Testing Kotlin Coroutines

I need a time machine

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Dev

Outline

- Android and coroutines
- Problem
- What I want
- Fix
- Demo
  - Hello 8 Ball
  - Slow - Fast
  - Flakey - Predictable
  - ViewModel tests

What next?

Android and Coroutines

Problem

Well,

Code does **not** run on Main/UI thread

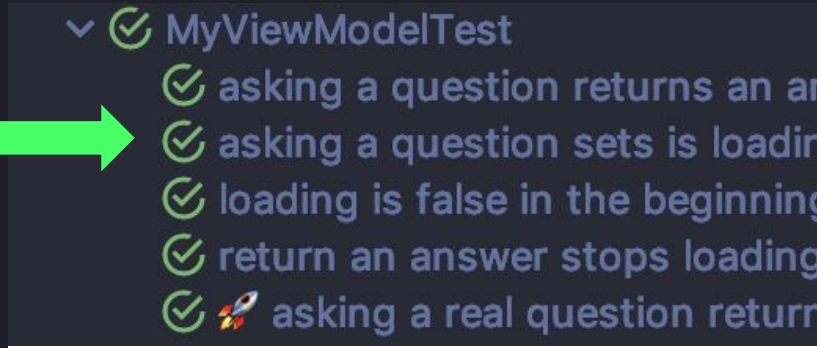
Lifecycle aware components check for Main/UI thread

Tests finish **before** the code runs

// don’t change … the test might fail ¯_(ツ)_/¯

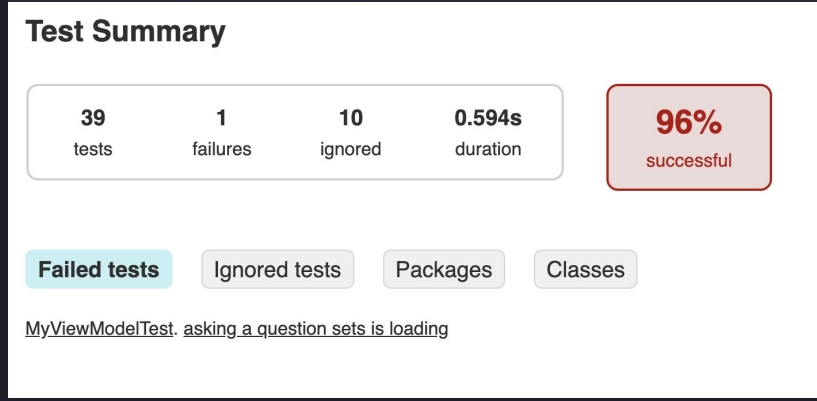
delay(3000)

pass/fail locally



fail/pass on CI

BUILD FAIL



```
@Ignore("This test takes too long")

@Ignore("This test sometimes fails")
```

What I want

Fast
Predictable
CI

Fix

Fix - a time machine

- Run everything on **one** thread
  - runBlocking -> runBlockingTest [1]
  - Swap out UI/Main thread [1]
  - Inject
- **Control** the dispatchers [1]
- Architecture
- JVM

[1] experimental kotlinx-coroutines-test

kotlin-coroutines-test

- TestCoroutineDispatcher
  - runBlockingTest ⏯️
  - pauseDispatcher ⏸️
  - advanceTimeBy ⏰

kotlin-coroutines-test

- Main delegation
  - setMain
  - resetMain

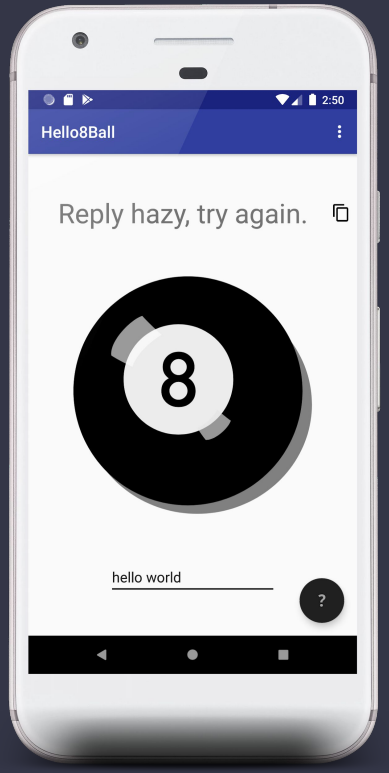
```
class CoroutinesTestRule(
    val testDispatcher: TestCoroutineDispatcher = TestCoroutineDispatcher()
) : TestWatcher() {
```

