
Pivotal
Why Spring ❤ Kotlin
Sébastien Deleuze
@sdeleuze

Today most popular way to build web applications

Spring Boot

+

Let’s see why and how far we can go with ...

Spring Boot

+

Kotlin

Introducing Kotlin support in Spring Framework 5.0

À l'origine en anglais

Introducing Kotlin support in Spring Framework 5.0

Following the Kotlin support on start.spring.io we introduced a few months ago, we have continued to work to ensure that Spring and Kotlin play well together. One of the key strengths of Kotlin is...

spring.io

RETWEETS 214 J'AIME 231

15:06 - 4 janv. 2017

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Sample Spring Boot blog application

SPRING BLOG

Creating a blog using Spring Boot 2.0, Spring WebFlux functional API and Kotlin

RECENT POSTS

Reactor Bismuth is out

By **Simon**, on **September 28th 2017**

It is my great pleasure to announce the GA release of **Reactor Bismuth**, which notably encompasses `reactor-core` **3.1.0.RELEASE** and `reactor-netty` **0.7.0.RELEASE** \uD83C\uDF89

Introducing Kotlin support in Spring Framework 5.0

By **Sebastien**, on **January 4th 2017**

Following the Kotlin support on start.spring.io we introduced a few months ago, we have continued to work to ensure that Spring and Kotlin play well together.

Spring Framework 5.0 goes GA

By **Juergen**, on **September 28th 2017**

Dear Spring community, It is my pleasure to announce that, after more than a year of milestones and RCs and almost two years of development overall, Spring Framework 5.0 is finally generally available as 5.0.0.RELEASE from repo.spring.io and Maven Central!

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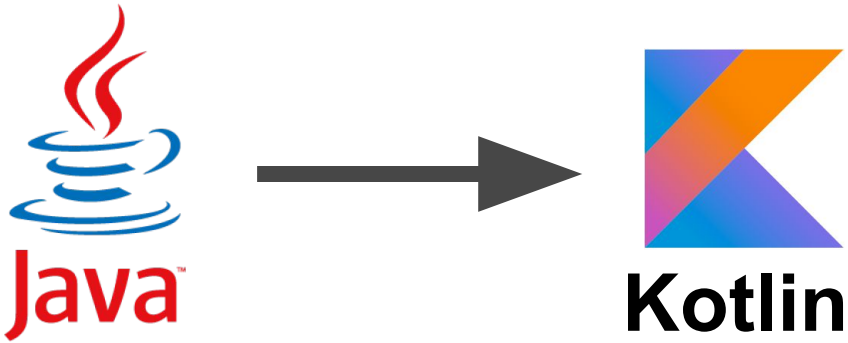
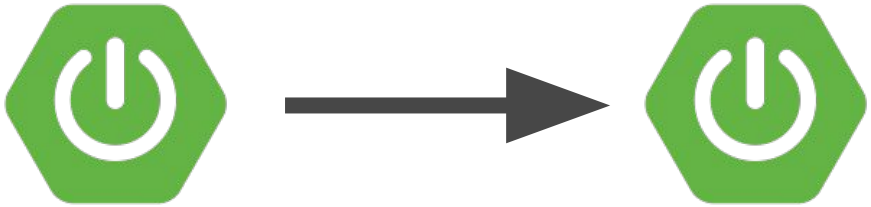
Step 1



