KotlinConf

Kotlin for the Pragmatic Functionalist

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@pacoworks

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Special thanks to Facebook for allowing me to work on this on my spare time. Kategory is not an internal Facebook project, nor it is an incubator. It is an external project of community contributors.

In any case facebookers are bunch of devs excited about Kotlin too!

Kotlin is ready for Functional Programming

TODAY

We’re growing

We’re improving

We want all of you

Our community goal

- Use of Kotlin in JS, Native, JVM
- One codebase for mobile, backend, frontend
- Same idioms across languages and ecosystems

The objective of this talk is to give you a peek bleeding edge technologies for Kotlin, and what future language features will look like.

- Where is Kotlin today
- What are we bringing into the ecosystem
- Where would we like to be

Kotlin today

Key cornerstones

- Data classes, sealed classes
- Inliner
- Extension functions
- Type aliases
- Enhanced resolution of generic parameters

Data & sealed classes

Data

- Plain information
- Stores specifics
- Closed and immutable by default

Sealed

- Pure behavior
- Indicates branching in execution
- Checked at compile time

Inliner

- Copies a function in its call site
- Inline functions’ body is copied at compile time
- All call sites with static dispatch are known at compile time
- Enables runtime generics

Reified

Extension functions

- Converts static functions into object methods
- All call sites with static dispatch are known at compile time
- Can extend just for specific generic parameters

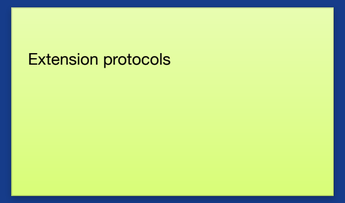
Kotlin today with Kategory

Key features

- Extension Interfaces
- Ad-hoc polymorphism for generic type constructors
- Imperative async code
- Smarter boilerplate removal

Extension Interfaces

- Implement any interface for already existing types
- Use the extension interface as a parameter
- WIP: automatic extension interface lookup



Extension Interface Jsonable

```
interface Jsonable<T> {
    fun toJson(T element): String

    fun fromJson(String json): T
}

fun <T> jsonable(): Jsonable<T> =
  // lookup code
```

Extension Interface Jsonable

```
object EmployeeJsonable: Jsonable<Employee> {
    val gson = Gson()

    fun toJson(Employee element): String =
      gson.toJsonString(element)

    fun fromJson(String json): Employee =
      gson.fromJsonString(json)
}
```

Extension Interface Jsonable

```
fun parser(
    company: Company,
    parser: Jsonable<Company> = jsonable<Company>()
): String =
  parser.toJson(company)
```

Note the lookup code

And if this seems like a lot of work, we have a KEEP to integrate a simpler version in the language

KEEP–87

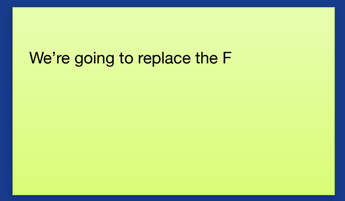
- Introduce Extension Interfaces into the language under the name “Type Classes”
- Compile time lookup & injection
- Aim for parity with Swift’s Extension Protocols

Ad-hoc polymorphism for generic type constructors

- Functions that support any generic type constructor
- Express agnosticity to implementation
- Safe downcast from generic to implementation

Generic type constructor

```
interface Hk<F, A>
```



- F is the type of the container
- A is the type of the content

Generic constructor implementations

```
sealed class Option<A>: Hk<OptionHK, A>

data class ListWrap<A>(…): Hk<ListWrapHK, A>

sealed class Try<A> : Hk<TryHK, A>
```

- F becomes a “tag” type
- A remains as the type of the content

Returning generic type constructors

```
fun <F> getUserById(
    id: String
): Hk<F, User> =
  ???
```

Extension Interface Factory

```
interface Factory<F> {
  fun <A> create(element: A): Hk<F, A>
}

fun <T> factory(): Factory<T> =
  // lookup code
```

Polymorphism for generic type constructors

```
fun <F> getUserById(
    id: String,
    factory: Factory<F> = factory<F>()
): Hk<F, User> =
  factory.create(getUser(id))
```

How do I convert that F back to a real value?

