Scala Developers Barcelona

Supporting your data model with Slick

Jan Christopher Vogt

About me

- ~ 3 years software engineer in the EPFL Scala team
- Working on Slick together with Typesafe
- Recently started part time at Sport195 in NYC
- Previously freelance for web platforms
- Background in programming languages, web dev, databases, python, pragmatic functional programming, software quality, automated testing

Slick (vs. ORM)

- **Functional-Relational Mapper**
- natural fit (no impedance mismatch)
- declarative
- embraces relational
- stateless
- Slick is to ORM what Scala is to Java

Part 1
8 practical reasons for using Slick

1
Scala collection-like API

Scala collection-like API

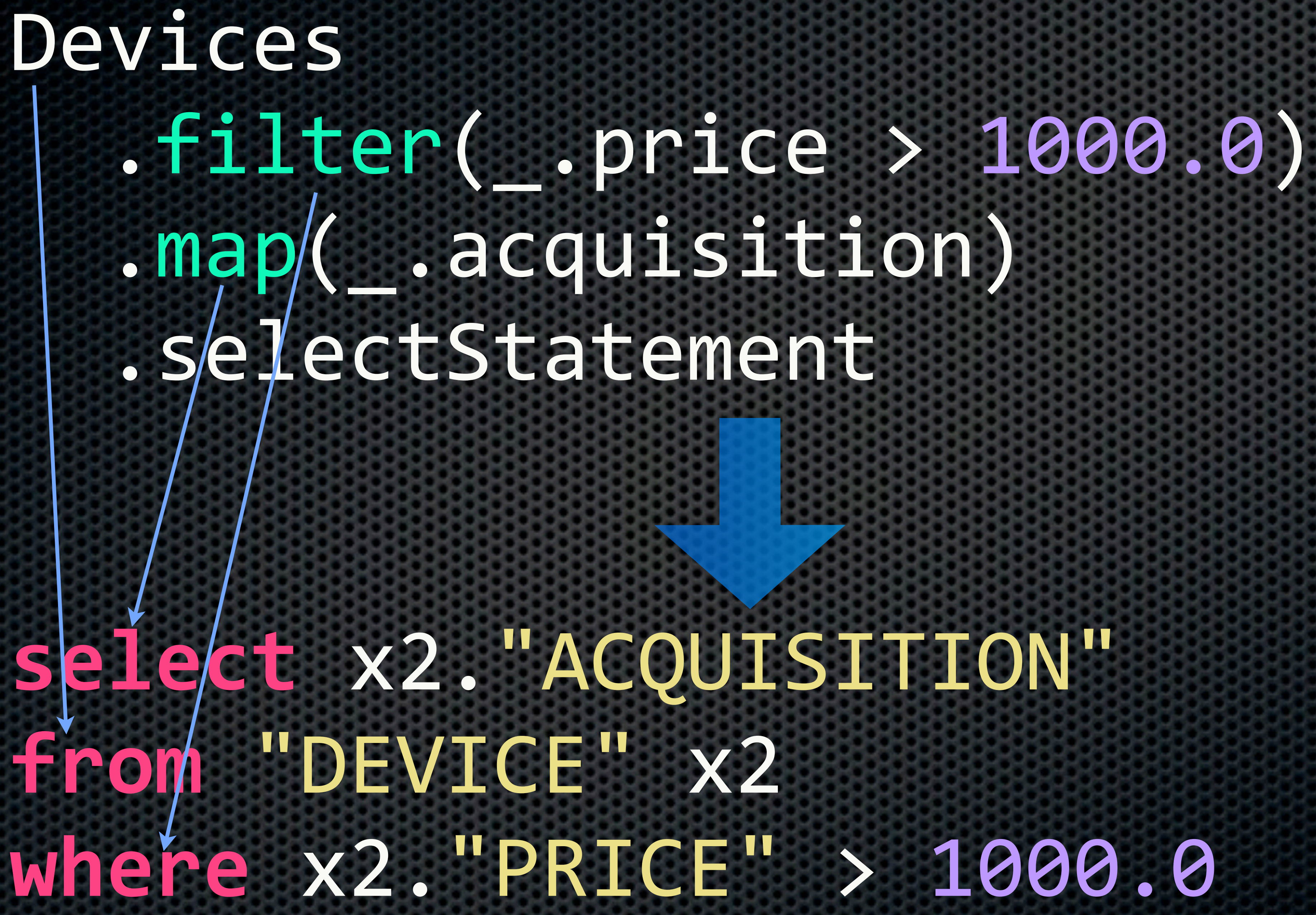
```
for ( d <- Devices;
      if d.price > 1000.0
) yield d.acquisition

Devices
  .filter(_.price > 1000.0)
  .map(_.acquisition)
```

Device
id: Long
price: Double
acquisition: Date

2
Predictable SQL structure

Predictable SQL structure



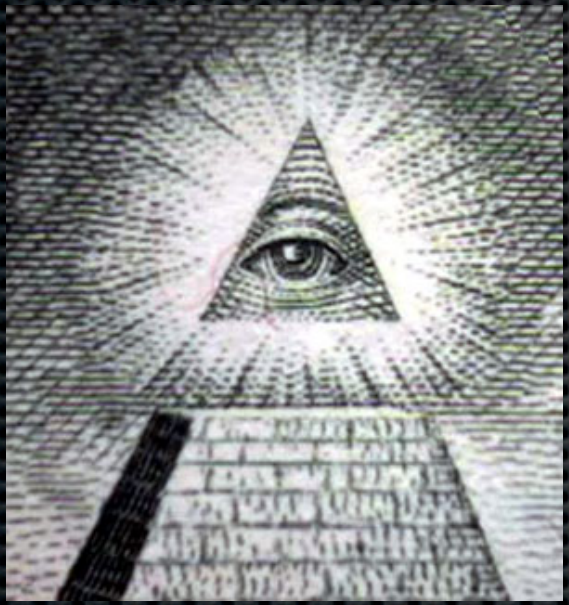
```
Devices
   .filter(_.price > 1000.0)
   .map(_.acquisition)
   .selectStatement
```

```
select x2."ACQUISITION"
from "DEVICE" x2
where x2."PRICE" > 1000.0
```

3
Type-safety

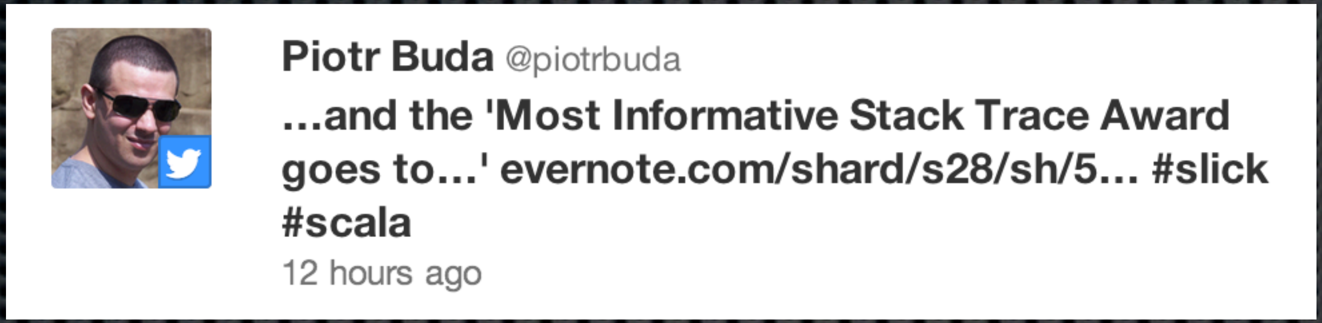
Compile-Time Safety

- Spelling mistake in column name?
- Wrong column type?
- Query doesn’t match expected result type?



scalac sees it all!

