IT's TINKOFF

Шаблонный доклад

Алексей Троицкий

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IT's TINKOFF

https://github.com/road21/talks

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Telegram, github: road21

IT's TINKOFF

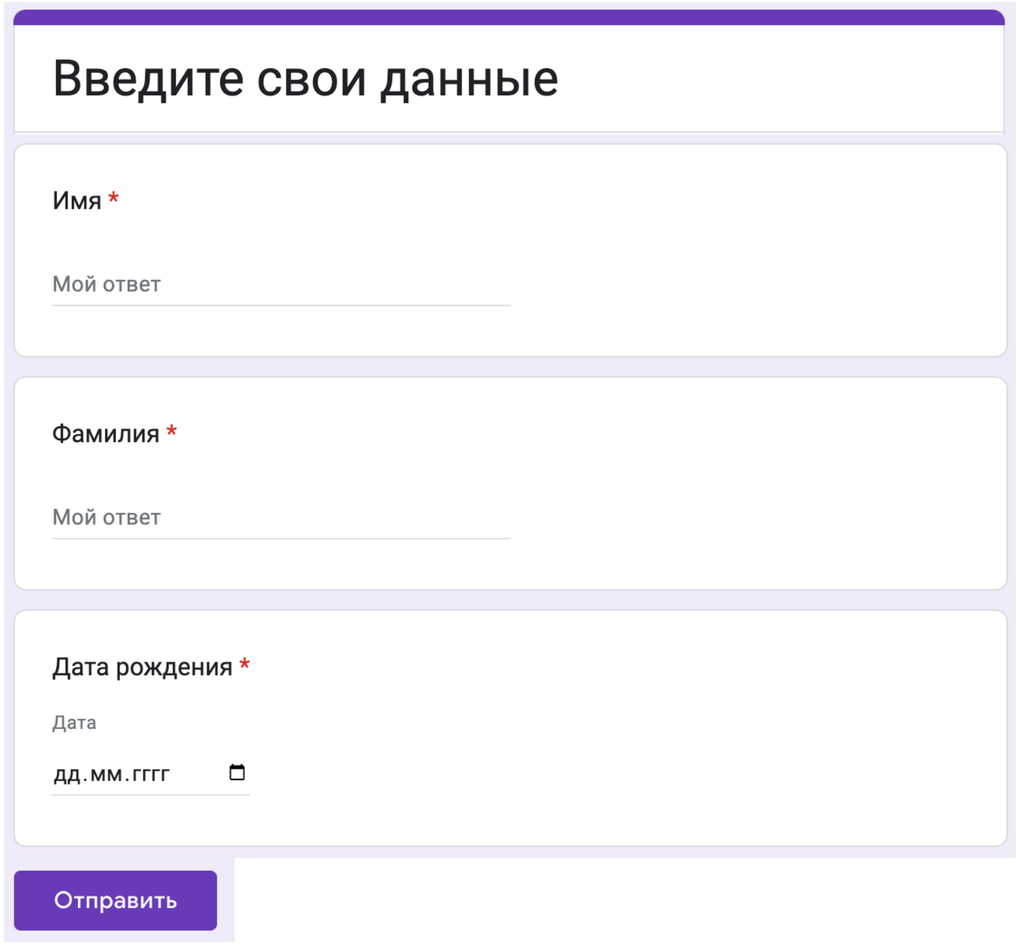
План

1. Ставим задачу
2. Решаем на scala
3. Усложняем задачу
4. Опять решаем на scala
5. Опять усложняем
6. Опять решаем на scala

Задача

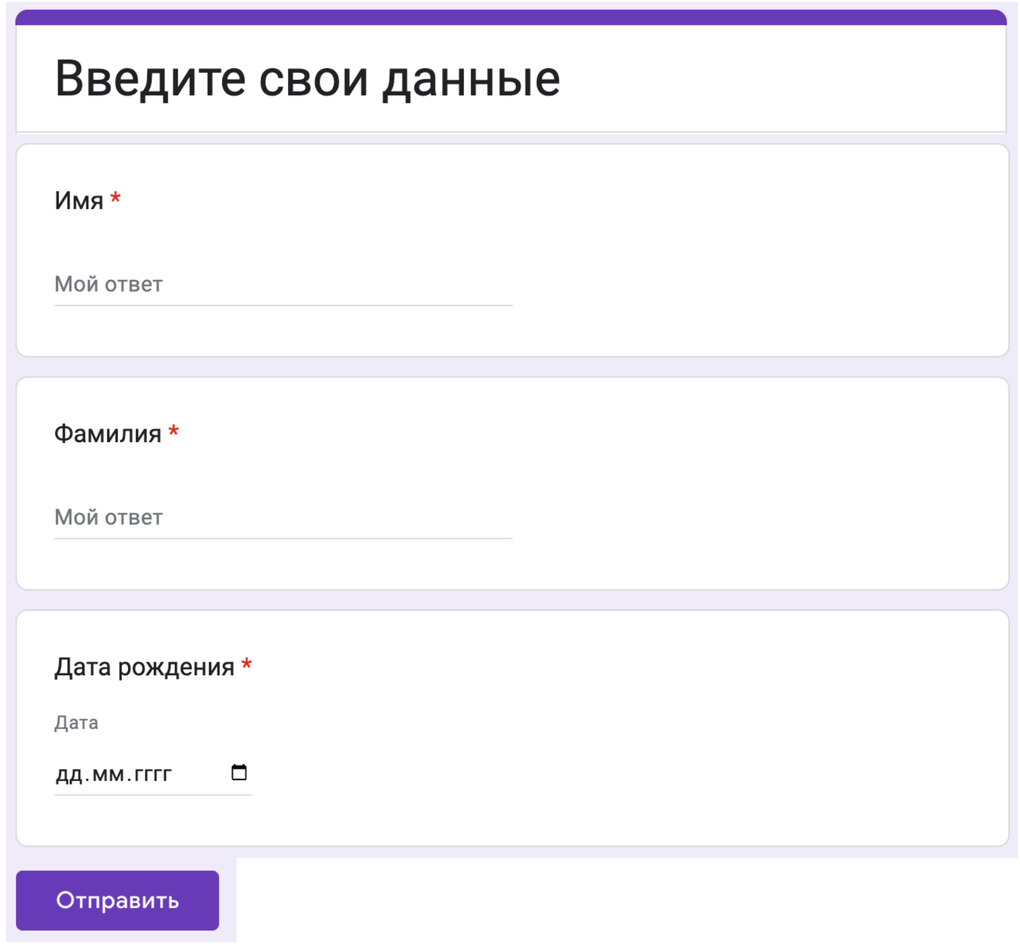
Движок для заполнения форм (например, для процесса подачи заявки)

- фронт получает описание формы которую нужно заполнить пользователю
- В описании формы есть вся необходимая информация для заполнения и валидации
- фронт не знает что именно заполняет пользователь, вся логика реализуется на бэке