Step 2

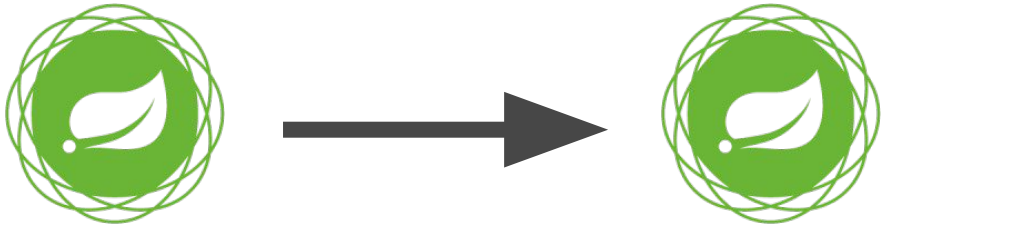


Spring Boot 1

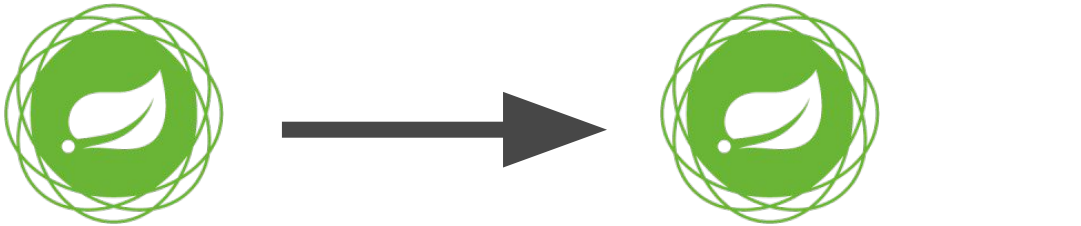
Spring Boot 2

based on Spring Framework 5

Step 3



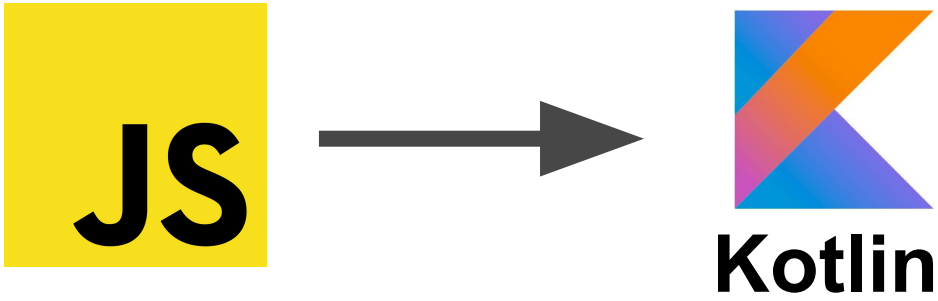
Step 4



Spring WebFlux
@nnotations

Spring WebFlux
Functional API & Kotlin DSL

Step 5



Step 1 Kotlin

Step 2 Boot 2

Step 3 WebFlux @annotations

Step 4 Functional & DSL

Step 5 Kotlin for frontend

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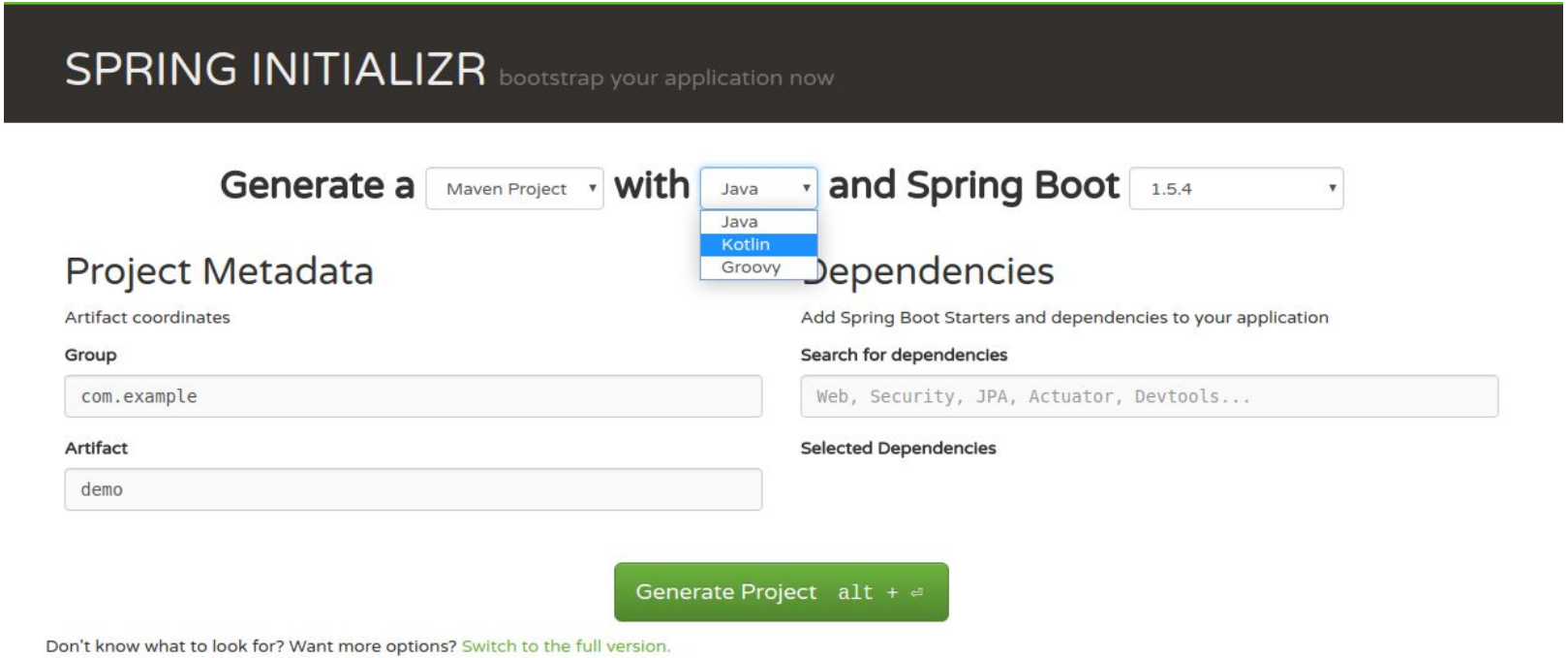
https://start.spring.io/#!language=kotlin



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kotlin-spring compiler plugin

Automatically open Spring annotated classes and methods

Without kotlin-spring plugin

```
@SpringBootApplication
open class Application {

  @Bean
  open fun foo() = Foo()

  @Bean
  open fun bar(foo: Foo) = Bar(foo)

}
```

With kotlin-spring plugin

```
@SpringBootApplication
class Application {

  @Bean
  fun foo() = Foo()

  @Bean
  fun bar(foo: Foo) = Bar(foo)

}
```

Domain model

```kotlin
@Document
data class Post(
    @Id val slug: String,
    val title: String,
    val headline: String,
    val content: String,
    @DBRef val author: User,
    val addedAt: LocalDateTime = now())

@Document
data class User(
        @Id val login: String,
        val firstname: String,
        val lastname: String,
        val description: String? = null)
```

```java
@Document
public class Post {

   @Id
   private String slug;

   private String title;

   private LocalDateTime addedAt;

   private String headline;

   private String content;

   @DBRef
   private User author;


   public Post() {
   }

   public Post(String slug, String title, String
headline, String content, User author) {
       this(slug, title, headline, content, author,
LocalDateTime.now());
   }

   public Post(String slug, String title, String
headline, String content, User author, LocalDateTime
addedAt) {
       this.slug = slug;
       this.title = title;
       this.addedAt = addedAt;
       this.headline = headline;
       this.content = content;
       this.author = author;
   }

   public String getSlug() {
       return slug;
   }

   public void setSlug(String slug) {
       this.slug = slug;
   }

   public String getTitle() {
       return title;
   }
```

Spring MVC controller written in Java

```java
@RestController
public class UserController {

    private final UserRepository userRepository;

    public UserController(UserRepository userRepository) {
        this.userRepository = userRepository;
    }

    @GetMapping("/user/{login}")
    public User findOne(@PathVariable String login) {
        return userRepository.findOne(login);
    }

    @GetMapping("/user")
    public Iterable<User> findAll() {
        return userRepository.findAll();
    }

    @PostMapping("/user")
    public User save(@RequestBody User user) {
        return userRepository.save(user);
    }
}
```

Spring MVC controller written in Kotlin

```
@RestController
class UserController(val repo: UserRepository) {

  @GetMapping("/user/{id}")
  fun findOne(@PathVariable id: String) = repo.findOne(id)

  @GetMapping("/user")
  fun findAll() = repo.findAll()

  @PostMapping("/user")
  fun save(@RequestBody user: User) = repo.save(user)
}
```

Inferred type hints in IDEA

```
@RestController
class UserController(val repo: UserRepository) {
    @GetMapping("/user/{id}")
    fun findOne(@PathVariable id: String) : User = repo.findOne(id)

    @GetMapping("/user")
    fun findAll() : List<User> = repo.findAll()

    @PostMapping("/user")
    fun save(@RequestBody user: User) : Unit = repo.save(user)
}
```

Settings
Editor
General
Appearance
Show parameter name hints
Select Kotlin
Check “Show function/property/local value return type hints”

Expressive test names with backticks

```
class EmojTests {

    @Test
    fun `Why Spring ❤ Kotlin?`() {
        println("Because I can use emoj in function names \uD83D\uDE09")
    }

}
```

```
> Because I can use emoj in function names 😉
```

