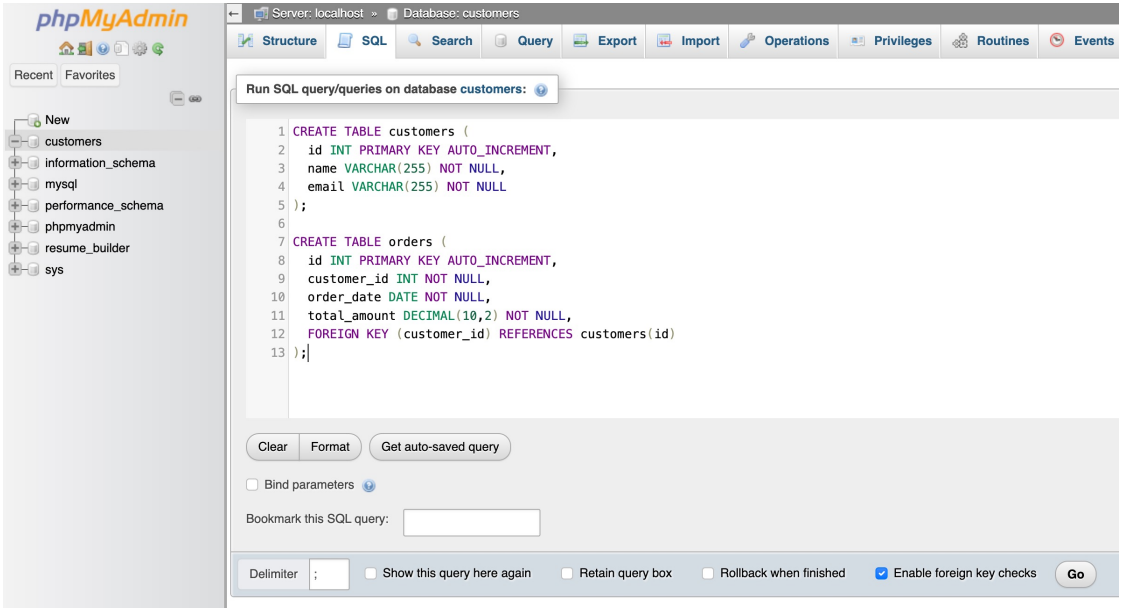
- In Lab 3, you'll learn how to use the command line to create a new database.

Creating the Tables

- You can create a table and add columns via the GUI



- OR
- Use the SQL Create Statement



Code in week4_code/sql/create_table.sql

The PHPMyAdmin - Designer

- You can also use the Designer to create tables and relationships
- An ERD is automatically created

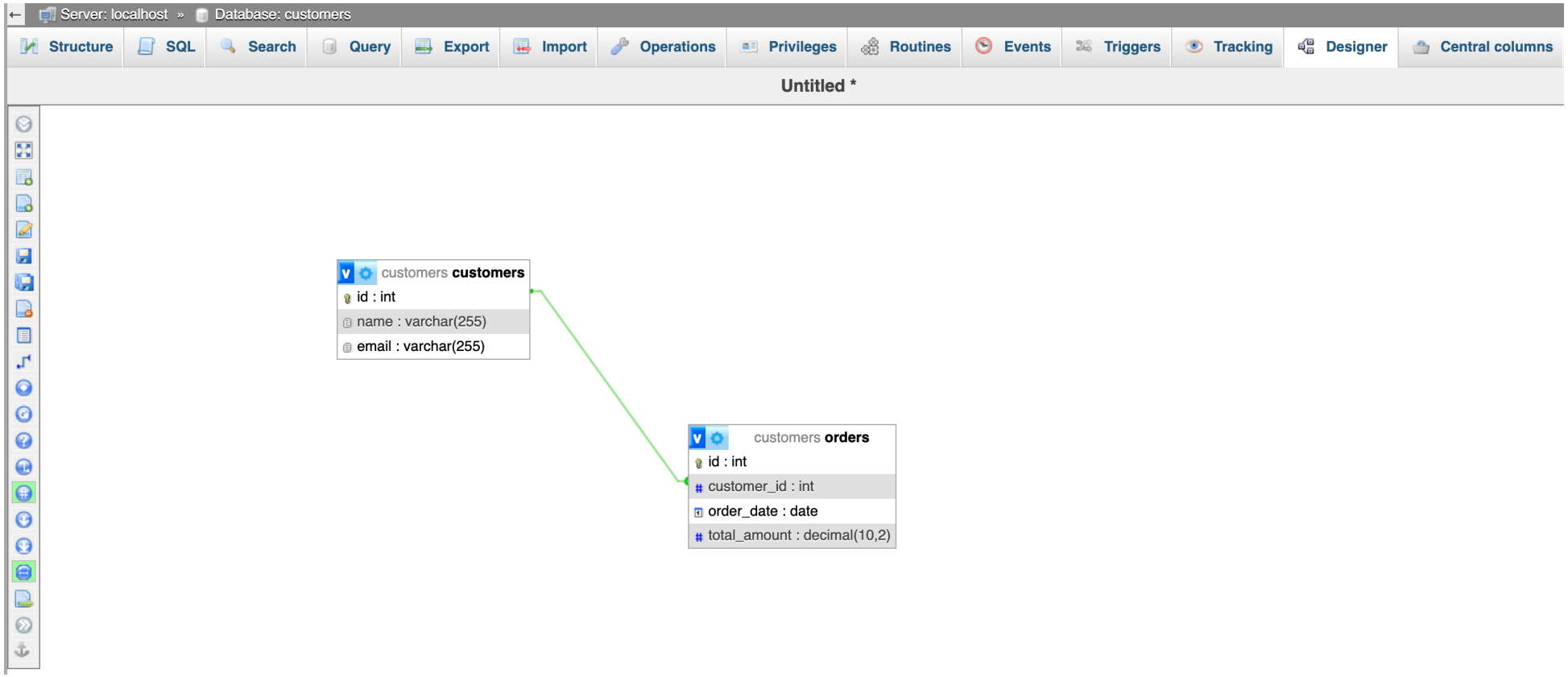


Table Datatypes in MySQL

CHAR (n) **– holds a fixed length string**

- the length must be n

VARCHAR (n) – holds a variable length string

- the maximum size is n

BLOB – binary large object

- Images, audio or other multimedia objects

DATE

- Format: YYYY-MM-DD

TIME

- Format: HH:MM:SS

TIMESTAMP

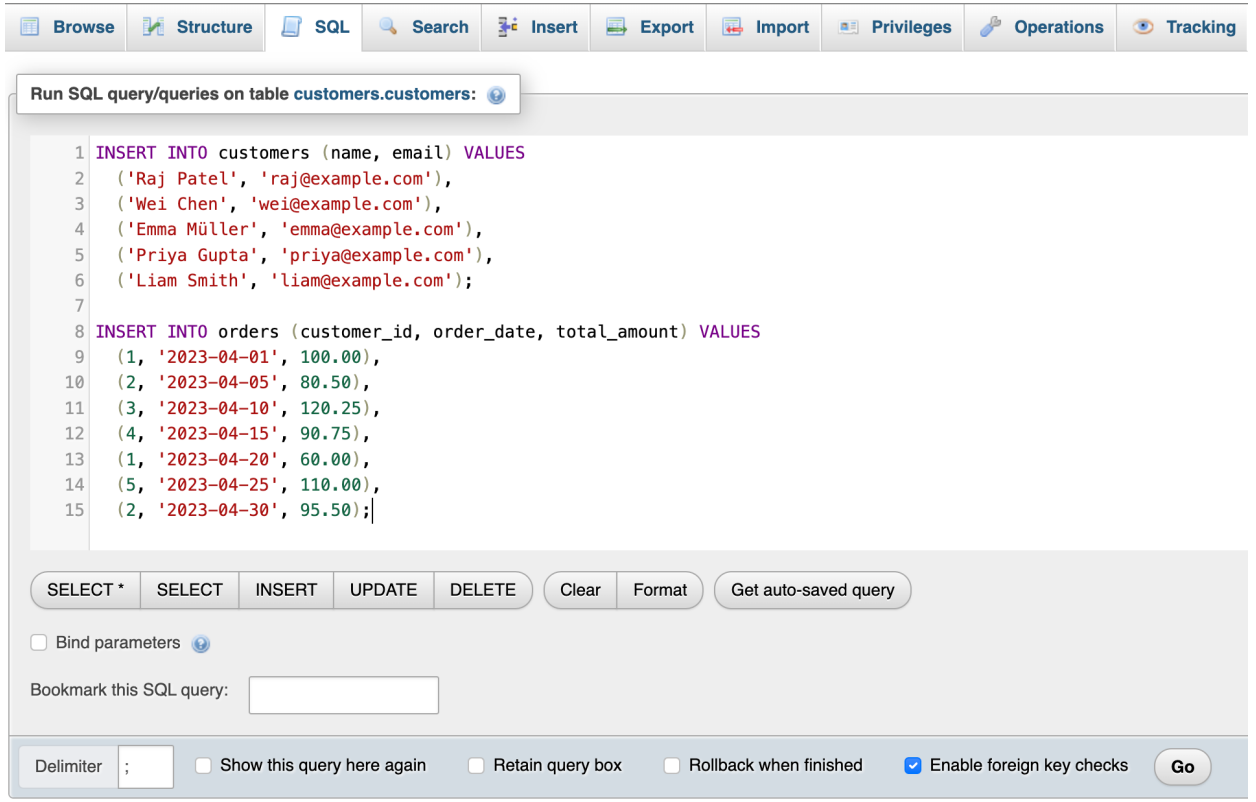
- Format: YYYY-MM-DD HH:MM:SS
- The supported range is from '1970-01-01 00:00:01' UTC to '2038-01-09 03:14:07' UTC
- Automatically set itself to the current date and time, in an INSERT or UPDATE query