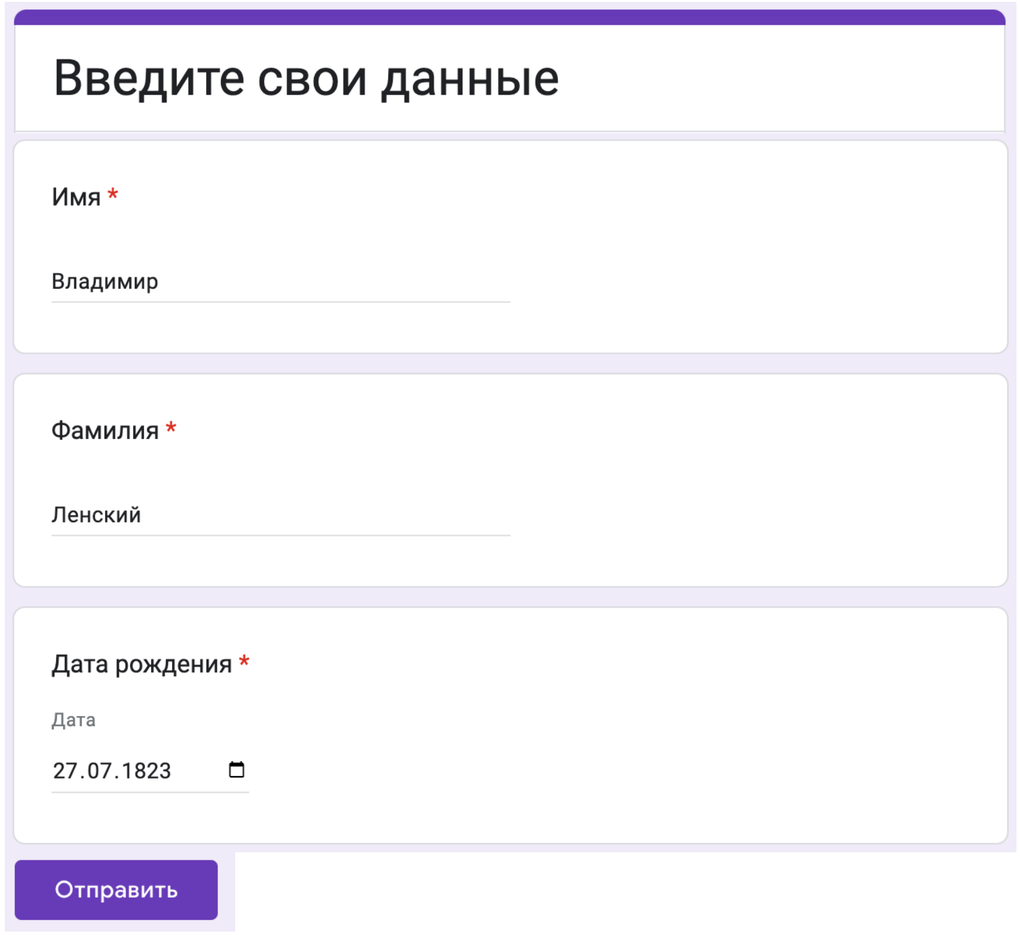


Протокол

```
{
  "title" : "Введите свои данные",
  "fields" : [
    { "title" : "Имя",
      "hint" : "Мой ответ",
      "type" : "string" },
    { "title" : "Фамилия",
      "hint" : "Мой ответ",
      "type" : "string" },
    { "title" : "Дата рождения",
      "hint" : "Дата",
      "type" : "date" }
  ],
  "actions" : [
    { "id" : "send",
      "title" : "Отправить",
      "type" : "Send" }
  ]
}
```



Протокол




```
{
  "fields" : [
    { "string" : { "value" : "Владимир" } },
    { "string" : { "value" : "Ленский" } },
    { "date" : { "value" : "1823-07-27" } }
  ],
  "actionId" : "send"
}
```

Модели

```
case class Form(title: String, fields: List[Field], actions: List[Action])

case class Field(title: String, hint: String, `type`: FieldType)

case class Action(id: String, title: String, `type`: ActionType)

enum FieldType:
  case string, date

enum ActionType:
  case send
```

Модели

```
case class Form(title: String, fields: List[Field], actions: List[Action])

case class Field(title: String, hint: String, `type`: FieldType)

case class Action(id: String, title: String, `type`: ActionType)

enum FieldType:
  case string, date

enum ActionType:
  case send

case class FormValue(fields: List[FieldValue], actionId: String)

enum FieldValue:
  case string(value: String)
  case date(value: LocalDate)
```

Кодеки

```
import io.circe.{Encoder, Decoder}
case class Form(title: String, fields: List[Field], actions: List[Action])

case class Field(title: String, hint: String, `type`: FieldType)

case class Action(id: String, title: String, `type`: ActionType)

enum FieldType:
  case string, date

enum ActionType:
  case send

case class FormValue(fields: List[FieldValue], actionId: String)

enum FieldValue:
  case string(value: String)
  case date(value: LocalDate)
```

Кодеки

```
import io.circe.{Encoder, Decoder}
case class Form(title: String, fields: List[Field], actions: List[Action]) derives Encoder.AsObject

case class Field(title: String, hint: String, `type`: FieldType) derives Encoder.AsObject

case class Action(id: String, title: String, `type`: ActionType) derives Encoder.AsObject

enum FieldType derives Encoder.AsObject:
  case string, date

enum ActionType derives Encoder.AsObject:
  case send

case class FormValue(fields: List[FieldValue], actionId: String) derives Decoder

enum FieldValue derives Decoder:
  case string(value: String)
  case date(value: LocalDate)
```

Кодеки

```scala
import io.circe.{Encoder, Decoder}
case class Form(title: String, fields: List[Field], actions: List[Action]) derives Encoder.AsObject

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enum FieldType derives Encoder.AsObject:
  case string, date

enum ActionType derives Encoder.AsObject:
  case send

case class FormValue(fields: List[FieldValue], actionId: String) derives Decoder

enum FieldValue derives Decoder:
  case string(value: String)
  case date(value: LocalDate)
```

```scala
object Action:
  given Encoder.AsObject[Action] = Encoder.AsObject.derived
```

Кодеки

```
import io.circe.{Encoder, Decoder}
case class Form(title: String, fields: List[Field], actions: List[Action]) derives Encoder.AsObject

case class Field(title: String, hint: String, `type`: FieldType) derives Encoder.AsObject

case class Action(id: String, title: String, `type`: ActionType) derives Encoder.AsObject

enum FieldType derives Encoder.AsObject:
  case string, date

enum ActionType derives Encoder.AsObject:
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case class FormValue(fields: List[FieldValue], actionId: String) derives Decoder

enum FieldValue derives Decoder:
  case string(value: String)
  case date(value: LocalDate)
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Кодеки

```scala
import io.circe.{Encoder, Decoder}
case class Form(title: String, fields: List[Field], actions: List[Action]) derives Encoder.AsObject

case class Field(title: String, hint: String, `type`: FieldType) derives Encoder.AsObject

case class Action(id: String, title: String, `type`: ActionType) derives Encoder.AsObject

enum FieldType derives Encoder.AsObject:
  case string, date

enum ActionType derives Encoder.AsObject:
  case send

case class FormValue(fields: List[FieldValue], actionId: String) derives Decoder

enum FieldValue derives Decoder:
  case string(value: String)
  case date(value: LocalDate)
```

```
"type" : {
  "string" : {}
}
```

```
"type" : {
  "send" : {}
}
```

Кодеки

```scala
import io.circe.{Encoder, Decoder}
case class Form(title: String, fields: List[Field], actions: List[Action]) derives Encoder.AsObject

case class Field(title: String, hint: String, `type`: FieldType) derives Encoder.AsObject

case class Action(id: String, title: String, `type`: ActionType) derives Encoder.AsObject

enum FieldType:
  case string, date

object FieldType:
  given Encoder[FieldType] = Encoder[String].contramap(_.toString)

enum ActionType:
  case send

object ActionType:
  given Encoder[ActionType] = Encoder[String].contramap(_.toString)

case class FormValue(fields: List[FieldValue], actionId: String) derives Decoder

enum FieldValue derives Decoder:
  case string(value: String)
  case date(value: LocalDate)
```

Локализация

