

The Kotlin Programming Language

Andrey Breslav



What is Kotlin?



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- Statically typed



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- object-oriented



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- developed by JetBrains
 - ➔ intended for industrial use
- Docs available today
- Public beta is planned for the end of 2011



Goal-wise...



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- Number of research papers we are planning to publish on Kotlin is



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- Number of research papers we are planning to publish on Kotlin is
 - ➔ Zero



Goal-wise...

- Number of research papers we are planning to publish on Kotlin is
 - ➔ Zero
 - ➔ ... or really close to that



Outline

- Motivation
- Feature overview
- Basic syntax
- Classes and Types
- Higher-order functions
- Type-safe Groovy-style Builders



Motivation



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- Why a new language?



Motivation

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 - ➔ We are not satisfied with the existing ones
 - ➔ And we have had a close look at many of them over 10 years



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 - ➔ **Full Java interoperability**



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 - ➔ **Full Java interoperability**
 - ➔ **Compiles as fast as Java**



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 - ➔ **Full Java interoperability**
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 - ➔ **More concise than Java**



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- Why a new language?
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- Design goals
 - ➔ **Full Java interoperability**
 - ➔ **Compiles as fast as Java**
 - ➔ **Safer than Java**
 - ➔ **More concise than Java**
 - ➔ **Way simpler than Scala**



Feature overview



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- Language features



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 - ➔ Static null-safety guarantees



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 - ➔ Reified generics



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 - ➔ Extension functions



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 - ➔ Modules and Build infrastructure



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 - ➔ Inline-functions (zero-overhead closures)



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 - ➔ Modules and Build infrastructure
 - ➔ Inline-functions (zero-overhead closures)
 - ➔ Pattern matching
 - ➔ ...
- Full-featured IDE by JetBrains from the very beginning



Code examples

- Functions
- Java interoperability
- String templates
- Local variables
- Type inference
- Extension functions and properties
- Null-safety



Hello, world!

```
namespace hello
```

```
fun main(args : Array<String>) : Unit {  
    println("Hello, world!")  
}
```

```
fun println(message : String) {  
    System.out?.println(message)  
}
```



Hello, <names>!

```
fun main(args : Array<String>) {  
    var names : String = ""  
  
    for (i in args.indices) {  
        names += args[i]  
        if (i + 1 < args.size)  
            names += ", "  
    }  
  
    println("Hello, $names!")  
}  
  
val Array<*>.indices : Iterable<Int>  
    get() = IntRange<Int>(0, size - 1)
```



Hello, <names>! (Faster version)

```
fun main(args : Array<String>) {  
    val names = StringBuilder()  
  
    for (i in args.indices) {  
        names += args[i]  
        if (i + 1 < args.size)  
            names += ", "  
    }  
  
    println("Hello, $names!")  
}  
  
fun StringBuilder.plusAssign(s : String) {  
    this.append(s)  
}
```



Hello, <names>! (Realistic version)

```
fun main(args : Array<String>) {  
    println("Hello, ${args.join(", ")}!")  
}  
  
fun <T> Iterable<T>.join(separator : String) : String {  
    val names = StringBuilder()  
    forit (this) {  
        names += it.next()  
        if (it.hasNext())  
            names += separator  
    }  
    return names.toString()  
}
```



join() and forit()

```
fun <T> Iterable<T>.join(separator : String) : String {  
    val names = StringBuilder()  
    forit (this) {  
        names += it.next()  
        if (it.hasNext())  
            names += separator  
    }  
    return names.toString()  
}
```

```
fun <T> forit(col : Iterable<T>, f : fun(Iterator<T>) : Unit) {  
    val it = col.iterator()  
    while (it.hasNext()) {  
        f(it)  
    }  
}
```



Null-safety

```
fun parseInt(s : String) : Int? {  
    try {  
        return Integer.parseInt(s)  
    } catch (e : NumberFormatException) {  
        return null  
    }  
}  
  
fun main(args : Array<String>) {  
    val x = parseInt("123")  
    val y = parseInt("Hello")  
    print(x?.times(2))           // Can't say: print(x * 2)  
  
    if (x != null) {  
        print(x * 2)  
    }  
}
```



Types

Syntax	
Class types	List<Foo>
Nullable types	Foo?
Function types	fun (Int) : String
Tuple types	(Double, Double)
Self type	This

Special types	
Top	Any?
Bottom	Nothing
No meaningful return value	Unit



Mapping to Java types

Kotlin	GEN →	Java	LOAD →	Kotlin
Any		Object		Any?
Unit		void		Unit
Int		int		Int
Int?		Integer		Int?
String		String		String?
Array<Foo>		Foo[]		Array<Foo?>?
Array<Int>		int []		Array<Int>?
Nothing		–		–
Foo		Foo		Foo?



