

From 'Java Sucks' to 'Java...Eh, Not Bad'

How Vert.x & Java 21 Made Me Stop Complaining

Thomas Gebert

Who Am I?

- Software Engineer in New York City.

Who Am I?

- Software Engineer in New York City.
- There is nothing else interesting about me.

Java.

Java.

- If you are at this conference, you probably have an opinion of Java

Java.

- If you are at this conference, you probably have an opinion of Java
- Likely very negative.

Java.

- If you are at this conference, you probably have an opinion of Java
- Likely very negative.

Why the Java Hate?

Why the Java Hate?

- Java is bloated and verbose.

Why the Java Hate?

- Java is bloated and verbose.
- Encourages bad concurrency practices.

Why the Java Hate?

- Java is bloated and verbose.
- Encourages bad concurrency practices.
- Java Enterprise Edition.

Why the Java Hate?

- Java is bloated and verbose.
- Encourages bad concurrency practices.
- Java Enterprise Edition.
- Java programmers...

Examples of (Historically) Bad Things In Java.

Examples of (Historically) Bad Things In Java.

- IO is blocking by default

Examples of (Historically) Bad Things In Java.

- IO is blocking by default
- synchronized is evil.

Examples of (Historically) Bad Things In Java.

- IO is blocking by default
- synchronized is evil.
- Core design encourages mutation.

Examples of (Historically) Bad Things In Java.

- IO is blocking by default
- synchronized is evil.
- Core design encourages mutation.

Storytime.

Storytime.



Figure 1: CF

Storytime.



Figure 1: CF

Examples of (Historically) Bad Things In Java.

Examples of (Historically) Bad Things In Java.

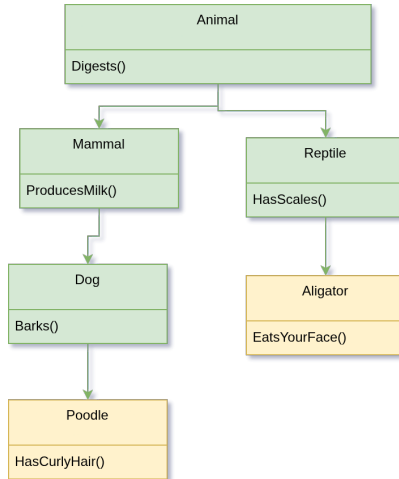


Figure 2: UML

So Why Would We Want To Even Use Java?

So Why Would We Want To Even Use Java?

- A metric ton of well-tested and supported libraries and guides online.

So Why Would We Want To Even Use Java?

- A metric ton of well-tested and supported libraries and guides online.
- Relatively portable, even still.

So Why Would We Want To Even Use Java?

- A metric ton of well-tested and supported libraries and guides online.
- Relatively portable, even still.
- Lots of great tooling around the language in the form of IDEs and benchmarking tools available.

So Why Would We Want To Even Use Java?

- A metric ton of well-tested and supported libraries and guides online.
- Relatively portable, even still.
- Lots of great tooling around the language in the form of IDEs and benchmarking tools available.
- (Can be) fast.

Why Not Kotlin? Or Clojure?

Why Not Kotlin? Or Clojure?

- You should use Clojure if you can!

Why Not Kotlin? Or Clojure?

- You should use Clojure if you can!
- Java is inescapable.

Why Not Kotlin? Or Clojure?

- You should use Clojure if you can!
- Java is inescapable.
- A lot of companies still have tens of thousands of lines of Java that already exist.

Why Not Kotlin? Or Clojure?

- You should use Clojure if you can!
- Java is inescapable.
- A lot of companies still have tens of thousands of lines of Java that already exist.
- Many companies will find it infeasible to migrate to a better language, and would rather spend infinitely more money hiring dozens of engineers to write a million incremental patches to a Java codebase.

Why Not Kotlin? Or Clojure?

