Asynchrónnosť corutiny

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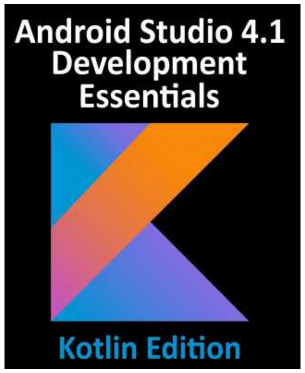


Kap. 64. A Basic Overview of Threads and AsyncTasks

Kap. 65. An Introduction to Kotlin Coroutines

Kap. 66. An Android Kotlin Coroutines Tutorial

Asynchrónnosť corutiny

nabudúce

AsyncTask
Retrofit
RoomDB

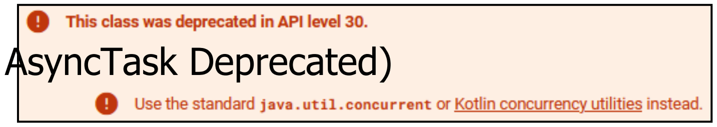
Coroutines
- channel
- flow
- Shared state
  - Atomická premenná
  - prepínanie kontextov
  - mutex

na Cvičení

Asynchronnosť

- je vážny problém
  - ako vykonávať niečo, čo môže dlho trvať, napr. výpočet, simuláciu ... (thread/vlákno), a event.
  - čo ak potrebujeme výsledok tohoto procesu pre ďalší svoj výpočet ... (čakanie na výsledok)

- v rôznych jazykoch sa rieši rôzne
  - Javascript: **callback** vedie k tzv. callback hell
  - Java: **Thread**, FutureTask, RxJava
  - GO: **go rutiny**, kanály, ...
  - Android: **AsyncTask** (donedávna, ale dnes už je AsyncTask Deprecated)


This class was deprecated in API level 30.

Use the standard `java.util.concurrent` or Kotlin concurrency utilities instead.

- v Kotline od verzie 1.3 existuje koncept **corutiny** (nie go-rutiny)
  - nie je to len knižnica/package
  - ale je to súčasť jazyka, Kotlin obsahuje kľúčové slová (napr. `suspend, async`)
  - podpora IDE

- lepšie môžeme pochopiť koncept corutín bez Android environmentu
  - IntelliJ – projekt Coroutines1 obsahuje ~30 malých gradujúcich Kotlin-corutín príkladov

Coroutines1/...

Asynchronnosť
(obsah cvičenia)

- súvisiace problémy - ako **zdieľať dáta** medzi konkurentne bežiacimi kódmi
  - posielať **agresívne** – zodpovedá koncept kanálu (trieda **Channel<T>**)
    - do značnej miery zodpovedá kanálu v jazyku GO (asi aj tam sa inšpirovali...)
    - je ale dravý/eager/**hot** – to čo do neho napíšete, to sa dá prečítať…
  - posielať **lenivo** – zodpovedá koncept toku (trieda **Flow<T>**)
    - do značnej miery zodpovedá **generátorom z jazyka Python**, resp. **lazy listom** z Haskellu
    - je lenivý/lazy/**cold** – začne sa do neho písať, len až sa niekto zaujíma o hodnoty, a niekto ich chce čítať
- môj "vážny" terminologický problém
  - píše sa to coroutine (EN)
  - ale coroutina, corutina, korutina ???

Callback je cesta do pekla ☺

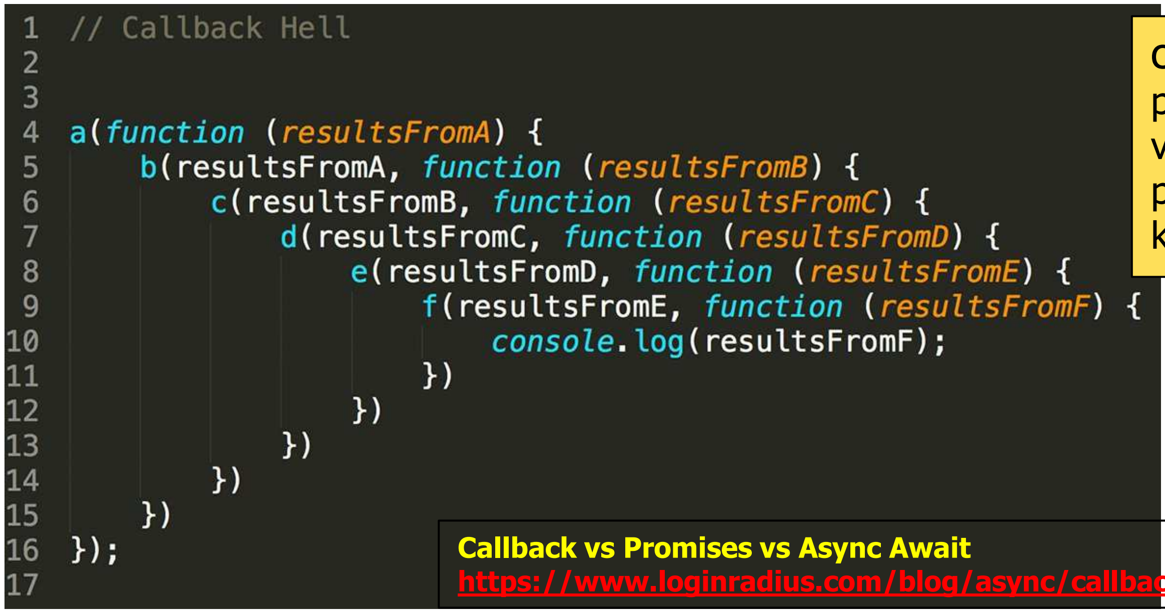
čo je callback ?

```
fun getValueAsync(onCompletion: (R) -> Unit) {
      val result = getValue()  // toto trvá dĺho ...
      onCompletion(result)
}
```

Callback je pointer na inú procedúru, ktorá sa má vykonať, keď sa dopočíta dlho trvajúci výpočet

```
getValueAsync() {
   result -> print(result)
}
```

čo je callback hell (pojem známy z Javascript) ?



```
// Callback Hell


a(function (resultsFromA) {
    b(resultsFromA, function (resultsFromB) {
        c(resultsFromB, function (resultsFromC) {
            d(resultsFromC, function (resultsFromD) {
                e(resultsFromD, function (resultsFromE) {
                    f(resultsFromE, function (resultsFromF) {
                        console.log(resultsFromF);
                    })
                })
            })
        })
    })
});
```

callback hell
pri sekvenčnom volaní viacerych dlho-trvajúcich procedúr dôjde ku kaskádovému vnoreniu kódu

Callback vs Promises vs Async Await
https://www.loginradius.com/blog/async/callback-vs-promises-vs-async-await/

Kotlin suspend function

podpora v jazyku

```
suspend fun getValue(): R { // procedúra trvá dĺho ...
      val result = getValue()     // toto trvá dĺho ...
      return result              // vráti hodnotu
}
```

corutina - funkcia označená **suspend** - jej výpočet môže trvať dlho

```
launch { // coroutine scope
   val res = getValue()
   print(res)
}
```

v coroutine scope (oblasť corutiny) môžeme volať iné **suspend** funkcie

```
launch {
   val res = getValue()    // trvá..
    val nextRes = getNextValue(res)
     val nextNextRes = getNextNextValue(nextRes)
   print(nextNextRes)
}
```

coroutine scope

aj sekvenciu takých funkcií, nevzniká callback-hell

Corutiny umožňujú písať
- elegantne,
- asynchrónny kód,
- bez vnárania
- bez callback hell

Corutina

`suspend fun` – alias corutina je funkcia, ktorej výpočet môže dlho trvať z akýchkoľvek dôvodov. Takáto funkcia NESMIE byť vykonávana v hlavnom GUI vlákne aplikácie, inak task manager zavrie aplikáciu, ak nereaguje na UI eventy

Taká funkcia/výpočet sa púšťa v tzv. corutine scope.

Výpočet corutiny v corutine scope

- môže trvať (I/O, DB, NETWORK, scientific computation, simulácia čohosi)
- môže byť pozastavený bez toho, aby sa to dotklo hlavného vlákna
- viaceré corutiny môžu bežať konkurentne v rôznych vláknach

```
launch {
  val res = getValue()
  val nextRes = getNextValue(res)
  print(nextRes)
}
```

```
launch {
  val res = getValue()
  val nextRes = getNextValue(res)
  print(nextRes)
}
```

Corutina

- je odľahčené vlákno https://kotlinlang.org/docs/reference/coroutines/basics.html#coroutines-are-light-weight
- non-preemptive multitasking
- 1958 zaviedli ich Donald Knuth a Melvin Conway, ale predbehli dobu...
- vyskytujú sa v iných jazykoch, C#, javascript, continuation-passing style
- ale nemajú podporu jazyka (len ako knižnice)

`suspend` je modifikátor funkcie, ktorá sa vykonávaná v corutine scope, a preto môže byť pozdržaná

`await()` je čaká na hodnotu výpočtu bez blokovania corutiny.

```
fun main() = runBlocking {
    repeat(100_000) { // launch 10^5 coroutines
        launch {
            delay(5000L) // wait 5s.
            print(".")
        }
    }
}
```

