

Kotlin support for compilation directly to JavaScript (i.e., the classic back-end) is considered stable since Kotlin 1.3 by its developers, while the new Kotlin/JS(IR) is in beta as of version 1.5.30. The new optimized implementations of Kotlin/JVM(IR) and Kotlin/JS (IR-based) were introduced in version 1.4. Kotlin/JVM(IR) is considered stable as of the version 1.5 release. Kotlin/Native (for e.g. Apple silicon support) has been considered beta since version 1.3.^{[9][10]}

Classes are final by default

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- [WebAssembly](#)
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OS	Cross-platform
License	Apache License 2.0
Filename extensions	.kt, .kts, .ktm
Website	kotlinlang.org (https://kotlinlang.org)
Influenced by	
C# · Eiffel · Gosu · Groovy · Java · JavaScript · ML · Python · Scala	

History

In July 2011, [JetBrains](#) unveiled Project Kotlin, a new language for the JVM, which had been under development for a year.^[11] JetBrains lead Dmitry Jemerov said that most languages did not have the features they were looking for, with the exception of [Scala](#). However, he cited the slow [compilation](#) time of Scala as a deficiency.^[11] One of the stated goals of Kotlin is to compile as quickly as Java. In February 2012, JetBrains open sourced the project under the [Apache 2 license](#).^[12]

The name comes from [Kotlin Island](#), near [St. Petersburg](#). [Andrey Breslav](#) mentioned that the team decided to name it after an island, just like Java was named after the Indonesian island of [Java](#)^[13] (though the programming language Java was perhaps named after the coffee named after the island).^[14]

JetBrains hopes that the new language will drive [IntelliJ IDEA](#) sales.^[15]

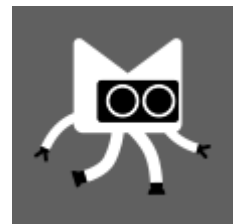
Kotlin v1.0 was released on February 15, 2016.^[16] This is considered to be the first officially stable release and JetBrains has committed to long-term backwards compatibility starting with this version.

At [Google I/O 2017](#), Google announced first-class support for Kotlin on [Android](#).^[17]

Kotlin v1.2 was released on November 28, 2017.^[18] Sharing code between JVM and JavaScript platforms feature was newly added to this release (as of version 1.4 multiplatform programming is an [alpha feature](#)^[19] upgraded from "experimental"). A [full-stack](#) demo has been made with the new Kotlin/JS Gradle Plugin.^{[20][21]}

Kotlin v1.3 was released on October 29, 2018, bringing coroutines for asynchronous programming.

On May 7, 2019, Google announced that the Kotlin programming language is now its preferred language for Android app developers.^[7]



A 2D picture of Kotlin mascot



A 3D picture of Kotlin mascot

Kotlin v1.4 was released in August 2020, with e.g. some slight changes to the support for Apple's platforms, i.e. to the Objective-C/Swift interop.^[22]

Kotlin v1.5 was released in May 2021.

Kotlin v1.6 was released in November 2021.

Design

Development lead Andrey Breslav has said that Kotlin is designed to be an industrial-strength object-oriented language, and a "better language" than Java, but still be fully interoperable with Java code, allowing companies to make a gradual migration from Java to Kotlin.^[23]

Semicolons are optional as a statement terminator; in most cases a newline is sufficient for the compiler to deduce that the statement has ended.^[24]

Kotlin variable declarations and parameter lists have the data type come after the variable name (and with a colon separator), similar to BASIC, Pascal, TypeScript and Rust. This, according to an article from Roman Elizarov, current project lead, results in alignment of variable names and is more pleasing to eyes especially when there are a few variable declarations in succession and one or more of the types is too complex for type inference or needs to be declared explicitly for human readers to understand.^{[25][26]}

Variables in Kotlin can be read-only, declared with the `val` keyword, or mutable, declared with the `var` keyword.^[27]

Class members are public by default, and classes themselves are final by default, meaning that creating a derived class is disabled unless the base class is declared with the `open` keyword.

