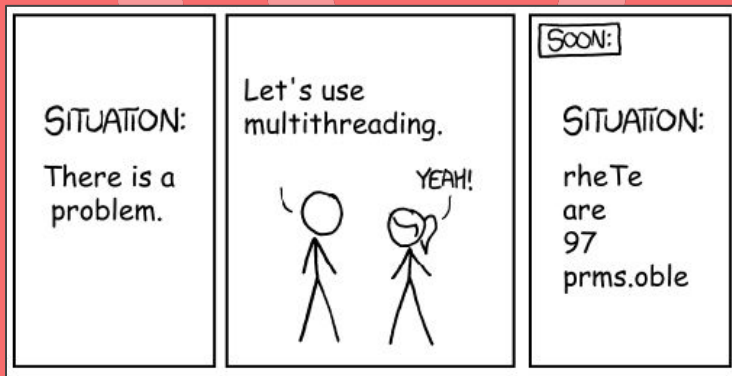


Reactive Streams

Async for the Masses

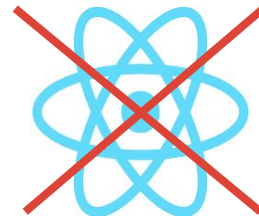


- ◆ Reactive Programming, Streams and Systems
- ◆ Demo: Reactive Programming in three flavours
- ◆ Reactive Programming in Quarkus and Spring Boot
- ◆ How-to decide on imperative vs reactive programming

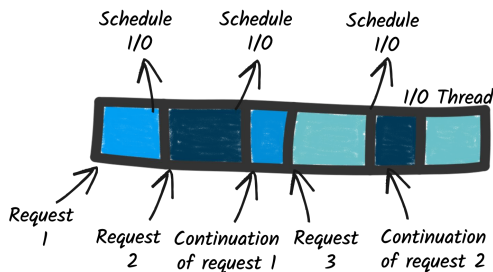


Reactive Programming, Streams & Systems (and not React!)

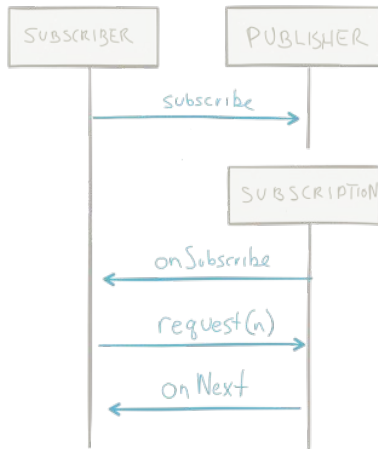
Reactive is a **set of design principles** to build **robust, efficient, and concurrent applications and systems**. These principles let you **handle more load** than traditional approaches while **using the resources** (CPU and memory) **more efficiently**.



