CP3406_CP5307 Codelab 1.2: Kotlin Functions

Contents

1. Explore the main() function

In this task, you create a Kotlin program and learn about the `main()` function. You will also find out how to pass arguments to a program from the command line.

You may remember the `greeting()` function from a previous codelab:

```
fun greeting() {
    println ("Hello, Kotlin!!!")
}
```

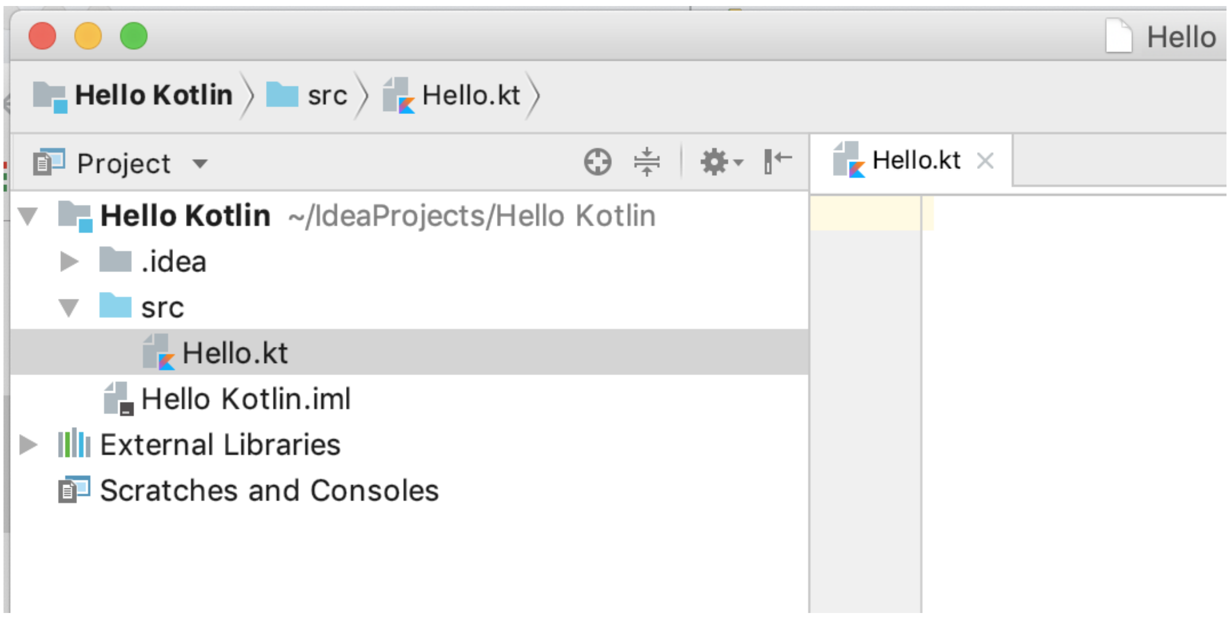
```
⇒ Hello World
```

You define functions using the `fun` keyword, followed by the name of the function. As with other programming languages, the parentheses `()` are for function arguments, if any. Curly braces `{}` frame the code block for the function and provide a scoping context. There is no return type for our `greeting()` function, because it doesn't return anything.

Step 1: Create a Kotlin file

1. Open IntelliJ IDEA, if it's not already open.
2. You should already have the "Hello Kotlin" project from the previous codelab, so open that. If not, create a new project now.
3. Right-click on the src folder in your Project. Select **New > Kotlin File**.
4. Name the file **Hello**, and ensure that File is selected from the list.
5. Hit **Enter**.

There is now a file in the **src** folder called **Hello.kt**.



Step 2: Add code and run your program

1. As with other languages, the Kotlin `main()` function specifies the entry point for execution. Any command line arguments are passed as an array of strings.