```
enum Lang:
  case RU, EN
```

Локализация

```
enum Lang:
  case RU, EN

val keys: Map[String, (String, String)] = Map(
  "name_form_title" -> ("Введите свои данные", "Enter personal info"),
  "first_name_field_title" -> ("Имя", "First name"),
  "last_name_field_title" -> ("Фамилия", "Last name"),
  "name_hint" -> ("Мой ответ", "My answer"),
  "birth_date_field_title" -> ("Дата рождения", "Date of birth"),
  "birth_date_hint" -> ("Дата", "Date"),
  "confirm_action_title" -> ("Подтвердить", "Confirm"),
)
```

Локализация

```
enum Lang:
  case RU, EN

val keys: Map[String, (String, String)] = Map(
  "name_form_title" -> ("Введите свои данные", "Enter personal info"),
  "first_name_field_title" -> ("Имя", "First name"),
  "last_name_field_title" -> ("Фамилия", "Last name"),
  "name_hint" -> ("Мой ответ", "My answer"),
  "birth_date_field_title" -> ("Дата рождения", "Date of birth"),
  "birth_date_hint" -> ("Дата", "Date"),
  "confirm_action_title" -> ("Подтвердить", "Confirm"),
)

def localize(lang: Lang): String => String = key =>
  keys.get(key).fold(key) {
    case (ru, en) =>
      lang match
        case Lang.RU => ru
        case Lang.EN => en
  }
```

Локализация

```
enum Lang:
  case RU, EN

val keys: Map[String, (String, String)] = Map(
  "name_form_title" -> ("Введите свои данные", "Enter personal info"),
  "first_name_field_title" -> ("Имя", "First name"),
  "last_name_field_title" -> ("Фамилия", "Last name"),
  "name_hint" -> ("Мой ответ", "My answer"),
  "birth_date_field_title" -> ("Дата рождения", "Date of birth"),
  "birth_date_hint" -> ("Дата", "Date"),
  "confirm_action_title" -> ("Подтвердить", "Confirm"),
)

def localize(lang: Lang): String => String = key =>
  keys.get(key).fold(key) { // не обрабатываем отсутствие перевода
    case (ru, en) =>
      lang match
        case Lang.RU => ru
        case Lang.EN => en
  }
```

Локализация

```
def localizeForm(lang: Lang): Form => Form = ???
```

Локализация

```
def localizeField(lang: Lang): Field => Field = ???

def localizeAction(lang: Lang): Action => Action = ???

def localizeForm(lang: Lang): Form => Form = ???
```

Локализация

```
def localizeField(lang: Lang): Field => Field =
  case Field(title, hint, typ) =>
    Field(localize(lang)(title), localize(lang)(hint), typ)

def localizeAction(lang: Lang): Action => Action =
  case Action(id, title, typ) =>
    Action(id, localize(lang)(title), typ)

def localizeForm(lang: Lang): Form => Form = ???
```

Локализация

```
def localizeField(lang: Lang): Field => Field =
  case Field(title, hint, typ) =>
    Field(localize(lang)(title), localize(lang)(hint), typ)

def localizeAction(lang: Lang): Action => Action =
  case Action(id, title, typ) =>
    Action(id, localize(lang)(title), typ)

def localizeForm(lang: Lang): Form => Form =
  case Form(title, fields, actions) =>
    Form(
      localize(lang)(title),
      fields.map(localizeField(lang),
      actions.map(localizeAction(lang)))
    )
```

Локализация

```
def localizeField(lang: Lang): Field => Field =
  case Field(title, hint, typ) =>
    Field(localize(lang)(title), localize(lang)(hint), typ)

def localizeAction(lang: Lang): Action => Action =
  case Action(id, title, typ) =>
    Action(id, title, typ)

def localizeForm(lang: Lang): Form => Form =
  case Form(title, fields, actions) =>
    Form(
      localize(lang)(title),
      fields.map(localizeField(lang),
      actions.map(localizeAction(lang)))
    )
```

Локализация

```
def localizeField(lang: Lang): Field => Field =
  case Field(title, hint, typ) =>
    Field(localize(lang)(title), localize(lang)(hint), typ)

def localizeAction(lang: Lang): Action => Action =
  case Action(id, title, typ) =>
    Action(id, localize(lang)(title), typ)

def localizeForm(lang: Lang): Form => Form =
  case Form(title, fields, actions) =>
    Form(
      localize(lang)(title),
      fields.map(localizeField(lang),
      actions.map(localizeAction(lang)))
    )
```

Локализация

```
case class Form(title: Text, fields: List[Field], actions: List[Action])

case class Field(title: Text, hint: Text, typ: FieldType)

case class Action(actionId: String, title: Text, typ: ActionType)


case class FormL(title: LKey, fields: List[FieldL], actions: List[ActionL])

case class FieldL(title: LKey, hint: LKey, typ: FieldType)

case class ActionL(actionId: String, title: LKey, typ: ActionType)
```

Локализация

```
case class Form(title: Text, fields: List[Field], actions: List[Action])

case class Field(title: Text, hint: Text, typ: FieldType)

case class Action(actionId: String, title: Text, typ: ActionType)


case class FormL(title: LKey, fields: List[FieldL], actions: List[ActionL])

case class FieldL(title: LKey, hint: LKey, typ: FieldType)

case class ActionL(actionId: String, title: LKey, typ: ActionType)
```

Локализация

```
case class Form(title: Text, fields: List[Field], actions: List[Action])

case class Field(title: Text, hint: Text, typ: FieldType)

case class Action(actionId: String, title: Text, typ: ActionType)


case class FormL(title: LKey, fields: List[FieldL], actions: List[ActionL])

case class FieldL(title: LKey, hint: LKey, typ: FieldType)

case class ActionL(actionId: String, title: LKey, typ: ActionType)


def localize(lang: Lang): LKey => Text = ???
def localizeField(lang: Lang): FieldL => Field = ???
def localizeAction(lang: Lang): ActionL => Action = ???
def localizeForm(lang: Lang): FormL => Form = ???
```

New types

```
type Text = String

type LKey = String
```

New types

```
type Text = String

type LKey = String

def localizeAction(lang: Lang): ActionL => Action =
  case ActionL(actionId, title, typ) =>
    Action(actionId, title, typ)
```

New types

```
type Text <: String

type LKey <: String
```

New types

```
type Text = Text.T
object Text:
  type T <: String

type LKey = LKey.K
object LKey:
  type K <: String
```

New types

```
type Text = Text.T
object Text:
  type T <: String
  def apply(str: String): T = str.asInstanceOf[T]

type LKey = LKey.K
object LKey:
  type K <: String
  def apply(str: String): K = str.asInstanceOf[K]
```

New types

```
type Text = Text.T
object Text:
  opaque type T <: String = String
  def apply(key: String): T = key

type LKey = LKey.K
object LKey:
  opaque type K <: String = String
  def apply(key: String): K = key
```

New types

```
type Text = Text.T
object Text:
  opaque type T <: String = String
  def apply(key: String): T = key

type LKey = LKey.K
object LKey:
  opaque type K <: String = String
  def apply(key: String): K = key
```

Снаружи

Внутри

New types

```
type Text = Text.T
object Text extends TextInstances:
  opaque type T <: String = String
  def apply(key: String): T = key

trait TextInstances:
  given Encoder[Text] = Encoder[String].contramap(x => x)

type LKey = LKey.K
object LKey extends LKeyInstances:
  opaque type K <: String = String
  def apply(key: String): K = key

trait LKeyInstances:
  given Encoder[LKey] = Encoder[String].contramap(x => x)
```

Локализация

