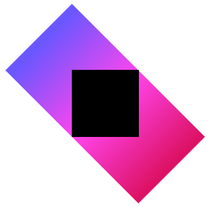
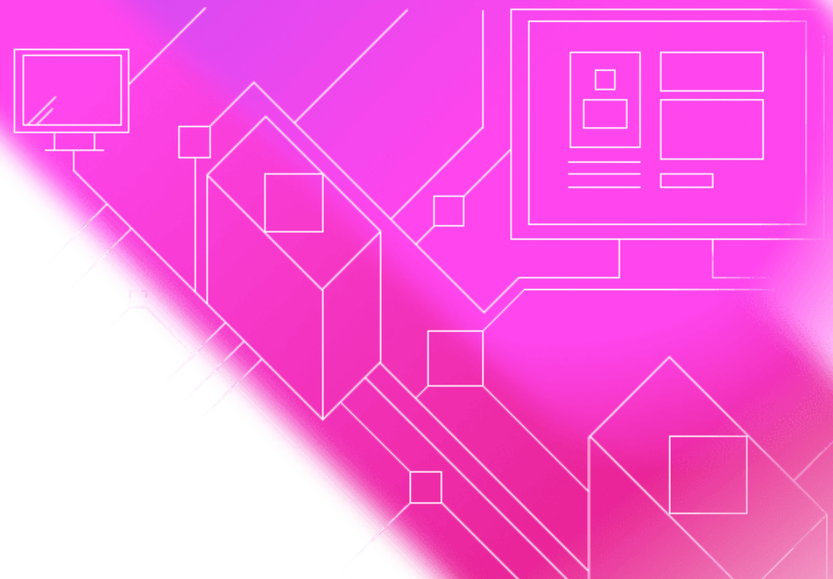
JETBRAINS

# Full Stack



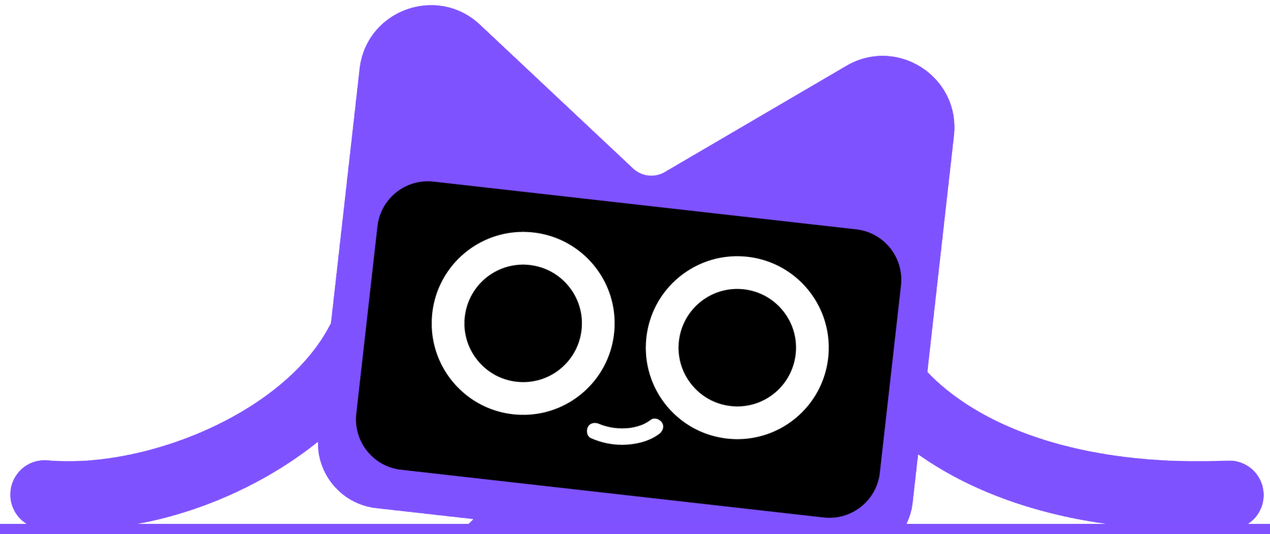
# Ktor



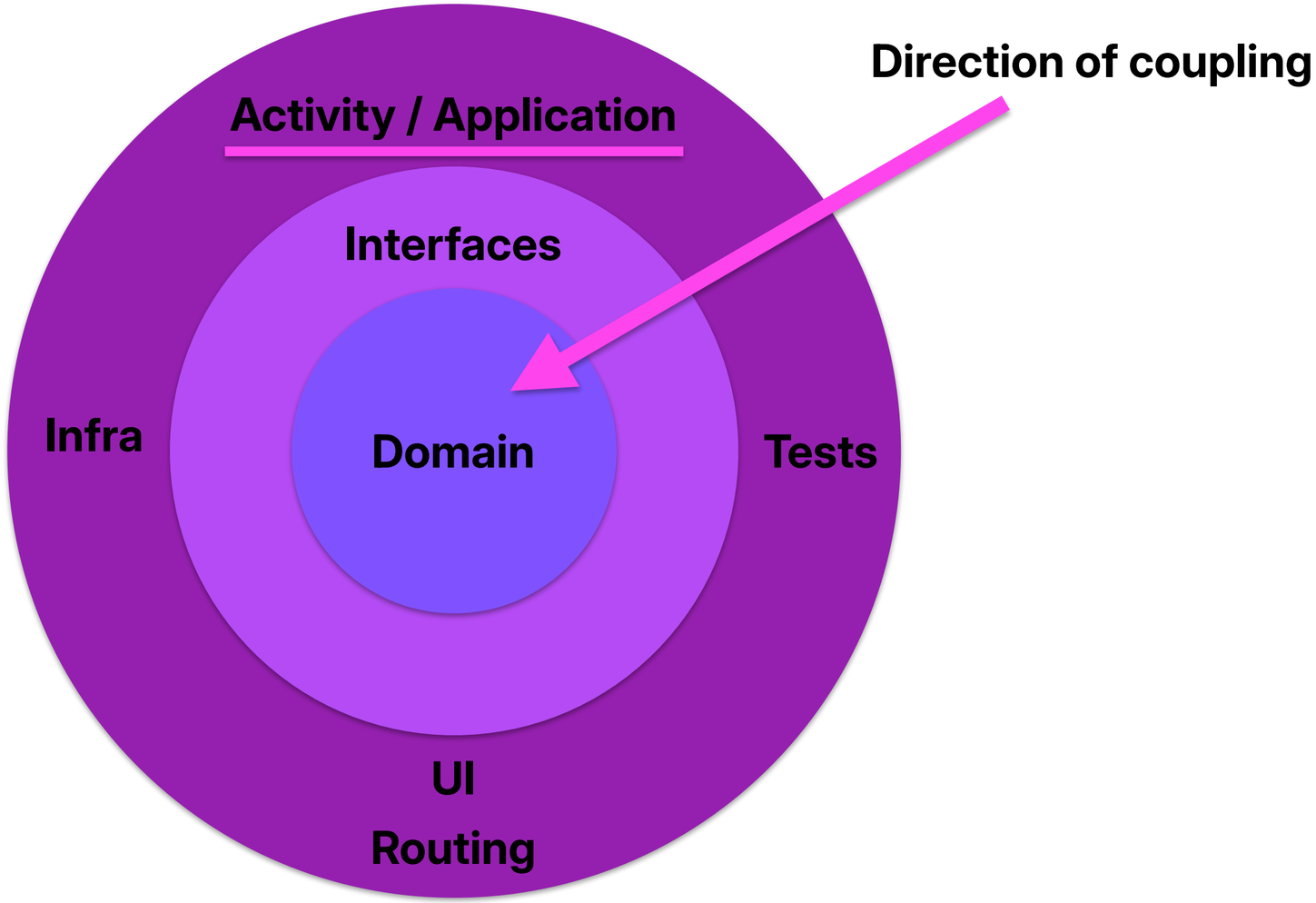
Simon Vergauwen
**Developer Advocate**

# Why Ktor?

- Kotlin 1st
- Coroutines
- DSL
- Unopinionated on architecture
- Re-use and transfer existing knowledge!



# Architecture




# Application.kt

```
fun main() {
    embeddedServer(Netty, host = "0.0.0.0", port = 8080) {
        // suspend Application.() -> Unit
  }.start(wait = true)
}
```

Android Emulator ⇒ 10.0.2.2:8080

# Java's main-class

```
plugins {
    alias(libs.plugins.kotlin.jvm)
    alias(ktorLibs.plugins.ktor)
}

application {
    mainClass.set("org.jetbrains.demo.ApplicationKt")
}

./gradlew run
```

# fatJar

A fatJar is a jar that includes all its dependencies

```
ktor {
    fatJar {
        allowZip64 = true
        archiveFileName.set("gdg-capetown.jar")
    }
}
```

```
./gradlew buildFatJar
java -jar build/libs/gdg-capetown.jar
```

# Docker image

```
ktor {
    docker {
        localImageName = “ktor-server”
        imageTag = project.version.toString()
        externalRegistry =
            googleContainerRegistry(
                projectName = provider { “GDG Capetown" },
                appName = providers.environmentVariable(“APP_ID"),
                username = providers.environmentVariable("USERNAME"),
                password = providers.environmentVariable("PASSWORD"),
            )
    }
}
```

# Gradle Version Catalog

```
dependencyResolutionManagement {
    versionCatalogs {
        create("ktorLibs") {
            from(“io.ktor:ktor-version-catalog:3.2.3")
        }
    }
}
```

# Gradle Version Catalog

```
dependencies {
    implementation(ktorLibs.server.netty)
    implementation(ktorLibs.server.config.yaml)
    implementation(ktorLibs.server.auth.jwt)
    implementation(ktorLibs.server.contentNegotiation)
    implementation(ktorLibs.serialization.kotlinx.json)
}
```

# BuildConfig

```
android {
    defaultConfig {
        buildConfigField("String", "URL", “\"${property("URL")}\"")
    }
}


HttpClient(Android) {
    defaultRequest {
        url(BuildConfig.API_BASE_URL)
    }
}
```

# src/main/resources/application.yaml

```yaml
app:
  host: "$HOST:0.0.0.0"
  port: "$PORT:8080"
```

Environment Variable

Fallback Value

# AppConfig

```
@Serializable
data class AppConfig(val host: String, val port: Int)

val config = ApplicationConfig("application.yaml")
    .property("app")
    .getAs<AppConfig>()
```