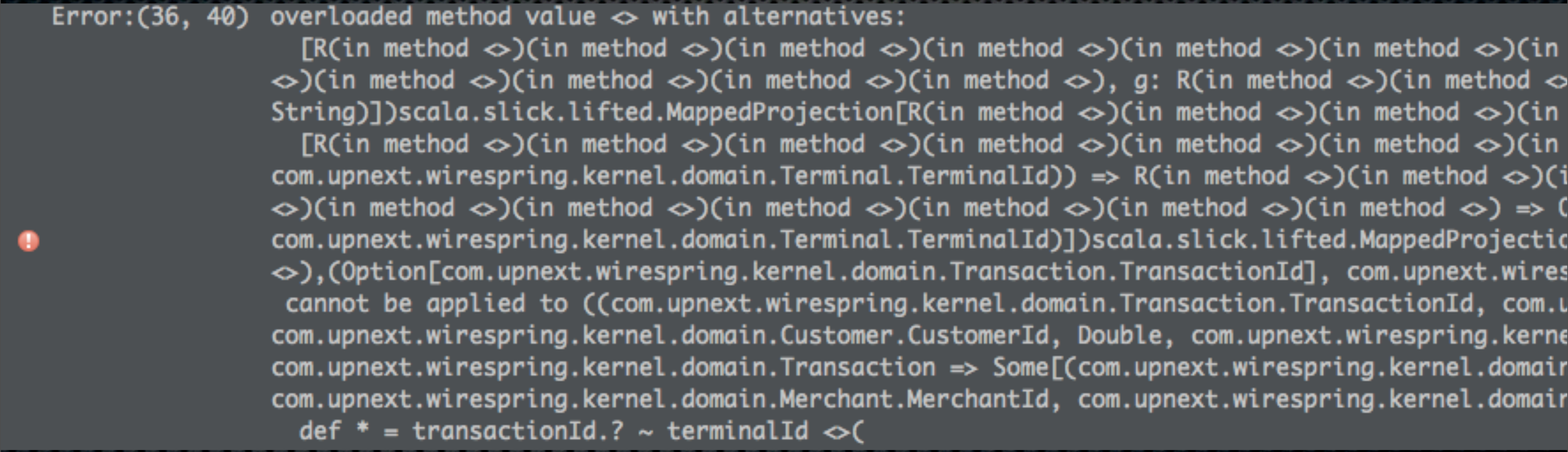
But: Error messages can be bad



Piotr Buda @piotrbuda

...and the 'Most Informative Stack Trace Award goes to...' evernote.com/shard/s28/sh/5... #slick #scala

12 hours ago



```
Error:(36, 40) overloaded method value <> with alternatives:
                 [R(in method <>)(in method <>)(in method <>)(in method <>)(in method <>)(in method <>)(in
               <>)(in method <>)(in method <>)(in method <>)(in method <>), g: R(in method <>)(in method <
               String)])scala.slick.lifted.MappedProjection[R(in method <>)(in method <>)(in method <>)(in
                 [R(in method <>)(in method <>)(in method <>)(in method <>)(in method <>)(in method <>)(in
               com.upnext.wirespring.kernel.domain.Terminal.TerminalId)) => R(in method <>)(in method <>)(i
               <>)(in method <>)(in method <>)(in method <>)(in method <>)(in method <>)(in method <>) => (
               com.upnext.wirespring.kernel.domain.Terminal.TerminalId)])scala.slick.lifted.MappedProjectio
               <>),(Option[com.upnext.wirespring.kernel.domain.Transaction.TransactionId], com.upnext.wires
                cannot be applied to ((com.upnext.wirespring.kernel.domain.Transaction.TransactionId, com.u
               com.upnext.wirespring.kernel.domain.Customer.CustomerId, Double, com.upnext.wirespring.kerne
               com.upnext.wirespring.kernel.domain.Transaction => Some[(com.upnext.wirespring.kernel.domai
               com.upnext.wirespring.kernel.domain.Merchant.MerchantId, com.upnext.wirespring.kernel.domai
                 def * = transactionId.? ~ terminalId <>(
```

Enforce schema consistency

- Generate DDL from table classes
- Slick 2.x: Generate table classes and mapped classes from database

4
Small configuration using Scala code

Table description

```
class Devices(tag: Tag)
      extends Table[(Long, Double, Date)](tag,"DEVICES") {
  def id          = column[Long]  ("ID", O.PrimaryKey)
  def price       = column[Double]("PRICE")
  def acquisition = column[Date]  ("ACQUISITION")
  def * = (id, price, acquisition)

}
def Devices = TableQuery[Devices]
```

can be auto-generated in Slick 2.x

Connect

```
import scala.slick.driver.H2Driver.simple._

val db = Database.forURL(
  "jdbc:h2:mem:testdb", "org.h2.Driver")

db.withTransaction { implicit session =>

  // <- run queries here

}
```

5
Explicit control over execution and transfer

Execution control

```
val query = for {
    d <- Devices
      if d.price > 1000.0
  } yield d.acquisition

db.withTransaction { implicit session =>

  val acquisitonDates = query.run

}
```

Device
id: Long
price: Double
acquisition: Date

no unexpected behavior,
no loading strategy configuration,
just write code

6
Loosely-coupled, flexible mapping

Mapping to tuples

```
class Devices(tag: Tag)
extends Table[(Long, Double, Date)](tag,"DEVICES") {
  def id          = column[Long]  ("ID", O.PrimaryKey)
  def price       = column[Double]("PRICE")
  def acquisition = column[Date]  ("ACQUISITION")
  def * = (id, price, acquisition)

}
val Devices = TableQuery[Devices]
```

Mapping to HLists

```
class Devices(tag: Tag)
extends Table[Long :: Double :: Date :: HNil)](tag,"DEVICES") {
  def id          = column[Long]  ("ID", O.PrimaryKey)
  def price       = column[Double]("PRICE")
  def acquisition = column[Date]  ("ACQUISITION")
  def * = id :: price :: acquisition :: HNil

}
val Devices = TableQuery[Devices]
```

Mapping to case classes

```
case class Device(id: Long,
  price: Double,
  acquisition: Date)

class Devices(tag: Tag)
extends Table[Device](tag,"DEVICES") {
  def id          = column[Long]  ("ID", O.PrimaryKey)
  def price       = column[Double]("PRICE")
  def acquisition = column[Date]  ("ACQUISITION")
  def * = (id, price, acquisition) <>
            (Device.tupled,Device.unapply)
}
val Devices = TableQuery[Devices]
```

Mapping to case classes

```
def construct : ((Long,Double,Date)) => CustomType
def extract: CustomType => Option[(Long,Double,Date)]

class Devices(tag: Tag)
      extends Table[CustomType](tag,"DEVICES") {
  def id          = column[Long]  ("ID", O.PrimaryKey)
  def price       = column[Double]("PRICE")
  def acquisition = column[Date]  ("ACQUISITION")
  def * = (id, price, acquisition) <>
                   (construct,extract)
}
val Devices = TableQuery[Devices]
```

7
First-class SQL support

Plain SQL support

```
import scala.slick.jdbc.{GetResult, StaticQuery}
import StaticQuery.interpolation

implicit val getDeviceResult =
  GetResult(r => Device(r.<<, r.<<, r.<<))

val price = 1000.0

val expensiveDevices: List[Device] =
  sql"select * from DEVICES where PRICE > $price"
    .as[Device].list
```

8
composable /
re-usable queries

Composable queries

```
def deviceLocations
 (companies: Query[Companies,Company])
 : Query[Column[String],String] = {
  companies.computers.devices.sites.map(_.location)
}

val apples = Companies.filter(_.name iLike "%apple%")
val locations : Seq[String] = {
  deviceLocations(apples)
    .filter(_.inAmerica: Column[String]=>Column[Boolean])
    .run
}
```

Composable queries

Re-use queries

```
def deviceLocations
 (companies: Query[Companies,Company])
 : Query[Column[String],String] = {
  companies.computers.devices.sites.map(_.location)
}

val apples = Companies.filter(_.name iLike "%apple%")
val locations : Seq[String] = {
  deviceLocations(apples)
    .filter(_.inAmerica: Column[String]=>Column[Boolean])
    .run
}
```

Composable queries

```
def deviceLocations
 (companies: Query[Companies,Company])
 : Query[Column[String],String] = {
  companies.computers.devices.sites.map(_.location)
}

val apples = Companies.filter(_.name iLike "%apple%")
val locations : Seq[String] = {
  deviceLocations(apples)
    .filter(_.inAmerica: Column[String]=>Column[Boolean])
    .run
}
```