```
def localize(lang: Lang): LKey => Text = ...

def localizeAction(lang: Lang): ActionL => Action =
  case ActionL(actionId, title, typ) =>
    Action(actionId, localize(lang)(title), typ)

def localizeField(lang: Lang): FieldL => Field =
  case FieldL(title, hint, typ) =>
    Field(localize(lang)(title), localize(lang)(hint), typ)

def localizeForm(lang: Lang): FormL => Form =
  case FormL(title, fields, actions) =>
    Form(
      localize(lang)(title),
      fields.map(localizeField(lang)),
      actions.map(localizeAction(lang))
    )
```

Локализация

```
def localize(lang: Lang): LKey => Text = ...

def localizeAction(lang: Lang): ActionL => Action =
  case ActionL(actionId, title, typ) =>
    Action(actionId, localize(lang)(title), typ)

def localizeField(lang: Lang): FieldL => Field =
  case FieldL(title, hint, typ) =>
    Field(localize(lang)(title), localize(lang)(title), typ)

def localizeForm(lang: Lang): FormL => Form =
  case FormL(title, fields, actions) =>
    Form(
      localize(lang)(title),
      fields.map(localizeField(lang)),
      actions.map(localizeAction(lang))
    )
```

Что получилось

```
case class FieldL(
  title: LKey,
  hint: LKey,
  typ: FieldType
)

case class ActionL(
  actionId: String,
  title: LKey,
  typ: ActionType
)

case class FormL(
  title: LKey,
  fields: List[FieldL],
  actions: List[ActionL]
)
```

```
case class Field(
  title: Text,
  hint: Text,
  typ: FieldType
)

case class Action(
  actionId: String,
  title: Text,
  typ: ActionType
)

case class Form(
  title: Text,
  fields: List[Field],
  actions: List[Action]
)
```

Что получилось

```
case class FieldL(
  title: LKey,
  hint: LKey,
  typ: FieldType
)

case class ActionL(
  actionId: String,
  title: LKey,
  typ: ActionType
)

case class FormL(
  title: LKey,
  fields: List[FieldL],
  actions: List[ActionL]
)
```

```
case class Field[A](
  title: A,
  hint: A,
  typ: FieldType
)

case class Action[A](
  id: String,
  title: A,
  typ: ActionType
)

case class Form[A](
  title: A,
  fields: List[Field[A]],
  actions: List[Action[A]]
)
```

```
case class Field(
  title: Text,
  hint: Text,
  typ: FieldType
)

case class Action(
  actionId: String,
  title: Text,
  typ: ActionType
)

case class Form(
  title: Text,
  fields: List[Field],
  actions: List[Action]
)
```

Что получилось

```scala
case class FieldL(
  title: LKey,
  hint: LKey,
  typ: FieldType
)
```

Field[LKey]

```scala
case class ActionL(
  actionId: String,
  title: LKey,
  typ: ActionType
)
```

Action[LKey]

```scala
case class FormL(
  title: LKey,
  fields: List[FieldL],
  actions: List[ActionL]
)
```

Form[LKey]

```scala
case class Field[A](
  title: A,
  hint: A,
  typ: FieldType
)

case class Action[A](
  id: String,
  title: A,
  typ: ActionType
)

case class Form[A](
  title: A,
  fields: List[Field[A]],
  actions: List[Action[A]]
)
```

Field[Text]

```scala
case class Field(
  title: Text,
  hint: Text,
  typ: FieldType
)
```

Action[Text]

```scala
case class Action(
  actionId: String,
  title: Text,
  typ: ActionType
)
```

Form[Text]

```scala
case class Form(
  title: Text,
  fields: List[Field],
  actions: List[Action]
)
```

Field[A]

```
def localize(lang: Lang): LKey => Text = ...


def localizeForm(lang: Lang): Form[LKey] => Form[Text] =
  ???
```

```
case class Field[A](
  title: A,
  hint: A,
  typ: FieldType
)

case class Action[A](
  id: String,
  title: A,
  typ: ActionType
)

case class Form[A](
  title: A,
  fields: List[Field[A]],
  actions: List[Action[A]]
)
```

Field[A]

```
def localize(lang: Lang): LKey => Text = ...


def localizeForm(lang: Lang): Form[LKey] => Form[Text] =
  _.map(localize(lang))
```

```
case class Field[A](
  title: A,
  hint: A,
  typ: FieldType
)

case class Action[A](
  id: String,
  title: A,
  typ: ActionType
)

case class Form[A](
  title: A,
  fields: List[Field[A]],
  actions: List[Action[A]]
)
```

Field[A]

```
def localize(lang: Lang): LKey => Text = ...


def localizeForm(lang: Lang): Form[LKey] => Form[Text] =
  Functor[Form].map(_)(localize(lang))
```

```
trait Functor[F[_]]:
  def map[A, B](fa: F[A])(f: A => B): F[B]
```

```
case class Field[A](
  title: A,
  hint: A,
  typ: FieldType
)

case class Action[A](
  id: String,
  title: A,
  typ: ActionType
)

case class Form[A](
  title: A,
  fields: List[Field[A]],
  actions: List[Action[A]]
)
```

Field[A]

```scala
def localize(lang: Lang): LKey => Text = ...
```

```scala
def localizeForm(lang: Lang): Form[LKey] => Form[Text] =
  Functor[Form].map(_)(localize(lang))
```

```scala
trait Functor[F[_]]:
  def map[A, B](fa: F[A])(f: A => B): F[B]
```

```scala
import cats.Functor
import cats.derived.* // kittens
```

```scala
case class Field[A](
  title: A,
  hint: A,
  typ: FieldType
) derives Functor

case class Action[A](
  id: String,
  title: A,
  typ: ActionType
) derives Functor

case class Form[A](
  title: A,
  fields: List[Field[A]],
  actions: List[Action[A]]
) derives Functor
```

Field[A]

```scala
def localize(lang: Lang): LKey => Text = ...
```

```scala
def localizeForm(lang: Lang): Form[LKey] => Form[Text] =
  Functor[Form].map(_)(localize(lang))
```

```scala
trait Functor[F[_]]:
  def map[A, B](fa: F[A])(f: A => B): F[B]
```

```scala
private[cats] trait ComposedFunctor[F[_], G[_]] extends
Functor[λ[α => F[G[α]]]] with ComposedInvariant[F, G] { outer =>
  def F: Functor[F]
  def G: Functor[G]

  override def map[A, B](fga: F[G[A]])(f: A => B): F[G[B]] =
    F.map(fga)(ga => G.map(ga)(f))
}
```

```scala
import cats.Functor
import cats.derived.* // kittens
```

```scala
case class Field[A](
  title: A,
  hint: A,
  typ: FieldType
) derives Functor

case class Action[A](
  id: String,
  title: A,
  typ: ActionType
) derives Functor

case class Form[A](
  title: A,
  fields: List[Field[A]],
  actions: List[Action[A]]
) derives Functor
```

А что там с кодеками?

```
import cats.derived.*

case class Field[A](
  title: A,
  hint: A,
  typ: FieldType
) derives Functor

case class Action[A](
  id: String,
  title: A,
  typ: ActionType
) derives Functor

case class Form[A](
  title: A,
  fields: List[Field[A]],
  actions: List[Action[A]]
) derives Functor
```

А что там с кодеками?

```
import cats.derived.*

case class Field[A](
  title: A,
  hint: A,
  typ: FieldType
) derives Functor, Encoder.AsObject

case class Action[A](
  id: String,
  title: A,
  typ: ActionType
) derives Functor, Encoder.AsObject

case class Form[A](
  title: A,
  fields: List[Field[A]],
  actions: List[Action[A]]
) derives Functor, Encoder.AsObject
```

А что там с кодеками?