Step 1 Kotlin

Step 2 Boot 2

Step 3 WebFlux @annotations

Step 4 Functional & DSL

Step 5 Kotlin for frontend

Spring ❤ Kotlin

and officially supports it

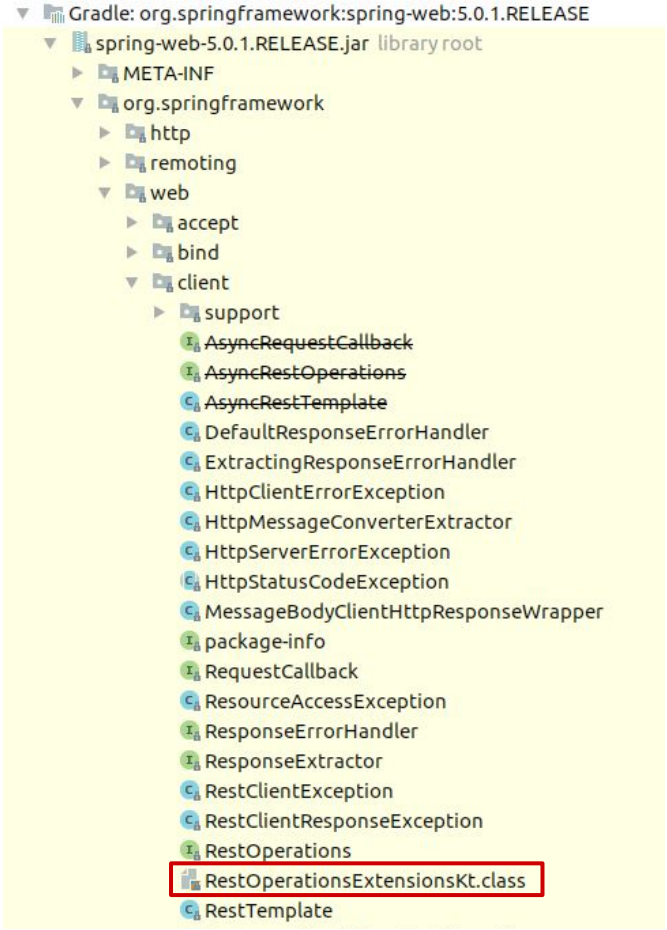
Spring Framework 5

Reactor Core 3.1

Spring Data Kay

Spring Boot 2 (late 2017)

Kotlin bytecode builtin in Spring JARs



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Kotlin support reference documentation

https://goo.gl/uwyjQn

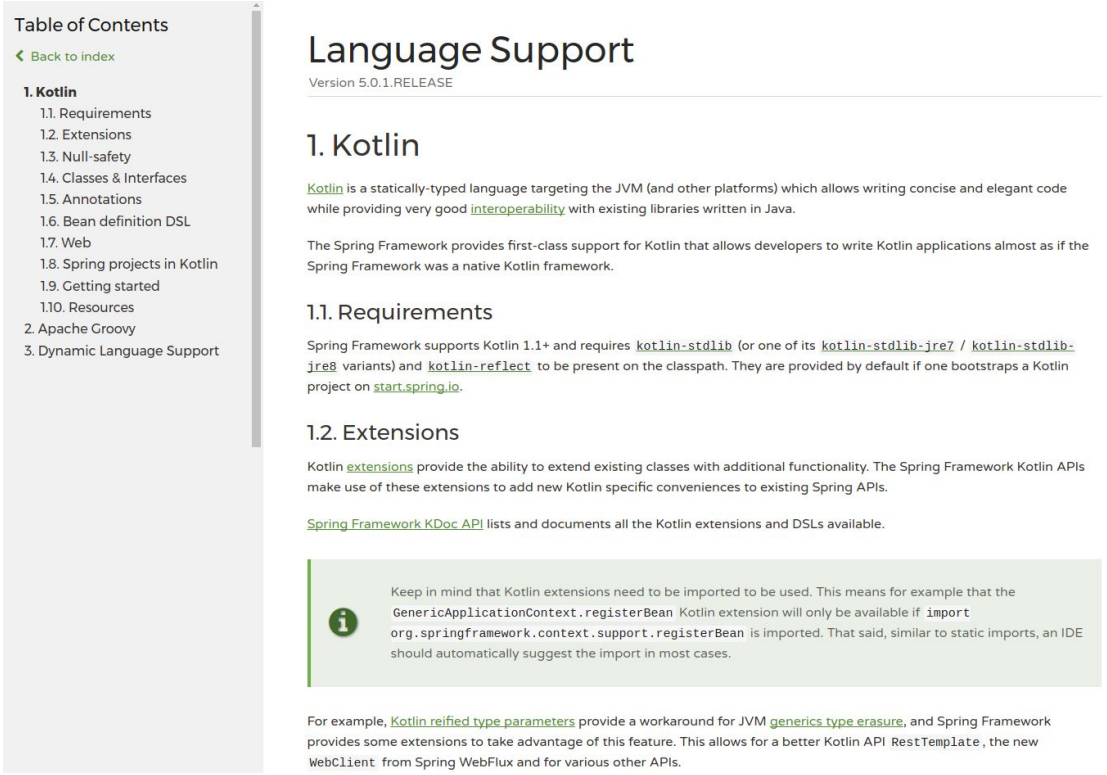

Table of Contents

Back to index

Language Support

Version 5.0.1.RELEASE

1. Kotlin

Kotlin is a statically-typed language targeting the JVM (and other platforms) which allows writing concise and elegant code while providing very good interoperability with existing libraries written in Java.

The Spring Framework provides first-class support for Kotlin that allows developers to write Kotlin applications almost as if the Spring Framework was a native Kotlin framework.

1.1. Requirements

Spring Framework supports Kotlin 1.1+ and requires `kotlin-stdlib` (or one of its `kotlin-stdlib-jre7` / `kotlin-stdlib-jre8` variants) and `kotlin-reflect` to be present on the classpath. They are provided by default if one bootstraps a Kotlin project on start.spring.io.

1.2. Extensions

Kotlin extensions provide the ability to extend existing classes with additional functionality. The Spring Framework Kotlin APIs make use of these extensions to add new Kotlin specific conveniences to existing Spring APIs.

Spring Framework KDoc API lists and documents all the Kotlin extensions and DSLs available.

> Keep in mind that Kotlin extensions need to be imported to be used. This means for example that the `GenericApplicationContext.registerBean` Kotlin extension will only be available if `import org.springframework.context.support.registerBean` is imported. That said, similar to static imports, an IDE should automatically suggest the import in most cases.

For example, Kotlin reified type parameters provide a workaround for JVM generics type erasure, and Spring Framework provides some extensions to take advantage of this feature. This allows for a better Kotlin API `RestTemplate`, the new `WebClient` from Spring WebFlux and for various other APIs.

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Kotlin API documentation

https://goo.gl/svCLL1

spring-framework / org.springframework.web.reactive.function.server

Package org.springframework.web.reactive.function.server

Types

RouterFunctionDsl	open class RouterFunctionDsl Provide a RouterFunction Kotlin DSL in order to be able to write idiomatic Kotlin code.