Insert Records into a Database

Syntax

Insert into *TableName* values (*value1*, *value2*, …)

Insert into *TableName* (*attribute1*, *attribute2*, …) values (*value1*, *value2*, …)



Code in week4_code/sql/create_table.sql

Check that the Records have been added

Customers Table

	id	name	email
Edit Copy Delete	1	Raj Patel	raj@example.com
Edit Copy Delete	2	Wei Chen	wei@example.com
Edit Copy Delete	3	Emma Müller	emma@example.com
Edit Copy Delete	4	Priya Gupta	priya@example.com
Edit Copy Delete	5	Liam Smith	liam@example.com

Check all *With selected:* Edit Copy Delete Export

Orders Table

	id	customer_id	order_date	total_amount
Edit Copy Delete	1	1	2023-04-01	100.00
Edit Copy Delete	2	2	2023-04-05	80.50
Edit Copy Delete	3	3	2023-04-10	120.25
Edit Copy Delete	4	4	2023-04-15	90.75
Edit Copy Delete	5	1	2023-04-20	60.00
Edit Copy Delete	6	5	2023-04-25	110.00
Edit Copy Delete	7	2	2023-04-30	95.50

Check all *With selected:* Edit Copy Delete Export

Retrieving Data from a Table

Syntax

Select *fields* **from** *TableName* **where** *condition*

Some examples:

SELECT * FROM customers;

SELECT name, email FROM customers;

SELECT * FROM customers WHERE id = 3;

SELECT * FROM customers WHERE email LIKE '%Chen%';

SELECT COUNT(name) FROM customers WHERE name LIKE '%P%';

SELECT * FROM customers WHERE email LIKE '%example.com';

Note:

The **WHERE** clause is used to extract only those records that fulfil a specified criterion.

The **LIKE** pattern matching operator can also be used in the conditional selection of the where clause.

"%" can be used as a wild card to match any possible character

SQL to Join Tables

Syntax

SELECT column1, column2, ...

FROM table1

JOIN table2 ON table1.column = table2.column;

Get all orders for each customer

```
SELECT o.id AS order_id, o.order_date, o.total_amount, c.name, c.email
FROM orders o JOIN customers c ON o.customer_id = c.id;
```

order_id	order_date	total_amount	name	email
1	2023-04-01	100.00	Raj Patel	raj@example.com
5	2023-04-20	60.00	Raj Patel	raj@example.com
2	2023-04-05	80.50	Wei Chen	wei@example.com
7	2023-04-30	95.50	Wei Chen	wei@example.com
3	2023-04-10	120.25	Emma Müller	emma@example.com
4	2023-04-15	90.75	Priya Gupta	priya@example.com
6	2023-04-25	110.00	Liam Smith	liam@example.com

SQL to Join Tables

Get orders for a specific customer by ID

```
SELECT o.id AS order_id, o.order_date, o.total_amount, c.name, c.email
FROM orders o
JOIN customers c ON o.customer_id = c.id
WHERE c.id = 2;
```

order_id	order_date	total_amount	name	email
2	2023-04-05	80.50	Wei Chen	wei@example.com
7	2023-04-30	95.50	Wei Chen	wei@example.com

Retrieving Data from a Table

A bit more…

ORDER BY: to sort the result-set

```
SELECT column_name(s)
FROM table_name
ORDER BY column_name(s) ASC|DESC
```

SQL uses single quotes around text values; Numeric values should not be enclosed in quotes.

```
SELECT * FROM customers WHERE Name='Emma'
SELECT * FROM customers WHERE Name=Emma
```

AND & OR Operator

```
SELECT * FROM customers
WHERE Name='Emma' AND id > 2
```

Deleting Data

Syntax

```
DELETE FROM table_name
WHERE some_column=some_value
```

```
DELETE FROM customers
WHERE name='Mary'
```

Notes:

Delete all rows in a table without deleting the table

```
DELETE FROM table_name
or
DELETE * FROM table_name
```

The table structure, attributes, and indexes will be intact

Update Records in a Table

Syntax

```
UPDATE table_name
SET column1=value,
column2=value2,...
WHERE some_column=some_value
```

```
UPDATE StudentRecord
SET Name='Jack'
WHERE studentID = '1234'
```

Warning!

Result?

```
UPDATE customers
SET Name='Jack'
```

Always include a WHERE clause

Alter Table

Syntax

Add a column in a table

```
ALTER TABLE table_name
ADD column_name datatype
```

```
ALTER TABLE customers
ADD Country varchar(20)
```

Change the data type of a column in a table

```
ALTER TABLE table_name
ALTER COLUMN column_name datatype
```

```
ALTER TABLE customers
ALTER COLUMN birthday year
```

Delete a column

```
ALTER TABLE table_name
DROP COLUMN column_name
```

```
ALTER TABLE customers
DROP COLUMN DriverL
```

Drop Table

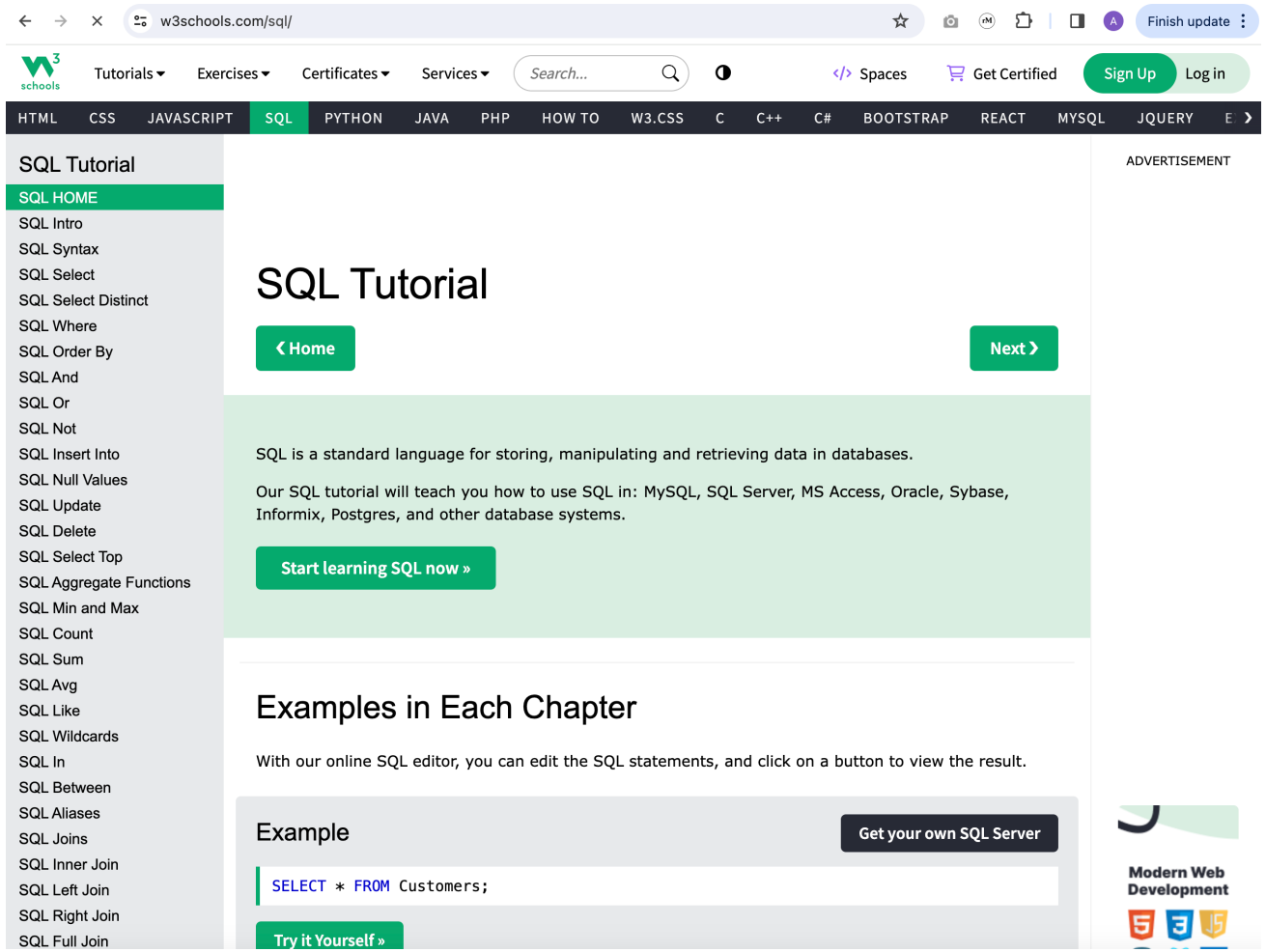
Syntax

Drop a table (or Remove)

```
DROP TABLE table_name
```

```
DROP TABLE customers
```

SQL Reference



https://www.w3schools.com/sql/

CodeIgniter – How does it help with Data Access?