```
import cats.derived.*

case class Field[A](
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case class Action[A](
  id: String,
  title: A,
  typ: ActionType
) derives Functor, Encoder.AsObject

case class Form[A](
  title: A,
  fields: List[Field[A]],
  actions: List[Action[A]]
) derives Functor, Encoder.AsObject
```

```
Encoder.AsObject[Form[LKey]]

[error] 77 |  Encoder.AsObject[Form[LKey]]
[error]    |                           ^
[error]    |No given instance of type
io.circe.Encoder.AsObject[routine.Form[routi
ne.LKey]] was found for parameter instance
of method apply in object AsObject.
...
[error]    |But no implicit values were
found that match type
io.circe.export.Exported[io.circe.Encoder.As
Object[routine.LKey.T]].
```

А что там с кодеками?

```
import cats.derived.*

case class Field[A](
  title: A,
  hint: A,
  typ: FieldType
) derives Functor, Encoder.AsObject

case class Action[A](
  id: String,
  title: A,
  typ: ActionType
) derives Functor, Encoder.AsObject

case class Form[A](
  title: A,
  fields: List[Field[A]],
  actions: List[Action[A]]
) derives Functor, Encoder.AsObject
```

```
Encoder.AsObject[Form[LKey]]

[error] 77 |  Encoder.AsObject[Form[LKey]]
[error]    |                           ^
[error]    |No given instance of type
io.circe.Encoder.AsObject[routine.Form[routi
ne.LKey]] was found for parameter instance
of method apply in object AsObject.
...
[error]    |But no implicit values were
found that match type
io.circe.export.Exported[io.circe.Encoder.As
Object[routine.LKey.T]].
```

А что там с кодеками?

```scala
import cats.derived.*

case class Field[A](
  title: A,
  hint: A,
  typ: FieldType
) derives Functor, Encoder.AsObject

case class Action[A](
  id: String,
  title: A,
  typ: ActionType
) derives Functor, Encoder.AsObject

case class Form[A](
  title: A,
  fields: List[Field[A]],
  actions: List[Action[A]]
) derives Functor, Encoder.AsObject
```

```scala
object Field:
  given [A: Encoder.AsObject]: Encoder.AsObject[Field[A]] =
    Encoder.AsObject.derived[Field[A]]
```

```scala
Encoder.AsObject[Form[LKey]]
```

```
[error] 77 |  Encoder.AsObject[Form[LKey]]
[error]    |                              ^
[error]    |No given instance of type
io.circe.Encoder.AsObject[routine.Form[routi
ne.LKey]] was found for parameter instance
of method apply in object AsObject.
...
[error]    |But no implicit values were
found that match type
io.circe.export.Exported[io.circe.Encoder.As
Object[routine.LKey.T]].
```

А что там с кодеками?

```scala
import cats.derived.*

case class Field[A](
  title: A,
  hint: A,
  typ: FieldType
) derives Functor, Encoder.AsObject

case class Action[A](
  id: String,
  title: A,
  typ: ActionType
) derives Functor, Encoder.AsObject

case class Form[A](
  title: A,
  fields: List[Field[A]],
  actions: List[Action[A]]
) derives Functor, Encoder.AsObject
```

```scala
object Field:
  given [A: Encoder]: Encoder.AsObject[Field[A]] =
    Encoder.AsObject.derived[Field[A]]
```

А что там с кодеками?

```scala
import cats.derived.*

case class Field[A](
  title: A,
  hint: A,
  typ: FieldType
) derives Functor, Encoder.AsObject

case class Action[A](
  id: String,
  title: A,
  typ: ActionType
) derives Functor, Encoder.AsObject

case class Form[A](
  title: A,
  fields: List[Field[A]],
  actions: List[Action[A]]
) derives Functor, Encoder.AsObject
```

```scala
object Field:
  given [A: Encoder]: Encoder.AsObject[Field[A]] =
    Encoder.AsObject.derived[Field[A]]
```

А что там с кодеками?

```scala
import cats.derived.*

case class Field[A](
  title: A,
  hint: A,
  typ: FieldType
) derives Functor, Encoder.AsObject

case class Action[A](
  id: String,
  title: A,
  typ: ActionType
) derives Functor, Encoder.AsObject

case class Form[A](
  title: A,
  fields: List[Field[A]],
  actions: List[Action[A]]
) derives Functor, Encoder.AsObject
```

```scala
object Field:
  given [A: Encoder]: Encoder[Field[A]] =
    Encoder.AsObject.derived[Field[A]]
```

А что там с кодеками?

```
import cats.derived.*
import EncoderDerived.*
case class Field[A](
  title: A,
  hint: A,
  typ: FieldType
) derives Functor, Encoder

case class Action[A](
  id: String,
  title: A,
  typ: ActionType
) derives Functor, Encoder

case class Form[A](
  title: A,
  fields: List[Field[A]],
  actions: List[Action[A]]
) derives Functor, Encoder
```

```
object EncoderDerived:
  extension (e: Encoder.type)
    inline def derived[A](using inline A: Mirror.Of[A]):
Encoder[A] =
      Encoder.AsObject.derived[A]
```

А что там с кодеками?

```
import cats.derived.*
import EncoderDerived.*
case class Field[A](
  title: A,
  hint: A,
  typ: FieldType
) derives Functor, Encoder

case class Action[A](
  id: String,
  title: A,
  typ: ActionType
) derives Functor, Encoder

case class Form[A](
  title: A,
  fields: List[Field[A]],
  actions: List[Action[A]]
) derives Functor, Encoder
```

```
object EncoderDerived:
  extension (e: Encoder.type)
    inline def derived[A](using inline A: Mirror.Of[A]):
Encoder[A] =
      Encoder.AsObject.derived[A]
```

```
[error] -- [E008] Not Found Error
[error]    |) derives Functor, Encoder.AsObject
[error]    |           ^
[error]    |    value derived is not a member of object cats.Functor.
```

А что там с кодеками?

```scala
import cats.derived.*
import EncoderDerived.*
case class Field[A](
  title: A,
  hint: A,
  typ: FieldType
) derives Functor, Encoder

case class Action[A](
  id: String,
  title: A,
  typ: ActionType
) derives Functor, Encoder

case class Form[A](
  title: A,
  fields: List[Field[A]],
  actions: List[Action[A]]
) derives Functor, Encoder
```

```scala
object EncoderDerived:
  extension (e: Encoder.type)
    inline def derived[A](using inline A: Mirror.Of[A]):
Encoder[A] =
      Encoder.AsObject.derived[A]
```

```
[error] -- [E008] Not Found Error
[error]    |) derives Functor, Encoder.AsObject
[error]    |           ^
[error]    |    value derived is not a member of object cats.Functor.
```

```scala
extension (x: cats.Functor.type)
  inline def derived[F[_]]: cats.Functor[F] = ...
```

А что там с кодеками?