Functions

body	fun <T : Any> BodyBuilder.body(publisher: Publisher<T>): Mono<ServerResponse> Extension for ServerResponse.BodyBuilder.body providing a body(Publisher<T>) variant.
bodyToFlux	fun <T : Any> ServerRequest.bodyToFlux(): Flux<T> Extension for ServerRequest.bodyToFlux providing a bodyToFlux<Foo>() variant leveraging Kotlin reified type parameters.
bodyToMono	fun <T : Any> ServerRequest.bodyToMono(): Mono<T> Extension for ServerRequest.bodyToMono providing a bodyToMono<Foo>() variant leveraging Kotlin reified type parameters.
bodyToServerSentEvents	fun <T : Any> BodyBuilder.bodyToServerSentEvents(publisher: Publisher<T>): Mono<ServerResponse> Extension for ServerResponse.BodyBuilder.body providing a bodyToServerSentEvents(Publisher<T>) variant.
router	fun router(routes: RouterFunctionDsl.() -> Unit): RouterFunction<ServerResponse> Allow to create easily a RouterFunction<ServerResponse> from a Kotlin router DSL based on the same building blocks than the Java one

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Run SpringApplication with Boot 1

```
@SpringBootApplication
class Application

fun main(args: Array<String>) {
     SpringApplication.run(Application::class.java, *args)
}
```

Run SpringApplication with Boot 2

```
@SpringBootApplication
class Application

fun main(args: Array<String>) {
    runApplication<FooApplication>(*args)
}
```

Declaring additional beans

```
@SpringBootApplication
class Application {

    @Bean
    fun foo() = Foo()

    @Bean
    fun bar(foo: Foo) = Bar(foo)
}

fun main(args: Array<String>) {
    runApplication<FooApplication>(*args)
}
```

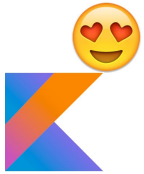
Customizing SpringApplication

```
@SpringBootApplication
class Application {

    @Bean
    fun foo() = Foo()

    @Bean
    fun bar(foo: Foo) = Bar(foo)
}

fun main(args: Array<String>) {
    runApplication<FooApplication>(*args) {
        setBannerMode(Banner.Mode.OFF)
    }
}
```

Array-like Kotlin extension for Model

```kotlin
operator fun Model.set(attributeName: String, attributeValue: Any) {
  this.addAttribute(attributeName, attributeValue)
}
```


```java
@GetMapping("/")
public String blog(Model model) {
    model.addAttribute("title", "Blog");
    model.addAttribute("posts", postRepository.findAll());
    return "blog";
}
```



```kotlin
@GetMapping("/")
fun blog(model: Model): String {
    model["title"] = "Blog"
    model["posts"] = repository.findAll()
    return "blog"
}
```

Reified type parameters Kotlin extension

Goodbye type erasure, we are not going to miss you at all!

```
inline fun <reified T: Any> RestOperations.getForObject(url: URI): T? =
        getForObject(url, T::class.java)
```


```
List<Post> posts = restTemplate.exchange(
    "/api/post/", HttpMethod.GET, null,
    new ParameterizedTypeReference<List<Post>>(){}).getBody();
```

```
val posts = restTemplate.getForObject<List<Post>>("/api/post/")
```

Leveraging Kotlin nullable information

To determine `@RequestParam` or `@Autowired` required attribute

```
@Controller  // foo is mandatory, bar is optional
class FooController(val foo: Foo, val bar: Bar?) {

    @GetMapping("/")  // Equivalent to @RequestParam(required=false)
    fun foo(@RequestParam baz: String?) = ...

}
```

Null safety of Spring APIs

By default, Kotlin consider Java types as platform types (unknown nullability)


```java
// Spring Framework RestOperations.java
public interface RestOperations {

    URI postForLocation(String url,
                        Object request,
                        Object ... uriVariables)

}
```

```
postForLocation(url: String!, request: Any!, varags uriVariables: Any!): URI!
```

Null safety of Spring APIs

Nullability annotations meta annotated with JSR 305 for generic tooling support

```java
// Spring Framework package-info.java
@NonNullApi
package org.springframework.web.client;

// Spring Framework RestOperations.java
public interface RestOperations {

    @Nullable
    URI postForLocation(String url,
                        @Nullable Object request,
                        Object... uriVariables)

}
```

```
postForLocation(url: String, request: Any?, varargs uriVariables: Any): URI?
```

@ConfigurationProperties

Not yet available

Spring Boot 1

```
@ConfigurationProperties("foo")
class FooProperties {
    var baseUri: String? = null
    val admin = Credential()

    class Credential {
        var username: String? = null
        var password: String? = null
    }
}
```

Spring Boot 2

```
@ConfigurationProperties("foo")
interface FooProperties {
    val baseUri: String
    val admin: Credential

    interface Credential {
        val username: String
        val password: String
    }
}
```

Data classes would be also interesting to support, but they are likely not going to be support in Boot 2, see issue #8762 for more details

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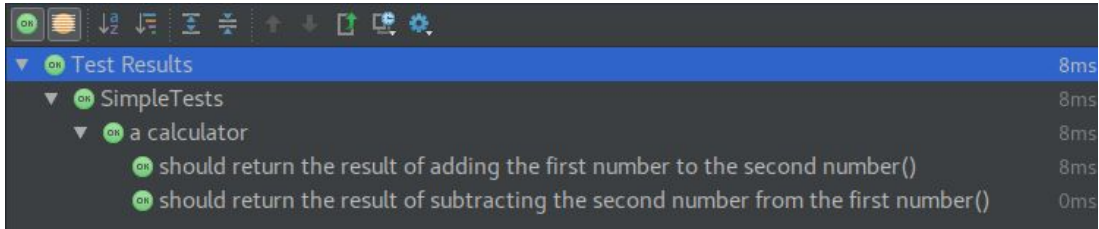
JUnit 5 supports non-static @BeforeAll @AfterAll

With “per class” lifecycle defined via `junit-platform.properties` or `@TestInstance`

```
class IntegrationTests {

  private val application = Application(8181)
  private val client = WebClient.create("http://localhost:8181")

  @BeforeAll
  fun beforeAll() { application.start() }

  @Test
  fun test1() { // ... }

  @Test
  fun test2() { // ... }

  @AfterAll
  fun afterAll() { application.stop() }

}
```

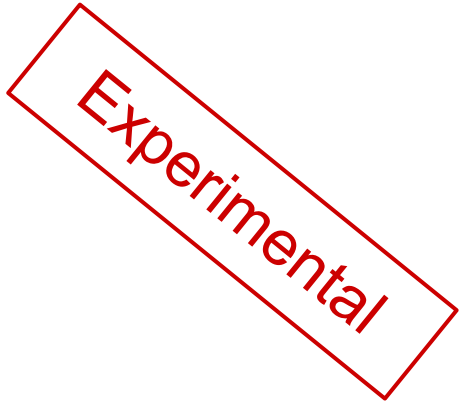
Specification-like tests with Kotlin and JUnit 5

```kotlin
class SimpleTests {

  @Nested
  @DisplayName("a calculator")
  inner class Calculator {
     val calculator = SampleCalculator()

     @Test
     fun `should return the result of adding the first number to the second number`() {
        val sum = calculator.sum(2, 4)
        assertEquals(6, sum)
     }

     @Test
     fun `should return the result of subtracting the second number from the first number`() {
        val subtract = calculator.subtract(4, 2)
        assertEquals(2, subtract)
     }
  }
}
```