Re-use joins

Composable queries

```
def deviceLocations
 (companies: Query[Companies,Company])
 : Query[Column[String],String] = {
  companies.computers.devices.sites.map(_.location)
}

val apples = Companies.filter(_.name iLike "%apple%")
val locations : Seq[String] = {
  deviceLocations(apples)
    .filter(_.inAmerica: Column[String]=>Column[Boolean])
    .run
}
```

user-defined functions

Composable queries

```
def deviceLocations
 (companies: Query[Companies,Company])
 : Query[Column[String],String] = {
  companies.computers.devices.sites.map(_.location)
}

val apples = Companies.filter(_.name iLike "%apple%")
val locations : Seq[String] = {
  deviceLocations(apples)
    .filter(_.inAmerica: Column[String]=>Column[Boolean])
    .run
}
```

exactly one db roundtrip

Composable queries

```
def deviceLocations
 (companies: Query[Companies,Company])
 : Query[Column[String],String] = {
  companies.computers.devices.sites.map(_.location)
}

val apples = Companies.filter(_.name iLike "%apple%")
val locations : Seq[String] = {
  deviceLocations(apples)
    .filter(_.inAmerica: Column[String]=>Column[Boolean])
    .run
}
```

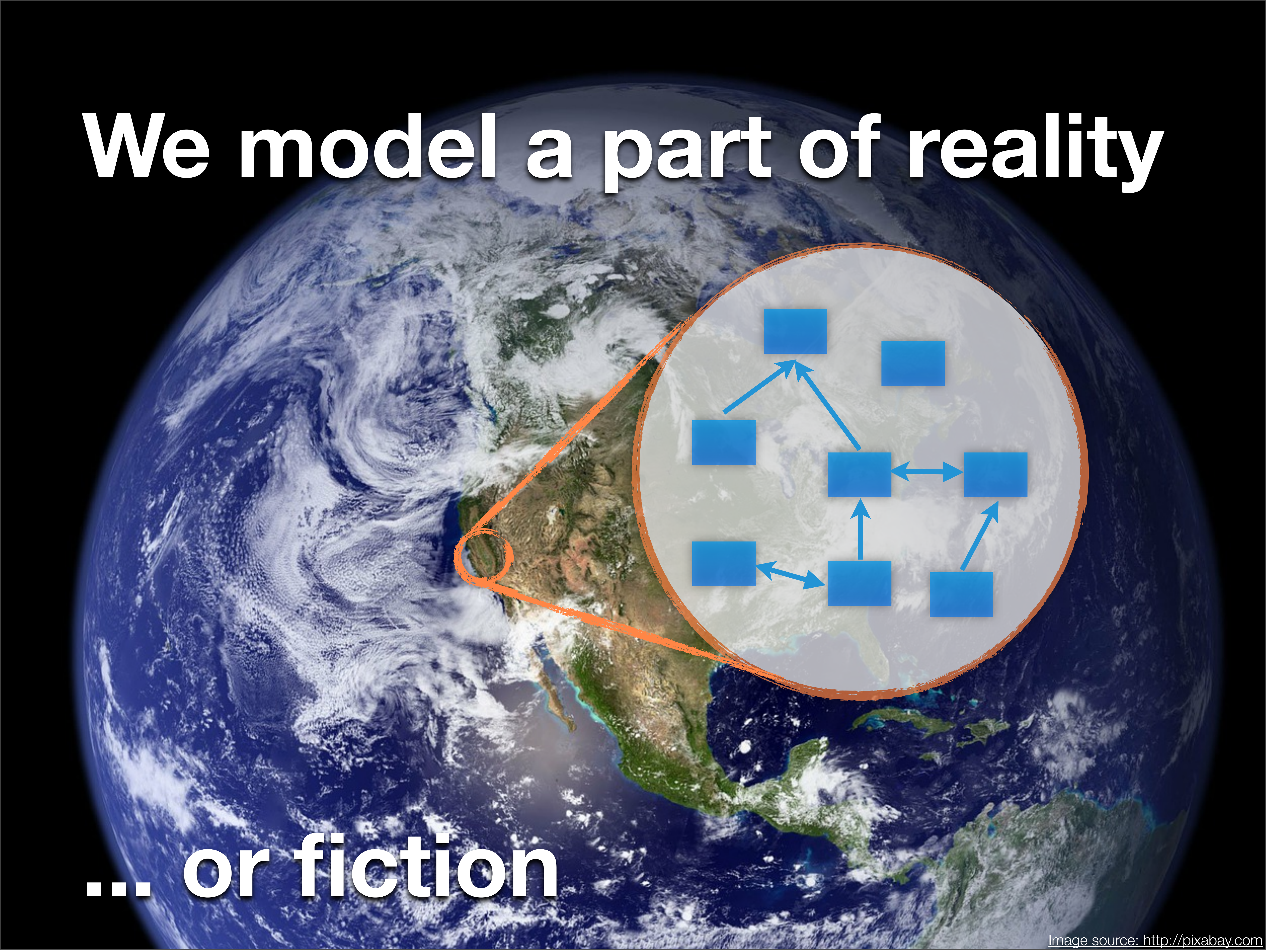
let’s take a step back...

Part 2

Software data modeling

What are we doing?

We model a part of reality



… or fiction

Image source: http://pixabay.com

The model is NOT in a single place of our code

Play

Slick

DAO

API

Validation

It’s all over the place

Serialization

SQL

Scala

GUI

Examples

db schema

```
create table "COMPUTER" (
  "ID" INTEGER PRIMARY KEY,
  "NAME" VARCHAR NOT NULL,
  "INTRODUCED" DATE,
  "DISCONTINUED" DATE,
  "COMPANY_ID" INTEGER
);
```

Slick Table

```
class Computers(tag: Tag) extends Table[Computer](tag, "COMPUTER")
  def * = (name, introduced, discontinued, companyId, id.?) <> ...
  val name = column[String]("NAME")
  val introduced = column[Option[java.sql.Date]]("INTRODUCED")
  val discontinued = column[Option[java.sql.Date]]("DISCONTINUED")
  val companyId = column[Option[Int]]("COMPANY_ID")
  val id = column[Int]("ID", O.AutoInc, O.PrimaryKey)
}
```

```
case class Computer(
  name: String, introduced: Option[java.sql.Date],
  discontinued: Option[java.sql.Date], companyId: Option[Int], id: Option[Int] = None)
```

Scala case class

```
Form(
      mapping(
        "name" -> nonEmptyText,
        "introduced" -> optional(sqlDate("yyyy-MM-dd")),
        "discontinued" -> optional(sqlDate("yyyy-MM-dd")),
        "companyId" -> optional(number),
        "id" -> optional(number)
      )(Computer.apply)(Computer.unapply)
)
```

Play form / html

```
@inputText(computerForm("name"), '_label -> "Computer name")
@inputText(computerForm("introduced"), '_label -> "Introduced date")
@inputText(computerForm("discontinued"), '_label -> "Discontinued date")
```

Play

Slick

DAO

API

Validation

Why the repetition?