- Using a Web Framework should make your life as a developer easier
- A Framework will include a number of abstractions to help you write code to interact with a database

- CodeIgniter 4 has numerous features:
  - Central config file (.env) to store database connections
  - Migrations to help you create tables and have database version control
  - Models to simplify reading, inserting, updating and deleting content from a database table (just use simple objects instead of using SQL)
  - The Spark command line to help you create Migration files and new model files.
  - Very competitive with other frameworks (e.g. Django)

Adding Database Config in CodeIgniter 4

Add database details to the .env file

- Main steps on UQCloud
  - Setup the mysql service
    - `sudo webprojctl enable mysql`
  - Get MySQL Password
    - `sudo mdata-get mysql_pw`
  - Setup in CodeIgniter .env file
  - Remember to uncomment by removing the #

cidemo > .env

```
8   # By default, all of the settings are commented out. If you want
9   # to override the setting, you must un-comment it by removing the '#'
10  # at the beginning of the line.
11  #--------------------------------------------------------------------
12
13  #--------------------------------------------------------------------
14  # ENVIRONMENT
15  #--------------------------------------------------------------------
16
17  CI_ENVIRONMENT = development
18
19  #--------------------------------------------------------------------
20  # APP
21  #--------------------------------------------------------------------
22
23  app.baseURL = 'https://infs32022024v2.uqcloud.net/cidemo/'
24  # If you have trouble with `.`, you could also use `_`.
25  # app_baseURL = ''
26  # app.forceGlobalSecureRequests = false
27  # app.CSPEnabled = false
28
29  #--------------------------------------------------------------------
30  # DATABASE
31  #--------------------------------------------------------------------
32
33  database.default.hostname = localhost
34  database.default.database = resume_builder
35  database.default.username = yourusername
36  database.default.password = yourdbserverpassword
37  database.default.DBDriver = MySQLi
38  # database.default.DBPrefix =
39  database.default.port = 3306
40
```

Creating Migrations in CodeIgniter 4

What is a Migration?

- **Versioned Database Schemas**:
  Migrations in CodeIgniter 4 provide a method for version controlling your database schema. This allows for easy management of database changes over time.

- **Automated Database Changes**:
  They automate the process of applying database changes, such as creating or altering tables, adding indexes, and more, ensuring consistency across different environments.

- **Simplifies Development and Deployment Workflow**:
  Migrations simplify the development workflow by allowing team members to share and apply database changes in a controlled and systematic manner. Easy to deploy the schema of a database

- **Programmatic Schema Manipulation**:
  Migrations are PHP classes that contain methods to programmatically execute database operations, giving developers a powerful tool to manipulate the schema.

CodeIgniter – What is spark?

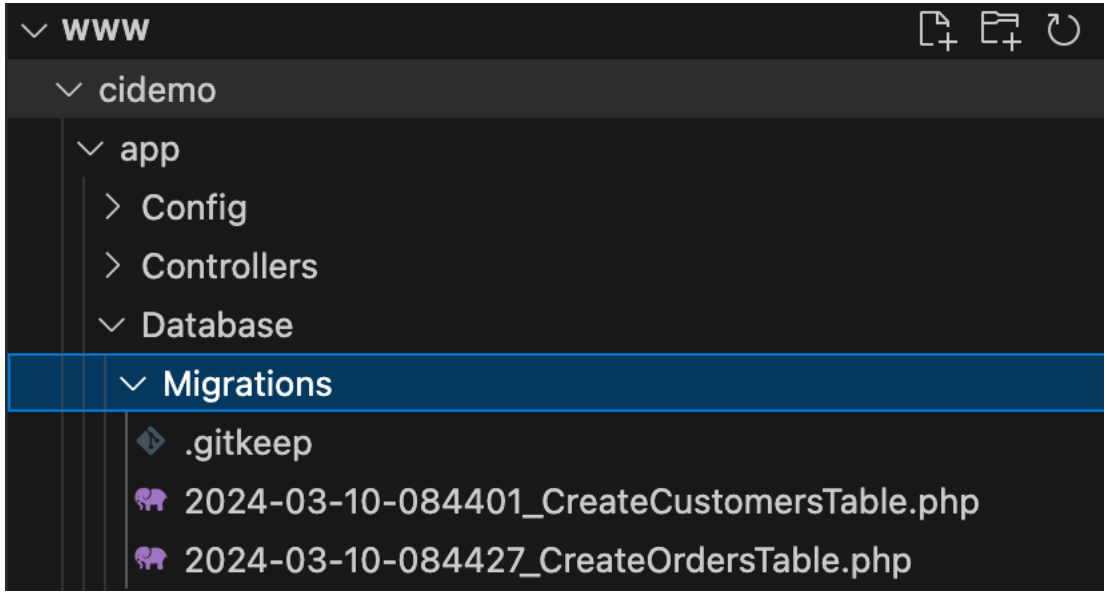
- In CodeIgniter 4, “spark” is a command-line tool that facilitates the development and management of CodeIgniter applications.
  - Running database migrations and seeders to manage database schema and initial data setup
  - Starting a development web server
  - Generating boilerplate code (new files) for new controllers, models, and other components.
  - Listing routes, displaying current environment settings, and more, providing insights into the application configuration

```
uqabakh1@uqabakh1-9893 codeignitertest % php spark

CodeIgniter v4.4.4 Command Line Tool - Server Time: 2024-03-02 09:04:45 UTC+00:00

Cache
  cache:clear          Clears the current system caches.
  cache:info           Shows file cache information in the current system.

CodeIgniter
  env                  Retrieves the current environment, or set a new one.
  filter:check         Check filters for a route.
  help                 Displays basic usage information.
  list                 Lists the available commands.
  namespaces           Verifies your namespaces are setup correctly.
  publish              Discovers and executes all predefined Publisher classes.
  routes               Displays all routes.
  serve                Launches the CodeIgniter PHP-Development Server.

Database
  db:create            Create a new database schema.
  db:seed              Runs the specified seeder to populate known data into the database.
  db:table             Retrieves information on the selected table.
  migrate              Locates and runs all new migrations against the database.
  migrate:refresh      Does a rollback followed by a latest to refresh the current state of the database.
  migrate:rollback     Runs the "down" method for all migrations in the last batch.
  migrate:status       Displays a list of all migrations and whether they've been run or not.

Encryption
  key:generate         Generates a new encryption key and writes it in an `.env` file.

Generators
  make:cell            Generates a new Controlled Cell file and its view.
  make:command         Generates a new spark command.
  make:config          Generates a new config file.
  make:controller      Generates a new controller file.
  make:entity          Generates a new entity file.
  make:filter          Generates a new filter file.
  make:migration       Generates a new migration file.
  make:model           Generates a new model file.
  make:scaffold        Generates a complete set of scaffold files.
  make:seeder          Generates a new seeder file.
  make:validation      Generates a new validation file.
  migrate:create       [DEPRECATED] Creates a new migration file. Please use "make:migration" instead.
  session:migration    [DEPRECATED] Generates the migration file for database sessions, Please use  "make:migration --session"
                       instead.

Housekeeping
  debugbar:clear       Clears all debugbar JSON files.
  logs:clear           Clears all log files.
```

