And Java becomes more functional With Javaslang!

JAVASLANG

And Java becomes more functional with ~~Javaslang~~!

And Java becomes more functional with Vavr.io!

VAVR.IO

Functional Programming

What does it mean?

No more side effects!

Functions are first-class citizens
Immutability
Expressiveness
Safety

Referential Transparency

```
int globalValue = 0;
// No Referential Transparency
int rq(int x) {
	globalValue++;
	return x + globalValue;
}
//Referential Transparency
int rt(int x) {
	return x + 1;
}
```

Referential Transparency

Other example

```
// No Referential Transparency
Math.random();

//Referential Transparency
Math.max(5, 42);
```

Java 8 & Functional Programming

Lambda
Stream
Optional
Functional Interface
Function composition
Collections interfaces review

There's still stuff missing

Who I am ?

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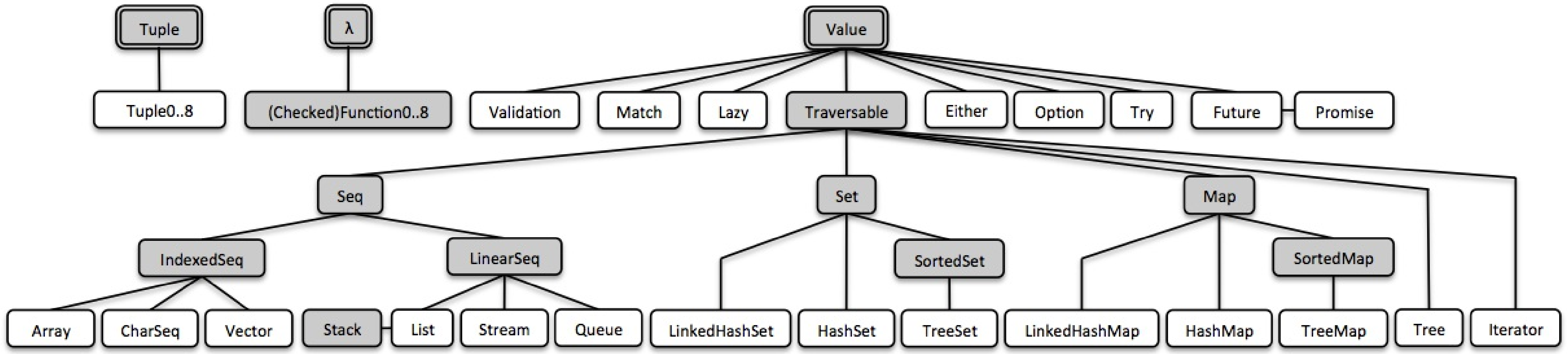
So ...

VAVr.io


Tuple
Tuple0..8
λ
(Checked)Function0..8
Value
Validation
Match
Lazy
Traversable
Either
Option
Try
Future
Promise
Seq
Set
Map
IndexedSeq
LinearSeq
SortedSet
SortedMap
Array
CharSeq
Vector
Stack
List
Stream
Queue
LinkedHashSet
HashSet
TreeSet
LinkedHashMap
HashMap
TreeMap
Tree
Iterator