Safely downcasting generic containers

- Extension functions can be defined to require just some of the generic parameters
- Extension functions are resolved at compile time

Safely downcasting generic containers

```
fun <A> Hk<OptionHK, A>.ev() =
  this as Option<A>

fun <A> Hk<TryHK, A>.ev() =
  this as Try<A>
```

Ad-hoc polymorphism for generic constructors

```
val a: Option<User> = getUserById(“123”).ev()

val b: Try<User> = getUserById(“123”).ev()
```

Lookup overhead: O(1) after first lookup. Ideally it should be 0 because the compiler does it for us.

Ad-hoc polymorphism for generic constructors

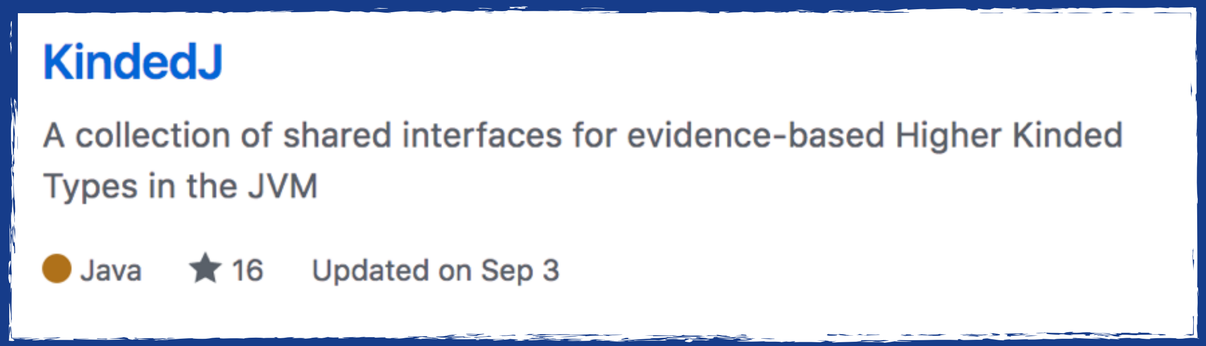
```
object OptionFactory: Factory<OptionHK> {
  fun <A> create(element: A): Hk<OptionHK, A> =
    Option.Some(a)
}

object TryFactory: Factory<TryHK> {
  fun <A> create(element: A): Hk<TryHK, A> =
    Try { a }
}
```

<-- global lookup!

KindedJ

- Initiative to share generic type constructors under the name “Higher Kinded Types”
- We’re speaking with other FP libraries for Java & eta-lang



Imperative async code

- Express asynchronous sequential and parallel execution as if they were synchronous
- For any existing framework and abstraction

Regular async code

```
fun <F> getUserFriends(
    id: String
): Observable<List<User>> =
  getUserById(id).flatMap { user ->
      Observable.merge(
        user.friends.map { friend ->
          getUserById(friend.id)
        }
      ).toList()
  }
```

Imperative async code

```
fun <F> getUserFriends(
    id: String,
    coroutinable: Coroutinable<F> = coroutinable<F>()
): Hk<F, List<User>> =
  coroutinable.bindingE {
    val user = getUserById(id).bind()
    val friendProfiles = user.friends.map { getUserById(it.id).bind() }
    yields(friendProfiles)
  }
```

Ad-hoc polymorphism for imperative async code

```
val a: Either<Exception, List<User>> = getUserFriends(“123”).ev()

val b: Try<List<User>> = getUserFriends(“123”).ev()

val c: ObservableKW<List<User>> = getUserFriends(“123”).ev()

val d: IO<List<User>> = getUserFriends(“123”).ev()
```

Coroutinable?

```
typealias Coroutinable<F> = MonadError<F>
```

Effects with MonadError

- Thin Extension Interface that can be implemented by any existing framework & abstraction
- With error handling, stack safety, threading & cancellation out of the box
- Current integrations: RxJava, kotlin.coroutines, IO
- Potential integrations: CompletableFuture, kotlinx.coroutines, AsyncTask, ArchComponents, Kovenant…

Implementations in Kategory

- Error handling: Option, Try, Validated, Either, Ior
- Collections: List, Sequence, Map, Set
- RWS: Reader, Writer, State
- Transformers: ReaderT, WriterT, OptionT, StateT, EitherT
- Evaluation: Eval, Trampoline, Free, Function0
- Others: Coproduct, Coreader, Const...