In addition to the classes and member functions (equivalent to methods) of object-oriented programming, Kotlin also supports procedural programming with the use of functions.^[28] Kotlin functions (and constructors) support default arguments, variable-length argument lists, named arguments and overloading by unique signature. Class member functions are virtual, i.e. dispatched based on the runtime type of the object they are called on.

Kotlin 1.3 adds (stable in stdlib; user-defined contracts experimental) support for contracts^[29] (inspired by Eiffel's design by contract^[30] programming paradigm)

According to Kotlin developers, you can call JavaScript code from Kotlin, e.g. write full, type-safe React applications, or write and maintain full-stack web applications sharing validation logic with the frontend, or you can "generate libraries from your Kotlin code that can be consumed as modules from any code base written in JavaScript or TypeScript".^[31]

Syntax

Procedural programming style

Kotlin relaxes Java's restriction of allowing static methods and variables to exist only within a class body. Static objects and functions can be defined at the top level of the package without needing a redundant class level. For compatibility with Java, Kotlin provides a `JvmName` annotation which specifies a class name used when the package is viewed from a Java project. For example, `@file:JvmName("JavaClassName")`.

Main entry point

As in C, C++, C#, Java, and Go, the entry point to a Kotlin program is a function named "main", which may be passed an array containing any command-line arguments. This is optional since Kotlin 1.3.^[32] Perl, PHP and Unix shell style string interpolation is supported. Type inference is also supported.

```

1 // Hello, World! example
2 fun main() {
3     val scope = "World"
4     println("Hello, $scope!")
5 }
6
7 fun main(args: Array<String>) {
8     for (arg in args)
9         println(arg)
10 }
```

Extension functions

Similar to C#, Kotlin allows adding an extension function to any class without the formalities of creating a derived class with new functions. An extension function has access to all the public interface of a class, which it can use to create a new function interface to a target class. An extension function will appear exactly like a function of the class and will be shown in code completion inspection of class functions. For example:

```

1 package MyStringExtensions
2
3 fun String.lastChar(): Char = get(length - 1)
4
5 >>> println("Kotlin".lastChar())
```

By placing the preceding code in the top-level of a package, the String class is extended to include a lastChar function that was not included in the original definition of the String class.

```

1 // Overloading '+' operator using an extension function
2 operator fun Point.plus(other: Point): Point {
3     return Point(x + other.x, y + other.y)
4 }
5
6 >>> val p1 = Point(10, 20)
7 >>> val p2 = Point(30, 40)
8 >>> println(p1 + p2)
9 Point(x=40, y=60)
```

Unpack arguments with spread operator

Similar to Python, the spread operator asterisk (*) unpacks an array's contents as comma-separated arguments to a function:

```

1 fun main(args: Array<String>) {
2     val list = listOf("args: ", *args)
3     println(list)
4 }
```

Destructuring declarations

Destructuring declarations decompose an object into multiple variables at once, e.g. a 2D coordinate object might be *destructured* into two integers, x and y.

For example, the `Map.Entry` object supports destructuring to simplify access to its key and value fields:

```
1 for ((key, value) in map)
2     println("$key: $value")
```

Nested functions

Kotlin allows local functions to be declared inside of other functions or methods.

```
1 class User(val id: Int, val name: String, val address: String)
2
3 fun saveUserToDb(user: User) {
4     fun validate(user: User, value: String, fieldName: String) {
5         require(value.isNotEmpty()) { "Can't save user ${user.id}: empty $fieldName" }
6     }
7
8     validate(user, user.name, "Name")
9     validate(user, user.address, "Address")
10    // Save user to the database
11    ...
12 }
```

Classes are final by default

In Kotlin, to derive a new class from a base class type, the base class needs to be explicitly marked as "open". This is in contrast to most object-oriented languages such as Java where classes are open by default.