Type or paste the following code into the **Hello.kt** file:

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

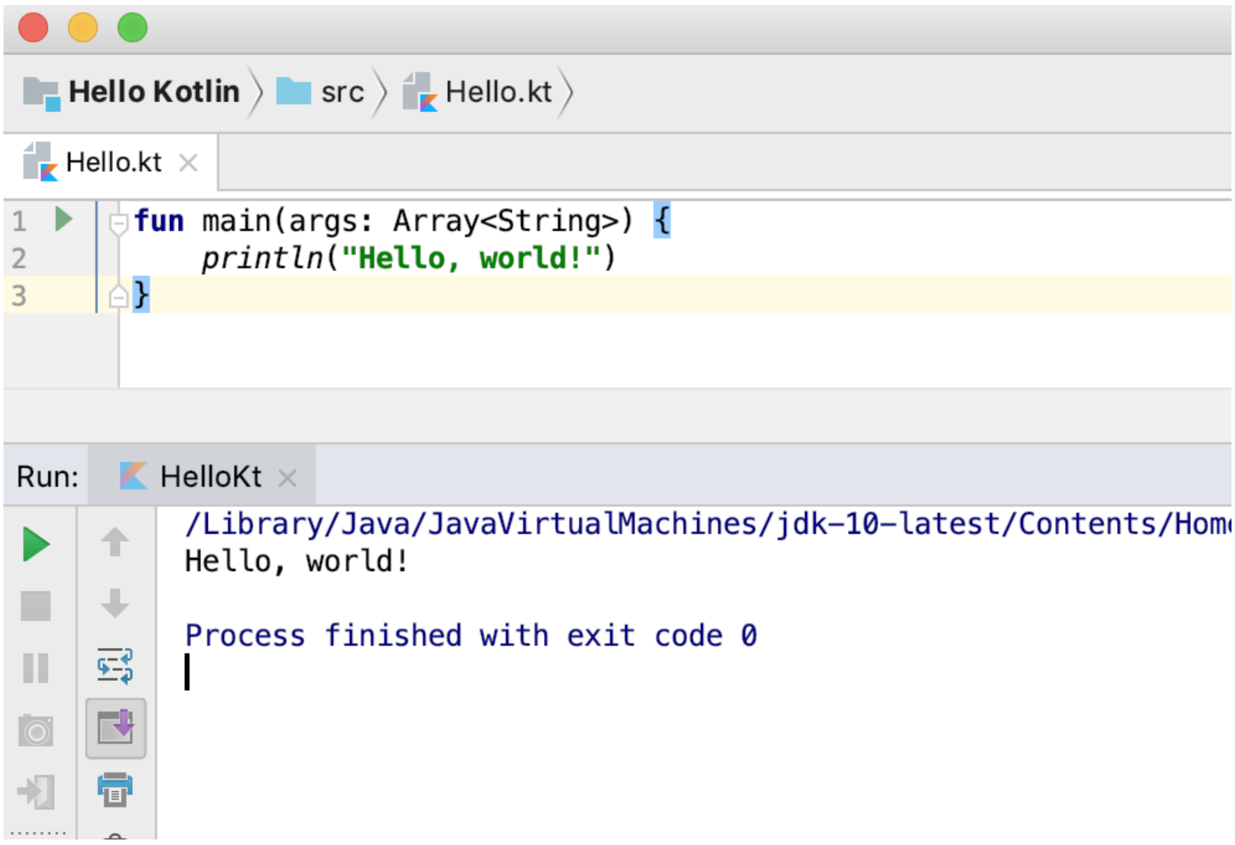
Tip: As of Kotlin 1.3, if your `main()` function doesn't use any parameters, you don't need to define `args`.

Like your earlier printHello() function, this function has no return statement. In Kotlin, every function returns something, even when nothing is explicitly specified. When a function does not explicitly have a return statement, the function returns Unit (formally kotlin.Unit). So this main() function which does not have an explicit return statement, returns Unit.

Note: When a function returns `kotlin.Unit`, you don't have to specify it explicitly. This is different from some other languages, where you have to explicitly say that you are returning nothing.

2. To run your program, click the green triangle to the left of the `main()` function. Select **Run 'HelloKt'** from the menu.

IntelliJ IDEA compiles the program and runs it. The results appear in the log at the bottom, as shown below.



