Spring Boot JPA + H2: Build a CRUD Rest APIs

In this lab, we're gonna build a Spring Boot Rest CRUD API with Maven that use Spring Data JPA to interact with H2 database. You'll know:

- How to configure Spring Data, JPA, Hibernate to work with Database
- How to define Data Models and Repository interfaces
- Way to create Spring Rest Controller to process HTTP requests
- Way to use Spring Data JPA to interact with H2 Database

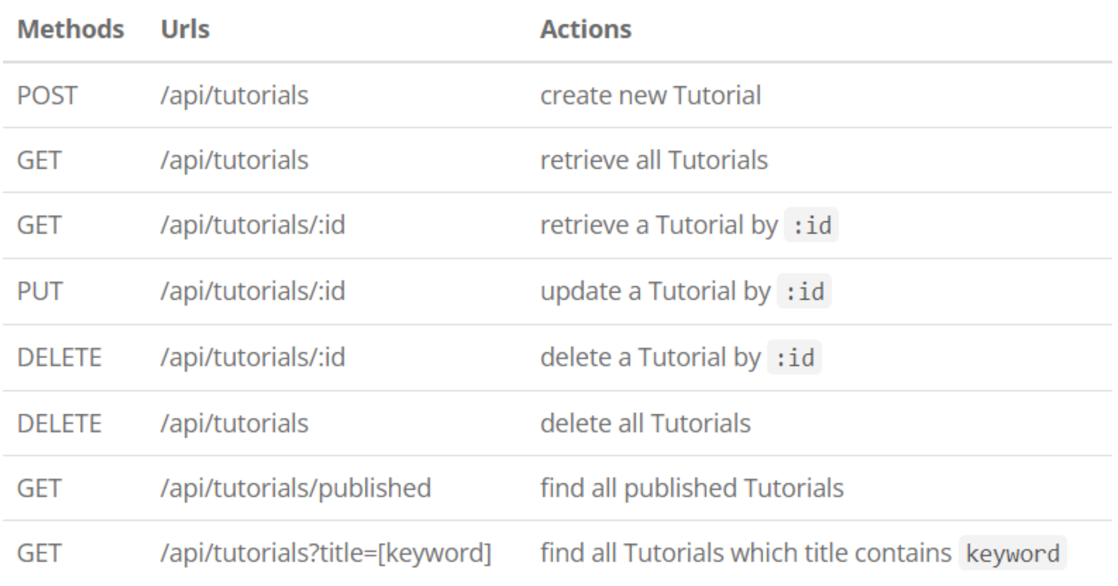
Overview of Spring Boot JPA + H2

Overview of Spring Boot JPA + H2

We will build a Spring Boot Rest Apis using Spring Data JPA with H2 Database for a Tutorial application in that:

- Each Tutorial has id, title, description, published status.
- Apis help to create, retrieve, update, delete Tutorials.
- Apis also support custom finder methods such as find by published status or by title.

These are APIs that we need to provide:



Methods	Urls	Actions
POST	/api/tutorials	create new Tutorial
GET	/api/tutorials	retrieve all Tutorials
GET	/api/tutorials/:id	retrieve a Tutorial by `:id`
PUT	/api/tutorials/:id	update a Tutorial by `:id`
DELETE	/api/tutorials/:id	delete a Tutorial by `:id`
DELETE	/api/tutorials	delete all Tutorials
GET	/api/tutorials/published	find all published Tutorials
GET	/api/tutorials?title=[keyword]	find all Tutorials which title contains `keyword`

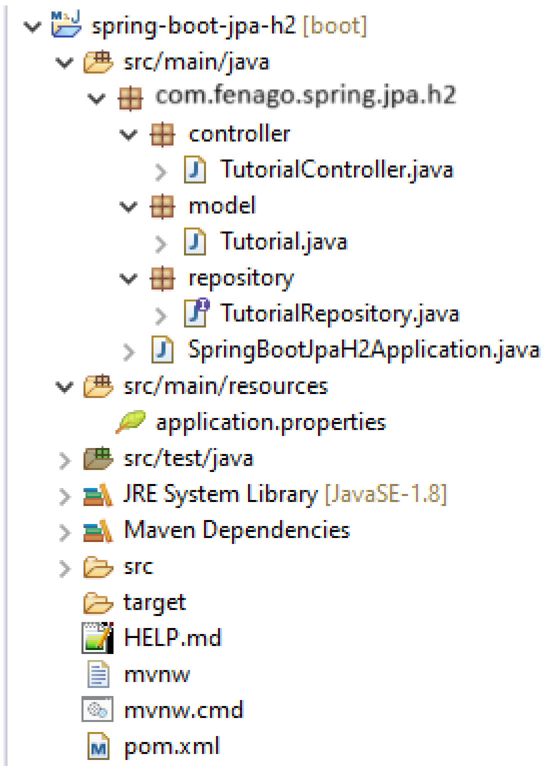
-- We make CRUD operations & finder methods with Spring Data JPA's `JpaRepository`.

-- The database will be H2 Database (in memory or on disk) by configuring project dependency & datasource.

[Technology]

- Java 17
- Spring Boot 3 / 2 (with Spring Web MVC, Spring Data JPA)
- H2 Database
- Maven

[Project Structure]



```
spring-boot-jpa-h2 [boot]
  src/main/java
    com.fenago.spring.jpa.h2
      controller
        TutorialController.java
      model
        Tutorial.java
      repository
        TutorialRepository.java
      SpringBootJpaH2Application.java
  src/main/resources
    application.properties
  src/test/java
  JRE System Library [JavaSE-1.8]
  Maven Dependencies
  src
  target
  HELP.md
  mvnw
  mvnw.cmd
  pom.xml
```

Let me explain it briefly.

-- `Tutorial` data model class corresponds to entity and table *tutorials*.
-- `TutorialRepository` is an interface that extends JpaRepository for CRUD methods and custom finder methods. It will be autowired in `TutorialController`.
-- `TutorialController` is a RestController which has request mapping methods for RESTful requests such as: *getAllTutorials*, *createTutorial*, *updateTutorial*, *deleteTutorial*, *findByPublished*...
-- Configuration for Spring Datasource, JPA & Hibernate in **application.properties**.
-- **pom.xml** contains dependencies for Spring Boot and H2 Database.

Setup Spring Boot project

Starter project is available at following path for this lab:

```
cd /workspace/angular-advanced-springboot/labs/lab4/spring-boot-starter-h2-database-crud/

mvn install
```

[Configure Spring Boot, JPA, h2, Hibernate]

Under **src/main/resources** folder, open *application.properties* and write these lines.

```
spring.h2.console.enabled=true
# default path: h2-console
spring.h2.console.path=/h2-ui
spring.h2.console.settings.web-allow-others=true

spring.datasource.url=jdbc:h2:file:./testdb
spring.datasource.driverClassName=org.h2.Driver
spring.datasource.username=sa
spring.datasource.password=

spring.jpa.show-sql=true
spring.jpa.properties.hibernate.dialect=org.hibernate.dialect.H2Dialect
spring.jpa.hibernate.ddl-auto= update
```

- `spring.datasource.url`: `jdbc:h2:mem:[database-name]` for In-memory database and `jdbc:h2:file:[path/database-name]` for disk-based database.
- `spring.datasource.username` & `spring.datasource.password` properties are the same as your database installation.
- Spring Boot uses Hibernate for JPA implementation, we configure `H2Dialect` for H2 Database
- `spring.jpa.hibernate.ddl-auto` is used for database initialization. We set the value to `update` value so that a table will be created in the database automatically corresponding to defined data model. Any change to the model will also trigger an update to the table. For production, this property should be `validate`.
- `spring.h2.console.enabled=true` tells the Spring to start H2 Database administration tool and you can access this tool on the browser: `https://8080-Gitpod_URL/h2-console`.
- `spring.h2.console.path=/h2-ui` is for H2 console's url, so the default url `https://8080-Gitpod_URL/h2-console` will change to `https://8080-Gitpod_URL/h2-ui`.