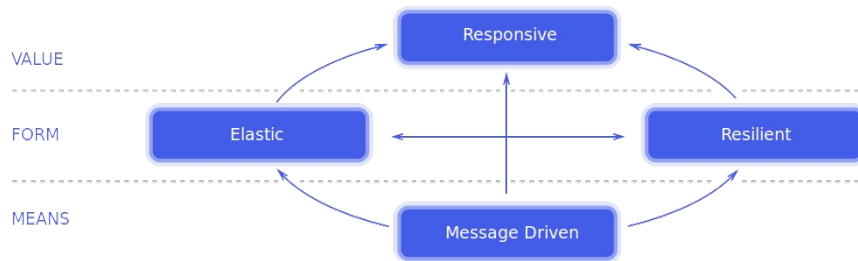
Reactive Programming



Reactive Streams



Reactive Systems



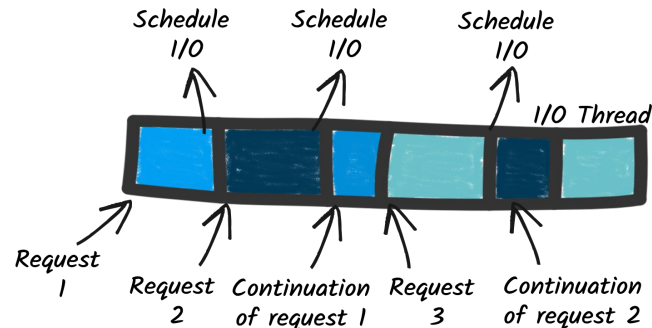
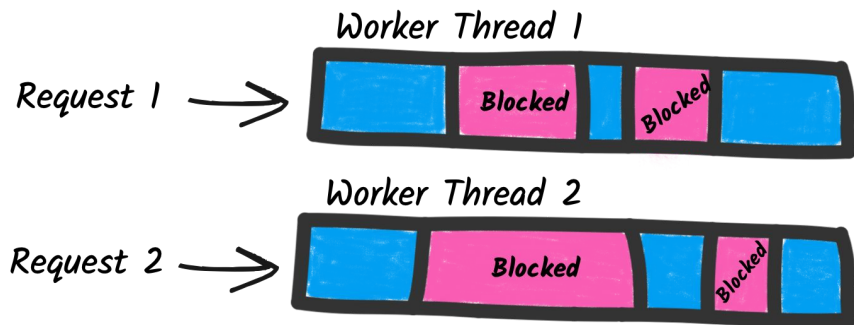


Reactive Programming - the Design Patterns

Reactive programming is programming with **asynchronous data streams**.

In technical terms, **reactive programming** is a paradigm in which declarative code is issued to construct **asynchronous processing pipelines**.

In other words, it's **programming with asynchronous data streams** that **sends** data to a **consumer** as it becomes available, which enables developers to write code that can **react to these state changes** quickly and asynchronously.

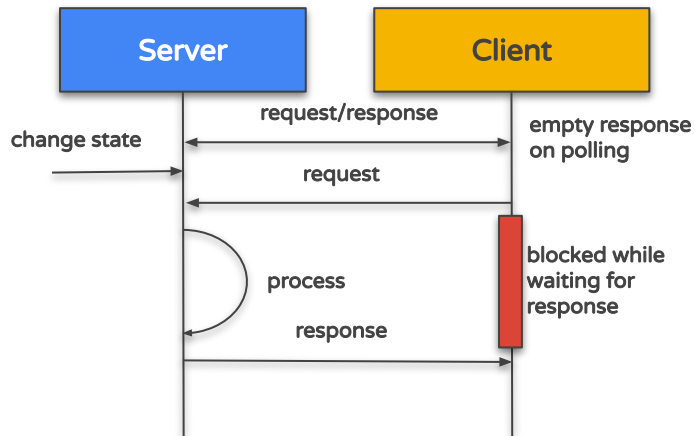




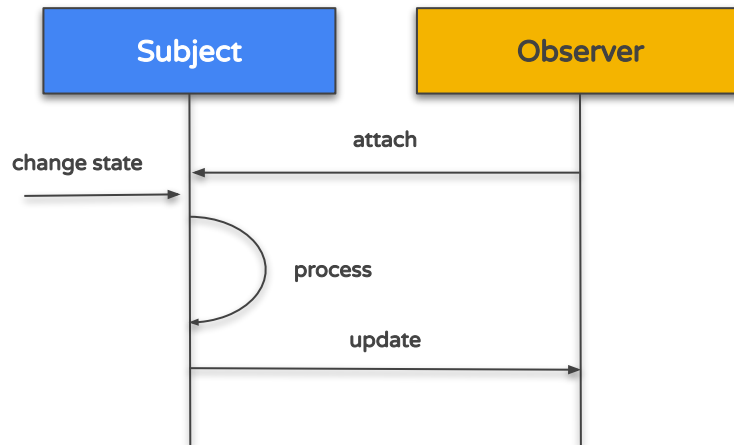
Reactive Programming - the Design Patterns

Reactive Programming combines functional programming, the observer pattern, and the iterable pattern.