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

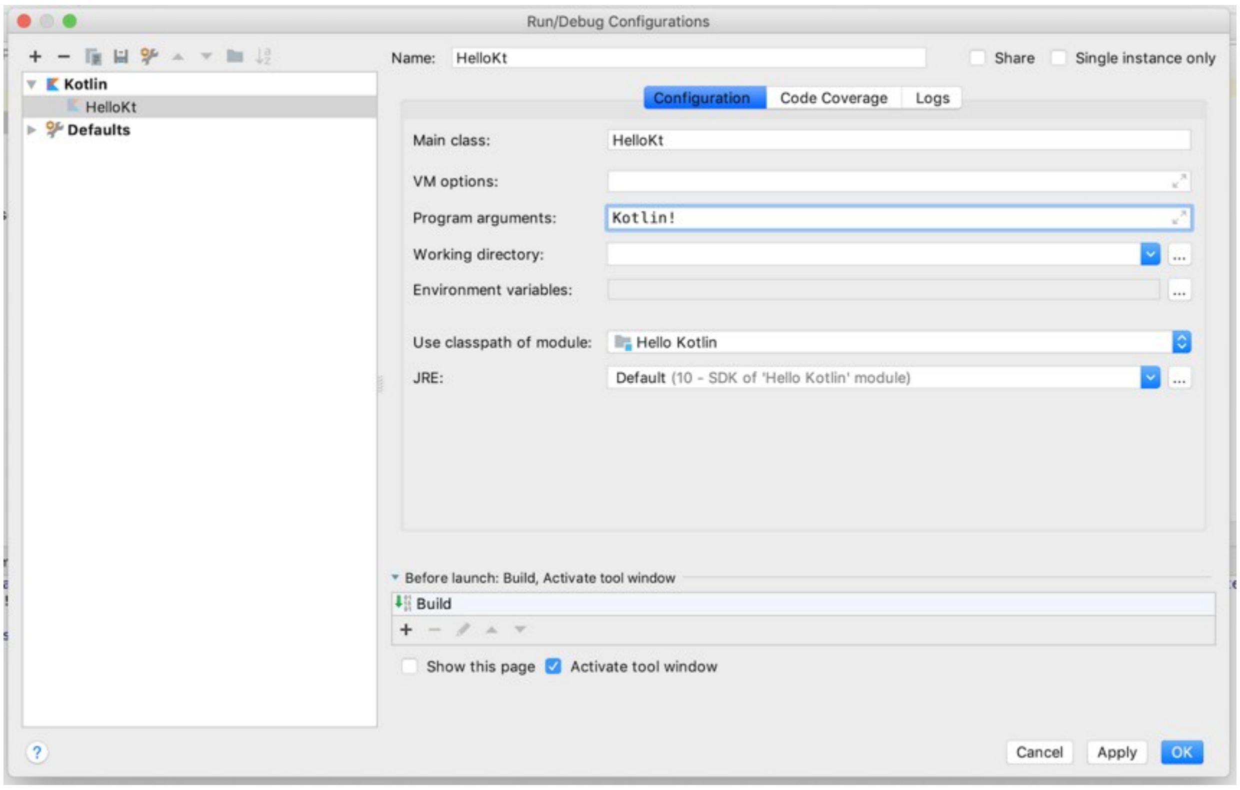
```
/Library/Java/JavaVirtualMachines/jdk-10-latest/Contents/Hom
Hello, world!

Process finished with exit code 0
```

Note to Java programmers: If you're using a previously installed version of IntelliJ IDEA instead of installing a fresh copy, at this point you may have problems accessing the Kotlin compiler. Be sure your project is referring to the correct version of the JDK.

Step 3: Pass arguments to main()

Because you are running your program from IntelliJ IDEA and not from the command line, you need to specify any arguments to the program a little differently.

1. Select **Run > Edit Configurations**. The **Run/Debug Configurations** window opens.
2. Type `Kotlin!` in the **Program arguments** field.
3. Click **OK**.


Run/Debug Configurations

Name: HelloKt

Main class: HelloKt

VM options:

Program arguments: Kotlin!

Working directory:

Environment variables:

Use classpath of module: Hello Kotlin

JRE: Default (10 - SDK of 'Hello Kotlin' module)

Before launch: Build, Activate tool window

Build

☐ Show this page ☑ Activate tool window

Step 4: Change the code to use a string template

A string template inserts a variable or expression into a string, and `$` specifies that part of the string will be a variable or expression. Curly braces `{}` frame the expression, if any.

