scala-miniboxing.org

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Scala Bay Area Meetup
Linkedin HQ, Mountain View

Vlad URECHE

PhD student in the Scala Team @ EPFL

Miniboxing guy. Also worked on specialization, the backend and scaladoc.


@VladUreche


@VladUreche


vlad.ureche@gmail.com

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What do **auto(un)boxing**, **specialization** and **value classes** have in common?

What do **auto(un)boxing**, **specialization** and **value classes** have in common?

What are they?

Auto(un)boxing

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def identity[T](t: T): T = t
```

Auto(un)boxing

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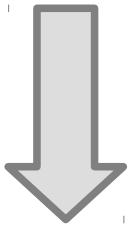

scalac / javac

Auto(un)boxing

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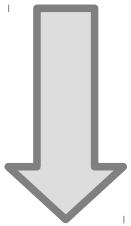

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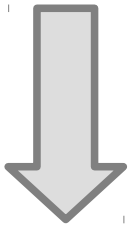

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The process is called **erasure**, and is the simplest translation of generics to bytecode.

Auto(un)boxing

identity(5)

Auto(un)boxing

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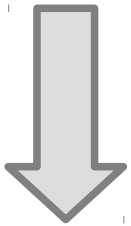

scalac / javac

Auto(un)boxing

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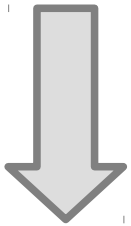
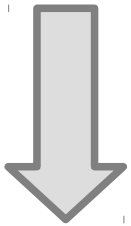


scalac / javac

identity(j.l.Integer.valueOf(5)).intValue

Auto(un)boxing

identity(5)



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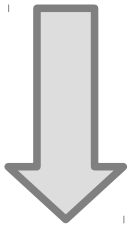
Object representation

Auto(un)boxing

identity(5)



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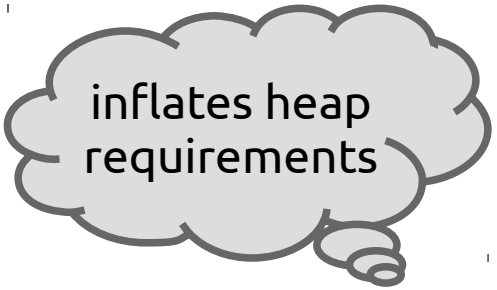

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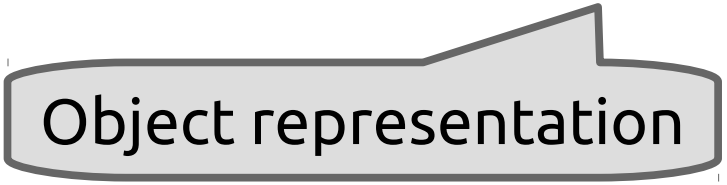

Auto(un)boxing

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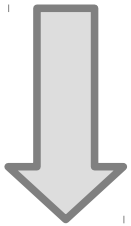

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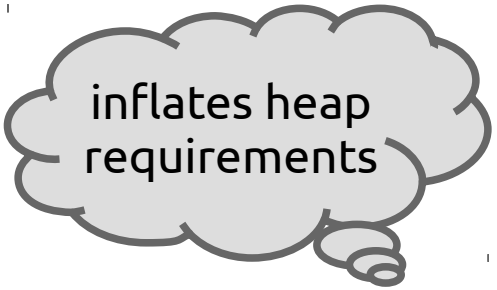

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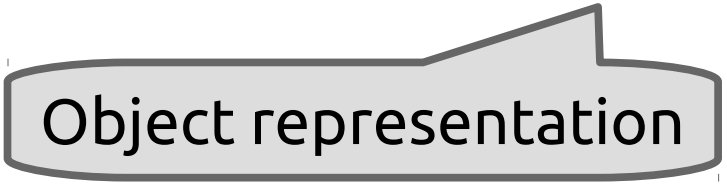

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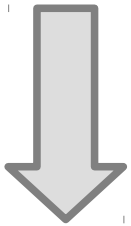

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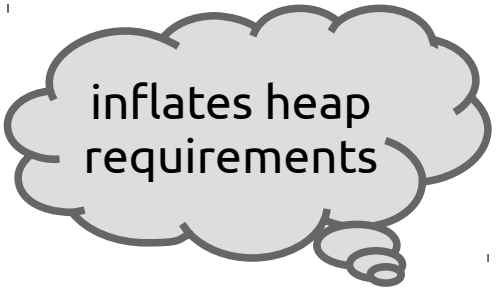

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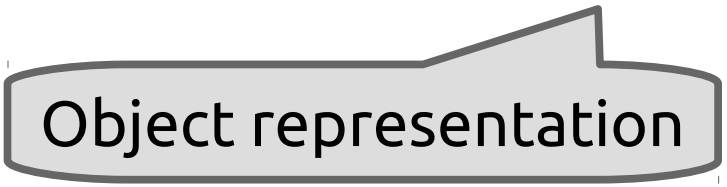

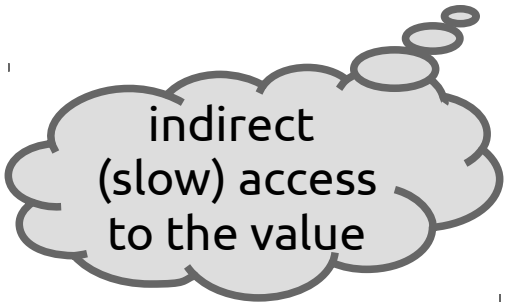

Auto(un)boxing

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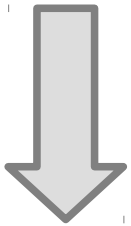

scalac / javac

inflates heap requirements

produces garbage

identity(j.l.Integer.valueOf(5)).intValue

Object representation

indirect (slow) access to the value

breaks locality guarantees

Auto(un)boxing

```
val five: Int = 5
```

Auto(un)boxing

scala.Int behaves like an object
(has methods, can be used with generics)

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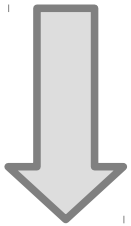

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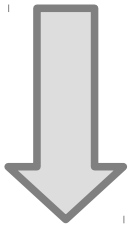

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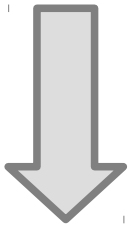

scalac

val five: int = 5

Unboxed integer

Auto(un)boxing

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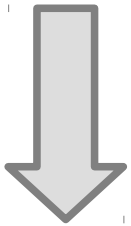
```
val five: Int = 5        five + 3
```



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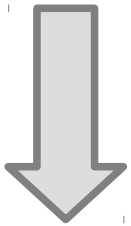

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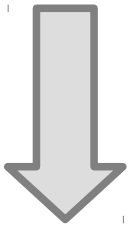

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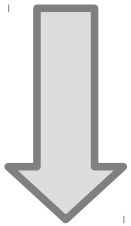

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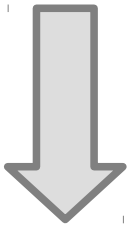

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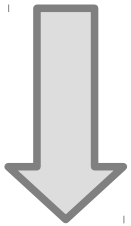

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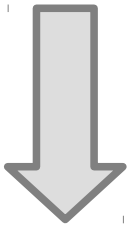

scalac

five + 3

Unboxed addition

Auto(un)boxing

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val five: Int = identity(5)
```

Auto(un)boxing

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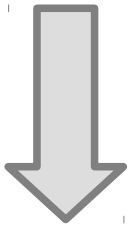

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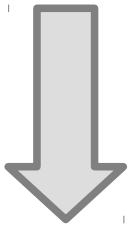

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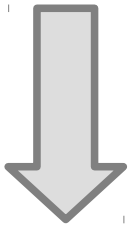

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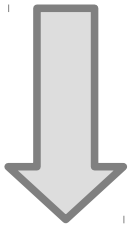

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Boxing coercion

Auto(un)boxing

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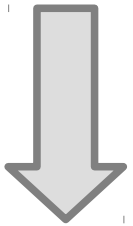

scalac

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Boxing coercion

Unboxing coercion

Auto(un)boxing

scala.Int

Auto(un)boxing

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scala.Int

int

- fast access
- no garbage collection
- locality

Auto(un)boxing

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java.lang.Integer

- indirect access
- object allocation
  - and thus garbage collection
- no locality guarantees
- **compatible with erased generics**

Auto(un)boxing

scala.Int

int

- fast access
- no garbage collection
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java.lang.Integer

- indirect access
- object allocation
  - and thus garbage collection
- no locality guarantees
- **compatible with erased generics**

incompatible
→ **coercions**

What do ~~**auto(un)boxing**~~, **specialization** and **value classes** have in common?

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Specialization

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def identity[T](t: T): T = t
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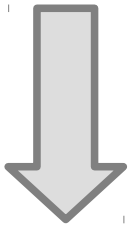

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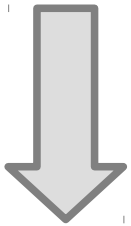


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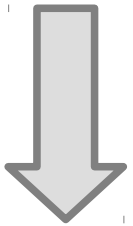

specialization

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def identity(t: Object): Object = t
def identity_Z(t: bool): bool = t
```

Specialization

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def identity[T](t: T): T = t
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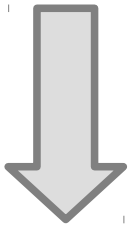

specialization

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def identity(t: Object): Object = t
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def identity_C(t: char): char = t
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Specialization

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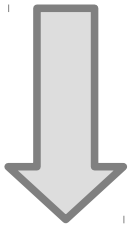

specialization

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def identity(t: Object): Object = t
def identity_Z(t: bool): bool = t
def identity_C(t: char): char = t
... (7 other variants)
```

Specialization

identity(5)

Specialization

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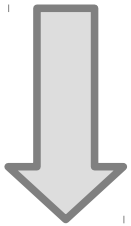

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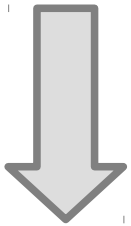
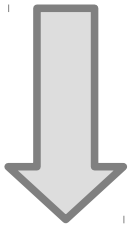


specialization

identity_I(5)

Specialization

identity(5)



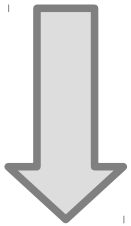
specialization

identity_I(5)

The variant of identity specialized for **int**

Specialization

identity(5)



specialization

identity_I(5) **// no boxing!**

The variant of identity specialized for **int**

Specialization

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def tupled[T1, T2](t1: T1, t2: T2) ...
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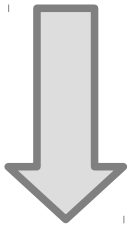

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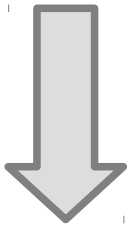

specialization

```
// 100 methods (10²)
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Specialization

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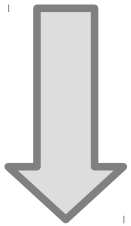

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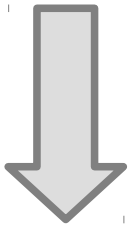

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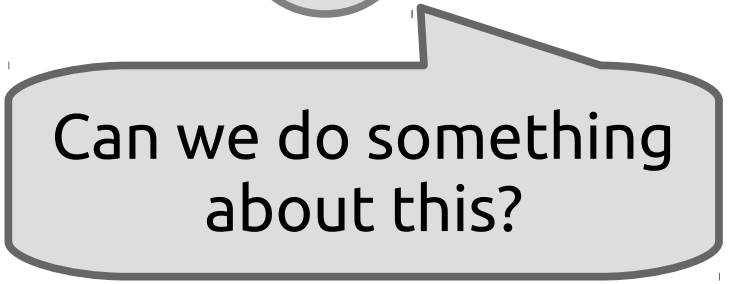
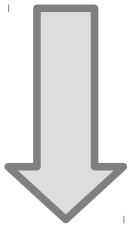


Specialization

```
def tupled[T1, T2](t1: T1, t2: T2) ...
```



specialization

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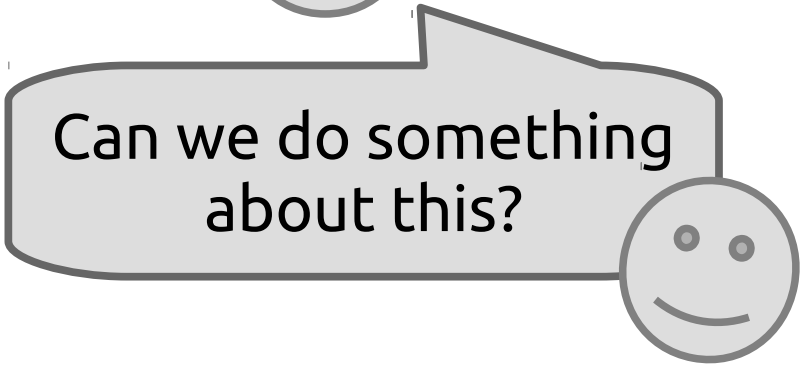
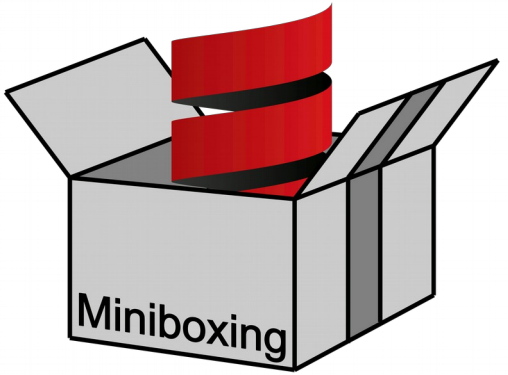


Miniboxing


