
Monadische Transaktionen
...
In Java


Monadic transactions
...
In Java

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Who knows what

- a function is?
- a lambda expression is?
- a higher order function is?
- a monad is?

```
public void save(T entity) {
    beginTransaction();
    entityManager.persist(entity);
    commitTransaction();
}

private void beginTransaction() {
    try {
        entityManager.getTransaction().begin();
    } catch (IllegalStateException e) {
        rollBackTransaction();
    }
}

private void commitTransaction() {
    try {
        entityManager.getTransaction().commit();
    } catch (IllegalStateException | RollbackException e) {
        rollBackTransaction();
    }
}
```

A typical repository

Move a scattered and/or repeated responsibility into one single method

Execute around method pattern

```
public void update(int id, Consumer<T>... updates) throws Exception {
   T entity = find(id);
   transactional(em -> Arrays.stream(updates).forEach(up -> up.accept(entity)));
}

public void remove(int id) {
   transactional(em -> em.remove(find(id)));
}

private void transactional(Consumer<EntityManager> action) {
   try {
       entityManager.getTransaction().begin();
       action.accept(entityManager);
       entityManager.getTransaction().commit();
   } catch (RuntimeException e) {
       entityManager.getTransaction().rollback();
       throw e;
   }
}
```

Execute around method pattern

Concise code

Execute around method pattern

Reduces the risk of incorrect transaction management

Execute around method pattern

A function should only return nothing if it does nothing. Any other observed effect is a side effect.

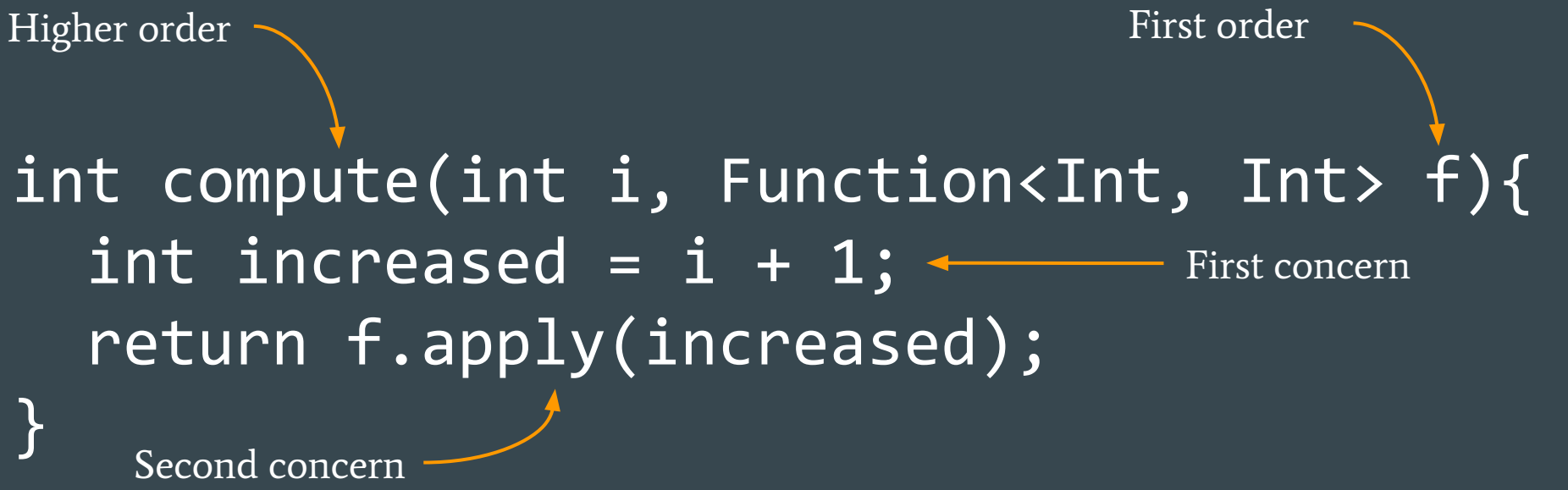
Execute around method pattern

Transaction execution is the immediate side effect

Execute around method pattern

Difficult code reuse: update and remove in the same transaction?