1. In **Hello.kt**, change the greeting message to use the first argument passed into the program, `args[0]`, instead of `"world"`.

```
fun main(args: Array<String>) {
    println("Hello, ${args[0]}")
}
```

2. Run the program, and the output includes the argument you specified.

```
⇒ Hello, Kotlin!
```

2. Learn why (almost) everything has a value

In this task, you learn why almost everything in Kotlin has a value, and why that's useful.

Some programming languages have only *statements*, which are lines of code that don't have a value. In Kotlin, almost everything is an *expression* and has a value—even if that value is `kotlin.Unit`.

Note: Similar to other programming languages, the value of a Kotlin function is the value that is returned from that function. If a function does not return a value, its default value is `kotlin.Unit`.

1. In **Hello.kt**, write code in `main()` to assign the return value of `println()` to a variable called `isUnit` and print it. (`println()` does not explicitly return a value, so it returns `kotlin.Unit`.)

```
// Will assign kotlin.Unit
val isUnit = println("This is an expression")
println(isUnit)
```

2. Run your program. The first `println()` prints the string `"This is an expression"`. The second `println()` prints the value of the first `println()` statement, that is, `kotlin.Unit`.

```
This is an expression
kotlin.Unit
```

3. In your `main`() function in the file **Hello.kt**, declare a `val` called `temperature` and initialize it to 10.
4. Declare another `val` called `isHot` and assign the return value of an `if`/`else` statement to `isHot`, as shown in the following code. Because it is an expression, you can use the value of the `if` expression right away.

```
val temperature = 10
val isHot = if (temperature > 50) true else false
println(isHot)
```

The output would show:

```
false
```

5. Use the value of an expression in a string template. Add some code in your `main()` to check the temperature to determine whether a fish is safe or too warm, then run your program.

```
val temperature = 10
val message = "The water temperature is ${ if (temperature > 50) "too warm"
else "OK" }."
println(message)
```

The output would show:

```
The water temperature is OK.
```

Note: Loops are exceptions to "everything has a value." There's no sensible value for `for` loops or `while` loops, so they do not have values. If you try to assign a loop's value to something, the compiler gives an error.

3. Learn more about functions

In this task, you learn more about functions in Kotlin, and more about the very useful `when` conditional expression.

Step 1: Create some functions

In this step, you put together some of what you've learned and create functions with different types. You can replace the contents of **Hello.kt** with this new code.

6. Write a function called `feedTheFish()` that calls `randomDay()` to get a random day of the week. Use a string template to print a `food` for the fish to eat that day. For now, the fish eat the same food every day.

```
fun feedTheFish() {
    val day = randomDay()
    val food = "pellets"
    println ("Today is $day and the fish eat $food")
}

fun main(args: Array<String>) {
    feedTheFish()
}
```

7. Add a `randomDay()` function in **Hello.kt** to pick a random day from an array and return it.

The `nextInt()` function takes an integer limit, which limits the number from `Random()` to 0 through 6 to match the `week` array.

```
fun randomDay() : String {
    val week = arrayOf ("Monday", "Tuesday", "Wednesday", "Thursday",
            "Friday", "Saturday", "Sunday")
    return  week[Random().nextInt(week.size)]
}
```

8. The `Random()` and `nextInt()` functions are defined in `java.util.*`. At the top of the file, add the needed import:

```
import java.util.*     // required import
```

Tip: Before you add the import, `Random()` gives an unresolved reference error in IntelliJ IDEA. To add the import automatically, click on `Random()`, then press `Alt+Enter` (`Option+Enter` on a Mac). Select **Import > java.util.Random**.

9. Run your program, and check the output.

```
⇒ Today is Tuesday and the fish eat pellets
```

Step 2: Use a when expression

Extending this further, change the code to pick different food for different days using a `when` expression. The `when` statement is similar to `switch` in other programming languages, but `when` automatically breaks at the end of each branch. It also makes sure your code covers all the branches if you are checking an enum.