```
import cats.derived.*
import EncoderDerived.*
case class Field[A](
  title: A,
  hint: A,
  typ: FieldType
) derives Functor, Encoder

case class Action[A](
  id: String,
  title: A,
  typ: ActionType
) derives Functor, Encoder

case class Form[A](
  title: A,
  fields: List[Field[A]],
  actions: List[Action[A]]
) derives Functor, Encoder
```

```
object EncoderDerived:
  implicit class EncoderSyntax(e: Encoder.type):
    inline def derived[A](using inline A: Mirror.Of[A]):
Encoder[A] =
      Encoder.AsObject.derived[A]
```

Локализация с эффектом

```
trait Localizer[F[_]]:
  def localize(lang: Lang, key: LKey): F[Text]
```

Локализация с эффектом

```
trait Localizer[F[_]]:
  def localize(lang: Lang, key: LKey): F[Text]

def localizeField[F[_]](lang: Lang)(using loc: Localizer[F]): Field[LKey] => F[Field[Text]] =
  temp =>
    Functor[Field].map(temp)(loc.localize(lang, _)): Field[F[Text]]
```

Локализация с эффектом

```
trait Localizer[F[_]]:
  def localize(lang: Lang, key: LKey): F[Text]

def localizeField[F[_]](lang: Lang)(using loc: Localizer[F]): Field[LKey] => F[Field[Text]] =
  temp =>
    val Field(title: F[Text], hint: F[Text], typ: FieldType) =
      Functor[Field].map(temp)(loc.localize(lang, _))
```

Локализация с эффектом

```
trait Localizer[F[_]]:
  def localize(lang: Lang, key: LKey): F[Text]

def localizeField[F[_]](lang: Lang)(using loc: Localizer[F]): Field[LKey] => F[Field[Text]] =
  temp =>
    val Field(title: F[Text], hint: F[Text], typ: FieldType) =
      Functor[Field].map(temp)(loc.localize(lang, _))
```

```
(F[Text], F[Text], FieldType) => F[Field[Text]]
```

Локализация с эффектом

```
trait Localizer[F[_]]:
  def localize(lang: Lang, key: LKey): F[Text]

def localizeField[F[_]](lang: Lang)(using loc: Localizer[F]): Field[LKey] => F[Field[Text]] =
  temp =>
    val Field(title: F[Text], hint: F[Text], typ: FieldType) =
      Functor[Field].map(temp)(loc.localize(lang, _))
```

```
(F[Text], F[Text], FieldType) => F[Field[Text]]

(F[Text], F[Text]) => F[(Text, Text)]
(F[(Text, Text)], FieldType) => F[Field[Text]]
```

Локализация с эффектом

```
trait Localizer[F[_]]:
  def localize(lang: Lang, key: LKey): F[Text]

def localizeField[F[_]](lang: Lang)(using loc: Localizer[F]): Field[LKey] => F[Field[Text]] =
  temp =>
    val Field(title: F[Text], hint: F[Text], typ: FieldType) =
      Functor[Field].map(temp)(loc.localize(lang, _))
```

```
(F[Text], F[Text], FieldType) => F[Field[Text]]

(F[Text], F[Text]) => F[(Text, Text)]
(F[(Text, Text)], FieldType) => F[Field[Text]] // Functor
```

Локализация с эффектом

```
trait Localizer[F[_]]:
  def localize(lang: Lang, key: LKey): F[Text]

def localizeField[F[_]: Applicative](lang: Lang)(using loc: Localizer[F]): Field[LKey] =>
  F[Field[Text]] =
  temp =>
    val Field(title: F[Text], hint: F[Text], typ: FieldType) =
      Functor[Field].map(temp)(loc.localize(lang, _))
```

```
(F[Text], F[Text], FieldType) => F[Field[Text]]

(F[Text], F[Text]) => F[(Text, Text)] // Applicative
(F[(Text, Text)], FieldType) => F[Field[Text]] // Functor
```

```
trait Applicative[F[_]] extends Functor[F]:
  def ap[A, B](ff: F[A => B])(fa: F[A]): F[B]
  def pure[A](x: A): F[A]

  def product[A, B](fa: F[A], fb: F[B]): F[(A, B)] =
    ap(map(fa)(a => (b: B) => (a, b)))(fb)
```

Локализация с эффектом

```
trait Localizer[F[_]]:
  def localize(lang: Lang, key: LKey): F[Text]

def localizeField[F[_]: Applicative](lang: Lang)(using loc: Localizer[F]): Field[LKey] =>
  F[Field[Text]] =
  temp =>
    val Field(title: F[Text], hint: F[Text], typ: FieldType) =
      Functor[Field].map(temp)(loc.localize(lang, _))
    Applicative[F].product(title, hint).map((t, h) => Field(t, h, typ))
```

```
trait Applicative[F[_]] extends Functor[F]:
  def ap[A, B](ff: F[A => B])(fa: F[A]): F[B]
  def pure[A](x: A): F[A]

  def product[A, B](fa: F[A], fb: F[B]): F[(A, B)] =
    ap(map(fa)(a => (b: B) => (a, b)))(fb)
```

Локализация с эффектом

```
trait Localizer[F[_]]:
  def localize(lang: Lang, key: LKey): F[Text]

def localizeField[F[_]: Applicative](lang: Lang)(using loc: Localizer[F]): Field[LKey] =>
  F[Field[Text]] =
  temp =>
    val fieldF: Field[F[Text]] = Functor[Form].map(temp)(loc.localize(lang, _))
```

Локализация с эффектом

```
trait Localizer[F[_]]:
  def localize(lang: Lang, key: LKey): F[Text]

def localizeField[F[_]: Applicative](lang: Lang)(using loc: Localizer[F]): Field[LKey] =>
  F[Field[Text]] =
  temp =>
    val fieldF: Field[F[Text]] = Functor[Form].map(temp)(loc.localize(lang, _))
    Traverse[Field].sequence(fieldF)
```

```
trait Traverse[F[_]] extends Functor[F]:
  def traverse[G[_]: Applicative, A, B](fa: F[A])(f: A => G[B]): G[F[B]]

  def sequence[G[_]: Applicative, A](fga: F[G[A]]): G[F[A]] = traverse(fga)(ga => ga)
```

Локализация с эффектом

```
trait Localizer[F[_]]:
  def localize(lang: Lang, key: LKey): F[Text]

def localizeField[F[_]: Applicative](lang: Lang)(using loc: Localizer[F]): Field[LKey] =>
  F[Field[Text]] =
  Traverse[Field].traverse(_)(loc.localize(lang, _))
```

```
trait Traverse[F[_]] extends Functor[F]:
  def traverse[G[_]: Applicative, A, B](fa: F[A])(f: A => G[B]): G[F[B]]

  def sequence[G[_]: Applicative, A](fga: F[G[A]]): G[F[A]] = traverse(fga)(ga => ga)
```

Локализация с эффектом

```
trait Localizer[F[_]]:
  def localize(lang: Lang, key: LKey): F[Text]

def localizeForm[F[_]: Applicative](lang: Lang)(using loc: Localizer[F]): Form[LKey] =>
  F[Form[Text]] =
  Traverse[Form].traverse(_)(loc.localize(lang, _))

import cats.derived.* // kittens

case class Field[A](title: A, hint: A, typ: FieldType)
  derives Traverse, Encoder

case class Action[A](id: String, title: A, typ: ActionType)
  derives Traverse, Encoder

case class Form[A](title: A, fields: List[Field[A]], actions: List[Action[A]])
  derives Traverse, Encoder
```

Шаблоны

```
case class FieldL(
  title: LKey,
  hint: LKey,
  typ: FieldType
)

case class ActionL(
  actionId: String,
  title: LKey,
  typ: ActionType
)

case class FormL(
  title: LKey,
  fields: List[FieldL],
  actions: List[ActionL]
)
```

```
case class Field(
  title: Text,
  hint: Text,
  typ: FieldType
)

case class Action(
  actionId: String,
  title: Text,
  typ: ActionType
)

case class Form(
  title: Text,
  fields: List[Field],
  actions: List[Action]
)
```

Шаблоны