Example of a base class that is open to deriving a new subclass from it.

```
1 // open on the class means this class will allow derived classes
2 open class MegaButton {
3
4     // no-open on a function means that
5     // polymorphic behavior disabled if function overridden in derived class
6     fun disable() { ... }
7
8     // open on a function means that
9     // polymorphic behavior allowed if function is overridden in derived class
10    open fun animate() { ... }
11 }
12
13 class GigaButton: MegaButton {
14
15     // Explicit use of override keyword required to override a function in derived class
16    override fun animate() { println("Giga Click!") }
17 }
```

Abstract classes are open by default

Abstract classes define abstract or "pure virtual" placeholder functions that will be defined in a derived class. Abstract classes are open by default.

```
1 // No need for the open keyword here, it's already open by default
2 abstract class Animated {
3
4     // This virtual function is already open by default as well
5     abstract fun animate()
6
7     open fun stopAnimating() { }
8
9     fun animateTwice() { }
10 }
```

Classes are public by default

Kotlin provides the following keywords to restrict visibility for top-level declaration, such as classes, and for class members: `public`, `internal`, `protected`, and `private`.

When applied to a class member:

Keyword	Visibility
<code>public</code> (default)	Everywhere
<code>internal</code>	Within a module
<code>protected</code>	Within subclasses
<code>private</code>	Within a class

When applied to a top-level declaration:

Keyword	Visibility
<code>public</code> (default)	Everywhere
<code>internal</code>	Within a module
<code>private</code>	Within a file

Example:

```
1 // Class is visible only to current module
2 internal open class TalkativeButton : Focusable {
3     // method is only visible to current class
4     private fun yell() = println("Hey!")
5
6     // method is visible to current class and derived classes
7     protected fun whisper() = println("Let's talk!")
8 }
```

Primary constructor vs. secondary constructors

Kotlin supports the specification of a "primary constructor" as part of the class definition itself, consisting of an argument list following the class name. This argument list supports an expanded syntax on Kotlin's standard function argument lists, that enables declaration of class properties in the primary constructor, including visibility, extensibility and mutability attributes. Additionally, when defining a subclass, properties in super-interfaces and super-classes can be overridden in the primary constructor.

```
1 // Example of class using primary constructor syntax
2 // (Only one constructor required for this class)
3 open class PowerUser(
```

```

4     protected val nickname: String,
5     final override var isSubscribed: Boolean = true)
6     : User(...) {
7         ...
8     }

```

However, in cases where more than one constructor is needed for a class, a more general constructor can be used called **secondary constructor syntax** which closely resembles the constructor syntax used in most object-oriented languages like C++, C#, and Java.

```

1 // Example of class using secondary constructor syntax
2 // (more than one constructor required for this class)
3 class MyButton : View {
4
5     // Constructor #1
6     constructor(ctx: Context) : super(ctx) {
7         // ...
8     }
9
10    // Constructor #2
11    constructor(ctx: Context, attr: AttributeSet) : super(ctx, attr) {
12        // ...
13    }
14 }

```

Sealed classes

The Sealed classes and interfaces restrict the subclass hierarchies, meaning more control over the inheritance hierarchy.

Declaration of sealed interface and class:

```

1 sealed interface Expr
2 sealed class Job

```

All the subclasses of the sealed class are defined at compile time. No new subclasses can be added to it after the compilation of the module having the sealed class. For example, a sealed class in a compiled jar file cannot be subclassed.

```

1 sealed class Vehicle
2 data class Car(val brandName: String, val owner: String, val color: String): Vehicle()
3 class Bike(val brandName: String, val owner: String, val color: String): Vehicle()
4 class Tractor(val brandName: String, val owner: String, val color: String): Vehicle()
5 val kiaCar = Car("KIA", "John", "Blue")
6 val hyundaiCar = Car("Hyundai", "Britto", "Green")