Imperative Programming



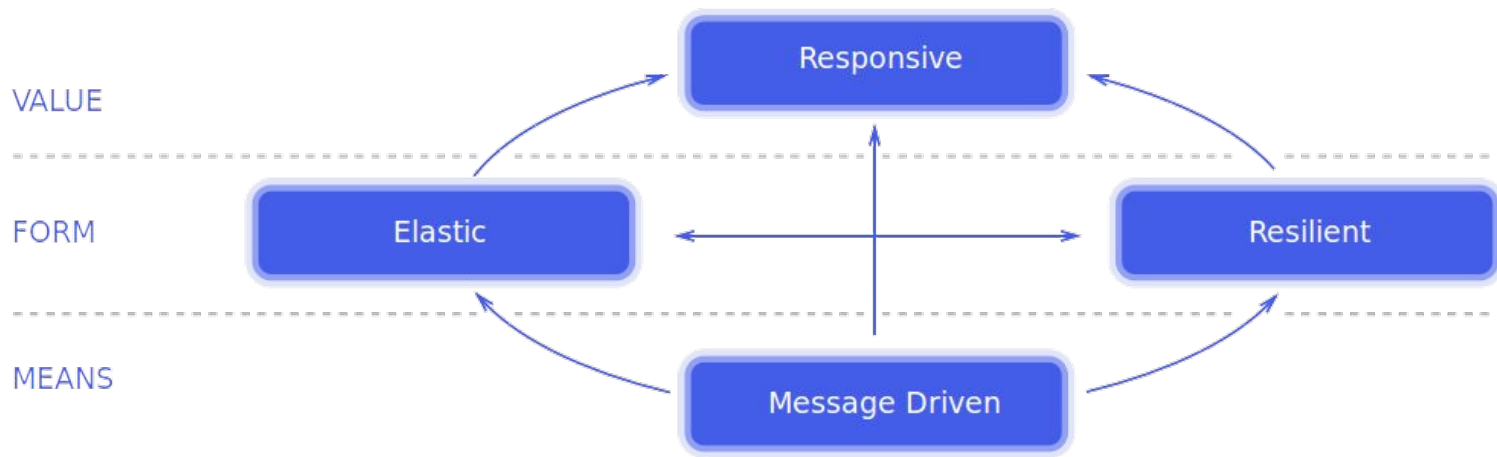
Reactive Programming





Reactive Programming, Systems & Streams

Systems built as **Reactive Systems** are **more flexible, loosely-coupled and scalable**.
This makes them **easier to develop** and **amenable to change**.





How do Reactive Programming and Systems relate?

Reactive Programming is a distinct **subset** of Reactive Systems
at the implementation level.

Reactive Programming offers productivity for Developers—through performance and resource efficiency—at the component level for **internal logic** and **dataflow management**.

It is highly beneficial to use **Reactive Programming within the components of a Reactive System.**

It is highly beneficial to **use Reactive Systems** to create the **system around the components** written **using Reactive Programming.**



Reactive Streams & Reactive Extensions

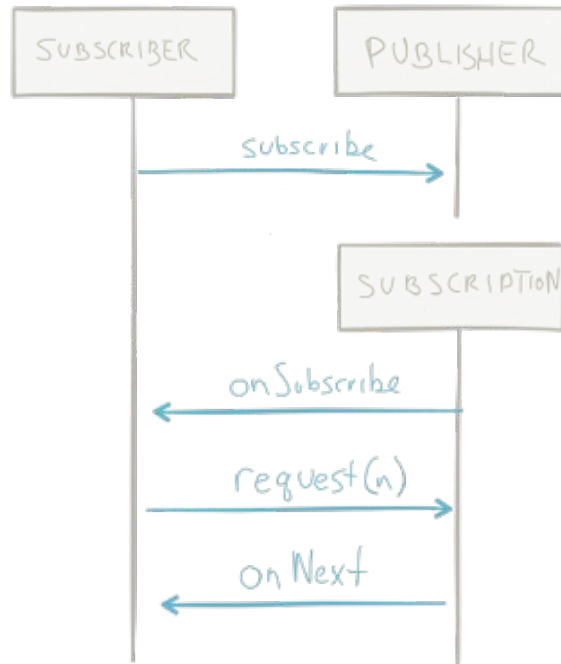
A stream is “a sequence of data elements made available over time”

Reactive Streams is an initiative to provide a standard for **asynchronous** stream processing **with non-blocking back pressure**.

Reactive extensions enables **imperative programming languages to compose asynchronous and event-based programs by using observable sequences**. Reactive extensions **combine the observer and iterator patterns** and functional idioms to give you a sort of toolbox, enabling your application to create, combine, merge, filter, and transform data streams.