# Application.kt

```
fun main() {
    val config = ApplicationConfig("application.yaml")
        .property("app")
        .getAs<AppConfig>()

    embeddedServer(Netty, host = config.host, port = config.port) {
        // suspend Application.() -> Unit
    }.start(wait = true)
}
```

**Yaml & HOCON Support**

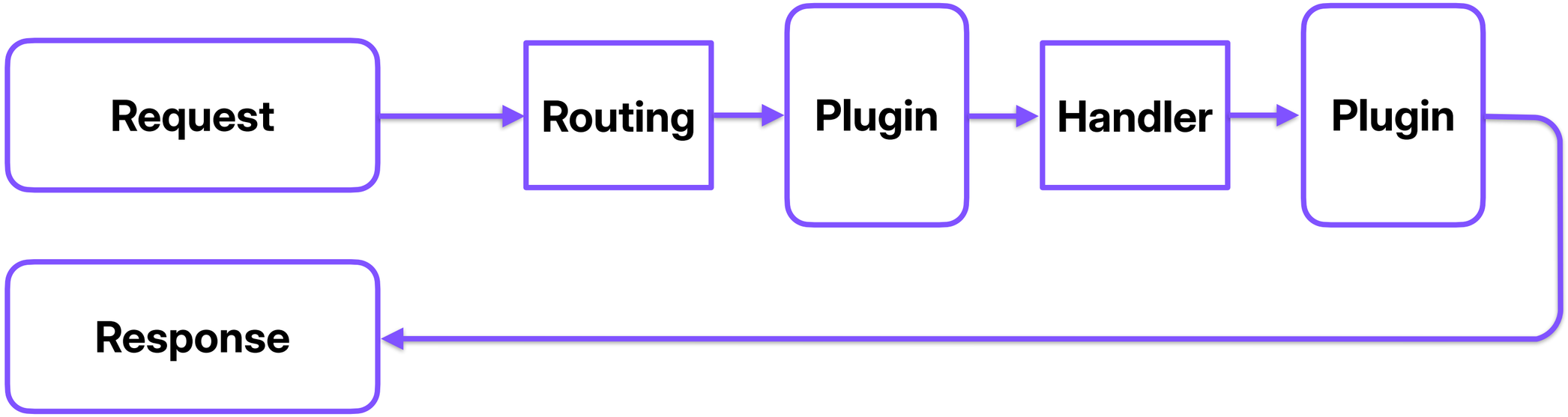
# EmbeddedServer

```
fun main() {
    val config = ApplicationConfig("application.yaml")
        .property("app")
        .getAs<AppConfig>()

    embeddedServer(Netty, host = config.host, port = config.port) {
        app(config)
    }.start(wait = true)
}

suspend fun Application.app(config: AppConfig) { }
```

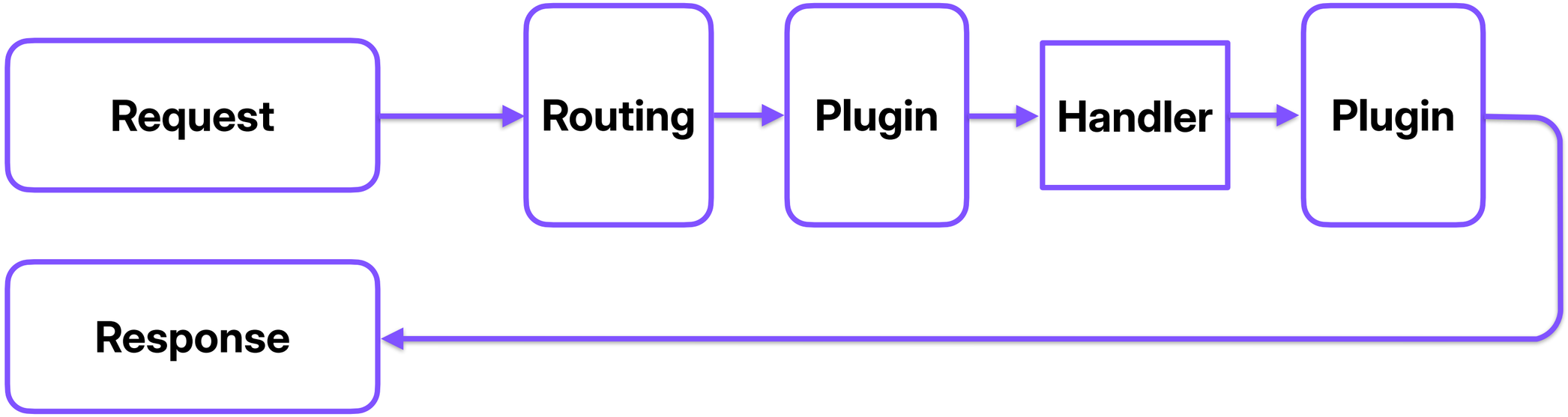
# TestApplication

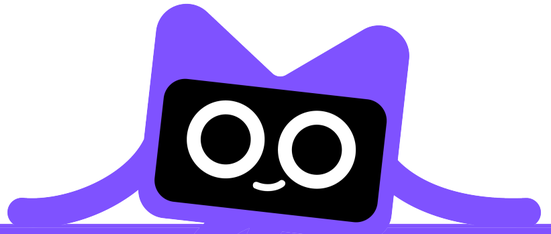
```
@Test
fun test() = testApplication {
    application {
        app(AppConfig(host = "not-used-in-test", port = 9999))
    }
    val client= createClient {
        install(ContentNegotiation) { json() }
    }
    val response = client.get("/call-some-endpoint")
    assertEquals(HttpStatusCode.OK, response.status)
}
```

# App - plugins



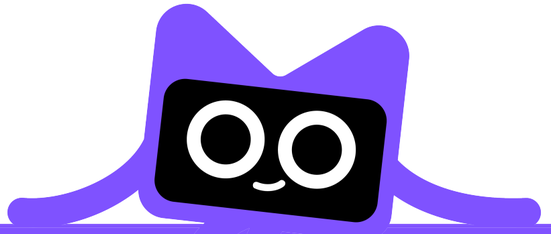

# App - plugins



# App - plugins

```
suspend fun Application.app(config: AppConfig) {
    install(ContentNegotiation) {
        json(Json {
            encodeDefaults = true
            isLenient = true
        })
    }
}
```



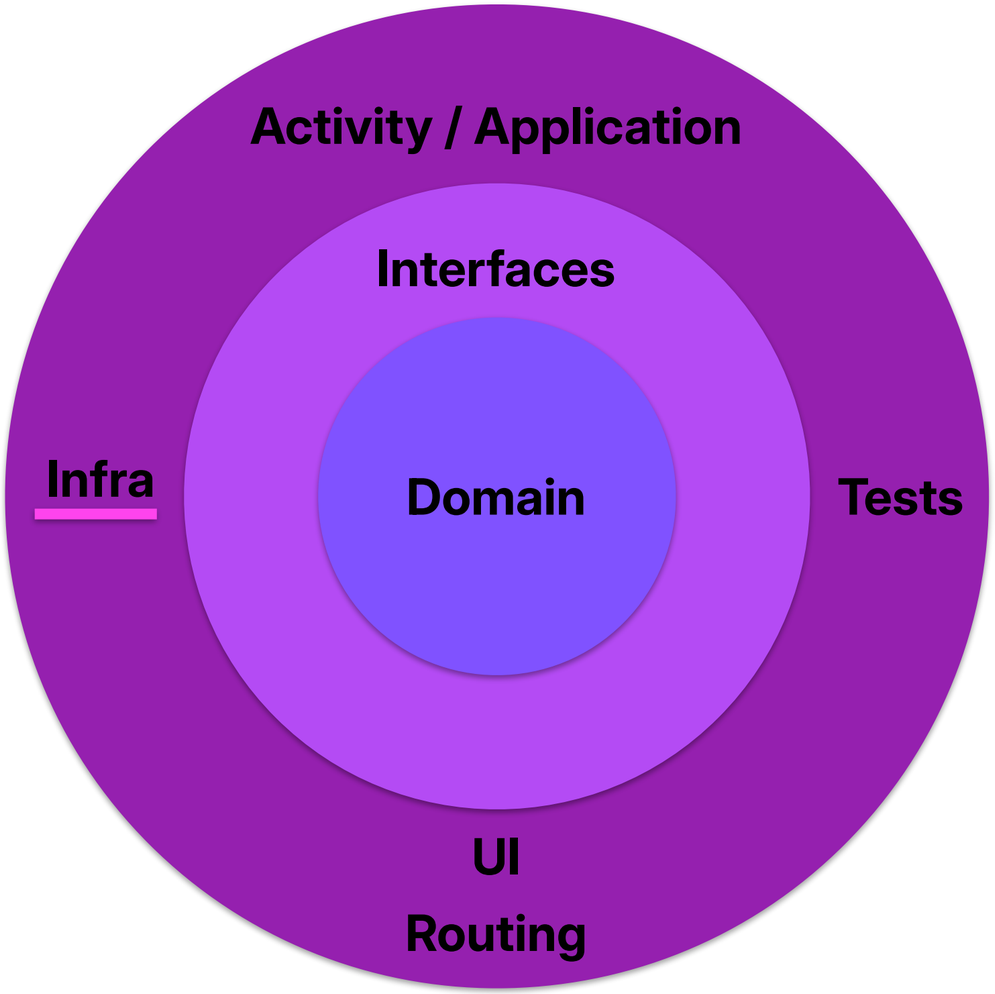
# App - plugins

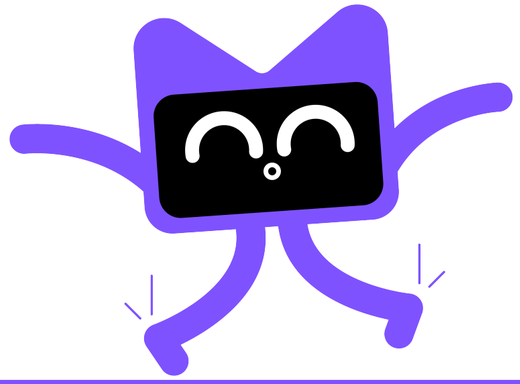
```
suspend fun Application.app(config: AppConfig) {
    install(ContentNegotiation) {
        json(Json {
            encodeDefaults = true
            isLenient = true
        })
    }
    if (developmentMode) install(CallLogging)
}
```

# App - plugins

```
suspend fun Application.app(config: AppConfig) {
    install(ContentNegotiation) {
        json(Json {
            encodeDefaults = true
            isLenient = true
        })
    }
    if (developmentMode) install(CallLogging)
    install(SSE)
    install(WebSockets) {
        pingPeriod = 15.seconds
        timeout = 15.seconds
    }
}
```