[Define Data Model]

Our Data model is Tutorial with four fields: id, title, description, published.
In **model** package, we define `Tutorial` class.

model/Tutorial.java

```
package com.fenago.spring.jpa.h2.model;

import jakarta.persistence.*;

@Entity
@Table(name = "tutorials")
public class Tutorial {

  @Id
  @GeneratedValue(strategy = GenerationType.AUTO)
  private long id;

  @Column(name = "title")
  private String title;

  @Column(name = "description")
  private String description;
  @Column(name = "published")
  private boolean published;

  public Tutorial() {

  }

  public Tutorial(String title, String description, boolean published) {
    this.title = title;
    this.description = description;
    this.published = published;
  }

  public long getId() {
    return id;
  }

  public String getTitle() {
    return title;
  }

  public void setTitle(String title) {
    this.title = title;
  }

  public String getDescription() {
    return description;
  }

  public void setDescription(String description) {
    this.description = description;
  }

  public boolean isPublished() {
    return published;
  }

  public void setPublished(boolean isPublished) {
    this.published = isPublished;
  }

  @Override
  public String toString() {
    return "Tutorial [id=" + id + ", title=" + title + ", desc=" + description + ",
published=" + published + "]";
  }

}
```

-- `@Entity` annotation indicates that the class is a persistent Java class.
-- `@Table` annotation provides the table that maps this entity.

-- `@Id` annotation is for the primary key.
-- `@GeneratedValue` annotation is used to define generation strategy for the primary key.
`GenerationType.AUTO` means Auto Increment field.
-- `@Column` annotation is used to define the column in database that maps annotated field.

[Create Repository Interface]

Let's create a repository to interact with Tutorials from the database.
In **repository** package, create `TutorialRepository` interface that extends `JpaRepository`.

repository/TutorialRepository.java

```
package com.fenago.spring.jpa.h2.repository;

import java.util.List;

import org.springframework.data.jpa.repository.JpaRepository;

import com.fenago.spring.jpa.h2.model.Tutorial;

public interface TutorialRepository extends JpaRepository<Tutorial, Long> {
  List<Tutorial> findByPublished(boolean published);

  List<Tutorial> findByTitleContainingIgnoreCase(String title);
}
```

Now we can use JpaRepository's methods: `save()`, `findOne()`, `findById()`, `findAll()`, `count()`, `delete()`, `deleteById()`... without implementing these methods.

We also define custom finder methods: -- `findByPublished()`: returns all Tutorials with `published` having value as input `published`.
-- `findByTitleContaining()`: returns all Tutorials which title contains input `title`.

[Create Spring Rest APIs Controller]

Finally, we create a controller that provides APIs for creating, retrieving, updating, deleting and finding Tutorials.

controller/TutorialController.java

```
package com.fenago.spring.jpa.h2.controller;

import java.util.ArrayList;
import java.util.List;
import java.util.Optional;

import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.http.HttpStatus;
import org.springframework.http.ResponseEntity;
import org.springframework.web.bind.annotation.CrossOrigin;
import org.springframework.web.bind.annotation.DeleteMapping;
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.PathVariable;
import org.springframework.web.bind.annotation.PostMapping;
import org.springframework.web.bind.annotation.PutMapping;
import org.springframework.web.bind.annotation.RequestBody;
import org.springframework.web.bind.annotation.RequestMapping;
import org.springframework.web.bind.annotation.RequestParam;
import org.springframework.web.bind.annotation.RestController;

import com.fenago.spring.jpa.h2.model.Tutorial;
import com.fenago.spring.jpa.h2.repository.TutorialRepository;

@CrossOrigin(origins = "*")
@RestController
@RequestMapping("/api")
public class TutorialController {

  @Autowired
  TutorialRepository tutorialRepository;

  @GetMapping("/tutorials")
  public ResponseEntity<List<Tutorial>> getAllTutorials(@RequestParam(required =
false) String title) {
    try {
      List<Tutorial> tutorials = new ArrayList<Tutorial>();

      if (title == null)
        tutorialRepository.findAll().forEach(tutorials::add);
      else

tutorialRepository.findByTitleContainingIgnoreCase(title).forEach(tutorials::add);

      if (tutorials.isEmpty()) {
        return new ResponseEntity<>(HttpStatus.NO_CONTENT);
      }

      return new ResponseEntity<>(tutorials, HttpStatus.OK);
    } catch (Exception e) {
      return new ResponseEntity<>(null, HttpStatus.INTERNAL_SERVER_ERROR);
    }
  }

  @GetMapping("/tutorials/{id}")
  public ResponseEntity<Tutorial> getTutorialById(@PathVariable("id") long id) {
    Optional<Tutorial> tutorialData = tutorialRepository.findById(id);

    if (tutorialData.isPresent()) {
      return new ResponseEntity<>(tutorialData.get(), HttpStatus.OK);
    } else {
      return new ResponseEntity<>(HttpStatus.NOT_FOUND);
    }
  }

  @PostMapping("/tutorials")
  public ResponseEntity<Tutorial> createTutorial(@RequestBody Tutorial tutorial) {
    try {
      Tutorial _tutorial = tutorialRepository.save(new Tutorial(tutorial.getTitle(),
tutorial.getDescription(), false));
      return new ResponseEntity<>(_tutorial, HttpStatus.CREATED);
    } catch (Exception e) {
      return new ResponseEntity<>(null, HttpStatus.INTERNAL_SERVER_ERROR);
    }
  }

  @PutMapping("/tutorials/{id}")
  public ResponseEntity<Tutorial> updateTutorial(@PathVariable("id") long id,
@RequestBody Tutorial tutorial) {
    Optional<Tutorial> tutorialData = tutorialRepository.findById(id);

    if (tutorialData.isPresent()) {
      Tutorial _tutorial = tutorialData.get();
      _tutorial.setTitle(tutorial.getTitle());
      _tutorial.setDescription(tutorial.getDescription());
      _tutorial.setPublished(tutorial.isPublished());
      return new ResponseEntity<>(tutorialRepository.save(_tutorial), HttpStatus.OK);
    } else {
      return new ResponseEntity<>(HttpStatus.NOT_FOUND);
    }
  }

  @DeleteMapping("/tutorials/{id}")
  public ResponseEntity<HttpStatus> deleteTutorial(@PathVariable("id") long id) {
    try {
      tutorialRepository.deleteById(id);
      return new ResponseEntity<>(HttpStatus.NO_CONTENT);
    } catch (Exception e) {
      return new ResponseEntity<>(HttpStatus.INTERNAL_SERVER_ERROR);
    }
  }

  @DeleteMapping("/tutorials")
  public ResponseEntity<HttpStatus> deleteAllTutorials() {
    try {
      tutorialRepository.deleteAll();
      return new ResponseEntity<>(HttpStatus.NO_CONTENT);
    } catch (Exception e) {
      return new ResponseEntity<>(HttpStatus.INTERNAL_SERVER_ERROR);
    }

  }

  @GetMapping("/tutorials/published")
  public ResponseEntity<List<Tutorial>> findByPublished() {
    try {
      List<Tutorial> tutorials = tutorialRepository.findByPublished(true);

      if (tutorials.isEmpty()) {
        return new ResponseEntity<>(HttpStatus.NO_CONTENT);
      }
      return new ResponseEntity<>(tutorials, HttpStatus.OK);
    } catch (Exception e) {
      return new ResponseEntity<>(HttpStatus.INTERNAL_SERVER_ERROR);
    }
  }

}
```

-- `@CrossOrigin` is for configuring allowed origins.
-- `@RestController` annotation is used to define a controller and to indicate that the return value of the methods should be be bound to the web response body.
-- `@RequestMapping("/api")` declares that all Apis' url in the controller will start with `/api`.
-- We use `@Autowired` to inject `TutorialRepository` bean to local variable.