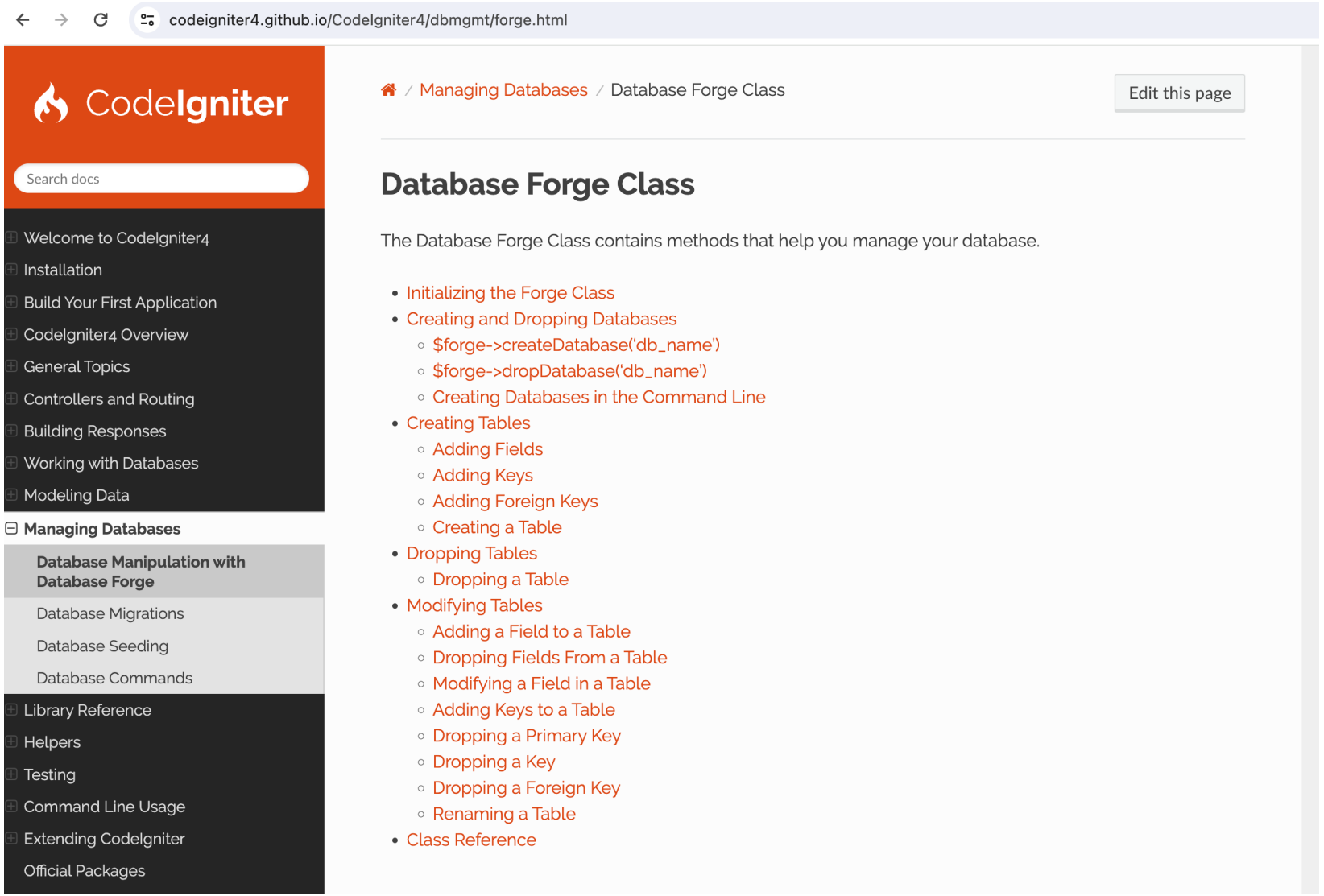
Create a Migration

- Use the spark make:migration command
  - `php spark make:migration create_customers_table`
  - `php spark make:migration create_orders_table`

- This will create a new file in the app/Databases/Migrations folder
  - The file will have a data time stamp and be versioned
  - You need to add the fields that need to be created in the table
    - The up() method defines the schema for creating the tables.
    - The down() method defines the schema for dropping the tables.



Create a Migration – The Forge Class



- Reference for making field types

https://codeigniter4.github.io/CodeIgniter4/dbmgmt/forge.html

Create a Migration – The Customers Table

- Fields for the Customers Table

cidemo > app > Database > Migrations > 2024-03-10-084401_CreateCustomersTable.php

```php
<?php

namespace App\Database\Migrations;

use CodeIgniter\Database\Migration;

class CreateCustomersTable extends Migration
{
    public function up()
    {
        $this->forge->addField([
            'id' => [
                'type' => 'INT',
                'constraint' => 11,
                'unsigned' => true,
                'auto_increment' => true,
            ],
            'name' => [
                'type' => 'VARCHAR',
                'constraint' => 255,
            ],
            'email' => [
                'type' => 'VARCHAR',
                'constraint' => 255,
            ],
        ]);
        $this->forge->addKey('id', true);
        $this->forge->createTable('customers');
    }

    public function down()
    {
        $this->forge->dropTable('customers');
    }
}

```

Code in week4_code/migrations/create_customers_table.php

Create a Migration – The Orders Table

- Fields for the Orders Table

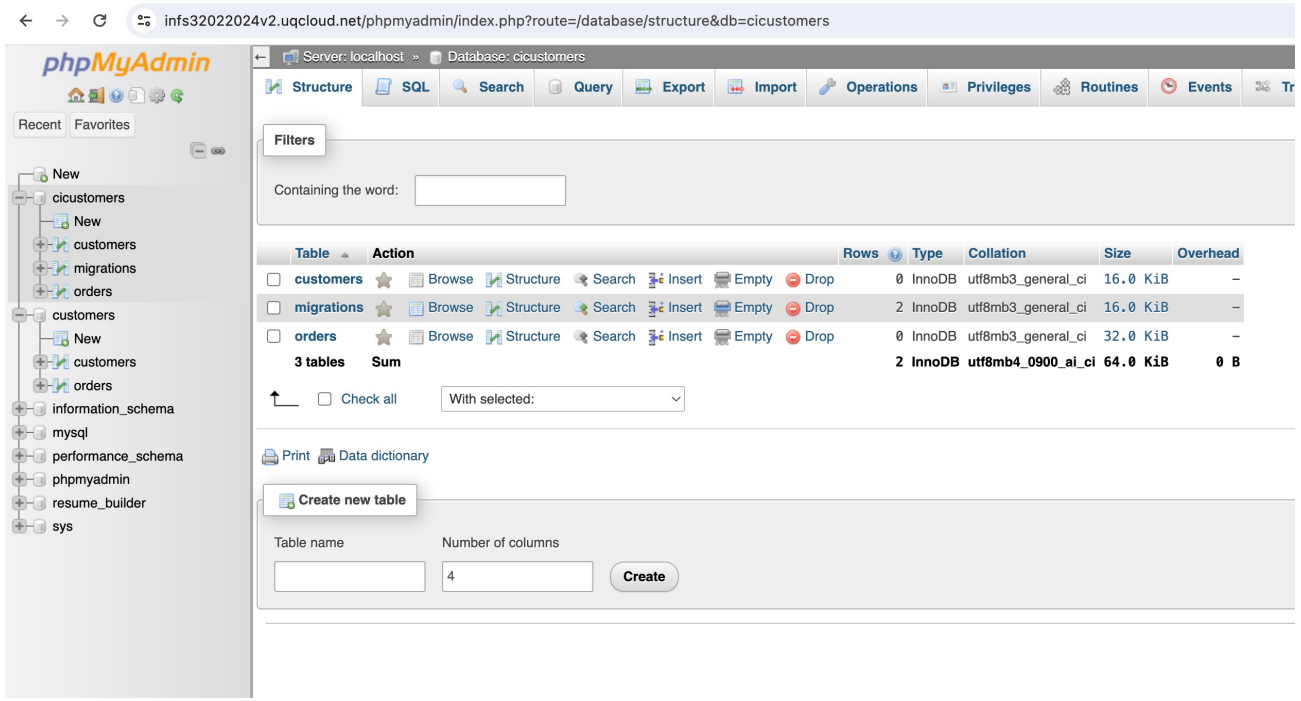
cidemo > app > Database > Migrations > 2024-03-10-084427_CreateOrdersTable.php

```php
<?php

namespace App\Database\Migrations;

use CodeIgniter\Database\Migration;

class CreateOrdersTable extends Migration
{
    public function up()
    {
        $this->forge->addField([
            'id' => [
                'type' => 'INT',
                'constraint' => 11,
                'unsigned' => true,
                'auto_increment' => true,
            ],
            'customer_id' => [
                'type' => 'INT',
                'constraint' => 11,
                'unsigned' => true,
            ],
            'order_date' => [
                'type' => 'DATE',
            ],
            'total_amount' => [
                'type' => 'DECIMAL',
                'constraint' => '10,2',
            ],
        ]);
        $this->forge->addKey('id', true);
        $this->forge->addForeignKey('customer_id', 'customers', 'id', 'CASCADE', 'CASCADE');
        $this->forge->createTable('orders');
    }

    public function down()
    {
        $this->forge->dropTable('orders');
    }
}
```

Code in week4_code/migrations/create_orders_table.php

Run the Migration

- Use Spark to run the Migrations
  - `php spark migrate`
  - This will run and execute create table sql specific for your database.
- Use PHPMyAdmin to check that the tables have been created
- There will also be a Migrations table. This is where the versioning of the migrations are stored.
- In Lab 3 you will learn how to use migrations to add data, but in the demo we'll run out insert
- statements.