Kotlin type-safe templates

https://github.com/sdeleuze/kotlin-script-templating



➔ Available via Spring MVC & WebFlux JSR-223 support
➔ Regular Kotlin code, no new dialect to learn
➔ Extensible, refactoring and auto-complete support
➔ Need to cache compiled scripts for good performances

```
import io.spring.demo.*
"""
${include("header")}
<h1>${i18n("title")}</h1>
<ul>
   ${users.joinToLine{ "<li>${i18n("user")} ${it.name}</li>" }}
</ul>
${include("footer")}
"""
```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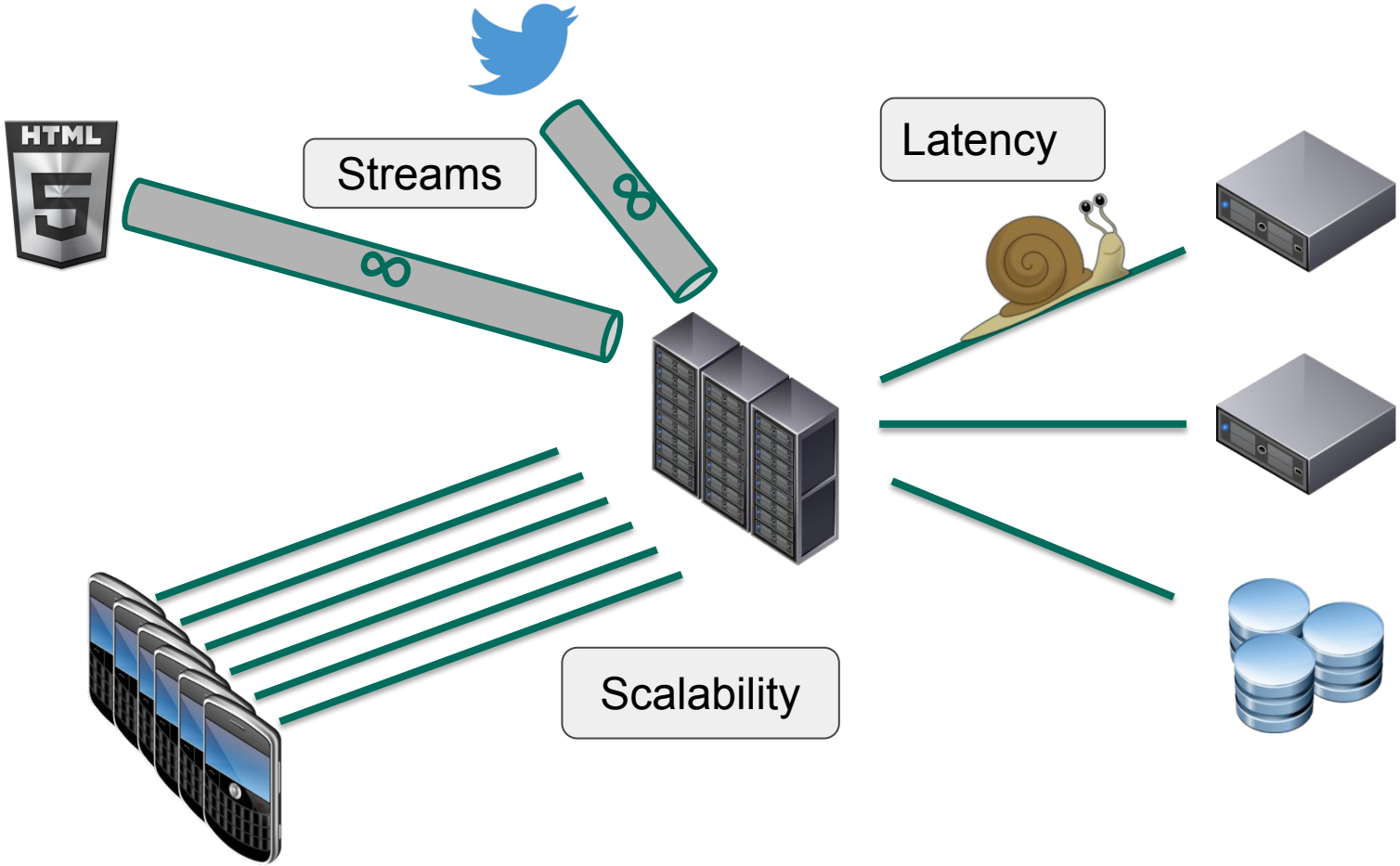
Step 1 Kotlin
Step 2 Boot 2
Step 3 WebFlux @nnotations
Step 4 Functional & DSL
Step 5 Kotlin for frontend

Spring Framework 5 comes with 2 web stacks

Spring MVC
Blocking
Servlet

Spring WebFlux
Non-blocking
Reactive Streams



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Reactive Streams

Subscribe then
request(n) data
(Backpressure)

Publisher

Subscriber

0..N data then
0..1 (Error | Complete)

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WebFlux supports various async and Reactive API

CompletableFuture
Flow.Publisher

RxJava

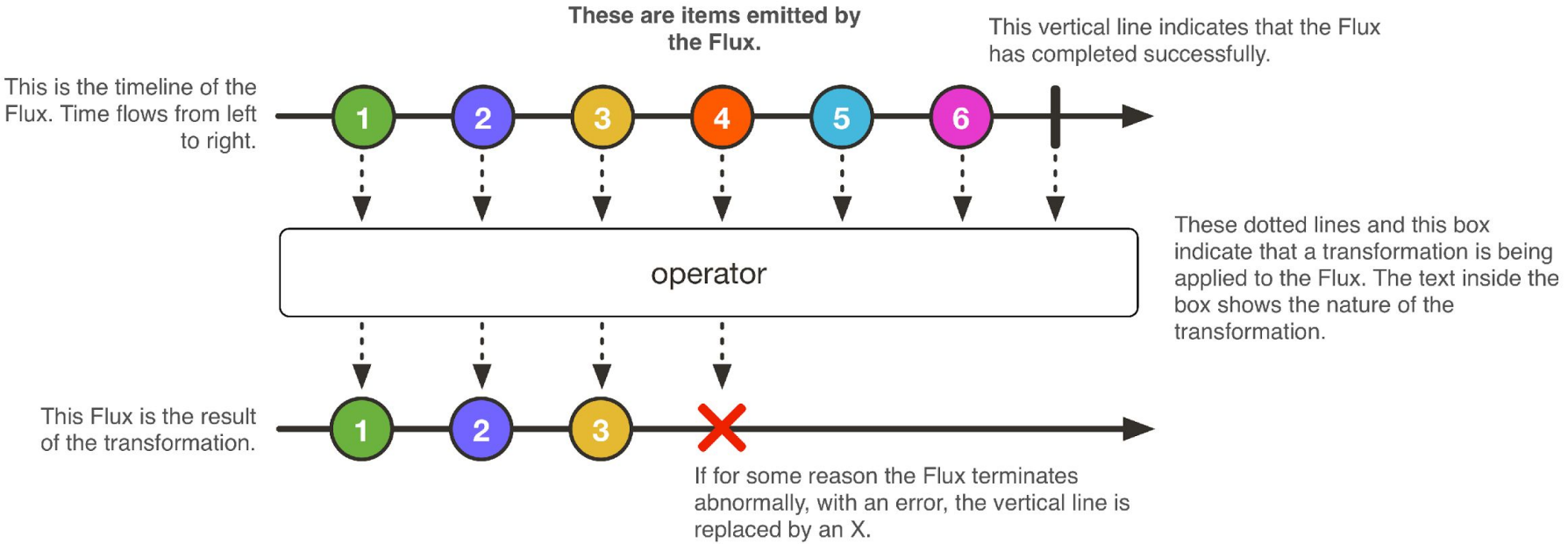
Reactor

Akka Streams
(via Reactive Streams)