Serialization

SQL

Scala

GUI

Why the repetition

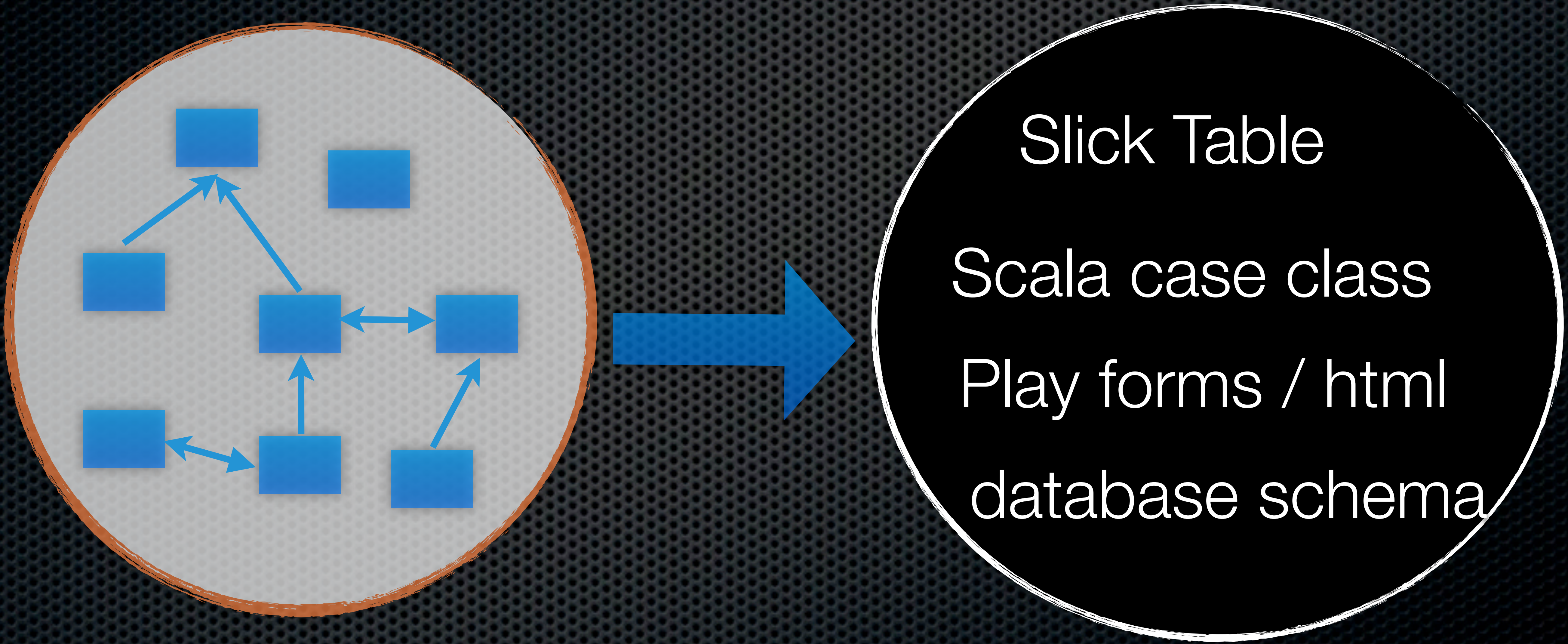
- Language limitations
- Language / system borders
- Avoiding complicated types in abstractions
- Separation of concerns (e.g. Frontend / Backend)

Problems of repetition

- Bad out of the box experience
- Implementation effort
- Maintenance effort (refactoring, etc.)
- Inconsistencies !
- Repeated bugs

Let’s refactor

Data model driven software



Slick Table

Scala case class

Play forms / html

database schema

MDA

MDSE

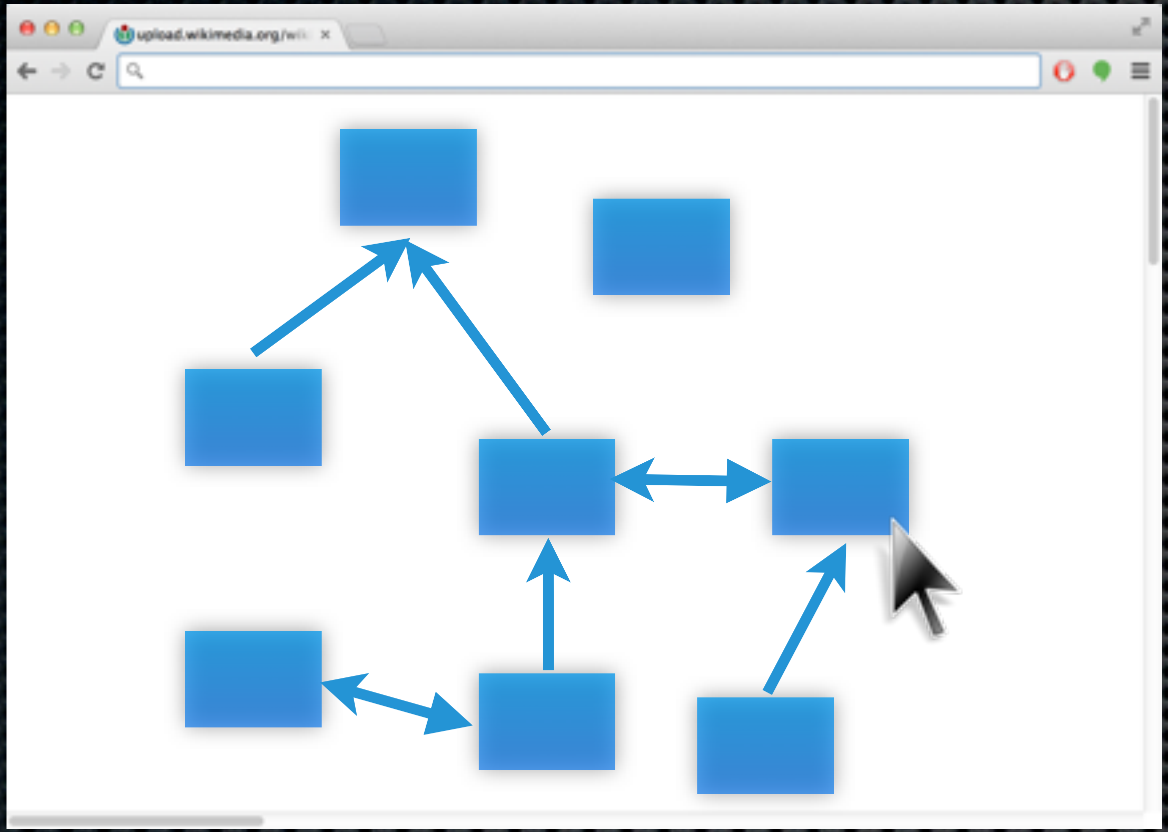
Wait... didn’t model driven fail?

MDD

MDE

MDSD

Visual tool driven?



?

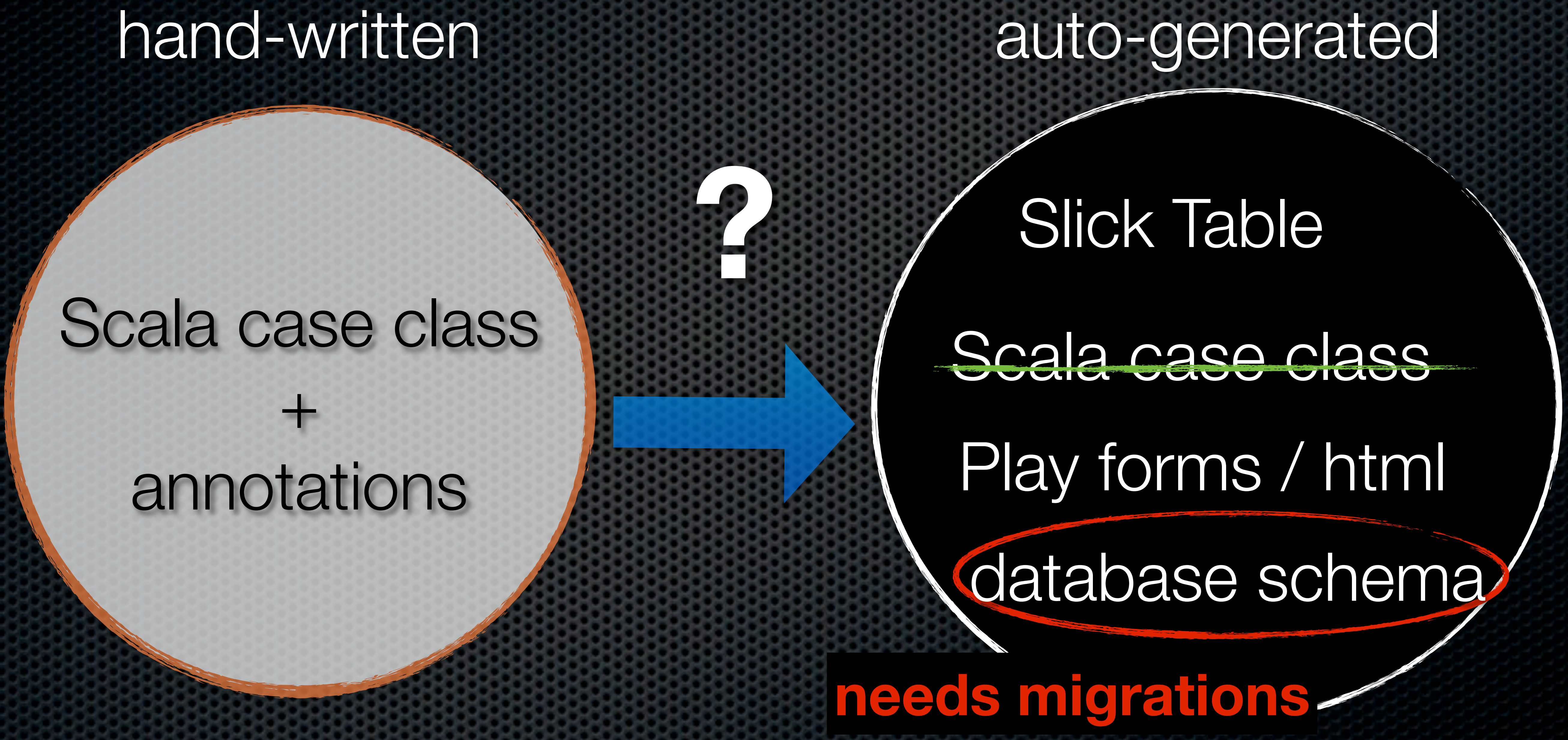
Slick Table

Scala case class

Play forms / html

database schema

Scala code driven?