- You should use Clojure if you can!
- Java is inescapable.
- A lot of companies still have tens of thousands of lines of Java that already exist.
- Many companies will find it infeasible to migrate to a better language, and would rather spend infinitely more money hiring dozens of engineers to write a million incremental patches to a Java codebase.
- Many of us are stuck in this hell.

Modern Java

Modern Java

- In 2024 I took a job doing Java full-time.

Modern Java

- In 2024 I took a job doing Java full-time.
- They were unreceptive to my pleas to use Clojure, no matter how much I complained.

Modern Java

- In 2024 I took a job doing Java full-time.
- They were unreceptive to my pleas to use Clojure, no matter how much I complained.
- Eventually, I realized that I wasn't going to win this fight and instead I should at least figure out what Java 21 had to offer.

Modern Java

- In 2024 I took a job doing Java full-time.
- They were unreceptive to my pleas to use Clojure, no matter how much I complained.
- Eventually, I realized that I wasn't going to win this fight and instead I should at least figure out what Java 21 had to offer.
- Much to my astonishment, I actually enjoyed it!

Modern Java

- In 2024 I took a job doing Java full-time.
- They were unreceptive to my pleas to use Clojure, no matter how much I complained.
- Eventually, I realized that I wasn't going to win this fight and instead I should at least figure out what Java 21 had to offer.
- Much to my astonishment, I actually enjoyed it!

What Changed?

What Changed?

- Since Java 8 and Java 11, there has been a much higher emphasis on functional programming concepts and updated syntax to facilitate it.

What Changed?

- Since Java 8 and Java 11, there has been a much higher emphasis on functional programming concepts and updated syntax to facilitate it.
- Java programmers have finally joined the 21st century and will occasionally use non-blocking IO.

What Changed?

- Since Java 8 and Java 11, there has been a much higher emphasis on functional programming concepts and updated syntax to facilitate it.
- Java programmers have finally joined the 21st century and will occasionally use non-blocking IO.
- Concurrency is an even bigger part of the language, and a lot of the features from concurrent-first languages have been brought over.

What Changed?

- Since Java 8 and Java 11, there has been a much higher emphasis on functional programming concepts and updated syntax to facilitate it.
- Java programmers have finally joined the 21st century and will occasionally use non-blocking IO.
- Concurrency is an even bigger part of the language, and a lot of the features from concurrent-first languages have been brought over.

Java 8 and 11 New features

Java 8 and 11 New features

```
int count = 0;
for (String word : words) {
    if (word.length() > 10) {
        count++;
    }
}
System.out.println("Long words: " + count);
```

Java 8 and 11 New features

```
int count = 0;
for (String word : words) {
    if (word.length() > 10) {
        count++;
    }
}
System.out.println("Long words: " + count);
```

```
long count = words.stream()
                    .filter(w -> w.length() > 10)
                    .count();

System.out.println("Long words: " + count);
```

Java 8 and 11 New features

Java 8 and 11 New features

```
public interface Greeter {  
    void greet(String name);  
  
    default void greetPolitely(String name) {  
        System.out.println("Hello, " + name + ". It's nice to m  
    }  
}
```

Java 8 and 11 New features

```
public interface Greeter {  
    void greet(String name);  
  
    default void greetPolitely(String name) {  
        System.out.println("Hello, " + name + ". It's nice to m  
    }  
}
```

Old Underutilized Java Feature

Old Underutilized Java Feature

`BlockingQueue (java.util.concurrent)`

Old Underutilized Java Feature

BlockingQueue (`java.util.concurrent`)

- A thread-safe queue that blocks on `put` and `take` operations

Old Underutilized Java Feature

BlockingQueue (`java.util.concurrent`)

- A thread-safe queue that blocks on `put` and `take` operations
- Useful for producer-consumer patterns

Old Underutilized Java Feature

BlockingQueue (`java.util.concurrent`)

- A thread-safe queue that blocks on put and take operations
- Useful for producer-consumer patterns
- Comes in several flavors: `ArrayBlockingQueue`, `LinkedBlockingQueue`, `PriorityBlockingQueue`, etc.