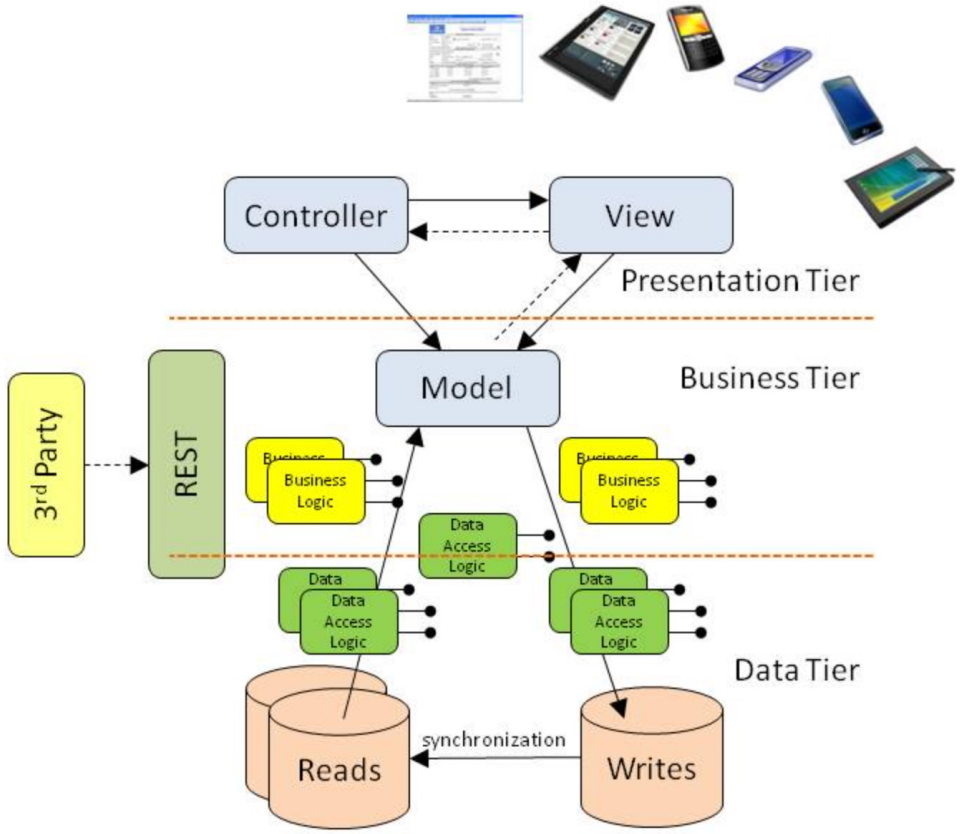


How does this help developer workflow?

- A few scenarios
  - You develop locally and then deploy to production:
    - You can just run the migration when you deploy and update your application
  - You have multiple developers
    - When a database change is made, the code for the change is committed to the code repository
    - Other developers can then run the migration to update their local databases
  - You release open source software
    - The same migration code and create SQL create and modify statements for multiple databases
    - Each developer that downloads your software can choose their own database server (e.g. Postgres) and not worry about conflicts

CodeIgniter Models

Model View Controller (MVC)

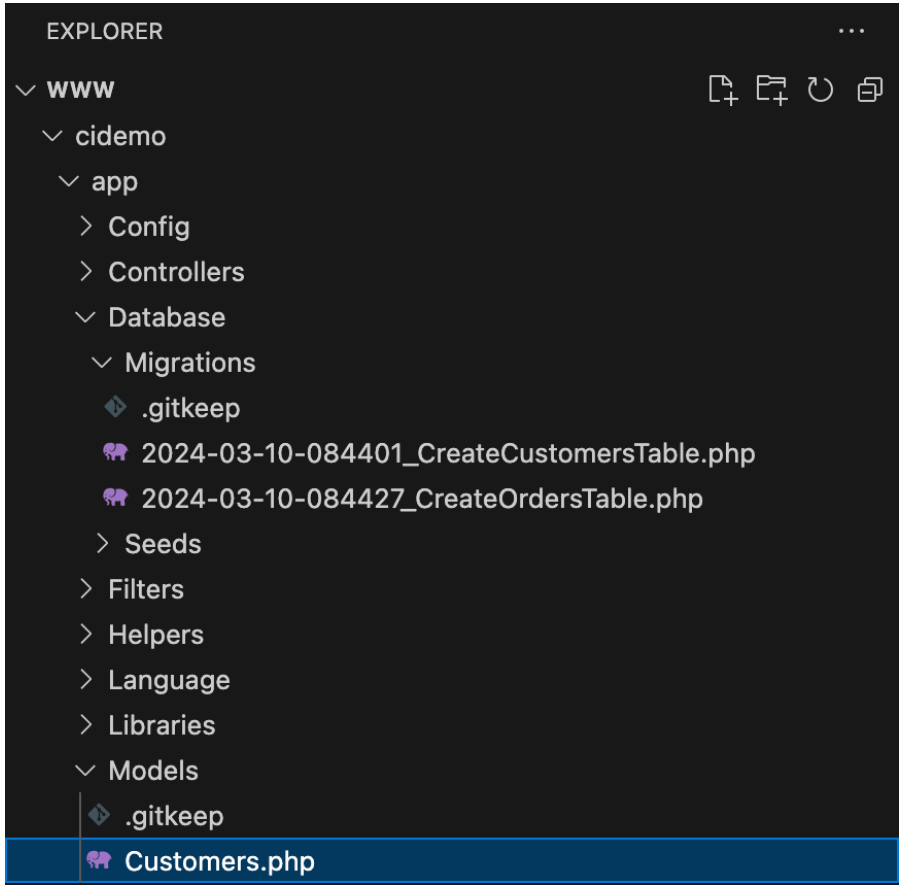


The MVC pattern is a specialized form of 3-layer architecture, making it highly relevant to modern web development practices

Image from https://en.wikiversity.org/wiki/Three-Tier_Architecture#/media/File:MVC3tierArchitecture.jpg

CodeIgniter Models

- **The CodeIgniter's Model offers convenient features and additional functionality to make working with a single table in the database easier.**
  - automatic database connection;
  - basic Create Read Update Delete methods;
  - in-model validation;
  - automatic pagination;
  - and more
- Models in CodeIgniter 4 are stored in the app/Models directory
- Use Spark to create a new model file e.g.
  `php spark make:model Customers`
- A new file called Customers.php is placed in app/Models
- To access models within your classes, you can create a new instance or use the model() helper function.



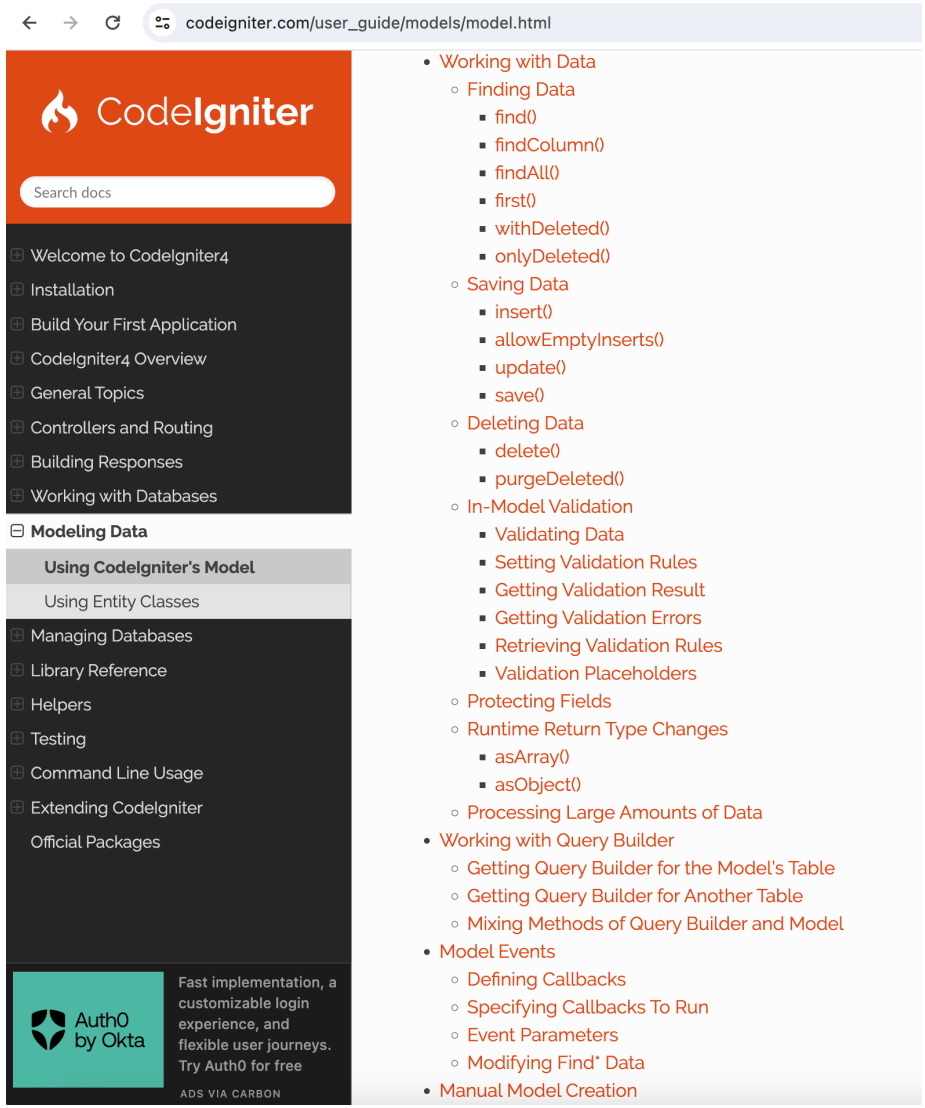
Creating a Model Class

- **Model Configuration: The model class provides configuration options to facilitate the smooth functioning of its methods.**
  - **$table**: Specifies the database table that this model primarily works with.
  - **$primaryKey**: Specifies the name of the column that uniquely identifies the records in this table.
  - **$useAutoIncrement**: Specifies if the table uses an auto-increment feature for $primaryKey.
  - **$returnType**: This setting allows you to define the type of data that is returned.
  - **$allowedFields**: This array should be updated with the field names that can be set during save(), insert(), or update() methods. A

cidemo > app > Models > Customers.php

```php
<?php

namespace App\Models;

use CodeIgniter\Model;

class Customers extends Model
{
    protected $table            = 'customers';
    protected $primaryKey       = 'id';
    protected $useAutoIncrement = true;
    protected $returnType       = 'array';
    protected $useSoftDeletes   = false;
    protected $protectFields    = true;
    protected $allowedFields    = [];

}
```

