



Kotlin

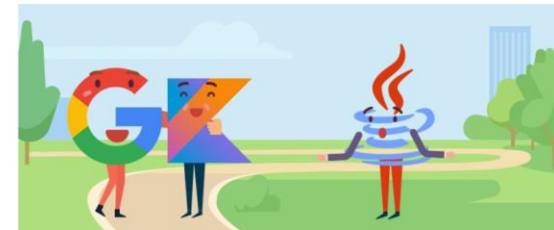
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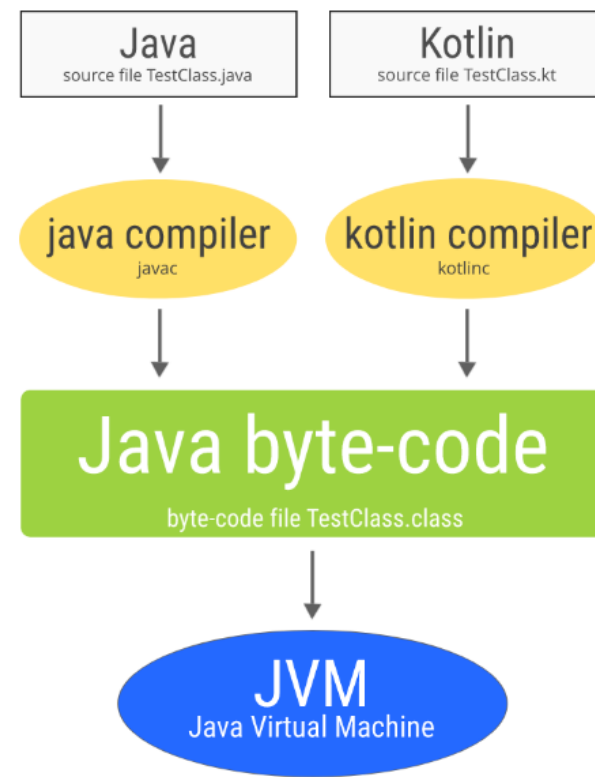


Highlights of Kotlin

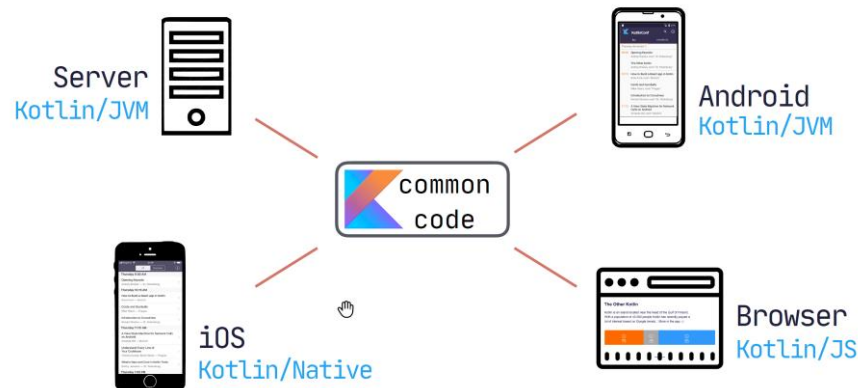
- Statically typed language: Type **validation** at compile time
- Supports **Type Inference**: type automatically determined from the context
- Much more concise and readable code than Java
- Runs on Java JVM
 - Interoperable with Java code + libraries
 - But can also be compiled to JavaScript and iOS Swift
- Both **functional** and **object-oriented**
- Started in 2011 by JetBrains
 - Kotlin v1.0 was released on 15 February 2016
 - On 7 May 2019, Google announced that the Kotlin as its preferred language for Android app development
 - Current version 1.9 (released August 23, 2023)



How does it work after all?