Old Underutilized Java Feature

Old Underutilized Java Feature

```
BlockingQueue<String> queue = new LinkedBlockingQueue<>();

// Producer
new Thread(() -> {
    queue.put("data");
}).start();

// Consumer
new Thread(() -> {
    String item = queue.take();
}).start();
```

Java 21 New Features.

Java 21 New Features.

Virtual Threads.

Java 21 New Features.

Virtual Threads.

- Virtual Threads are what should have been in Java twenty years ago.

Java 21 New Features.

Virtual Threads.

- Virtual Threads are what should have been in Java twenty years ago.
- Roughly analogous to goroutines in Go.

Java 21 New Features.

Virtual Threads.

- Virtual Threads are what should have been in Java twenty years ago.
- Roughly analogous to goroutines in Go.
- Allow you to have blocking code inside the thread without it breaking the pool.
 - The JVM will park the thread upon seeing a blocking call.

Java 21 New Features.

Virtual Threads.

- Virtual Threads are what should have been in Java twenty years ago.
- Roughly analogous to goroutines in Go.
- Allow you to have blocking code inside the thread without it breaking the pool.
 - The JVM will park the thread upon seeing a blocking call.
- Extremely lightweight, hundreds of thousands can easily be spun up guilt-free.

Java 21 New Features.

Virtual Threads.

- Virtual Threads are what should have been in Java twenty years ago.
- Roughly analogous to goroutines in Go.
- Allow you to have blocking code inside the thread without it breaking the pool.
 - The JVM will park the thread upon seeing a blocking call.
- Extremely lightweight, hundreds of thousands can easily be spun up guilt-free.
- Implements the same interfaces as regular threads and thus are drop-in replacement.

Java 21 New Features.

Virtual Threads.

- Virtual Threads are what should have been in Java twenty years ago.
- Roughly analogous to goroutines in Go.
- Allow you to have blocking code inside the thread without it breaking the pool.
 - The JVM will park the thread upon seeing a blocking call.
- Extremely lightweight, hundreds of thousands can easily be spun up guilt-free.
- Implements the same interfaces as regular threads and thus are drop-in replacement.

Pre-virtual-threads

Pre-virtual-threads

```
ExecutorService executor = Executors.newFixedThreadPool(4);

for (int i = 0; i < 10; i++) {
    int taskId = i;
    executor.submit(() -> {
        System.out.println("Running task " + taskId +
                           " on thread " + Thread.currentThread().getName());
    });
}

executor.shutdown();
```

Pre-virtual-threads

Pre-virtual-threads

- Worked ok, but could break if you did any kind of blocking IO.

Pre-virtual-threads

- Worked ok, but could break if you did any kind of blocking IO.
- Did not properly park IO blocking.

Java 21 New Features*

Java 21 New Features*

* (Actually a Java 15 feature that I wasn't aware of until Java 21)

ZGC

Java 21 New Features*

* (Actually a Java 15 feature that I wasn't aware of until Java 21)

ZGC

- Low-latency garbage collector.

Java 21 New Features*

* (Actually a Java 15 feature that I wasn't aware of until Java 21)

ZGC

- Low-latency garbage collector.
- Pause times are generally sub-millisecond and almost never exceed ten milliseconds.

Java 21 New Features*

* (Actually a Java 15 feature that I wasn't aware of until Java 21)

ZGC

- Low-latency garbage collector.
- Pause times are generally sub-millisecond and almost never exceed ten milliseconds.
- Configurable, can be enabled or disabled per-project.

Java 21 New Features.

Java 21 New Features.

Records

Java 21 New Features.

Records

- Much simpler than a class.

Java 21 New Features.

Records

- Much simpler than a class.
- Doesn't require its own dedicated file.

Java 21 New Features.