Models use Object Oriented Syntax



https://codeigniter.com/user_guide/models/model.html

Models use Object Oriented Syntax

To support Create, Read, Update, Delete operations, several functions are provided:

- **Finding data:**
  - find(): returns a single row given a primary key

```
$user = $userModel->find($user_id);
//You can specify more than one row to return
//by passing an array of primaryKey values instead of just one:
$users = $userModel->find([1, 2, 3]);
```

  - findColumn()
  - findAll()
  - …

```
$user = $userModel->findColumn($column_name);
$users = $userModel->findAll();
```

Models use Object Oriented Syntax

To support Create, Read, Update, Delete operations, several functions are provided:

- **Saving data:**
  - insert(): inserts multiple rows of data

```php
$data = [
    'username' => 'darth',
    'email'    => 'd.vader@theempire.com',
];
// Inserts data and returns inserted row's primary key
$userModel->insert($data);

// Inserts data and returns true on success and false on failure
$userModel->insert($data, false);

// Returns inserted row's primary key
$userModel->getInsertID();

}
```

The first parameter is an associative array of data to create a new row of data in the database. If an object is passed instead of an array, it will attempt to convert it to an array.

The second parameter is an optional boolean type. If set to false, the method will return a boolean value that indicates the success or failure of the query.

Models use Object Oriented Syntax

To support Create, Read, Update, Delete operations, several functions are provided:

- **Saving data:**
  - save(): automatically handles **inserting** or **updating** a record based on whether it finds an array key matching the primary key value.

```php
<?php
// Defined as a model property
$primaryKey = 'id';
// Does an insert()
$data = [
    'username' => 'sen',
    'email'    => 'sen.wang@uq.edu.au',
];

$userModel->save($data);

// Performs an update, since the primary key, 'id', is found.
$data = [
    'id'       => 3,
    'username' => 'tom',
    'email'    => 'tom.zhang@uq.edu.au',
];
$userModel->save($data);
```

Question: What if the ”id” =3 for username=“sen”?

Models use Object Oriented Syntax

To support Create, Read, Update, Delete operations, several functions are provided:

- **Saving data:**
  - update(): updates an existing record in the database. Must specify the primary key.

```php
$data = [
    'username' => 'sen',
    'email'    => 'sen.wang@uq.edu.au',
];

$userModel->update($id, $data);
```

  - Can update multiple records, give

```php
$data = [
    'fulltime' => 1,
];

$userModel->update([1, 2, 3], $data);
```

Models use Object Oriented Syntax

To support Create, Read, Update, Delete operations, several functions are provided:

- **Deleting data:**
  - delete(): Takes a primary key value(s) as the first parameter and deletes the matching record from the model's table.

```
$userModel->delete(10);
$userModel->delete([1, 2, 3]);
```

  - purgeDeleted(): Cleans out the database table by permanently removing all rows that have 'deleted_at IS NOT NULL'.

```
$userModel->purgeDeleted();
```

Raw SQL & QueryBuilder Class

- We can use query() function to pass in real SQL scripts as a parameter.

```
$db = db_connect();
$db->query('SELECT * FROM STUDENTS');
```

- Builder can help you generate the raw SQL scripts, which will be sent to query().
- To load the Query Builder, use the **table()** method on the database connection.
- It's important to note that the Query Builder needs to be explicitly loaded if you require.
- Get Data(i.e. SELECT *): **$builder->get()**

Raw SQL – Use QueryBuilder Class

- **From:** $builder->from('table')

```
$builder = $db->table('users');
$builder->select('username, id, coursename');
$builder->from('courses');
$query = $builder->get();
// Produces: SELECT title, content, date FROM users, courses
```

- **Join:** $builder->join()

```
$builder = $db->table('users');
$builder->select('username, id, coursename');
$builder->join('course_enrolment','users.id = course_enrolment.id')
$query = $builder->get();
// Produces: SELECT username, id, coursename JOIN course_enrolment ON
// users.id = course_enrolment.id
```

Raw SQL – Use QueryBuilder Class

- **CodeIgniter Model has one instance of the Query Builder for that model's database connection. You can get access to the shared instance of the Query Builder any time you need it:**

```
$builder = $userModel->builder();
```

- **Once you get the Query Builder instance, you can call methods of the Query Builder. However, since Query Builder is not a Model, you cannot call methods of the Model.**

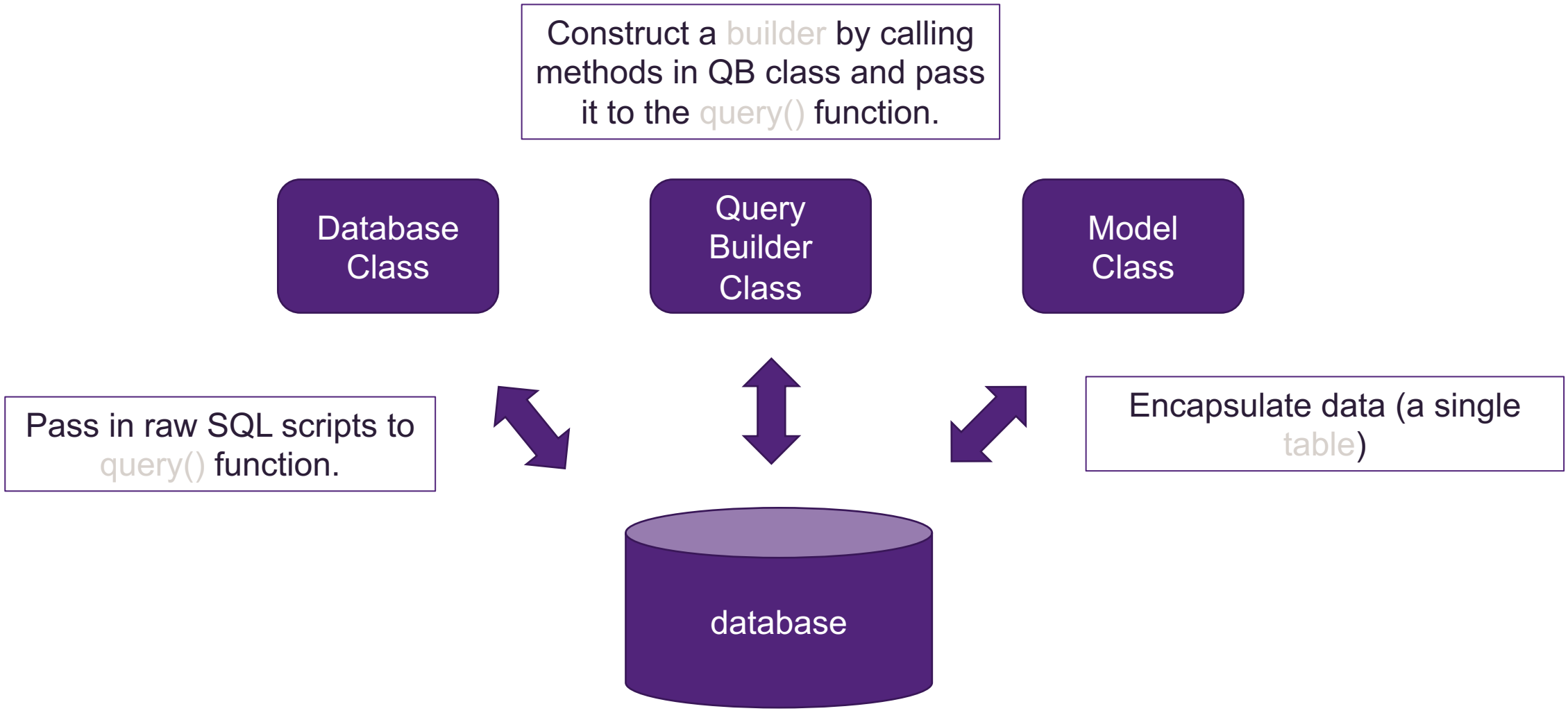
```
$customerBuilder = $userModel->builder('customers');
```