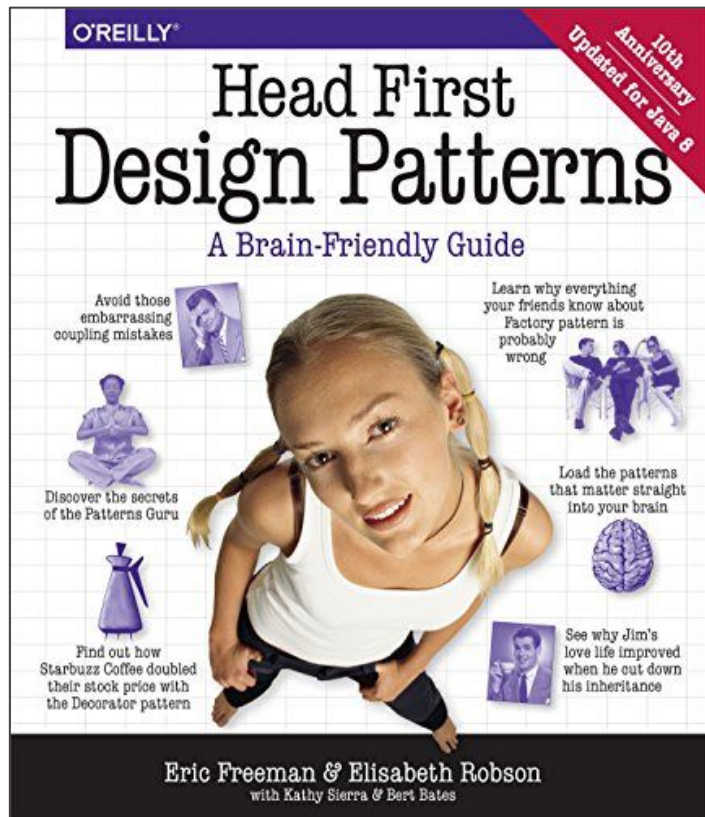
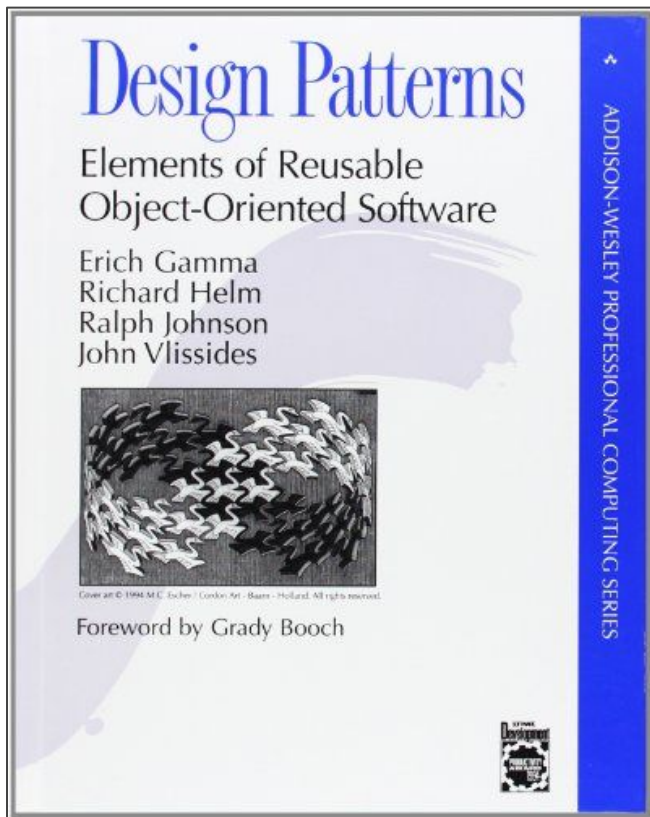
Reactive Streams is an initiative that was created to provide a standard to **unify reactive extensions and deal with asynchronous stream processing with non-blocking backpressure**, which encompasses efforts aimed at runtime environments as well as network protocols.

Note: While the **asynchronous boundary** is about **decoupling in time**, what **Reactive Streams does not yet give us is decoupling in space — distribution**. This would allow us to distribute load across nodes and clusters, ideally with **location transparency**.





