Spring(boot)

Matthias Colin

Spring

Framework Java with components to develop Backend Applications

A component Spring is often a wrapper to a JEE component

- Controller Web to deal with HTTP: Rest, MVC
- Spring Security: authentication, cryptography, CORS
- Spring Data: JPA, JDBC, MongoDB
- Reactive: asynchronous
- Tests
- Batch, Messaging
- Micro Services

Spring

Framework 2 in 1

- Spring 6: Web Application to deploy in a Java Application Server (Tomcat, Wildfly)
- Spring Boot 3: standalone application containing
  - All dependencies: JEE, Spring, others
  - Application Server: Tomcat, Jetty

Java SE

JDK 1.0	JDK 1.1	J2SE 1.2	J2SE 1.3	J2SE 1.4	**J2SE 5.0**	Java SE 6	Java SE 7	**Java SE 8**
1996	1997	1998	2000	2002	2004	2006	2011	2014
Oak		Playground	Kestrel	Merlin	Tiger	Mustang	Dolphin	Kenai

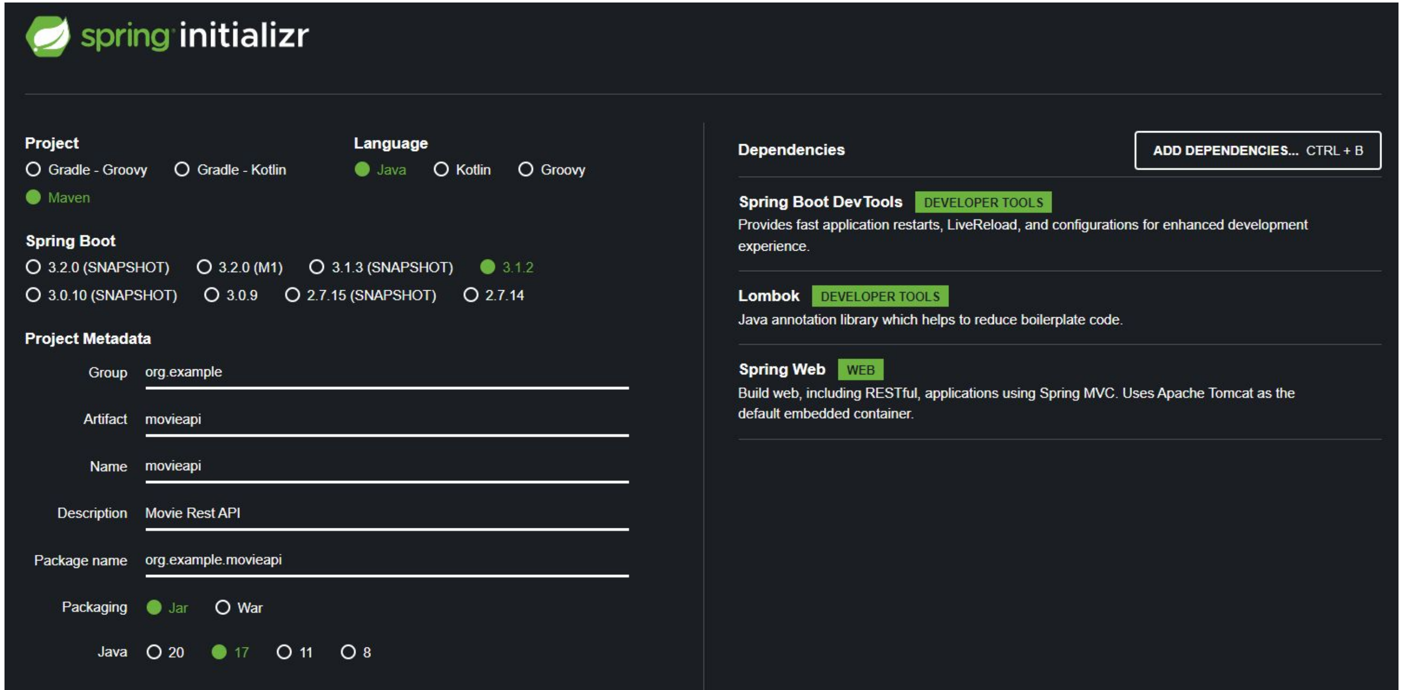
Java SE 9	Java SE 10	**Java SE 11 (LTS)**	…	**Java 17 (LTS)**	…	**Java SE 21 (LTS)**
2017-09	2018-03	2018-09		2021-09	…	2023-09

Spring and JEE

- Java EE 8 by Oracle: Spring 5, Spring Boot 2.7, Java **8-11**-17
  - javax.persistence.Entity (JPA)
  - javax.validation.constraints.NotNull (Bean Validation)
  - Tomcat 9
- Jakarta EE 9 (10) by Eclipse Foundation: Spring 6, Spring boot 3+, Java **17**
  - jakarta.persistence.Entity (JPA)
  - jakarta.validation.constraints.NotNull (Bean Validation)
  - Tomcat 10
- All Spring components are JEE Bean components
  - DI: Dependency Injection