Immutable Collections

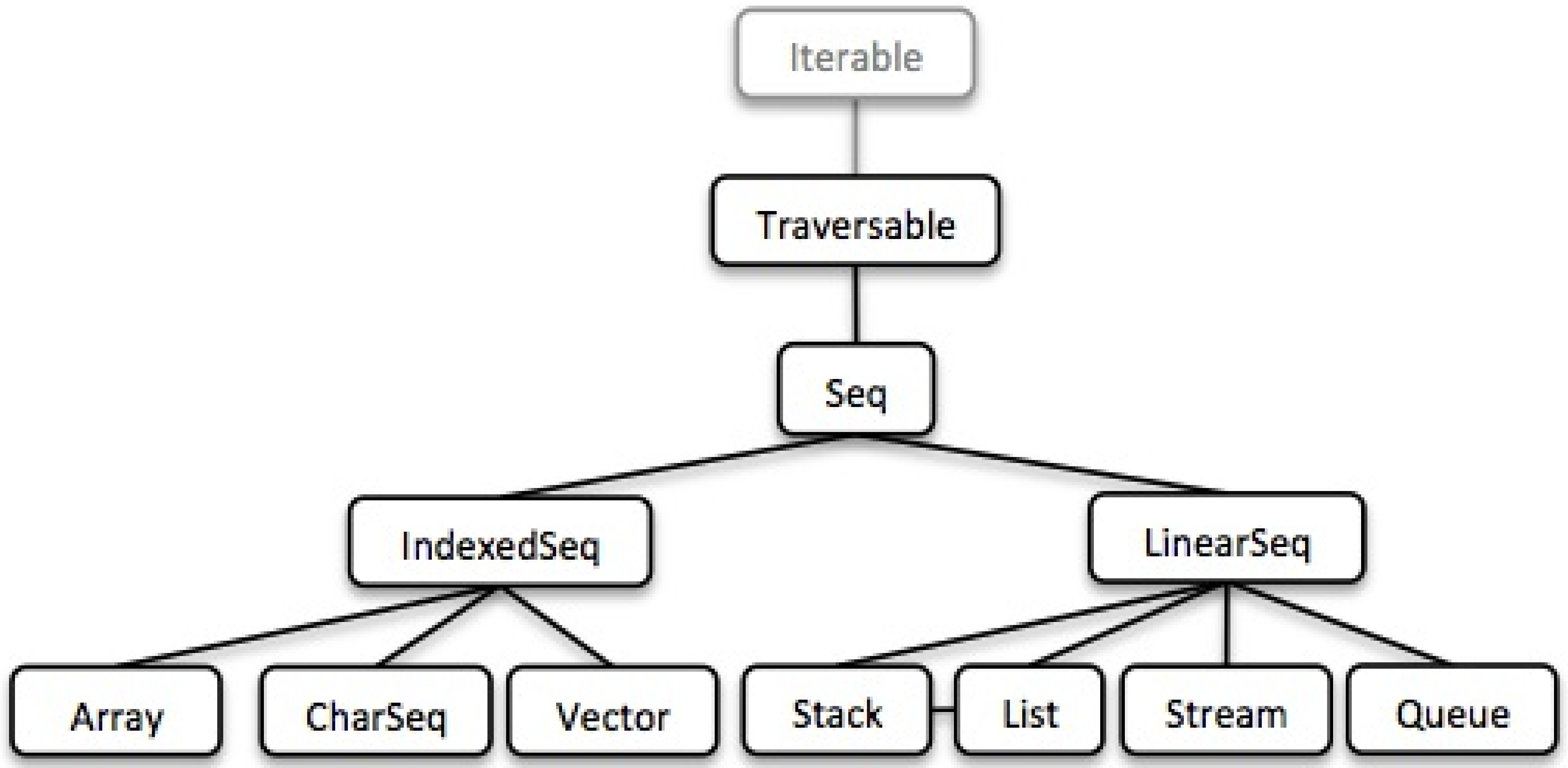
It's already in JDK 8 !

Humm....

```
public List<Integer> unmodifiableListJdk8() {
        List<Integer> jdkList = IntStream.range(0,20)
                .boxed()
                .collect(Collectors.toList());
        return Collections.unmodifiableList(jdkList);
}

@Test
public void should_verify_behaviour_of_jdk_8_unmodifiable_list() throws Exception {
        List<Integer> unmodifiableList = this.examples.unmodifiableListJdk8();
        unmodifiableList.add(21);
        assertThat(unmodifiableList).hasSize(21);
}
```

List, Array, Stream ...



Java 8 example

```
java.util.List<User> filterUserWithValidEmail() {
        return this.usersJdk8
                .stream()
                .filter(user -> {
                        try {
                                return user.isEmailValid();
                        } catch (InvalidFormatException e) {
                                return false;
                        }
                })
                .collect(Collectors.toList());
}
```

With Vavr

```
public List<User> filterUserWithValidAddressVavr() {
        return this.usersVavr
                .filter(user -> Try.of(() -> user
                                .isAddressValid())
                                .getOrElse(false));
    }
```