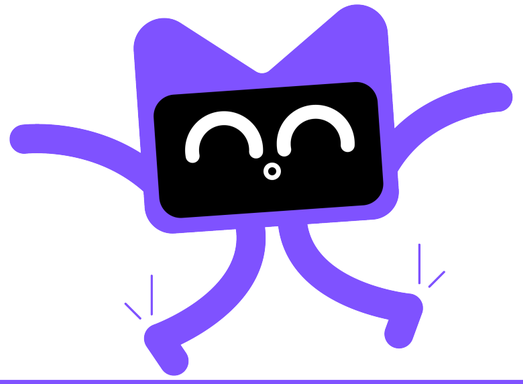
# Infrastructure



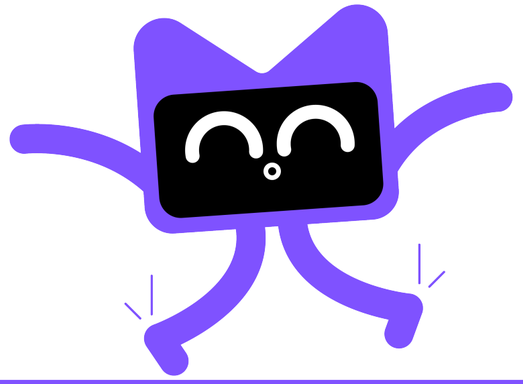
# Infrastructure

```
@Serializable
data class DatabaseConfig(
    val url: String,
    val username: String,
    val password: String,
)
```



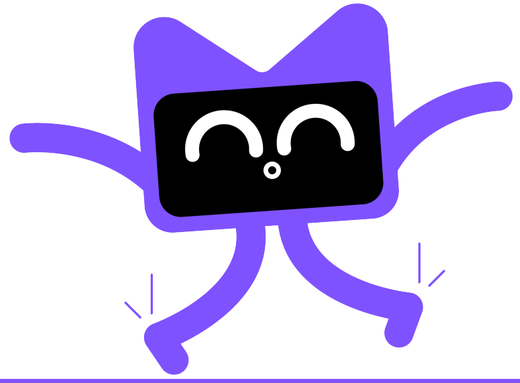
# Persistence

```
app:
  host: "$KTOR_HOST:0.0.0.0"
  port: "$KTOR_PORT:8080"
  database:
    url: "$DB_URL:jdbc:postgresql://localhost:5432/postgres"
    username: "$DB_USERNAME:ktor_user"
    password: "$DB_PASSWORD:ktor_password"
```



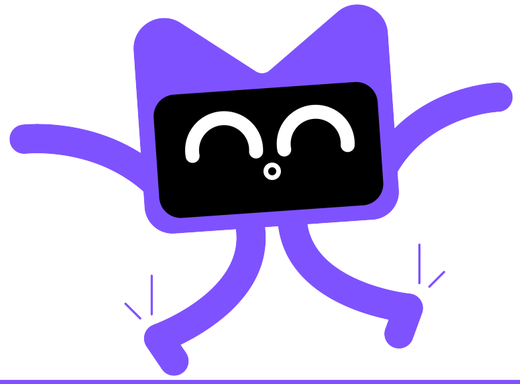
# HikariDataSource

```
private fun dataSource(config: DatabaseConfig): HikariDataSource =
    HikariDataSource(
        HikariConfig().apply {
            jdbcUrl = config.url
            username = config.username
            password = config.password
        }
    )
```



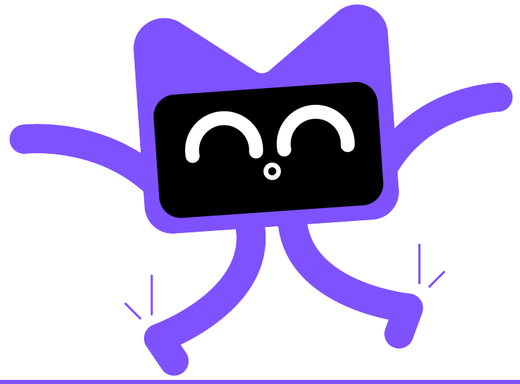
# Exposed

```
fun Application.database(config: DatabaseConfig): Database {
    val dataSource = dataSource(config)
    val database = Database.connect(dataSource)
    return database
}
```



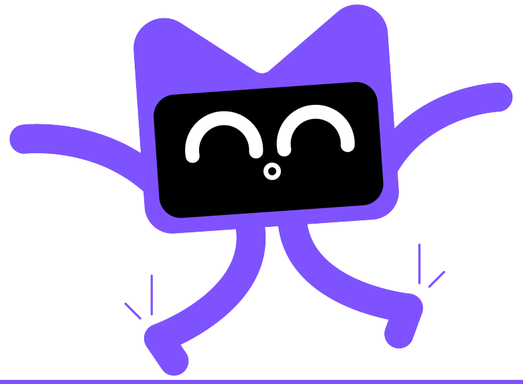
# Lifecycle

```
fun Application.database(config: DatabaseConfig): Database {
    val dataSource = dataSource(config)
    val database = Database.connect(dataSource)
    monitor.subscribe(ApplicationStopped) {
        TransactionManager.closeAndUnregister(database)
        dataSource.close()
    }
    return database
}
```



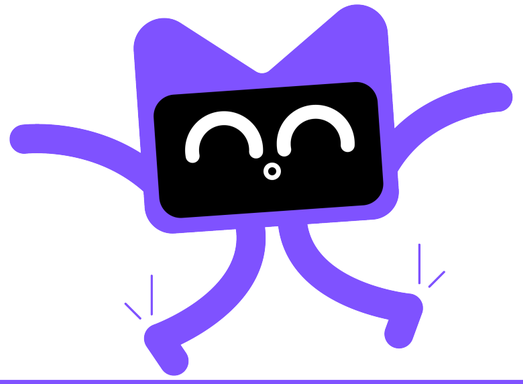
# Integration Testing with Testcontainers®

```
fun PostgreSQLContainer<Nothing>.config(): DatabaseConfig =
    DatabaseConfig(
        url = jdbcUrl,
        username = username,
        password = password,
    )
```

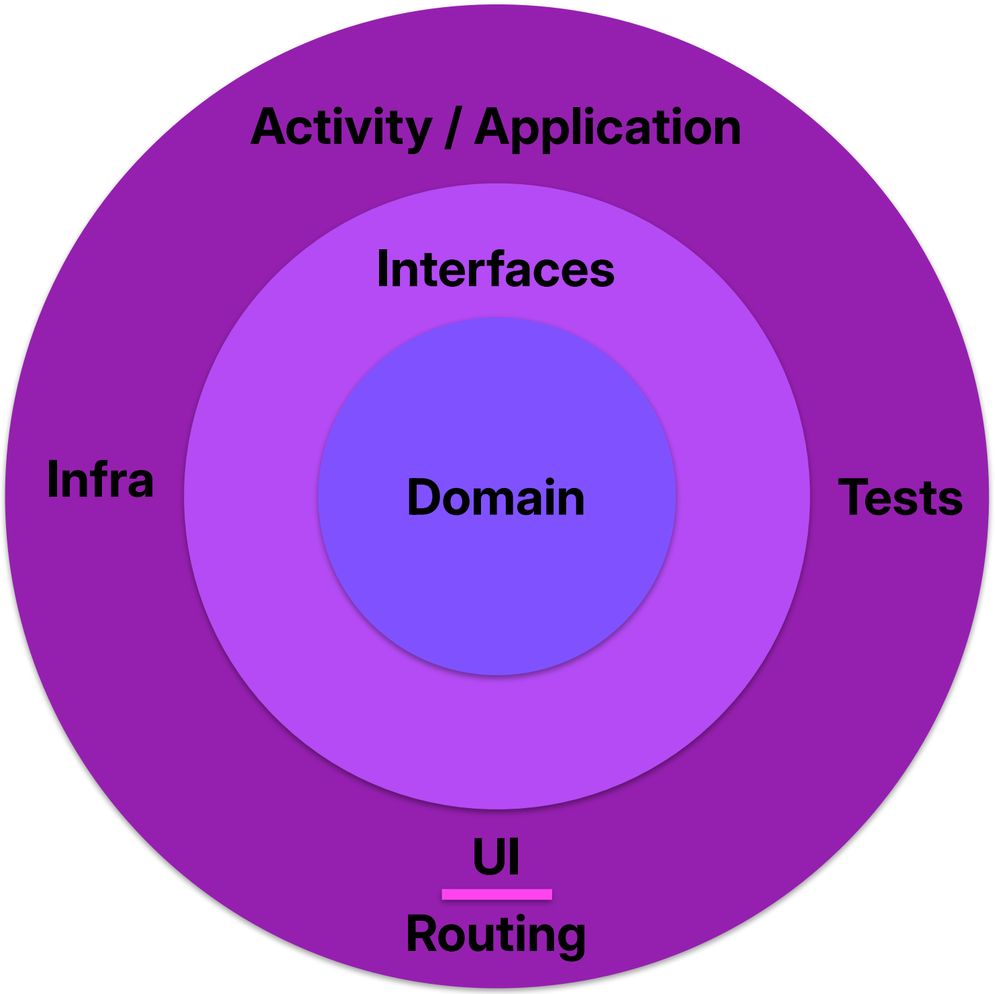


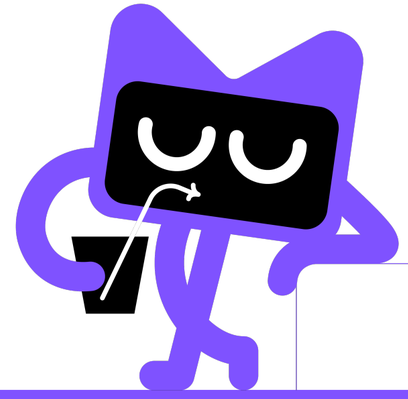
# Integration Testing with Testcontainers®

```
val container by lazy {
    PostgreSQLContainer<Nothing>("postgres:16-alpine")
        .also { it.start() }
}
```