Can target other platforms



Declaring Variables

val vs. var

- **val** is **immutable** (read-only) and you can only assign a value to them exactly one time
- **var** is **mutable** and can be reassigned

// val means final - cannot change once initialized

```
val name = "Ali"
```

```
val c: Int
```

```
c = 1
```

//Mutable - can be changed

```
var x = 5
```

```
x += 1
```

/ Type is auto-inferred - The variable datatype is derived from the assigned value */*

```
val city = "Doha"
```

Main Data Types

- Integer types: Byte, Short, Int, Long
- Unsigned integers: UByte, UShort, UInt, ULong
- Floating-point types: Float, Double
- Boolean
- Char
- String
- Any (equivalent to Object in Java)

Strings

//Strings and String Template

```
val firstName = "Ali"  
val lastName = "Faleh"
```

- **String Template** allow creating dynamic templated string with placeholders (instead of string concatenation!)
 - Simple reference uses **\$** and an expression uses **\${}**

```
val fullName = "$firstName $lastName"  
val sum = "2 + 2 = ${2 + 2}"
```

//Multiline Strings

```
val multiLinesStr = """  
    First name: $firstName  
    Last name: $lastName  
    """
```


Convert a number to a string

- Use number's *toString* method

```
val num = 10
```

```
val str = num.toString()
```

Convert a string to a number

- Use string's *toInt* method

```
num = str.toInt()
```

Smart Cast

```
var myVar: Any = "Ali"  
//Smart auto-cast  
if (myVar is String) {  
    println(myVar.last())  
}
```

Nullable Types

- By default, variables in Kotlin are **non-nullable**
- Nullable variables are declared **explicitly** to accept a null using **?** after the data type
- **Syntax:**
 - `val iCannotBeNull = "Not Null"`
 - `val iCanBeNull: String? = null`
- `val nullableName: String = null`
 - Compilation Error: Can't assign null to a non-null String
- `val nullableName: String? = null`
 - Compiles ok



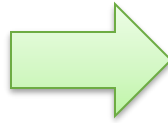
Null Safety

- Safe calls:

```
val len = if (name != null) {  
    name.length  
}
```

Safe accessor (?)

```
val len = name?.length
```



- Chaining:

```
student1?.department?.head?.name
```

- Elvis Operator (?:)

```
val len = if (name != null) name.length else 0
```

```
// Better syntax is to use the Elvis operator (?:)
```

```
val len = name?.length ?: 0
```

```
// !! means access it as non-null and throw an exception if null
```

```
val len = name!!.length
```

Best way for Null Safety

```
val name : String? = "Ali"  
// ** Best 👍 ** : Checking for null using the 'let' operator  
// The 'let' block only executes if 'name' is not null  
name?.let {  
    // 'it' is the non-null value stored in 'name'  
    println("$it is not null")  
}
```

Comments

// slash slash line comment

*/**

slash star

block comment

**/*

Control Flow: if, when expressions



if-else expression

```
val age = 20
```

```
// Using 'if' as an expression
```

```
val ageCategory = if (age < 18) {  
    "Teenager"  
} else {  
    "Young Adult"  
}
```

When expression

- Assign a value based on matching condition

```
val month = 8
val season = when (month) {
    12, 1, 2 -> "Winter"
    in 3..5 -> "Spring"
    in 6..8 -> "Summer"
    in 9..11 -> "Autumn"
    else -> "Invalid Month"
}
```


Equals & reference equality

```
val set1 = setOf(1, 2, 3)  
val set2 = setOf(1, 2, 3)
```

calls equals

```
set1 == set2
```

true

checks reference equality

```
set1 === set2
```

false

- `===` return true only if both variables hold a reference to the same object

while (...)
do { ... }
for { ... }
Loops

Execute Blocks of Code Multiple Times



While Loop

- While Loop:

```
while (condition) {  
    statements  
}
```



- Do-While Loop:

```
do {  
    statements  
}  
while (condition)
```

for Loop Example

```
val names = listOf("Sara", "Fatima", "Ali")
```

```
for (name in names) {  
    println(name)  
}
```

// Loop with index and value

```
for ( (idx, value) in names.withIndex()) {  
    println("$idx -> $value")  
}
```

Ranges

- Usually defined by: `1..100`
- `1 until 100` // Range excludes 100
- Negative step: `100 downTo 40`
- Decrement by 3
`100 downTo 40 step 3`