```
def identity[T](t: T): T = t
```

Miniboxing

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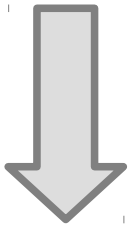

miniboxing

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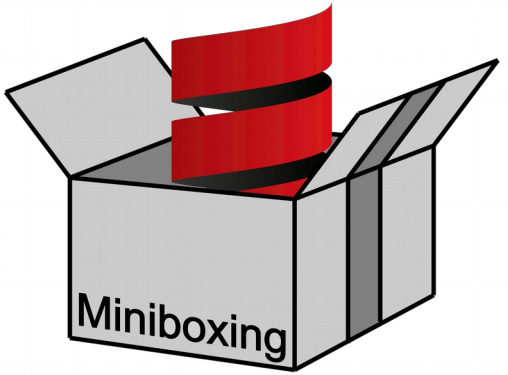


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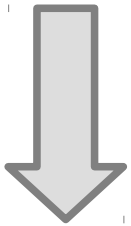

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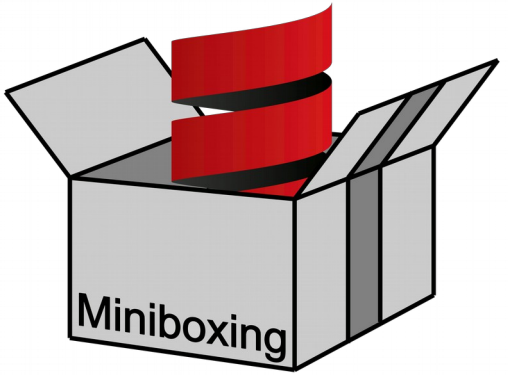


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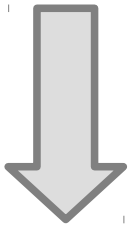
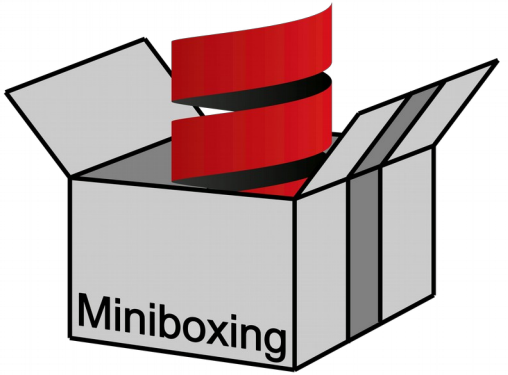


miniboxing

```
def identity(t: Object): Object = t
def identity_M(..., t: long): long = t
```

Miniboxing

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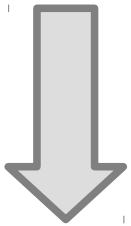

miniboxing

```
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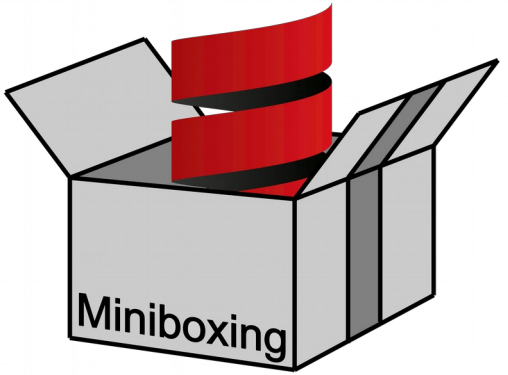
```

long **encodes** all primitive types

Miniboxing

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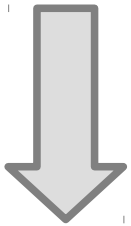

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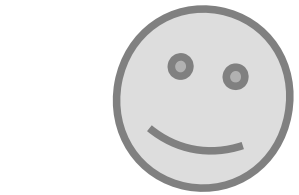


Only 2^n variants

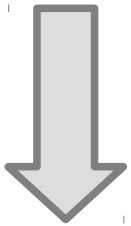
scala-miniboxing.org

Miniboxing

identity(3)

Miniboxing

identity(3)



miniboxing

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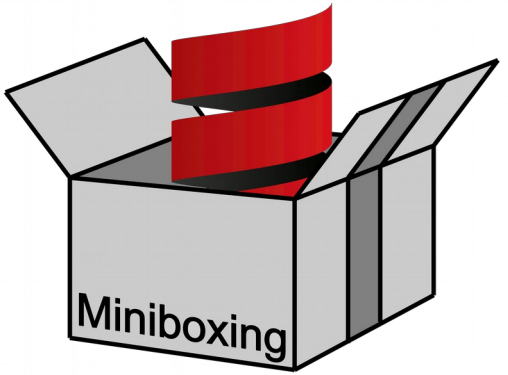

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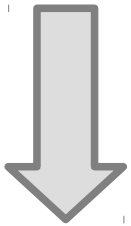
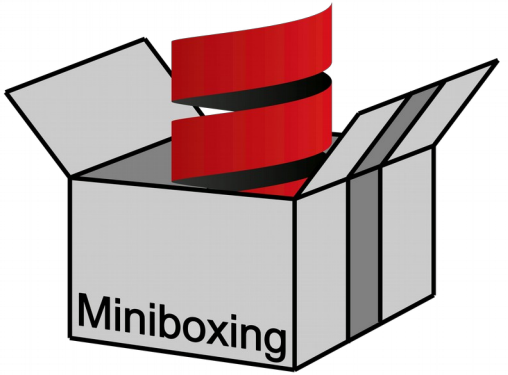


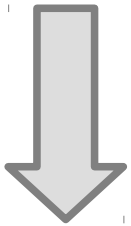
miniboxing

identity_M(..., int2minibox(3))

Miniboxing



identity(3)



miniboxing

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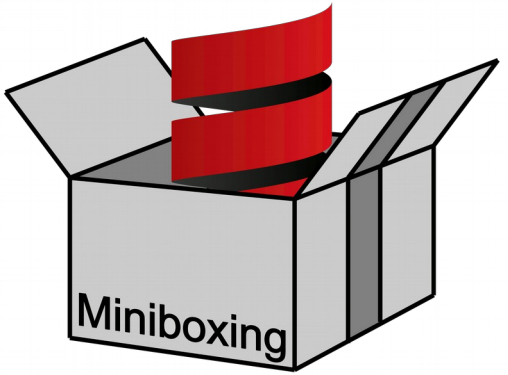
Coercion

Miniboxing



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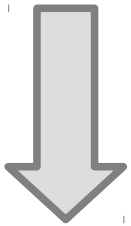


miniboxing

identity_M(..., int2minibox(3))

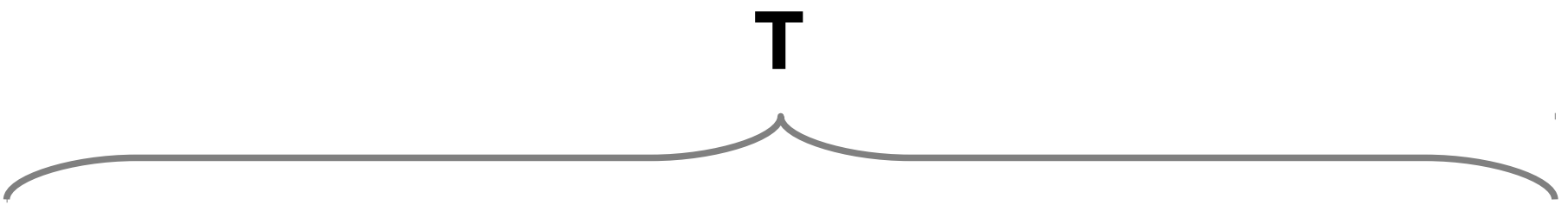
The miniboxed variant of identity

Coercion

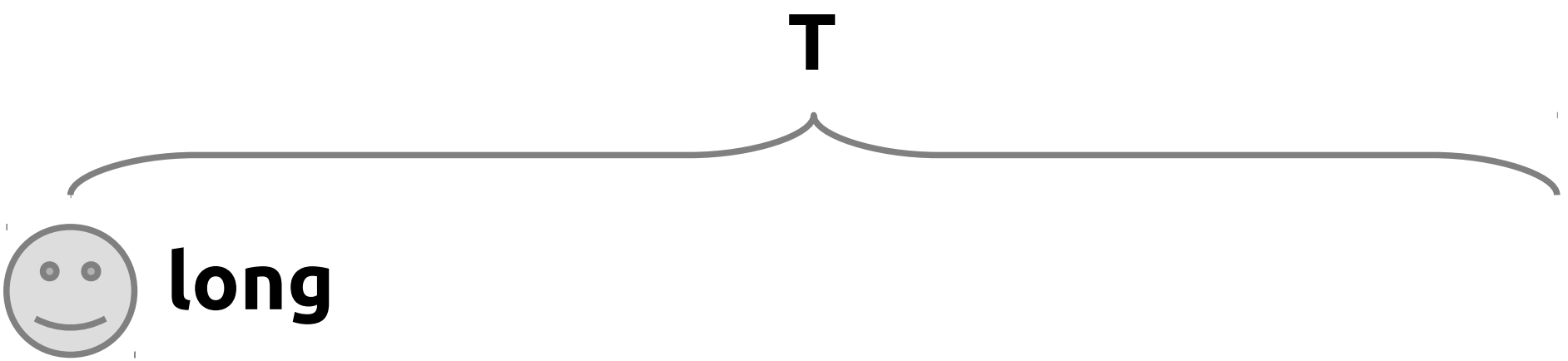
Miniboxing

T

Miniboxing



Miniboxing



long

- preferred encoding

Miniboxing

T

long

- preferred encoding

T (erased to Object)

- fallback encoding
- **compatible with**
  - **method calls**
  - **supertypes**
  - **erased generics**

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incompatible
→ **coercions**

What do ~~**auto(un)boxing**~~, ~~**specialization**~~ and **value classes** have in common?

Value Classes

```
def abs(c: Complex): Double = ...
```

Value Classes

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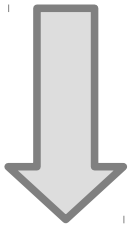

value class transformation

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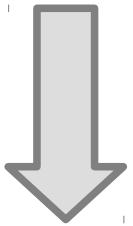

value class transformation

```
def abs(c_re: Double,
        c_im: Double): Double = ...
```

Value Classes

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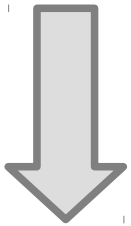

value class transformation

```
def abs(c_re: Double,
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```

No object created!

Value Classes

```
val c: Complex = Complex(2,1)
```

Value Classes

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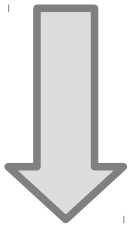

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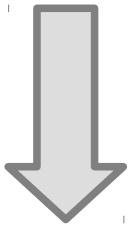

value class transformation

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val c_re: Double = 2
val c_im: Double = 1
```

Value Classes

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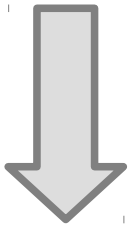

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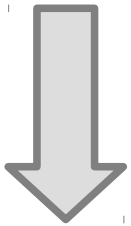

value class transformation

Value Classes

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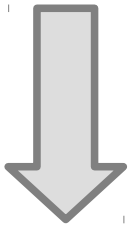

value class transformation