- **You can also use Query Builder methods and the Model's CRUD methods in the same chained call, allowing for very elegant use:**

```
$users = $userModel->where('status', 'active')
    ->orderBy('last_login', 'asc')
    ->findAll();
```

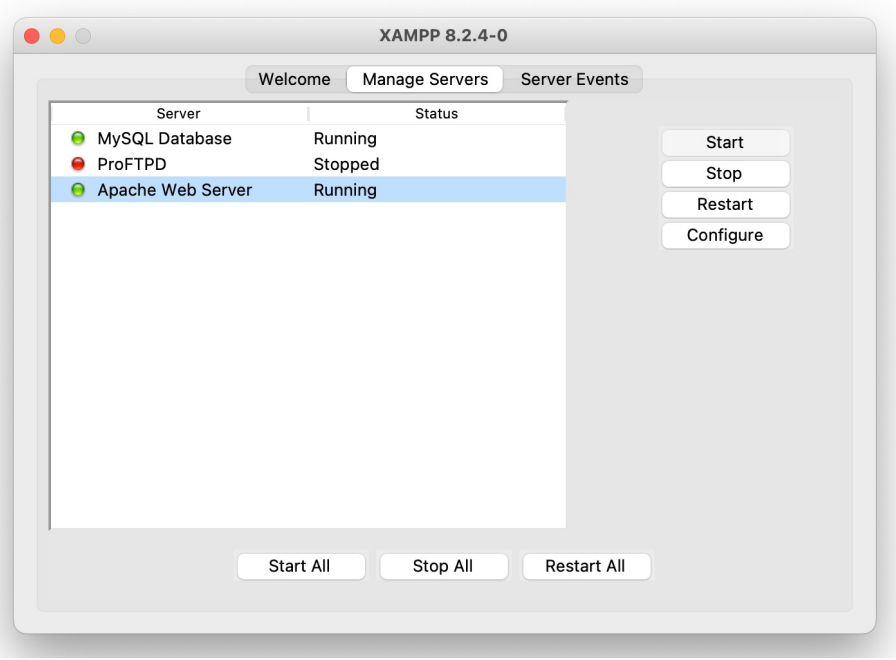
In this case, it operates on the shared instance of the Query Builder held by the model.

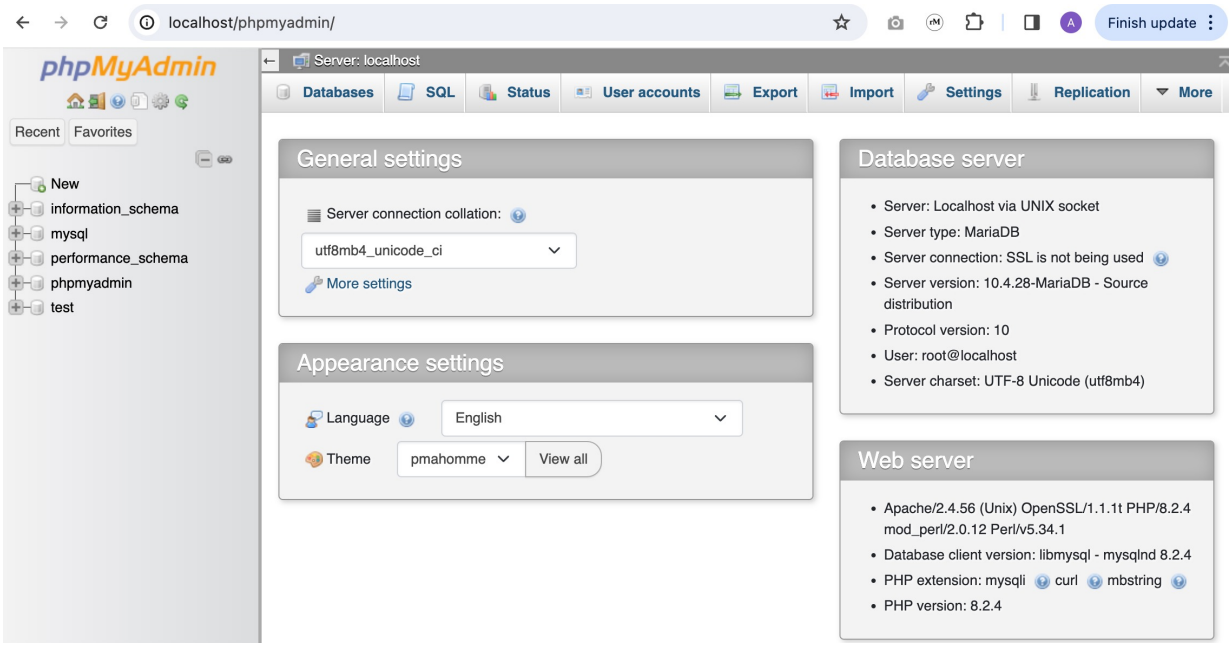
CodeIgniter Database Access



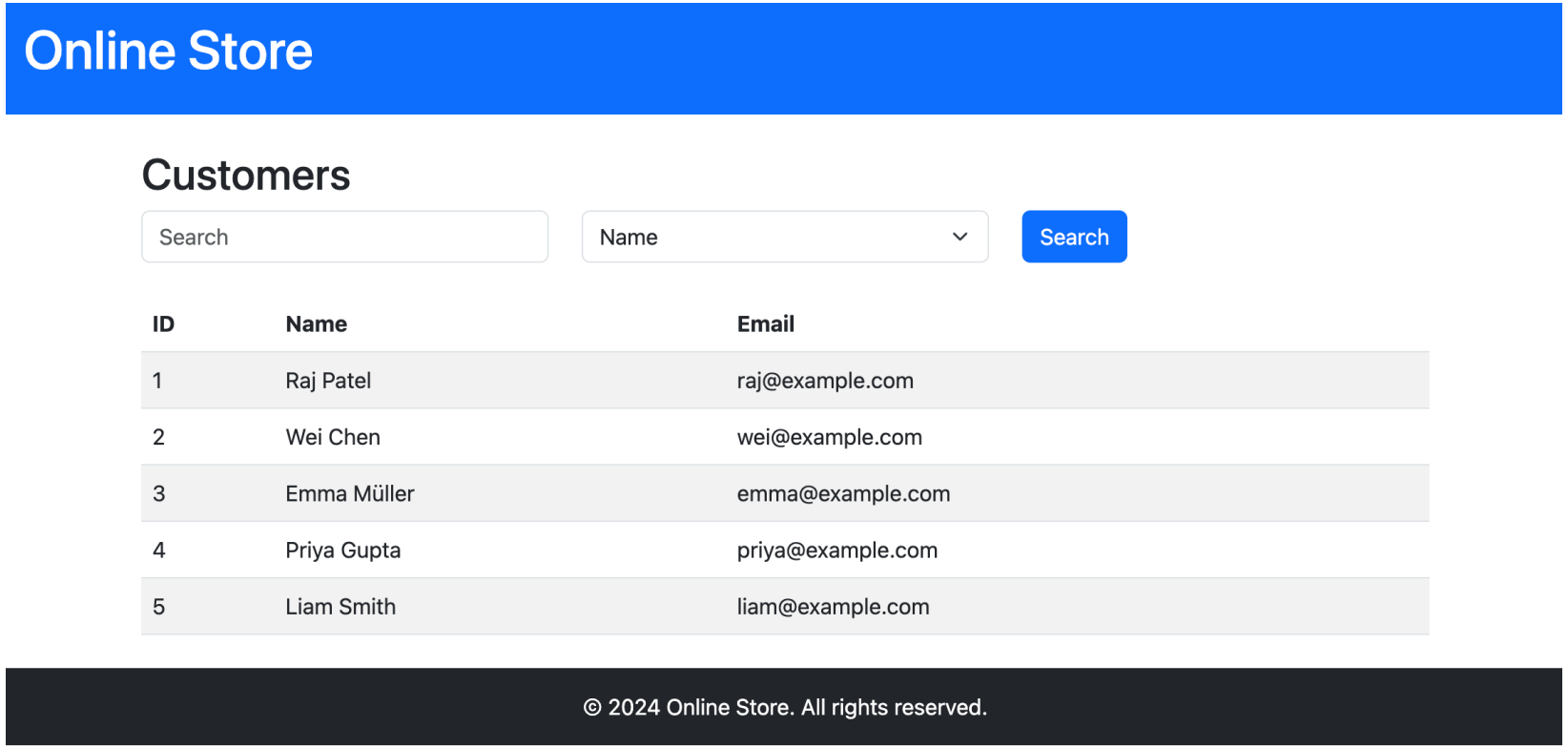
Local Database Options

- If you installed XAMPP
  - https://www.apachefriends.org/
  - You get both MySQL and PHPMyAdmin
- You can also use Sqllite
  - It is a file system database
  - Just change the .env
- MySQL Workbench
  - https://www.mysql.com/products/workbench/
  - Install locally and access your UQCloud Zone MySQL server





Code Walkthrough:
Creating a Customer Search Page



- Could you improve the search?
  E.g. Allow searches for partial names with %

Code in week4_code/ci_customersearch/

Designing a Database

Database Design Goals

- Each table must represents a single subject
- No data item will be unnecessarily stored in more than one table, i.e., No data redundancy
- All non-key attributes in a table are dependent on the primary key
- Each table is void of insertion, update, deletion anomalies
- Objective of normalisation is to ensure that all tables are in at least 3rd Normal Form (3NF)

Let’s look at an example

StudentID	StudentName	CourseID	CourseName	CourseCredits	InstructorName
1	John Doe	CS101	Programming	3	Dr. Smith
1	John Doe	MAT201	Calculus	4	Prof. Johnson
2	Jane Smith	CS101	Programming	3	Dr. Smith
3	Michael Lee	CS101	Programming	3	Dr. Smith
3	Michael Lee	PHY301	Physics	4	Dr. Brown

- We'll walk through the process of normalizing a single table with duplicates to 3rd Normal Form (3NF) and explain the different types of relationships that emerge.