hand-written

auto-generated

Scala case class
+
annotations

?

Slick Table

~~Scala case class~~

Play forms / html

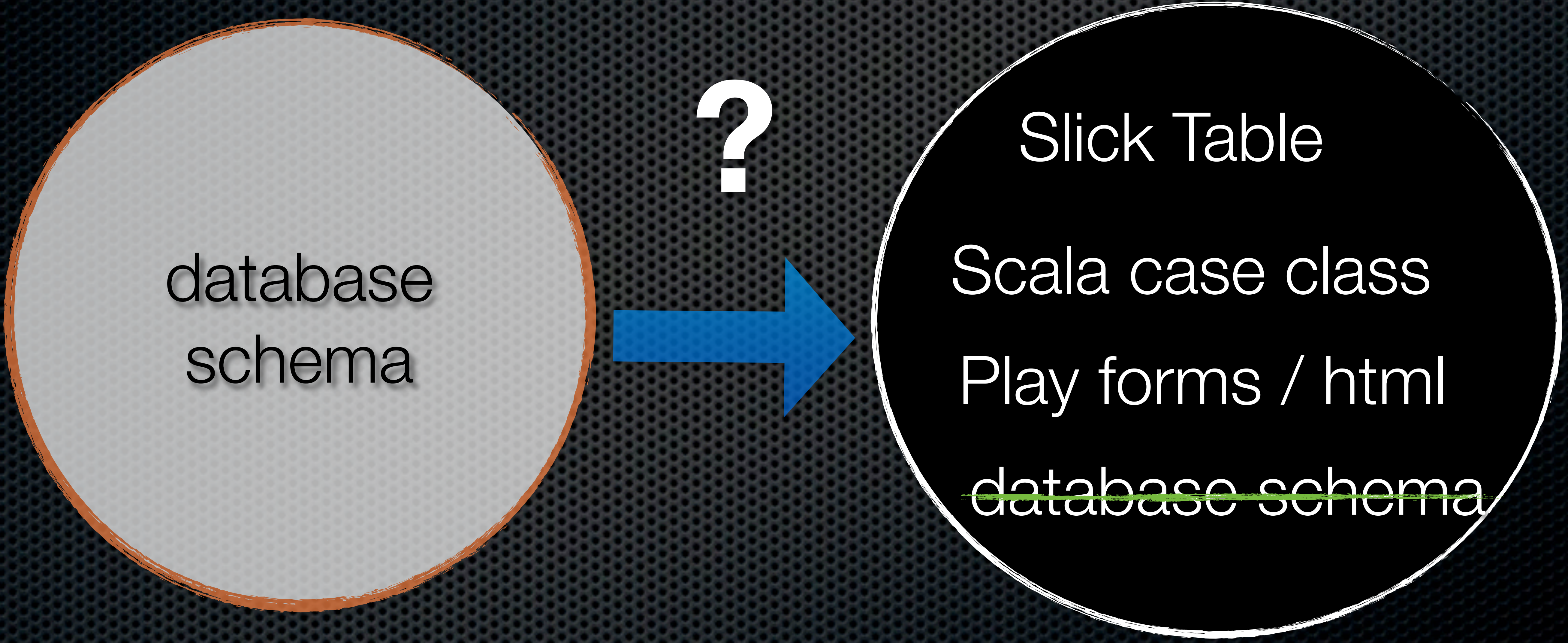
database schema

needs migrations

Database schema driven?

managed by hand

auto-generated



database schema

?

Slick Table

Scala case class

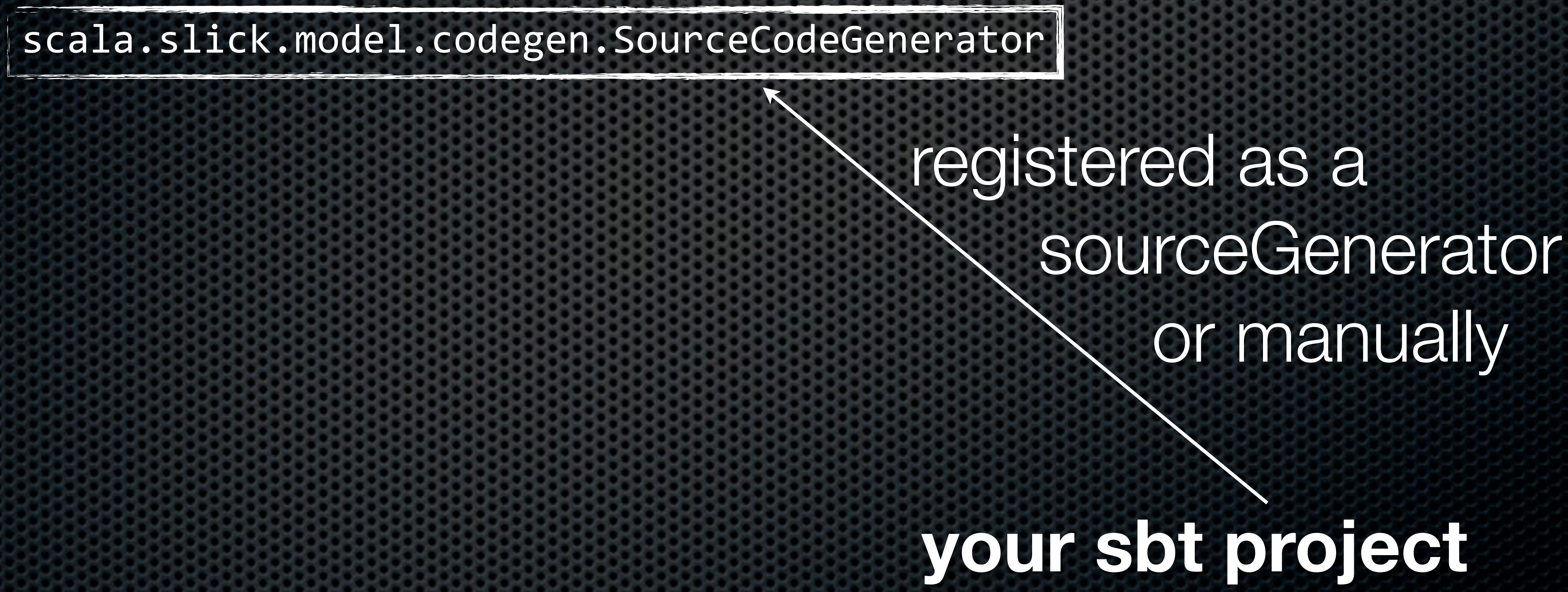
Play forms / html

~~database schema~~

New in Slick 2

Slick code generation

Slick out-of-the-box codegen



```
scala.slick.model.codegen.SourceCodeGenerator
```