```
val a: Object =
        new Complex(c_re, c_im)
```

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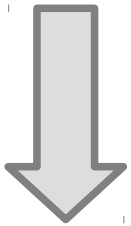

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Coercion!

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value class

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structure **(by-val)**

- preferred encoding

Value Classes

value class

structure (by-val)

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class (by-ref)

- fallback encoding
- **compatible with**
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What do ~~**auto(un)boxing**~~, ~~**specialization**~~ and ~~**value classes**~~ have in common?

Multi-stage programs too, but we won't go there!

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What do **auto(un)boxing**, **specialization** and **value classes** have in common?

Auto(un)boxing

scala.Int

int

- fast access
- no garbage collection
- locality

java.lang.Integer

- indirect access
- garbage collection
  - and object allocation
- no locality guarantees
- **compatible with erased generics**

incompatible
→ **coercions**

Miniboxing

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Starting from a high-level concept:

What do **auto(un)boxing**, **specialization** and **value classes** have in common?

Starting from a high-level concept:

(1) **split it into multiple representations** based on **external constaints**

What do **auto(un)boxing**, **specialization** and **value classes** have in common?

Starting from a high-level concept:

(1) **split it into multiple representations** based on **external constaints**

(2) introduce the **necessary coercions** when the representation has to be converted

What do **auto(un)boxing**, **specialization** and **value classes** have in common?

Why is this important?

The transformation

Benchmark

Conclusion

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Why is this important?

Late Data Layout (LDL)

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concept

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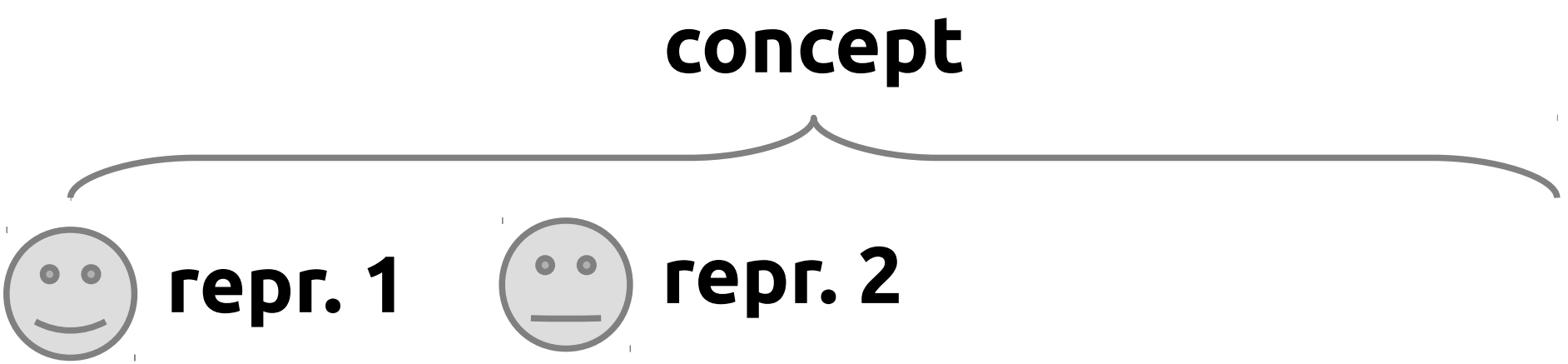
concept

repr. 1

Late Data Layout (LDL)



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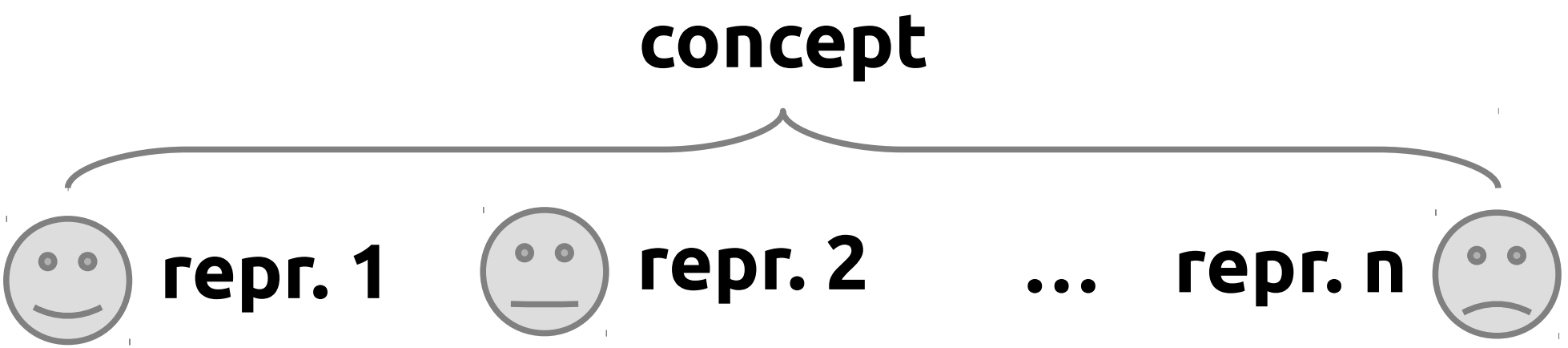

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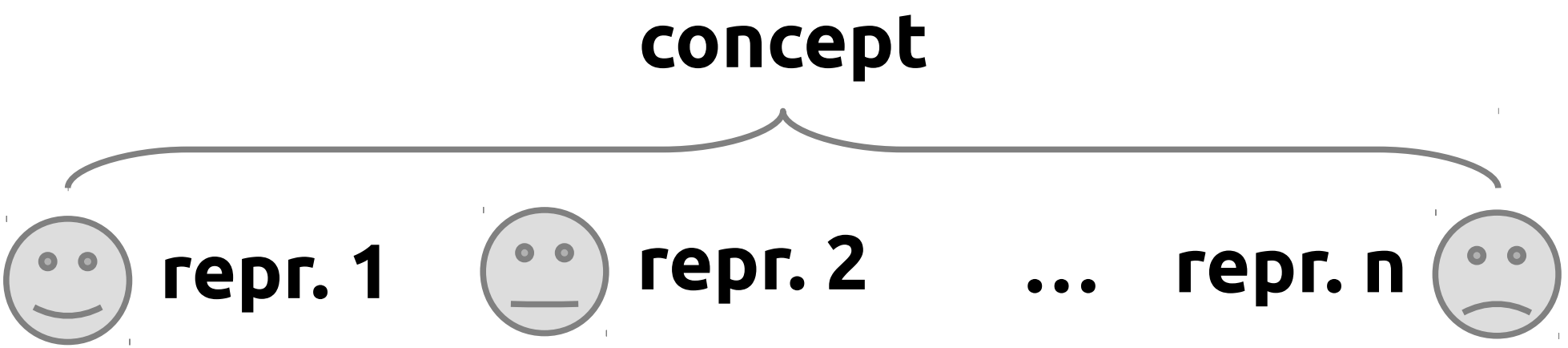

Constraints from the interaction with other language features:

- generics
- subtyping
- virtual dispatch
- DSL semantics (staging)

Late Data Layout (LDL)

concept

repr. 1

repr. 2

...

repr. n

Constraints from the interaction with other language features:
- generics
- subtyping
- virtual dispatch
- DSL semantics (staging)

We've seen this pattern over and over again:
- autounboxing
- specialization
- value classes
- multi-stage programming
- function representation
- **collection representation**

Collection Representation

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List[T]

Stream[T]

- preferred encoding
- for pure comprehensions

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Collection Representation

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val c = List(1,2,3)
val d = c.map(_+1).filter(_%2==0)
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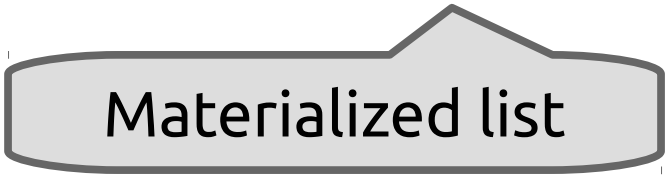

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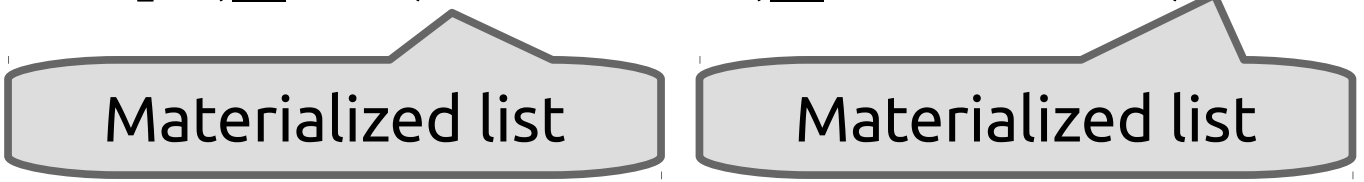

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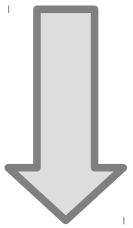

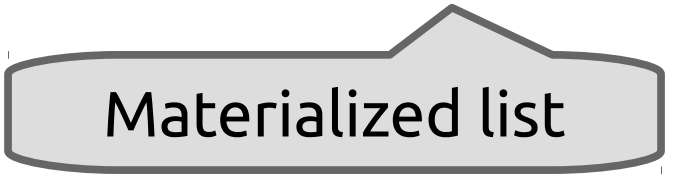

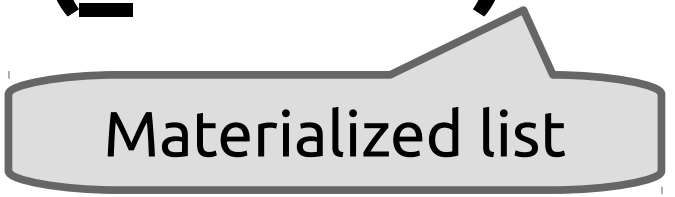

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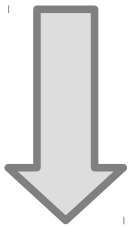

Materialized list

Materialized list

```
val c: Stream[Int] =
       List(1,2,3).toStream
```

Collection Representation

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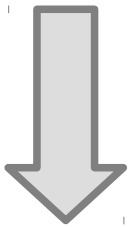
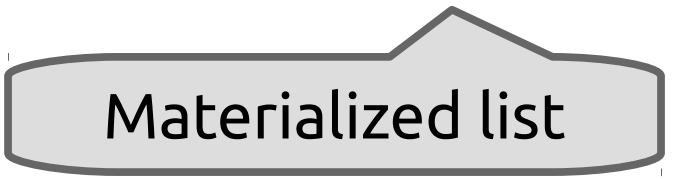
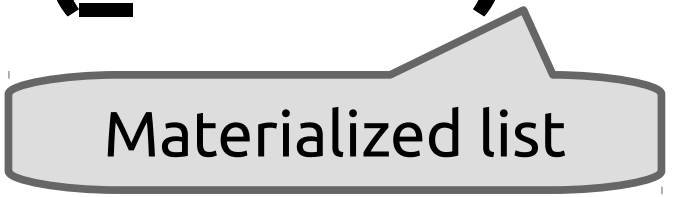
```



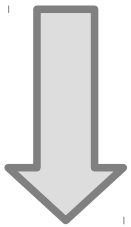





```
val c: Stream[Int] =
       List(1,2,3).toStream
val d: Stream[Int] =
       c.map(_+1).filter(_%2==0)
```

Collection Representation

```
val c = List(1,2,3)
val d = c.map(_+1).filter(_%2==0)
```