An other Java 8 example

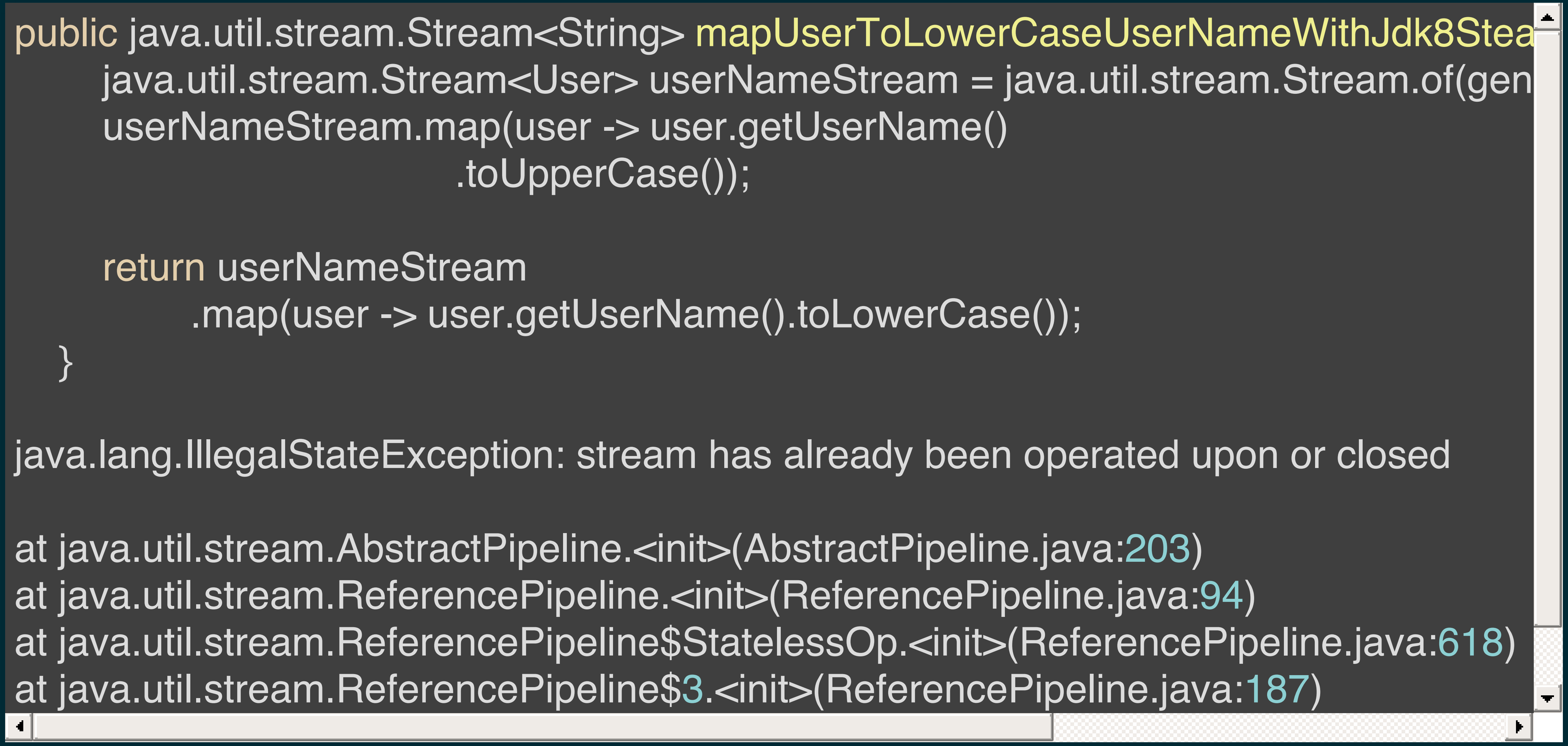
```
public java.util.List<Address> filterInvalidAddressFromRouenJdk8() {
        return this.usersJdk8.stream()
                .filter(User::isInvalidAddressFromRouen)
                .map(User::getAddress)
                .collect(Collectors.toList());
}
```

And With Vavr

```
public List<Address> filterInvalidAddressFromRouenVavr() {
        return this.usersVavr
                .filter(User::isInvalidAddressFromRouen)
                .map(User::getAddress);
    }
```

Stream consistency

Java 8



```
public java.util.stream.Stream<String> mapUserToLowerCaseUserNameWithJdk8Stea
        java.util.stream.Stream<User> userNameStream = java.util.stream.Stream.of(gen
        userNameStream.map(user -> user.getUserName()
                                        .toUpperCase());

        return userNameStream
                .map(user -> user.getUserName().toLowerCase());
    }

java.lang.IllegalStateException: stream has already been operated upon or closed

at java.util.stream.AbstractPipeline.<init>(AbstractPipeline.java:203)
at java.util.stream.ReferencePipeline.<init>(ReferencePipeline.java:94)
at java.util.stream.ReferencePipeline$StatelessOp.<init>(ReferencePipeline.java:618)
at java.util.stream.ReferencePipeline$3.<init>(ReferencePipeline.java:187)
```