Execute around method pattern



Higher order functions

A means to describe the transaction and delay its execution

Higher order functions

```java
public T convert(int id, UnaryOperator<T> converter){
    Function<EntityManager, T> find = em -> em.find(entityType, id);
    Function<EntityManager, T> transaction = transactional(find.andThen(converter));
    return transaction.apply(entityManager);
}

private <U> Function<EntityManager, U> transactional(Function<EntityManager, U> action){
    return em -> {
        try {
            em.getTransaction().begin();
            final U result = action.apply(em);
            em.getTransaction().commit();
            return result;
        } catch (RuntimeException e) {
            em.getTransaction().rollback();
            throw e;
        }
    };
}
```

Higher order functions

Compose descriptions without the burden of side effects

Higher order functions

Execute the description by applying it to the entity manager

The actual database is determined upon execution

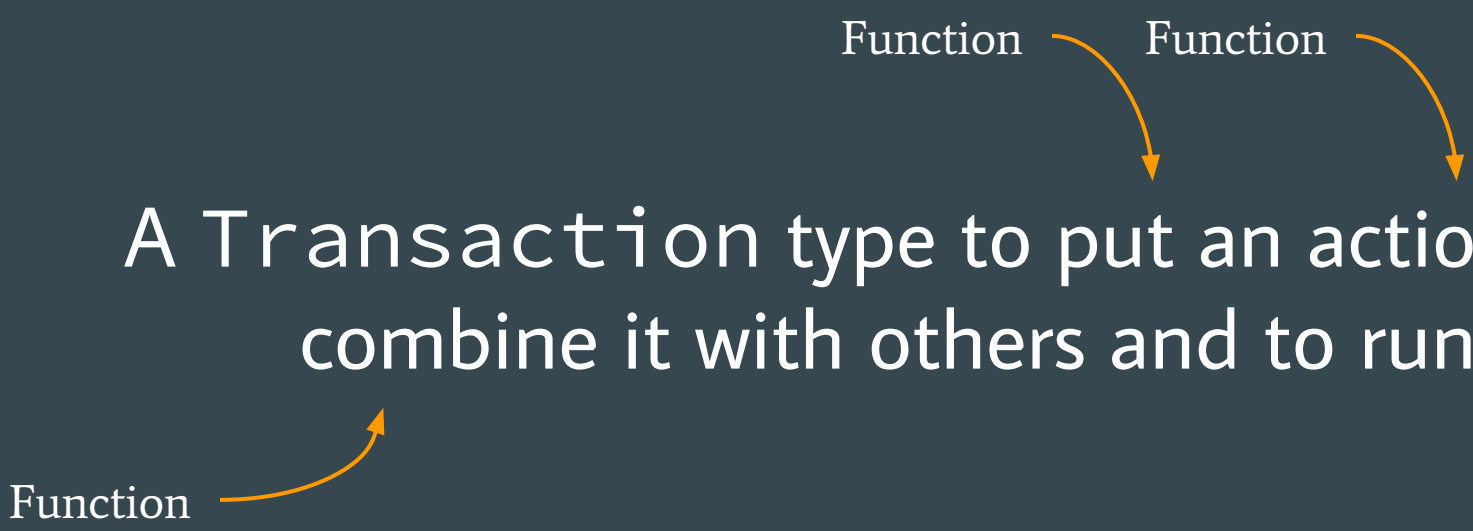
```
public Function<EntityManager, T> convert(int id, UnaryOperator<T> converter){
   return transactional(find(id).andThen(converter));
}

public Function<EntityManager, T> find(int id){
   return em -> em.find(entityType, id);
}

private <U> Function<EntityManager, U> transactional(Function<EntityManager, U> action){
   return em -> {
       try {
           em.getTransaction().begin();
           final U result = action.apply(em);
           em.getTransaction().commit();
           return result;
       } catch (RuntimeException e) {
           em.getTransaction().rollback();
           throw e;
       }
   };
}
```