Coroutines1/Example100000

Async/Await in Python

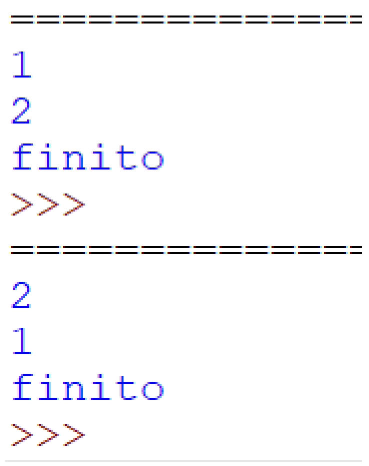
Mali by ste poznať z Python 3.7 +

```
import asyncio

async def coroutine1():
    task = asyncio.create_task(coroutine2())
    await task
    print(1)

async def coroutine2():
    print(2)
    await asyncio.sleep(1)

asyncio.run(coroutine1())
print("finito")
```



```
===============
1
2
finito
>>>
===============
2
1
finito
>>>
```

https://www.youtube.com/watch?v=t5Bo1Je9EmE

Hádanka 1

neobsajuje corutinu ale stream (Java StreamAPI)

```
fun main() {
    println("Start")
    val list = listOf(1,2,3,4,5,6,7,8,9,10)
    val newList = list.stream()

        .map {
          Thread.sleep(1000)
          it*it      // return it * it
    }
    println("End")
    newList.forEach { // výpis kolekcie
        println(it)
    }
}
```

```
Stream.of(1,2,3,4,5,6,7,8,9,10)
```

```
08:59:32.832 Start
08:59:32.834 End    Start+0sec.
08:59:33.839 1             +1sec.
08:59:34.841 4             +2sec.
08:59:35.842 9
08:59:36.844 16
08:59:37.846 25
08:59:38.849 36
08:59:39.851 49
08:59:40.854 64
08:59:41.856 81
08:59:42.858 100
```

Coroutines1/Hadanka1

stream bez .collect() je *lenivá* kolekcia

Hádanka 2

neobsajuje corutinu ale stream (Java StreamAPI)

```
fun main() {
    println("Start")
    val newList = Stream.of(1,2,3,4,5,6,7,8,9,10)
        .map {
            Thread.sleep(1000)
            it*it
    }.collect(Collectors.toList())
    println("End")
    newList.forEach { // výpis kolekcie
        println(it)
    }
}
```

```
09:02:23.363  Start
09:02:33.389  End   Start+10sec.
09:02:33.389  1            +0sec.
09:02:33.389  4            +0sec.
09:02:33.389  9
09:02:33.389  16
09:02:33.389  25
09:02:33.389  36
09:02:33.390  49
09:02:33.390  64
09:02:33.390  81
09:02:33.390  100
```

Coroutines1/Hadanka2

Hádanka 3

neobsajuje corutinu ale stream (Java StreamAPI)

```
fun main() {
    println("Start")
    val newList = (1..10).toList()
        .parallelStream()
        .map {
            Thread.sleep(1000)
            it*it
        }.collect(Collectors.toList())
    println("End")
    newList.forEach { // výpis kolekcie
        println(it)
    }
}
```

?(1..100)?

parallelStream používa
toľko paralelizmu, koľko je #cores
`Runtime.getRuntime()`
`.availableProcessors() == 8`

```
8
09:04:06.410 Start
09:04:09.420 End     Start+3sec.
09:04:09.420 1            +0sec.
09:04:09.420 4            +0sec.
09:04:09.420 9
09:04:09.420 16
09:04:09.420 25
09:04:09.420 36
09:04:09.421 49
09:04:09.421 64
09:04:09.421 81
09:04:09.422 100
```

Coroutines1/Hadanka3

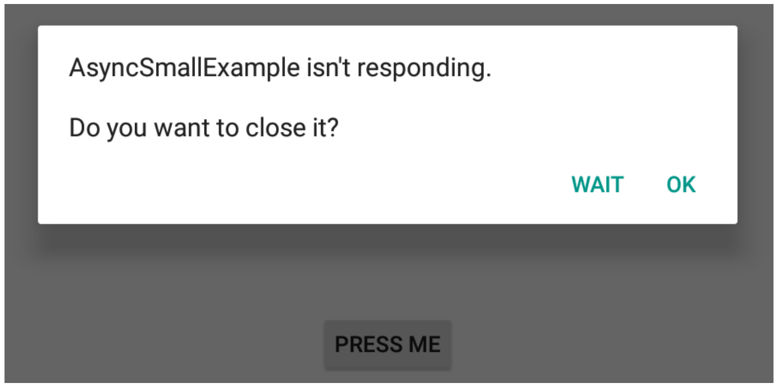
Asynchrónne operácie

trochu androidu

- nie je možné robiť časovo náročné operácie v hlavnom vlákne aplikácie
  - extra komplikovaný (matematický) výpočet
  - simuláciu procesu spomaľovanú napr. Thread.sleep(…)
  - dlho trvajúce požiadavky (napr. IO/http/sql-request)

- takýto kód zablokuje hlavné vlákno, a ak vyvoláte GUI eventy (napr. pochabým klikaním v priebehu 20s), správca aplikácií usúdi, že aplikácia je mŕtva zavrie ju

```
fun buttonClick(view: View) {
  for (i in 0..20) {
    try {
      Thread.sleep(1000) // zabije
      i++            // hlavné vlákno
    }
    catch (e: Exception) {
        e.printStackTrace()
    }
  }
}
```


AsyncSmallExample isn't responding.

Do you want to close it?

AsyncSmallExample.zip

Async Task
(doInBackground)

Parametrizovaná trieda AsyncTask je thread-wrapper a rieši problém, existuje od API-3

```
                                typ parametrov, type progresu, typ výsledku
private inner class MyTask : AsyncTask<String, Int, String>() {

 pred -{ override fun onPreExecute(){…}// vykoná sa pred doInBackground
         // celé jadro toho, čo sa má vykonávať v extra vlákne
vo vlákne override fun doInBackground(vararg params: String): String {
        ------>  while (i in 0..20) {
            try {
               Thread.sleep(1000)
               publishProgress(i)                       // Counter = $i
            } catch (e: Exception) { … }
            return "Button Pressed"
         }

 počas  ┌  override fun onProgressUpdate(vararg values: Int?) { … }
        ┤
 po     └  override fun onPostExecute(result:String){…}// po doInBackgr.
}
```

AsyncSmallExample.zip

Async Task

(onPre/PostExecue)

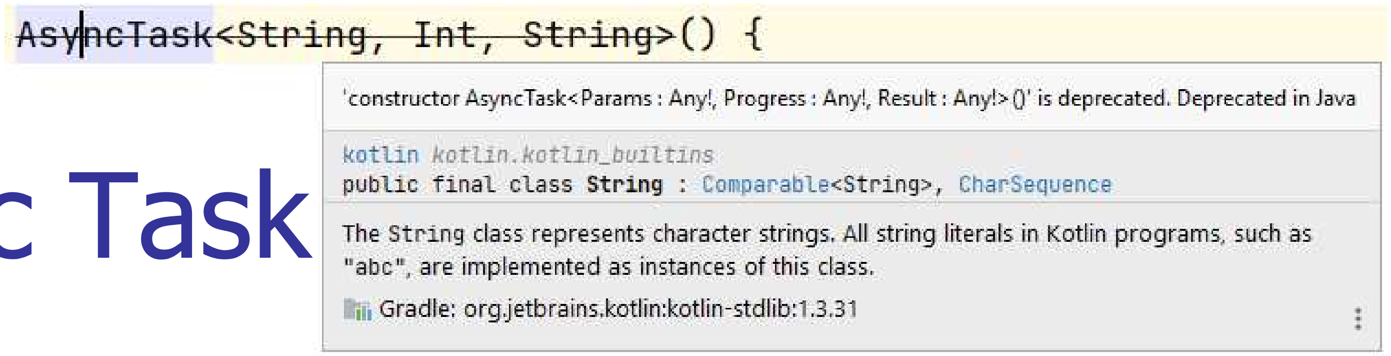
```
private inner class MyTask : AsyncTask<String, Int, String>() {
    var color : Int = Color.BLACK
    override fun onPreExecute() {
        color =  ... Random Color ...
    }

    override fun doInBackground(vararg params:String):String {}
    // varargs je variabilný počet argumentov, ako ... v Jave

    override fun onProgressUpdate(vararg values: Int?) {
        myTextView.setTextColor(color) // beží v main threade
        val counter = values.get(0)
        myTextView.text = "Counter = $counter"
    }

    override fun onPostExecute(result:String) { "Button Pressed"
        myTextView.setTextColor(color)
        myTextView.text = result
    }
}
```

AsyncSmallExample.zip



```
~~AsyncTask<String, Int, String>()~~ {
```

'constructor AsyncTask<Params : Any!, Progress : Any!, Result : Any!> ()' is deprecated. Deprecated in Java

```
kotlin kotlin.kotlin_builtins
public final class String : Comparable<String>, CharSequence
```

The String class represents character strings. All string literals in Kotlin programs, such as "abc", are implemented as instances of this class.

Gradle: org.jetbrains.kotlin:kotlin-stdlib:1.3.31

Async Task

(spustenie)

Štandardne sa rôzne inštancie AsyncTask spúšťajú sériovo, kým nedobehne jedna, ostatné čakajú vo fronte, blokujú sa...

```
val task1 = MyTask().execute()   // serial run of AsyncTask
```

...vyskúšaj...

Ak ich chceme spustiť viacero a paralelne, tak cez POOL_EXECUTOR

```
task = MyTask().executeOnExecutor(AsyncTask.THREAD_POOL_EXECUTOR)
```

...vyskúšaj...

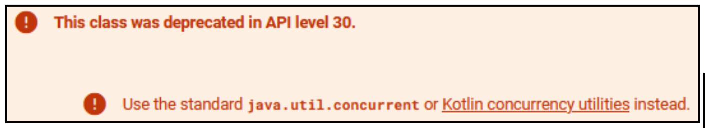
Ale počet paralelne bežiacich AsyncTaskov je limitovaný, v závislosti od počtu jadier CPU

```
val cpu_cores = Runtime.getRuntime().availableProcessors()
```

Reálne väčším problémom, že napriek popularite a jednoduchosti používania AsyncTask je od Android 11 AsyncTask zastaralý (*deprecated*)

https://www.xda-developers.com/asynctask-deprecate-android-11/amp/?__twitter_impression=true

Z toho zatiaľ nie je jasné, či ho Google odstráni, ale ...



This class was deprecated in API level 30.

Use the standard `java.util.concurrent` or Kotlin concurrency utilities instead.