1. In **Hello.kt**, add a function called `fishFood()` that takes a day as a `String` and returns the fish's food for the day as a `String`. Use `when()`, so that each day the fish gets a specific food. Run your program a few times to see different outputs.

```
fun fishFood (day : String) : String {
    var food = ""
    when (day) {
        "Monday" -> food = "flakes"
        "Tuesday" -> food = "pellets"
        "Wednesday" -> food = "redworms"
        "Thursday" -> food = "granules"
        "Friday" -> food = "mosquitoes"
        "Saturday" -> food = "lettuce"
        "Sunday" -> food = "plankton"
    }
    return food
}
fun feedTheFish() {
    val day = randomDay()
    val food = fishFood(day)
    println ("Today is $day and the fish eat $food")
}
```

```
⇒ Today is Thursday and the fish eat granules
```

2. Add a default branch to the `when` expression using `else`. For testing, to make sure the default is taken sometimes in your program, remove the `Tuesday` and `Saturday` branches.

Having a default branch ensures that `food` gets a value before being returned, so it doesn't need to be initialized anymore. Because the code now assigns a string to `food` only once, you can declare `food` with `val` instead of `var`.

```
fun fishFood (day : String) : String {
    val food : String
    when (day) {
        "Monday" -> food = "flakes"
        "Wednesday" -> food = "redworms"
        "Thursday" -> food = "granules"
        "Friday" -> food = "mosquitoes"
        "Sunday" -> food = "plankton"
        else -> food = "nothing"
    }
    return food
}
```

3. Because every expression has a value, you can make this code a little more concise. Return the value of the `when` expression directly, and eliminate the `food` variable. The value of the `when` expression is the value of the last expression of the branch that satisfied the condition.

```
fun fishFood (day : String) : String {
    return when (day) {
        "Monday" -> "flakes"
        "Wednesday" -> "redworms"
        "Thursday" -> "granules"
        "Friday" -> "mosquitoes"
        "Sunday" -> "plankton"
        else -> "nothing"
    }
}
```

The final version of your program looks something like the code below.

```
import java.util.*    // required import

fun randomDay() : String {
     val week = arrayOf ("Monday", "Tuesday", "Wednesday",
                         "Thursday","Friday", "Saturday", "Sunday")
     return  week[Random().nextInt(week.size)]
}
fun fishFood (day : String) : String {
     return when (day) {
          "Monday" -> "flakes"
          "Wednesday" -> "redworms"
          "Thursday" -> "granules"
          "Friday" -> "mosquitoes"
          "Sunday" -> "plankton"
          else -> "nothing"
     }
}
fun feedTheFish() {
     val day = randomDay()
     val food = fishFood(day)
     println ("Today is $day and the fish eat $food")
}
fun main(args: Array<String>) {
      feedTheFish()
}
```

4. Explore default values and compact functions

In this task, you learn about default values for function parameters. You also learn about *compact functions*, which can make your code more concise and readable, and can reduce the number of code paths for testing. Compact functions are also called *single-expression functions*.

Step 1: Create a default value for a parameter

In Kotlin, you can pass arguments by the name of the parameter. You can also specify default values for parameters: if an argument isn't supplied by the caller, the default value is used. Later, when you write methods (member functions), it means you can avoid writing lots of overload versions of the same method.

1. In **Hello.kt**, write a `swim()` function with a `String` parameter named `speed` that prints the fish's speed. The `speed` parameter has a default value of `"fast"`.

```
fun swim(speed: String = "fast") {
   println("swimming $speed")
}
```

2. From the `main()` function, call the `swim()` function three ways. First call the function using the default. Then call the function and pass the `speed` parameter without a name, then call the function by naming the `speed` parameter.

```
swim()   // uses default speed
swim("slow")   // positional argument
swim(speed="turtle-like")   // named parameter
```

```
⇒ swimming fast
  swimming slow
  swimming turtle-like
```

Note: Arguments don't have to use the parameter names; you can just pass the arguments in the defined order. But with default values, this can get a little confusing, so it is best practice to put parameters without defaults first, and the ones with defaults after.

Step 2: Add required parameters

If no default is specified for a parameter, the corresponding argument must always be passed.

1. In **Hello.kt**, write a `shouldChangeWater()` function that takes three parameters: `day`, `temperature`, and a `dirty` level. The function returns `true` if the water should be changed, which happens if it's Sunday, if the temperature is too high, or if the water is too dirty. The day of the week is required, but the default temperature is 22, and the default dirty level is 20.