Spring(boot)

- Main site: spring.io
- Spring Initializr: https://start.spring.io/



spring initializr

Project

Gradle - Groovy Gradle - Kotlin [✓ Maven]

Language

[✓ Java] Kotlin Groovy

Spring Boot

3.2.0 (SNAPSHOT) 3.2.0 (M1) 3.1.3 (SNAPSHOT) [✓ 3.1.2]
3.0.10 (SNAPSHOT) 3.0.9 2.7.15 (SNAPSHOT) 2.7.14

Project Metadata

Group	org.example
Artifact	movieapi
Name	movieapi
Description	Movie Rest API
Package name	org.example.movieapi
Packaging	[✓ Jar] War
Java	20 [✓ 17] 11 8

Dependencies

Spring Boot DevTools DEVELOPER TOOLS
Provides fast application restarts, LiveReload, and configurations for enhanced development experience.

Lombok DEVELOPER TOOLS
Java annotation library which helps to reduce boilerplate code.

Spring Web WEB
Build web, including RESTful, applications using Spring MVC. Uses Apache Tomcat as the default embedded container.

HTTP(S)

- Protocole de communication Client-Server
- Domaines
  - Web: HTML + CSS + images + …
  - Web Service : SOAP, WSDL (XML) by W3C
  - API Rest : HTTP + JSON (ou XML)
- Elements
  - Headers
    - Method: GET, POST, PUT/PATCH, DELETE
    - Url: http[s]://www.example.org/api/movies
    - Status:
      - 1xx: Information
      - 2xx: OK
      - 3xx: redirection
      - 4xx: mauvaise demande du client
      - 5xx: erreur serveur
    - Other Headers: Accept, User-Agent, Content-Type, Content-Length, Date
  - Body: HTML, CSS, IMG, JSON, XML, …

HTTP(2)

- Headers for Request/Response
  - Content-Type: MIME-TYPE (image/png, text/html, application/json, …, */*)
  - Accept: MIME-TYPE(s)
  - Content-Length
  - Date
  - Server

Spring Web

- Web MVC : Controller + view HTML (template)
- Web Services: SOAP + WSDL
- Rest API:
    - Expose a Repository as Rest Api
    - Rest Controller (variants)

Spring Boot Rest Controller

(De)Serialization default Content-Type:

- Simple data (String, int, double, boolean, …) : text/plain
- Object: application/json

For other media types: XML, CSV, … Spring just need a converter

Routing

2 ways

- A rest controller class (@RestController + @RequestMapping) with methods:
  - Entry point: method annotated with @GetMapping, @PostMapping, …
- A routing class : FunctionalRoute
  - Entry point: route => function

Example: controller running in tomcat listening at address localhost:8080

```
GET http://localhost:8080/api/movies/byTitle?t=Batman

@RestController @RequestMapping("/api/movies")
class  MovieController {
        @GetMapping("byTitle")
        Movie getByTitle(String title)
}
```

Classic Routing

Resource: /api/movies

method	path	semantic
GET		Read All Movies
GET	123	Read Movie #123
POST		Add new Movie
PUT/PATCH	123	Update Movie #123
DELETE	123	Delete Movie #123

Rest controller: params

- query param: url?t=Batman&y=2022
    - 1st param: name=t value=Batman
    - 2nd param: name=y value=2022
    - @RequestParam with validation:
        - Required
        - Conversion String => boolean, int, double, …, LocalDate, …
- path param: /api/movies/{id}
    - Example: /api/movie/123
    - @PathVariable
- body param: complex data (Collection, Custom Object)
    - @BodyRequest

Rest Controller: Custom Data

- Java class with default constructor and getters/setters
- Java 17 immutable Records
- Converter JSON: Jackson

Rest Controller Development

1. Define a service interface: MovieService
2. Write Unit Tests for all methods of controller: MovieController
3. Correct code of the methods tested until success

Bean Validation

- Specification JEE, provider Hibernate Validator
- Constraints:
  - Builtins: @NotNull, @NotBlank, @Min, @Size, …
  - Custom constraint
- Spring Rest Controller
  - @Valid request body
  - simple constraint on request params

Controller + error

- throw ResponseStatusException with status + message
- throw custom exception
  - annotated with @ResponseStatus
- throw already defined or custom exception + controller advice
  - HTTP status + message ou problem dto
  - Example: DataAccessException => CONFLICT, BAD REQUEST, …

DI: Dependency Injection

What can be injected: @Bean (java/jakarta EE)

Spring beans:

- @Component
- @Controller, @RestController
- @Service
- @Repository

Spring Data

https://spring.io/projects/spring-data

- JPA
- JDBC
- MongoDB
- others …

Java with RDBMS (2)

- JDBC
- specification java JEE: JPA (Java Persistence API) :
  - main provider Hibernate (https://hibernate.org/orm/)
  - ORM: Object Relational Mapper
- Spring Data: JPARepository
  https://spring.io/projects/spring-data-jpa

Java application with Relational Database

- communication appli Java <-> RDBMS
- langage commun de communication SQL
- JDBC : Java Database Connectivity (inclus Java SE)
  - Comment gérer des requêtes (insert, update, delete, select)
  - package java.sql et javax.sql
    - Driver : spécification d’un driver éditeur
    - Connection : établir une connexion avec la base de données
      - host, port, dbname, user (, password)
    - DataSource : pool de connexion(s)
    - Statement : exécuter une requête
      - select * from movies where year = 2020
    - PreparedStatement : exécuter une requête préparée
      - select * from movies where year = ?
      - paramètre #1 pourra être 2020, 2021, …
    - ResultSet : résultat d’une requête
  - Driver JDBC apporté par l’éditeur ou la communauté
    - postgresql-42.2.20.jar
- JNDI : externaliser les settings JDBC de l’appli => serveur appli

ORM in Object Oriented Languages

- Java: Java/Jakarta EE JPA + provider Hibernate ORM (or Eclipse Link)
- Python: Django ORM, SQLAlchemy
- .NET: Entity Framework
- php: symfony doctrine

ORM JPA

JPA = Java Persistence API

- J2EE, Java EE, JEE: JPA 1 and JPA 2
  - Hibernate 1 to 5
  - package javax.persistence.*
- Jakarta EE: JPA 2 and 3 (3.1)
  - Hibernate 6
  - package jakarta.persistence.*

ORM

ORM = Object Relational Mapper

- entity: class Java: Movie <-> table DB: movies
  - attribute: String title <-> column title
    - **id** <-> column id (Primary Key)
- association:
  - Movie-Person director <-> column director_id (FK)
  - Movie-Person; actors <-> table play
- crud
  - save(movie: Movie) <-> insert into movies …
  - List<Movie> res = read(...) <-> select … from movies where …

Spring JPA Repository

- CRUD
  - save, saveAll, saveAndFlush, saveAllAndFlush
  - (update)
  - delete, deleteById, …
  - findById
  - findAll
  - findAll(Sort)
  - findAll(Pageable)
  - findAll(Example)
- Add business methods
  - with method name only: SQL query automatically generated
  - with JPA JPQL query
  - with JPA entity graph
  - with JPA api criteria
  - with native SQL (vendor dependant)

JPA

- class tagged with @Entity
  - default constructor
  - getter/setter for each persistent field
  - by default all fields are persistent
  - primary key: @Id, @GeneratedValue
    - strategy: IDENTITY, SEQUENCE, AUTO, TABLE, UUID
  - tuning names, constraints
    - class: @Table
    - fields: @Column

JPA Associations

- Kind
  - One to one
  - Many to one
  - One to many
  - Many to many
- Navigability
  - Unidirectional
    - Queries: add query to cross association backward
    - Update: +
  - Bidirectional
    - Queries: +
    - Update: -

SQL vocabulary

CRUD: DML = **Data Manipulation** Language

- INSERT
- UPDATE
- DELETE
- SELECT

DDL = **Data Definition** Language: table, view, index, user, …

- CREATE
- ALTER
- DROP

Hibernate settings

- dialect: H2, MariaDB, MySQL, PostgreSQL, …

  https://docs.jboss.org/hibernate/orm/6.2/userguide/html_single/Hibernate_User_Guide.html#database-dialect

- hbm2ddl.auto: DDL (JPA: jakarta.persistence.schema-generation.database.action)
    - none: no ddl generation (production)
    - update: create new table, alter existing table
    - create: drop previous version of all tables, then create all tables
    - create-drop: idem create + drop all tables when shutting down hibernate
- show_ql: show DDL and DML SQL queries
- format_sql: pretty print SQL

JPA Queries

- Traduction to native SQL according to chosen dialect (MariaDB, PostgreSQL, …)
  - Advantage: Java code independent from DB vendor
  - Techniques
    - JPQL: pseudo SQL with entities (not tables)
    - API Criteria: Java Code with methods .from(), .where(), .join()
- Native SQL
  - Drawback: Java code dependent from DB vendor

Spring AOP

AOP = Aspect Oriented Programming

adding additional behavior to existing code without modifying the code itself.