Higher order functions

Type `Function` does not convey the information whether a transaction is executed during application

```
public Function<EntityManager, T> transactionalConvert(int id, UnaryOperator<T> converter){
   return transactional(transactional(find(id)).andThen(converter));
}

public Function<EntityManager, T> find(int id){
   return em -> em.find(entityType, id);
}

private <U> Function<EntityManager, U> transactional(Function<EntityManager, U> action){
   return em -> {
       try {
           em.getTransaction().begin();
           final U result = action.apply(em);
           em.getTransaction().commit();
           return result;
       } catch (RuntimeException e) {
           em.getTransaction().rollback();
           throw e;
       }
   };
}
```

Higher order functions


Function
Function
A Transaction type to put an action in, to combine it with others and to run it
Function

Is type `Transaction` a monad?

Functional languages are based on the lambda calculus

Brief background about functional languages

Applying conversions on expressions

$\lambda x.x$

Brief background about functional languages

How to integrate side effects and stay pure?

Brief background about functional languages

Don’t: Lisp (Clojure, Scheme), Standard ML

```
(println (read-line))
```

Brief background about functional languages

“Or I could use a monad” -- Philip Wadler

Brief background about functional languages

“‘In order to understand monads you first need to learn category theory’ is like saying ‘In order to understand Pizza you first need to learn Italian.’” -- Mario Fusco (Italian)

Brief background about functional languages

A monad of type `M` represents some computation: I/O, potential absent values, values available in the future, lists, etc.

A brief and mostly incorrect introduction to monads

A function to turn a value into a computation that produces the value

```
M<T> of(T value)
```

A brief and mostly incorrect introduction to monads

A function to combine computations

```
M<U> flatMap(M<T> m, Function<T, M<U>> f)
```

A brief and mostly incorrect introduction to monads

```
M<String> hello = of("hello");

Function<String, M<String>> world = str -> of(str + "World");

M<String> helloWorld = flatMap(hello, world);
```