Materialized list

Materialized list

```
val c: Stream[Int] =
       List(1,2,3).toStream
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```

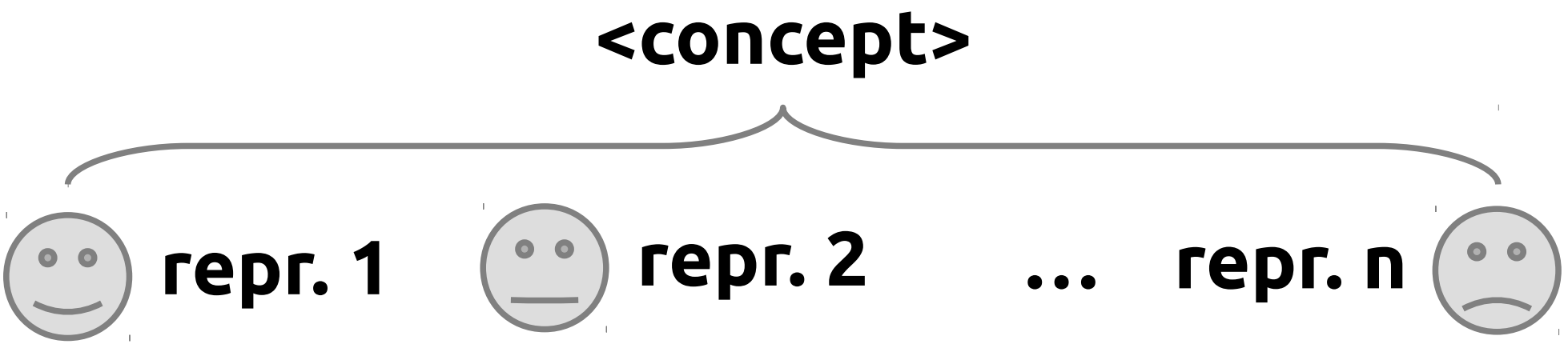
No materialization!

<Your Use Case>

<Your Use Case>

<concept>

<Your Use Case>



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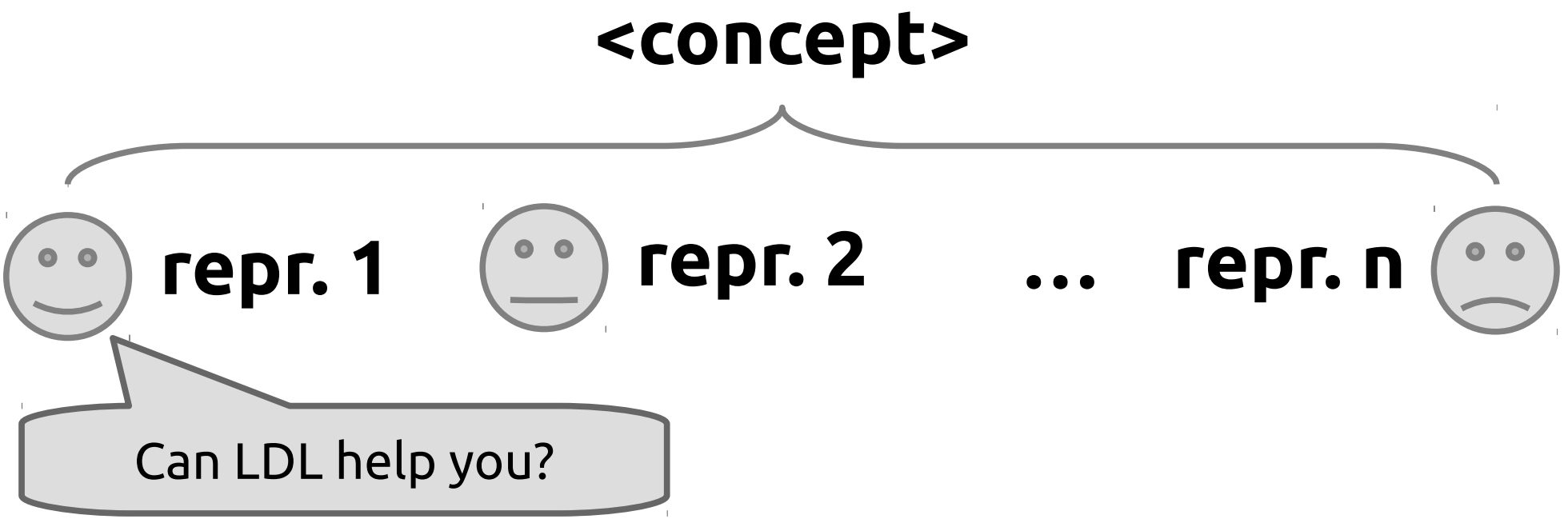

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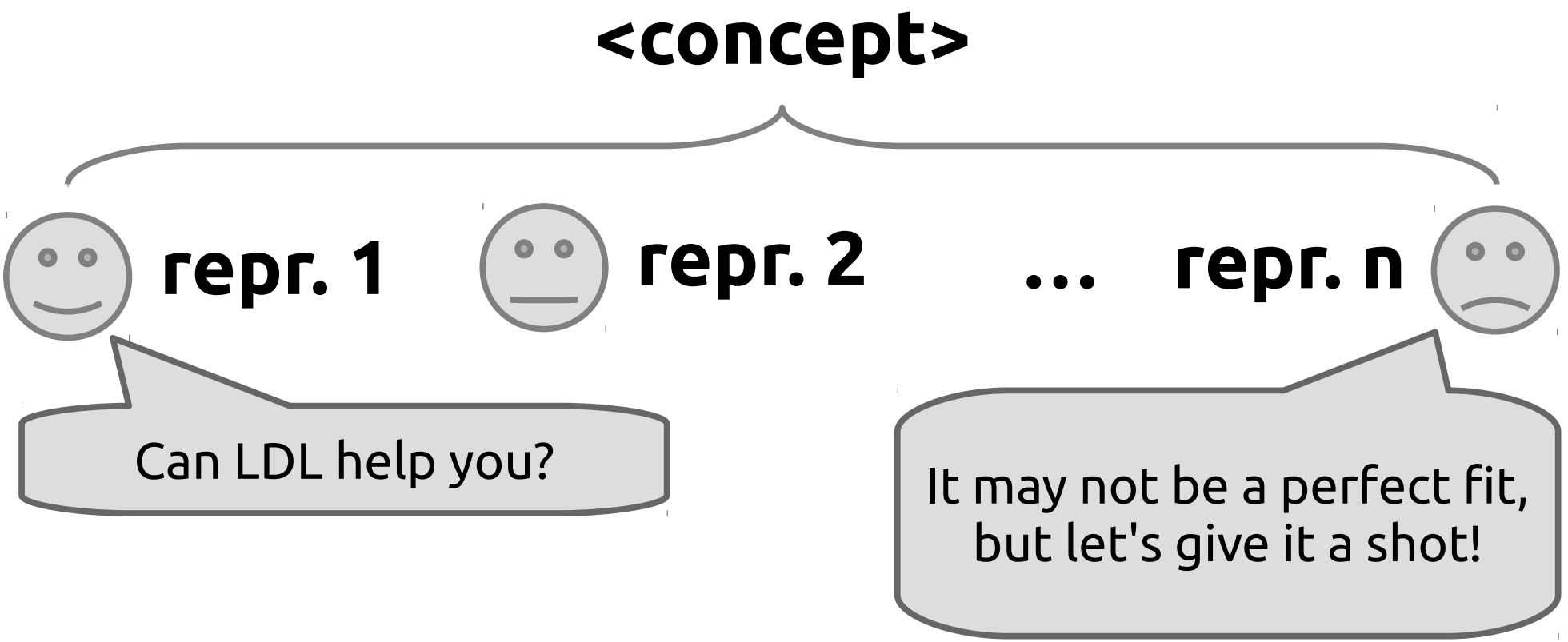

What do **auto(un)boxing**, **specialization** and **value classes** have in common?

Why is this important?

The transformation

Benchmark

Conclusion

scala-miniboxing.org

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Why is this important?

The transformation

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scala-miniboxing.org

How do transform a program?

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If you understand the high-level picture, you will immediately see if your usecase matches.

How do transform a program?

If you understand the high-level picture, you will immediately see if your usecase matches.

We'll use autounboxing as the running example, to keep things simple

Auto(un)boxing

scala.Int

int

- fast access
- no garbage collection
- locality

java.lang.Integer

- indirect access
- object allocation
  - and thus garbage collection
- no locality guarantees
- **compatible with erased generics**

Auto(un)boxing

scala.Int

int

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java.lang.Integer

- indirect access
- object allocation
  - and thus garbage collection
- no locality guarantees
- **compatible with erased generics**

incompatible
→ **coercions**

Naive transformation

Syntax-based transformation

Type-based LDL transformation

scala-miniboxing.org

Naive transformation

```
val x: Int = List[Int](1, 2, 3).head
val y: List[Int] = List[Int](x)
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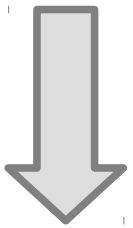

naive unboxing

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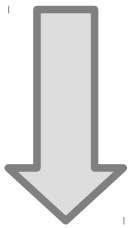

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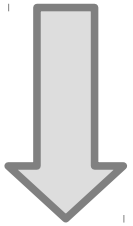

naive unboxing

representation mismatch:
expected: **int**
found: **Int**

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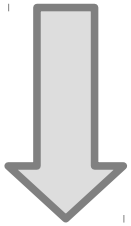

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expected: **Int**
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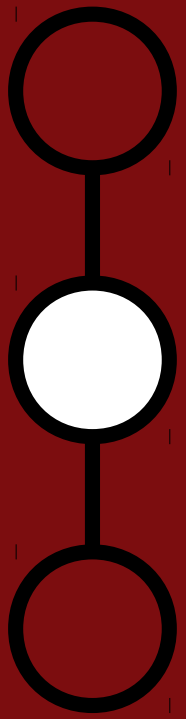
Naive transformation

- naively replacing representations
  - leads to mismatches
  - which are hard to recover
    (impossible for value classes and miniboxing)
- we need **coercions** between representations



Naive transformation

Syntax-based transformation

Type-based LDL transformation

scala-miniboxing.org

Syntax-based

- when transforming a value
  - coerce the definition right-hand side
  - coerce all references to it

Syntax-based

```
val x: Int = List[Int](1, 2, 3).head
```

Syntax-based

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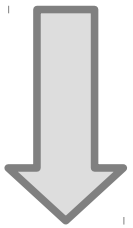

syntax-based unboxing

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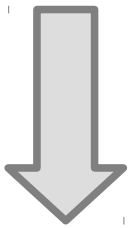

syntax-based unboxing

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val x: int =
```

Syntax-based

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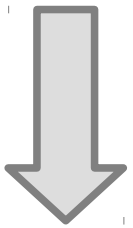

syntax-based unboxing

```
val x: int =
    unbox(List[Int](1, 2, 3).head)
```

Syntax-based

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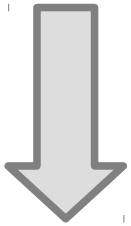

syntax-based unboxing

```
val x: int =
    unbox(List[Int](1, 2, 3).head)
```

There are no references to x,
so there's nothing else to do.

Syntax-based

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val x: Int = List[Int](1, 2, 3).head
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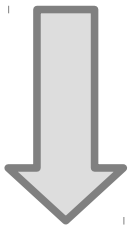

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Syntax-based

Transform one by one

```
val x: Int = List[Int](1, 2, 3).head
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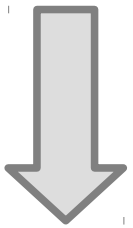

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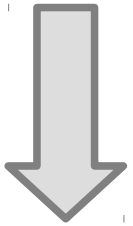

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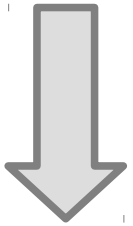

syntax-based unboxing

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val x: int =
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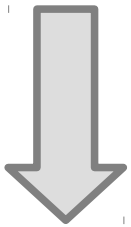

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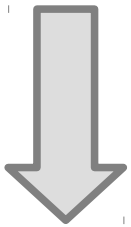

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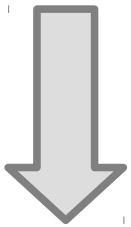

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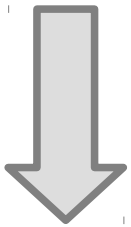

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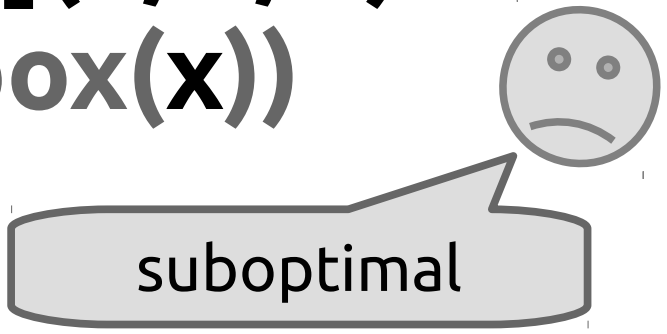