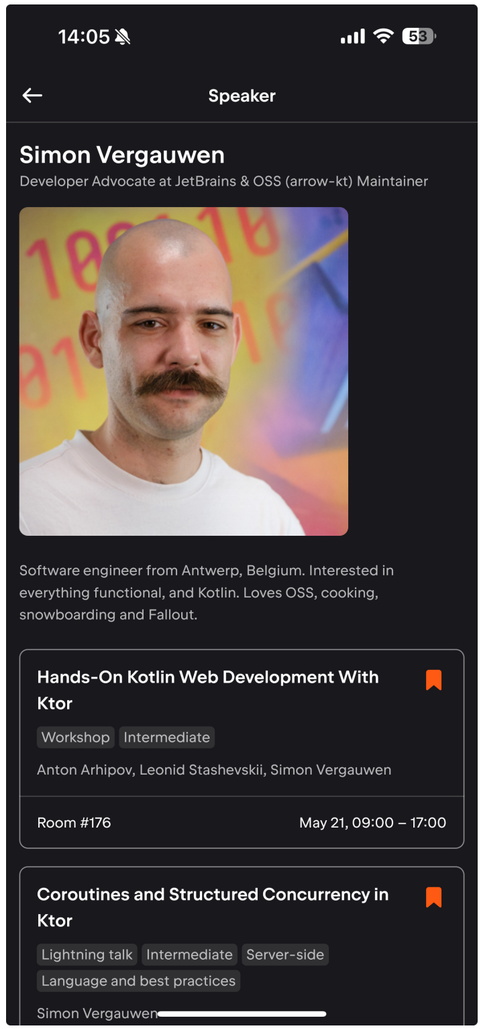


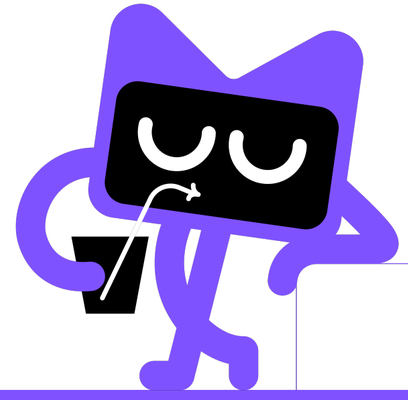
# Architectural layering



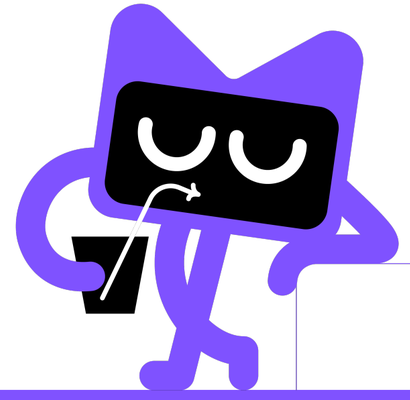
# View / UI


14:05
Speaker
Simon Vergauwen
Developer Advocate at JetBrains & OSS (arrow-kt) Maintainer
Software engineer from Antwerp, Belgium. Interested in everything functional, and Kotlin. Loves OSS, cooking, snowboarding and Fallout.
Hands-On Kotlin Web Development With Ktor
Workshop
Intermediate
Anton Arhipov, Leonid Stashevskii, Simon Vergauwen
Room #176
May 21, 09:00 – 17:00
Coroutines and Structured Concurrency in Ktor
Lightning talk
Intermediate
Server-side
Language and best practices
Simon Vergauwen



# CRUD <~> HttpMethod

- CREATE → HttpMethod.Post
- READ → HttpMethod.Get
- UPDATE → HttpMethod.Put
- DELETE → HttpMethod.Delete



# HttpStatusCode

## 2xx

- 200 OK
- 201 Created
- 204 No Conflict

## 4xx

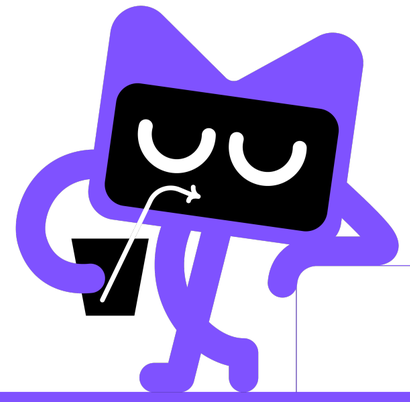
- 400 Bad Request
- 401 Unauthorised
- 404 Not Found

## 3xx

- 301 Moved Permanently
- 302 Found

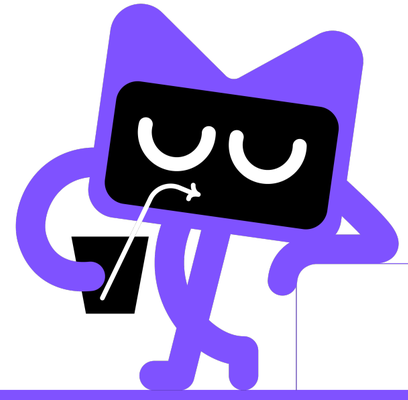
## 5xx

- 500 Internal Server



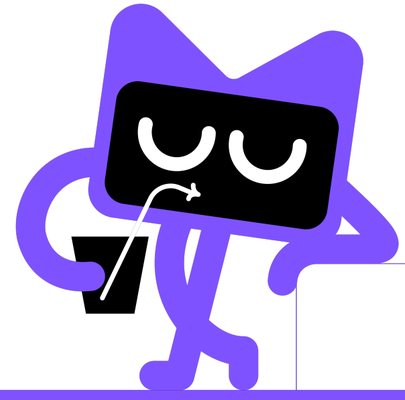
# Routing

```
fun Application.userRoutes(users: UserService) =
    routing {
        post(“/user/register") { }
        get(“/user/{userId}") { }
        put(“/user/update") { }
        delete(“/user/delete") { }
    }
```



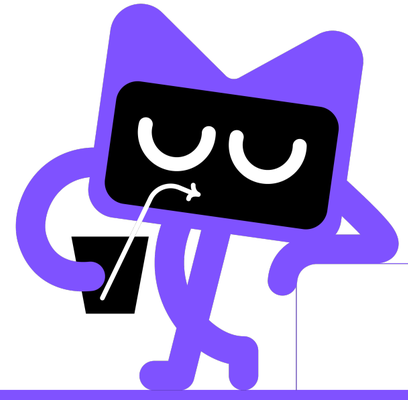
# Grouping routes

```
fun Application.userRoutes(users: UserService) =
    routing {
        route("/user") {
            post("/register") { }
            get("/{userId}") { }
            put("/update") { }
            delete("/delete") { }
        }
    }
```



# RouteHandler

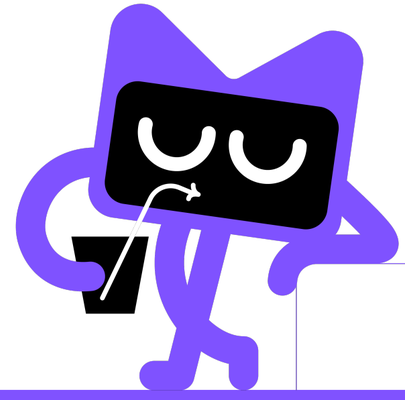
```
get("/{userId}") {
    val userId = call.pathParameters.getOrFail("userId")
}
```



# RouteHandler

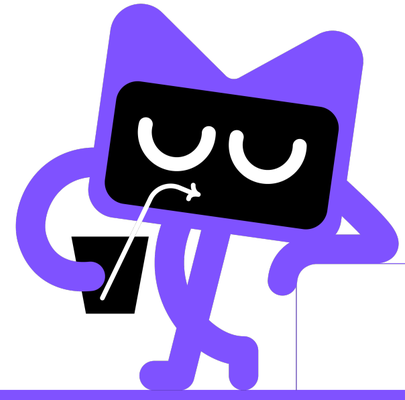
```
enum class Extras { Profile, Followers; }


get("/{userId}") {
    val userId = call.pathParameters.getOrFail("userId")
    val extras = call.queryParameters.getOrFail<List<Extras>>("extras")
}
```

All primitives and enums



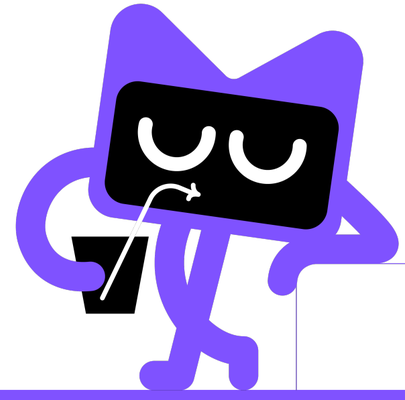
# RouteHandler

```
get("/{userId}") {
    val userId = call.pathParameters.getOrFail("userId")
    val extras = call.queryParameters.getOrFail<List<Extras>>("extras")
    val userAgent = call.request.headers["User-Agent"]
}
```



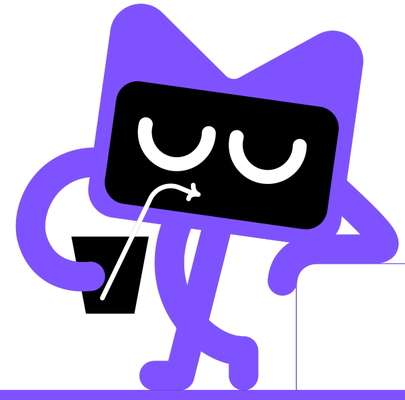
# RouteHandler

```
get("/{userId}") {
    val userId = call.pathParameters.getOrFail("userId")
    val extras = call.queryParameters.getOrFail<List<Extras>>("extras")
    val userAgent = call.request.headers["User-Agent"]
    val cookie = call.request.cookies["my-cookie"]

}
```



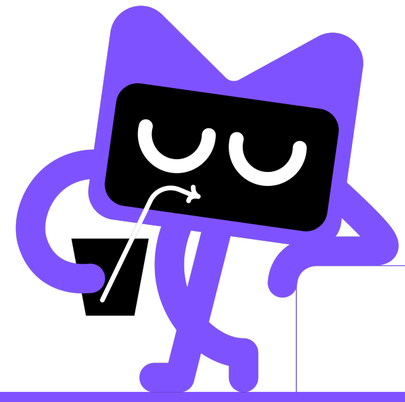
# RouteHandler

```
get("/{userId}") {
    val userId = call.pathParameters.getOrFail("userId")
    val extras = call.queryParameters.getOrFail<List<Extras>>("extras")
    val userAgent = call.request.headers["User-Agent"]
    val cookie = call.request.cookies["my-cookie"]

    val user = users.getUserOrNull(userId)
}
```