Caution!

```
val notARange = 100 to 40
// => Pair(100, 40)
```

- To check if a value belongs to the range:
`val is5inRange = 5 in range`

Ranges

```
if (i in 1..10) { // 1 <= i && i <= 10    for (i in 1..4 step 2) print(i) // "13"
    println(i)
}

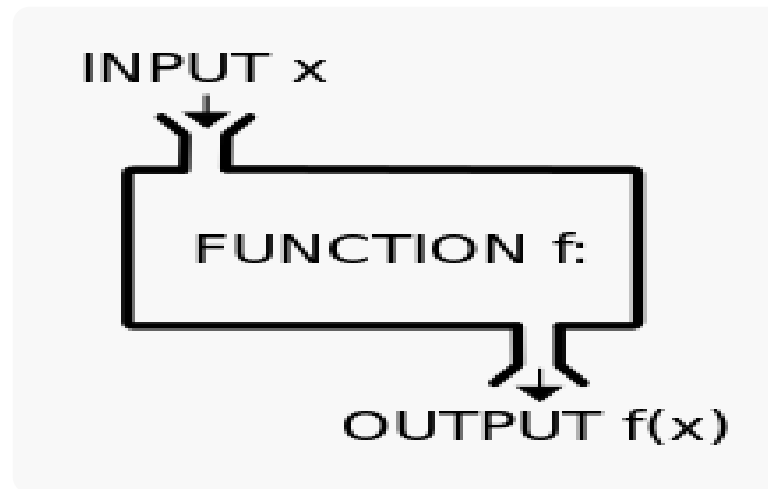
for (i in 1..4) print(i) // "1234"

for (i in 4 downTo 1 step 2)
    print(i) // "42"

for (i in 4..1) print(i) // No Output
for (i in 4 downTo 1)
    print(i) // "4321"

// i in [1, 10), 10 is excluded
for (i in 1 until 10) {
    println(i)
}
```

Functions



Functions

- Can be declared at the **top level** of a file (without belonging to a class)
- Can have a **block or expression body**
- Can have default parameter values to avoid method overloading
- Can use **named** arguments in a function call

```
fun max(a: Int, b: Int): Int { //name - parameters - return type
|   return if(a>b) a else b    //function block body
}
```

```
fun max(a: Int, b: Int) = if(a>b) a else b //expression body
```

```
max(a = 1, b = 2) //call with named arguments
```

```
max(a: 1, b: 2)
```


Functions

// Function with block body

```
fun sum(a: Int, b: Int): Int {  
    return a + b  
}
```

// Function with expression body

// Omit return type

```
fun sum(a: Int, b: Int) = a + b
```

//Arrow function - called Lambda expression

```
val sum = { a: Int, b: Int -> a + b }
```

Unit return type

- When defining a function that doesn't return a value, we can use **Unit** as the return type (Unit is equivalent to void in Java)
 - Specifying Unit as a return type is NOT mandatory can omit it

```
fun display(value : Any) : Unit {  
    println(value)  
}
```

Use default parameters instead of overloads

```
fun print() {  
    print(",")  
}
```

```
fun print(separator: String) {  
}
```

```
fun main() {  
    print("|")  
}
```

```
fun print(separator: String = ",") {  
}
```

```
fun main() {  
    print(separator = "|")  
}
```

Extension Function

- Enable adding functions and properties to existing classes

// Extension method extending Int class

```
fun Int.isEven() = this % 2 == 0
```

```
fun main() {  
    val num = 10  
    println("Is $num even: ${num.isEven()}")  
}
```

Extension Function Example

```
fun String.lastChar() = this.get(this.length - 1)
```



this can be omitted

```
fun String.lastChar() = get(length - 1)
```

```
val c: Char = "abc".l
```

- λ lastChar() for String in com
- λ last {...} (predicate: (Char
- λ last() for String in kotlin
- λ lastOrNull {...} (predicate:
- λ lastOrNull() for String in k
- ✓ length

Infix function calls

- Functions marked with the **infix** keyword can be called using the infix notation (omitting the dot and the parentheses for the call)
- Infix function must satisfy 3 requirements:
 - Must be member function or extension function.
 - Must have a single parameter.
 - The parameter must not accept a variable number of arguments

```
infix fun Int.add(b : Int) : Int = this + b
```

```
fun main() {  
    val x = 10.add(20)  
    val y = 10 add 20    // infix call  
}
```

Exceptions

- Throw:

```
throw Exception("Invalid input")
```

- Handling

```
try {  
}  
catch (e: Exception) {  
}  
finally {  
}
```

- Expression

```
val num = try { input.toInt() }  
          catch (e: NumberFormatException){ null }
```