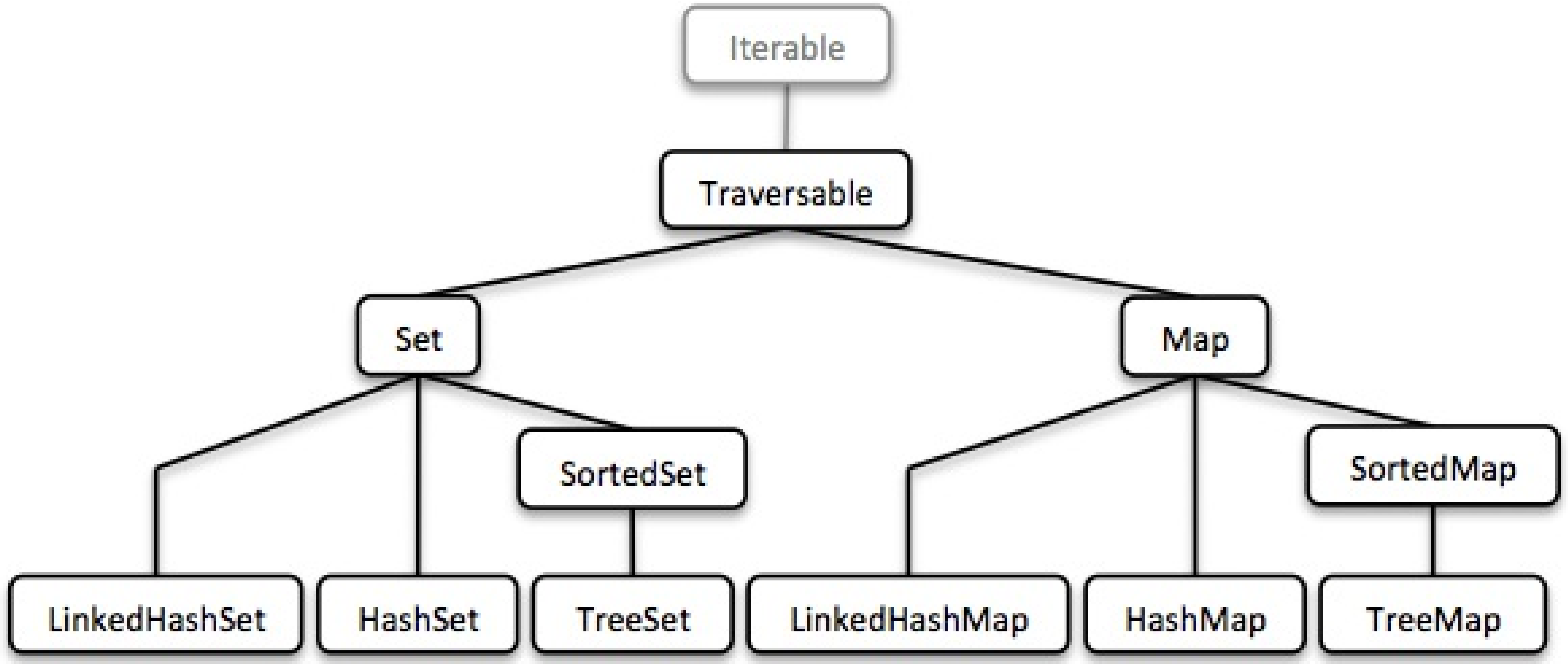
Stream consistency

Vavr

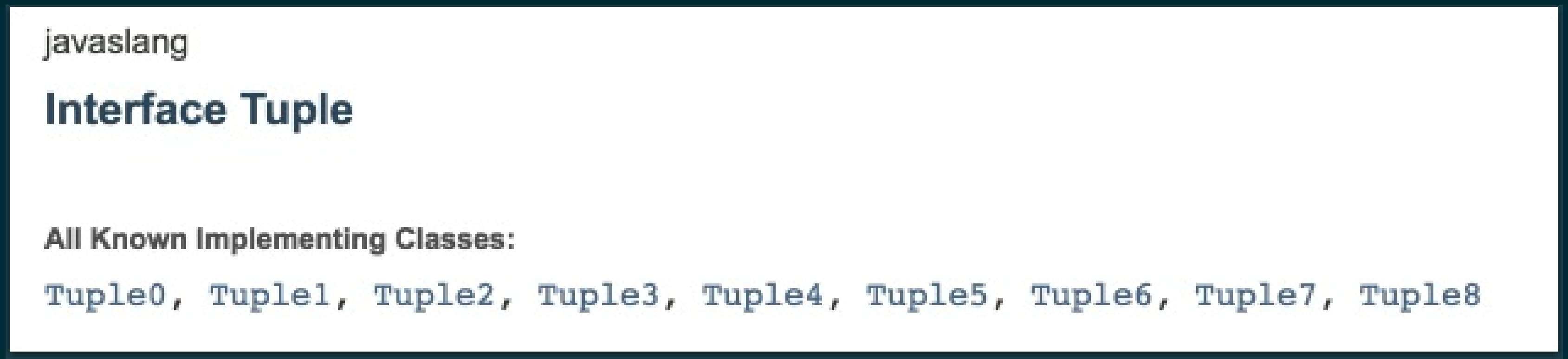
```
public Stream<String> mapUserToLowerCaseUserNameWithVavrStream() {
        Stream<User> userNameStream = Stream.of(generateUser(7), generateUser(15));
        userNameStream.map(user -> user.getUserName()
                                        .toUpperCase());

        return userNameStream
                .map(user -> user.getUserName().toLowerCase());
}
```

Map, Set ...