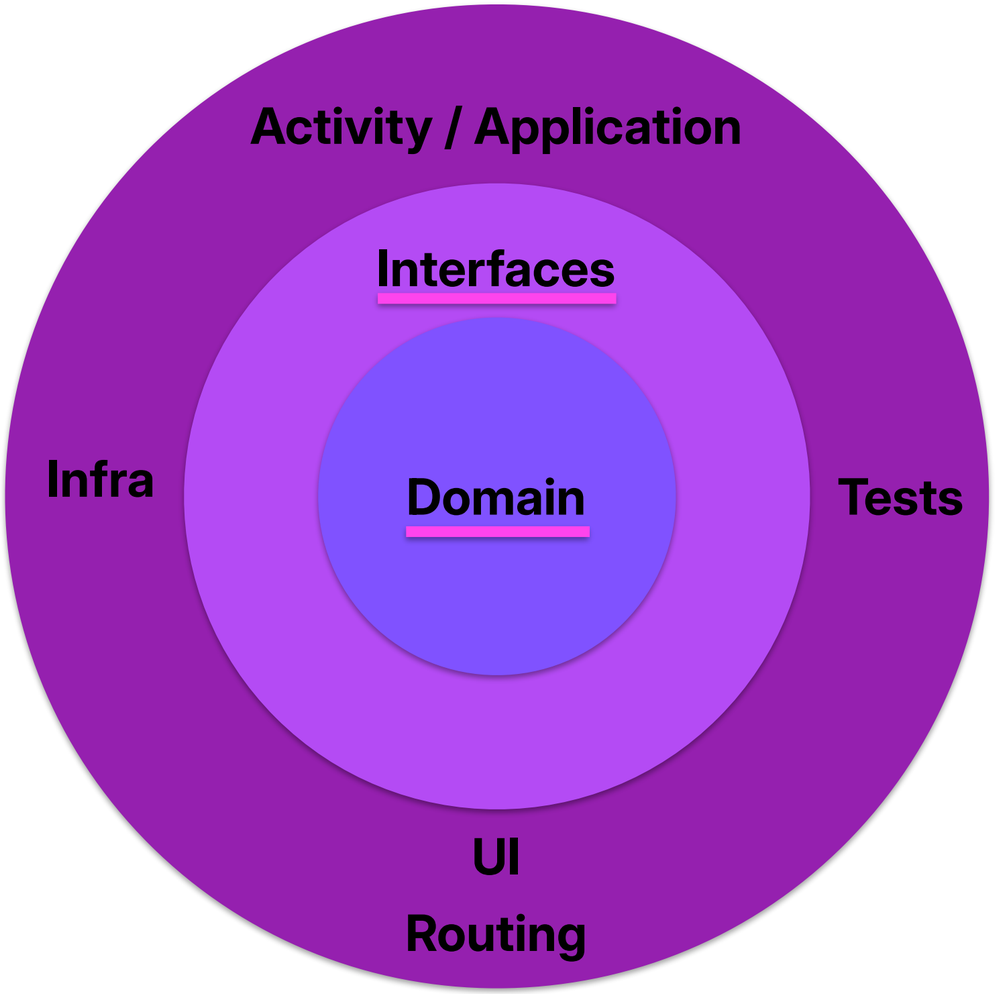


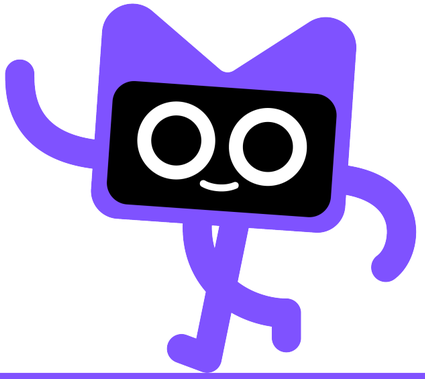
# RouteHandler

```
get("/{userId}") {
    val userId = call.pathParameters.getOrFail("userId")
    val extras = call.queryParameters.getOrFail<List<Extras>>("extras")
    val userAgent = call.request.headers["User-Agent"]
    val cookie = call.request.cookies[“my-cookie"]

    val user = users.getUserOrNull(userId)

    if (user =/= null) call.respond(HttpStatusCode.OK, user)
    else call.respond(HttpStatusCode.NotFound)
}
```



# Architectural layering



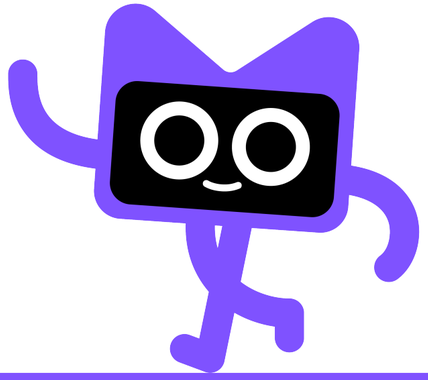



# Domain / Model

Shared between client and server

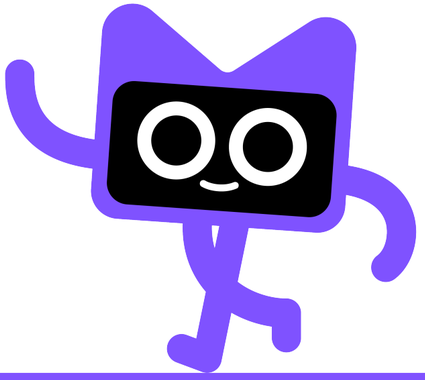
```kotlin
@Serializable
data class UpsertUser(
    val email: String,
    val displayName: String?,
    @SerialName("about_me")
    val aboutMe: String?,
)
```

```kotlin
@Serializable
data class User(
    val userId: Long,
    val email: String,
    val displayName: String,
    val aboutMe: String,
)
```



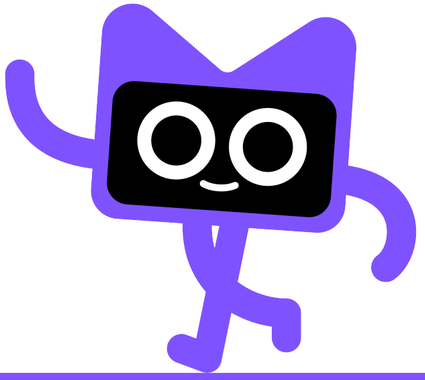
# CRUD Repository

```
interface UserRepository {
    suspend fun create(subject: String): User
    suspend fun findOrNull(subject: String): User?
    suspend fun findAll(): List<User>
    suspend fun update(subject: String, updateUser: UpdateUser): User
    suspend fun delete(subject: String): Boolean
}
```



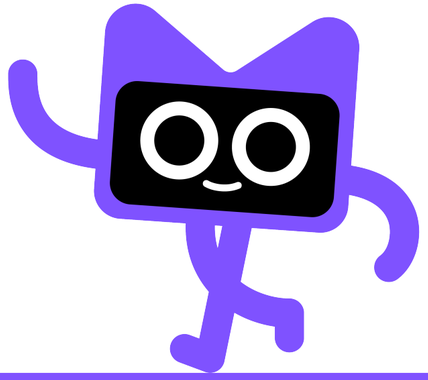
# Exposed Table

```
object UserTable : LongIdTable("users", "user_id") {
    val subject = varchar("subject", 256).uniqueIndex()
    val email = varchar("email", 256).nullable()
    val displayName = varchar("display_name", 256).nullable()
    val aboutMe = varchar("about_me", 256).nullable()
}
```



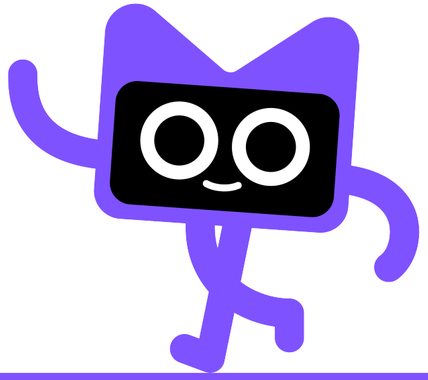
# Exposed Repository

```
class ExposedUserRepository(private val db: Database) : UserRepository {
}
```



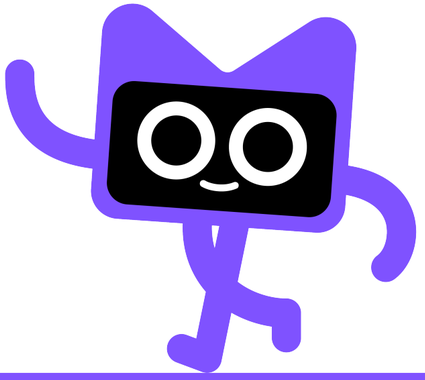
# Exposed Repository

```
class ExposedUserRepository(private val db: Database) : UserRepository {
    override suspend fun create(subj: String): User
}
```



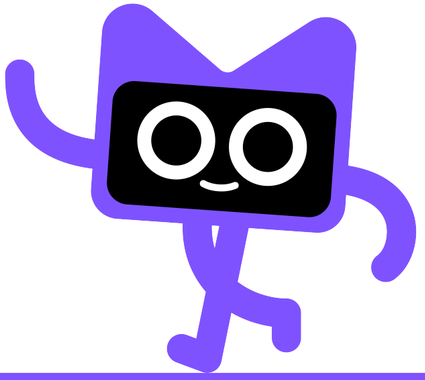
# Exposed Repository

```
class ExposedUserRepository(private val db: Database) : UserRepository {
    override suspend fun create(subj: String): User =
        withContext(Dispatchers.IO) {

        }
}
```



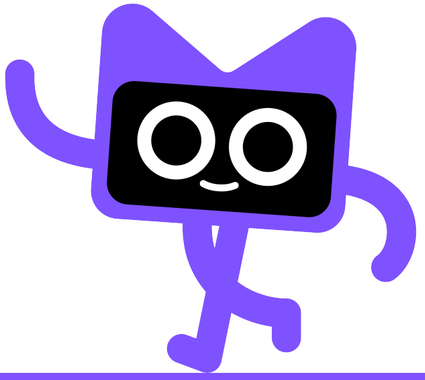
# Exposed Repository

```
class ExposedUserRepository(private val db: Database) : UserRepository {
    override suspend fun create(subj: String): User =
        withContext(Dispatchers.IO) {
            transaction(db) {

            }
        }
}
```