OOP


Java Class vs. Kotlin Class

```
public class Person {  
    private final String name;  
    private final int age;  
  
    public Person(String name, int age) {  
        this.name = name;  
        this.age = age;  
    }  
  
    public String getName() {  
        return name;  
    }  
  
    public int getAge() {  
        return age;  
    }  
}
```

person.getName() 


 Concise primary constructor

```
class Person(  
    val name: String,  
    val age: Int  
)
```

person.name 

Class

```
class Person(val firstName: String,  
             val lastName: String,  
             val age: Int) {  
    val fullName: String  
        get() = "$firstName $lastName"  
    fun isUnderAge() = age < 18  
}
```



Properties

- **Instantiate:**

```
val student = Person ("Fatima", "Ali", 18)
```

- **Named arguments:**

```
val student = Person (firstName = "Fatima",  
                      lastName = "Ali", 18)
```

Properties are directly accessible without getters / setters

- `val` – read only properties
- `var` – read/write properties
- The primary constructor **cannot** contain any code.

```
class Person(val firstName: String,  
             val lastName: String,  
             var age: Int) {  
    val fullName: String  
        get() = "$firstName $lastName"  
    fun isUnderAge() = age < 18  
}
```

```
val student = Person ("Fatima", "Ali", 18)  
student.age = 20
```

Class with a computed property

```
class Rectangle(val height: Int, val width: Int) {  
    val isSquare: Boolean  
        get() {  
            return height == width  
        }  
}
```

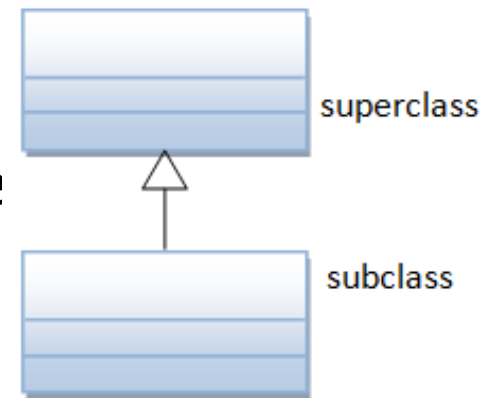
Secondary Constructor

```
class Conference(val name: String,  
                 val city: String,  
                 val isFree: Boolean = true) {  
    var fee : Double = 0.0  
  
    // Secondary Constructor  
    constructor(name: String,  
                city: String,  
                fee: Double) : this(name, city, false) {  
        this.fee = fee  
    }  
}  
  
fun main() {  
    al conference = Conference("Kotlin Conf.", "Doha", 200.0)  
}
```

Inheritance

- **Ideas**

- Common properties and methods are placed in a **superclass** (also called *parent class* or *base class*)
- You can create a subclass that **inherits** the properties and methods of the super class
 - Subclass also called *child class* or *derived class*
- Subclass can extend the superclass by **adding new properties/methods** and/or **overriding the superclass methods**



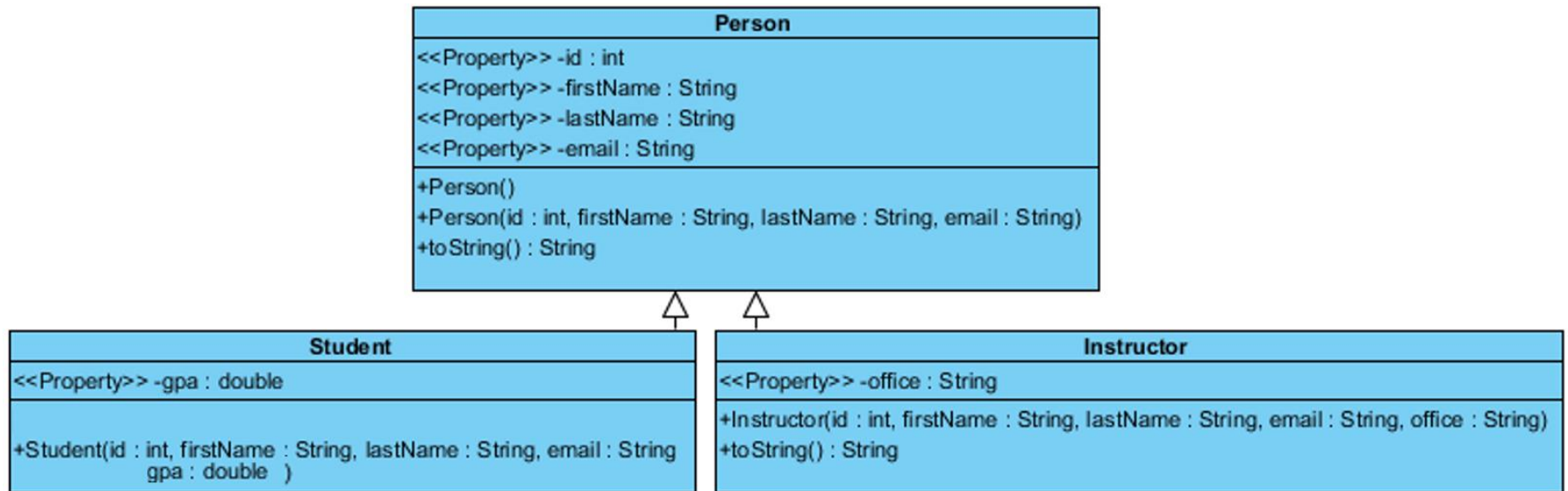
- **Syntax**

```
class SubClass( ... ) : SuperClass( ... ) { ... }
```