AsyncSmallExample.zip

Alternatívy
Kotlin - corutiny

Čo je alternatíva:

- RxJava-library (Reactive Externsion) observable.subscribe(…
- Java’s Concurrency framework - ForkJoinPool
- Kotlin coroutines od verzie Kotlin 1.3

build.gradle:

-
```
implementation
     "org.jetbrains.kotlinx:kotlinx-coroutines-core:1.4.1"
```

import

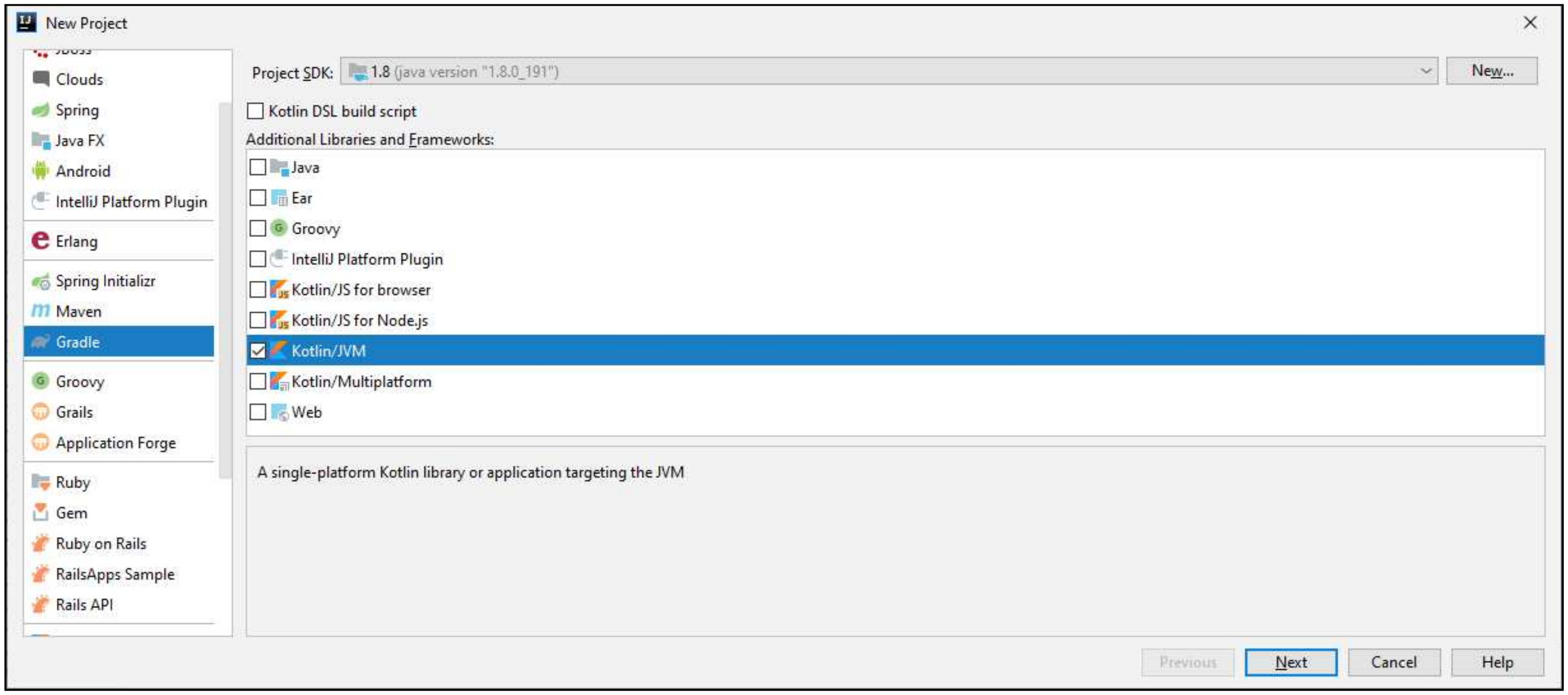
-
```
import kotlinx.coroutines.*
```

first-touch tutorial:

- https://kotlinlang.org/docs/coroutines-basics.html#an-explicit-job

IntelliJ/Gradle/KotlinJVM1.8 IntelliJ

- koncept corutiny je zložitý dosť na to ho študovať separátne, bez androidového okolia,
- ale ukážeme aj použitie corutín v reálnych Android aplikáciach, časom...
- V IntelliJ si vytvorte Gradle project/KotlinJVM


New Project

Project SDK: 1.8 (java version "1.8.0_191") New...

[ ] Kotlin DSL build script

Additional Libraries and Frameworks:

[ ] Java
[ ] Ear
[ ] Groovy
[ ] IntelliJ Platform Plugin
[ ] Kotlin/JS for browser
[ ] Kotlin/JS for Node.js
[✓] Kotlin/JVM
[ ] Kotlin/Multiplatform
[ ] Web

A single-platform Kotlin library or application targeting the JVM

Pridanie Couroutine dependencies do build.gradle

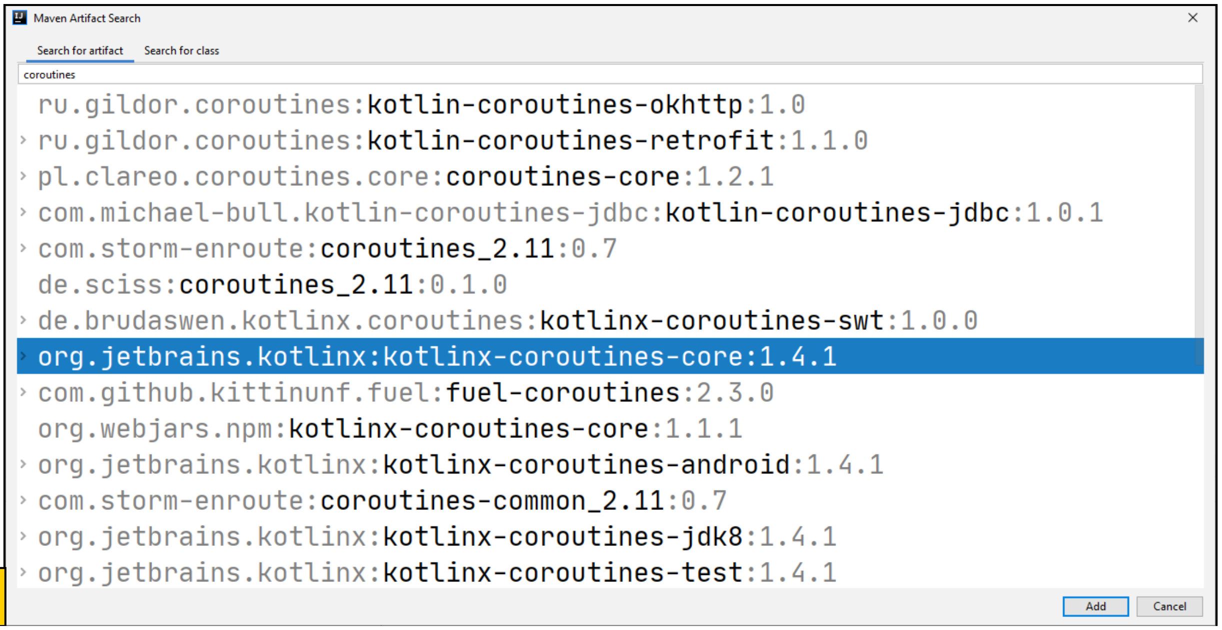
- na súbore build.gradle (app), right click/Generate/Add Maven Artifact dependencies/Search for artifacts:"coroutines", vyber
- org.jetbrains.kotlinx-coroutines-core:1.*.1

```
dependencies {
    implementation "org.jetbrains.kotlin:kotlin-stdlib-jdk8"
    compile 'org.jetbrains.kotlinx:kotlinx-coroutines-core:1.4.1'
}
```

nechajte syncovať gradle, ~60sec.

Alebo si importujte projekt Coroutines1

Coroutines1



coroutines

```
ru.gildor.coroutines:kotlin-coroutines-okhttp:1.0
ru.gildor.coroutines:kotlin-coroutines-retrofit:1.1.0
pl.clareo.coroutines.core:coroutines-core:1.2.1
com.michael-bull.kotlin-coroutines-jdbc:kotlin-coroutines-jdbc:1.0.1
com.storm-enroute:coroutines_2.11:0.7
de.sciss:coroutines_2.11:0.1.0
de.brudaswen.kotlinx.coroutines:kotlinx-coroutines-swt:1.0.0
org.jetbrains.kotlinx:kotlinx-coroutines-core:1.4.1
com.github.kittinunf.fuel:fuel-coroutines:2.3.0
org.webjars.npm:kotlinx-coroutines-core:1.1.1
org.jetbrains.kotlinx:kotlinx-coroutines-android:1.4.1
com.storm-enroute:coroutines-common_2.11:0.7
org.jetbrains.kotlinx:kotlinx-coroutines-jdk8:1.4.1
org.jetbrains.kotlinx:kotlinx-coroutines-test:1.4.1
```

Corutina

(Spustenie – blokujúce, neblokujúce)

.launch spustí novú corutinu a neblokuje hlavné vlákno
.corutina delay(ms) pozastaví výpočet corutiny na ms..
.runBlocking spustí novú corutinu a blokuje hlavné vlákno

```
suspend fun delay(timeMillis: Long)
```

```
Log.d(TAG, "Start")
GlobalScope.launch {   // Start a coroutine, non-blocking
    delay(1000)        // wait 1s.
    Log.d(TAG, "Hello")
}
Thread.sleep(3000)     // wait for 3s.
Log.d(TAG, "Stop")
runBlocking {          // Start a coroutine, blocking
    delay(4000)
}
Log.d(TAG, "Finish")
```

```
21:22:18.220 Start
21:22:19.225 Hello     Start+1sec.
21:22:21.222 Stop      Start+3sec.
21:22:25.225 Finish    Start+7sec.
```

https://simply-how.com/kotlin-coroutines-by-example-guide

Coroutines1/Example0

Corutina

(Spustenie – blokujúce, neblokujúce)

.join počká na dokončenie spustenej corutiny/jobu

```
println("Start")
val job:Job = GlobalScope.launch {// Start a non-blocking
    delay(1000)                   // wait 1s.
    println("Hello")
}
Thread.sleep(3000)                // wait for 3s.
println("Stop")
runBlocking {                     // Start a blocking
    job.join()             // waiting until job finishes
}
println("Finish")
```

```
interface Job
  suspend fun join()
```

```
16:29:18.408 Start
16:29:19.498 Hello       Start+1sec.
16:29:21.484 Stop        Start+3sec.
16:29:21.496 Finish      Start+3sec.
```