registered as a
sourceGenerator
or manually

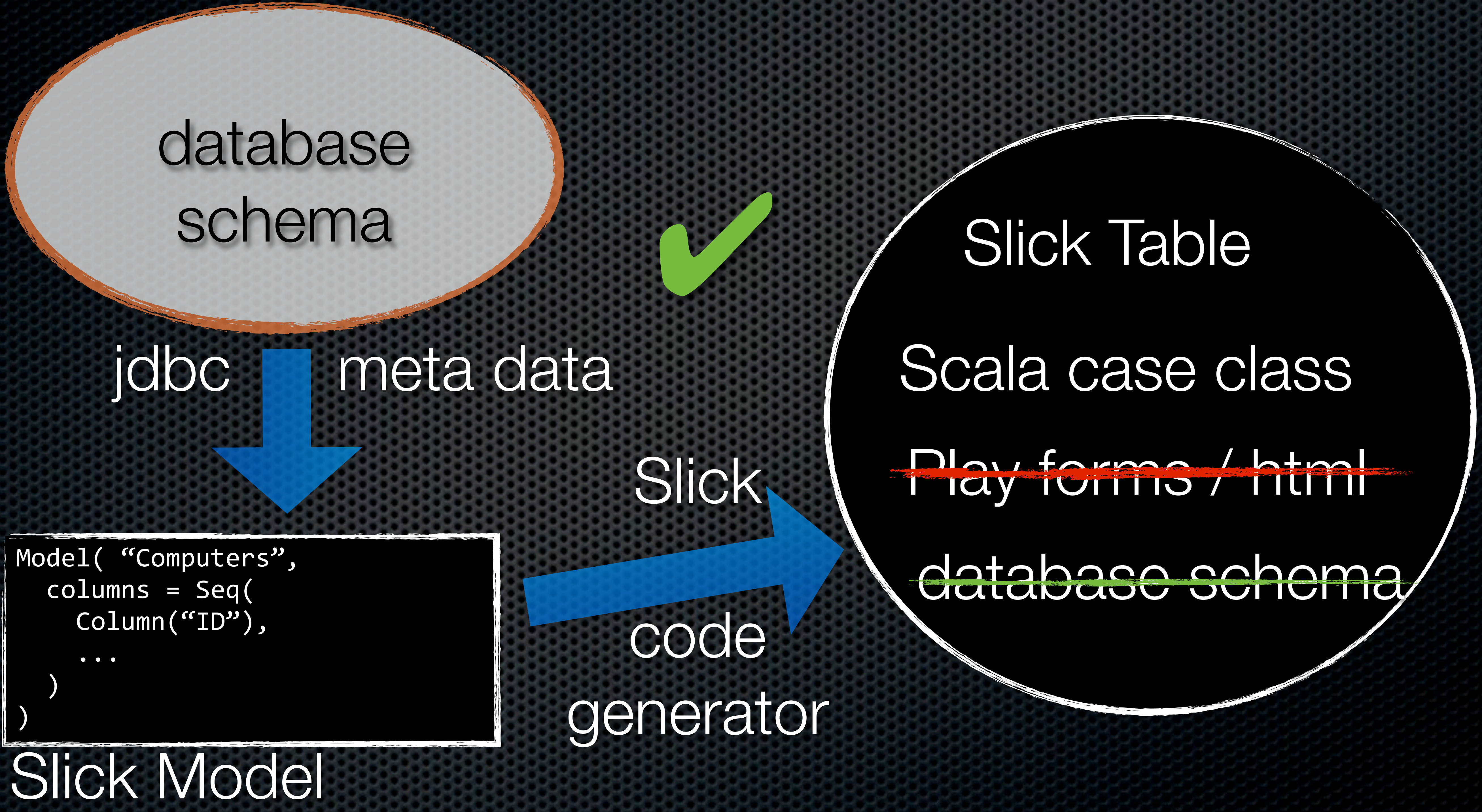
your sbt project

Template: https://github.com/slick/slick-codegen-example

Slick out-of-the-box codegen

- generates all types for slick queries
- minimal customization may be required
- textual codegen (not Scala macros)

Slick out-of-the-box codegen



database schema

✓

jdbc meta data

```
Model( “Computers”,
  columns = Seq(
    Column(“ID”),
    ...
  )
)
```

Slick Model

Slick code generator

Slick Table

Scala case class

~~Play forms / html~~

~~database schema~~

Template: https://github.com/slick/slick-codegen-example

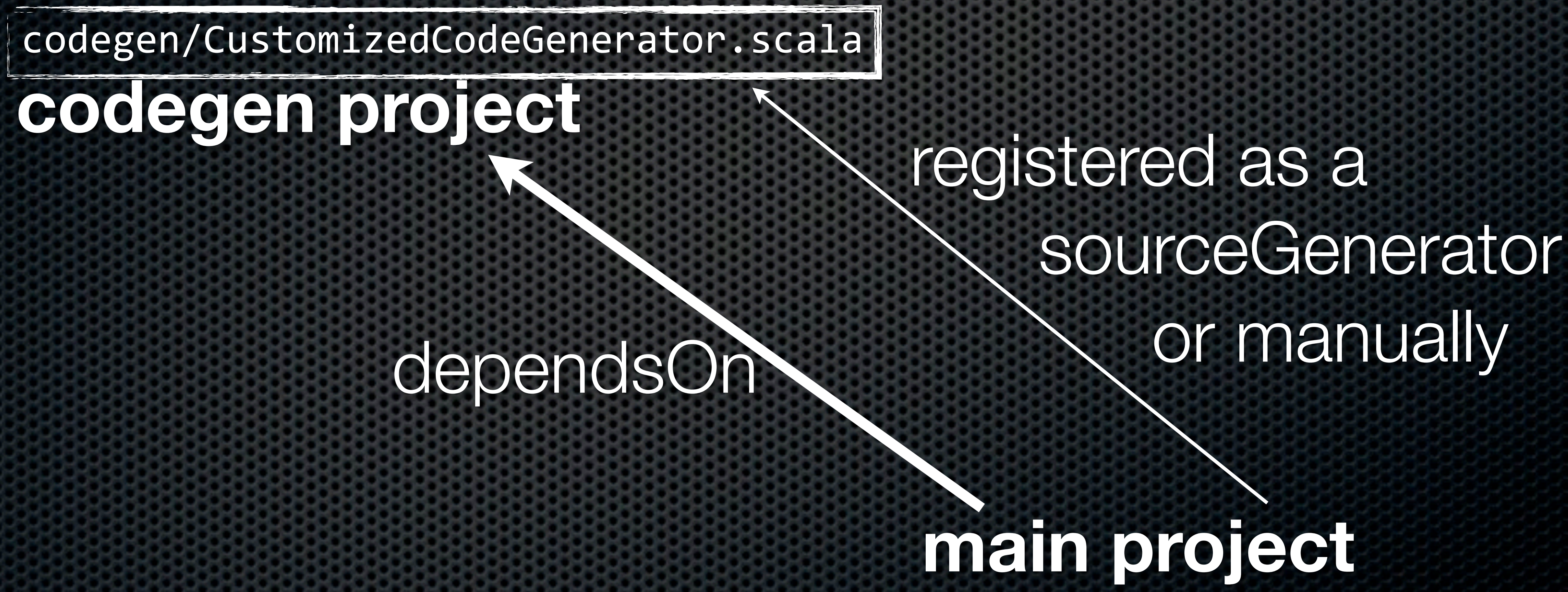
Slick customized code generation

Generate whatever

- play forms
- DAO
- gui
- ...