```
case class FieldL(
  title: LKey,
  hint: LKey,
  default: Option[UserProp],
  `type`: FieldType
)
```

```
enum UserProp:
  case birthDate, firstName, lastName
```

```
enum FieldValue derives Decoder:
  case string(value: String)
  case date(value: LocalDate)
```

```
case class Field(
  title: Text,
  hint: Text,
  default: Option[FieldValue],
  `type`: FieldType
)
```

```
case class ActionL(
  id: String,
  title: LKey,
  `type`: ActionType
)
```

```
case class Action(
  id: String,
  title: Text,
  `type`: ActionType
)
```

```
case class FormL(
  title: LKey,
  fields: List[Field],
  actions: List[Action]
)
```

```
case class Form(
  title: Text,
  fields: List[Field],
  actions: List[Action]
)
```

Шаблоны

```
case class FieldL(
  title: LKey,
  hint: LKey,
  default: Option[UserProp],
  `type`: FieldType
)
```

```
enum UserProp:
  case birthDate, firstName, lastName
```

```
enum FieldValue derives Decoder:
  case string(value: String)
  case date(value: LocalDate)
```

```
case class Field(
  title: Text,
  hint: Text,
  default: Option[FieldValue],
  `type`: FieldType
)
```

```
case class ActionL(
  id: String,
  title: LKey,
  `type`: ActionType
)
```

```
case class UserInfo(
  firstName: Option[String],
  lastName: Option[String],
  birthDate: Option[LocalDate]
)

def propToValue(userInfo: UserInfo):
  Option[UserProp] => Option[FieldValue]
= ...
```

```
case class Action(
  id: String,
  title: Text,
  `type`: ActionType
)
```

```
case class FormL(
  title: LKey,
  fields: List[Field],
  actions: List[Action]
)
```

```
case class Form(
  title: Text,
  fields: List[Field],
  actions: List[Action]
)
```

Можно ли обобщить?

```
case class FieldL(
  title: LKey,
  hint: LKey,
  default: Option[UserProp],
  `type`: FieldType
)
```

```
case class Field(
  title: Text,
  hint: Text,
  default: Option[FieldValue],
  `type`: FieldType
)
```

```
case class ActionL(
  id: String,
  title: LKey,
  `type`: ActionType
)
```

```
case class Action(
  id: String,
  title: Text,
  `type`: ActionType
)
```

```
case class FormL(
  title: LKey,
  fields: List[Field],
  actions: List[Action]
)
```

```
case class Form(
  title: Text,
  fields: List[Field],
  actions: List[Action]
)
```

Можно ли обобщить?

```scala
case class FieldL(
  title: LKey,
  hint: LKey,
  default: Option[UserProp]
  `type`: FieldType
)
```

Field[LKey, Option[UserProp]]

```scala
case class ActionL(
  id: String,
  title: LKey,
  `type`: ActionType
)
```

Action[LKey, Option[UserProp]]

```scala
case class FormL(
  title: LKey,
  fields: List[Field],
  actions: List[Action]
)
```

Form[LKey, Option[UserProp]]

```scala
case class Field[A, B](
  title: A,
  hint: A,
  default: B,
  `type`: FieldType
)

case class Action[A, B](
  id: String,
  title: A,
  `type`: ActionType

case class Form[A, B](
  title: A,
  fields: List[Field[A, B]],
  actions: List[Action[A, B]]
)
```

```scala
case class Field(
  title: Text,
  hint: Text,
  default: Option[FieldValue],
  `type`: FieldType
)
```

Field[Text, Option[FieldValue]]

```scala
case class Action(
  id: String,
  title: Text,
  `type`: ActionType
)
```

Action[Text, Option[FieldValue]]

```scala
case class Form(
  title: Text,
  fields: List[Field],
  actions: List[Action]
)
```

Form[Text, Option[FieldValue]]

Можно ли обобщить?

```scala
case class FieldL(
  title: LKey,
  hint: LKey,
  default: Option[UserProp]
  `type`: FieldType
)

case class ActionL(
  id: String,
  title: LKey,
  `type`: ActionType
)

case class FormL(
  title: LKey,
  fields: List[Field],
  actions: List[Action]
)
```

```scala
case class Field[F[_]](
  title: F[Localize],
  hint: F[Localize],
  default: F[Context],
  `type`: FieldType
)

case class Action[F[_]](
  id: String,
  title: F[Localize],
  `type`: ActionType
)

case class Form[F[_]](
  title: F[Localize],
  fields: List[Field[F]],
  actions: List[Action[F]]
)
```

```scala
case class Field(
  title: Text,
  hint: Text,
  default: Option[FieldValue],
  `type`: FieldType
)

case class Action(
  id: String,
  title: Text,
  `type`: ActionType
)

case class Form(
  title: Text,
  fields: List[Field],
  actions: List[Action]
)
```

Можно ли обобщить?

```scala
case class FieldL(
  title: LKey,
  hint: LKey,
  default: Option[UserProp]
  `type`: FieldType
)

case class ActionL(
  id: String,
  title: LKey,
  `type`: ActionType
)

case class FormL(
  title: LKey,
  fields: List[Field],
  actions: List[Action]
)
```

```scala
type Localize
type Context

case class Field[F[_]](
  title: F[Localize],
  hint: F[Localize],
  default: F[Context],
  `type`: FieldType
)

case class Action[F[_]](
  id: String,
  title: F[Localize],
  `type`: ActionType
)

case class Form[F[_]](
  title: F[Localize],
  fields: List[Field[F]],
  actions: List[Action[F]]
)
```

```scala
case class Field(
  title: Text,
  hint: Text,
  default: Option[FieldValue],
  `type`: FieldType
)

case class Action(
  id: String,
  title: Text,
  `type`: ActionType
)

case class Form(
  title: Text,
  fields: List[Field],
  actions: List[Action]
)
```

Можно ли обобщить?

```
case class FieldL(
  title: LKey,
  hint: LKey,
  default: Option[UserProp]
  `type`: FieldType
)
```

Field[Template]

```
case class ActionL(
  id: String,
  title: LKey,
  `type`: ActionType
)
```

Action[Template]

```
case class FormL(
  title: LKey,
  fields: List[Field],
  actions: List[Action]
)
```

Form[Template]

```
type Localize
type Context
```

```
type Template[x] = ???
type Rendered[x] = ???
```

```
case class Field[F[_]](
  title: F[Localize],
  hint: F[Localize],
  default: F[Context],
  `type`: FieldType
)
```

Field[Rendered]

```
case class Action[F[_]](
  id: String,
  title: F[Localize],
  `type`: ActionType
)
```

Action[Rendered]

```
case class Form[F[_]](
  title: F[Localize],
  fields: List[Field[F]],
  actions: List[Action[F]]
)
```

Form[Rendered]

```
case class Field(
  title: Text,
  hint: Text,
  default: Option[FieldValue],
  `type`: FieldType
)
```

```
case class Action(
  id: String,
  title: Text,
  `type`: ActionType
)
```

```
case class Form(
  title: Text,
  fields: List[Field],
  actions: List[Action]
)
```

Можно ли обобщить?