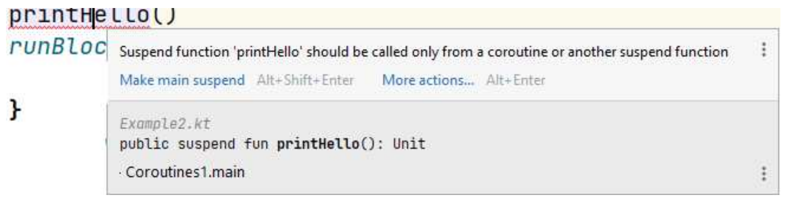
https://simply-how.com/kotlin-coroutines-by-example-guide

Coroutines1/Example1

Corutina
(suspend)

- corutina/suspend fun môže byť volaná len z coroutine scope
- corutina/suspend fun môže volať inú corutinu/suspend fun (napr. delay)

```
Log.d(TAG, "Start")
~~printHello()~~
runBlocking {
    printHello()
}
Log.d(TAG, "Finish")
```



```
printHello()
runBloc
}
```

Suspend function 'printHello' should be called only from a coroutine or another suspend function

Make main suspend Alt+Shift+Enter More actions... Alt+Enter

```
Example2.kt
public suspend fun printHello(): Unit
```

Coroutines1.main

```
suspend fun printHello() {
    delay(1000L)
    Log.d(TAG,"Hello")
}
```

```
21:27:34.083 Start
21:27:35.089 Hello     Start+1sec.
21:27:35.089 Finish    Start+1sec.
```

https://simply-how.com/kotlin-coroutines-by-example-guide

Coroutines1/Example2

GlobalScope/launch/delay

```
import kotlinx.coroutines.GlobalScope
import kotlinx.coroutines.delay
import kotlinx.coroutines.launch

fun main() {
    GlobalScope.launch {            // Start a non-blocking
        "world!".forEach {
            delay(200)
            print(it)
        }
    }
    print("Hello, ")
    Thread.sleep(2000)
}
```

```
12:46:15.811 Start
12:46:15.878 Hello,
12:46:16.106 w
12:46:16.318 o
12:46:16.519 r
12:46:16.721 l
12:46:16.924 d
12:46:17.130 !
12:46:17.882 Stop
```

Coroutines1/Example3

Corutina

(suspend)

```
Log.d(TAG,"Start main")

GlobalScope.launch {
    Log.d(TAG,"Start background")
    delay(1000L)
    Log.d(TAG,"Finish background")
}
Log.d(TAG, "Continue main")

runBlocking {
    delay(2000L)
    Log.d(TAG, "Stop main")
}
```

```
12:54:03.422 Start main
12:54:03.491 Continue main
12:54:03.495 Start background
12:54:04.501 Finish background
12:54:05.513 Stop main
```

https://simply-how.com/kotlin-coroutines-by-example-guide

Coroutines1/Example4

Corutina
(async/await)

```
12:59:07.099 Start main
12:59:07.175 Awaiting computations...
12:59:08.192 Computation1 finished
12:59:09.188 Computation2 finished
12:59:09.188 The result is 3
12:59:09.189 Stop main
```

.async spustí novú corutinu, ktorá počíta nejaký výsledok
.await čaká na tento výsledok

```
 runBlocking {     // defered=odložený/oneskorený výsledok
    val result1:Deferred<Int> = async { computation1() }
    val result2:Deferred<Int> = async { computation2() }
    Log.d(TAG, "Awaiting computations...")
    val result = result1.await() + result2.await()
    Log.d(TAG, "The result is $result")
} }
suspend fun computation1(): Int {
    delay(1000L) // simulated computation
    Log.d(TAG,"Computation1 finished")
    return 1 }
suspend fun computation2(): Int {
    delay(2000L)
    Log.d(TAG,"Computation2 finished")
    return 2 }
```

```
16:32:10 Start main
16:32:10 Awaiting computations...
16:32:11 Computation1 finished
16:32:12 Computation2 finished
16:32:12 The result is 3
16:32:12 Stop main
```

https://simply-how.com/kotlin-coroutines-by-example-guide

Coroutines1/Example5

Corutina
(cancel)

```
14:23:50.411 Start main
14:23:50.488 Processing 0 ...
14:23:51.499 Processing 1 ...
14:23:52.513 Processing 2 ...
14:23:53.520 Processing 3 ...
14:23:54.534 Processing 4 ...
14:23:55.546 Processing 5 ...
14:23:56.554 Processing 6 ...
14:23:57.568 Processing 7 ...
14:23:58.582 Processing 8 ...
14:23:59.597 Processing 9 ...
14:24:00.490 main: The user requests the cancellation
14:24:00.505 main: The batch is cancelled
```

```
runBlocking {
    val job = launch { // Emulate some batch processing
        repeat(30) { i ->
            Log.d(TAG, "Processing $i ...")
            delay(1000L)
        }
    }
    delay(10000L)
    Log.d(TAG, "main: The user requests the cancellation")
    job.cancelAndJoin()
      // cancel the job and wait for it's completion
    Log.d(TAG, "main: The batch is cancelled")
}
```

https://simply-how.com/kotlin-coroutines-by-example-guide

Coroutines1/Example6

Corutina

(withTimeout)

```
14:28:58.109 Start main
14:28:58.192 Processing 0 ...
14:28:59.205 Processing 1 ...
14:29:00.214 Processing 2 ...
14:29:01.227 Processing 3 ...
14:29:02.239 Processing 4 ...
14:29:03.249 Processing 5 ...
14:29:04.262 Processing 6 ...
14:29:05.267 Processing 7 ...
14:29:06.280 Processing 8 ...
14:29:07.293 Processing 9 ...
14:29:08.194 The processing return status is: null
```

```
runBlocking {
    val status = withTimeoutOrNull(10000L) {
        repeat(30) { i ->
            Log.d(TAG, "Processing $i ...")
            delay(1000L)
        }
        "Finished"
    }
    Log.d(TAG, "The processing return status is: $status")
}
```

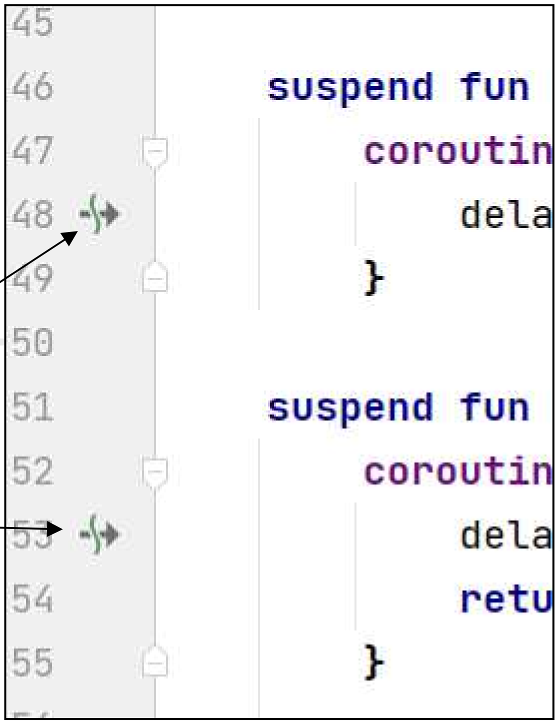
https://simply-how.com/kotlin-coroutines-by-example-guide

Coroutines1/Example7

Kotlin Coroutines

praktické použitie

- Courotines:
  - už tušíme základy
  - majú podporu v AS aj IntelliJ IDE
- MVVM
  - download image
  - processing image, image filter, ...
- Retrofit
  - download json
  - upload json
- Courotines ďalšie koncepty – asi na cviku, na pidi príkladoch... triedy
  - Flow
  - Channel
- Room database – na budúce
  - lokálna SQL databáza
  - DAO – data access object



```
    suspend fun
        coroutin
            dela
        }

    suspend fun
        coroutin
            dela
            retu
        }
```

Dispatchers

vlákna, v ktorých môžu bežať corutiny, tzv. **`CoroutineDispatcher`**

- **`Dispatchers.Main`** - hlavné Android vlákno, interaguje s UI, pre ľahšie operácie
- **`Dispatchers.IO`** - vlákno optimalizované na sieťové IO mimo hlavného vlákna

  hlavné použitie:
  - databázové operácie
  - I/O, čítanie/písanie do súborov
  - sieťové veci (http requests, ...)
- **`Dispatchers.Default`** – vlákno optimalizované pre CPU intenzívne operácie mimo hlavného vlákna

  hlavné použitie:
  - ťažké výpočty, matematické výpočty, simulácie, triedenie zoznamov, ...
  - spracovanie väčších dát

Corutiny v Android projekte

build.gradle

```
dependencies {
   implementation 'org.jetbrains.kotlinx:kotlinx-coroutines-core:1.5.0'
   implementation 'org.jetbrains.kotlinx:kotlinx-coroutines-android:1.5.0'
```

import do *.kt

```
import kotlinx.coroutines.*
```

```
val cCount = 10                         // počet corutín
fun launchCoroutines(view: View) { // onClickListerner pre Button
     (1..cCount).forEach {
          Log.d(TAG, "$it")
          statusText.append("<$it")
          CoroutineScope(Dispatchers.Main).launch {
            val result: Deferred<String> = async { perform2(it) }
              statusText.append(result.await())
}    }    }

suspend fun perform2(corIndex: Int): String {
     delay(Random.nextLong(5_000))
     return ">$corIndex"
}
```