- **Motivation**

- Allow **code reuse**. **Common properties and methods are placed in a super class** then inherited by subclasses (i.e., avoids writing the same code twice to ease maintenance)

Inheritance – Person Example



- The Person class has the common properties and methods
- Each subclass can add its own specific properties and methods (e.g., **office** for Instructor and **gpa** for Student)
- Each subclass can **override** (redefine) the parent method (e.g., Instructor class overrode the `toString()` method).

Inheritance – Person Example

```
open class Person( ... ) { ... }
```

```
class Student(firstName: String,  
              lastName: String,  
              age: Int,  
              val gpa: Double  
              ) : Person(firstName, lastName, age) {  
  
    /*  
    - Override a base class method  
    - super keyword to call the implementation of the base class  
    */  
    override fun toString() = "${super.toString()}. GPA: ${gpa}"  
}
```

- Add **open** keyword to the base class and to properties and methods to be overridden

Data Classes

- Data classes provide autogenerated implementations of **equals()**, **hashCode()**, **copy()** and **toString()** methods

```
data class User(val name: String, val age: Int)
val ali = User(name = "Ali", age = 18)
```

//Copy:

```
val olderAli = ali.copy(age = 19)
```

//Destructuring

```
val (name, age) = ali
```

// prints "Ali, 18 years of age"

```
println("$name, $age years of age")
```

Use 'copy' method for data classes

```
class Person(val name: String,  
             var age: Int)  
  
fun happyBirthday(person: Person) {  
    person.age++  
}
```

```
data class Person(val name: String,  
                  val age: Int)  
  
fun happyBirthday(person: Person) =  
    person.copy(  
        age = person.age + 1)
```

object = singleton

- Once instance for the whole app

```
object Util {  
    fun getNumberOfCores() = Runtime.getRuntime().availableProcessors()  
  
    val randomInt: Int  
        get() = Random().nextInt()  
}  
  
fun main() {  
    println(Util.getNumberOfCores())  
    println(Util.randomInt)  
}
```

No static keyword -> alternatives

- **Top-level** functions and properties
(e.g. placed outside the class)
- **Companion objects:** special object inside a class to place static properties and methods
- **object** declaration used to create a **Singleton** (i.e., a single instance for the whole app):
 - Used for declaring the class
 - And providing a single instance of it

```
class Foo {  
    companion object {  
        fun bar() {  
            //...  
        }  
    }  
}
```

```
object Singleton {  
    fun doSomething() {  
        //..  
    }  
}
```

Foo.bar()

Singleton.doSomething()

Abstract Classes

- Idea
 - Use an abstract class when you want to define a **template** to guarantee that all **subclasses** in a hierarchy will have certain common methods
 - Abstract classes can contain implemented methods and **abstract methods** that are NOT implemented
- Syntax