Automatic casts and When

```
fun foo(obj : Any?) {  
    if (obj is String) {  
        obj.get(0)  
    }  
    when (obj) {  
        is String => obj.get(0)  
        is Int => obj.plus(1)  
        !is Boolean => null  
    }  
}
```



More on when-expressions

```
fun bar(x : Int) {  
    when (x) {  
        0 => "Zero"  
        1, 2, 3 => "1, 2 or 3"  
        x + 1 => "Really strange"  
        in 10..100 => "In range"  
        !in 100..1000 => "Out of range"  
    }  
}
```



Classes

```
open class Parent(p : Bar) {  
    open fun foo() {}  
    fun bar() {}  
}
```

```
class Child(p : Bar) : Parent(p) {  
    override fun foo() {}  
}
```

- **Any** is the default supertype
- Constructors must initialize supertypes
- Final by default, explicit override annotations



Traits

```
trait T1 : Class1, OtherTrait {  
    // No state  
}
```

```
class Foo(p : Bar) : Class1(p), T1, T2 {  
    ...  
}
```

```
class Decorator(p : T2) : Class2, T2 by p {  
    ...  
}
```



Disambiguation

```
trait A {  
    fun foo() : Int = 1 // open by default  
}
```

```
open class B() {  
    open fun foo() : Int = 2  
}
```

```
class C() : B(), A {  
    override fun foo() = super<A>.foo()  
}
```



First-class functions

- Functions
 - **fun** f(p : Int) : String
- Function types
 - **fun** (p : Int) : String
 - **fun** (Int) : String
- Function literals
 - {p => p.toString() }
 - {(p : Int) => p.toString() }
 - {(p : Int) : String => p.toString() }



Higher-order functions

```
fun <T> filter(  
    c : Iterable<T>,  
    f : fun(T) : Boolean) : Iterable<T>
```

- `filter(list, {s => s.length < 3})`
 - ➔ Sugar: last function literal argument
 - ◆ `filter(list) {s => s.length < 3}`
 - ➔ Sugar: one-parameter function literal
 - ◆ `filter(list) { it.length < 3 }`



Infix function calls: "LINQ"

```
a.contains(b)
```

// is the same as

```
a contains b
```

```
users
```

```
    filter { it hasPrivilege WRITE }
```

```
    map { it => it.fullName }
```

```
    orderBy { lastName }
```



Lock example (I)

```
myLock.lock()  
  
try {  
    // Do something  
}  
  
finally {  
    myLock.unlock()  
}
```



Lock example (II)

```
lock(myLock) {  
    // Do something  
}
```

```
fun lock(l : Lock, body : fun () : Unit)
```



Lock example (III)

```
inline fun lock(l : Lock, body : fun () : Unit) {  
    myLock.lock()  
    try {  
        body()  
    }  
    finally {  
        myLock.unlock()  
    }  
}
```



Extension functions

- Functions

- **fun** Foo.f(p : Int) : String

- Function types

- **fun** Foo.(p : Int) : String

- **fun** Foo.(Int) : String

- Function literals

- {Foo.(p : Int) => **this**.toString() }

- {Foo.(p : Int) : String => **this**.toString() }



Builders in Groovy

```
html {  
    head {  
        title "XML encoding with Groovy"  
    }  
    body {  
        h1 "XML encoding with Groovy"  
        p "this format can be used as an alternative markup to XML"  
  
        /* an element with attributes and text content */  
        a href: 'http://groovy.codehaus.org' [ "Groovy" ]  
    }  
}
```



Builders in Kotlin

```
html {  
    head {  
        title { +"XML encoding with Kotlin" }  
    }  
    body {  
        h1 { +"XML encoding with Kotlin" }  
        p { +"this format is now type-safe" }  
  
        /* an element with attributes and text content */  
        a(href="http://jetbrains.com/kotlin") { +"Kotlin" }  
    }  
}
```



Builders: Implementation (I)

- Function definition

```
fun html(init : fun HTML.( ) : Unit) : HTML {  
    val html = HTML()  
    html.init()  
    return html  
}
```

- Usage

```
html {  
    this.head { ... }  
}
```



Builders: Implementation (II)