```

Data classes

Kotlin's `data class` construct defines classes whose primary purpose is storing data. This construct is similar to normal classes except that the key functions `equals`, `toString`, and `hashCode` are automatically generated from the class properties. In Java, such classes are expected to provide a standard assortment of functions such as those. Data classes are not required to declare any methods, though each must have at least one property. A data class often is written without a body, though it is possible to give a data class any methods or secondary constructors that are valid for any other class. The `data` keyword is used before the `class` keyword to define a data class.^[33]

```

1 fun main(args: Array) {
2     // create a data class object like any other class object
3     var book1 = Book("Kotlin Programming", 250)
4     println(book1)
5     // output: Book(name=Kotlin Programming, price=250)
6 }
7
8 // data class with parameters and their optional default values
9 data class Book(val name: String = "", val price: Int = 0)

```

Kotlin interactive shell

```

$ kotlinc-jvm
type :help for help; :quit for quit
>>> 2 + 2
4
>>> println("Hello, World!")
Hello, World!

```

Kotlin as a scripting language

Kotlin can also be used as a scripting language. A script is a Kotlin source file (.kts) with top level executable code.

```

1 // list_folders.kts
2 import java.io.File
3 val folders = File(args[0]).listFiles { file -> file.isDirectory() }
4 folders?.forEach { folder -> println(folder) }

```

Scripts can be run by passing the `-script` option and the corresponding script file to the compiler.

```
$ kotlinc -script list_folders.kts "path_to_folder_to_inspect"
```

Null safety

Kotlin makes a distinction between nullable and non-nullable data types. All nullable objects must be declared with a "?" postfix after the type name. Operations on nullable objects need special care from developers: null-check must be performed before using the value. Kotlin provides null-safe operators to help developers:

- `?.` (safe navigation operator) can be used to safely access a method or property of a possibly null object. If the object is null, the method will not be called and the expression evaluates to null.
- `?:` (null coalescing operator) often referred to as the Elvis operator:

```

1 fun sayHello(maybe: String?, neverNull: Int) {
2     // use of elvis operator
3     val name: String = maybe ?: "stranger"
4     println("Hello $name")
5 }

```

An example of the use of the safe navigation operator:


```

1 // returns null if...
2 // - foo() returns null,
3 // - or if foo() is non-null, but bar() returns null,
4 // - or if foo() and bar() are non-null, but baz() returns null.
5 // vice versa, return value is non-null if and only if foo(), bar() and baz() are non-null
6 foo()?.bar()?.baz()

```

Lambdas

Kotlin provides support for higher-order functions and anonymous functions or lambdas.^[34]

```

1 // the following function takes a lambda, f, and executes f passing it the string "lambda"
2 // note that (String) -> Unit indicates a lambda with a String parameter and Unit return type
3 fun executeLambda(f: (String) -> Unit) {
4     f("lambda")
5 }

```

Lambdas are declared using braces, `{ }`. If a lambda takes parameters, they are declared within the braces and followed by the `->` operator.

```

1 // the following statement defines a lambda that takes a single parameter and passes it to the
  println function
2 val l = { c : Any? -> println(c) }
3 // lambdas with no parameters may simply be defined using { }
4 val l2 = { print("no parameters") }

```

Complex "hello world" example

```

1 fun main(args: Array<String>) {
2     greet {
3         to.place
4     }.print()
5 }
6
7 // Inline higher-order functions
8 inline fun greet(s: () -> String) : String = greeting andAnother s()
9
10 // Infix functions, extensions, type inference, nullable types,
11 // lambda expressions, labeled this, Elvis operator (?:)
12 infix fun String.andAnother(other : Any?) = buildString()
13 {
14     append(this@andAnother); append(" "); append(other ?: "")
15 }
16
17 // Immutable types, delegated properties, lazy initialization, string templates
18 val greeting by lazy { val doubleEl: String = "ll"; "he${doubleEl}o" }
19
20 // Sealed classes, companion objects
21 sealed class to { companion object { val place = "world" } }
22
23 // Extensions, Unit
24 fun String.print() = println(this)

```

Tools

- IntelliJ IDEA has plug-in support for Kotlin.^[35] IntelliJ IDEA 15 was the first version to bundle the Kotlin plugin in the IntelliJ Installer, and provide Kotlin support out of the box.^[36]
- JetBrains also provides a plugin for Eclipse.^{[37][38]}