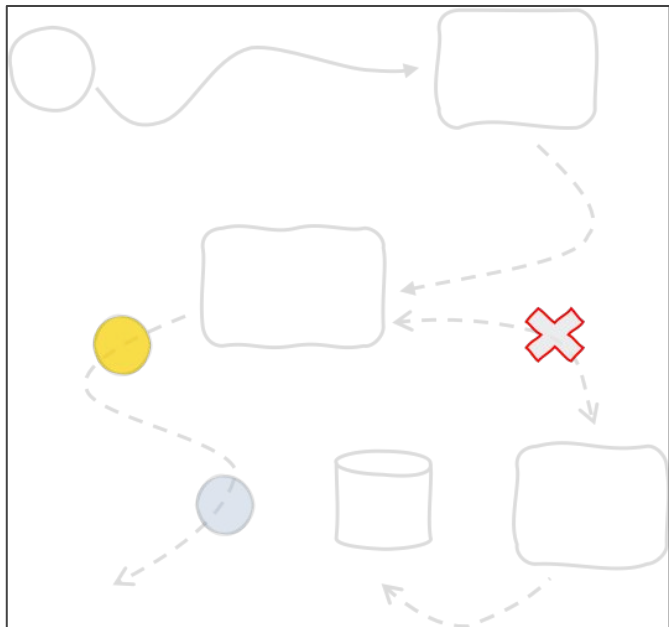
GoF Patterns: Observer & Iterator





Gotchas with Reactive Programming

Communications in distributed systems are inherently asynchronous and unreliable.
Anything can go wrong, anytime, and often with no prior notice.



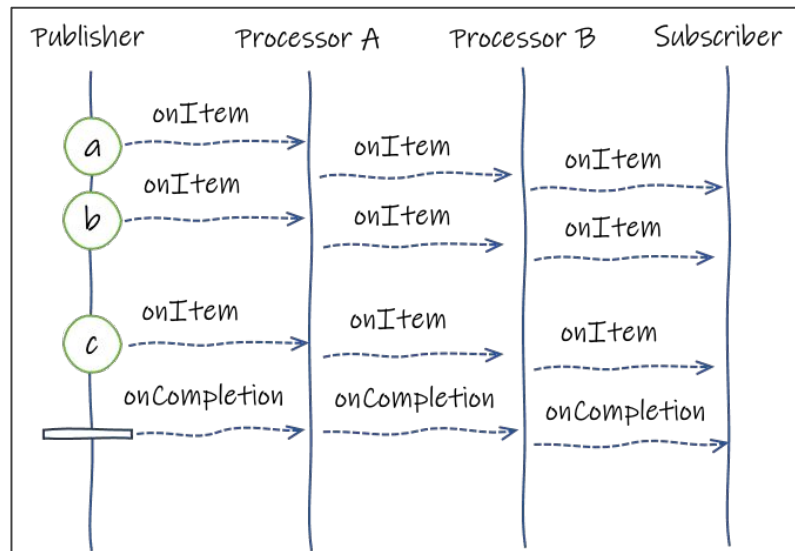
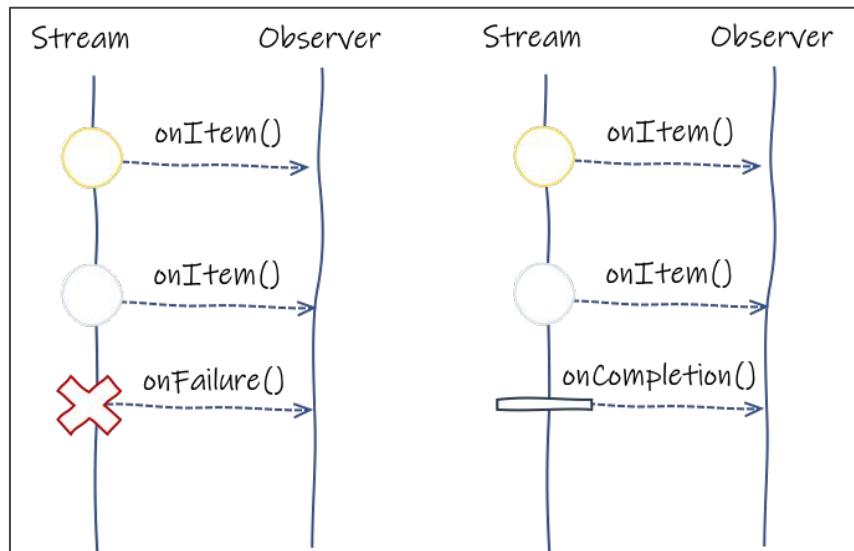
Most **classic applications** use a **synchronous development model**. Synchronous code is **easy to reason about, more comfortable to write and read than asynchronous code**, but it has some **hidden cost**. This cost emerges when building I/O intensive applications, quite common in distributed applications.