Use a `when` expression without an argument, which in Kotlin acts as a series of `if/else if` checks.

```
fun shouldChangeWater (day: String, temperature: Int = 22, dirty: Int =
20): Boolean {
    return when {
        temperature > 30 -> true
        dirty > 30 -> true
        day == "Sunday" -> true
        else -> false
    }
}
```

2. Call `shouldChangeWater()` from `feedTheFish()` and supply the day. The `day` parameter doesn't have a default, so you must specify an argument. The other two parameters of `shouldChangeWater()` have default values, so you don't have to pass arguments for them.

```
fun feedTheFish() {
    val day = randomDay()
    val food = fishFood(day)
    println ("Today is $day and the fish eat $food")
    println("Change water: ${shouldChangeWater(day)}")
}
```

```
⇒ Today is Thursday and the fish eat granulesChange
   water: false
```

Step 3: Make compact functions

The `when` expression that you wrote in the previous step packs a lot of logic into a small amount of code. If you wanted to unpack it a little, or if the conditions to check were more complicated, you could use some well-named local variables. But the Kotlin way to do it is with compact functions.

Compact functions, or single-expression functions, are a common pattern in Kotlin. When a function returns the results of a single expression, you can specify the body of the function after an `=` symbol, omit the curly braces `{}`, and omit the `return`.

1. in **Hello.kt**, add compact functions to test the conditions.

```
fun isTooHot(temperature: Int) = temperature > 30
fun isDirty(dirty: Int) =dirty > 30
fun isSunday(day: String) = day == "Sunday"
```

2. Change `shouldChangeWater()` to call the new functions.

```
fun shouldChangeWater (day: String, temperature: Int = 22, dirty: Int =
20): Boolean {
    return when {
        isTooHot(temperature) -> true
        isDirty(dirty) -> true
        isSunday(day) -> true
        else  -> false
    }
}
```

3. Run your program. The output from the `println()` with `shouldChangeWater()` should be the same as it was before you switched to using compact functions.

Default values

The default value for a parameter doesn't have to be a value. It can be another function, as shown in the following partial sample:

```
fun shouldChangeWater (day: String, temperature: Int = 22, dirty: Int =
getDirtySensorReading()): Boolean {
    ...
```

Note: A function used as a default value is evaluated at runtime, so do not put an expensive operation like a file read or a large memory allocation in the function. The operation is executed every time your function is called, which may slow down your program.

5. Get started with filters

In this task, you learn a bit about filters in Kotlin. Filters are a handy way to get part of a list based on some condition.

Step 1: Create a filter

3. In **Hello.kt**, define a list of aquarium decorations at the top level with `listOf()`. You can replace the contents of **Hello.kt**.

```
val decorations = listOf ("rock", "pagoda", "plastic plant", "alligator",
"flowerpot")
```

4. Create a new `main()` function with a line to print only the decorations that start with the letter ‘p'. The code for the filter condition is in curly braces `{}`, and `it` refers implicitly to each item as the filter loops through the list. If the expression returns `true`, the item is included.

```
fun main() {
    println( decorations.filter {it[0] == 'p'})
}
```

5. Run your program, and you see the following output in the **Run** window:

```
⇒ [pagoda, plastic plant]
```

Step 2: Compare eager and lazy filters

If you're familiar with filters in other languages, you may wonder whether filters in Kotlin are *eager* or *lazy*. Is the result list created immediately (eager), or when the list is accessed (lazy)? In Kotlin, it happens whichever way you need it to. By default, `filter` is eager, and each time you use the filter, a list is created.

To make the filter lazy, you can use a `Sequence`, which is a collection that can only look at one item at a time, starting at the beginning, and going to the end. Conveniently, this is exactly the API that a lazy filter needs.

1. In **Hello.kt**, change your code to assign the filtered list to a variable called `eager`, then print it.

```
fun main() {
    val decorations = listOf ("rock", "pagoda", "plastic plant",
"alligator", "flowerpot")
    // eager, creates a new list
    val eager = decorations.filter { it [0] == 'p' }
    println("eager: $eager")
```

2. Below that code, evaluate the filter using a `Sequence` with `asSequence()`. Assign the sequence to a variable called `filtered`, and print it.

```
   // lazy, will wait until asked to evaluate
    val filtered = decorations.asSequence().filter { it[0] == 'p' }
    println("filtered: $filtered")
```

When you return the filter results as a `Sequence`, the `filtered` variable won't hold a new list—it'll hold a `Sequence` of the list elements and knowledge of the filter to apply to those elements. Whenever you access elements of the `Sequence`, the filter is applied, and the result is returned to you.