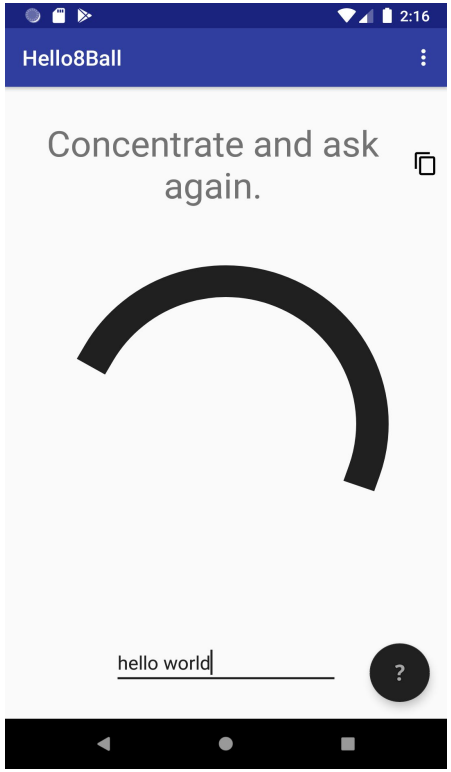
```kotlin
override fun starting(description: Description?) {
    super.starting(description)
    Dispatchers.setMain(testDispatcher)
}

override fun finished(description: Description?) {
    super.finished(description)
    Dispatchers.resetMain()
    testDispatcher.cleanupTestCoroutines()
}
```