Peephole Optimization

```
val y: int = unbox(box(x))
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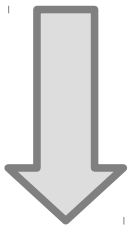

peephole

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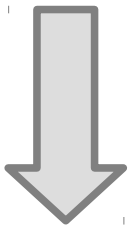

peephole

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Peephole Optimization

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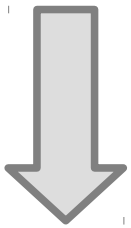

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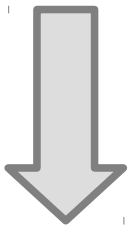

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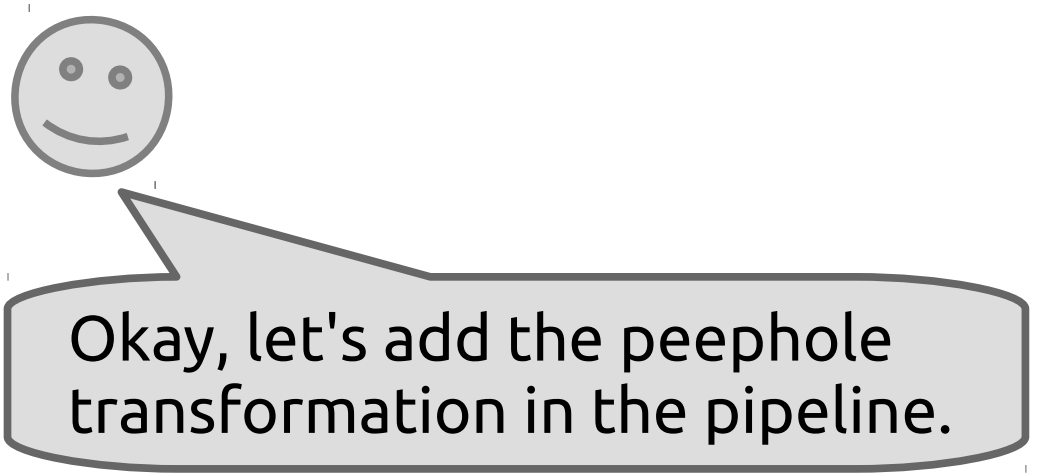

Syntax-based

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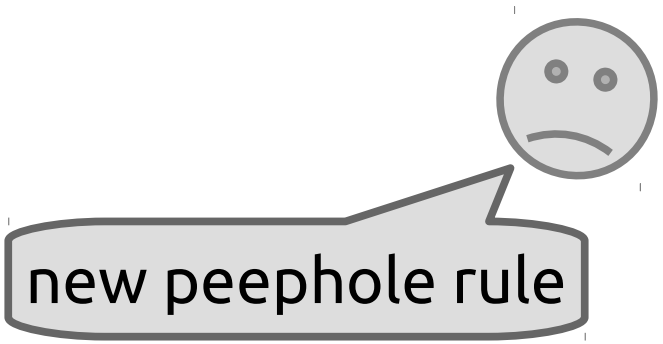

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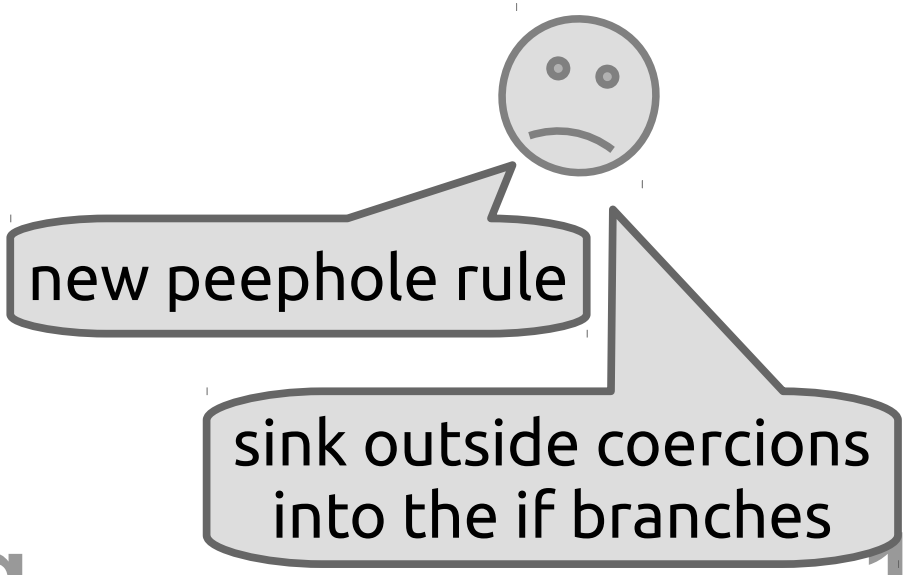

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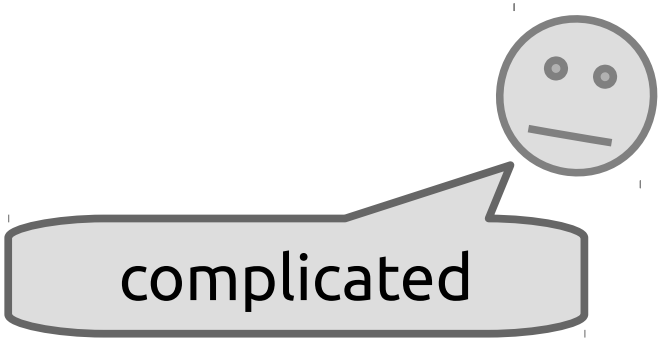


Syntax-based

- peephole transformation does not scale
  - needs multiple rules for each node
  - needs successive rewriting => slow
  - **impossible to guarantee optimality**

Naive transformation

Syntax-based transformation

Type-based LDL transformation

scala-miniboxing.org

Type-based transformation

- propagate representation information
  - into the type system (based on annotated types)
  - let the type system propagate this information

Type-based transformation

- re-typechecking the tree
  - exposes inconsistencies in the representation
  - so we introduce coercions
    - **only when representations don't match**

Type-based transformation

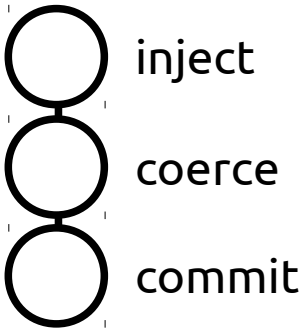
- three-stage mechanism
  - inject → annotate the values to be unboxed
  - coerce → introduce coercion markers
  - commit → commit to the alternative representations

Type-based transformation

Warning!

Throughout the presentation we'll be writing annotations written **before types** (e.g. “@unboxed Int”), although in the Scala syntax they are written **after the type** (e.g.“Int @unboxed”). This makes it easier to read the types aloud.

Type-based



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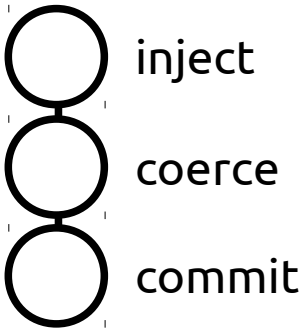


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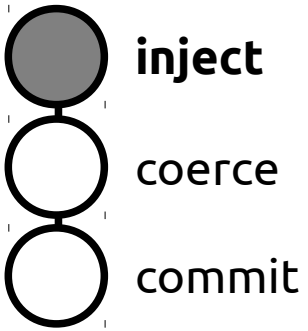


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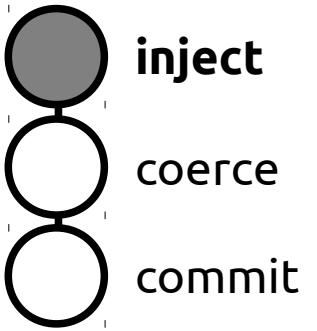
Type-based

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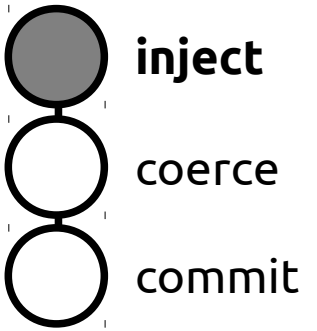


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```
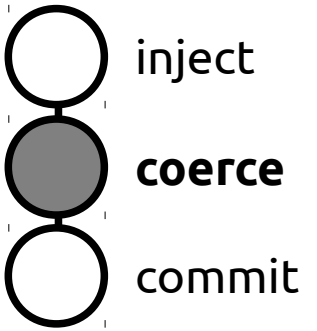

configurable introduction of annotations
based on external constraints

Type-based

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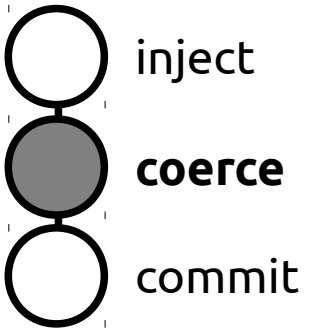


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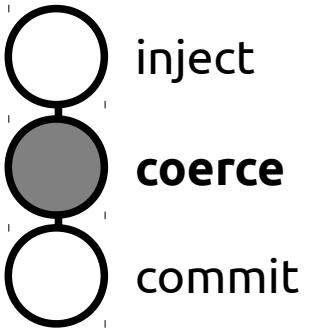


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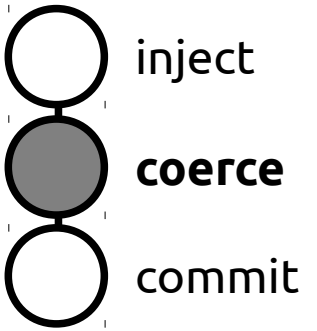

the rhs expression must be of type **@unboxed Int**

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def choice(t1: @unboxed Int,
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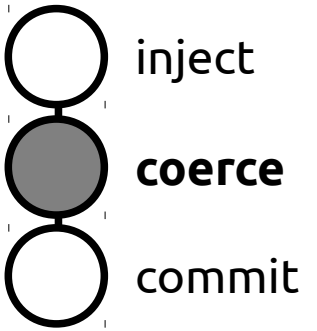
Type-based



the rhs expression must be of type @unboxed Int

```
def choice(t1: @unboxed Int,
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    t1
  else
    t2                                    : @unboxed Int
```
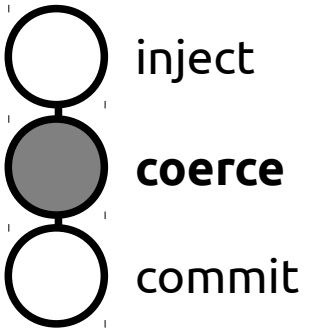

Type-based



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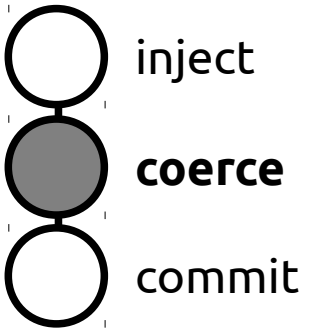
  else
    t2                                    : @unboxed Int
```

expected type
(part of local type inference)

Type-based




```
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    t1
  else
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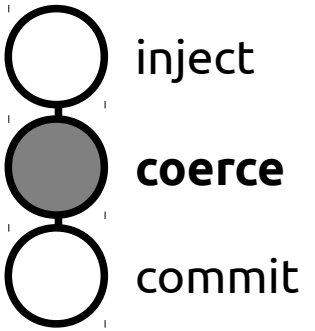
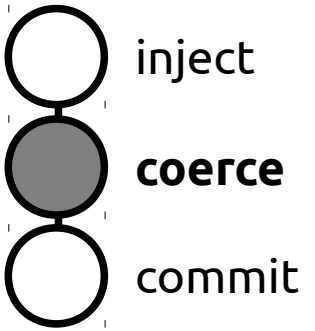
Type-based




```
def choice(t1: @unboxed Int,
           t2: @unboxed Int): @unboxed Int =
  if (Random.nextBoolean()) : Boolean
    t1
  else
    t2
```

matches:
expected: **Boolean**
found: **Boolean**

Type-based

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    t1 : @unboxed Int
  else
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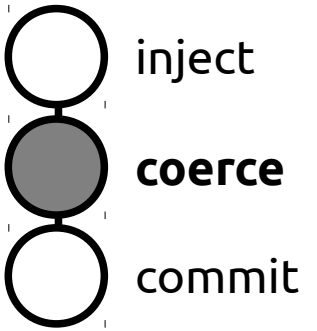
```

Type-based

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```
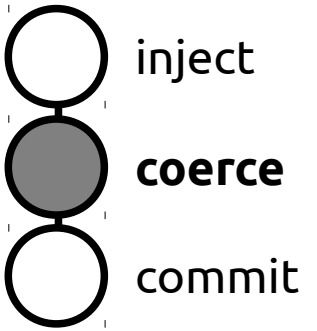

matches:
expected: @unboxed Int
found: @unboxed Int

Type-based

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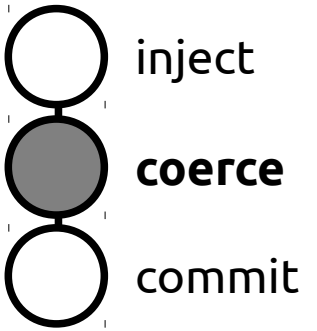


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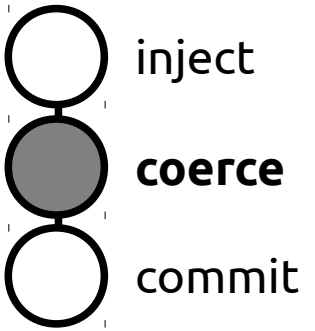
  else
    t2 : @unboxed Int
```

matches:

...

Type-based

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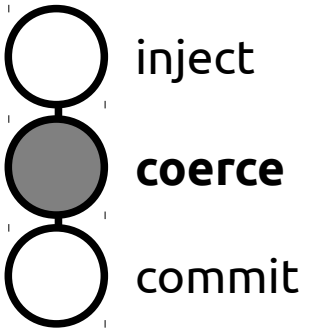


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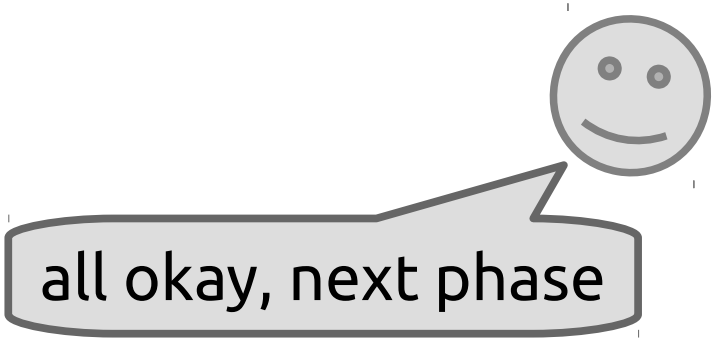
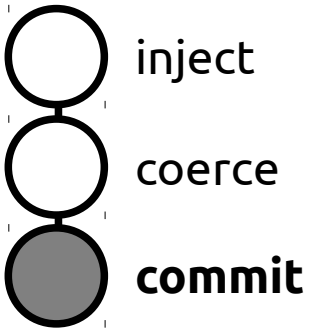


Type-based

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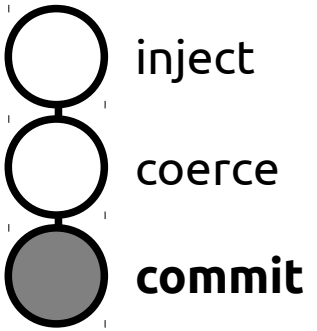
Type-based

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    t1
  else
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```
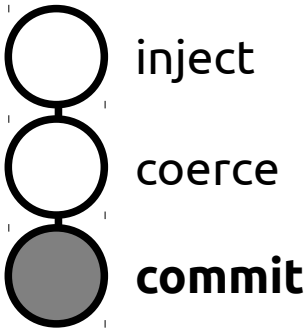

Replace:
@unboxed **Int** → **int**
(not showing **Int** → **j.l.Integer**)

Type-based

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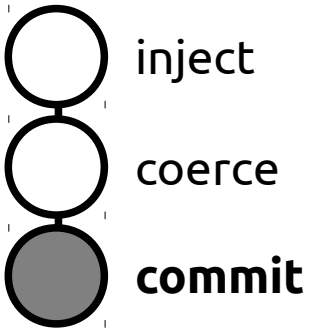
```

Type-based

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```

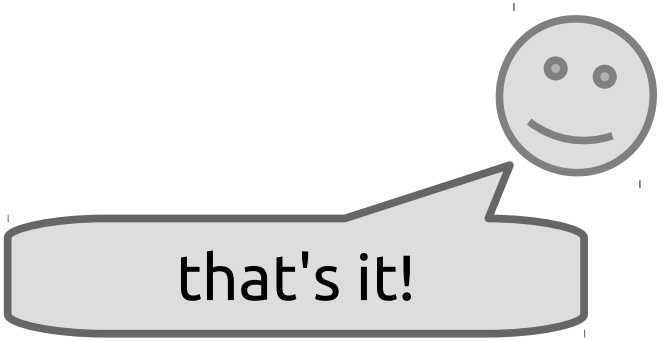

Type-based transformation

- three-stage mechanism
  - inject: add annotations
  - coerce: add coercions (based on the annotations)
  - commit: final representation semantics

Type-based transformation

- Scalac's erasure
  - similar transformation
  - less flexible (no annotations)
  - entangled with other transformations
- we took what's good
  - and allowed the transformation to work on other usecases as well

Type-based transformation

- why do this?
  - at the core of:
    - miniboxing (http://scala-miniboxing.org)
    - value classes plugin (https://github.com/miniboxing/value-plugin)
    - multi-stage plugin (https://github.com/miniboxing/staging-plugin)
    - **<your transformation here>**

Type-based transformation

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  - at the core of:
    - miniboxing (http://scala-miniboxing.org)
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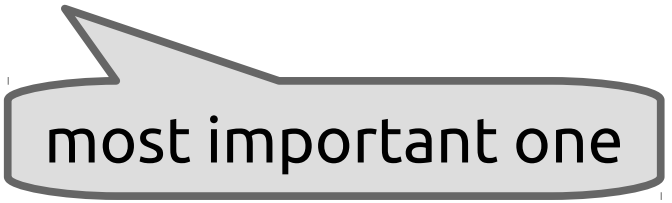
    - **<your transformation here>**