CoturineSmallExample.zip

async/await

```
10:28:06.613 : 1
10:28:06.680 : 2
10:28:06.681 : 3
10:28:06.682 : 4
10:28:06.683 : 5
10:28:06.684 : 6
10:28:07.809 : 2 has duration 70
10:28:07.987 : 1 has duration 251
10:28:08.014 : 6 has duration 276
10:28:08.760 : 4 has duration 1023
10:28:09.575 : 3 has duration 1838
10:28:09.676 : 5 has duration 1938
```

```
fun launchCoroutines(view: View) {
    (1..cCount).forEach {                // spustí cCount corutín
        Log.d(TAG, "$it")
        statusText.append("<$it")
        CoroutineScope(Dispatchers.Main).launch {
            perform1(it)
            statusText.append("$it>")
}   }   }

suspend fun perform1(corIndex: Int) {
    delay(1_000)
    val x = CoroutineScope(Dispatchers.Main).async {
        val duration = Random.nextLong(2_000)
        delay(duration)
        duration                     // vráti hodnotu, koľko spala
    }.await()                        // prečíta hodnotu z corutiny
    Log.d(TAG, "$corIndex has duration $x")
    delay(Random.nextLong(3_000))
}
```

CoturineSmallExample.zip

async/await

```
fun launchCoroutines(view: View) {
    (1..cCount).forEach {
        Log.d(TAG, "$it")
        statusText.append("<$it")
        CoroutineScope(Dispatchers.Main).launch(Dispatchers.Main) {
           statusText.append("$it>")
             statusText.append(perform3(it).await())
}   }    }

suspend fun perform3(corIndex: Int): Deferred<String> =
     CoroutineScope(Dispatchers.Main).async {
        delay(Random.nextLong(5_000))
        return@async ">$corIndex"
}
```

CoturineSmallExample.zip

Image download

from url

- download image from URL
- image processing

```
CoroutineScope(Dispatchers.Main).launch {          ← Main
    val originalImage = async(Dispatchers.IO) {      ← IO
      URL(IMAGE_URL).openStream().use { // download image from URL
        BitmapFactory.decodeStream(it)
      }
    }                         // wait for complete download of an image
    val originalBitmap = originalImage.await()
    val filteredImage = async(Dispatchers.Default) {     ← Default
       toBlackAndWhite(originalBitmap)
    }                        // wait for processing image
    val filteredBitmap = filteredImage.await()
    progressBar.visibility = View.GONE
    imageView.setImageBitmap(filteredBitmap)
    imageView.visibility = View.VISIBLE
}
```

CoroutineImage

Process Image

spracovanie Bitmap – nepodstatné z pohľadu corutín ...

- image processing

```
fun toBlackAndWhite(source: Bitmap): Bitmap {
  val w = source.width
  val h = source.height
  val bitmapArray = IntArray(w*h)
  source.getPixels(bitmapArray,0,w,0,0,w,h) // array from source
  (0 until h).forEach { y->
    (0 until w).forEach { x->
      val index = x+y*w  // index in 2D-matrix
      val R = Color.red(bitmapArray[index])
      val G = Color.green(bitmapArray[index])
      val B = Color.blue(bitmapArray[index])
      val grey = (R + G + B)/3
      bitmapArray[index] = Color.rgb(grey, grey, grey)
  }  }
  val bitmapOut = Bitmap.createBitmap(w,h,Bitmap.Config.RGB_565)
  bitmapOut.setPixels(bitmapArray, 0, w, 0, 0, w, h) // bitmap
  bitmapOut // return bitmap
}
```

CoroutineImage

ClearText HTTP Problem

no longer in Android9+ – nepodstatné z pohľadu corutín

- `java.io.IOException: Cleartext HTTP traffic to dai.fmph.uniba.sk not permitted`

Starting with Android 9 (API level 28), cleartext support is disabled by default...

- **Option 1**: URL with "https://" instead of "http://"

```
private val IMAGE_URL = httpS://dai.fmph.uniba.sk/courses/VMA/ISLAND2.JPG
```

- **Option 2**: Pridaj `network_security_config` link do AndroidManifest.xml:

```
<manifest
    <uses-permission android:name="android.permission.INTERNET" />
    <application
          android:networkSecurityConfig="@xml/network_security_config„
```

vytvor súbor res/xml/network_security_config.xml obsahujúci:

```
<?xml version="1.0" encoding="utf-8"?>
<network-security-config>
    <base-config cleartextTrafficPermitted="true">
        <trust-anchors>
            <certificates src="system" />
        </trust-anchors>
    </base-config>
</network-security-config>
```

- **Option 3**: Pridaj do AndroidManifest.xml:

```
<application
      android:usesCleartextTraffic="true"
```

https://stackoverflow.com/questions/45940861/android-8-cleartext-http-traffic-not-permitted

CoroutineImage

Kotlin Coroutines

praktické použitie

- Courotines:
  - už tušíme základy
- Download big image
  - download image
  - processing image, image filter, ...
- Retrofit + MVVM
  - download json
  - upload json
- Room database
  - lokálna SQL databáza
  - DAO – data access object

Retrofit

RECOVER JOINTS, CARTILAGE AND BONES
STACKER
JOINT FIT
UNIQUE FORMULA DESIGNED TO STRENGTHEN JOINTS!
ORANGE LEMONADE
300 GRAMS
30

- Retrofit je REST klient pre Android
- zjednodušuje download & upload JSON (cez HTTP GET/POST)
- používa napr. Gson converter
- build.gradle treba doplniť o

```
implementation 'com.squareup.retrofit2:retrofit:2.6.2'
implementation 'com.squareup.retrofit2:converter-gson:2.6.2'
```

- data class zodpovedajúci JSONu (mapovanie na json tagy):

```
data class Stat (
    @SerializedName("name")       /* -> */  val countryName: String?,
    @SerializedName("capital")    /* -> */  val capital: String?,
    @SerializedName("flagPNG")    /* -> */  val flag: String?,
    @SerializedName("latlng")     /* -> */  val latlng: Array<Float>?,
    @SerializedName("borders")    /* -> */  val borders: List<String>?,
    @SerializedName("alpha3Code") /* -> */  val code: String?
)
```

- REST API pre Retrofit

```
interface StatInterface {
    @GET("vlajky/staty.json")
    suspend fun get(): Response<List<Stat>>
}
```

https://dai.fmph.uniba.sk/courses/VMA/vlajky/staty.json

CoroutineRetrofit

Coroutines+MVVM+Retrofit
(model)

https://dai.fmph.uniba.sk/courses/VMA/vlajky/staty.json

```kotlin
data class Stat(
    @SerializedName("name")      /* -> */  val countryName: String?,
    @SerializedName("capital")   /* -> */  val capital: String?,
    @SerializedName("flagPNG")   /* -> */  val flag: String?,
    @SerializedName("latlng")    /* -> */  val latlng: Array<Float>?,
    @SerializedName("borders")   /* -> */  val borders: List<String>?,
    @SerializedName("alpha3Code") /* -> */  val code: String?
)
```

```
/*
  {
    "alpha2Code": "SK",
    "alpha3Code": "SVK",
    "altSpellings": [
      "SK",
      "Slovak Republic",
      "Slovensk\u00e1 republika"
    ],
    "area": 49037,
    "borders": [
      "AUT",
      "CZE",
      "HUN",
      "POL",
      "UKR"
    ],
    "callingCodes": [
      "421"
    ],
    "capital": "Bratislava",
    "currencies": [
      {
        "code": "EUR",
        "name": "Euro",
        "symbol": "\u20ac"
      }
    ],
    "demonym": "Slovak",
        "flagPNG":
"https://dai.fmph.uniba.sk/courses/VMA/vlajky/svk.png",
```

```
    "gini": 26.0,
    "languages": [
      {
        "iso639_1": "sk",
        "iso639_2": "slk",
        "name": "Slovak",
        "nativeName": "sloven\u010dina"
      }
    ],
    "latlng": [
      48.66666666,
      19.5
    ],
    "name": "Slovakia",
    "nativeName": "Slovensko",
    "numericCode": "703",
    "population": 5426252,
    "region": "Europe",
    "regionalBlocs": [
      {
        "acronym": "EU",
        "name": "European Union"
      }
    ],
    "subregion": "Eastern Europe",
    "timezones": [
      "UTC+01:00"
    ],
```

CoroutineRetrofit

Coroutines+MVVM+Retrofit
(REST API - model)

```
interface StatInterface {
    @GET("vlajky/staty.json")
    suspend fun get(): Response<List<Stat>>
}

object StatService {
    private val BASE_URL = "https://dai.fmph.uniba.sk/courses/VMA/"

    fun get(): StatInterface =
        Retrofit.Builder()
                .baseUrl(BASE_URL)
                .addConverterFactory(GsonConverterFactory.create())
                .build()
                .create(RetroInterface::class.java)
    }
}
```

https://dai.fmph.uniba.sk/courses/VMA/vlajky/staty.json

461 kB/ 250x~200kB.png

CoroutineRetrofit

Coroutines+MVVM+Retrofit
(viewmodel)

```
class ListViewModel: ViewModel() {
    val service = StatService.get()
    lateinit var job: Job
    val staty = MutableLiveData<List<Stat>>()

    fun fetch() {
        job = CoroutineScope(Dispatchers.IO)
            .launch {
               val response = service.get()  // : Response<List<Stat>>
               withContext(Dispatchers.Main) {
                   if (response.isSuccessful)
                        staty.value = response.body()
                   else
                       Log.d("MODEL", "Error: ${response.message()}")
    }       }  }
    override fun onCleared() {
        super.onCleared()
        job.cancel()
}   }
```

CoroutineRetrofit

Coroutines+MVVM+Retrofit
(view)

```
class MainActivity : AppCompatActivity() {
    lateinit var viewModel: ListViewModel
    private val listAdapter = ListAdapter(arrayListOf())
    override fun onCreate(savedInstanceState: Bundle?) {
        super.onCreate(savedInstanceState)
        setContentView(R.layout.activity_main)
        viewModel = ViewModelProviders.of(this).get(ListViewModel::class.java)
        viewModel.fetch()
        listview.apply {
            layoutManager = LinearLayoutManager(context)
            adapter = listAdapter
        }
        observeViewModel()
    }
    fun observeViewModel() {
        viewModel.staty.observe(this, Observer { staty ->
            staty?.let {                                   // if staty != null …
                countriesList.visibility = View.VISIBLE
                listAdapter.updateCountries(it)
            }
        })
} }
```