Slick customized codegen

sbt multi-project build



`codegen/CustomizedCodeGenerator.scala`

codegen project

registered as a sourceGenerator or manually

dependsOn

main project

Template: https://github.com/slick/slick-codegen-customization-example

Textual codegen vs. Macros

- Macros are compiler-supported codegen
  - Easier multi-stage expansions
  - QuasiQuotes provide early syntax errors
- However
  - currently no preview of generated code
  - some compiler api knowledge requires, e.g. names

CustomizedSlickCodeGenerator.scala (from slick-codegen-customization-example)

```scala
// fetch data model
val model = db.withSession{ implicit session =>
  createModel(H2Driver.getTables.list,H2Driver)
}
// customize code generator
val codegen = new SourceCodeGenerator(model){
  override def code =
    "import foo.{MyCustomType,MyCustomTypeMapper}" + "\n" + super.code

  // override table generator
  override def Table = new Table(_){
    // disable entity class generation and mapping
    override def EntityType = new EntityType{
      override def classEnabled = false
    }
     // override contained column generator
    override def Column = new Column(_){
      override def rawType =
        if(model.name == "SOME_SPECIAL_COLUMN_NAME") "MyCustomType"
        else super.rawType
    }
  }
}
```

Slick SourceCodeGenerator

- allows very easy start
  - simple customizations
  - override methods like `def code`

Fully automatic Play CRUD demo app:

https://github.com/slick/play-slick-codegen

Demo app codegen features

- case classes
- Slick Tables
- Play form bindings / validations
- Play html view helpers / formatters / forms
- JavaScript form validation
- Many-to-one relationships in forms

All this, but at what price?

vanilla app

play-slick / computer-database

app/

hand-written: 1114 LOC

this demo app

slick / play-slick-codegen

app/

hand-written: 1148 LOC

generated: 228 LOC

slick-codegen/

hand-written: 204 LOC

total: **1352 LOC**

Real world case study

Sport195

- www.sport195.com
- Sports social network - Athlete, Fan, Organization
- Sport data provider / content platform
- REST api using Scala/Slick/Play
- **107** tables, **1120** columns mapped using Slick, shared with RoRails app
- migrated from Slick 1 -> Slick 2 -> Slick 2 + codegen

hand-written -> codegen

- initial migration of code took ~3 weeks (107 tables)
  - wrong types (4 cases)
  - wrong nullability (109 cases in 66 tables)
  - wrong / missing column (few cases)
- after that new features for all tables 1-3 days

Generated features at S195

- case class-like classes (>22 cols)
- Slick Tables
- CRUD / with hooks
- typed associations
- polymorphic associations
- json serialization / deserialization

Sport195 codegen benefits

all model code for 107 tables, 1120 columns

before codegen

Model-specific: 15127 LOC

Abstractions: 781 LOC

Scala macros: 309 LOC

total: **16217 LOC**

using codegen

Model-specific: 10698 LOC

Abstractions: 615 LOC

Scala macros: 0 LOC

Code generator: 399 LOC

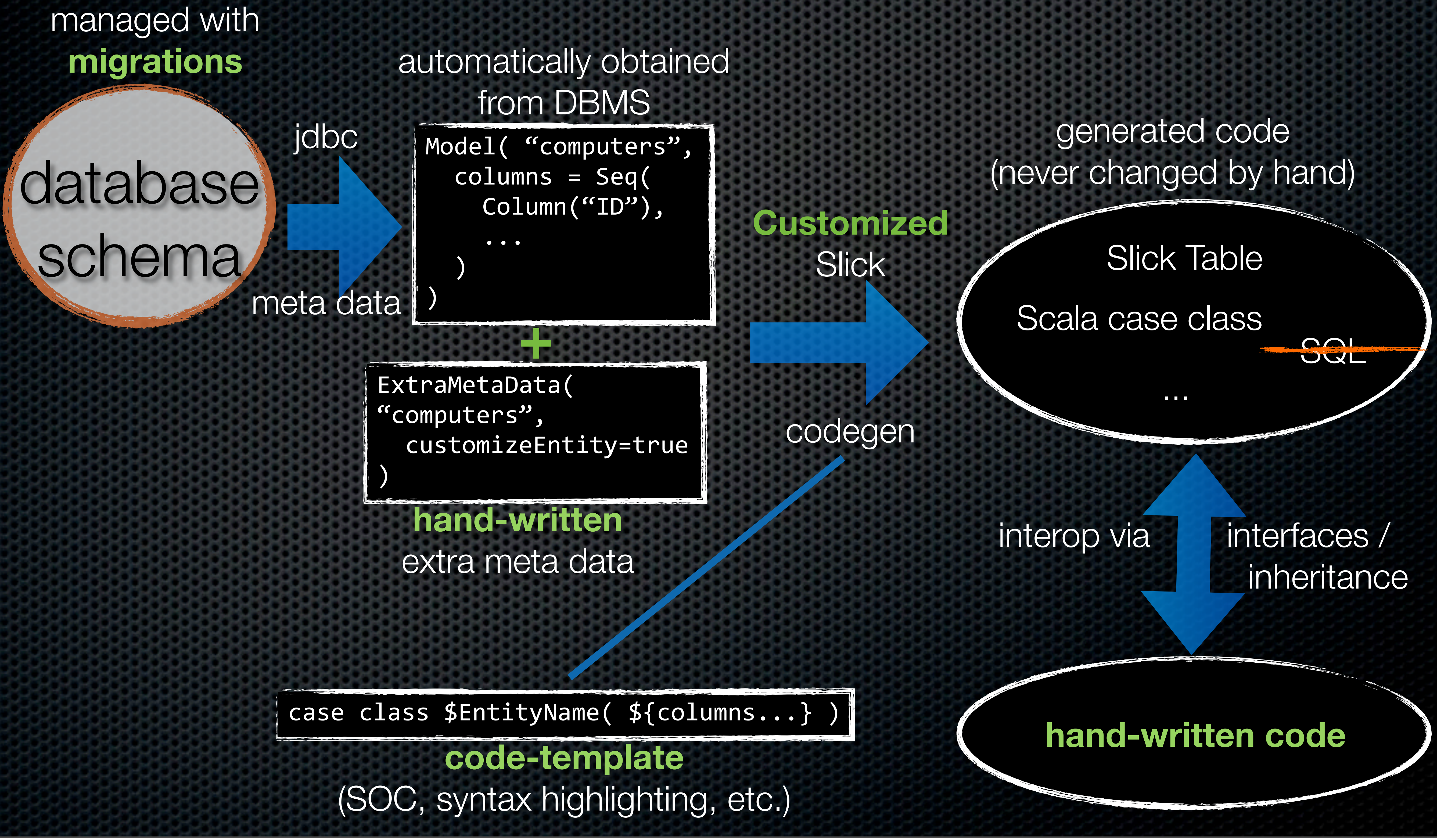
Code template: 301 LOC

total: **12013 LOC**

generated: 37542 LOC

hand-written: **25% reduction**

S195 codegen architecture



managed with **migrations**

database schema

jdbc

meta data

automatically obtained from DBMS

```
Model( “computers”,
  columns = Seq(
    Column(“ID”),
    ...
  )
)
```

+

```
ExtraMetaData(
“computers”,
  customizeEntity=true
)
```

hand-written extra meta data

Customized Slick

codegen

```
case class $EntityName( ${columns...} )
```

code-template (SOC, syntax highlighting, etc.)

generated code (never changed by hand)

Slick Table

Scala case class

~~SQL~~

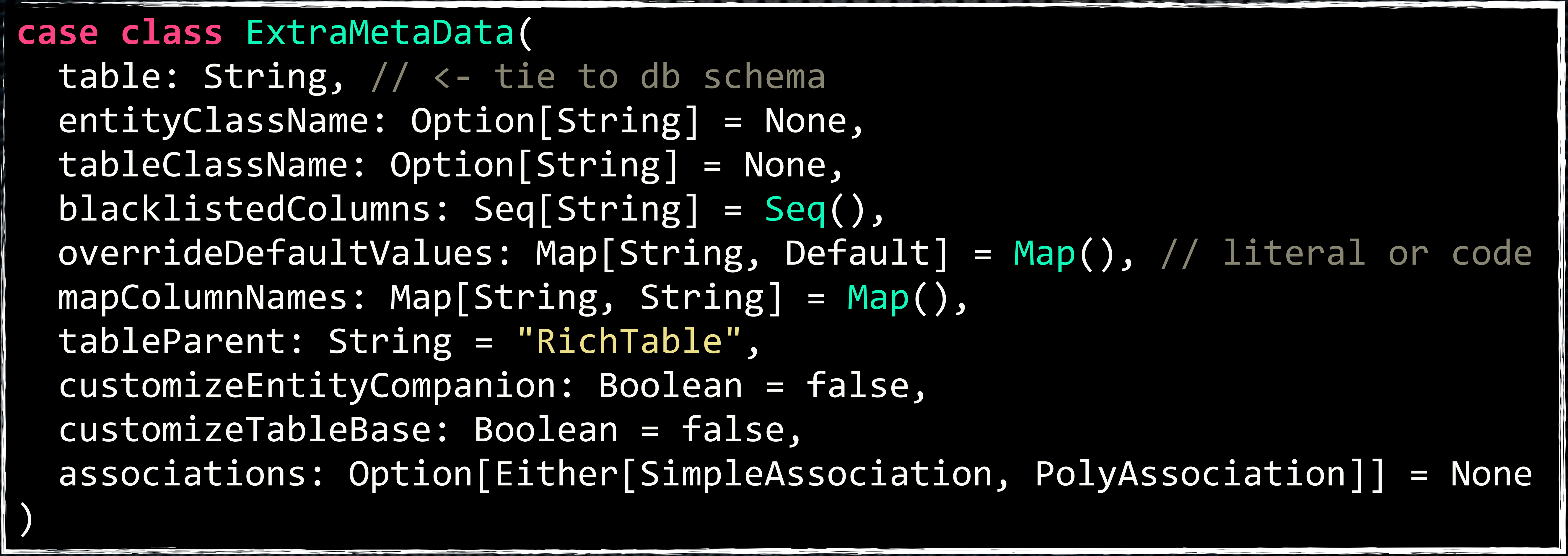
...

