Building a GraphQL service

Spring for GraphQL provides support for Spring applications built on GraphQL Java.

This guide walks you through the process of creating a GraphQL service in Java using Spring for GraphQL.

What You Will Build

You will build a service that will accept GraphQL requests at `http://localhost:8080/graphql`.

What You Need

- About 15 minutes
- A favorite text editor or IDE
- Java 17 or later
- Gradle 7.5+ or Maven 3.5+
- You can also import the code straight into your IDE:
  - Spring Tool Suite (STS)
  - IntelliJ IDEA
  - VSCode

How to complete this guide

Like most Spring Getting Started guides, you can start from scratch and complete each step or you can bypass basic setup steps that are already familiar to you. Either way, you end up with working code.

To **start from scratch**, move on to Starting with Spring Initializr.

To **skip the basics**, do the following:

- Download and unzip the source repository for this guide, or clone it using Git: `git clone https://github.com/spring-guides/gs-graphql-server.git`
- cd into `gs-graphql-server/initial`
- Jump ahead to A very short introduction to GraphQL.

When you finish, you can check your results against the code in `gs-graphql-server/complete`.

Starting with Spring Initializr

If you like, you can use this pre-populated Spring Initializr link to load the correct settings. Otherwise, continue on to manually set up the Initializr.

To manually initialize the project:

1. Navigate to https://start.spring.io. This service pulls in all the dependencies you need for an application and does most of the setup for you.
2. Choose either Gradle or Maven and the language you want to use. This guide assumes that you chose Java.
3. Click **Dependencies** and select **Spring for GraphQL** and **Spring Web**.
4. Click **Generate**.
5. Download the resulting ZIP file, which is an archive of a GraphQL application that is configured with your choices.

If your IDE has the Spring Initializr integration, you can complete this process from your IDE.

You can also fork the project from GitHub and open it in your IDE or other editor.

A very short introduction to GraphQL

GraphQL is a query language to retrieve data from a server. It is an alternative to REST, SOAP, or gRPC. In this tutorial, we will query the details for a specific book from an online store backend.

This is an example request you can send to a GraphQL server to retrieve book details:

```
query bookDetails {
  bookById(id: "book-1") {
    id
    name
    pageCount
    author {
      firstName
      lastName
    }
  }
}
```

This GraphQL request says:

- perform a query for a book with id "book-1"
- for the book, return id, name, pageCount and author
- for the author, return firstName and lastName

The response is in JSON. For example:

```
{
  "bookById": {
    "id":"book-1",
    "name":"Effective Java",
    "pageCount":416,
    "author": {
      "firstName":"Joshua",
      "lastName":"Bloch"
    }
  }
}
```

An important feature of GraphQL is that it defines a schema language, and that it is statically typed. The server knows exactly what types of objects requests can query and what fields those objects contain. Furthermore, clients can introspect the server to ask for schema details.

The word schema in this tutorial refers to a "GraphQL Schema", which is not related to other schemas like "JSON Schema" or "Database Schema".

The schema for the above query is:

```
type Query {
    bookById(id: ID): Book
}

type Book {
    id: ID
    name: String
    pageCount: Int
    author: Author
}

type Author {
    id: ID
    firstName: String
    lastName: String
}
```

This tutorial will focus on how to implement a GraphQL server with this schema in Java.

We've barely scratched the surface of what's possible with GraphQL. Further information can be found on the official GraphQL page.

Our example API: getting book details

These are the main steps to create a server with Spring for GraphQL:

1. Define a GraphQL schema
2. Implement the logic to fetch the actual data for a query

Our example app will be a simple API to get details for a specific book. It is not intended to be a comprehensive API.

Schema

In your Spring for GraphQL application prepared earlier, add a new file `schema.graphqls` to the `src/main/resources/graphql` folder with the following content:

```
type Query {
    bookById(id: ID): Book
}

type Book {
    id: ID
    name: String
    pageCount: Int
    author: Author
}

type Author {
    id: ID
    firstName: String
    lastName: String
}
```

Every GraphQL schema has a top-level `Query` type, and the fields under it are the query operations exposed by the application. Here the schema defines one query called `bookById` that returns the details of a specific book.