Let’s focus on Reactor for now

Reactor

Reactor `Flux` is a `Publisher` for 0..n elements



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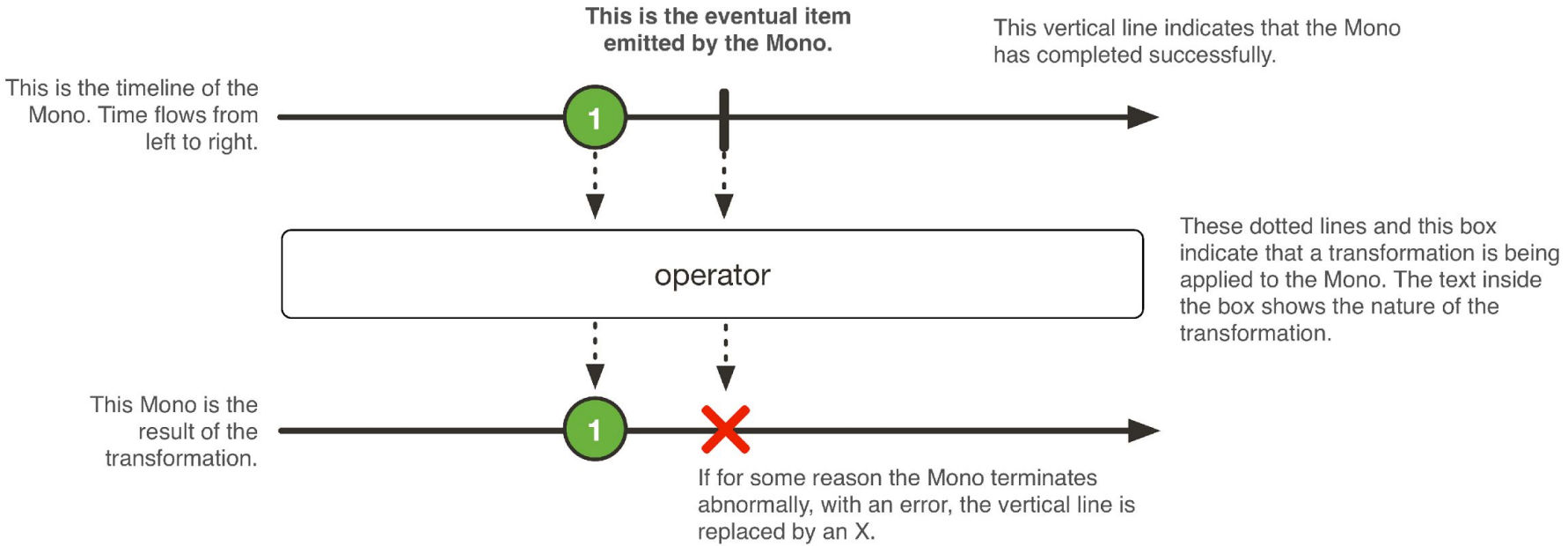
Reactor `Mono` is a `Publisher` for 0..1 element



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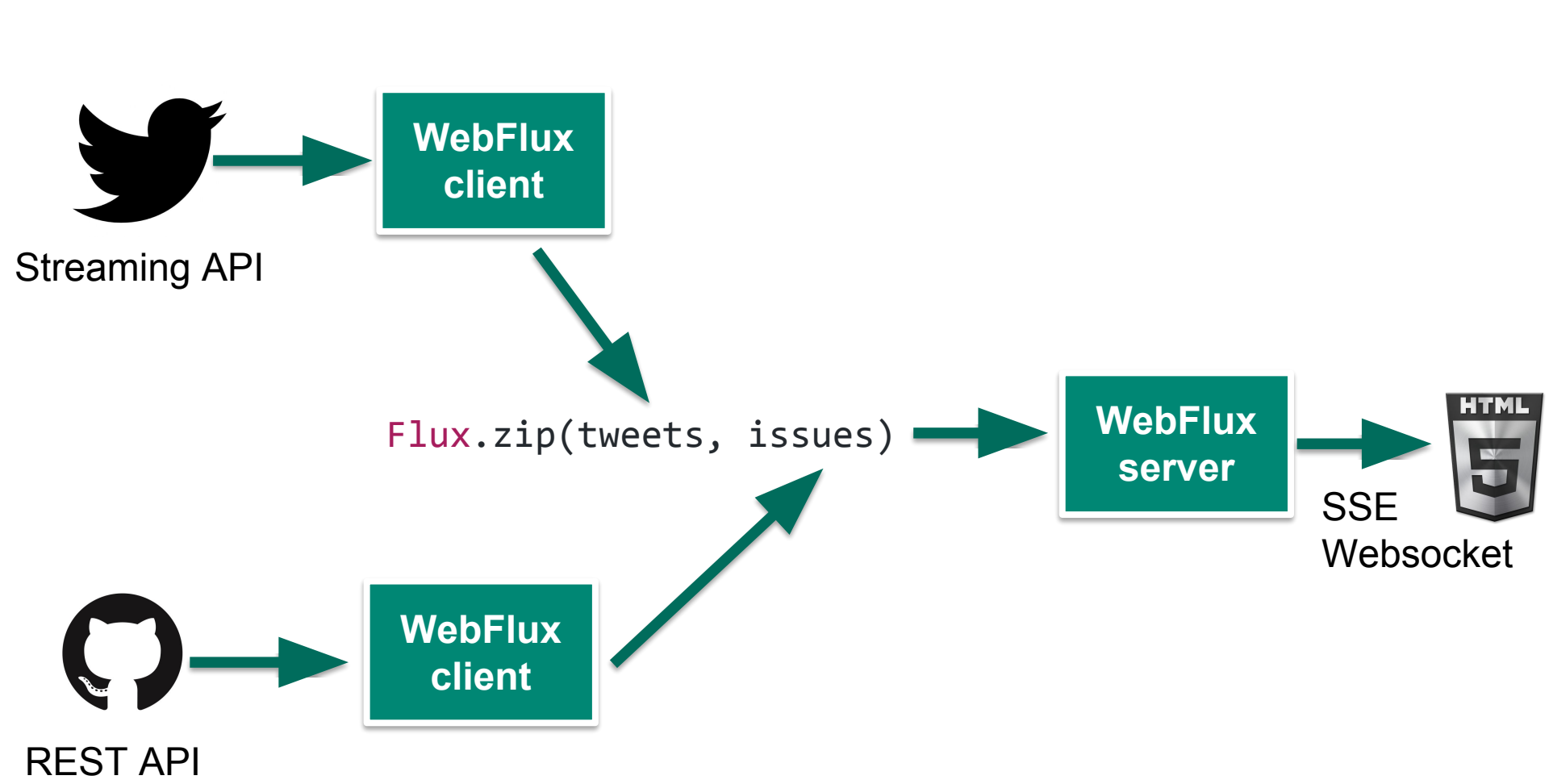
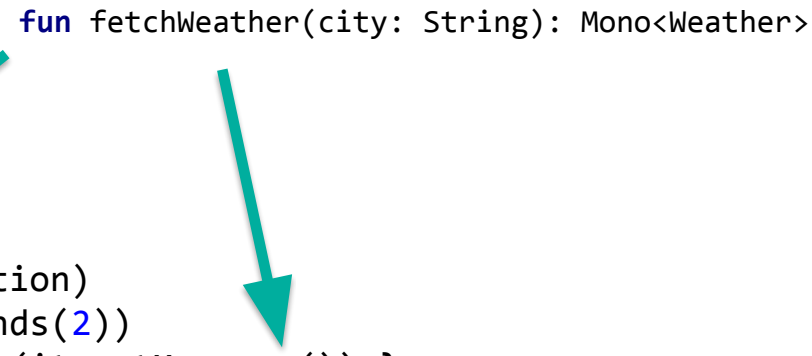