3. Force evaluation of the sequence by converting it to a `List` with `toList()`. Print the result.

```
    // force evaluation of the lazy list
    val newList = filtered.toList()
    println("new list: $newList")
```

4. Run your program and observe the output.

```
⇒ eager: [pagoda, plastic plant]
filtered: kotlin.sequences.FilteringSequence@386cc1c4
new list: [pagoda, plastic plant]
```

To visualize what's going on with the `Sequence` and lazy evaluation, use the `map()` function. The `map()`

function performs a simple transformation on each element in the sequence.

5. With the same `decorations` list as above, make a transformation with `map()` that does nothing, and simply returns the element that was passed. Add a `println()` to show each time an element is accessed, and assign the sequence to a variable called `lazyMap`.

```
val lazyMap = decorations.asSequence().map {
    println("access: $it")
    it
}
```

6. Print `lazyMap`, print the first element of `lazyMap` using `first()`, and print `lazyMap` converted to a `List`.

```
println("lazy: $lazyMap")
println("-----")
println("first: ${lazyMap.first()}")
println("-----")
println("all: ${lazyMap.toList()}")
```

7. Run your program, and observe the output. Printing `lazyMap` just prints a reference to the `Sequence`—the inner `println()` isn't called. Printing the first element accesses only the first element. Converting the `Sequence` to a `List` accesses all the elements.

```
⇒ lazy: kotlin.sequences.TransformingSequence@5ba23b66
-----
access: rock
first: rock
-----
access: rock
access: pagoda
access: plastic plant
access: alligator
access: flowerpot
all: [rock, pagoda, plastic plant, alligator, flowerpot]
```

8. Create a new `Sequence` using the original filter before applying `map`. Print that result.

```
val lazyMap2 = decorations.asSequence().filter {it[0] == 'p'}.map {
    println("access: $it")
    it
}
println("-----")
println("filtered: ${lazyMap2.toList()}")
```

9. Run your program and observe the additional output. As with getting the first element, the inner `println()` is only called for the elements that are accessed.

⇒

```
--------
access: pagoda
access: plastic plant
filtered: [pagoda, plastic plant]
```

10. Another useful transformation function for Kotlin collections is `flatten`(). This function creates a list from a collection of collections, for example an array of arrays or a list of lists.
11. Create a list of lists. Then apply the flatten() function to transform all the lists into one list. Print the result.

```
val mysports = listOf("basketball", "fishing", "running")
val myplayers = listOf("LeBron James", "Ernest Hemingway", "Usain Bolt")
val mycities = listOf("Los Angeles", "Chicago", "Jamaica")
val mylist = listOf(mysports, myplayers, mycities)     // list of lists
println("---------")
println("Flat: ${mylist.flatten()}")
```

⇒

```
--------
Flat: [basketball, fishing, running, LeBron James, Ernest Hemingway, Usain
Bolt, Los Angeles, Chicago, Jamaica]
```

6. Get started with lambdas and higher-order functions

In this task, you get an introduction to lambdas and higher-order functions in Kotlin.

Lambdas

In addition to traditional named functions, Kotlin supports lambdas similar to Java. A *lambda* is an expression that describes a function. But instead of declaring a named function, you declare a function that has no name. What makes this useful is the lambda expression can now be passed as data. In other languages, lambdas are called *anonymous functions*, *function literals*, or similar names.

Step 1: Learn about lambdas

1. Like named functions, lambdas can have parameters. For lambdas, the parameters (and their types, if needed) go on the left of what is called a function arrow `->`. The code to execute goes to the right of the function arrow. Once the lambda is assigned to a variable, you can call it just like a function.