What if I want my own?

Smarter boilerplate removal

- Eugenio Marletti’s collaboration & mentorship
- Generate boilerplate for all the features show using annotations

Bye bye boring code

- **Generic constructors**
  - @higherkind
- **Extension Interfaces**
  - @derives
  - @instance
- **Manipulation of immutable data & sealed classes**
  - kategory-optics by Simon Vergauwen

```
+ @higherkind sealed class Either<A, B> : EitherKind<A, B>
-
- class EitherHK private constructor()
-
- typealias EitherKindPartial<A> = kindedj.Hk<EitherHK, A>
- typealias EitherKind<A, B> = kindedj.Hk<EitherKindPartial<A>, B>
-
- inline fun <A, B> EitherKind<A, B>.ev(): Either<A, B> = this as Either<A, B>
```

So how did we reach this point?

Challenges & Pitfalls

- IDE resolution of deeply nested generics
- Scopes with ambiguity for `it` and `this`
- Reified generics are “contagious”
- Unexpected behavior caused by inlining
- Generics and interoperating with Java
- Error recovery in coroutines

And many more, come talk to us!

Where would we like to be

scala_logo.svg

Swift5
_0.png

rustPro
mo.png

haskell_lambda
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ELM
LANG.
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EtaLang
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F-sharp-
main.png

Bring your tools in

- Threading
- Databases
- Network
- Error Handling
- Reactive Programming

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- Static analyzers
- UI frameworks
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- UI frameworks
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- Data science
- Machine learning
- Videogames
- Computer vision
- Serialization

Bring your tools in

- Category Theory
- Threading
- Parsers
- Data science
- Web frameworks
- Databases
- Compilers
- Machine learning
- New Architectures
- Package management
- Network
- Static analyzers
- Videogames
- Collection libraries
- Error Handling
- UI frameworks
- Computer vision
- Stream pipelines
- Reactive Programming
- Math & statistics
- Serialization

We’re growing our tools

We’re improving our ecosystem

We want all of you to be part of it

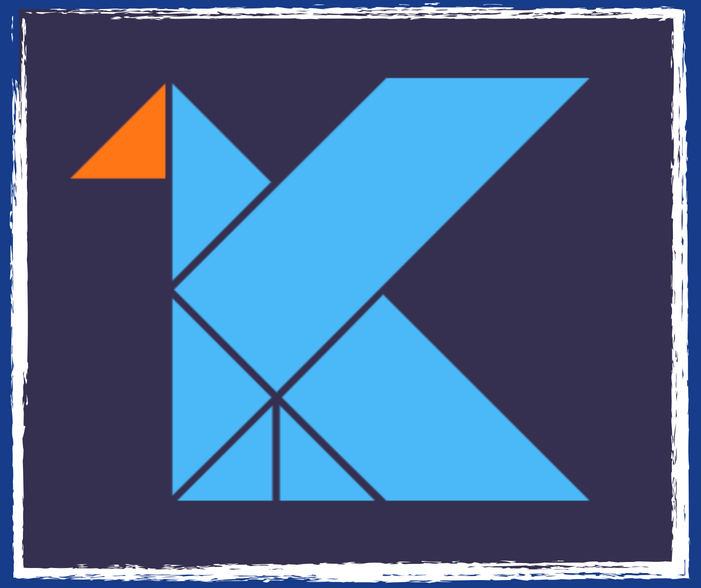
Kategory: kategory.io

Introduction to Kategory:
tinyurl.com/KatIntro

KEEP-87:
github.com/Kotlin/KEEP/pull/87

Gitter: gitter.im/kategory

#kategory in KotlinLang
#kategory in ASG



Special thanks to all Kategory contributors & supporters!

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