A brief and mostly incorrect introduction to monads

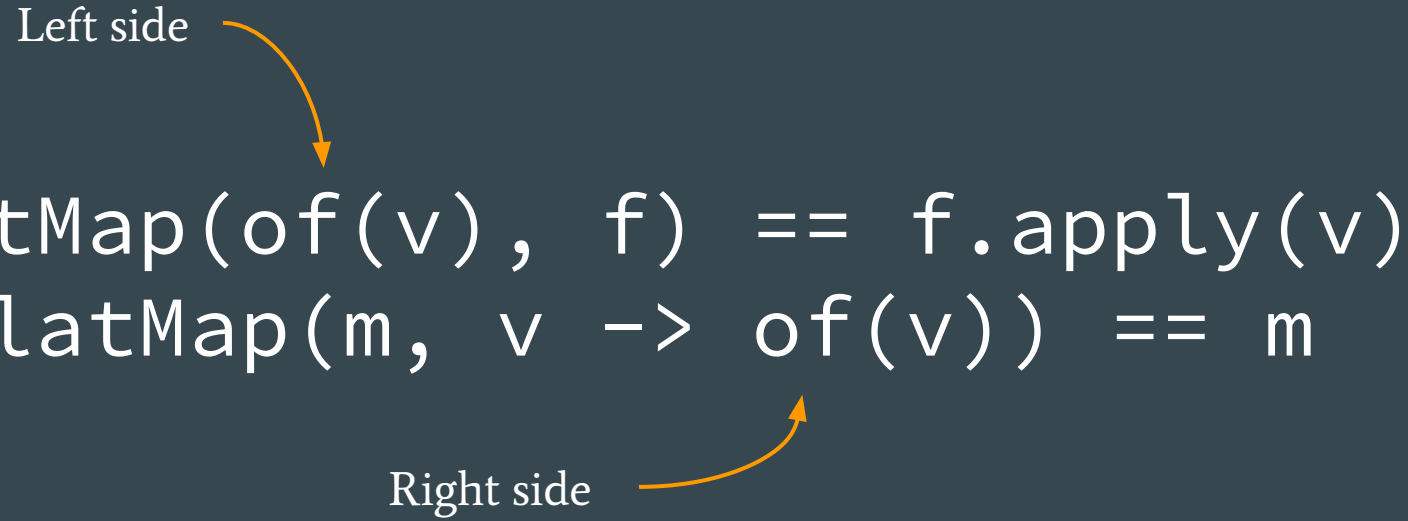
A monad is a tuple `(M, of, flatMap)`

A brief and mostly incorrect introduction to monads

Monad laws describe how operations relate to each other and, thus, make reasonable assumptions about their behavior

A brief and mostly incorrect introduction to monads

Identity laws guarantee that the `of` function just puts the value into the computation and does not manipulate it



A brief and mostly incorrect introduction to monads

The associativity law guarantees that function composition holds across the combination of computations

A brief and mostly incorrect introduction to monads

```
flatMap(flatMap(m, f), g) ==
flatMap(m,v -> flatMap(f.apply(v), g))
```

A brief and mostly incorrect introduction to monads

Laws do not provide a mental model what a monad is or what a monad means

A brief and mostly incorrect introduction to monads

We are used to perceive interfaces as a generalization of specific representations

A brief and mostly incorrect introduction to monads

For example: Interface `List` is a generalization of `ArrayList` and `LinkedList`

Monad does not generalize one type or another

A brief and mostly incorrect introduction to monads

A type is monadic if it has operations which satisfy the laws

A brief and mostly incorrect introduction to monads

The monad operations are often just a small fragment of the full API for a given type that happens to be a monad

The monad contract does not specify what is happening between the lines, only that whatever is happening satisfies the laws

CompletableFuture
Stream

Monads in Java

```
completedFuture("hello").thenCompose(v -> completedFuture(v + "world"));

completedFuture("hello").thenComposeAsync(v -> completedFuture(v + "world"));

Stream.of("hello").flatMap(v -> Stream.of(v + "world"));
```

Monads in Java

Type `Transaction` is monadic*

```
userRepository.convert(10, clone).run(entityManager);
final UnaryOperator<User> clone = user -> new User(user.getName(), user.getEmail());

public Transaction<T> convert(int id, UnaryOperator<T> converter){
   return find(id).flatMap(entity -> Transaction.of(converter.apply(entity)));
}

public Transaction<T> find(int id) {
   return findById(id).apply(entityClass);
}

private Function<Class<T>, Transaction<T>> findById(int id) {
   return clazz -> Transaction.of(em -> em.find(clazz, id));
}
```

Towards a transaction monad

Given the capability of describing a transaction before execution, a simple set of CRUD transactions can be factored in an own interface

```java
public interface CrudTransactions<T> {

    default Transaction<Void> saveEntity(T entity) {
        return transactional(em -> em.persist(entity));
    }

    default Transaction<Void> removeEntity(T entity) {
        return transactional(em -> em.remove(entity));
    }

    default Transaction<Void> transactional(Consumer<EntityManager> action){
        return Transaction.withoutResult(action);
    }

    default Function<Class<T>, Transaction<T>> findById(int id) {
        return clazz -> Transaction.of(em -> em.find(clazz, id));
    }
}
```

Towards a transaction monad

```java
public class Repo<T> implements EntityRepository<T>, CrudTransactions<T> {
    // some code is left out
    public Transaction<T> find(int id) {
        return findById(id).apply(entityClass);
    }

    public Transaction<T> convert(int id, UnaryOperator<T> conv){
        return find(id).flatMap(entity -> Transaction.of(conv.apply(entity)));
    }

    public Transaction<Void> save(T entity) {
        return saveEntity(entity);
    }

    public Transaction<Void> remove(int id) {
        return find(id).flatMap(this::removeEntity);
    }
}
```