- Include AspectJ from Eclipse

  https://eclipse.dev/aspectj/doc/released/progguide/index.html

  https://www.digitalocean.com/community/tutorials/spring-aop-example-tutorial-aspect-advice-pointcut-joinpoint-annotations

  https://howtodoinjava.com/spring-aop/aspectj-pointcut-expressions/

- Spring boot starter

AOP Pointcuts and Advices

- Pointcuts:
  - execution
  - within
  - args
  - @annotable
  - custom
- Advices
  - @Before
  - @After
  - @AfterReturning
  - @AfterThrow
  - @Around

Spring Security

- Authentication
- Client-Server
  - CORS
  - CSRF
  - …

Reactive

Asynchronous in Java:

- ThreadPool, ForkJoinPool, Future

Spring

- Reactor project: Publisher, Mono, Flux
- WebFlux: rest controller
- Reactive Repository:
  - NoSQL: MongoDB, Redis, Cassandra, …
  - SQL: R2DBC repo

Hibernate: Hibernate Reactive ORM

Article comparatif:
https://medium.com/geekculture/spring-data-jpa-spring-data-r2dbc-hibernate-reactive-bcc43e321566

Examples

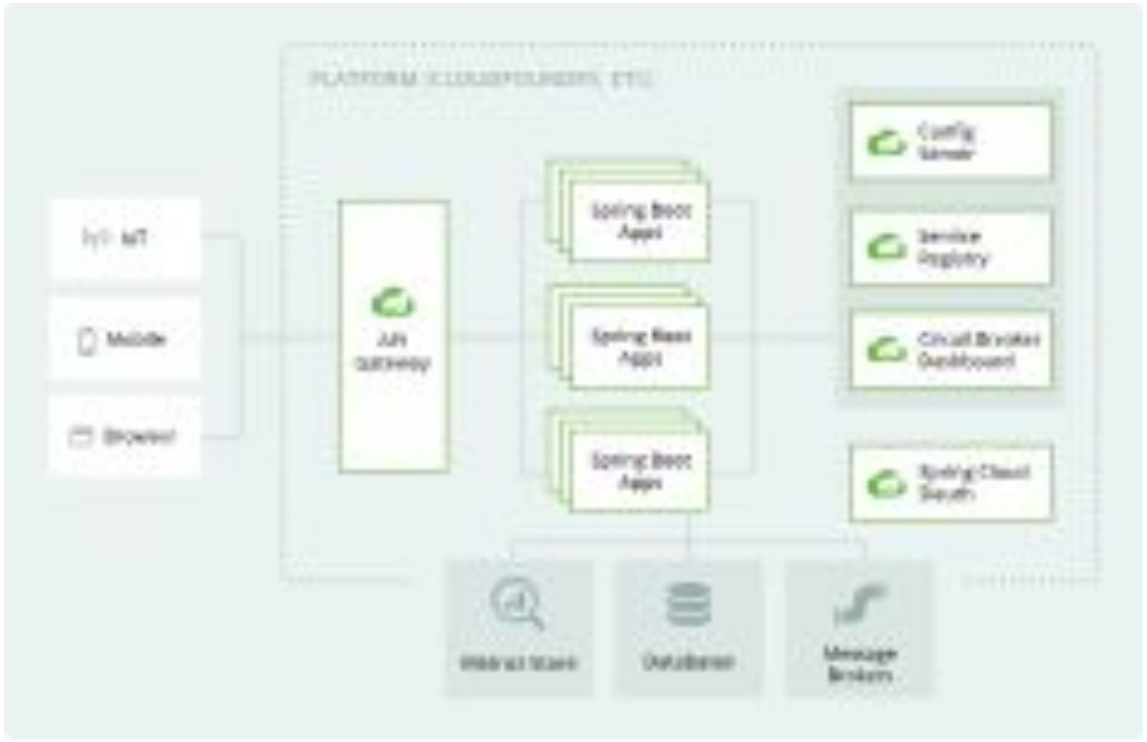
- WebFlux + R2DBC Reactive Repository
- WebFlux + MongoDB Reactive Repository

Association handling example:

https://medium.com/pictet-technologies-blog/reactive-programming-with-spring-data-r2dbc-ee9f1c24848b

https://gokhana.dev/spring-r2dbc-for-reactive-relational-databases-in-reactive-programming/

Micro Services



Examples

Registry

https://spring.io/guides/gs/service-registration-and-discovery/

API Gateway

https://spring.io/guides/gs/gateway/

Run / Deploy

- Target bootRun from maven or gradle
- java -jar movieapi.jar (fat jar or classpath defined)
    - Optional: application.properties to add or override properties from jar
    - Option -Dsomeproperty=value
- docker

Miscellaneous

- WebSocket
  https://spring.io/guides/gs/messaging-stomp-websocket/
- Batch
  https://spring.io/projects/spring-batch
- Messaging (JMS)
  https://spring.io/guides/gs/messaging-jms/
- GraphQL
  https://spring.io/projects/spring-graphql
- Vault
  https://spring.io/projects/spring-vault