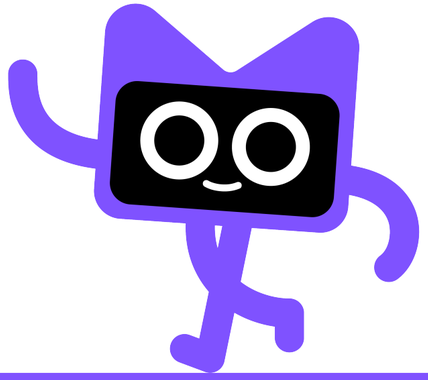
# Exposed Repository

```
class ExposedUserRepository(private val db: Database) : UserRepository {
    override suspend fun create(subj: String): User =
        withContext(Dispatchers.IO) {
            transaction(db) {
                UserTable.upsertReturning(
                    keys = arrayOf(UserTable.subject)
                )
            }
        }
}
```



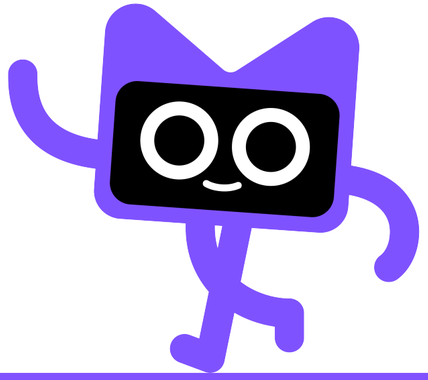
# Exposed Repository

```
class ExposedUserRepository(private val db: Database) : UserRepository {
    override suspend fun create(subj: String): User =
        withContext(Dispatchers.IO) {
            transaction(db) {
                UserTable.upsertReturning(
                    keys = arrayOf(UserTable.subject)
                ) { upsert →
                    upsert[subject] = subj
                }
            }
        }
}
```



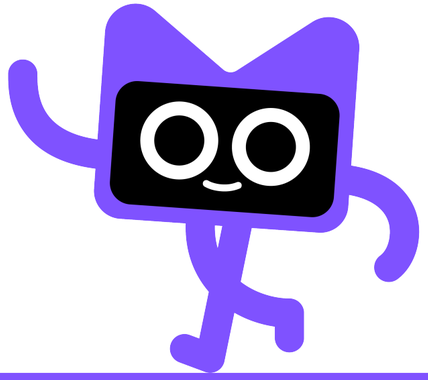
# Exposed Repository

```
class ExposedUserRepository(private val db: Database) : UserRepository {
    override suspend fun create(subj: String): User =
        withContext(Dispatchers.IO) {
            transaction(db) {
                UserTable.upsertReturning(
                    keys = arrayOf(UserTable.subject)
                ) { upsert →
                    upsert[subject] = subj
                }.single().toUser()
            }
        }
}
            Iterable<ResultRow>.single(): ResultRow
```



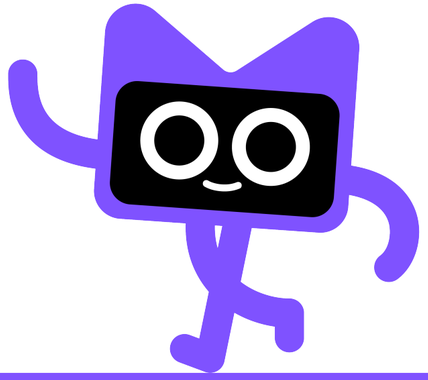
# Exposed Repository

```
private fun ResultRow.toUser(): User = User(
    this[UserTable.id].value,
    this[UserTable.subject],
    this[UserTable.email],
    this[UserTable.displayName],
    this[UserTable.aboutMe],
)
```



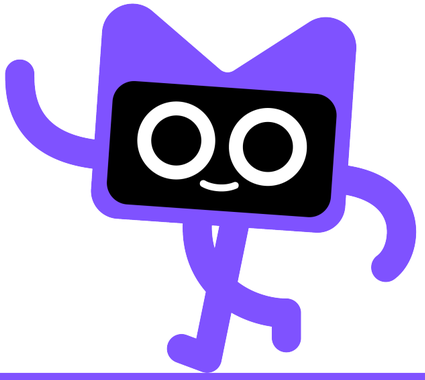
# UserService = UserRepository + …

```
interface UserService {
    suspend fun userSessions(
        userId: String,
        userAgent: String?
    ): List<String>

    suspend fun deleteSessions(
        userId: String,
        userAgent: String?
    ): Boolean
}
```

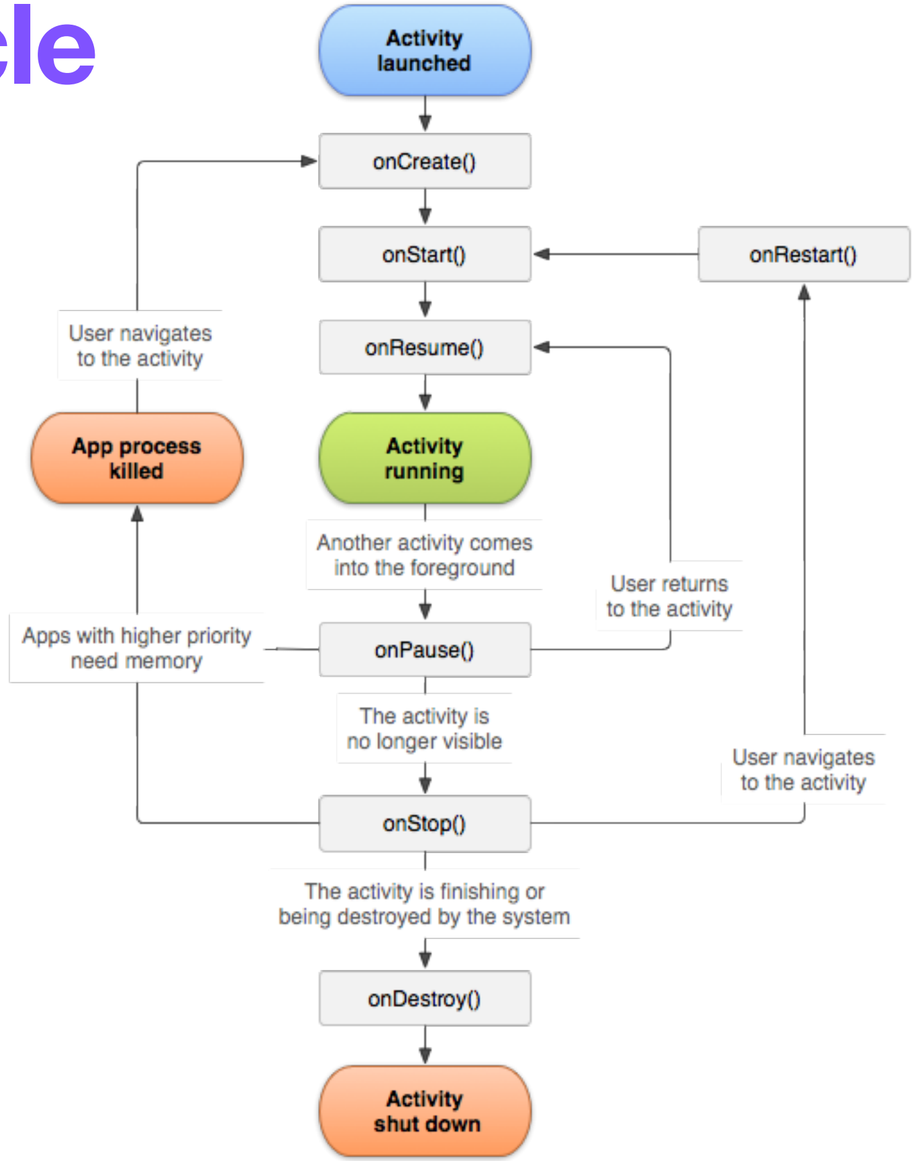


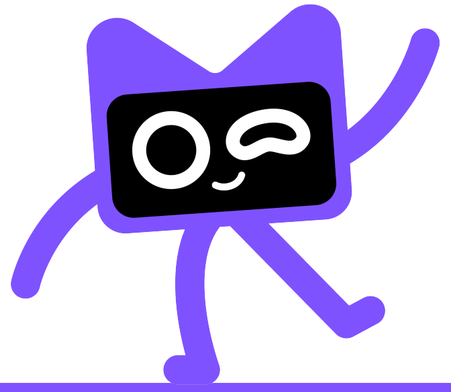
# Application.kt

```
suspend fun Application.app(config: AppConfig) {
    val database = database(config.database)
    val userRepository: UserRepository = ExposedUserRepository(database)

    install(ContentNegotiation) { json() }
    if (developmentMode) install(CallLogging)

    routing {
        userRoutes(userRepository)
    }
}
```