Towards a transaction monad

Build up reusable vocabularies to talk to the databases

Towards a transaction monad

```
UserDetails implements
Read<User>,Count<User>
```

Towards a transaction monad

Code of Transaction<T>

Towards a transaction monad

Knowing a type is monadic, let us reason about its behavior

For example: Exploit the associativity law and rearrange the function chaining

```
completedFuture("hello")
       .thenCompose(v -> completedFuture(v + "world"))
       .thenCompose(v -> completedFuture(v + "2017"));

completedFuture("hello").thenCompose(v ->
       completedFuture(v + "world")
       .thenCompose(w -> completedFuture(w + "2017"))
);
```

Benefits of monads

Java is a poor tool for monads

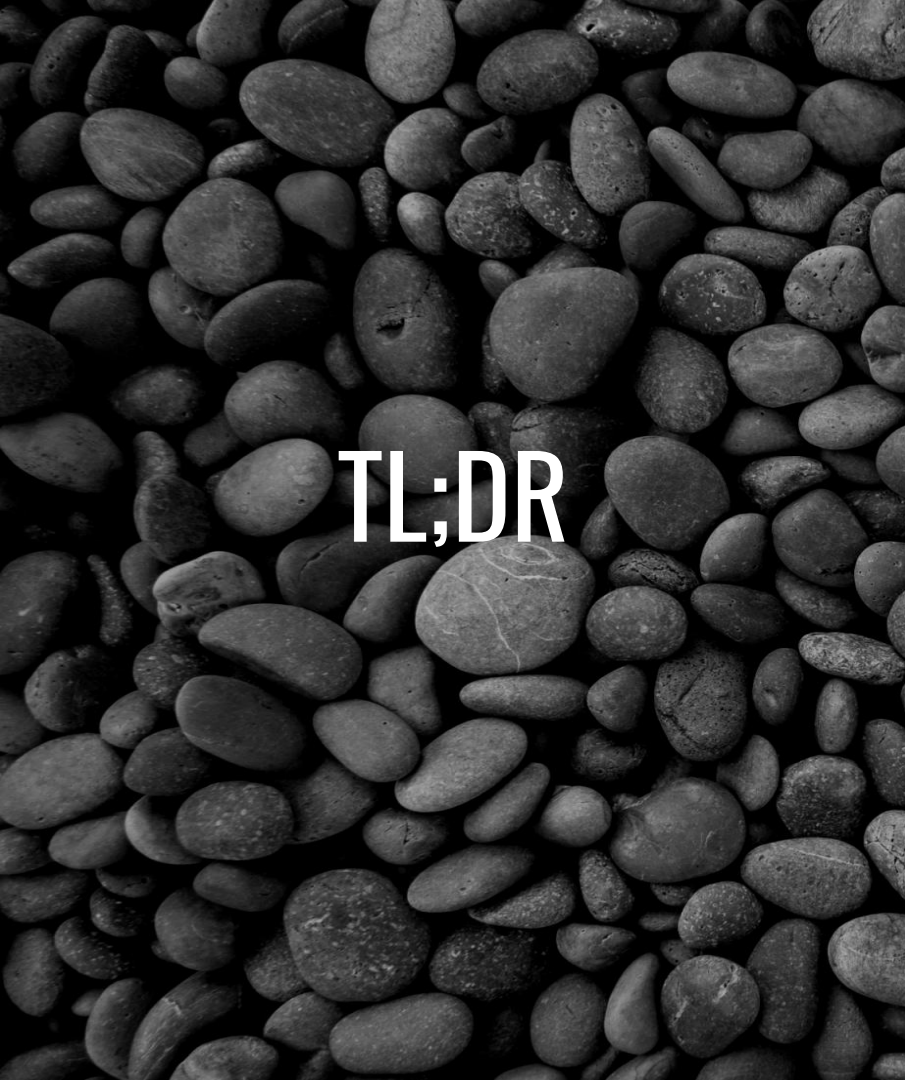
Benefits of monads

```
describe("Combination of crud methods"){
 it("should combine findById with update"){
   val em = ???
   val user = new User("Test", "test")
   findAndUpdate(user.getId, classOf[User], _.setEmail("mail")).run(em)

   def findAndUpdate(id:Int,clazz:Class[User],updates:Consumer[User]) = for {
     entity <- findById(id)(clazz)
     update <- updateEntity(entity, updates)
   } yield update

 }
}
```