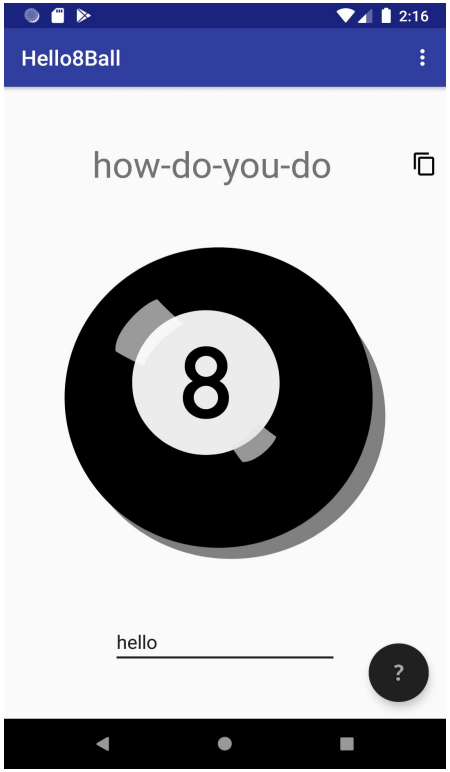
ViewModel Rule

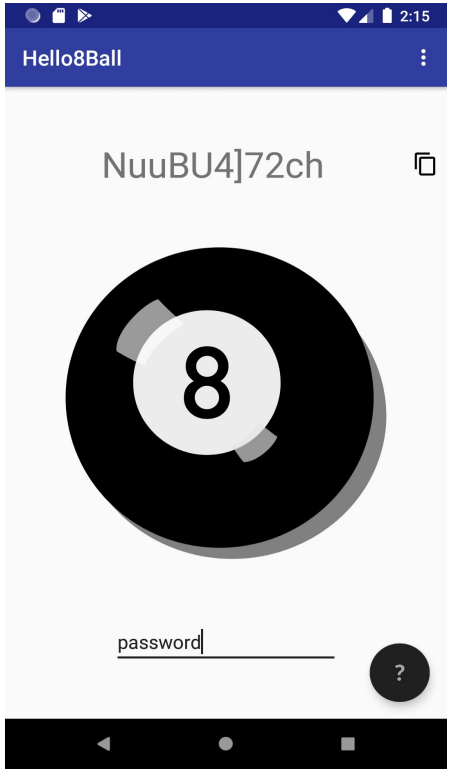
Demo

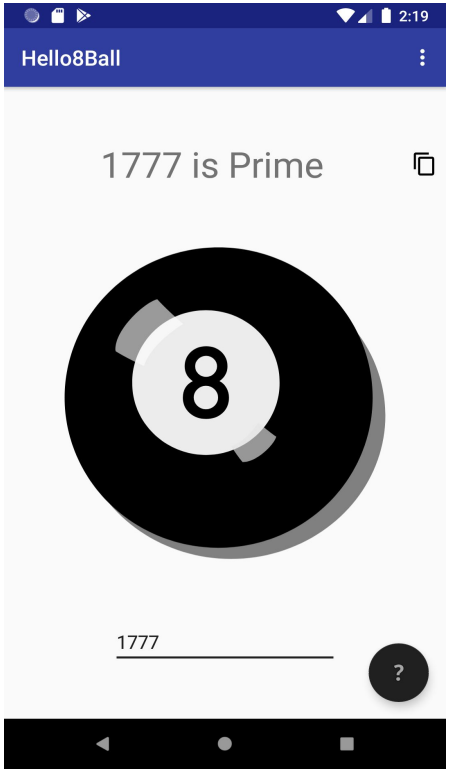
Hello 8 Ball