CoroutineRetrofit

Glide

- List adaptér používa Glide na čítanie obrázkov z URL
- https://medium.com/@vlonjatgashi/using-glide-with-kotlin-5e345b557547
- build.gradle:

```
apply plugin: 'kotlin-kapt'  // kotlin anotation processing tool

dependencies {
   implementation 'com.github.bumptech.glide:glide:4.4.0`
   kapt 'com.github.bumptech.glide:compiler:4.4.0'
}
```

- kód:

```
import com.bumptech.glide.Glide

val options=RequestOptions().error(R.mipmap.ic_launcher_round)
Glide.with(imageView)
    .setDefaultRequestOptions(options)
    .load(country.flag)
    .into(imageView)
```

CoroutineRetrofit

```
Glide.with(this)
     .load(IMAGE_URL)
     .into(imageView)
```

Glide

jednoduché demo

```
CoroutineScope(Dispatchers.Main).launch {
    Glide.with(this@MainActivity)
        .asBitmap()
        .error(R.mipmap.ic_launcher_round)
        .load(IMAGE_URL)
        .into(object : CustomTarget<Bitmap>() {
            override fun onResourceReady(
                resource: Bitmap,
                transition: Transition<in Bitmap>? ) {
              val filteredBitmap = toBlackAndWhite(resource)
              progressBar.visibility = View.GONE
              imageView.setImageBitmap(filteredBitmap)
              imageView.visibility = View.VISIBLE
            }
            override fun onLoadCleared(placeholder: Drawable?) { }
        })
}
```

CoroutineGlide

GSM-Retrofit

https://eu1.unwiredlabs.com/v2/process.php

```
{
   "token": "95b2941777892d",
   "mcc": 231,
   "mnc": 2,
   "cells": [{
      "lac": 1,
      "cid": 31441
   }],
   "address": 1
}
```

```
{
   "status": "ok",
   "balance": 97,
   "lat": 48.14875,
   "lon": 17.06679,
   "accuracy": 837,
   "address": "Botanická, Švédske
domky, Bratislava, Karlova Ves,
Bratislava, Region of Bratislava, 841
04, Slovakia"
}
```

V prednáške o polohe sme narazili
na problém, že GSM súradnice prekladá do lat-long servis

- potrebujeme mu poslať a prečítať json-dáta, cez HTTP-POST
  - ak zavrhneme riešenie, že "lepíme reťazce" do JSON a vyhľadávame v ňom podstringy, ...
  - riešenie založené na json knižnici **`android.util.JsonReader/JsonWriter`** (ukážeme)
  - riešenie založené na Gson knižnici (konvertuje json do objektu cez Java reflection model)

- nesmieme to robiť v hlavnom vlákne, lebo to môže trvať...
  - riešenie pomocou AsyncTask (old-school)
  - corutinovské riešenie (new-wave)

ako zo vzorky JSON to vyrobiť Kotlin Class ?

- build.gradle

GSMRetrofit

Výmena dát so serverom

Výmena dát klient-server

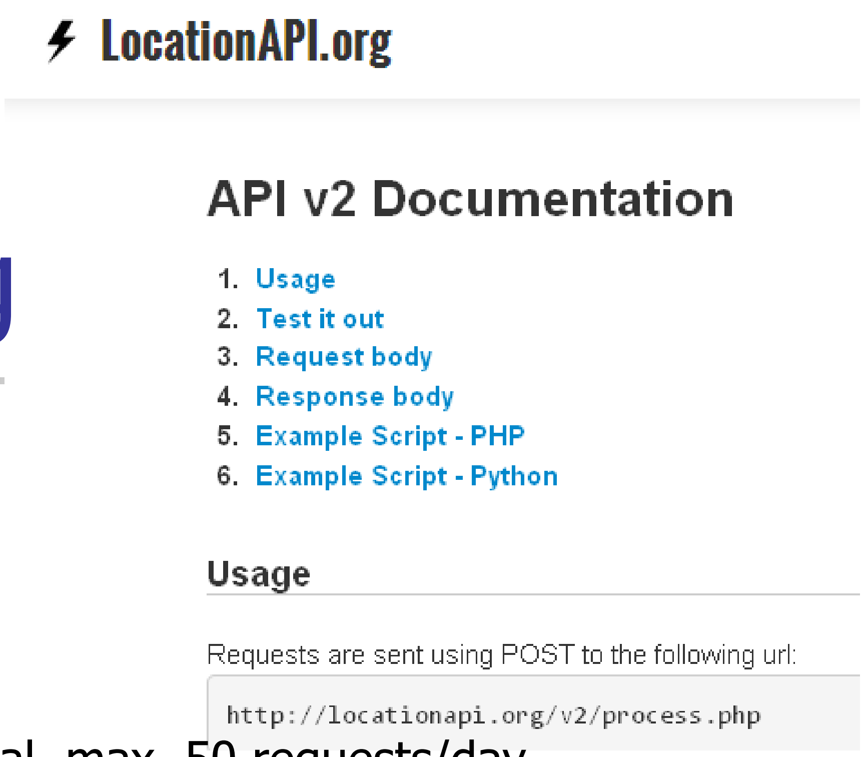
- cez parametre GET/POST requestu,
- cez obsah POST requestu,
- cez cookies - nebude

uvidíme:

- cez JSON objekt
  - **pomocou `org.json.*`**
  - **pomocou `com.google.gson.*`**
- cez xml formát
  - **pomocou `org.xml.sax.*;`**
  - http://dai.fmph.uniba.sk/courses/java2/sl/xml.pdf

LocationAPI.org

```
D/MyGSMLocation(19361): gsm cid: 396517
D/MyGSMLocation(19361): gsm lac: 1001
D/MyGSMLocation(19361): operator:23102
D/MyGSMLocation(19361): network: 23102
D/MyGSMLocation(19361): mcc: 231
D/MyGSMLocation(19361): mnc: 2
```


LocationAPI.org

API v2 Documentation

1. Usage
2. Test it out
3. Request body
4. Response body
5. Example Script - PHP
6. Example Script - Python

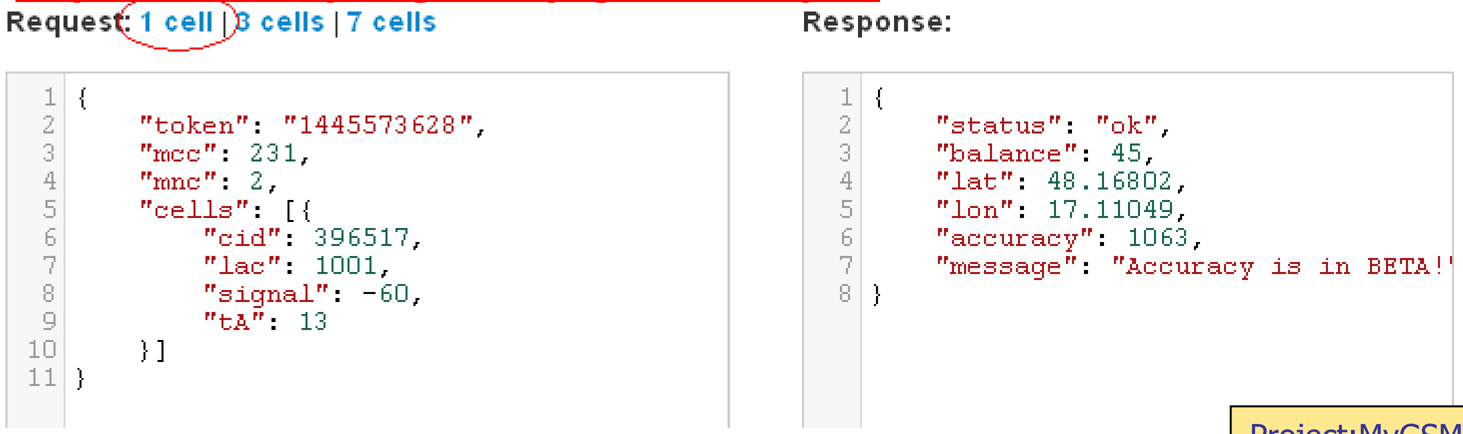
Usage

Requests are sent using POST to the following url:

```
http://locationapi.org/v2/process.php
```

- zaregistrujete sa napr. na 7-dňový trial, max. 50 requests/day
- dostanete kľúč (token), 95b2941777892d (keď toto čítate, asi už neplatí ☹
- skúste 95b2941777892d (7.dec 2017).

http://locationapi.org/site/page?view=apiv2


Request: 1 cell | 3 cells | 7 cells

```
{
    "token": "1445573628",
    "mcc": 231,
    "mnc": 2,
    "cells": [{
        "cid": 396517,
        "lac": 1001,
        "signal": -60,
        "tA": 13
    }]
}
```

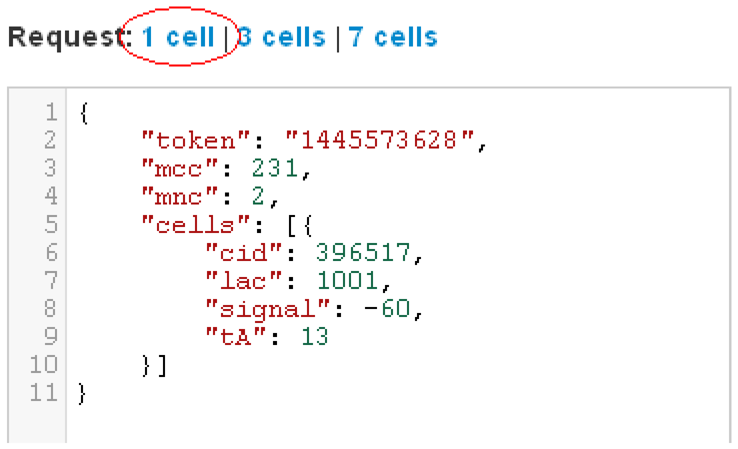
Response:

```
{
    "status": "ok",
    "balance": 45,
    "lat": 48.16802,
    "lon": 17.11049,
    "accuracy": 1063,
    "message": "Accuracy is in BETA!"
}
```