Using the REPL (**Tools > Kotlin > Kotlin REPL**), try out this code:

```
var dirtyLevel = 20
val waterFilter = { dirty : Int -> dirty / 2}
println(waterFilter(dirtyLevel))
```

```
⇒ 10
```

In this example, the lambda takes an `Int` named `dirty`, and returns `dirty / 2`. ()

2. Kotlin's syntax for function types is closely related to its syntax for lambdas. Use this syntax to cleanly declare a variable that holds a function:

```
val waterFilter: (Int) -> Int = { dirty -> dirty / 2 }
```

Here's what the code says:

- Make a variable called `waterFilter`.
- `waterFilter` can be any function that takes an `Int` and returns an `Int`.
- Assign a lambda to `waterFilter`.
- The lambda returns the value of the argument `dirty` divided by 2.

Note that you don't have to specify the type of the lambda argument anymore. The type is calculated by type inference.

Step 2: Create a higher-order function

So far, the examples for lambdas look mostly like functions. The real power of lambdas is using them to create higher-order functions, where the argument to one function is another function.

A higher-order function is a function that takes other functions as parameters, or it is a function that returns another function. You can pass a lambda to a higher-order function that takes a function as an argument. In the previous task, you created a higher-order function called filter. You passed the following lambda expression to filter as the condition to check:

```
{ it[0] == 'p' }
```

Similarly, `map` is a higher-order function, and the lambda you passed to it was the transformation to apply.

1. Write a higher-order function. Here's a basic example, a function that takes two arguments. The first argument is an integer. The second argument is a function that takes an integer and returns an integer. Try it out in the REPL.

```
fun updateDirty(dirty: Int, operation: (Int) -> Int): Int {
   return operation(dirty)
}
```

The body of the code calls the function that was passed as the second argument, and passes the first argument along to it.

2. To call this function, pass it an integer and a function.

```
val waterFilter: (Int) -> Int = { dirty -> dirty / 2 }
println(updateDirty(30, waterFilter))
```

```
⇒ 15
```

The function you pass doesn't have to be a lambda; it can be a regular named function instead. To specify the argument as a regular function, use the `::` operator. This way Kotlin knows that you are passing the function reference as an argument, not trying to call the function.

3. Try passing a regular named function to `updateDirty()`.

```
fun increaseDirty( start: Int ) = start + 1println(updateDirty(15,
::increaseDirty))
```

```
⇒ 16
```

Note: Kotlin prefers that any parameter that is a function is passed as the last parameter. When working with higher-order functions, Kotlin has a special syntax, called the last parameter call syntax, which can allow you to make the code even more concise. In this case, you can pass a lambda for the function parameter, but you don't need to put the lambda inside the parentheses. This style is considered more idiomatic Kotlin; you will encounter this programming style more often as you gain experience with Kotlin.
I

```
var dirtyLevel = 19
dirtyLevel = updateDirty(dirtyLevel) { dirtyLevel -> dirtyLevel + 23}
println(dirtyLevel)
```

```
⇒ 42
```

7. Summary

- To create new Kotlin source files in IntelliJ IDEA, click on "src" in the Project pane and right-click to bring up a menu. Select "New->Kotlin File/Class".
- To compile and run a program in IntelliJ IDEA, click the green triangle next to the `main()` function. Output appears in a window below.
- In IntelliJ IDEA, specify command line arguments to pass to the `main()` function in **Run > Edit Configurations**.
- Almost everything in Kotlin has a value. You can use this fact to make your code more concise by using the value of an `if` or `when` as an expression or return value.
- Default arguments remove the need for multiple versions of a function or method. For example: `fun swim(speed: String = "fast") { ... }`
- Compact functions, or single-expression functions, can make your code more readable. For example: `fun isTooHot(temperature: Int) = temperature > 30`
- You've learned some basics about filters, which use lambda expressions. For example: `val beginsWithP = decorations.filter { it [0] == 'p' }`
- A *lambda expression* is a function that is not bound to an identifier, i.e. it is an anonymous function. Lambda expressions are defined between curly braces `{}`.

- In a *higher-order function*, you pass a function such as a lambda expression to another function as data. For example: `dirtyLevel = updateDirty(dirtyLevel) { dirtyLevel -> dirtyLevel + 23}`

There's a lot in this lesson, especially if you're new to lambdas. A later lesson revisits lambdas and higher-order functions in more detail.

Note: You may have noticed that in Kotlin, as in some other languages, there is more than one correct way to do things. Making code more compact sometimes helps readability and performance, but sometimes it doesn't. As you learn more about Kotlin, you may find easier, more concise ways to do things.