While applications using **non-blocking I/O** are **more efficient** and better suited for the Cloud's distributed nature, they come with a considerable constraint: **you must never block the I/O thread**. Thus, you need to implement your **business logic** using an **asynchronous development model**.



Unis and Multis (Reactive Streams with Mutiny)

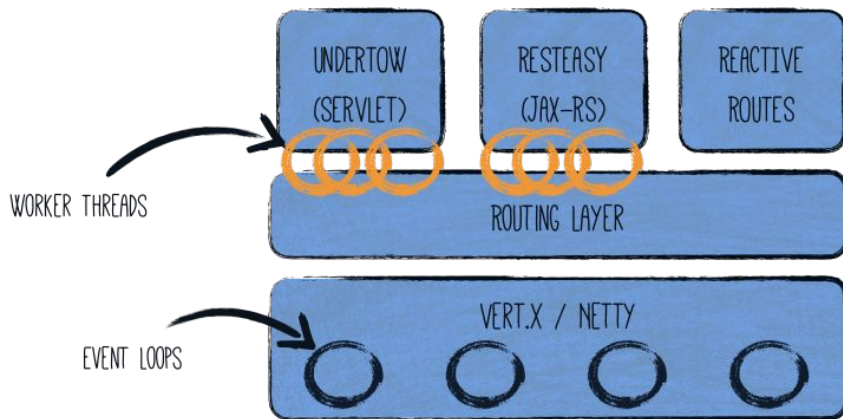
A **Uni** represents a *stream* that can only **emit** either **an item** or a **failure event**. You rarely create instances of **Uni** yourself, but, instead, **use a reactive client exposing a Mutiny API** that provides Unis. Quarkus with its unified (imperative & reactive) programming model exposes the Mutiny API.





What is special about Quarkus and Reactive Programming?

Quarkus is a **Reactive framework**. Since the beginning, Reactive has been an **essential tenet of the Quarkus architecture**. It includes **many reactive features** and offers a broad ecosystem. This is what Quarkus is about: **unifying reactive and imperative in a single runtime**.



Quarkus HTTP support is based on a non-blocking and reactive engine (Eclipse Vert.x and Netty). **All the HTTP requests your application receive are handled by event loops (IO Thread) and then are routed towards the code that manages the request.** Depending on the destination, it can invoke the code managing the request on a **worker thread (servlet, Jax-RS)** or use the **IO thread (reactive route)**.



Spring Boot with Project Reactor: no unified experience



Spring **Boot 2**



Reactor

Optional Dependency

Reactive Stack

Spring WebFlux is a non-blocking web framework built from the ground up to take advantage of multi-core, next-generation processors and handle massive numbers of concurrent connections.

Netty, Servlet 3.1+ Containers

Reactive Streams Adapters

Spring Security Reactive

Spring WebFlux

Spring Data Reactive Repositories

Mongo, Cassandra, Redis, Couchbase, R2DBC

Servlet Stack

Spring MVC is built on the Servlet API and uses a synchronous blocking I/O architecture with a one-request-per-thread model.

Servlet Containers

Servlet API

Spring Security

Spring MVC

Spring Data Repositories

JDBC, JPA, NoSQL



Links and other information

Reactive Design: System, Streams & Programming

- ❖ What is Reactive Design (Systems, Streams & Programming): <https://www.lightbend.com/white-papers-and-reports/reactive-programming-versus-reactive-systems>
- ❖ Reactive Manifesto: <https://www.reactivemanifesto.org/>
- ❖ Reactive Future in 2051: <https://paulstovell.com/reactive-programming/>
- ❖ IBM on Reactive Definitions: <https://developer.ibm.com/articles/defining-the-term-reactive/>

Reactive Streams & Reactive Extensions

- ❖ Reactive Streams Spec: <https://www.reactive-streams.org/>

Quarkus Reactive Concepts

- ❖ Getting Started with Reactive: <https://quarkus.io/guides/getting-started-reactive>
- ❖ Quarkus Reactive Architecture: <https://quarkus.io/guides/quarkus-reactive-architecture>



Links and other information

Tutorial

- ❖ **Getting Started (RESTEasy & Panache):** <https://quarkus.io/guides/getting-started-reactive>
- ❖ **Reactive Beer:** <https://redhat-developer-demos.github.io/quarkus-tutorial/quarkus-tutorial/reactive.html>