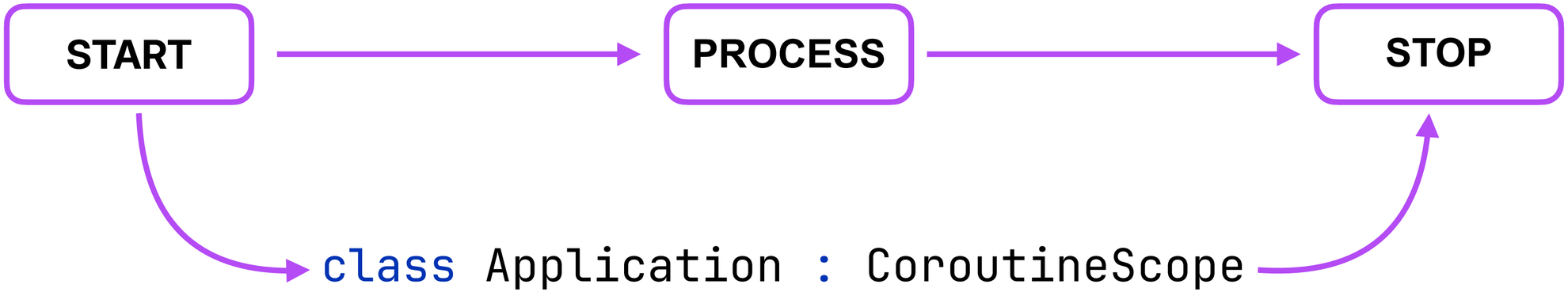


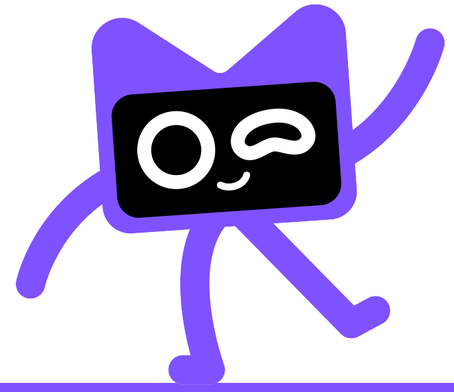
# Activity Lifecycle



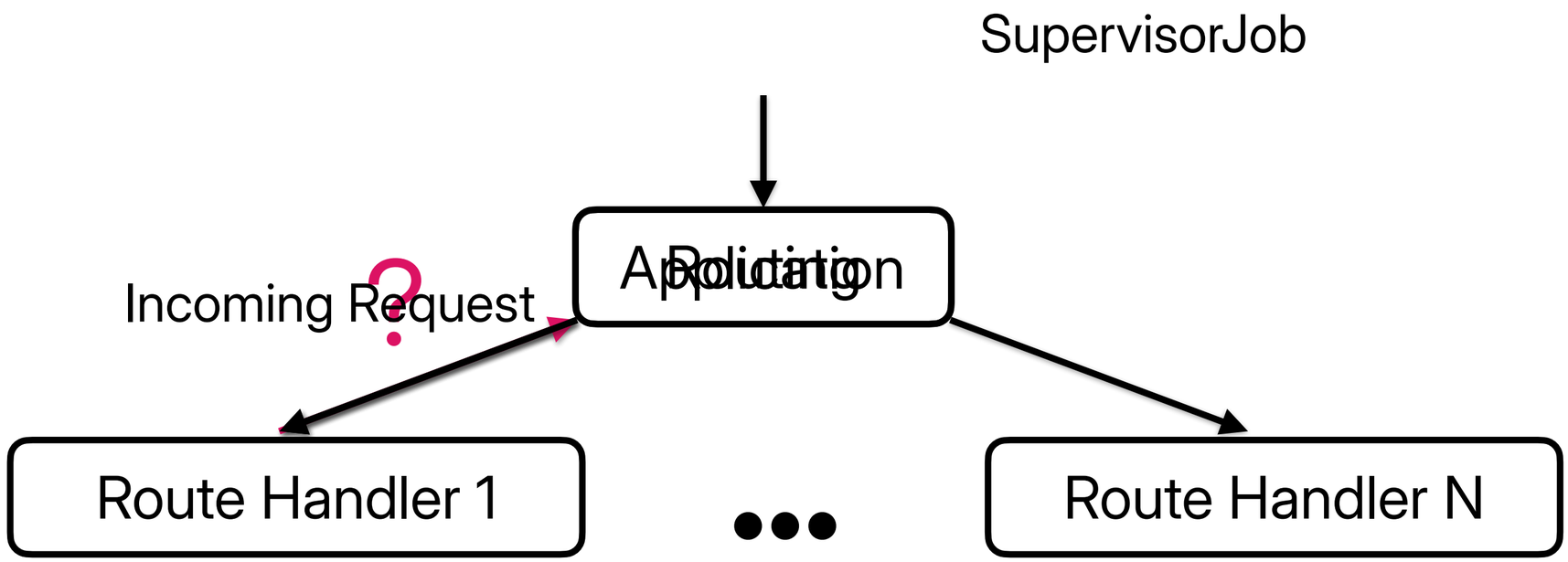



# Application Lifecycle

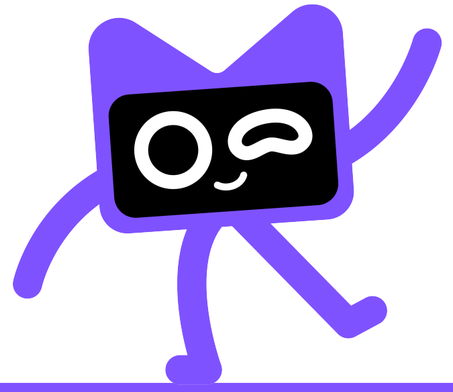


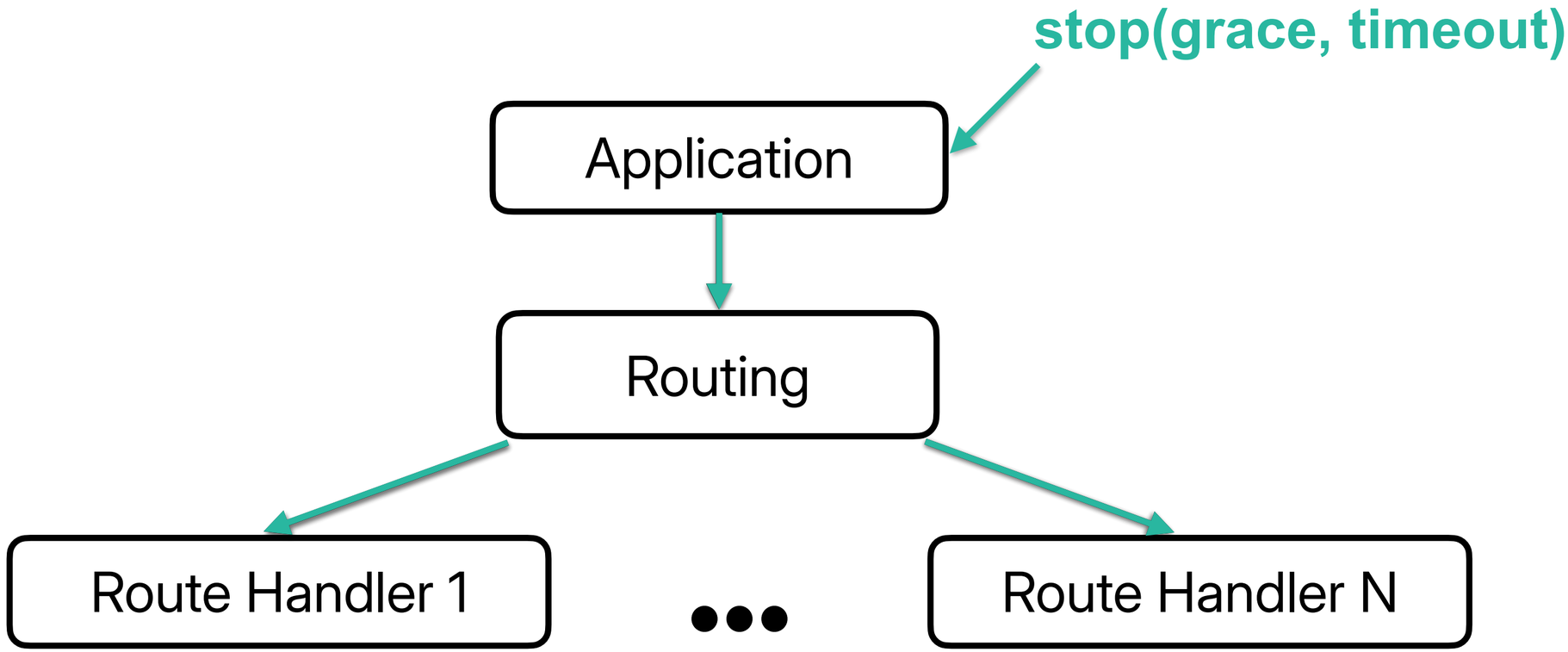
# Application Hierarchy

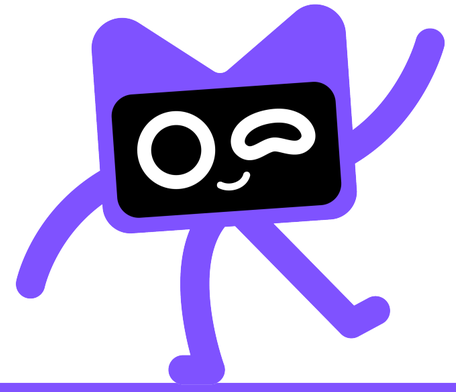



**Unhandled exception caught...**
**500 (Internal Server Error);**



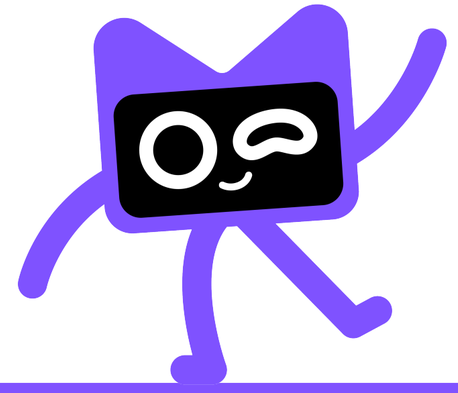
# Application



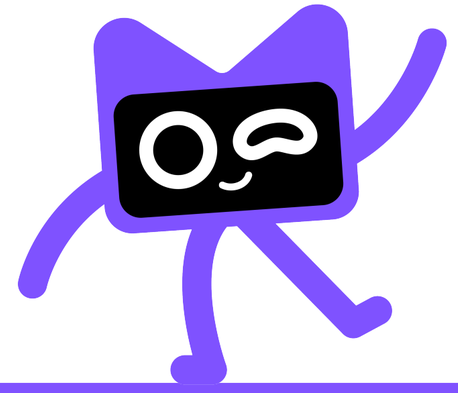
# Application Lifecycle

```
fun Application.scoped() = launch {
    try {
        awaitCancellation()
    } catch (e: CancellationException) {
        println("Server closed")
    }
}
```



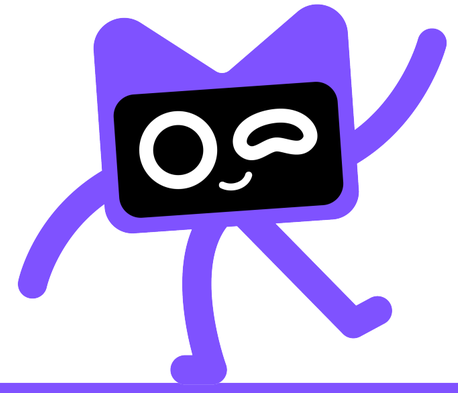
# Application Lifecycle

```
monitor.subscribe(ApplicationStopped) {
    TransactionManager.closeAndUnregister(database)
    dataSource.close()
}
```



# Application Lifecycle

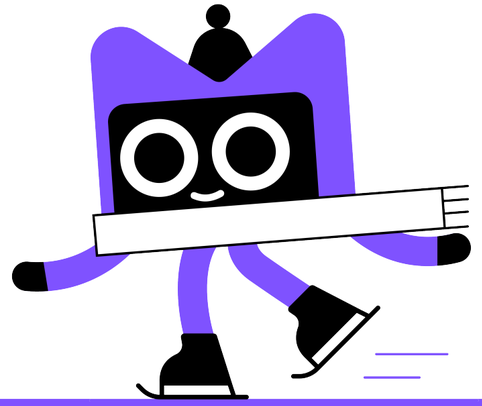
```
class MyService(private val scope: CoroutineScope) {
    fun trackMetrics() = scope.launch {
        /* Some code that runs in parallel */
    }
}

fun Application.module() {
    val service = MyService(this)
}
```