- Function definition

```
fun html(init : fun HTML.( ) : Unit) : HTML {  
    val html = HTML()  
    html.init()  
    return html  
}
```

- Usage

```
html {  
    head { ... }  
}
```



Builders: Implementation (III)

```
abstract class Tag(val name : String) : Element {  
    val children = ArrayList<Element>()  
    val attributes = HashMap<String, String>()  
}
```

```
abstract class TagWithText(name : String) : Tag(name) {  
    fun String.plus() {  
        children.add(TextElement(this))  
    }  
}
```

```
class HTML() : TagWithText("html") {  
    fun head(init : fun Head() : Unit) { }  
    fun body(init : fun Body() : Unit) { }  
}
```



Builders in Kotlin

```
html {  
    head {  
        title { +"XML encoding with Kotlin" }  
    }  
    body {  
        h1 { +"XML encoding with Kotlin" }  
        p { +"this format is now type-safe" }  
  
        /* an element with attributes and text content */  
        a(href="http://jetbrains.com/kotlin") { +"Kotlin" }  
    }  
}
```



Generics: Invariance

```
class List<T> {  
    fun add(t : T)  
    fun get(index : Int) : T  
}
```

```
val ints = List<Int>()
```

```
val anys : List<Any> = ints
```

```
anys.add("1") // Cause of the problem
```

```
val i : Int = ints.get(0) // !!!
```



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```
val i : Int = ints.get(0) // !!!
```



Generics: Declaration-site variance

```
class List<T> {
    fun add(t : T)
    fun get() : T
}
```

```
List<Int> >:< List<Any>
val ints = List<Int>()
val anys : List<Any> = ints
```



```
class Producer<out T> {
    fun get() : T
}
```

```
val ints = Producer<Int>()
val anys : Producer<Any> = ints
```

```
class Consumer<in T> {
    fun add(t : T)
}
```

```
val anys = Consumer<Any>()
val ints : Consumer<Int> = anys
```



Generics: Declaration-site variance

```
class List<T> {
    fun add(t : T)
    fun get() : T
}
```

```
List<Int> >:< List<Any>
val ints = List<Int>()
val anys : List<Any> = ints
```



```
class Producer<out T> {
    fun get() : T
}
```

```
val ints = Producer<Int>()
val anys : Producer<Any> = ints
```



```
class Consumer<in T> {
    fun add(t : T)
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```

```
val anys = Consumer<Any>()
val ints : Consumer<Int> = anys
```



Generics: Declaration-site variance

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class List<T> {
    fun add(t : T)
    fun get() : T
}
```

```
List<Int> >:< List<Any>
val ints = List<Int>()
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```
class Producer<out T> {
    fun get() : T
}
```

```
val ints = Producer<Int>()
val anys : Producer<Any> = ints
```



```
class Consumer<in T> {
    fun add(t : T)
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```

```
val anys = Consumer<Any>()
val ints : Consumer<Int> = anys
```



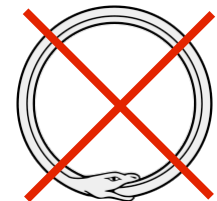
Generics: Use-site variance

```
val ints = List<Int>()
```

```
val anysOut : List<out Any> = ints
```

```
anysOut.add("1") // Not available
```

```
val i : Int = ints.get() // No problem
```



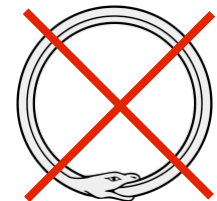
Generics: Use-site variance

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val ints = List<Int>()
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val anysOut : List<out Any> = ints
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```
anysOut.add("1") // Not available
```

```
val i : Int = ints.get() // No problem
```

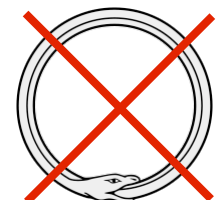


```
val anys = List<Any>()
```

```
val intsIn : List<in Int> = anys
```

```
intsIn.add(0)
```

```
val obj = intsIn.get() // : Any?
```



Reified generics

- Type information is retained at runtime
 - ➔ `foo is List<T>`
 - ➔ `Array<T>(3)`
 - ➔ `T.create()`
- Java types are still erased
 - ➔ `foo is java.util.List<*>`



Resources

- Documentation:
 - ➔ <http://jetbrains.com/kotlin>
- Blog:
 - ➔ <http://blog.jetbrains.com/kotlin>
- Twitter:
 - ➔ @project_kotlin
 - ➔ @abreslav