Type-based LDL transformation

Properties

Consistency

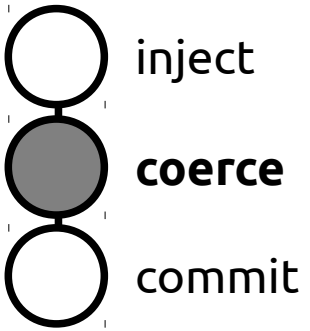
Selectivity

Optimality*

scala-miniboxing.org

* not formally proven yet

Consistency



- representations become explicit in types
  - representation mismatches
    - become type mismatches
    - are exposed by the type system
  - mismatches lead to coercions
    - explicit bridges between representations
    - are introduced automatically
  - regardless of the representations
    - at a meta-level

Type-based LDL transformation

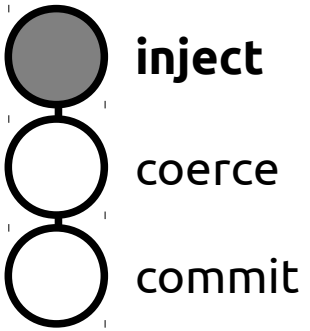
Properties

- Consistency
- Selectivity
- Optimality*

scala-miniboxing.org

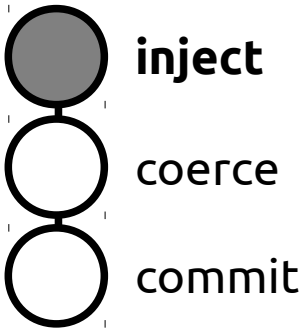
* not formally proven yet

Selectivity



- annotations allow selectively picking the values to be transformed
  - value classes
    - cannot unbox multi-param values in return position (not supported by the JVM platform)
    - bridge methods
  - staging
    - annotations signal **domain-specific knowledge**
      - can occur inside generics (List[@staged Int])

Selectivity

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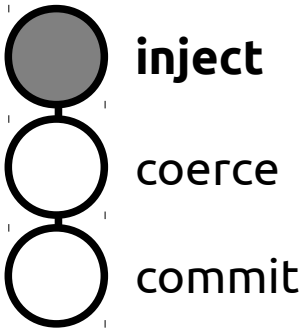
```

Selectivity



what if we did not annotate t1?

```
def choice(t1: Int,
           t2: Int): Int =
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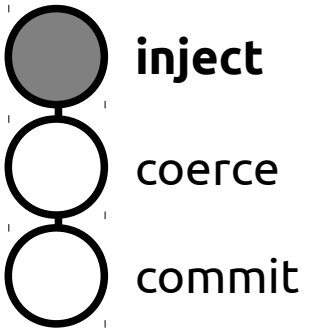
    t1
  else
    t2
```

Selectivity



what if we did not annotate t1?

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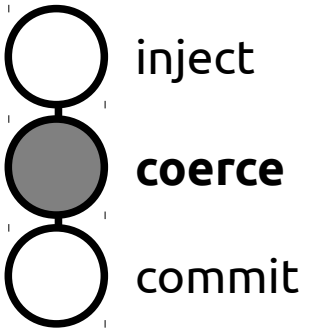
Selectivity

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    t1
  else
    t2                                    : @unboxed Int
```
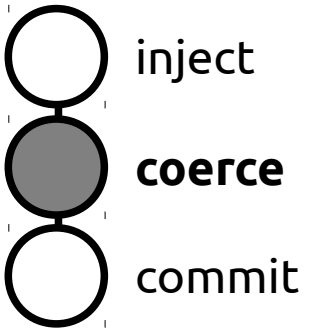

Selectivity

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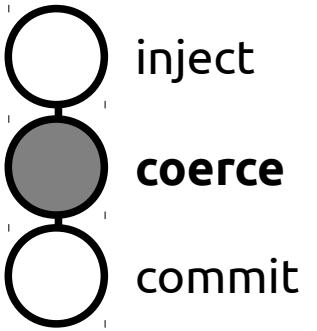
  else
    t2
```

Selectivity




```
def choice(t1: Int,
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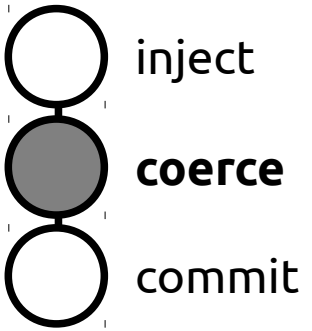
    t1 : @unboxed Int
  else
    t2
```

mismatch:
expected: @unboxed Int
found: Int

Selectivity

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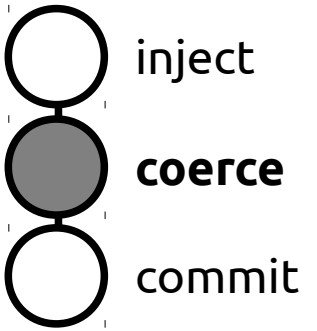
mismatch:
expected: @unboxed Int
found: Int

coercion

Selectivity




```
def choice(t1: Int,
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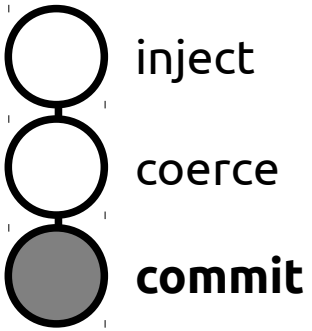
  if (Random.nextBoolean())
    unbox(t1)
  else
    t2
```

Selectivity




```
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 else
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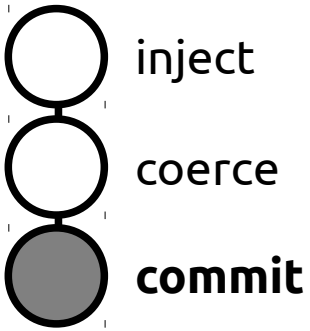
```

Selectivity




```
def choice(t1: Int,
                  t2: int): int =
  if (Random.nextBoolean())
    t1.intValue
  else
    t2
```

Type-based LDL transformation

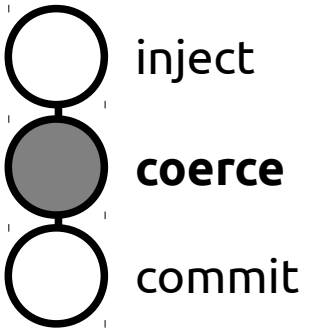
Properties

- Consistency
- Selectivity
- Optimality*

scala-miniboxing.org

* not formally proven yet

Optimality

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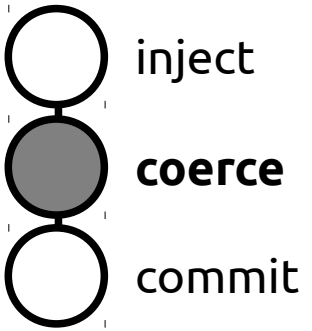


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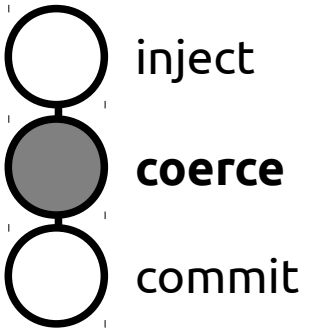
Optimality

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  else
    t2
```

Coercions are sunk in the tree → excute only if necessary

Type-based LDL transformation

Use cases

- Miniboxing
- Value Classes*
- Multi-stage Programming*

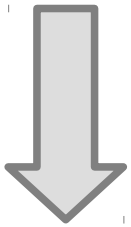
scala-miniboxing.org * early prototypes

LDL for miniboxing

```
def tupled[T1, T2](t1: T1, t2: T2) = ...
```

LDL for miniboxing

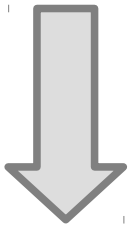
```
def tupled[T1, T2](t1: T1, t2: T2) = ...
```



miniboxing

LDL for miniboxing

```
def tupled[T1, T2](t1: T1, t2: T2) = ...
```

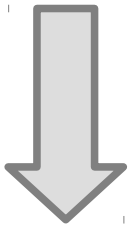


miniboxing

first: duplicate body

LDL for miniboxing

```
def tupled[T1, T2](t1: T1, t2: T2) = ...
```



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LDL for miniboxing

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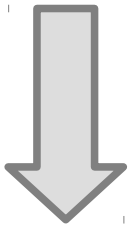

miniboxing

first: duplicate body

```
def tupled[T1, T2](t1: T1, t2: T2) = …
def tupled_ML[T1, T2](..., t1: T1, t2: T2) = …
```

LDL for miniboxing

```
def tupled[T1, T2](t1: T1, t2: T2) = ...
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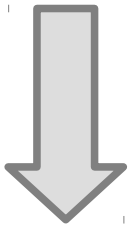

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LDL for miniboxing

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def tupled[T1, T2](t1: T1, t2: T2) = ...
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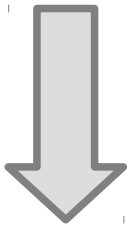

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LDL for miniboxing

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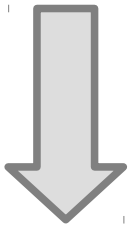

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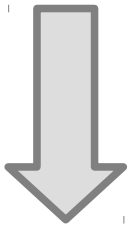
second: adapt it

LDL for miniboxing

```
def tupled[T1, T2](t1: T1, t2: T2) = ...
```



miniboxing

first: duplicate body

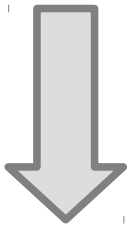
```
def tupled[T1, T2](t1: T1, t2: T2) = …
def tupled_ML[T1, T2](..., t1: @long T1, t2: T2) = …
def tupled_LM[T1, T2](..., t1: T1, t2: @long T2) = …
def tupled_MM[T1, T2](..., t1: @long T1, t2: @long T2) =
```

second: adapt it

* @long is used instead of @storage[Long]

LDL for miniboxing

```
def tupled[T1, T2](t1: T1, t2: T2) = ...
```



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second: adapt it

using the transformation

* @long is used instead of @storage[Long]

LDL for miniboxing

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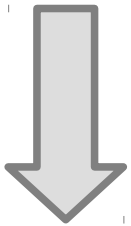

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second: adapt it

using the transformation

body gets adapted**

* @long is used instead of @storage[Long]

Type-based LDL transformation

Use cases

Miniboxing

Value Classes*

Multi-stage Programming*

scala-miniboxing.org * early prototypes

LDL for value classes

```
def abs(c: @unboxed Complex): Double = ...
```

LDL for value classes

```
def abs(c: @unboxed Complex): Double = ...
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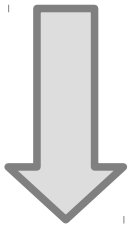

value class plugin
(commit phase)

LDL for value classes

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def abs(c: @unboxed Complex): Double = ...
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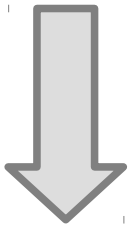
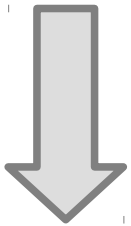


value class plugin
(commit phase)

```
def abs(c_re: Double, c_im: Double): Double = ...
```

LDL for value classes

```
def abs(c: @unboxed Complex): Double = ...
```



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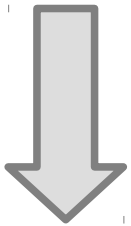

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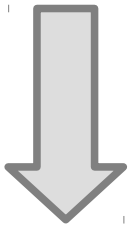

value class plugin
(commit phase)

```
def abs(c_re: Double, c_im: Double): Double = ...
```

I'm hiding **a lot of details** here.
But one could talk about this for an entire day

The one is @xeno-by!
He implemented this :)

Type-based LDL transformation

Use cases

- Miniboxing
- Value Classes*
- Multi-stage Programming*

scala-miniboxing.org * early prototypes

Type-based LDL transformation

Use cases

- Miniboxing
- Value Classes*
- Multi-stage Programming*

We won't go into it today, but see
github.com/miniboxing/staging-plugin

scala-miniboxing.org * early prototypes

What do **auto(un)boxing**, **specialization** and **value classes** have in common?

Why is this important?

The transformation

Benchmark

Conclusion

scala-miniboxing.org

What do **auto(un)boxing**, **specialization** and **value classes** have in common?