Records

- Much simpler than a class.
- Doesn't require its own dedicated file.
- Can be pattern-matched.

Java 21 New Features.

Records

- Much simpler than a class.
- Doesn't require its own dedicated file.
- Can be pattern-matched.

Before Records

Before Records

```
public class Point {  
    private final int x;  
    private final int y;  
  
    public Point(int x, int y) {  
        this.x = x;  
        this.y = y;  
    }  
  
    public int x() { return x; }  
    public int y() { return y; }  
  
    @Override  
    public boolean equals(Object o) {  
        if (this == o) return true;  
        if (!(o instanceof Point)) return false;  
        Point p = (Point) o;  
        return x == p.x && y == p.y;  
    }  
}
```

Sealed Interfaces

Sealed Interfaces

- Basically Algebraic Data Types

Sealed Interfaces

- Basically Algebraic Data Types
- Can be recursive.

Sealed Interfaces

- Basically Algebraic Data Types
- Can be recursive.
- Can be pattern matched.

Sealed Interfaces

- Basically Algebraic Data Types
- Can be recursive.
- Can be pattern matched.

Java 21 New Features.

Java 21 New Features.

Pattern Matching

Java 21 New Features.

Pattern Matching

- FINALLY! FINALLY!

Java 21 New Features.

Pattern Matching

- FINALLY! FINALLY!
- Can be done inside if statements and switch cases.

Java 21 New Features.

Pattern Matching

- FINALLY! FINALLY!
- Can be done inside if statements and switch cases.

Before pattern matching.

Before pattern matching.

```
public void handle(Object obj) {  
    if (obj instanceof String) {  
        String s = (String) obj;  
        System.out.println("String length: " + s.length());  
    } else if (obj instanceof Integer) {  
        Integer i = (Integer) obj;  
        System.out.println("Squared: " + (i * i));  
    } else {  
        System.out.println("Unknown type");  
    }  
}
```

Java NIO

Java NIO

- Java New IO.

Java NIO

- Java New IO.
- Gives fine-grained control over IO, both blocking and non-blocking.

Java NIO

- Java New IO.
- Gives fine-grained control over IO, both blocking and non-blocking.
- Not new at all, but underutilized.

Java NIO

- Java New IO.
- Gives fine-grained control over IO, both blocking and non-blocking.
- Not new at all, but underutilized.

Vert.x

Vert.x

- (In a hand-wavey way) a port of Node.js to Java.

Vert.x

- (In a hand-wavey way) a port of Node.js to Java.
- High performance.

Vert.x

- (In a hand-wavey way) a port of Node.js to Java.
- High performance.
- Provides constructs to handle local and distributed concurrency transparently.

Vert.x Core Primitives

Vert.x Core Primitives

Verticle

Vert.x Core Primitives

Verticle

- Units of deployment and concurrency

Vert.x Core Primitives

Verticle

- Units of deployment and concurrency
- Two types: `StandardVerticle` (blocking) and `WorkerVerticle` (non-blocking optional)

Vert.x Core Primitives

Verticle

- Units of deployment and concurrency
- Two types: `StandardVerticle` (blocking) and `WorkerVerticle` (non-blocking optional)
- Deployed with `vertx.deployVerticle(...)`

Vert.x Core Primitives

Event Loop

Vert.x Core Primitives

Event Loop

- Single or multi-threaded, async task execution

Vert.x Core Primitives

Event Loop

- Single or multi-threaded, async task execution
- Based on Netty

Vert.x Core Primitives

Event Loop

- Single or multi-threaded, async task execution
- Based on Netty
- Designed for minimal context switching and high throughput

Vert.x Core Primitives

Vert.x Core Primitives

Event Bus

Vert.x Core Primitives

Event Bus

- Lightweight messaging system

Vert.x Core Primitives

Event Bus

- Lightweight messaging system
- Supports publish/subscribe, point-to-point, and request-response