Benefits of monads

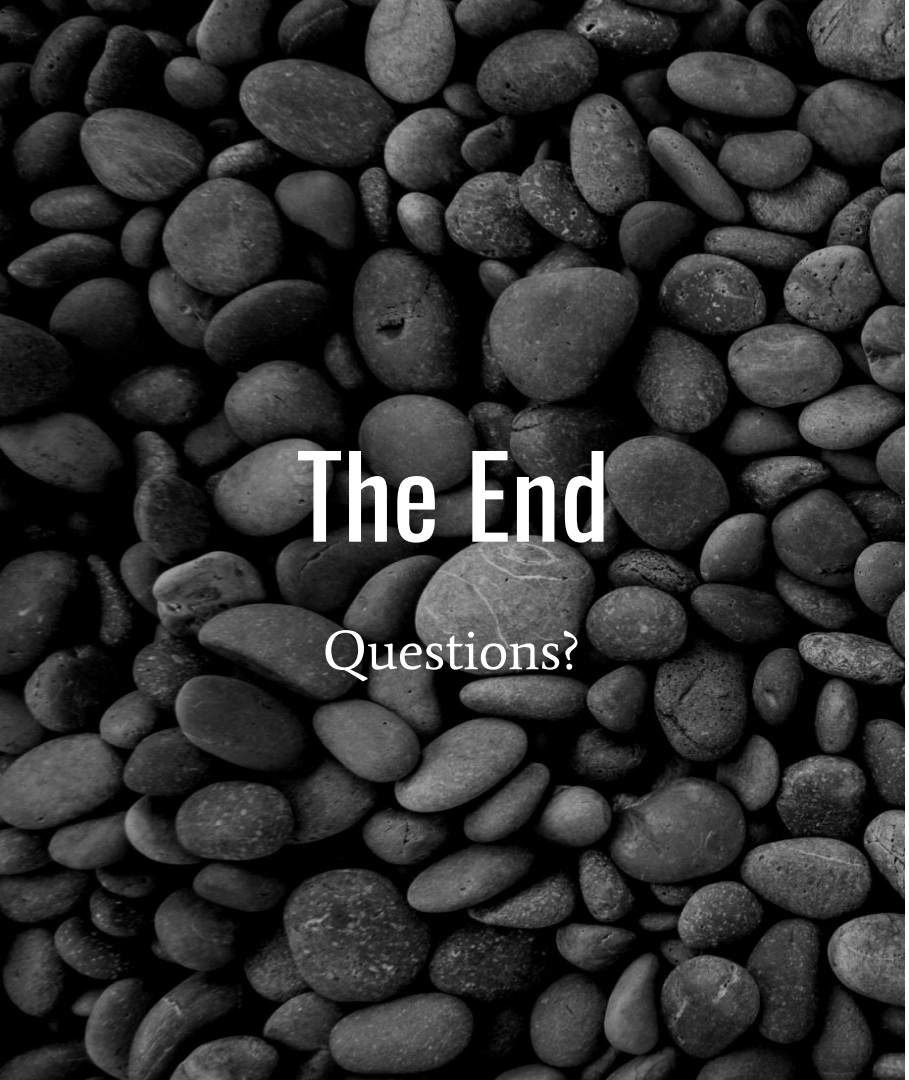
Monads are a part of a solution to a problem that never existed in Java