Iterable
Traversable
Set
Map
SortedSet
SortedMap
LinkedHashSet
HashSet
TreeSet
LinkedHashMap
HashMap
TreeMap

Tuple



javaslang

Interface Tuple

All Known Implementing Classes:

`Tuple0, Tuple1, Tuple2, Tuple3, Tuple4, Tuple5, Tuple6, Tuple7, Tuple8`

Java 8 example

```
public java.util.Map<String, User> filterMapOfUserWithValidAddressJdk8() {
        java.util.Map<String, User> usersMap = this.usersToMapJdk8();
        return usersMap.entrySet().stream()
                .filter(entry -> {
                    try {
                        return entry.getValue().isAddressValid();
                    } catch (InvalidFormatException e) {
                        return false;
                    }
                })
                .collect(Collectors.toMap((entry -> entry.getKey()), entry -> entry.getValue()));
    }
```

With Vavr

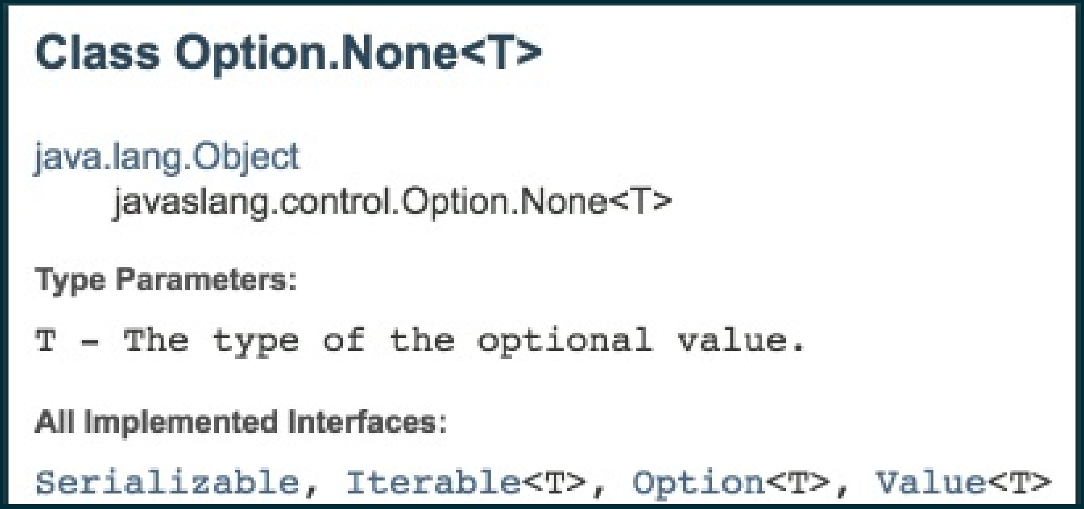
```
public Map<String, User> filterMapOfUserWithValidAddressVavr() {
        Map<String, User> userMap = this.usersToMap();
        return userMap
                .filter(tuple -> Try.of(() ->
                        tuple._2.isAddressValid()).getOrElse(false));
    }
```

Value Types

Option
Try
Either
Validation
(Lazy, Future, Promise, Match)

Option

1 Interface



Class Option.None<T>

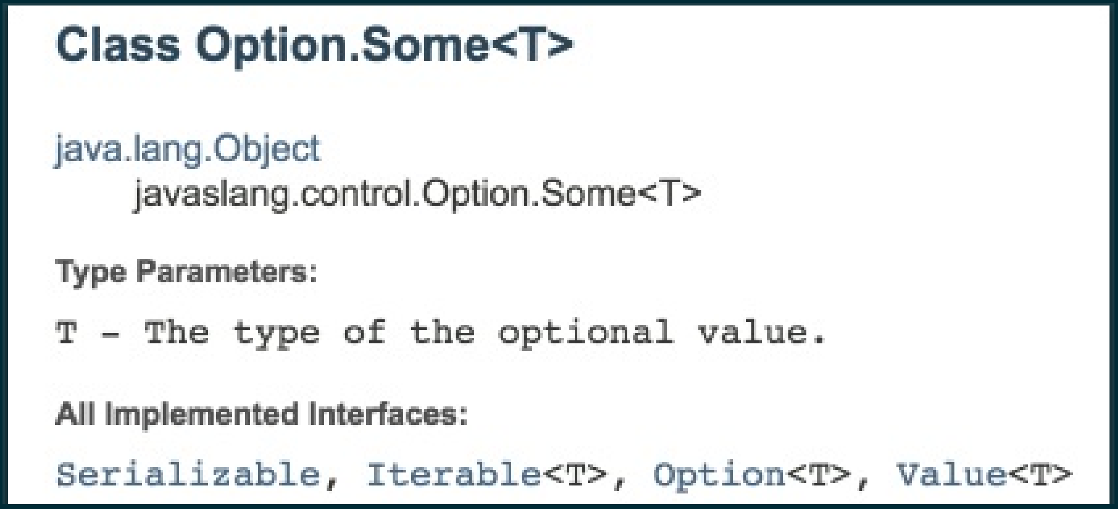
java.lang.Object
    javaslang.control.Option.None<T>

Type Parameters:

`T - The type of the optional value.`

All Implemented Interfaces:

`Serializable, Iterable<T>, Option<T>, Value<T>`



Class Option.Some<T>

java.lang.Object
    javaslang.control.Option.Some<T>

Type Parameters:

`T - The type of the optional value.`

All Implemented Interfaces:

`Serializable, Iterable<T>, Option<T>, Value<T>`

Java 8 Optional

```
public Optional<Address>  optionalOfUserAddress(String userName) {
        if( !this.usersJdk8.containsKey(userName)) {
            return Optional.empty();
        }
        return Optional.of(this.usersJdk8.get(userName).getAddress());
}

public Optional<Address> optionalOfNullUsageForUserAddress(String userName) {
        return Optional.ofNullable(this.usersJdk8.get(userName))
                .map(user -> user.getAddress());
}
```

Vavr Option

```
public Option<Address> optionOfUserAddress(String userName) {
        return this.usersVavr.get(userName)
                .map(user -> user.getAddress());
}
/* Because Map.get(key) return an Option in Vavr
Option<V>get(K var1);
*/
```

Try

May return an exception or a successful result

```
public Try tryOfUserAddress(String userName) {
        return Try.of(() -> this.usersVavr.get(userName)
                                .get().getAddressIfValid());
    }
```

Either

Represents a value of 2 possible types

Either is either Right or Left

by convention Right refers to the nominal case

Either Example

```
public Either<String, User> eitherOfUser(String userName)  {
       return this.usersVavr.get(userName)
                        .toRight("Not Found");
}
```

Validation

Errors accumulation

Processes all validations, no circuit breaking when an error is found

Example available on github

GitHub: https://goo.gl/BHcYRJ

Functions

What about the first-class citizens ?

Java 8 comes with Function and BiFunction

Vavr provides functional interfaces up to 8 parameters

In fact Vavr functional interfaces are Java 8 functional interfaces on steroids

Vavr documentation

Composition

Application of one function as the result of another to produce a new one

Composition example

```
private Function1<Option<User>, Option<String>> lastName
        = user -> user.map(exist -> exist.getLastName());

private Function1<Option<String>, Option<String>> toUpperCase
        = value -> value.map(string -> string.toUpperCase());

private Function1<Option<User>, Option<String>> lastNameInUpperCase
        = lastName.andThen(toUpperCase);

public String userLastNameToUpperCase(String userName) {
        return lastNameInUpperCase
                        .apply(usersJavaslang.get(userName))
                        .getOrElse("User Not Found");
}
```

Lifting

Turning a side effect function to a total function

Lifting example

```
private Function1<Option<User>, Address> getAddressWithSideEffect
        = user -< user.get().getAddress();

private Function1<Option<User>, Option<Address>> safeGetAddress
        = Function1.lift(getAddressWithSideEffect);

public Address sideEffectGetAddress(String userName) {
    return getAddressWithSideEffect
            .apply(usersJavaslang.get(userName));
}

public Option<Address> safeGetAddress(String userName) {
    return safeGetAddress
            .apply(this.usersVavr.get(userName));
}
```

Partial Application

Deriving a new function from an existing one by fixing some parameters

Partial Application example

```
private Function4 <Integer,Integer,Integer,Integer,Integer> sum
                = (a, b, c, d ) -> a + b + c + d;

private Function1<Integer, Integer> partialApplicationFunc
                = sum.apply(1,2,3);

public int partialApplication(int val) {
        return partialApplicationFunc.apply(val);
}
```

Currying

Deriving a new function from an existing by fixing 1 parameter and returning a new function with arity of 1

Currying example

```
private Function1<Integer, Function1<Integer, Function1<Integer, Integer>>> curriedFun
            = sum.curried().apply(5);

public int currying(int val1, int val2, int val3) {
      return curriedFunc.apply(val1).apply(val2).apply(val3);
}
```

Memoization

Kind of cache system

A function is executed only once and then returns the result from the cache

Memoization example

```
private Function0>Double< memoizedRandom = Function0.of(Math::random).memoized
public double memoize() {
	return memoizedRandom.apply();
}

@Test
public void should_use_memoization_to_add() throws Exception {
	double firstCall  = this.examples.memoize();

	assertThat(List.range(0, 20)
		.map(val -> this.examples.memoize()))
		.allMatch(val -> val == firstCall);
}
```

Pattern Matching and Property checking

Pattern Matching, the Vavr way

$() - wildcard pattern
$(value) - equals pattern
$(predicate) - conditional pattern