WebFlux client
Streaming API
Flux.zip(tweets, issues)
WebFlux server
HTML
SSE
Websocket
WebFlux client
REST API

Reactive APIs are functional



```
fun fetchWeather(city: String): Mono<Weather>
```

```
val location = "Lyon, France"

mainService.fetchWeather(location)
     .timeout(Duration.ofSeconds(2))
     .doOnError { logger.error(it.getMessage()) }
     .onErrorResume { backupService.fetchWeather(location) }
     .map { "Weather in ${it.getLocation()} is ${it.getDescription()}" }
     .subscribe { logger.info(it) }
```

Reactor Kotlin extensions

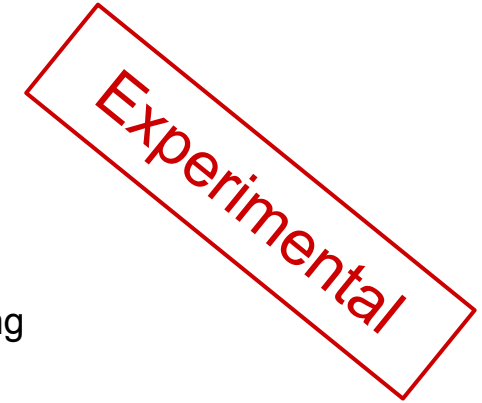
Java	Kotlin with extensions
`Mono.just("foo")`	`"foo".toMono()`
`Flux.fromIterable(list)`	`list.toFlux()`
`Mono.error(new RuntimeException())`	`RuntimeException().toMono()`
`flux.ofType(User.class)`	`flux.ofType<User>()`
`StepVerifier.create(flux).verifyComplete()`	`flux.test().verifyComplete()`
`MathFlux.averageDouble(flux)`	`flux.average()` 😍

Spring WebFlux with annotations

```
@RestController
class ReactiveUserController(val repository: ReactiveUserRepository) {

  @GetMapping("/user/{id}")
  fun findOne(@PathVariable id: String): Mono<User>
     = repository.findOne(id)

  @GetMapping("/user")
  fun findAll(): Flux<User>
     = repository.findAll()

  @PostMapping("/user")
  fun save(@RequestBody user: Mono<User>): Mono<Void>
     = repository.save(user)
}

interface ReactiveUserRepository {
  fun findOne(id: String): Mono<User>
  fun findAll(): Flux<User>
  fun save(user: Mono<User>): Mono<Void>
}
```

Spring Data Kay provides Reactive support for MongoDB, Redis, Cassandra and Couchbase

Spring & Kotlin Coroutines



- Coroutines are light-weight threads
- Main use cases are
  - Writing non-blocking applications while keeping imperative programming
  - Creating new operators for Reactor
- kotlinx.coroutines provides Reactive Streams and Reactor support
  - `fun foo(): Mono<T>    -> suspend fun foo(): T?`
  - `fun bar(): Flux<T>    -> suspend fun bar(): ReceiveChannel<T> or List<T>`
  - `fun baz(): Mono<Void> -> suspend fun baz()`
- Support for Spring MVC, WebFlux and Data Reactive MongoDB is available via https://github.com/konrad-kaminski/spring-kotlin-coroutine/ (nice work Konrad!)
- **Warning**
  - Coroutine are still experimental
  - No official Spring support yet, see SPR-15413
  - Ongoing evaluation of performances and back-pressure interoperability

Spring WebFlux with Coroutines

https://github.com/sdeleuze/spring-kotlin-deepdive/tree/step3-coroutine

Experimental

```
@RestController
class CoroutineUserController( val repository: CoroutineUserRepository) {
  @GetMapping("/user/{id}")
  suspend fun findOne(@PathVariable id: String): User
      = repository.findOne(id)

  @GetMapping("/user")
  suspend fun findAll(): List<User>
      = repository.findAll()

  @PostMapping("/user")
  suspend fun save(@RequestBody user: User)
      = repository.save(user)
}

interface CoroutineUserRepository {
  suspend fun findOne(id: String): User
  suspend fun findAll(): List<User>
  suspend fun save(user: User)
}
```

Step 1 Kotlin
Step 2 Boot 2
Step 3 WebFlux @nnotations
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Step 5 Kotlin for frontend

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Spring WebFlux comes in 2 flavors

Annotations

```
@Controller
@RequestMapping
```

NEW

Functional

```
RouterFunction
HandlerFunction
WebClient
```

Spring WebFlux Functional API

RouterFunction
`(ServerRequest) -> Mono<HandlerFunction>`

HandlerFunction
`(ServerRequest) -> Mono<ServerResponse>`

WebClient
Provides non-blocking fluent HTTP client API

WebFlux functional API with Kotlin DSL

```
val router = router {

  val users = Flux.just(
        User("Foo", "Foo", now().minusDays(1)),
        User("Bar", "Bar", now().minusDays(10)),
        User("Baz", "Baz", now().minusDays(100)))

  accept(TEXT_HTML).nest {
     "/" { ok().render("index") }
     "/sse" { ok().render("sse") }
     "/users" {
        ok().render("users", mapOf("users" to users.map { it.toDto() }))
     }
  }
  ("/api/users" and accept(APPLICATION_JSON)) {
     ok().body(users)
  }
  ("/api/users" and accept(TEXT_EVENT_STREAM)) {
     ok().bodyToServerSentEvents(users.repeat().delayElements(ofMillis(100)))
  }
}
```