Vert.x Core Primitives

Event Bus

- Lightweight messaging system
- Supports publish/subscribe, point-to-point, and request-response
- Accepts JSON, POJOs (with codec), and buffers

Vert.x Core Primitives

Event Bus

- Lightweight messaging system
- Supports publish/subscribe, point-to-point, and request-response
- Accepts JSON, POJOs (with codec), and buffers

Vert.x Core Primitives

Vert.x Core Primitives

Future & Promise

Vert.x Core Primitives

Future & Promise

- Asynchronous result handling

Vert.x Core Primitives

Future & Promise

- Asynchronous result handling
- `Future<T>` is the result placeholder

Vert.x Core Primitives

Future & Promise

- Asynchronous result handling
- `Future<T>` is the result placeholder
- `Promise<T>` is the result provider

Vert.x Core Primitives

Future & Promise

- Asynchronous result handling
- `Future<T>` is the result placeholder
- `Promise<T>` is the result provider
- Supports chaining with `.compose(...)` and `.map(...)`

Vert.x Core Primitives

Future & Promise

- Asynchronous result handling
- `Future<T>` is the result placeholder
- `Promise<T>` is the result provider
- Supports chaining with `.compose(...)` and `.map(...)`

Vert.x Core Primitives

Vert.x Core Primitives

Context

Vert.x Core Primitives

Context

- Execution environment for a Verticle

Vert.x Core Primitives

Context

- Execution environment for a Verticle
- Ensures thread-affinity

Vert.x Core Primitives

Context

- Execution environment for a Verticle
- Ensures thread-affinity
- Helps avoid shared-state concurrency bugs

Vert.x Core Primitives

Context

- Execution environment for a Verticle
- Ensures thread-affinity
- Helps avoid shared-state concurrency bugs

Vert.x Core Primitives

Vert.x Core Primitives

Buffer

Vert.x Core Primitives

Buffer

- Efficient binary data container

Vert.x Core Primitives

Buffer

- Efficient binary data container
- Higher-level alternative to Netty's ByteBuffer

Vert.x Core Primitives

Buffer

- Efficient binary data container
- Higher-level alternative to Netty's ByteBuffer
- Used in I/O and message passing

Vert.x Core Primitives

Buffer

- Efficient binary data container
- Higher-level alternative to Netty's ByteBuffer
- Used in I/O and message passing

Vert.x Core Primitives

Vert.x Core Primitives

WebClient / HttpClient

Vert.x Core Primitives

WebClient / HttpClient

- Non-blocking HTTP clients

Vert.x Core Primitives

WebClient / HttpClient

- Non-blocking HTTP clients
- Built-in connection pooling and retry logic

Vert.x Core Primitives

WebClient / HttpClient

- Non-blocking HTTP clients
- Built-in connection pooling and retry logic
- Supports JSON, form data, and streaming

Vert.x Core Primitives

WebClient / HttpClient

- Non-blocking HTTP clients
- Built-in connection pooling and retry logic
- Supports JSON, form data, and streaming

Vert.x Core Primitives

Vert.x Core Primitives

Timer / Periodic Tasks

Vert.x Core Primitives

Timer / Periodic Tasks

- Use `setTimer(...)` for delayed execution

Vert.x Core Primitives

Timer / Periodic Tasks

- Use `setTimer(...)` for delayed execution
- Use `setPeriodic(...)` for recurring tasks

Vert.x Core Primitives

Timer / Periodic Tasks

- Use `setTimer(...)` for delayed execution
- Use `setPeriodic(...)` for recurring tasks
- Executes on the event loop thread

Vert.x Core Primitives

Timer / Periodic Tasks

- Use `setTimer(...)` for delayed execution
- Use `setPeriodic(...)` for recurring tasks
- Executes on the event loop thread

```
void doSomethingAsync(Promise<String> promise) {  
    vertx.setTimer(500, id -> {  
        promise.complete("Hello, future!");  
    });  
}
```