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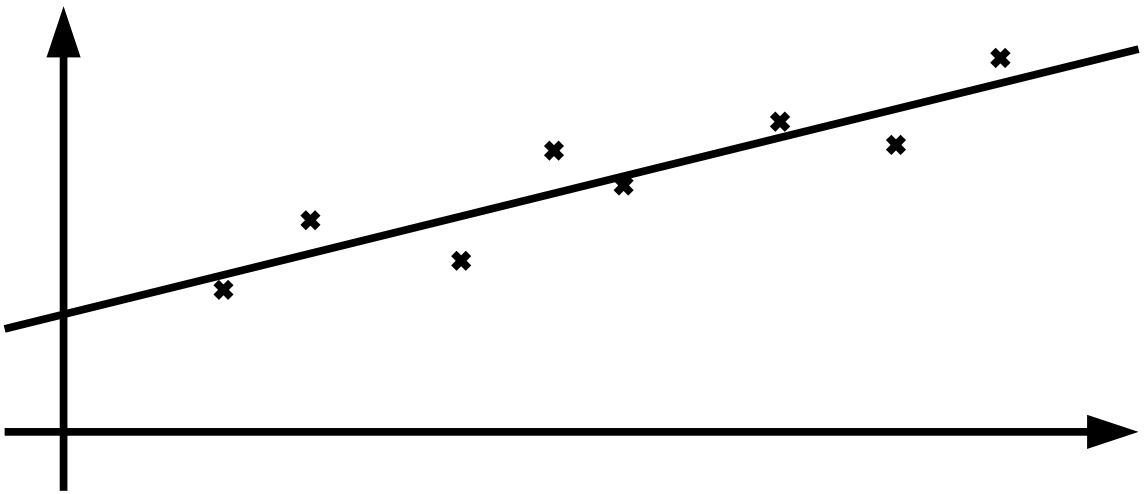
scala-miniboxing.org

Miniboxing Benchmarks

on the Scala library

- benchmark: Least Squares Method
  - using a mockup of **scala.collection.immutable.List**



Miniboxing Benchmarks
on the Scala library

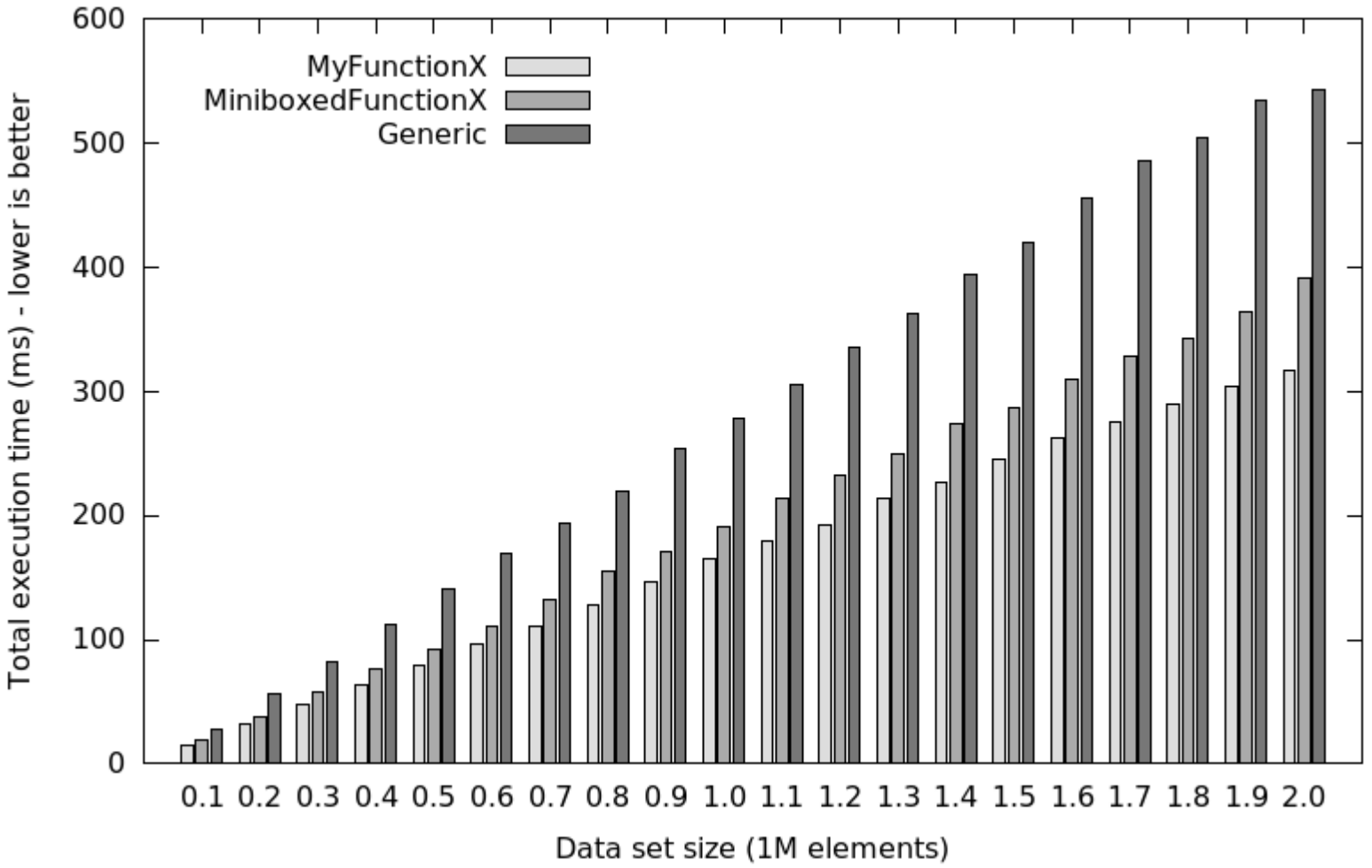
- work with Aymeric Genet (github: @MelodyLucid)
- mock-up of Scala linked List
  - Tuples
  - Traversable/TraversableLike
  - Iterator/Iterable/IterableLike
  - LinearSeqOptimized
  - Builder/CanBuildFrom
- FunctionX has a nice story

Miniboxing Benchmarks
on the Scala library

- **FunctionX** from the Scala library
  - specialized
  - no way to call from miniboxed code without boxing → slow
- **MiniboxedFunctionX ← benchmarked**
  - miniboxed, call without coercing
  - added automatically with another **LDL cycle**
- **MyFunctionX ← benchmarked**
  - miniboxed, call without coercing
  - added by hand to the library

Miniboxing Benchmarks

on the Scala library



Miniboxing Benchmarks

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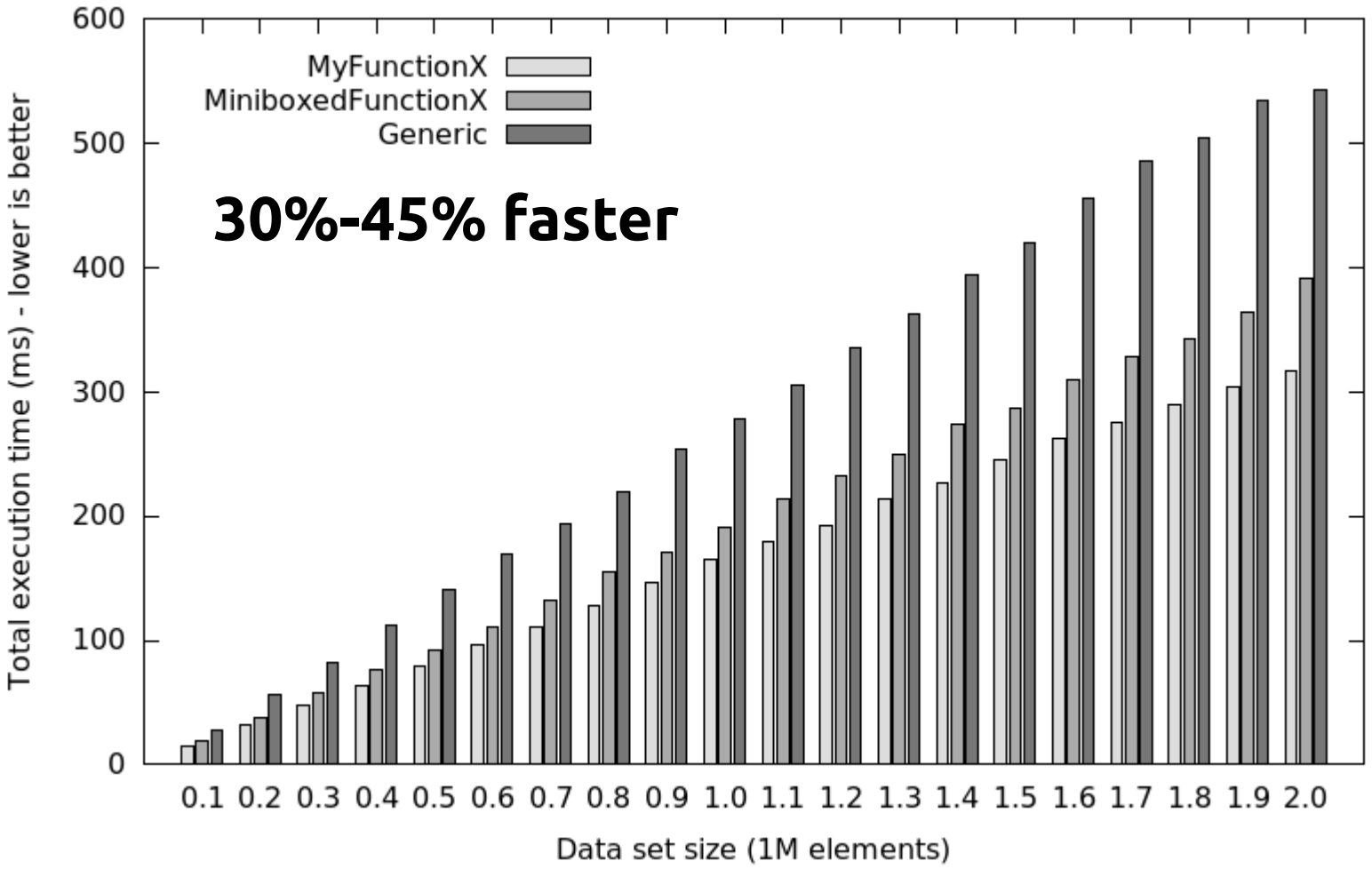

Miniboxing Benchmarks

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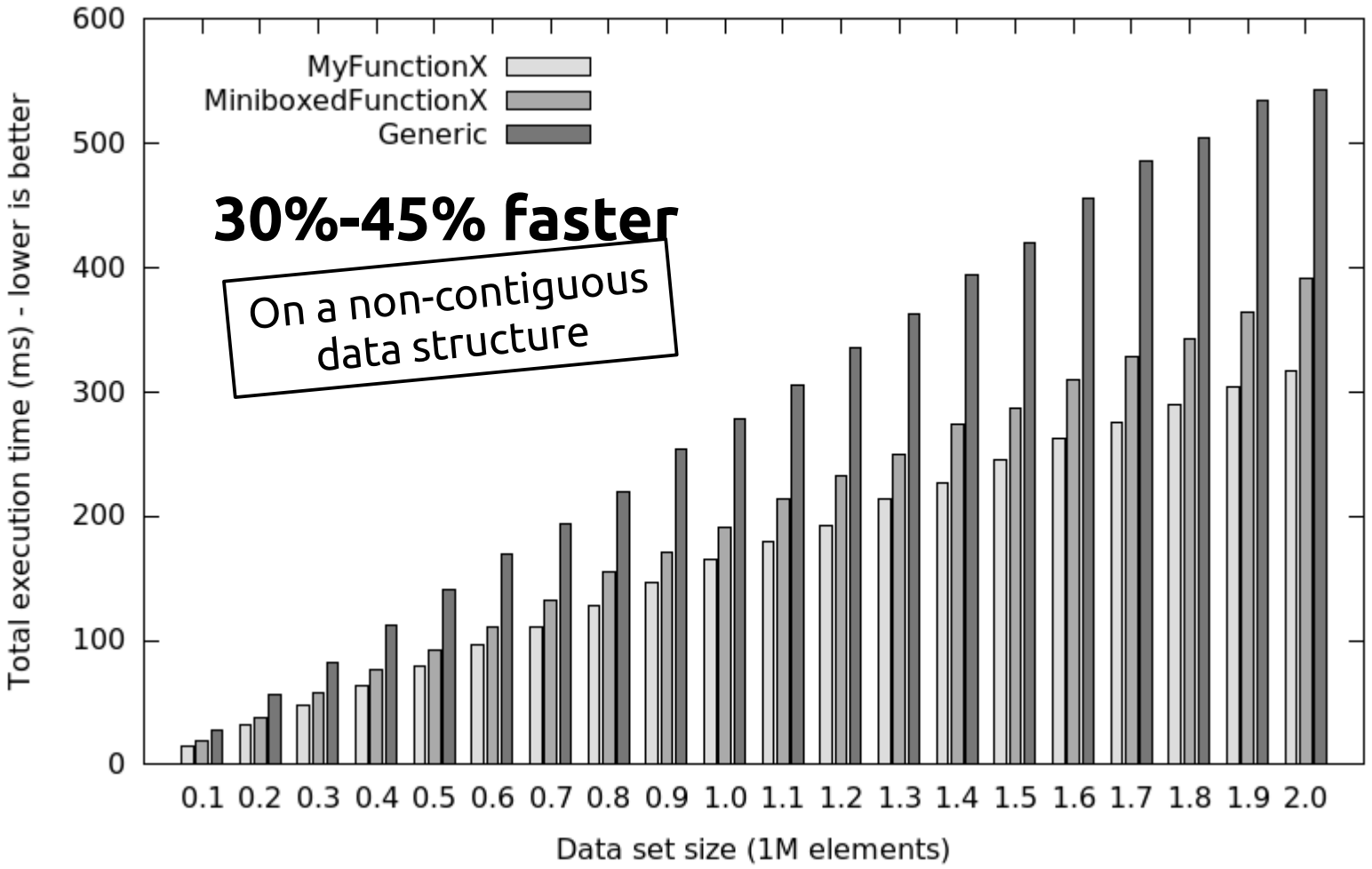
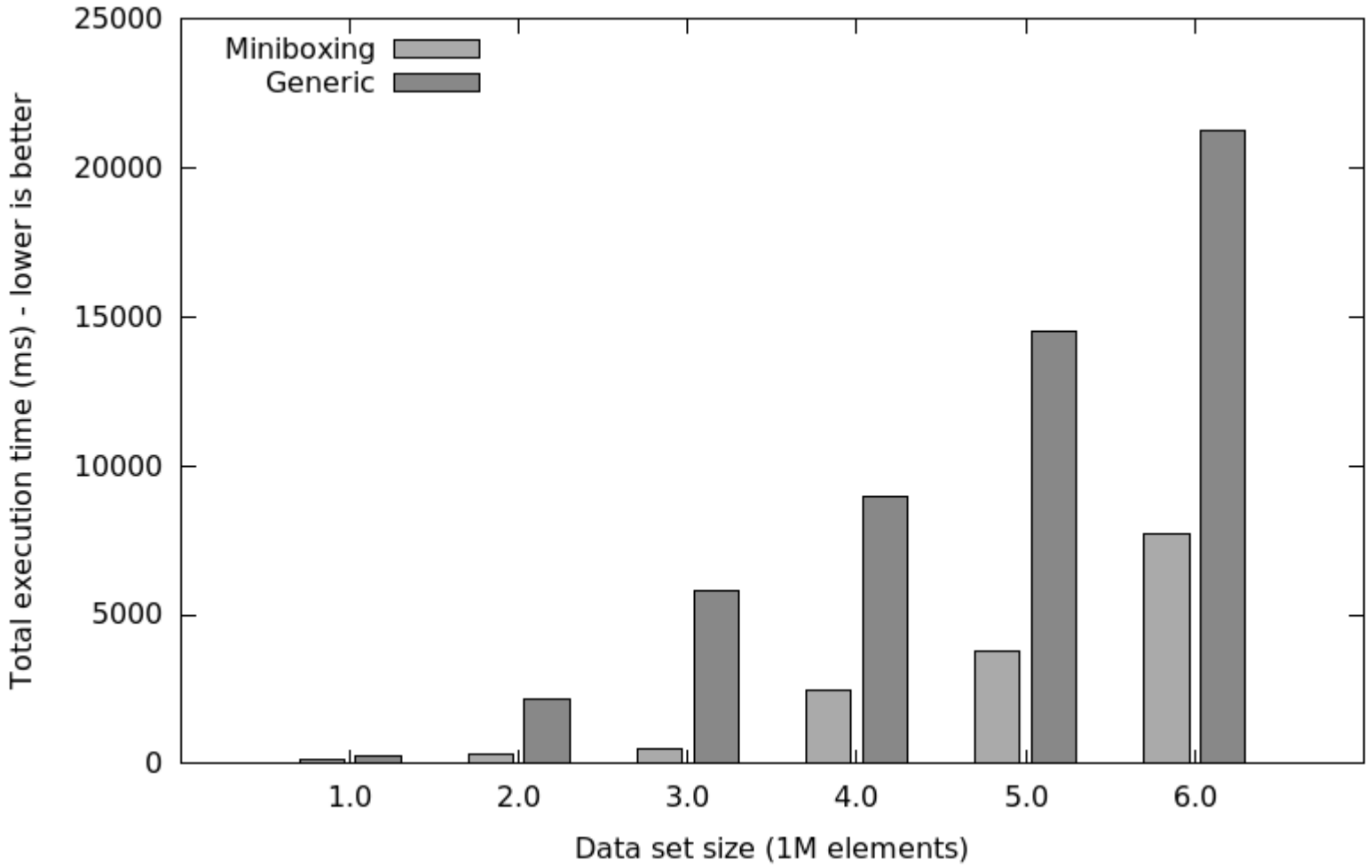