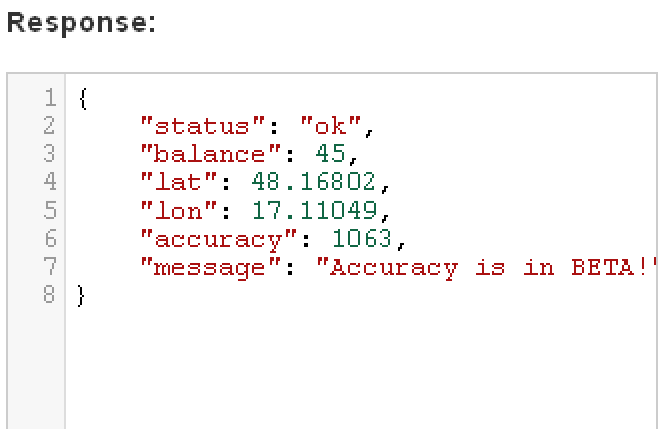
Project:MyGSMLocation.zip

LocationAPI z aplikácie

- potrebujeme urobiť http-POST request na http://locationapi.org/v2/process.php ✓
- keďže to niečo trvá, nesmieme to robiť v hlavnom vlákne – AsyncTask ✓
- do tela dotazu (requestu) potrebujeme zakódovať (cellID, lac, mcc, mnc + môj token) hoc jednoduchý, ale predsa-len JSON objekt ✓
- z tela odpovede (responsu) potrebujeme dekódovať hoc jednoduchý, ale JSON objekt, t.j. prečítať latitude-longitude ✓



```
{
    "token": "1445573628",
    "mcc": 231,
    "mnc": 2,
    "cells": [{
        "cid": 396517,
        "lac": 1001,
        "signal": -60,
        "tA": 13
    }]
}
```



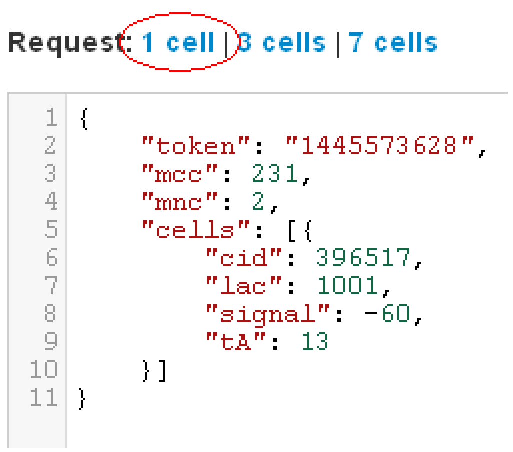
```
{
    "status": "ok",
    "balance": 45,
    "lat": 48.16802,
    "lon": 17.11049,
    "accuracy": 1063,
    "message": "Accuracy is in BETA!"
}
```

Project:MyGSMLocation.zip

Vytvorenie (malého) JSON objektu
(pre GET LocationAPI)

```
import android.util.JsonWriter
```

```
val sw = StringWriter()
val jw = JsonWriter(sw)
try {
   jw.beginObject()  -- {
     jw.name("token").value(token_locationAPIORG)
     jw.name("mcc").value(mcc)
     jw.name("mnc").value(mnc)
     jw.name("cells")
     jw.beginArray()   -- [
        .beginObject() -- {
                jw.name("cid").value(cid)
                jw.name("lac").value(lac)
                jw.name("signal").value(-60)
                jw.name("tA").value(13)
jw.endObject().endArray().endObject().close() -- } ] }
```


Request: 1 cell | 3 cells | 7 cells

```
{
    "token": "1445573628",
    "mcc": 231,
    "mnc": 2,
    "cells": [{
        "cid": 396517,
        "lac": 1001,
        "signal": -60,
        "tA": 13
    }]
}
```

Project:MyGSMLocation.zip

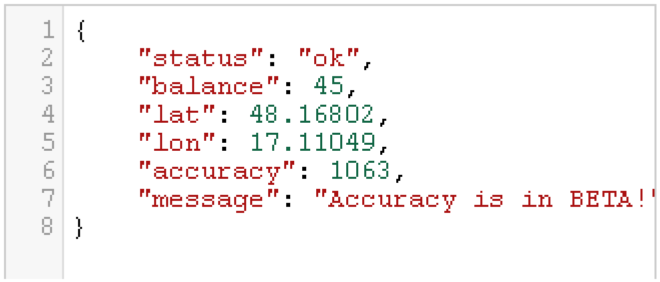
Dekódovanie (malého) JSON

```
import android.util.JsonReader
```

```
val sr = StringReader(result)
val jr = JsonReader(sr)
jr.beginObject() -- {
   jr.nextName() -- skip: “status”
   jr.nextString()     -- skip: “ok”
   jr.nextName() -- skip: “balance”
   jr.nextInt()  -- skip: 45

   jr.nextName() -- skip: “lat”
   lat = jr.nextDouble()
   jr.nextName() -- skip: “lon”
   lng = jr.nextDouble()
   jr.nextName()  -- skip: “accuracy”
   accur = jr.nextInt()
```

Response:



```
{
    "status": "ok",
    "balance": 45,
    "lat": 48.16802,
    "lon": 17.11049,
    "accuracy": 1063,
    "message": "Accuracy is in BETA!"
}
```

Project:MyGSMLocation.zip

GSON
(fromJson)

```
{
 "id": "1547257485",
 "name": "Peter Borovansky",
 "first_name": "Peter",
 "last_name": "Borovansky",
 "link":"http://www.facebook.com/
          peter.borovansky",
 "username": "peter.borovansky",
 "gender": "male",
 "locale": "cs_CZ"
}
```

Idea: k JSON objektu definujeme zodpovedajúcu (1:1) java triedu

Obmedzenia (viac https://github.com/google/gson/blob/master/UserGuide.md):

- mená JSON tagov sa musia zhodovať s java menami polí v triede

```
import com.google.gson
```

```
class FBHeader {
   public String id = "";
   public String name = "";
   public String first_name = "";
   public String last_name = "";
   public String link = "";
   public String username = "";
   public String gender = "";
   public String locale = "";                }

Gson gson = new GsonBuilder().create();
FBHeader header = gson.fromJson(jsonstring, FBHeader.class);
```

FB Friends

(fromJson)

```
{ "data":
          [ { "name": "Zuzka B…", "id": "582749468" },
            { "name": "Lubica K…", "id": "583024903" },
            { "name": "Barbora F…", "id": "632007063" },
          ],
   "paging": { "next":"https://graph.facebook.com/15...}
```

```
class FBFriends {  // dvojica
   public FBPairs[] data = null;
   public FBPaging paging = null; }
class FBPairs {    // dvojica
   public String name = "";
   public String id = ""; }
class FBPaging {   // singleton
   public String next = ""; }

Gson gson = new GsonBuilder().create();
FBFriends friends = gson.fromJson(result, FBFriends.class);
if (friends != null) {
   if (friends.data != null)
        for (int i = 0; i < friends.data.length; i++)
           if (friends.data[i] != null)
                tv.append(friends.data[i].name + ",");
}
```

```
import com.google.gson
```

GSON – ako to funguje ?

Reflexivita

Ukázali sme

- `fromJson (do Javy)`

ale analogicky funguje

- `toJson (z Javy)`

`org.json`

`vs.`

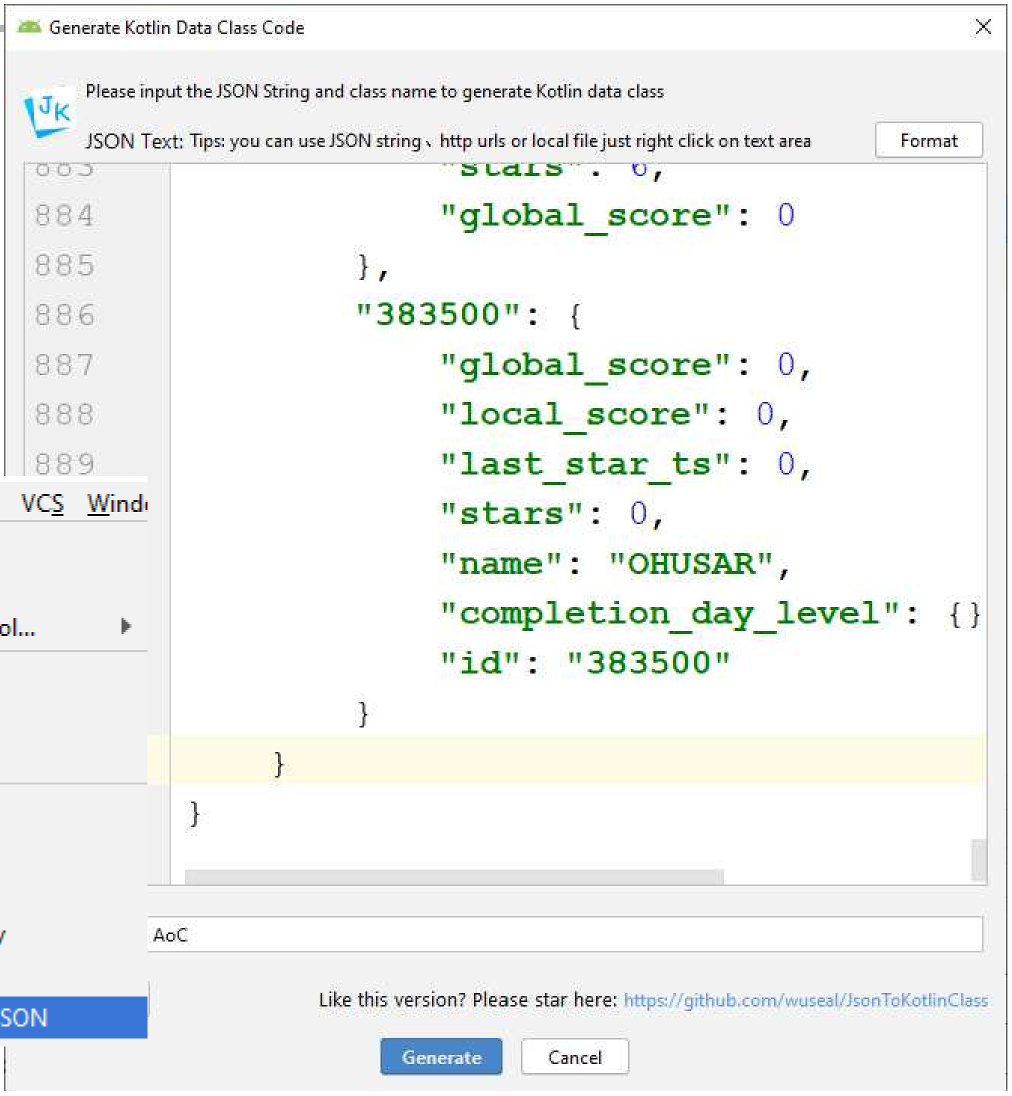
`com.google.gson`

Zdroj: http://www.huffingtonpost.com/2012/06/17/mc-escher-birthday_n_1591432.html