It also defines the types `Book` with fields `id`, `name`, `pageCount` and `author`, and the type `Author` with fields `firstName` and `lastName`.

The Domain Specific Language used above to describe a schema is called the Schema Definition Language or SDL. For more details, see the GraphQL documentation.

Source of the data

A key strength of GraphQL is that data can be sourced from anywhere. Data can come from a database, an external service, or a static in-memory list.

To simplify the tutorial, book and author data will come from static lists inside their respective classes.

Create the Book and Author data sources

Let's now create the `Book` and `Author` classes in the main application package, right next to `GraphQlServerApplication`. Use the following as their content:

```
package com.example.graphqlserver;

import java.util.Arrays;
import java.util.List;

public record Book (String id, String name, int pageCount, String authorId) {
    private static List<Book> books = Arrays.asList(
            new Book("book-1", "Effective Java", 416, "author-1"),
            new Book("book-2", "Hitchhiker's Guide to the Galaxy", 208, "author-2"),
            new Book("book-3", "Down Under", 436, "author-3")
    );

    public static Book getById(String id) {
        return books.stream()
                            .filter(book -> book.id().equals(id))
                            .findFirst()
                            .orElse(null);
    }
}
```

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```
package com.example.graphqlserver;

import java.util.Arrays;
import java.util.List;

public record Author (String id, String firstName, String lastName) {

    private static List<Author> authors = Arrays.asList(
            new Author("author-1", "Joshua", "Bloch"),
            new Author("author-2", "Douglas", "Adams"),
            new Author("author-3", "Bill", "Bryson")
    );

    public static Author getById(String id) {
        return authors.stream()
                            .filter(author -> author.id().equals(id))
                            .findFirst()
                            .orElse(null);
    }
}
```

Adding code to fetch data

Spring for GraphQL provides an annotation-based programming model. With controller annotated methods, we can declare how to fetch the data for specific GraphQL fields.

Add the following to `BookController.java` in the main application package, next to `Book` and `Author`:

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```
package com.example.graphqlserver;

import org.springframework.graphql.data.method.annotation.Argument;
import org.springframework.graphql.data.method.annotation.QueryMapping;
import org.springframework.graphql.data.method.annotation.SchemaMapping;
import org.springframework.stereotype.Controller;

@Controller
public class BookController {
    @QueryMapping
    public Book bookById(@Argument String id) {
        return Book.getById(id);
    }

    @SchemaMapping
    public Author author(Book book) {
        return Author.getById(book.authorId());
    }
}
```

By defining a method named `bookById` annotated with `@QueryMapping`, this controller declares how to fetch a `Book` as defined under the Query type. The query field is determined from the method name, but can also be declared on the annotation itself.

Spring for GraphQL uses `RuntimeWiring.Builder` that registers each such controller method as a GraphQL Java `graphql.schema.DataFetcher`. A `DataFetcher` provides the logic to fetch the data for a query or for any schema field. The Spring Boot starter for GraphQL has auto-configurations that automates this registration.

In the GraphQL Java engine, `DataFetchingEnvironment` provides access to a map of field-specific argument values. Use the `@Argument` annotation to have an argument bound to a target object and injected into the controller method. By default, the method parameter name is used to look up the argument, but can also be specified on the annotation itself.

This `bookById` method defines how to get a specific `Book`, but does not take care of fetching the related `Author`. If the request asks for the author information, GraphQL Java will need to fetch this field.

The `@SchemaMapping` annotation maps a handler method to a field in the GraphQL schema and declares it to be the `DataFetcher` for that field. The field name defaults to the method name, and the type name defaults to the simple class name of the source/parent object injected into the method. In this example, the field defaults to `author` and the type defaults to `Book`.