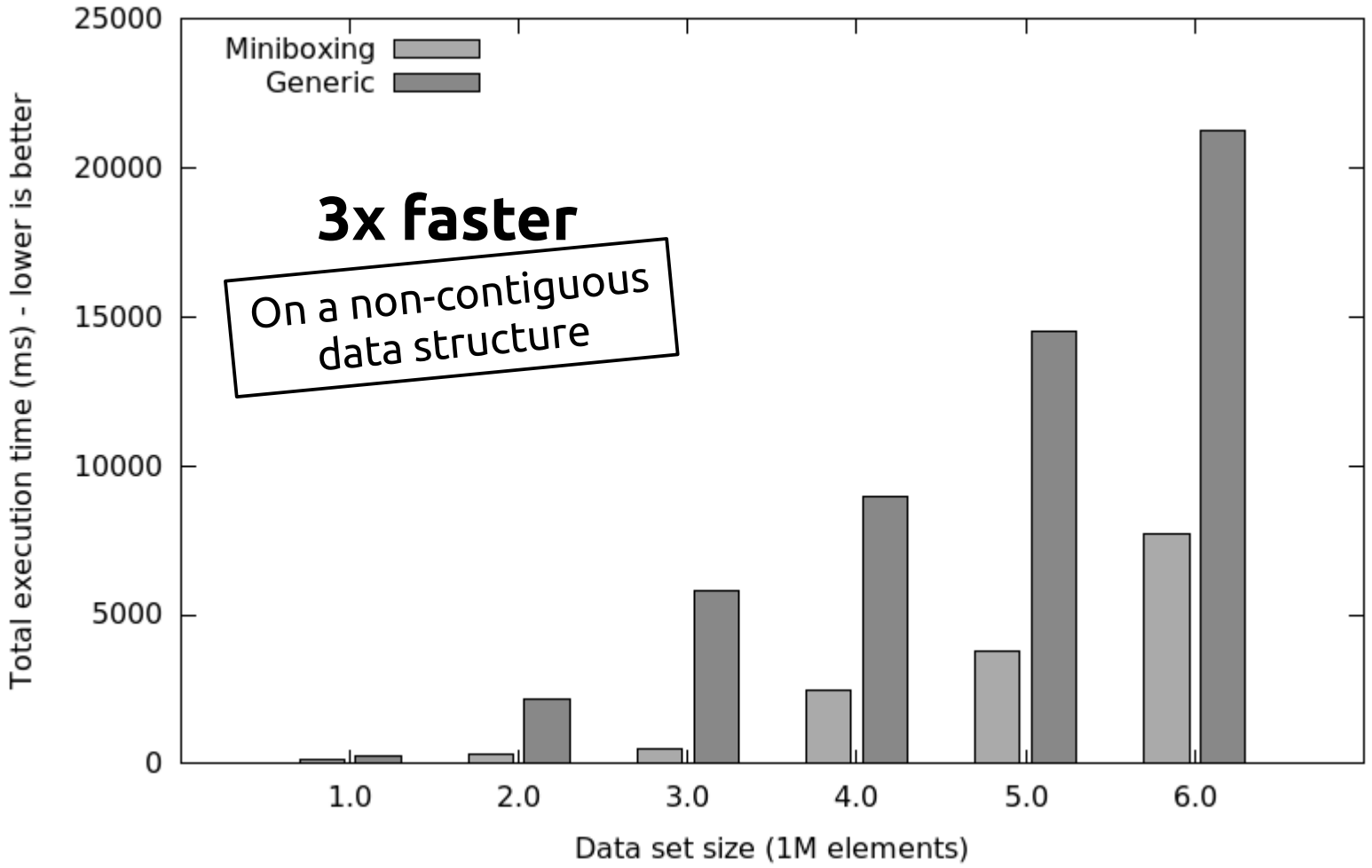
Miniboxing Benchmarks

on the Scala library (with GC)



Miniboxing Benchmarks

on the Scala library (with GC)



What do **auto(un)boxing**, **specialization** and **value classes** have in common?

Why is this important?

The transformation

Benchmark

Conclusion

scala-miniboxing.org

What do **auto(un)boxing**, **specialization** and **value classes** have in common?

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The transformation

Benchmark

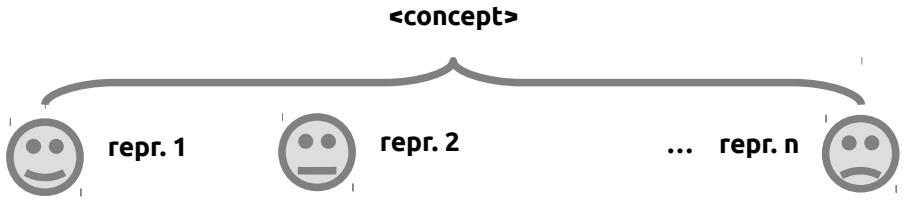
Conclusion

scala-miniboxing.org

Conclusion

LDL is a transformation

- that allows splitting a high-level concept
  - into multiple representations
  - in a **consistent** way (through coercions)
  - in a **selective** way (through annotations)
  - in an **optimal** way (coerce only if necessary)
- use cases covered
  - miniboxing
  - value classes
- what is your use case?



Credits and Thank you-s

- Cristian Talau - developed the initial prototype, as a semester project
- Eugene Burmako - the value class plugin based on the LDL transformation
- Aymeric Genet - developing collection-like benchmarks for the miniboxing plugin
- Martin Odersky, for his patient guidance
- Eugene Burmako, for trusting the idea enough to develop the value-plugin based on the LDL transformation
- Iulian Dragos, for his work on specialization and many explanations
- Miguel Garcia, for his original insights that spawned the miniboxing idea
- Michel Schinz, for his wonderful comments and enlightening ACC course
- Andrew Myers and Roland Ducournau for the discussions we had and the feedback provided
- Heather Miller for the eye-opening discussions we had
- Vojin Jovanovic, Sandro Stucki, Manohar Jonalagedda and the whole LAMP laboratory in EPFL for the extraordinary atmosphere
- Adriaan Moors, for the miniboxing name which stuck :))
- Thierry Coppey, Vera Salvisberg and George Nithin, who patiently listened to many presentations and provided valuable feedback
- Grzegorz Kossakowski, for the many brainstorming sessions on specialization
- Erik Osheim, Tom Switzer and Rex Kerr for their guidance on the Scala community side
- OOPSLA paper and artifact reviewers, who reshaped the paper with their feedback
- Sandro, Vojin, Nada, Heather, Manohar - reviews and discussions on the LDL paper
- Hubert Plociniczak for the type notation in the LDL paper
- Denys Shabalin, Dmitry Petrashko for their patient reviews of the LDL paper

Special thanks to the Scala Community for their support!
(@StuHood, @vpatryshev and everyone else!)

scala-miniboxing.org

Conclusion

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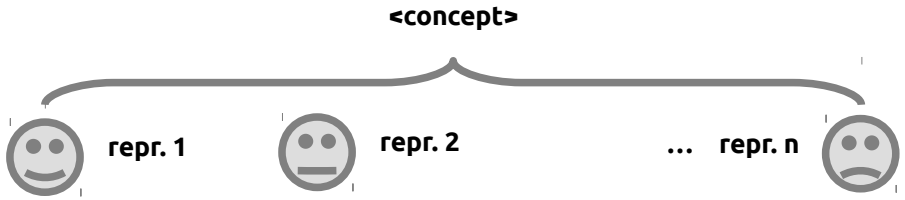

ScalaTeam @ EPFL

scala-miniboxing.org

ScalaTeam @ EPFL

- **Dependent Object Types** calculus
  - core type system of the **dotty** compiler
  - Nada Amin/Tiark Rompf


https://github.com/TiarkRompf/minidot


https://github.com/lampepfl/dotty

ScalaTeam @ EPFL

- **YinYang** multi-stage macro-based frontend
  - replacement for **scala-virtualized**
  - Vojin Jovanovic/Sandro Stucki + others

https://github.com/vjovanov/yin-yang

ScalaTeam @ EPFL

- **Scala.js** backend
  - compiles Scala to JavaScript
  - Sébastien Doeraene/Tobias Schlatter + others

www http://www.scala-js.org/

ScalaTeam @ EPFL

- **Staged Parser-combinators**
  - fast parser combinators through staging
  - Manohar Jonnalagedda + others

https://github.com/manojo/experiments

ScalaTeam @ EPFL

- **Pickling** framework and **Spores**
  - support for **distributed programming**
  - Heather Miller/Philipp Haller + others


https://github.com/scala/pickling


https://github.com/heathermiller/spores

ScalaTeam @ EPFL

- **dotty**
  - experimental compiler based on DOT
  - Martin Odersky/Dmitry Petrashko/Samuel Grütter/Tobias Schlatter + others

https://github.com/lampepfl/dotty

ScalaTeam @ EPFL

- **scala.meta** metaprogramming support
  - Improved reflection, macros, and many more
  - Eugene Burmako/Denys Shabalin + others

http://scalameta.org/

ScalaTeam @ EPFL

- **miniboxing** specialization
  - LDL transformation
  - Vlad Ureche/Aymeric Genêt + others

www http://scala-miniboxing.org/

ScalaTeam @ EPFL

- **scaladyno** plugin
  - giving Scala a dynamic language look and feel
  - Cédric Bastin/Vlad Ureche

https://github.com/scaladyno/scaladyno-plugin

ScalaTeam @ EPFL

- **ScalaBlitz** optimization framework
  - macro-based collection optimization
  - Dmitry Petrashko/Aleksandar Prokopec

www http://scala-blitz.github.io/

ScalaTeam @ EPFL

- **Type debugger** for Scala
  - debugging aid for Scala type errors
  - Hubert Plociniczak

http://lampwww.epfl.ch/~plocinic/type-debugger-tutorial/

ScalaTeam @ EPFL

- **ScalaMeter** benchmarking framework
  - google caliper for scala
  - Aleksandar Prokopec

www http://scalameter.github.io/

ScalaTeam @ EPFL

- the **new scalac backend**
  - good performance gains
  - Miguel Garcia
    - **on the job market right now**

http://magarciaepfl.github.io/scala/

miguel.garcia@tuhh.de

Thank you!

scala-miniboxing.org

1st of August 2014
Scala Bay Area Meetup
Linkedin HQ, Mountain View