Splitting router/handlers in integration in Boot

```
@SpringBootApplication()
class Application {

    @Bean
    fun router(htmlHandler: HtmlHandler, userHandler: UserHandler, postHandler: PostHandler) = router {
        accept(APPLICATION_JSON).nest {
            "/api/user".nest {
                GET("/", userHandler::findAll)
                GET("/{login}", userHandler::findOne)
            }
            "/api/post".nest {
                GET("/", postHandler::findAll)
                GET("/{slug}", postHandler::findOne)
                POST("/", postHandler::save)
                DELETE("/{slug}", postHandler::delete)
            }
        }
        (GET("/api/post/notifications") and accept(TEXT_EVENT_STREAM)).invoke(postHandler::notifications)
        accept(TEXT_HTML).nest {
            GET("/", htmlHandler::blog)
            (GET("/{slug}") and !GET("/favicon.ico")).invoke(htmlHandler::post)
        }
    }
}
```

Functional handlers

```
@Component
class HtmlHandler(private val userRepository: UserRepository,
                  private val markdownConverter: MarkdownConverter) {

   fun blog(req: ServerRequest) = ok().render("blog", mapOf(
                "title" to "Blog",
                "posts" to postRepository.findAll()
                                         .flatMap { it.toDto(userRepository, markdownConverter) } ))
}

@Component
class PostHandler(private val postRepository: PostRepository,
                  private val postEventRepository: PostEventRepository) {

   fun findAll(req: ServerRequest) =
      ok().body(postRepository.findAll())

   fun notifications(req: ServerRequest) =
      ok().bodyToServerSentEvents(postEventRepository.findWithTailableCursorBy())

}
```

Spring Framework 5 introduces functional bean registration

Very efficient, no reflection, no CGLIB proxy, no annotations

Functional bean definition DSL

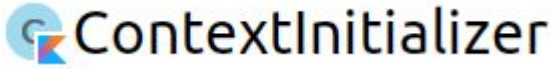
```
val webContext = beans {
    bean {
        val userHandler = ref<UserHandler>()
        router {
            accept(APPLICATION_JSON).nest {
                "/api/user".nest {
                    GET("/", userHandler::findAll)
                    GET("/{login}", userHandler::findOne)
                }
            }
            // ...
        }
        bean { Mustache.compiler().escapeHTML(false).withLoader(ref()) }
        bean<HtmlHandler>()
        bean<PostHandler>()
        bean<UserHandler>()
        bean<MarkdownConverter>()
}
```

Functional bean definition DSL

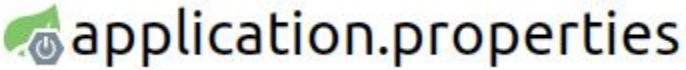
```
val databaseContext = beans {
    bean<PostEventListener>()
    bean<PostEventRepository>()
    bean<PostRepository>()
    bean<UserRepository>()
    environment( { !activeProfiles.contains("cloud") } ) {
        bean {
            CommandLineRunner {
                initializeDatabase(ref(), ref(), ref())
            }
        }
    }
}

fun initializeDatabase(ops: MongoOperations,
                       userRepository: UserRepository,
                       postRepository: PostRepository) { // ... }
```

Using bean DSL with Spring Boot




```
class ContextInitializer : ApplicationContextInitializer<GenericApplicationContext> {
   override fun initialize(context: GenericApplicationContext) {
       databaseContext.initialize(context)
       webContext.initialize(context)
   }
}
```




```
context.initializer.classes=io.spring.deepdive.ContextInitializer
```

Step 1 Kotlin
Step 2 Boot 2
Step 3 WebFlux @nnotations
Step 4 Functional & DSL
Step 5 Kotlin for frontend

Pivotal

Original JavaScript code

```
if (Notification.permission === "granted") {
    Notification.requestPermission().then(function(result) {
        console.log(result);
    });
}

let eventSource = new EventSource("/api/post/notifications");
eventSource.addEventListener("message", function(e) {
    let post = JSON.parse(e.data);
    let notification = new Notification(post.title);
    notification.onclick = function() {
        window.location.href = "/" + post.slug;
    };
});
```

Kotlin to Javascript

Type-safe, null safety, only 10 Kbytes with Dead Code Elimination tool

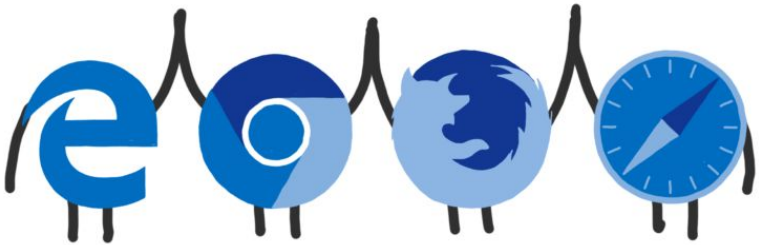
```
data class Post(val slug: String, val title: String)

fun main(args: Array<String>) {
    if (Notification.permission == NotificationPermission.GRANTED) {
        Notification.requestPermission().then { console.log(it) }
    }
    EventSource("/api/post/notifications").addEventListener("message", {
        val post = JSON.parse<Post>(it.data());
        Notification(post.title).addEventListener("click", {
            window.location.href = "/${post.slug}"
        })
    })
}

fun Event.data() = (this as MessageEvent).data as String // See KT-20743
```

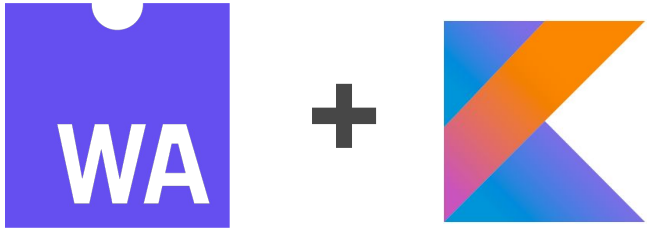
WebAssembly

Native platform for the Web



Read “An Abridged Cartoon Introduction To WebAssembly” by Lin Clark for more details
https://goo.gl/I0kQsC

Compiling Kotlin to WebAssembly instead of JavaScript



Just announced

- ➔ Kotlin will support WebAssembly via Kotlin Native (LLVM)
- ➔ Much better compilation target
- ➔ No DOM and Web API access yet but that's coming ...
- ➔ A Kotlin/Native Frontend ecosystem could arise
- ➔ Native level performances, low memory consumption
- ➔ Fallback via asm.js

Thanks!

Follow me on **@sdeleuze** for fresh Spring + Kotlin news

https://github.com/mixitconf/mixit
https://github.com/sdeleuze/spring-kotlin-fullstack
https://github.com/sdeleuze/spring-kotlin-deepdive
https://github.com/sdeleuze/spring-kotlin-functional