For more, see the documentation for the Spring for GraphQL annotated controller feature.

That's all the code we need!

Let's run our first query.

Running our first query

Enable the GraphiQL Playground

GraphiQL is a useful visual interface for writing and executing queries, and much more. Enable GraphiQL by adding this config to the `application.properties` file.

```
spring.graphql.graphiql.enabled=true
```

Boot the application

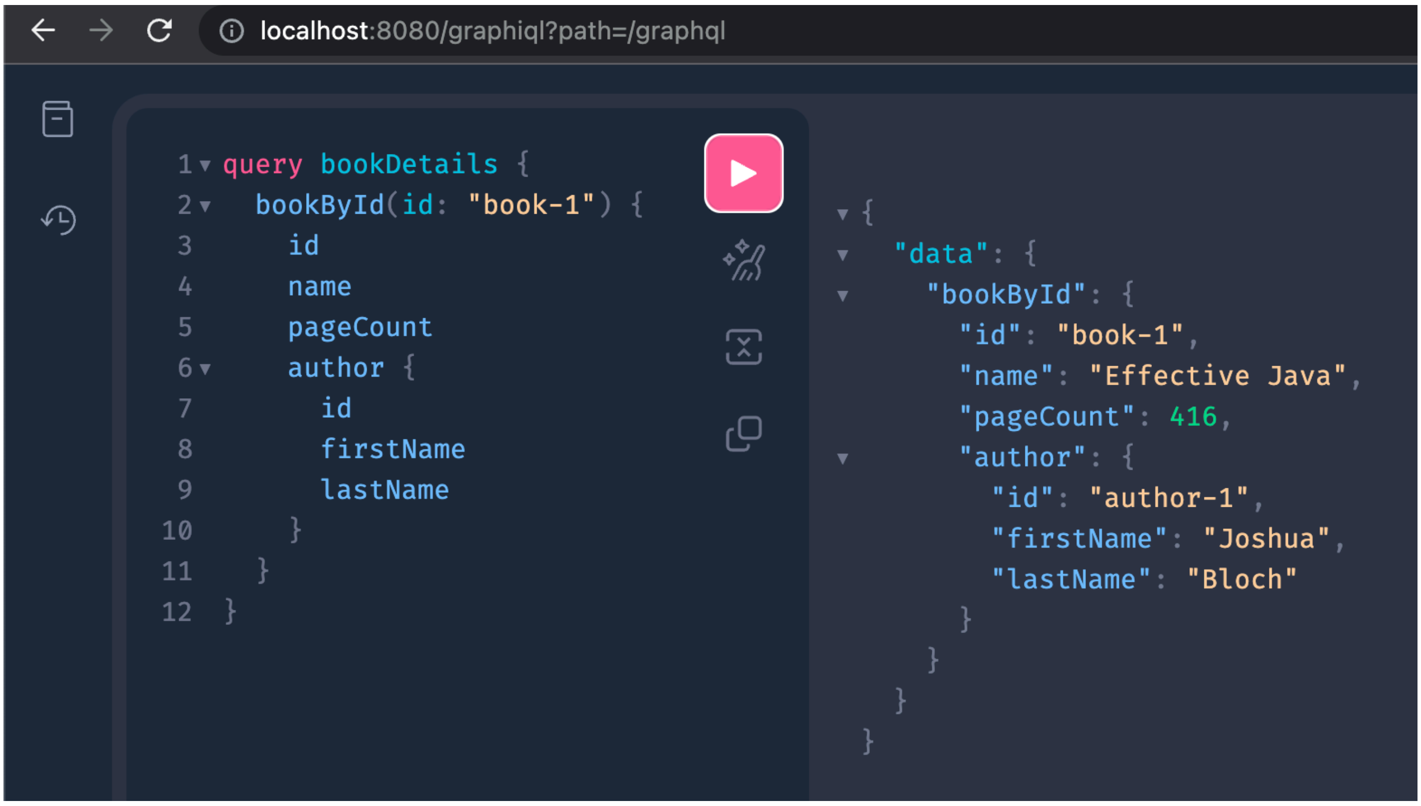
Start your Spring application. Navigate to http://localhost:8080/graphiql.