Though monadic types help us dealing with side effects in a predictable way



A monad
- is a triple (M, of, flatMap)
- adheres to laws
- is a *self-containing* interface
- is not well supported in Java

Transaction
- is a monadic type
- defines reusable transactions
- is a specialization of Reader



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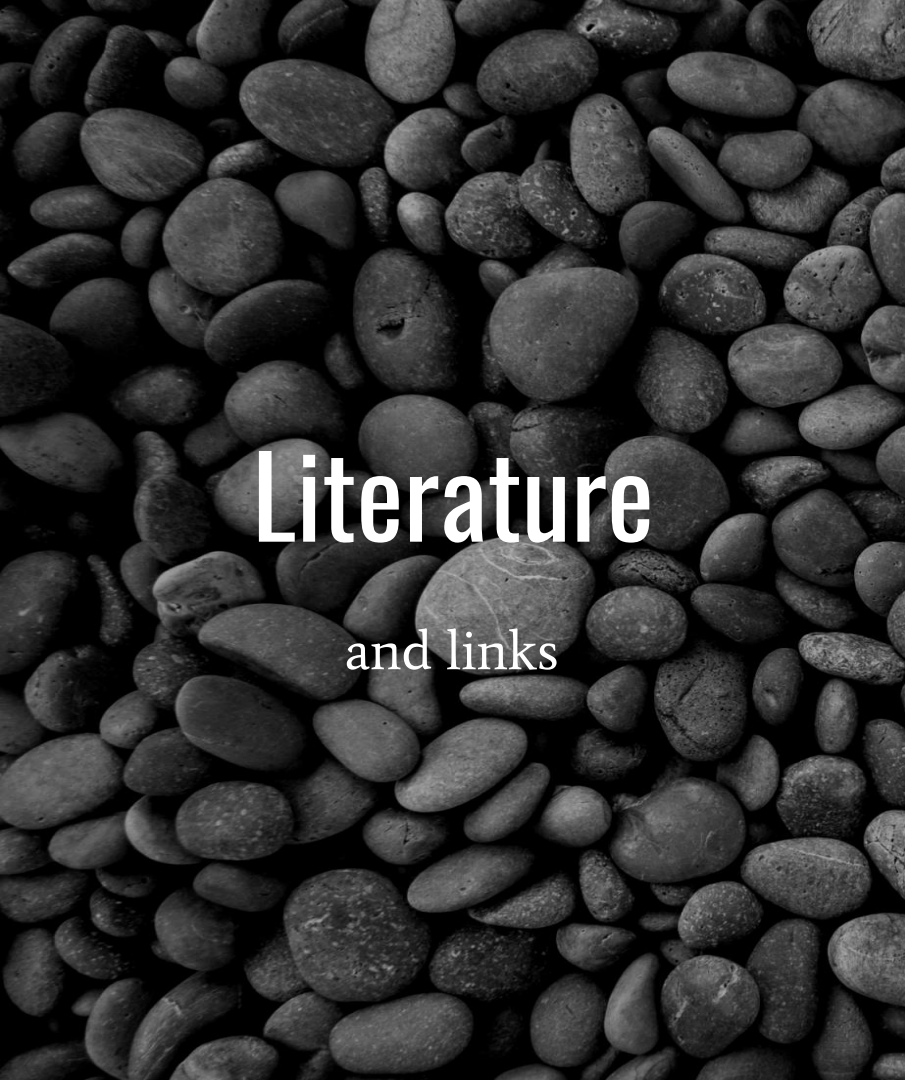

Literature

and links

- My blog
  - https://gtrefs.github.com
- FP in Scala
  - Paul Chiusano
  - Rúnar Bjarnason
- The essence of FP
  - Philip Wadler
- Background picture
  - by John Salzarulo