Plugin JSON to Kotlin Class

- z daného JSON vytvorí definíciu Kotlin tried

- potom stačí zavolať fromJson prekonvertuje vám json-string do dátovej štruktúry



Generate Kotlin Data Class Code

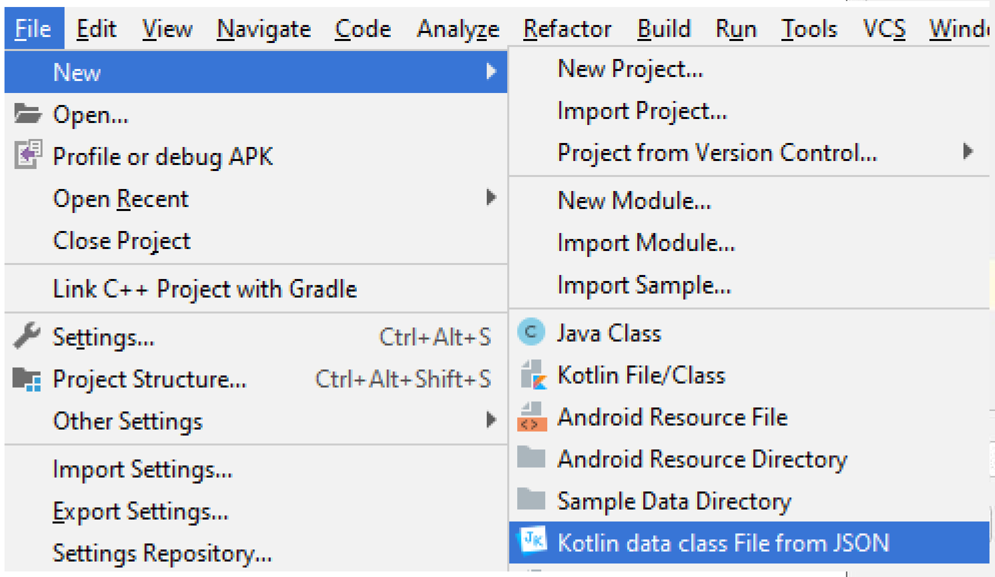
Please input the JSON String and class name to generate Kotlin data class

JSON Text: Tips: you can use JSON string、http urls or local file just right click on text area

```
            "stars": 0,
            "global_score": 0
        },
        "383500": {
            "global_score": 0,
            "local_score": 0,
            "last_star_ts": 0,
            "stars": 0,
            "name": "OHUSAR",
            "completion_day_level": {},
            "id": "383500"
        }
    }
}
```

AoC

Like this version? Please star here: https://github.com/wuseal/JsonToKotlinClass



GSM-Retrofit

https://eu1.unwiredlabs.com/v2/process.php

```
{
   "token": "95b2941777892d",
   "mcc": 231,
   "mnc": 2,
   "cells": [{
      "lac": 1,
      "cid": 31441
   }],
   "address": 1
}
```

GSMRequest

```
{
   "status": "ok",
   "balance": 97,
   "lat": 48.14875,
   "lon": 17.06679,
   "accuracy": 837,
   "address": "Botanická,
Švédske domky, Bratislava,
Karlova Ves, Bratislava,
Region of Bratislava, 841 04,
Slovakia"
}
```

GSMResponse

- JSON to Kotlin Class
- build.gradle

```
implementation 'com.google.code.gson:gson:2.8.5’
implementation 'com.squareup.retrofit2:retrofit:2.6.2'
implementation 'com.squareup.retrofit2:converter-gson:2.6.2’
```

- toto si dáme vygenerovať pluginom JSON to Kotlin Class

```
data class Cell(
    val cid: Int,
    val lac: Int
)
```

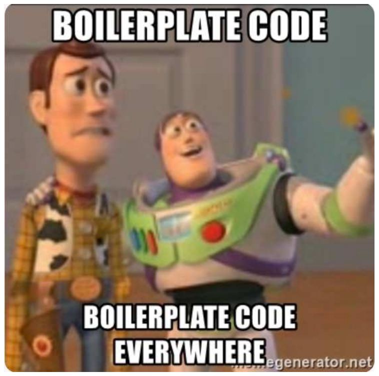
ak interné mená zodpovedajú JSON tagom, tak neriešime `@SerializedName`

```
data class GSMRequest(
    val address: Int,
    val cells:   List<Cell>,
    val mcc:     Int,
    val mnc:     Int,
    val token:   String
)
```

```
data class GSMResponse(
    val accuracy: Int,
    val address:  String,
    val balance:  Int,
    val lat:      Double,
    val lon:      Double,
    val status:   String
)
```

GSMRetrofit

process.php



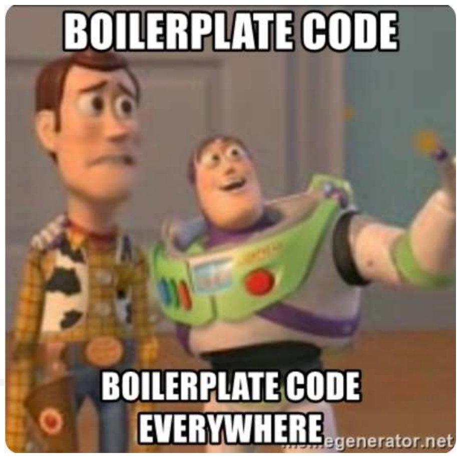
Rest API

```
interface RestApiInterface {
    @Headers("Content-Type: application/json")
    @POST("process.php")
    fun gsm2latlong(@Body gsmRequest: GSMRequest): Call<GSMResponse>
}
```

```
class RestApiService {
  suspend
  fun gsm2latlong(gsmRequest: GSMRequest, onResult: (GSMResponse?) -> Unit){
    val retrofit = ServiceBuilder.get()
    retrofit.gsm2latlong(gsmRequest).enqueue(
      object : Callback<GSMResponse> {
        override fun onFailure(call: Call<GSMResponse>, t: Throwable) {
          onResult(null)                                 ←  null
        }
        override fun onResponse(call: Call<GSMResponse>,
                                response: Response<GSMResponse>) {
           val resp = response.body()
           onResult(resp)                                ←  !=null
 }   } ) } }
```

GSMRetrofit

https://eu1.unwiredlabs.com/v2/



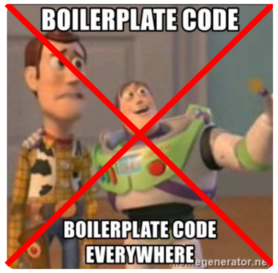
Service Builder

```
object ServiceBuilder {
    private val client = OkHttpClient.Builder().build()

    suspend
    fun get(): RestApiInterface =
        Retrofit.Builder()
        .baseUrl("https://eu1.unwiredlabs.com/v2/")
        .addConverterFactory(GsonConverterFactory.create())
        .client(client)
        .build()
        .create(RestApiInterface::class.java)
}
```

GSMRetrofit

Volanie - bez corutiny



```
class RestApiService {
  ~~suspend~~
  fun gsm2latlong(gsmRequest: GSMRequest,
                        onResult: (GSMResponse?) -> Unit)
```

```
val request = GSMRequest(
    token = "95b2941777892d",
    mcc = mcc,
    mnc = mnc,
    cells = listOf(Cell(lac = lac, cid = cid)),
    address = 1
)

    val apiService = RestApiService()
    val response = apiService.gsm2latlong(request) {
      response ->                         // toto je onResult
        if (response != null) {
            Log.d(TAG, "${response.lat}, ${response.lon}")
            latTV.text = response.lat.toString()
            longTV.text = response.lon.toString()
        } else
            Log.d(TAG, "response is null")
      }
```

GSMRetrofit

Volanie – s corutinou

```
class RestApiService {
  suspend
  fun gsm2latlong(gsmRequest: GSMRequest,
                        onResult: (GSMResponse?) -> Unit)
```

```
val request = GSMRequest(
    token = "95b2941777892d",
    mcc = mcc,
    mnc = mnc,
    cells = listOf(Cell(lac = lac, cid = cid)),
    address = 1
)
CoroutineScope(Dispatchers.IO).launch {
    val apiService = RestApiService()
    val response = apiService.gsm2latlong(request) {
      response ->                  // toto je onResult
        if (response != null) {
            Log.d(TAG, "${response.lat}, ${response.lon}")
            latTV.text = response.lat.toString()
            longTV.text = response.lon.toString()
        } else
            Log.d(TAG, "response is null")
      }
}
```

GSMRetrofit

GUI len ako Dispatchers.Main

```
val request = GSMRequest(
    token = "95b2941777892d",
    mcc = mcc,
    mnc = mnc,
    cells = listOf(Cell(lac = lac, cid = cid)),
    address = 1
)
CoroutineScope(Dispatchers.IO).launch {
    val apiService = RestApiService()
    val response = apiService.gsm2latlong(request) {
      response ->                    // toto je onResult
        if (response != null) {
            Log.d(TAG, "${response.lat}, ${response.lon}")
            CoroutineScope(Dispatchers.Main).launch {
                latTV.text = response.lat.toString()
                longTV.text = response.lon.toString()
            }
        } else
            Log.d(TAG, "response is null")
}   }
```

GSMRetrofit