Vert.x Core Primitives

Vert.x Core Primitives

SharedData

Vert.x Core Primitives

SharedData

- Minimal shared-state coordination mechanism

Vert.x Core Primitives

SharedData

- Minimal shared-state coordination mechanism
- Offers maps, locks, and counters

Vert.x Core Primitives

SharedData

- Minimal shared-state coordination mechanism
- Offers maps, locks, and counters
- Supports clustered and local modes

Vert.x Core Primitives

SharedData

- Minimal shared-state coordination mechanism
- Offers maps, locks, and counters
- Supports clustered and local modes

Backpressure in Vert.x

Backpressure in Vert.x

- Vert.x models backpressure using `ReadStream` and `WriteStream`

Backpressure in Vert.x

- Vert.x models backpressure using `ReadStream` and `WriteStream`
- Data is paused/resumed automatically when the receiver can't keep up

Backpressure in Vert.x

- Vert.x models backpressure using `ReadStream` and `WriteStream`
- Data is paused/resumed automatically when the receiver can't keep up
- Useful when handling large streams (e.g., file uploads, HTTP bodies)

Backpressure in Vert.x

Backpressure in Vert.x

Example: Handling a slow WriteStream

```
source.pipeTo(slowSink, res -> {  
    if (res.succeeded()) {  
        System.out.println("All data written.");  
    } else {  
        res.cause().printStackTrace();  
    }  
});
```

Vert.x distributed concurrency example

Vert.x distributed concurrency example

Deploying Verticles: Local vs Clustered

Vert.x distributed concurrency example

Deploying Verticles: Local vs Clustered

- Verticles are the basic unit of deployment and concurrency

Vert.x distributed concurrency example

Deploying Verticles: Local vs Clustered

- Verticles are the basic unit of deployment and concurrency
- Deployment is nearly identical across local and clustered environments

Vert.x distributed concurrency example

Deploying Verticles: Local vs Clustered

- Verticles are the basic unit of deployment and concurrency
- Deployment is nearly identical across local and clustered environments

Vert.x Concurrency Example.

Vert.x Concurrency Example.

```
public class MyVerticle extends AbstractVerticle {  
  
    @Override  
    public void start(Promise<Void> startPromise) {  
        System.out.println("Verticle started on thread: " + Thread.currentThread().getName());  
  
        vertx.setTimer(1000, id -> {  
            System.out.println("Timer fired after 1 second");  
        });  
  
        startPromise.complete();  
    }  
}
```

Vert.x Concurrency Example.

```
public class MyVerticle extends AbstractVerticle {  
  
    @Override  
    public void start(Promise<Void> startPromise) {  
        System.out.println("Verticle started on thread: " + Thread.currentThread().getName());  
  
        vertx.setTimer(1000, id -> {  
            System.out.println("Timer fired after 1 second");  
        });  
  
        startPromise.complete();  
    }  
}
```

Vert.x Concurrency Example.

Vert.x Concurrency Example.

Local Deployment

```
Vertx vertx = Vertx.vertx();  
vertx.deployVerticle(new MyVerticle());
```

Vert.x Concurrency Example.

Vert.x Concurrency Example.

Distributed Deployment

Vert.x Concurrency Example.

Distributed Deployment

```
Vertx.clusteredVertx(new VertxOptions(), res -> {  
    if (res.succeeded()) {  
        Vertx vertx = res.result();  
        vertx.deployVerticle(new MyVerticle());  
    } else {  
        res.cause().printStackTrace();  
    }  
});
```

Conclusion.

Conclusion.

- Java 21 isn't that bad.

Conclusion.

- Java 21 isn't that bad.
- Convince your employers to upgrade if you want to reclaim your sanity.
- Blah . . .
- Use libraries like Vert.x and Disruptor to make life simpler.

Conclusion.

- `thomas@gebert.app`
- `blog.tombert.com`