Syntactic Sugar

Predicate

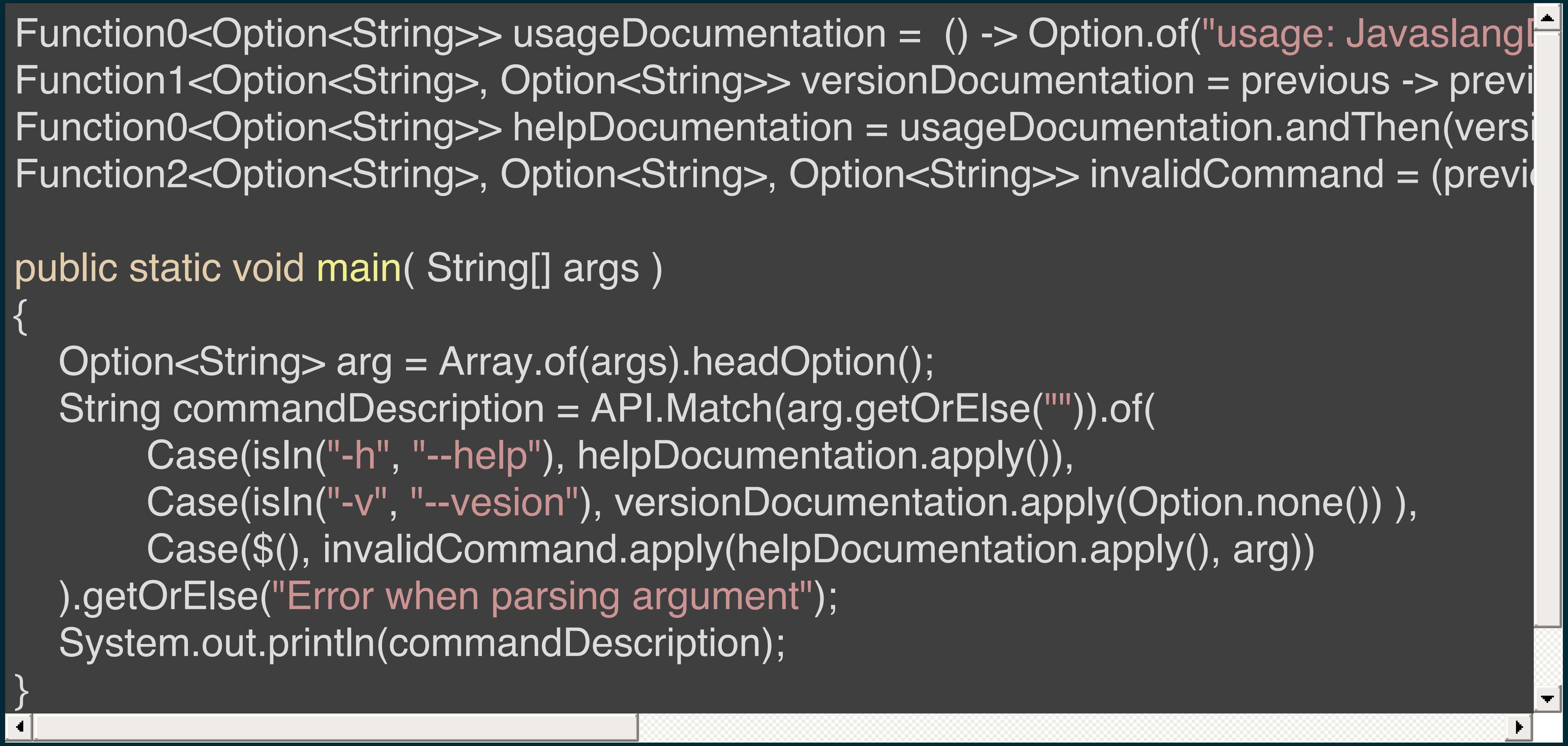
```
Case(is(1), "one")
```

Multiple conditions

```
Case(isIn("-h", "--help"), ...)
```

User-Defined Patterns, Guards ...

Pattern Matching example



```
Function0<Option<String>> usageDocumentation =  () -> Option.of("usage: Javaslang
Function1<Option<String>, Option<String>> versionDocumentation = previous -> previ
Function0<Option<String>> helpDocumentation = usageDocumentation.andThen(versi
Function2<Option<String>, Option<String>, Option<String>> invalidCommand = (previ

public static void main( String[] args )
{
    Option<String> arg = Array.of(args).headOption();
    String commandDescription = API.Match(arg.getOrElse("")).of(
            Case(isIn("-h", "--help"), helpDocumentation.apply()),
            Case(isIn("-v", "--vesion"), versionDocumentation.apply(Option.none()) ),
            Case($(), invalidCommand.apply(helpDocumentation.apply(), arg))
    ).getOrElse("Error when parsing argument");
    System.out.println(commandDescription);
}
```

Another example

```
public List<Either<Address, Address>> patternMatchingList() {
        List<User> users = this.usersVavr.map(tuple -> tuple._2).toList();
        return users.map(user ->
           Match(validateUser(Option.of(user))).of(
             Case(Valid($()), validUser -> Either.right(validUser.getAddress())),
             Case(Invalid($()), errorList -> Either.left(user.getAddress()))
           ));
}
```