Run & Test

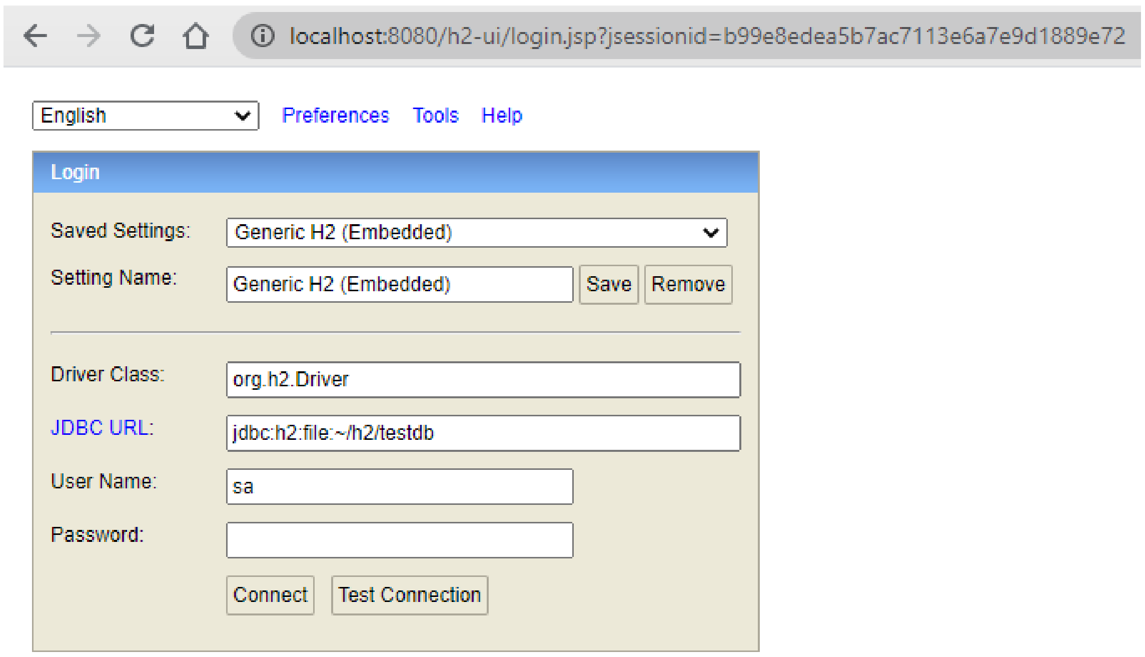
Run Spring Boot application with command: `mvn spring-boot:run`.

tutorials table will be automatically generated in Database.

Let's open H2 console with url: `https://8080-Gitpod_URL/h2-ui`:

IMPORTANT: Enter `jdbc:h2:file:./testdb` in JDBC URL field and click `Test Connection` to confirm connectivity:

-- For on Disk database:



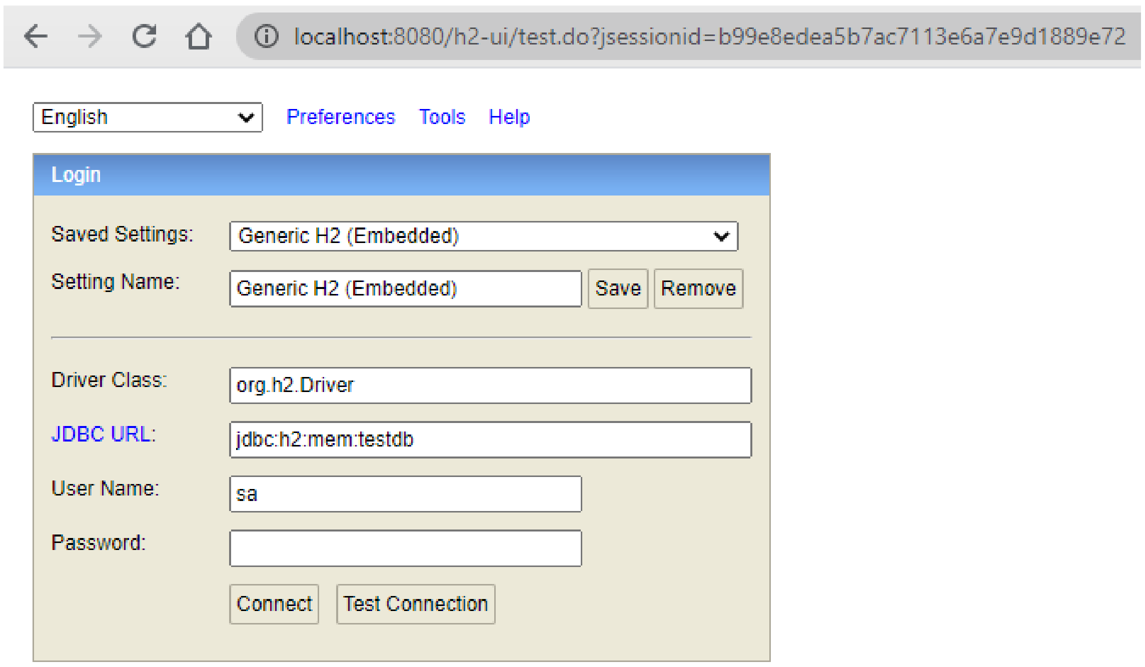
localhost:8080/h2-ui/login.jsp?jsessionid=b99e8edea5b7ac7113e6a7e9d1889e72

English | Preferences | Tools | Help

Login

Saved Settings:	Generic H2 (Embedded)
Setting Name:	Generic H2 (Embedded)
Driver Class:	org.h2.Driver
JDBC URL:	jdbc:h2:file:~/h2/testdb
User Name:	sa
Password:	

Note: If you are using In-memory database, you can connect like this:

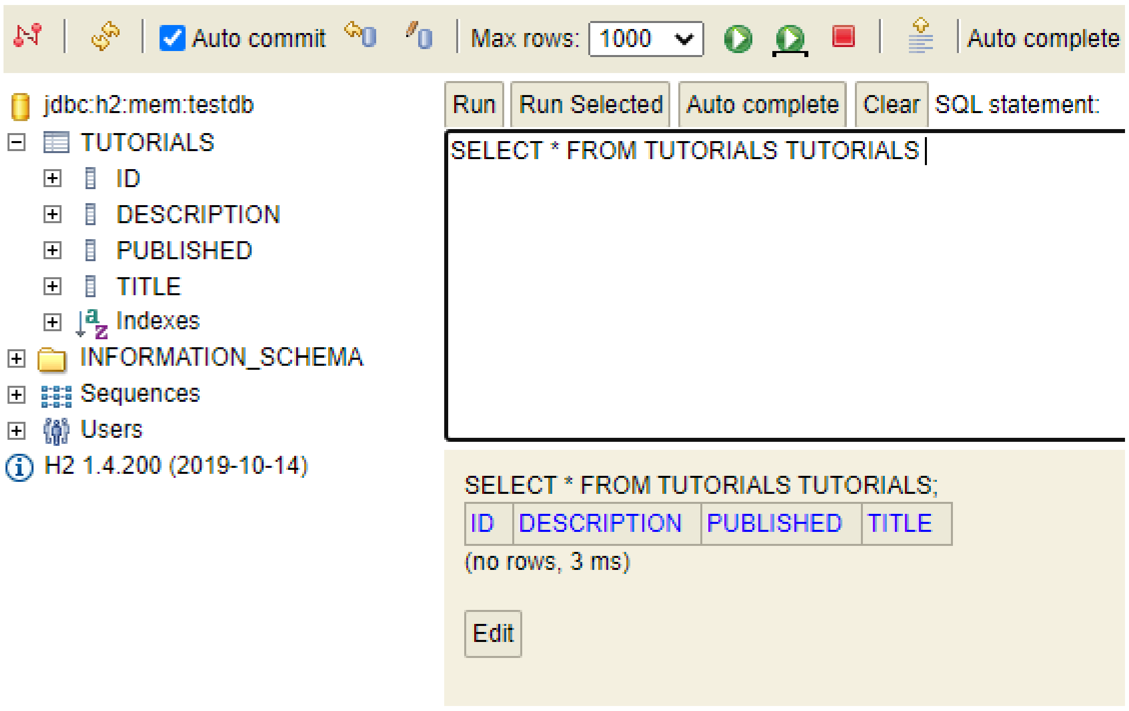


localhost:8080/h2-ui/test.do?jsessionid=b99e8edea5b7ac7113e6a7e9d1889e72

Saved Settings: Generic H2 (Embedded)
Setting Name: Generic H2 (Embedded)

Driver Class: org.h2.Driver
JDBC URL: jdbc:h2:mem:testdb
User Name: sa
Password:

Click on **Connect** button, then check H2 database, you can see things like this:



```
SELECT * FROM TUTORIALS TUTORIALS
```

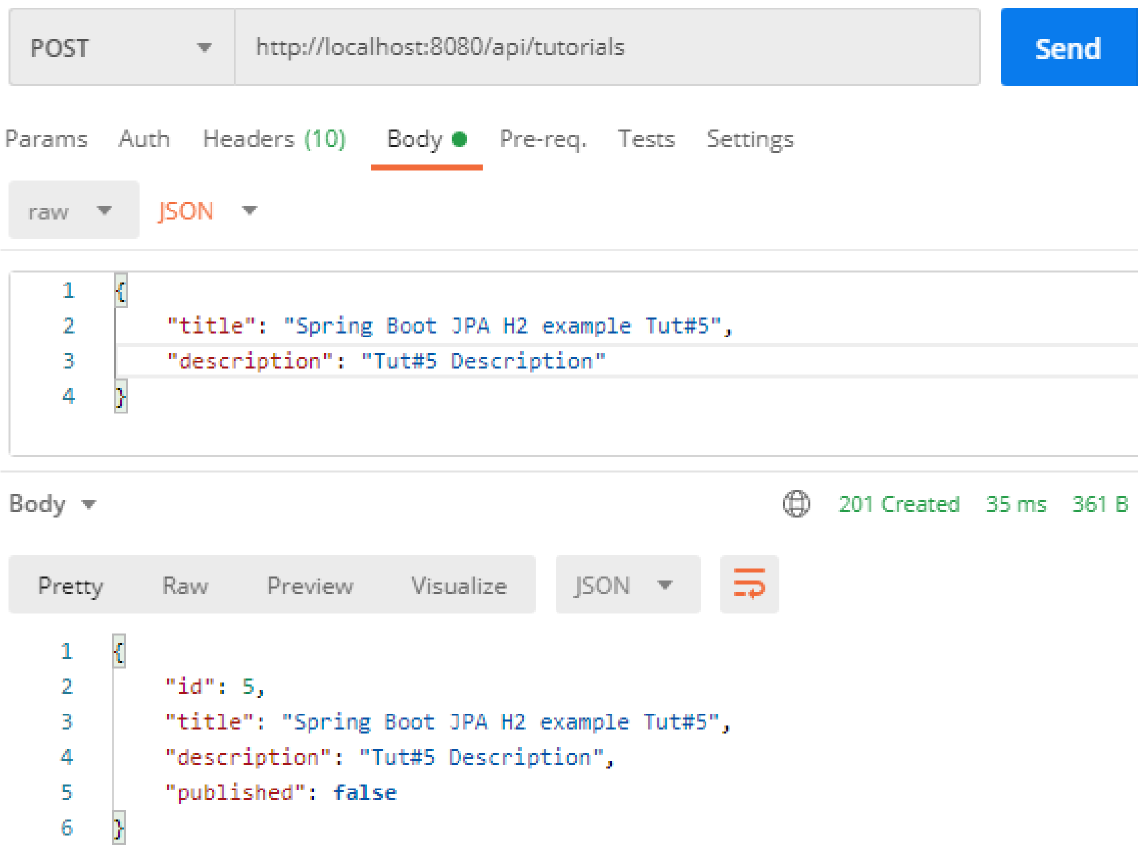
```
SELECT * FROM TUTORIALS TUTORIALS;
```

ID	DESCRIPTION	PUBLISHED	TITLE

(no rows, 3 ms)

Create some Tutorials:

Note: You will connect using Gitpod URL on port `8080`.



POST http://localhost:8080/api/tutorials

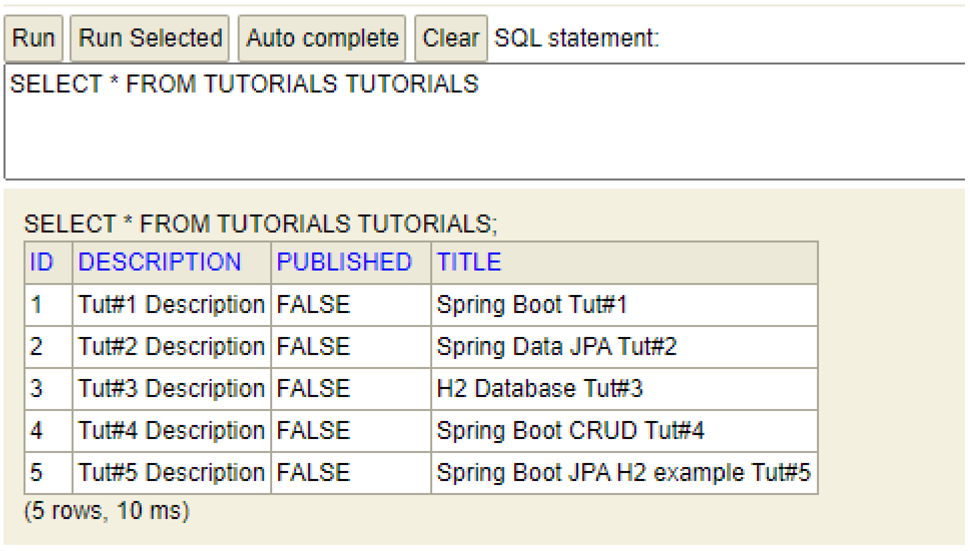
Body (raw, JSON):

```
{
    "title": "Spring Boot JPA H2 example Tut#5",
    "description": "Tut#5 Description"
}
```