interop via interfaces / inheritance

hand-written code

S195 additional meta data

complement your database schema as required



```
case class ExtraMetaData(
  table: String, // <- tie to db schema
  entityClassName: Option[String] = None,
  tableClassName: Option[String] = None,
  blacklistedColumns: Seq[String] = Seq(),
  overrideDefaultValues: Map[String, Default] = Map(), // literal or code
  mapColumnNames: Map[String, String] = Map(),
  tableParent: String = "RichTable",
  customizeEntityCompanion: Boolean = false,
  customizeTableBase: Boolean = false,
  associations: Option[Either[SimpleAssociation, PolyAssociation]] = None
)
```

Practical codegen tips

1

Never change generate code by hand

Never change generate code by hand

- keep codegen repeatable and evolvable
- change any of these instead of generated code:
  - code-generator
  - database schema
  - extra meta data

2
Codegen only if you have to

Initial cost of codegen

- more complex build
- more complex architecture for interop

If possible don’t codegen

- Keep it simple
- Generated code is often harder to maintain than hand-written (unless it is repetitive)
- Don’t codegen rare edge-cases, just write them by hand
- Abstract in Scala to support further abstractions
  - e.g. for Scala tuples, codegen breaks abstraction

When to codegen?

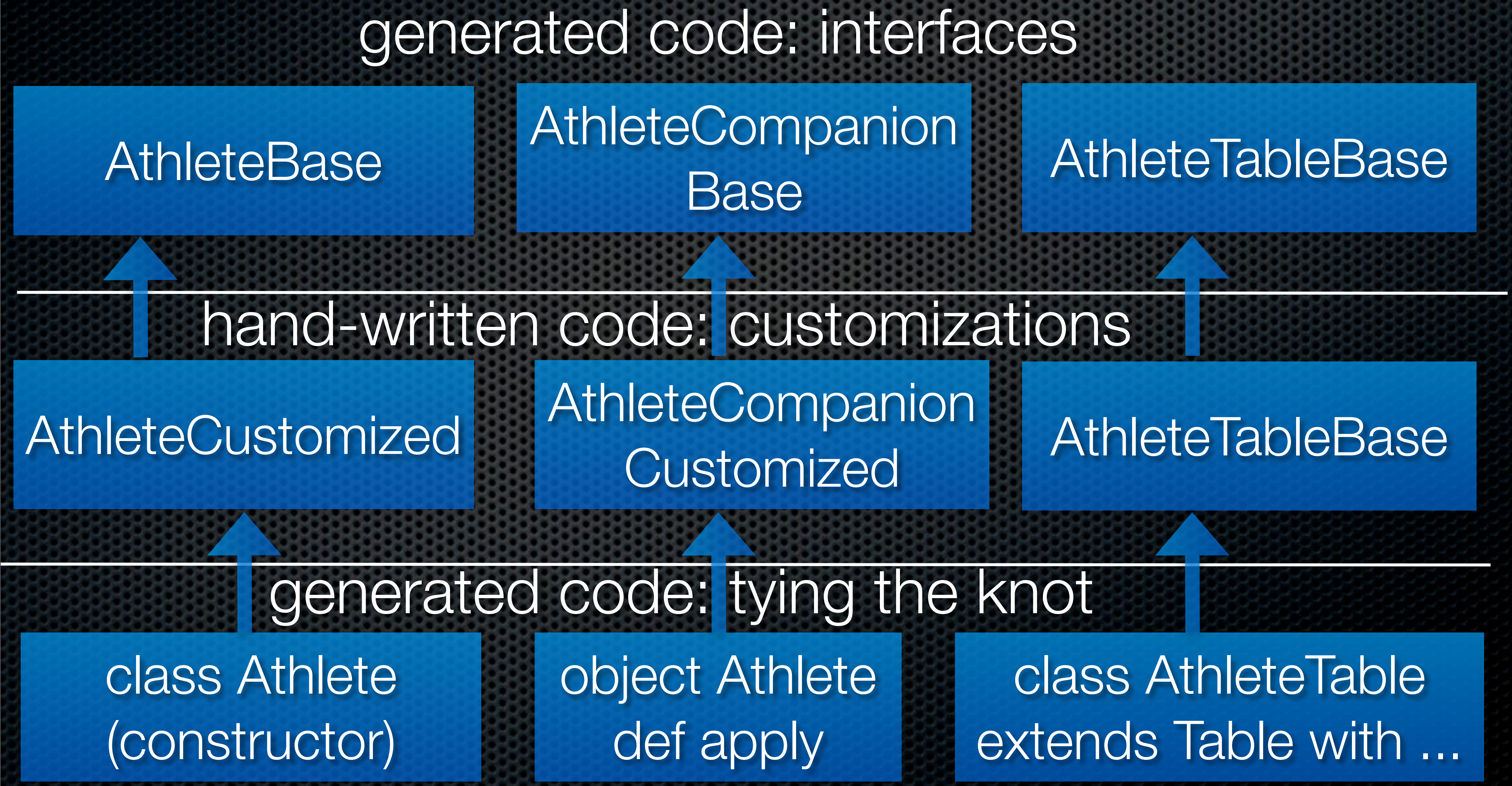
- as refactoring
  - when forced to repeat at least once or twice
- usual suspects
  - entity members (case classes, slick tables, etc.)
  - tuple sizes (tables > 22)
  - type-system limitations (constructor inheritance)

3
Have excellent interop
hand-written <-> generated

interop
hand-written <-> generated

- Don’t capture all edge-cases. Allow customization!
- Many ways: inheritance, apis, type classes
- Care about it! Avoid stuff creeping into codegen
- Use extra meta data for customization indicators

S195 codegen interop: Athlete



generated code: interfaces

AthleteBase

AthleteCompanion Base

AthleteTableBase

hand-written code: customizations

AthleteCustomized

AthleteCompanion Customized

AthleteTableBase

generated code: tying the knot

class Athlete (constructor)

object Athlete def apply

class AthleteTable extends Table with ...

4

The generator is not just a tool. It’s part of your code.

Part of your code

- integral part of your code!
- be agile, evolve your generator alongside your code
- keep refactoring
- put both in version control together

Scale generator as needed

- start easy
  - override def code / use string interpolation
- advance: pull out code into separate template, e.g. twirl
  - separation of concerns
  - syntax highlighting (highlight template as Scala)
- transcend: say goodbye to Slick's codegen class and use Slick's model exclusively

5

Put generated sources or schema in version control

versioning generated code

- for very understandable diffs
- for checking white-space/docs changes
- allow compile without db

versioning meta data instead

- e.g. schema.sql file
- (atm: don’t use different db for codegen and prod,
  jdbc drivers are too different)

6

make generated code readable!

indention & scaladoc

7
Consider exposing your schema in your webservice

For backend/frontend teams

- expose the schema in your api for re-use
- e.g. /computer/schema
- or generate javascript that represents the schema

Codegen summary

- Consider codegen to scrap your boiler plate
- It’s one way to do it. There are others.
- It works! Even for small projects. And it’s easy.
- Use it wisely.
- Enjoy productivity benefits :)

Thank you!

We are hiring at Sport195. Talk to me.

christopher.vogt@sport195.com

twitter: @cvogt

slick: http://slick.typesafe.com/