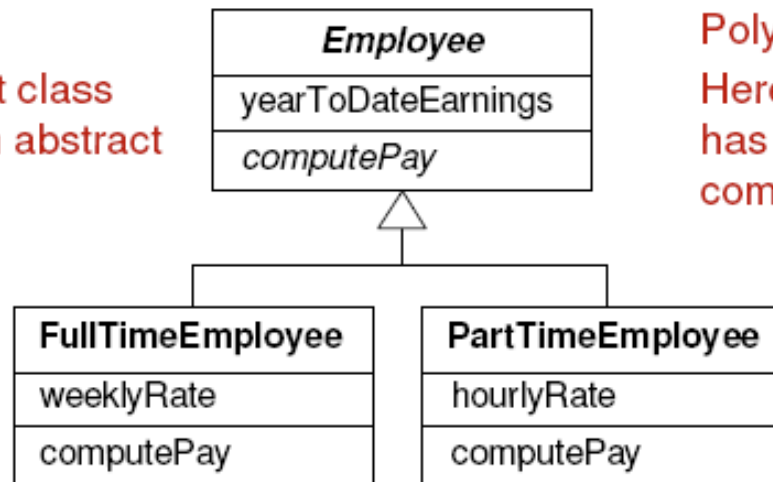
```
abstract class SomeClass() {  
    fun abstract method1(...) : SomeType // No body  
    fun method2(...) : SomeType { ... } // Not abstract  
}
```
- Motivation
 - Guarantees that all subclasses will have certain methods => **enforce a common design.**
 - Lets you make collections of mixed type objects that can be processed polymorphically

Abstract Classes

- An abstract class has one or more abstract properties/methods that subclasses **MUST** override
 - Abstract properties/methods do not provide implementations because they **cannot be implemented in a general way**
- An abstract class cannot be instantiated

Abstraction:

Employee is an abstract class and *computePay()* is an abstract operation (italicized)



Polymorphism:

Here, each type of Employee has its own version of *computePay()*

Abstract Class Example

Shape.kt

```
abstract class Shape {  
    abstract val area: Double  
    open val name: String  
        get() = "Shape"  
}
```

Rectangle.kt

```
class Rectangle(val width: Double,  
               val height: Double) : Shape() {  
    override val area: Double  
        get() = width * height  
  
    override val name: String  
        get() = "Rectangle"  
}
```

Circle.kt

```
class Circle(val radius: Double) : Shape() {  
    override val area: Double  
        get() = Math.PI * radius.pow(2)  
  
    override val name: String  
        get() = "Circle"  
}
```

Interfaces

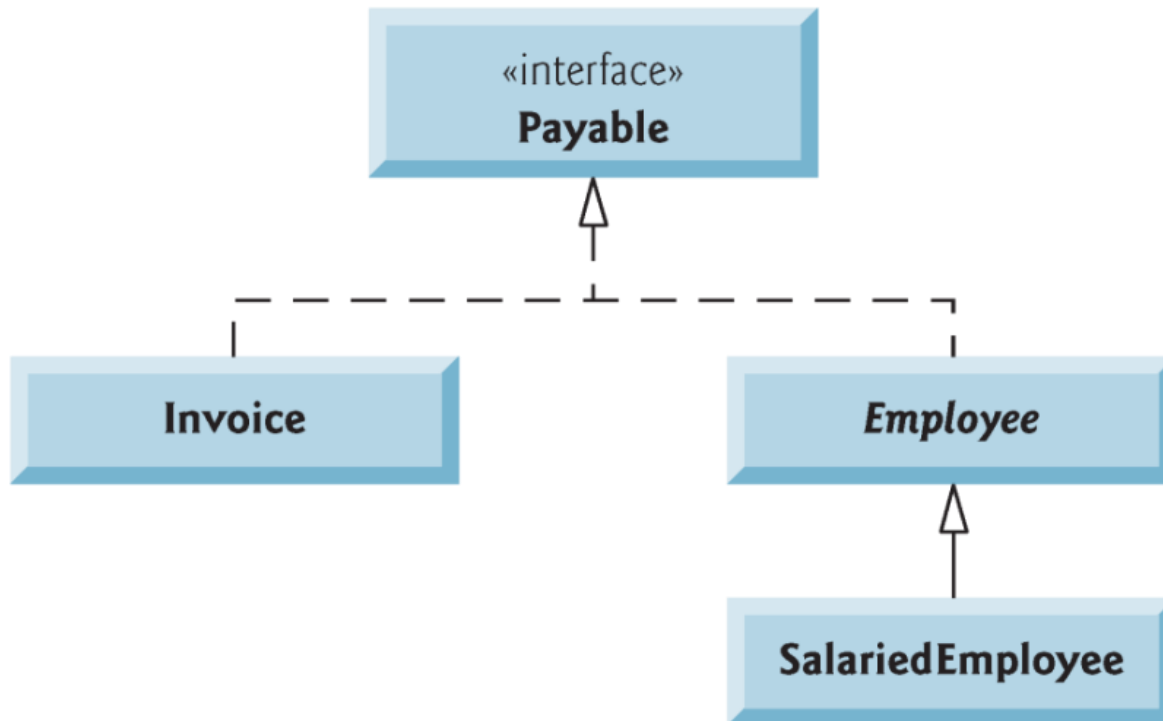
- Idea
 - **Interfaces** are used to define a set of common properties and methods that must be implemented by **classes not related by inheritance**
 - The interface specifies **what** methods a class must perform but does not specify **how** they are performed
- Syntax

```
interface SomeInterface {  
    fun method1(...): SomeType // No body  
    fun method2(...): SomeType // No body  
}  
class SomeClass() : SomeInterface {  
    // Real definitions of method1 and method 2  
}
```