201 Created 35 ms 361 B

```
{
    "id": 5,
    "title": "Spring Boot JPA H2 example Tut#5",
    "description": "Tut#5 Description",
    "published": false
}
```

H2 database `tutorials` table after that:



SQL statement:

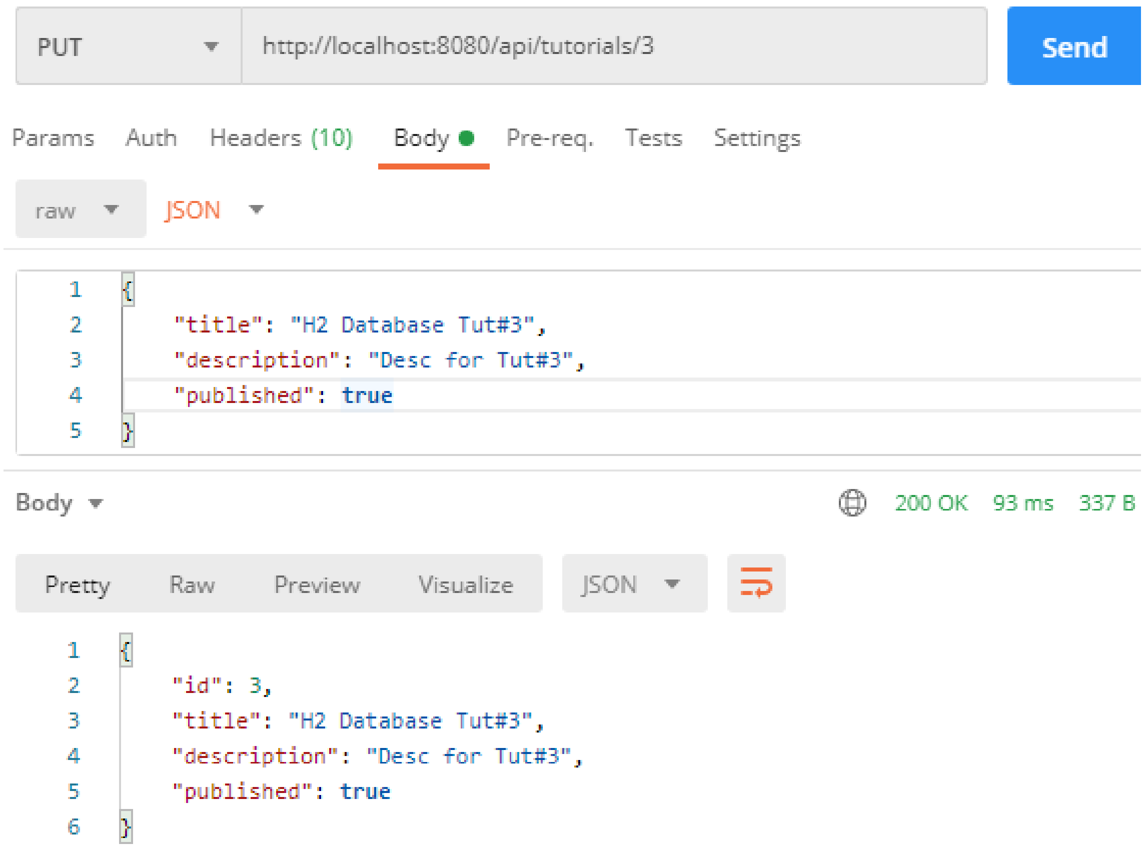
```
SELECT * FROM TUTORIALS TUTORIALS
```

SELECT * FROM TUTORIALS TUTORIALS;

ID	DESCRIPTION	PUBLISHED	TITLE
1	Tut#1 Description	FALSE	Spring Boot Tut#1
2	Tut#2 Description	FALSE	Spring Data JPA Tut#2
3	Tut#3 Description	FALSE	H2 Database Tut#3
4	Tut#4 Description	FALSE	Spring Boot CRUD Tut#4
5	Tut#5 Description	FALSE	Spring Boot JPA H2 example Tut#5

(5 rows, 10 ms)

Update some Tutorials:

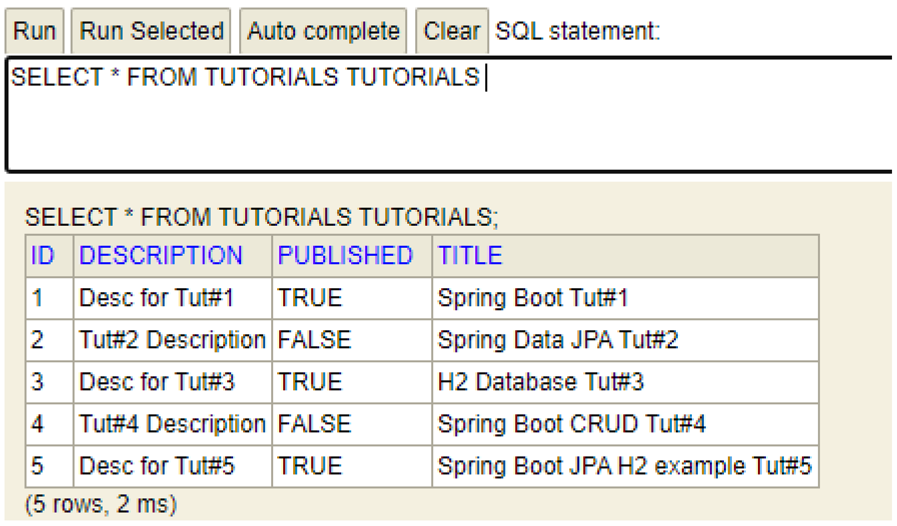


```
http://localhost:8080/api/tutorials/3
```

```
{
    "title": "H2 Database Tut#3",
    "description": "Desc for Tut#3",
    "published": true
}
```

```
{
    "id": 3,
    "title": "H2 Database Tut#3",
    "description": "Desc for Tut#3",
    "published": true
}
```

The table data is changed:



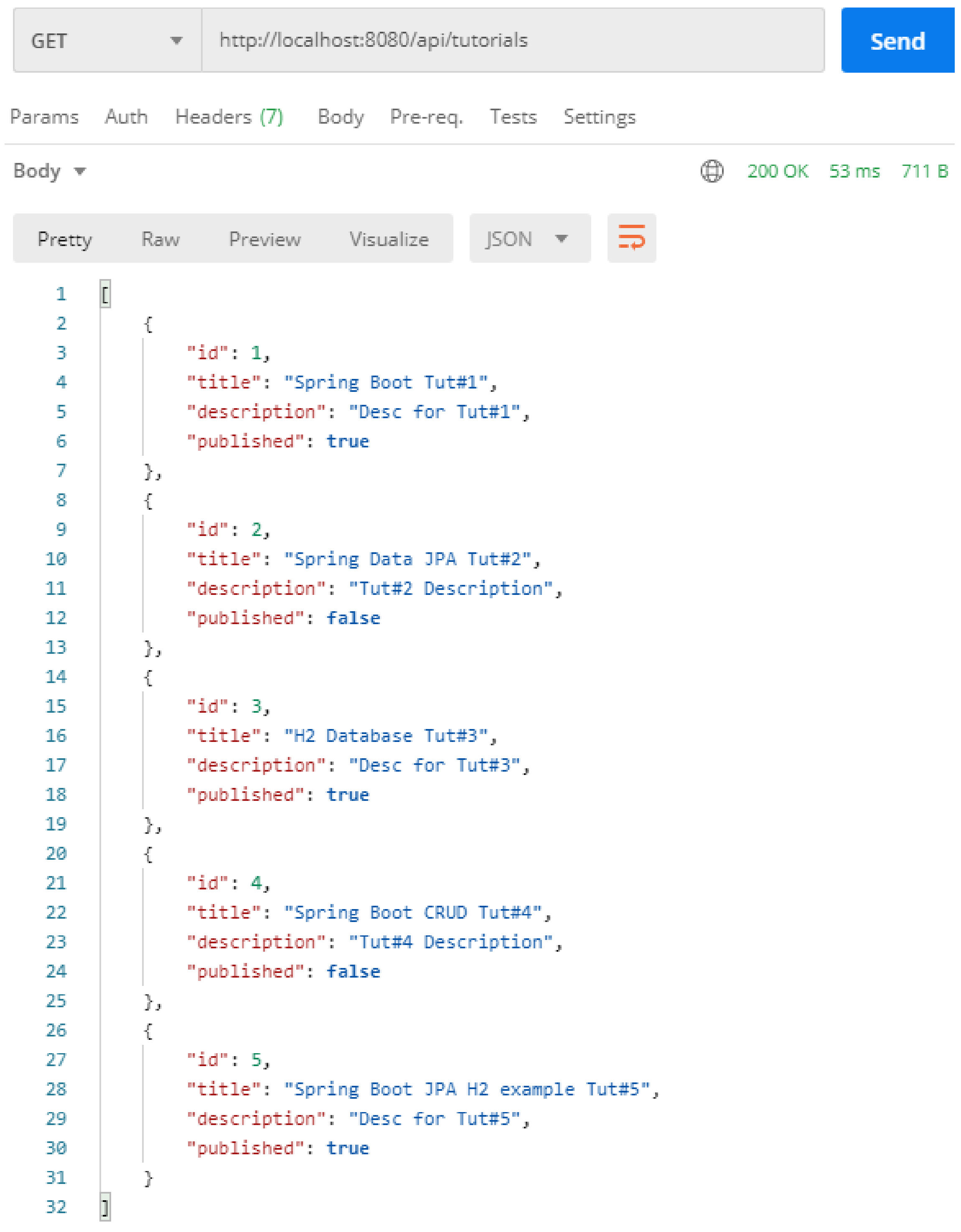
```
SELECT * FROM TUTORIALS TUTORIALS
```

SELECT * FROM TUTORIALS TUTORIALS;

ID	DESCRIPTION	PUBLISHED	TITLE
1	Desc for Tut#1	TRUE	Spring Boot Tut#1
2	Tut#2 Description	FALSE	Spring Data JPA Tut#2
3	Desc for Tut#3	TRUE	H2 Database Tut#3
4	Tut#4 Description	FALSE	Spring Boot CRUD Tut#4
5	Desc for Tut#5	TRUE	Spring Boot JPA H2 example Tut#5

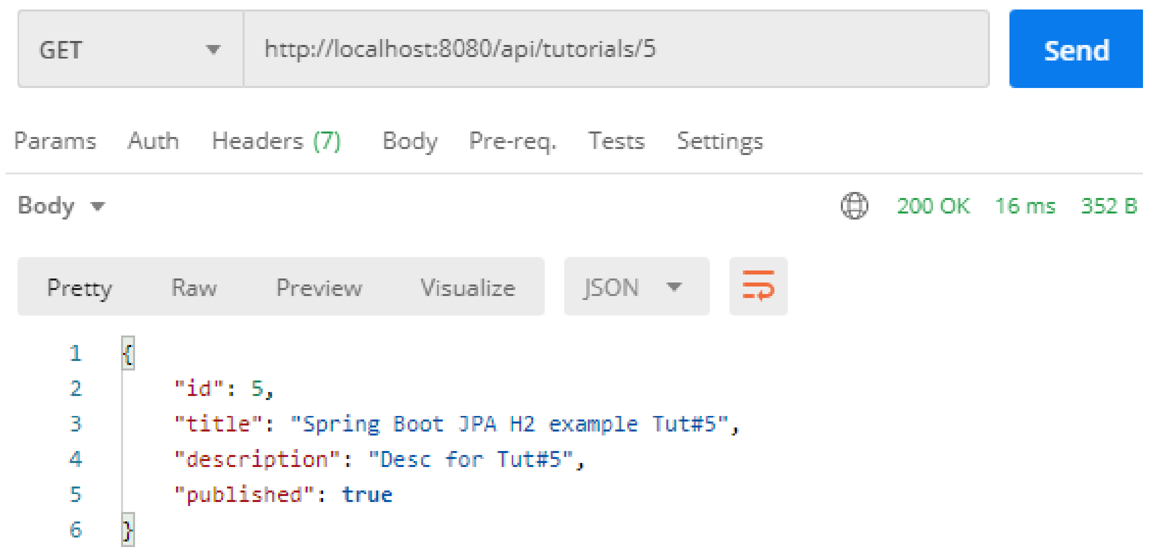
(5 rows, 2 ms)

Retrieve all Tutorials:



```
[
    {
        "id": 1,
        "title": "Spring Boot Tut#1",
        "description": "Desc for Tut#1",
        "published": true
    },
    {
        "id": 2,
        "title": "Spring Data JPA Tut#2",
        "description": "Tut#2 Description",
        "published": false
    },
    {
        "id": 3,
        "title": "H2 Database Tut#3",
        "description": "Desc for Tut#3",
        "published": true
    },
    {
        "id": 4,
        "title": "Spring Boot CRUD Tut#4",
        "description": "Tut#4 Description",
        "published": false
    },
    {
        "id": 5,
        "title": "Spring Boot JPA H2 example Tut#5",
        "description": "Desc for Tut#5",
        "published": true
    }
]
```

Retrieve a Tutorial by Id:

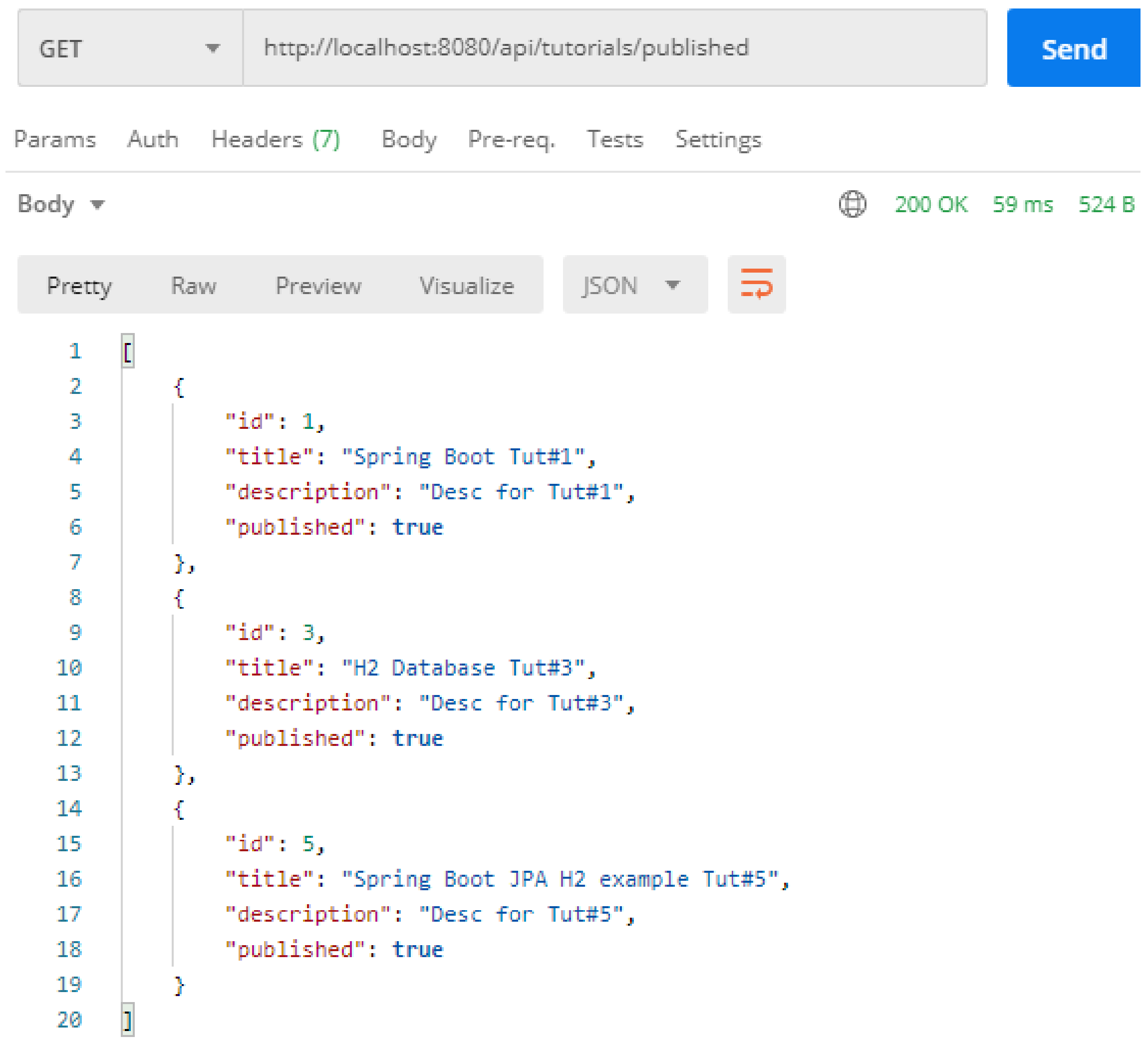


```
http://localhost:8080/api/tutorials/5
```

200 OK 16 ms 352 B

```
{
    "id": 5,
    "title": "Spring Boot JPA H2 example Tut#5",
    "description": "Desc for Tut#5",
    "published": true
}
```

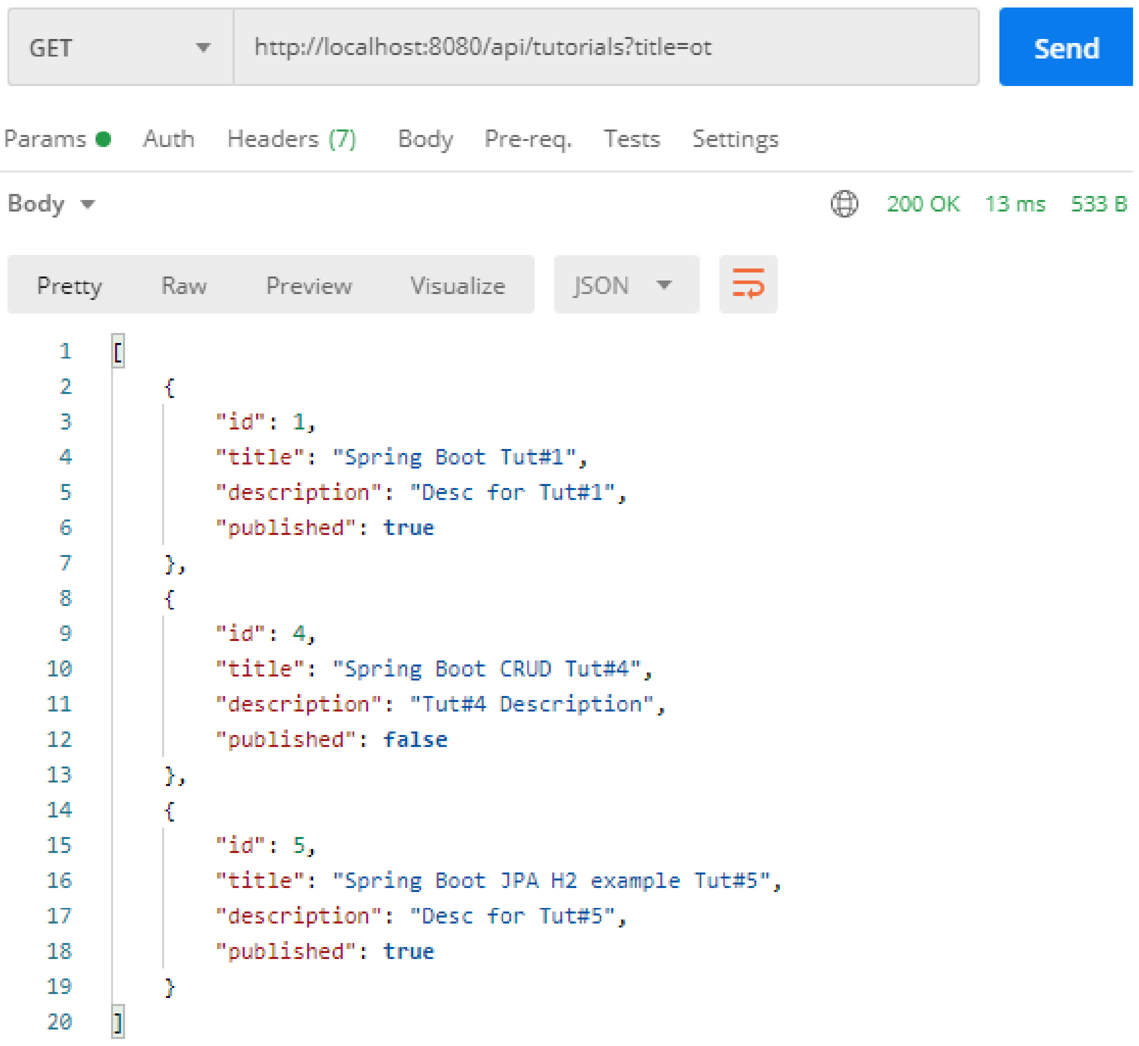
Find all ***published*** Tutorials:



```
http://localhost:8080/api/tutorials/published
```

```
[
    {
        "id": 1,
        "title": "Spring Boot Tut#1",
        "description": "Desc for Tut#1",
        "published": true
    },
    {
        "id": 3,
        "title": "H2 Database Tut#3",
        "description": "Desc for Tut#3",
        "published": true
    },
    {
        "id": 5,
        "title": "Spring Boot JPA H2 example Tut#5",
        "description": "Desc for Tut#5",
        "published": true
    }
]
```

Find all Tutorials which title contains string 'ot':