# Authorization Bearer

```
fun HttpClient(tokenProvider: TokenProvider): HttpClient =
    HttpClient {
        install(Auth) {
            bearer {
                loadTokens { tokenProvider.loadTokens() }
                refreshTokens { tokenProvider.refreshToken() }
            }
        }
    }
```

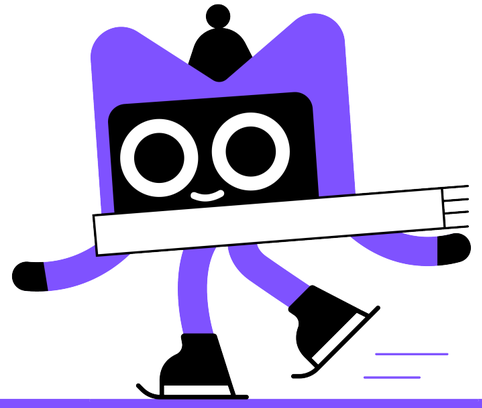
okhttp3.Authenticator



# Auth

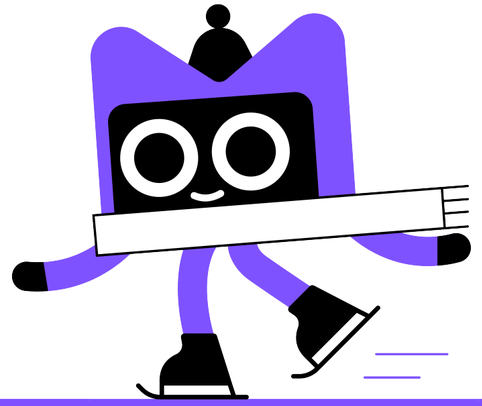
```
@Serializable
data class JwkConfig(val issuer: String, val jwkUrl: String)
```

```
app:
  jwk:
    issuer: "https://accounts.google.com"
    jwkUrl: "https://www.googleapis.com/oauth2/v3/certs"
```



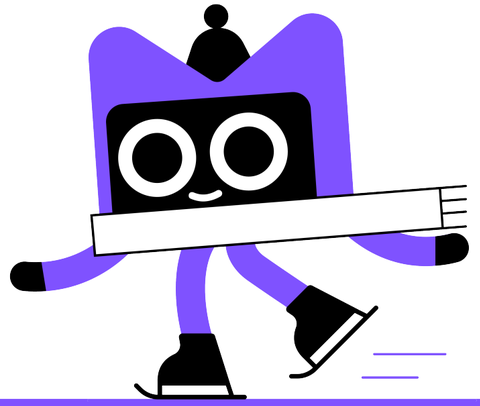
# Auth

```
fun Application.configureJwtAuth(config: JwkConfig) {
    authentication {

    }
}
```



# Auth

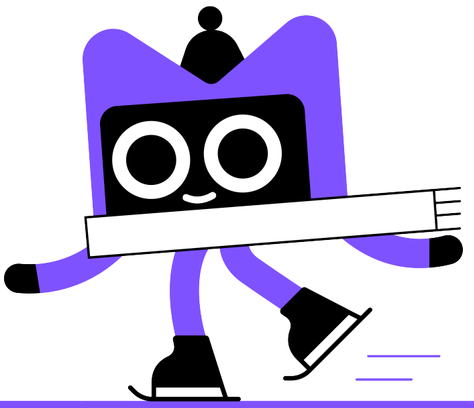
```
fun Application.configureJwtAuth(config: JwkConfig) {
    authentication {
        val jwk = JwkProviderBuilder(URL(config.jwkUrl))
            .cached(10, 24, TimeUnit.HOURS)
            .rateLimited(10, 1, TimeUnit.MINUTES)
            .build()
    }
}
```



# Auth

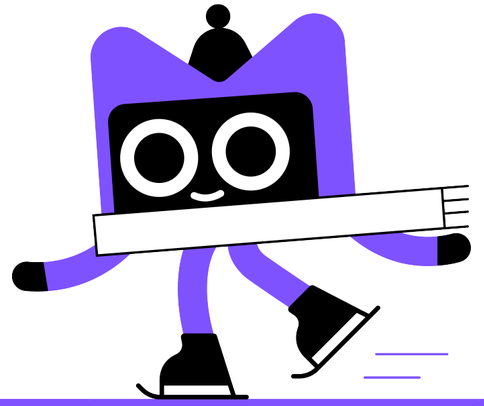
```
fun Application.configureJwtAuth(config: JwkConfig) {
    authentication {
        val jwk = JwkProviderBuilder(URL(config.jwkUrl))
        .cached(10, 24, TimeUnit.HOURS)
        .rateLimited(10, 1, TimeUnit.MINUTES)
        .build()

        jwt("google-jwt") {
            verifier(jwk, config.issuer)
        }
    }
}
```

Verifies signature, issuer, expiration



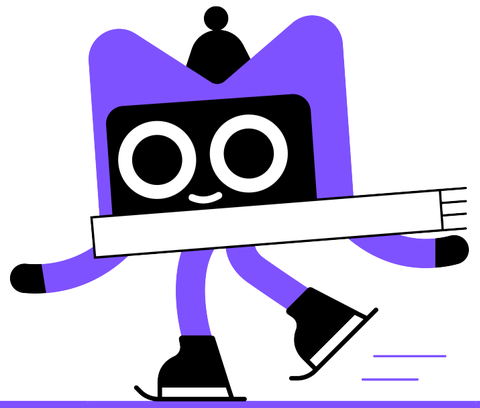
# Auth

```
jwt("google-jwt") {
    verifier(jwk, config.issuer)
    validate { cred: JWTCredential → cred }
}
```



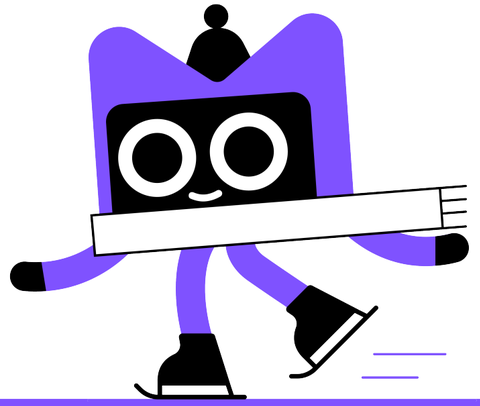
# Auth

```
jwt("google-jwt") {
    verifier(jwk, config.issuer)
    validate { cred: JWTCredential →
        val subject: String? = cred.payload.subject
        if (subject ≠ null) GoogleIdToken(subject, cred.payload)
        else null
    }
}

class GoogleIdToken(
    val subject: String,
    val payload: Payload
)
```



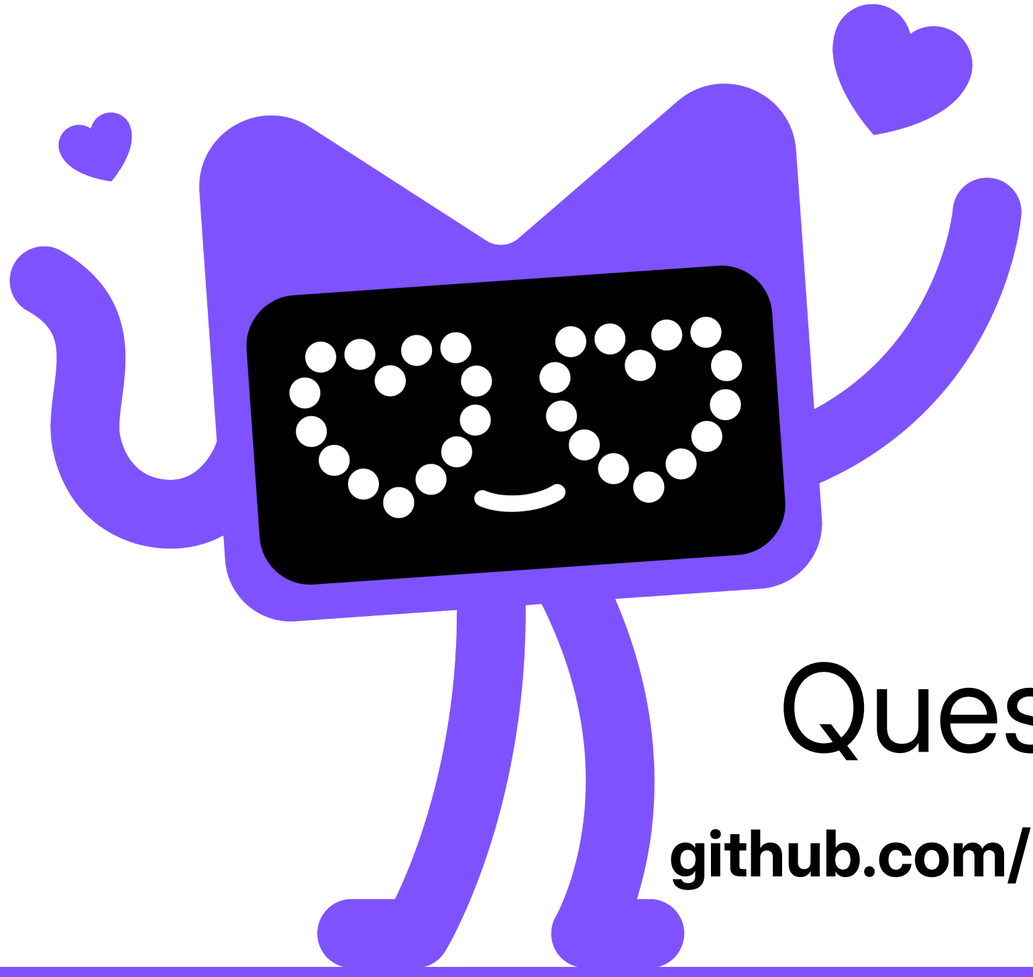
# Auth

```
fun Application.userRoutes(users: UserRepository) = routing {
    authenticate("google-jwt") {
        route("user") {
            get("/") {
                val idToken = call.principal<GoogleIdToken>()!!
                val user = users.findOrNull(idToken.subject)
                if (user ≠ null) call.respond(HttpStatusCode.OK, user)
                else call.respond(HttpStatusCode.NotFound)
            }
        }
    }
}
```



# Full Stack

Ktor



Questions?

github.com/nomisRev/full-stack-ktor-talk