- Motivation
 - Interfaces enables requiring that **unrelated classes implement a set of common methods**
 - **Ensure consistency** and guarantee that classes has certain methods
 - Let us make **collections of mixed type** objects that can processed polymorphically

Interface Example

- A finance system has Employees and Invoices
- Employee and Invoice are not related by inheritance
- But to the company, they are both *Payable*



Interface Example

Payable.kt

```
interface Payable {  
    fun getPayAmount(): Double  
}
```

Employee.kt

```
class Employee ( ... ) : Payable {  
    ...  
    override fun getPayAmount() = salary  
    ...  
}
```

Invoice.kt

```
class Invoice ( ... ) : Payable {  
    ...  
    override fun getPayAmount() = totalBill  
    ...  
}
```

Polymorphism Using interfaces

- A way of coding **generically**
 - way of referencing many related objects as one generic type
 - Cars and Bikes can both `move()` → refer to them as **Transporter** objects
 - Phones and Teslas can both `getCharged()` → refer to them as *Chargeable* objects, i.e., objects that implement **Chargeable** interface
 - Employees and invoices can both `getPayAmount()` → refer to them as *Payable* objects

```
for (payable : payables ) {  
    println ( payable.getPayAmount() )  
}
```

Abstract Class vs. Interface

- Abstract classes and interfaces cannot be instantiated
- Abstract classes and interfaces may have abstract methods that must be implemented by the subclasses
- Classes that implement an interface **can be from different inheritance hierarchies**
 - An interface is often used when unrelated classes need to provide **common properties and methods**
 - When a class implements an interface, it establishes an ***IS-A*** relationship with the interface type. Therefore, interface references can be used to invoke polymorphic methods just as an abstract superclass reference can.
- Concrete subclasses that extend an abstract superclass are **all related to one other by inheriting from a shared superclass**
- Classes can extend only ONE abstract class but they may implement more than one interface

Enum class

- Represents an enumeration

```
enum class Gender {  
    FEMALE, MALE  
}
```

```
enum class Direction {  
    LEFT, RIGHT, UP, DOWN  
}
```

Summary

- Inheritance = “factor out” the common properties and methods and place them in a single superclass
 - => Removing code redundancy will result in a smaller, more flexible program that is easier to maintain.
- Interfaces are contracts, can’t be instantiated
 - force classes that implement them to define specified methods
- Polymorphism allows for generic code by using superclass/interface type variables to manipulate objects of subclass type
 - make the client code more **generic** and ease extensibility

Kotlin Resources

- Kotlin docs
 - <https://kotlinlang.org/docs/home.html>
 - <https://kotlinlang.org/docs/learning-materials-overview.html>
- Kotlin online courses
 - <https://www.coursera.org/learn/kotlin-for-java-developers>
 - <https://www.udacity.com/course/kotlin-bootcamp-for-programmers--ud9011>
- Kotlin learning resources
 - <https://developer.android.com/courses/kotlin-bootcamp/overview>
 - <https://codelabs.developers.google.com/kotlin-bootcamp/>