```
case class FieldL(
  title: LKey,
  hint: LKey,
  default: Option[UserProp]
  `type`: FieldType
)
```

Field[Template]

```
case class ActionL(
  id: String,
  title: LKey,
  `type`: ActionType
)
```

Action[Template]

```
case class FormL(
  title: LKey,
  fields: List[Field],
  actions: List[Action]
)
```

Form[Template]

```
type Localize
type Context
```

```
type Template[x] = ???
type Rendered[x] = ???
```

```
case class Field[F[_]](
  title: F[Localize],
  hint: F[Localize],
  default: F[Context],
  `type`: FieldType
)
```

Field[Rendered]

```
case class Action[F[_]](
  id: String,
  title: F[Localize],
  `type`: ActionType
)
```

Action[Rendered]

```
case class Form[F[_]](
  title: F[Localize],
  fields: List[Field[F]],
  actions: List[Action[F]]
)
```

Form[Rendered]

```
case class Field(
  title: Text,
```

```
Template[Localize] = LKey
Template[Context] = Option[UserProp]

Rendered[Localize] = Text
Rendered[Context] = Option[FieldValue]
```

```
case class Action(
  id: String,
  title: Text,
  `type`: ActionType
)
```

```
case class Form(
  title: Text,
  fields: List[Field],
  actions: List[Action]
)
```

Form[F[_]]

```
type Localize
type Context

type Template[x] = ???
type Rendered[x] = ???
```

```
Template[Localize] = LKey
Template[Context] = Option[UserProp]

Rendered[Localize] = Text
Rendered[Context] = Option[FieldValue]
```

GADT

```
type Localize
type Context

enum Template[A]:
  case L(key: LKey) extends Template[Localize]
  case C(default: Option[UserProp]) extends Template[Context]

enum Rendered[A]:
  case L(text: Text) extends Rendered[Localize]
  case C(default: Option[FieldValue]) extends Rendered[Context]
```

```
Template[Localize] = LKey
Template[Context] = Option[UserProp]

Rendered[Localize] = Text
Rendered[Context] = Option[FieldValue]
```

GADT

```
type Localize
type Context

enum Template[A]:
  case L(key: LKey) extends Template[Localize]
  case C(default: Option[UserProp]) extends Template[Context]

enum Rendered[A]:
  case L(text: Text) extends Rendered[Localize]
  case C(default: Option[FieldValue]) extends Rendered[Context]

def localize(lang: Lang): LKey => Text = ...
def propToValue(user: UserInfo): Option[UserProp] => Option[FieldValue] = ...

def render[A](lang: Lang, user: UserInfo): Template[A] => Rendered[A] =
  case Template.L(key) => Rendered.L(localize(lang)(key))
  case Template.C(default) => Rendered.C(propToValue(user)(default))
```

```
Template[Localize] = LKey
Template[Context] = Option[UserProp]

Rendered[Localize] = Text
Rendered[Context] = Option[FieldValue]
```

Match types

```
type Localize
type Context

type Template[x] = x match
  case Localize => LKey
  case Context => Option[UserProp]

type Rendered[x] = x match
  case Localize => Text
  case Context => Option[FieldValue]
```

```
Template[Localize] = LKey
Template[Context] = Option[UserProp]

Rendered[Localize] = Text
Rendered[Context] = Option[FieldValue]
```

Match types

```
type Localize
type Context

type Template[x <: Localize | Context] = x match
  case Localize => LKey
  case Context => Option[UserProp]

type Rendered[x <: Localize | Context] = x match
  case Localize => Text
  case Context => Option[FieldValue]
```

```
Template[Localize] = LKey
Template[Context] = Option[UserProp]

Rendered[Localize] = Text
Rendered[Context] = Option[FieldValue]
```

Match types

```
type Localize
type Context

type Template[x] = x match
  case Localize => LKey
  case Context => Option[UserProp]

type Rendered[x] = x match
  case Localize => Text
  case Context => Option[FieldValue]

def render[A](lang: Lang, user: UserInfo): Template[A] => Rendered[A] =
  case key: LKey => localize(lang)(key).asInstanceOf[Rendered[A]]
  case prop: Option[UserProp] => propToValue(user)(prop).asInstanceOf[Rendered[A]]
```

```
Template[Localize] = LKey
Template[Context] = Option[UserProp]

Rendered[Localize] = Text
Rendered[Context] = Option[FieldValue]
```

Render Form[F[_]]

```
def render[A](lang: Lang, user: UserInfo): Template[A] => Rendered[A] =
  case Template.L(key) => Rendered.L(localize(lang)(key))
  case Template.C(default) => Rendered.C(propToValue(user)(default))

def renderForm(lang: Lang, user: UserInfo): Form[Template] => Form[Rendered] = ???
```

Render Form[F[_]]

```scala
def render[A](lang: Lang, user: UserInfo): Template[A] => Rendered[A] =
  case Template.L(key) => Rendered.L(localize(lang)(key))
  case Template.C(default) => Rendered.C(propToValue(user)(default))

def renderForm(lang: Lang, user: UserInfo): Form[Template] => Form[Rendered] =
  FunctorK[Form].mapK(_)([A] => (t: Template[A]) => render[A](lang, user)(t))
```

```scala
trait FunctorK[U[_[_]]]:
  def mapK[F[_], G[_]](af: U[F])(fk: [A] => F[A] => G[A]): U[G]
```

Render Form[F[_]]

```scala
def render[A](lang: Lang, user: UserInfo): Template[A] => Rendered[A] =
  case Template.L(key) => Rendered.L(localize(lang)(key))
  case Template.C(default) => Rendered.C(propToValue(user)(default))

def renderForm(lang: Lang, user: UserInfo): Form[Template] => Form[Rendered] =
  FunctorK[Form].mapK(_)([A] => (t: Template[A]) => render[A](lang, user)(t))
```

cats-tagless

```scala
trait FunctorK[U[_[_]]]:
  def mapK[F[_], G[_]](af: U[F])(fk: [A] => F[A] => G[A]): U[G]
```

Render с эффектом

```
def render[F[_]: Applicative: HasUserInfo: Localizer, A](
  lang: Lang
): Template[A] => F[Rendered[A]] =
  case Template.L(key) => summon[Localizer[F]].localize(lang, key).map(Rendered.L(_))
  case Template.C(prop) => propToValue[F].apply(prop).map(Rendered.C(_))

def renderForm[F[_]: Applicative: HasUserInfo: Localizer](
  lang: Lang
): Form[Template] => F[Form[Rendered]] = ???
```

Render с эффектом

```
def render[F[_]: Applicative: HasUserInfo: Localizer, A](
  lang: Lang
): Template[A] => F[Rendered[A]] =
  case Template.L(key) => summon[Localizer[F]].localize(lang, key).map(Rendered.L(_))
  case Template.C(prop) => propToValue[F].apply(prop).map(Rendered.C(_))

def renderForm[F[_]: Applicative: HasUserInfo: Localizer](
  lang: Lang
): Form[Template] => F[Form[Rendered]] = ???
```

Render с эффектом

```
def render[F[_]: Applicative: HasUserInfo: Localizer, A](
  lang: Lang
): Template[A] => F[Rendered[A]] =
  case Template.L(key) => summon[Localizer[F]].localize(lang, key).map(Rendered.L(_))
  case Template.C(prop) => propToValue[F].apply(prop).map(Rendered.C(_))

def renderForm[F[_]: Applicative: HasUserInfo: Localizer](
  lang: Lang
): Form[Template] => F[Form[Rendered]] =
  TraverseK[Form].traverseK(_)([A] => (t: Template[A]) => render[F, A](lang).apply(t))
```

```
trait TraverseK[U[_[_]]] extends FunctorK:
  def traverseK[A[_], B[_], F[_] : Applicative](ca: U[A])(f: [X] => A[X] => F[B[X]]): F[U[B]]
```

Итоги

Абстрактный код может быть безопаснее и короче

Повышается сложность кода

Иногда не хватает тулинга

Итоги

- Код со scala 3 стал чище
- Писать идиоматично везде пока не получается

Спасибо!