Let’s look at an example

StudentID	StudentName	CourseID	CourseName	CourseCredits	InstructorName
1	John Doe	CS101	Programming	3	Dr. Smith
1	John Doe	MAT201	Calculus	4	Prof. Johnson
2	Jane Smith	CS101	Programming	3	Dr. Smith
3	Michael Lee	CS101	Programming	3	Dr. Smith
3	Michael Lee	PHY301	Physics	4	Dr. Brown

- In this table, we can observe data duplication. The student names and course details are repeated for each enrollment. This design violates the principles of normalization and can lead to data anomalies and inconsistencies.

Step 1: First Normal Form (1NF)

- To achieve 1NF, we need to ensure that each column contains atomic values and there are no repeating groups.
- In this case, we can split the table into two separate tables: "Students" and "Enrollments".

Students Table:

StudentID	StudentName
1	John Doe
2	Jane Smith
3	Michael Lee

Enrollments Table:

EnrollmentID	StudentID	CourseID	CourseName	CourseCredits	InstructorName
1	1	CS101	Programming	3	Dr. Smith
2	1	MAT201	Calculus	4	Prof. Johnson
3	2	CS101	Programming	3	Dr. Smith
4	3	CS101	Programming	3	Dr. Smith
5	3	PHY301	Physics	4	Dr. Brown

Step 2: Second Normal Form (2NF)

- To achieve 2NF, we need to ensure that all non-key columns depend on the entire primary key.
- In the "Enrollments" table, the primary key is a combination of "StudentID" and "CourseID".
- However, the course details (CourseName, CourseCredits, InstructorName) depend only on the "CourseID".
- To resolve this, we can split the "Enrollments" table further into "Enrollments" and "Courses" tables.

Enrollments Table:

EnrollmentID	StudentID	CourseID
1	1	CS101
2	1	MAT201
3	2	CS101
4	3	CS101
5	3	PHY301

Courses Table:

CourseID	CourseName	CourseCredits	InstructorName
CS101	Programming	3	Dr. Smith
MAT201	Calculus	4	Prof. Johnson
PHY301	Physics	4	Dr. Brown

Step 3: Third Normal Form (3NF)

- To achieve 3NF, we need to ensure that there are no transitive dependencies. In the "Courses" table, the "InstructorName" depends on the "CourseID" but not directly. It depends on the instructor associated with the course. To resolve this, we can split the "Courses" table into "Courses" and "Instructors" tables.

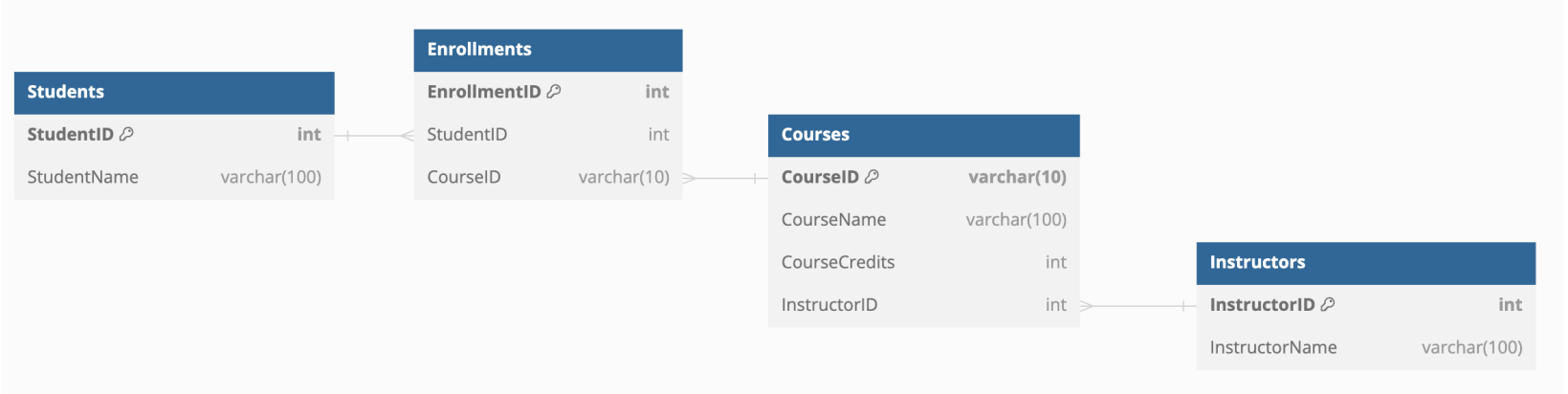
Courses Table:

CourseID	CourseName	CourseCredits	InstructorID
CS101	Programming	3	1
MAT201	Calculus	4	2
PHY301	Physics	4	3

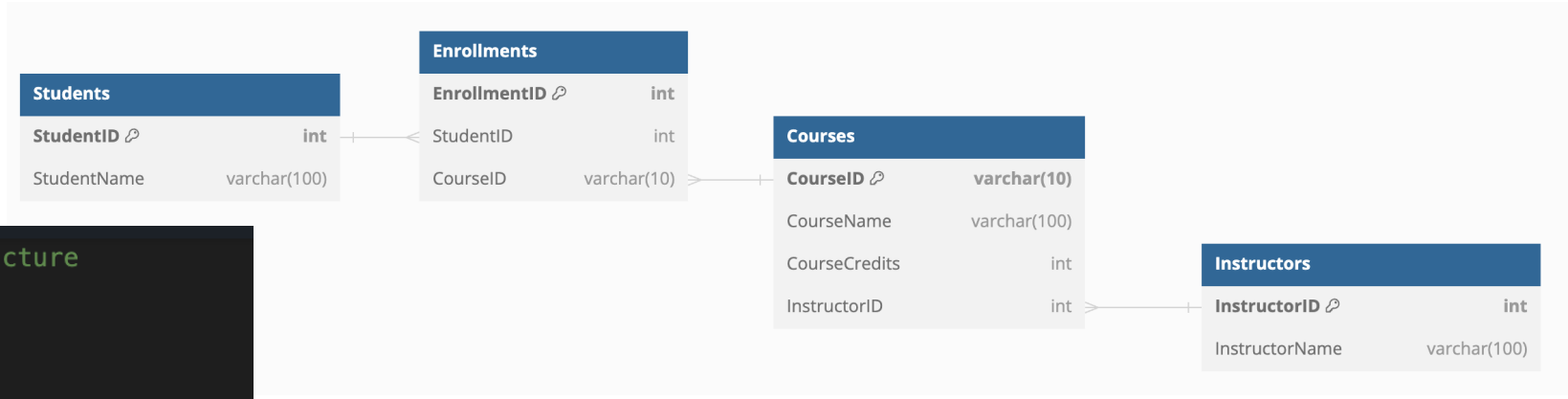
Instructors Table:

InstructorID	InstructorName
1	Dr. Smith
2	Prof. Johnson
3	Dr. Brown

The 3NF Schema



The 3NF Schema – Created with DBML




```
// Use DBML to define your database structure
// Docs: https://dbml.dbdiagram.io/docs

Table Students {
  StudentID int [pk]
  StudentName varchar(100)
}

Table Courses {
  CourseID varchar(10) [pk]
  CourseName varchar(100)
  CourseCredits int
  InstructorID int [ref: > Instructors.InstructorID]
}

Table Instructors {
  InstructorID int [pk]
  InstructorName varchar(100)
}

Table Enrollments {
  EnrollmentID int [pk]
  StudentID int [ref: > Students.StudentID]
  CourseID varchar(10) [ref: > Courses.CourseID]
}
```

- Represent the table in Database Markup Language (DBML)
- Rendered visually in https://www.dbdiagram.io
- You could also use Kroki.io or PHPMyAdmin or any other diagramming tool.

Week 4: Todo

- Weekly RiPPLE task is due in Week 4 on Friday at 3pm
- Complete Week 4 Lab 3
  - It is a challenging lab but by the end you will have created a database with multiple tables and a results-detail set of pages
- Continue with your Design Document Assessment Item
  - You should now be starting with the database design

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Q&A

Thank you