Property Checking

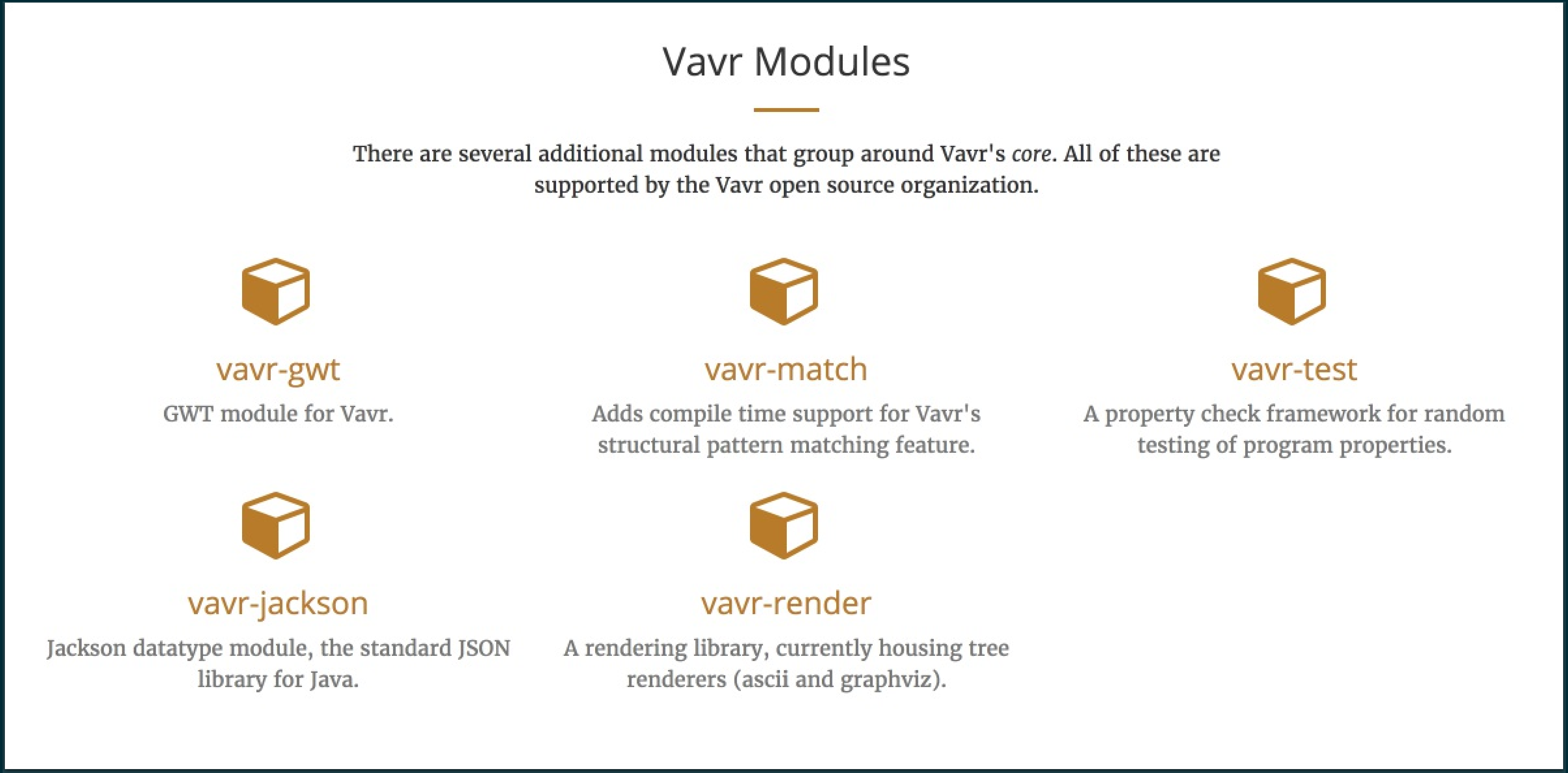
Property Checking example

```
@Test
public void should_l33t_string() throws Exception {
        Arbitrary<String>  leetCharEto3 = Arbitrary.string(Gen.frequency(
                        Tuple.of(1, Gen.choose('A','Z')),
                        Tuple.of(1, Gen.choose('a','z'))
        ))
        .filter(s -> s.length() > 10)
        .filter(s -> s.matches("\\w*[eE]+\\w*"));

Function1<String, String> transformETo3 =
                s -> s.replaceAll("[eE]", "3");

CheckedFunction1<String, Boolean> checkTransformETo3 =
                s -> transformETo3.apply(s)
                        .matches("\\w*[^eE]+\\w*")
                        && transformETo3.apply(s).contains("3");
```

Vavr Modules



Vavr Modules

There are several additional modules that group around Vavr's *core*. All of these are supported by the Vavr open source organization.

vavr-gwt
GWT module for Vavr.

vavr-match
Adds compile time support for Vavr's structural pattern matching feature.

vavr-test
A property check framework for random testing of program properties.

vavr-jackson
Jackson datatype module, the standard JSON library for Java.

vavr-render
A rendering library, currently housing tree renderers (ascii and graphviz).

Vavr Links

Documentation: https://goo.gl/dMKKjN

Javadoc: https://goo.gl/PHQ81g

Source code : https://goo.gl/p3ivLM

Thank You

Questions ?

source code: https://goo.gl/BHcYRJ