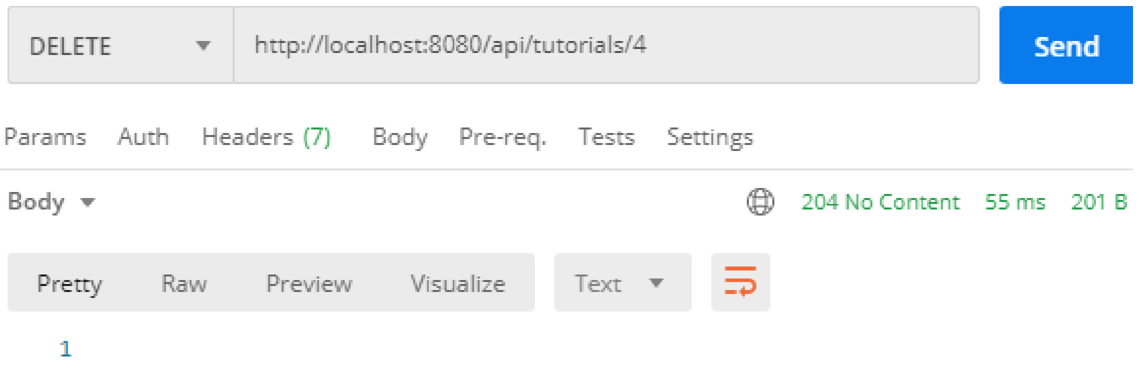


```
http://localhost:8080/api/tutorials?title=ot
```

```
200 OK   13 ms   533 B
```

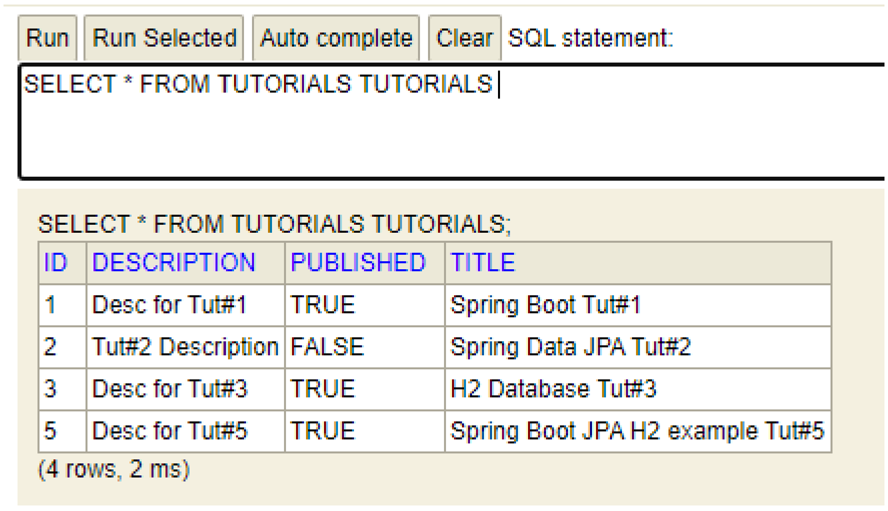
```json
[
    {
        "id": 1,
        "title": "Spring Boot Tut#1",
        "description": "Desc for Tut#1",
        "published": true
    },
    {
        "id": 4,
        "title": "Spring Boot CRUD Tut#4",
        "description": "Tut#4 Description",
        "published": false
    },
    {
        "id": 5,
        "title": "Spring Boot JPA H2 example Tut#5",
        "description": "Desc for Tut#5",
        "published": true
    }
]
```

Delete a Tutorial:



```
http://localhost:8080/api/tutorials/4
```

```
204 No Content   55 ms   201 B
```



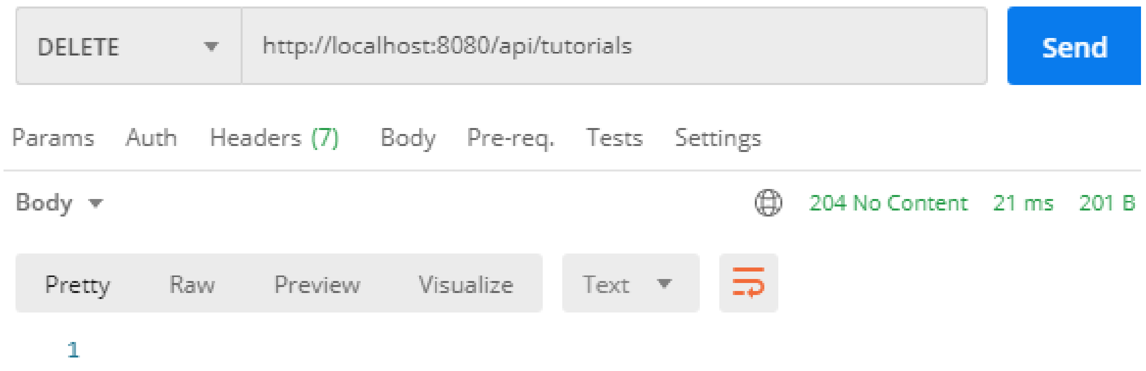
```
SELECT * FROM TUTORIALS TUTORIALS
```

SELECT * FROM TUTORIALS TUTORIALS;

ID	DESCRIPTION	PUBLISHED	TITLE
1	Desc for Tut#1	TRUE	Spring Boot Tut#1
2	Tut#2 Description	FALSE	Spring Data JPA Tut#2
3	Desc for Tut#3	TRUE	H2 Database Tut#3
5	Desc for Tut#5	TRUE	Spring Boot JPA H2 example Tut#5

(4 rows, 2 ms)

Delete all Tutorials:

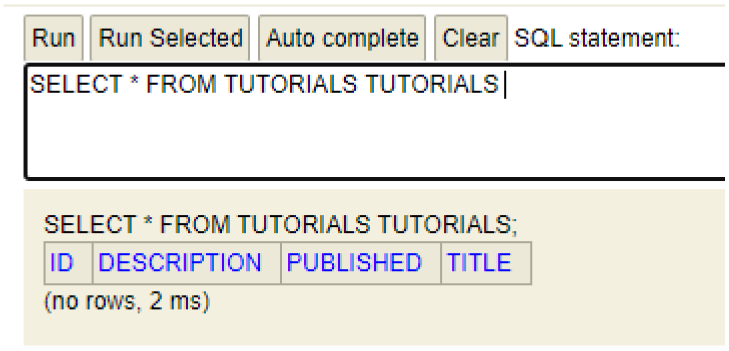


```
http://localhost:8080/api/tutorials
```

204 No Content 21 ms 201 B

```
1
```

H2 database table is clean now:



```
SELECT * FROM TUTORIALS TUTORIALS
```

SELECT * FROM TUTORIALS TUTORIALS;

ID	DESCRIPTION	PUBLISHED	TITLE

(no rows, 2 ms)

Lab Solution

Complete lab solution for this lab is also available in the lab environment. Run Spring Boot Server as shown below:

```
cd /workspace/angular-advanced-springboot/labs/lab4/spring-boot-h2-database-crud/

mvn spring-boot:run
```

Conclusion

In this lab, we've built a Rest CRUD API using Spring Boot, Spring Data JPA working with H2 Database.

We also see that `JpaRepository` supports a great way to make CRUD operations and custom finder methods without need of boilerplate code.

In the next lab, we will develop Angular frontend that connects with spring boot server.