- Integration with common Java build tools is supported including [Apache Maven](#),^[39] [Apache Ant](#),^[40] and [Gradle](#).^[41]
- [Android Studio](#) (based on IntelliJ IDEA) has official support for Kotlin, starting from Android Studio 3.^[42]
- [Emacs](#) has a Kotlin Mode in its Melpa package repository.
- [Vim](#) has a plugin maintained on GitHub.^[43]
- [Json2Kotlin](https://json2kotlin.com/) (<https://json2kotlin.com/>) generates [POJO](#) style native Kotlin code for web service response mapping.

Applications

When Kotlin was announced as an official Android development language at [Google I/O](#) in May 2017, it became the third language fully supported for Android, in addition to Java and C++.^[44] As of 2020, Kotlin is still most widely used on Android, with Google estimating that 70% of the top 1000 apps on the Play Store are written in Kotlin. Google itself has 60 apps written in Kotlin, including Maps and Drive. Many Android apps, such as Google's Home, are in the process of being migrated to Kotlin, and so use both Kotlin and Java. Kotlin on Android is seen as beneficial for its null-pointer safety as well as for its features that make for shorter, more readable code.^[45]

In addition to its prominent use on Android, Kotlin is gaining traction in server-side development. The [Spring Framework](#) officially added Kotlin support with version 5 on 4 January 2017.^[46] To further support Kotlin, Spring has translated all its documentation to Kotlin and added built-in support for many Kotlin-specific features such as coroutines.^[47] In addition to Spring, JetBrains has produced a Kotlin-first framework called Ktor for building web applications.^[48]

In 2020, JetBrains found in a survey of developers who use Kotlin that 56% were using Kotlin for mobile apps, while 47% were using it for a web back-end. Just over a third of all Kotlin developers said that they were migrating to Kotlin from another language. Most Kotlin users were targeting Android (or otherwise on the JVM), with only 6% using Kotlin Native.^[49]

Adoption

In 2018, Kotlin was the fastest growing language on GitHub with 2.6 times more developers compared to 2017.^[50] It is the fourth most loved programming language according to the 2020 Stack Overflow Developer Survey.^[51]

Kotlin was also awarded the O'Reilly Open Source Software Conference Breakout Award for 2019.^[52]

Many companies/organizations have used Kotlin for backend development:

- [Google](#)^[53]
- [Norwegian Tax Administration](#)^[54]
- [Gradle](#)^[55]
- [Amazon](#)^[56]
- [Square](#)^[57]
- [JetBrains](#)^[58]
- [Flux](#)^[59]
- [Allegro](#)^[60]
- [OLX](#)^[61]

- [Shazam](#)^[62]
- [Pivotal](#)^[63]
- [Rocket Travel](#)^[64]
- [Meshcloud](#)^[65]
- [Zalando](#)^[66]

Some companies/organizations have used Kotlin for web development:

- [JetBrains](#)^[67]
- [Data2viz](#)^[68]
- [Fritz2](#)^[69]
- [Barclay's Bank](#)^[70]

A number of companies have publicly stated they were using Kotlin:

- [DripStat](#)^[71]
- [Basecamp](#)^[72]
- [Pinterest](#)^[73]
- [Coursera](#)^[74]
- [Netflix](#)^[75]
- [Uber](#)^[76]
- [Square](#)^[77]
- [Trello](#)^[78]
- [Duolingo](#)^[79]
- [Corda](#), a distributed ledger developed by a consortium of well-known banks (such as [Goldman Sachs](#), [Wells Fargo](#), [J.P. Morgan](#), [Deutsche Bank](#), [UBS](#), [HSBC](#), [BNP Paribas](#), [Société Générale](#)), has over 90% Kotlin code in its codebase.^[80]

See also

- [Comparison of programming languages](#)

References

- This article contains quotations from Kotlin tutorials which are released under an Apache 2.0 license.
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- [Official website \(https://kotlinlang.org/\)](https://kotlinlang.org/) 

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