Run the query

Type in the query and click the play button at the top of the window.

```
query bookDetails {
  bookById(id: "book-1") {
    id
    name
    pageCount
    author {
      id
      firstName
      lastName
    }
  }
}
```

You should see a response like this.



```
localhost:8080/graphiql?path=/graphql
```

```
query bookDetails {
  bookById(id: "book-1") {
    id
    name
    pageCount
    author {
      id
      firstName
      lastName
    }
  }
}
```

```
{
  "data": {
    "bookById": {
      "id": "book-1",
      "name": "Effective Java",
      "pageCount": 416,
      "author": {
        "id": "author-1",
        "firstName": "Joshua",
        "lastName": "Bloch"
      }
    }
  }
}
```

Congratulations, you have built a GraphQL service and executed your first query! With the help of Spring for GraphQL, you were able to achieve this with only a few lines of code.

Testing

Spring for GraphQL provides helpers for GraphQL testing in the `spring-graphql-test` artifact. We have already included this artifact as part of the project generated by Spring Initializr.

Thoroughly testing a GraphQL service requires tests with different scopes. In this tutorial, we will write a `@GraphQlTest` slice test, which focuses on a single controller. There are other helpers to assist with full end-to-end integration tests and focused server side tests. For the full details, see the Spring for GraphQL Testing documentation and Auto-configured Spring for GraphQL tests in the Spring Boot documentation.

Let's write a controller slice test that verifies the same `bookDetails` query requested in the GraphiQL playground a few moments ago.

Add the following to a test file `BookControllerTests.java`. Save this file in a location within the `src/test/java/com/example/graphqlserver/` folder.

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```
package com.example.graphqlserver;

import org.junit.jupiter.api.Test;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.boot.test.autoconfigure.graphql.GraphQlTest;
import org.springframework.graphql.test.tester.GraphQlTester;

@GraphQlTest(BookController.class)
public class BookControllerTests {

    @Autowired
    private GraphQlTester graphQlTester;

    @Test
    void shouldGetFirstBook() {
        this.graphQlTester
                            .documentName("bookDetails")
                            .variable("id", "book-1")
                .execute()
                .path("bookById")
                .matchesJson("""
                    {
                        "id": "book-1",
                        "name": "Effective Java",
                        "pageCount": 416,
                        "author": {
                          "firstName": "Joshua",
                          "lastName": "Bloch"
                        }
                }
                """);
    }
}
```

This test refers to a GraphQL query similar to what we used in the GraphiQL Playground. It's parameterized with an `$id` to make it reusable. Add this query in a `bookDetails.graphql` file located in `src/test/resources/graphql-test`.

```
query bookDetails($id: ID) {
    bookById(id: $id) {
        id
        name
        pageCount
        author {
            id
            firstName
            lastName
        }
    }
}
```

Run the test and verify that the result is identical to the GraphQL query manually requested in the GraphiQL Playground.

The `@GraphQlTest` annotation is useful for writing controller slice tests, which are focused on a single controller. `@GraphQlTest` auto-configures the Spring for GraphQL infrastructure, without any transport nor server being involved. Automatic configuration enables us to write tests faster by skipping boilerplate code. As this is a focused slice test, only a limited number of beans are scanned including `@Controller` and `RuntimeWiringConfigurer`. For the list of scanned beans, see the documentation.

`GraphQlTester` is a contract that declares a common workflow for testing GraphQL requests, independent of transport. In our test, we provide a document with `documentName` with the required variables, then `execute` the request. We then select a part of the response with its JSON path and assert that the JSON at this location matches the expected result.

Congratulations! In this tutorial you built a GraphQL service, ran your first query, and wrote your first GraphQL test!