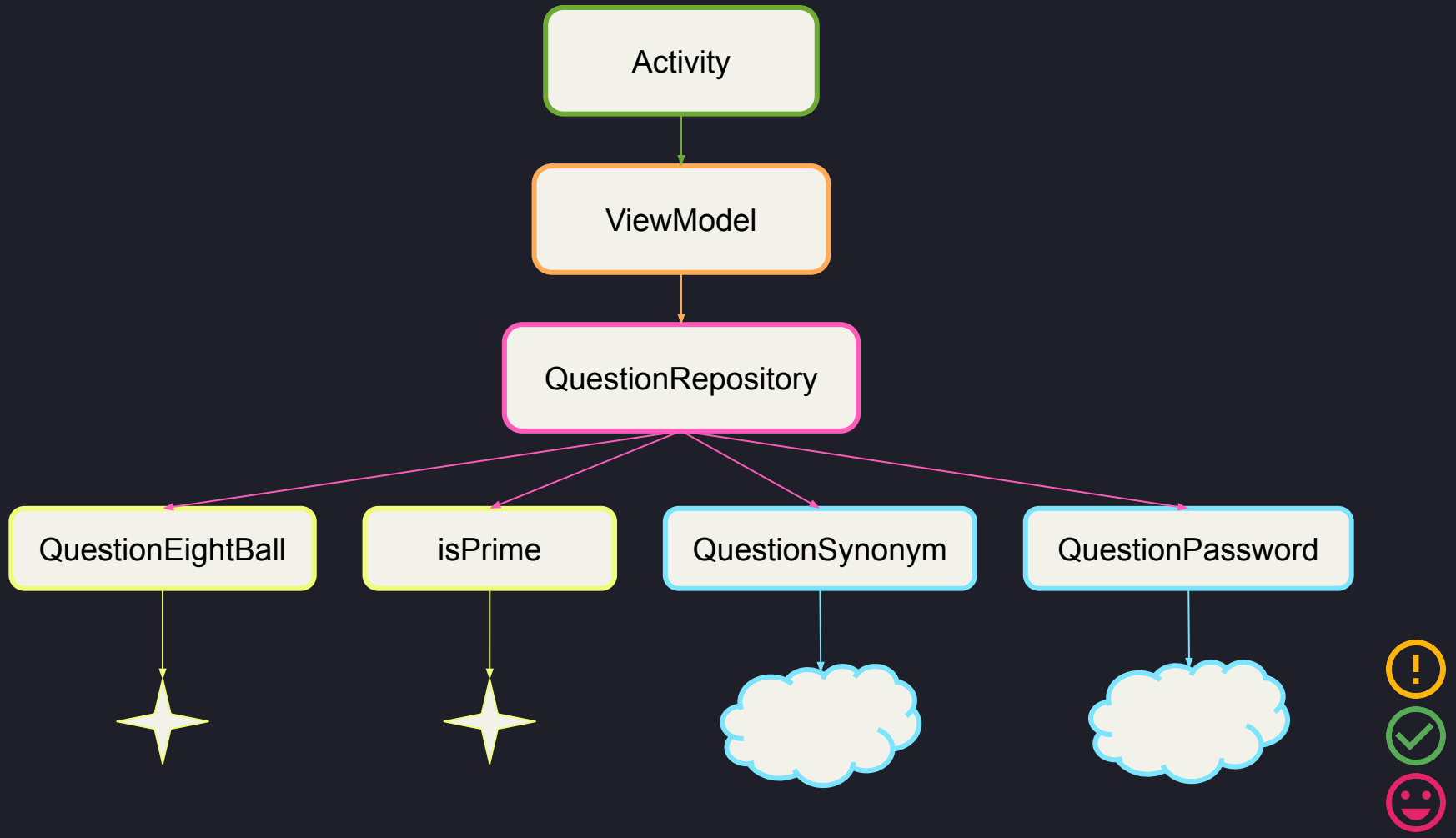


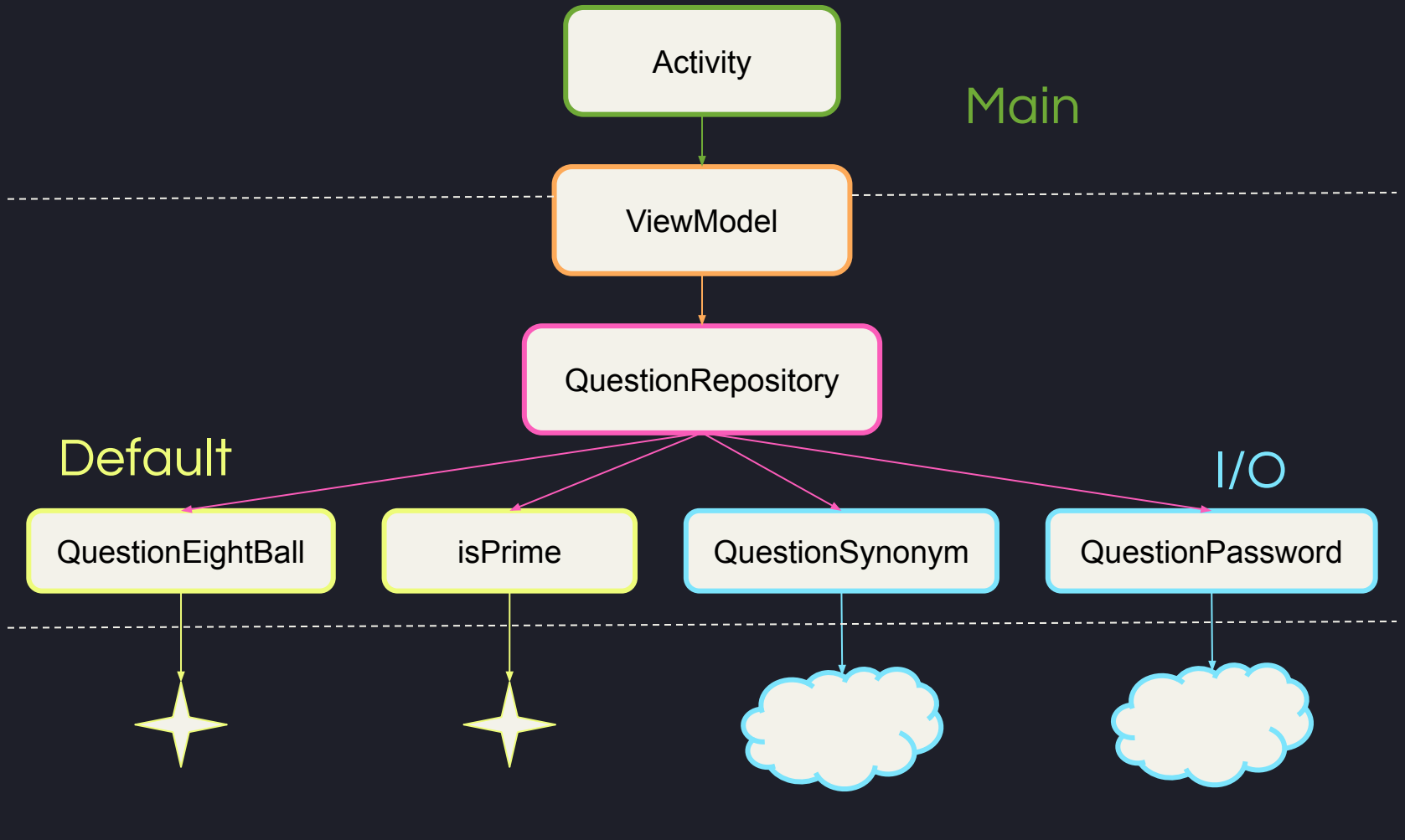

2:16
Hello8Ball
Concentrate and ask again.
hello world
?


2:16
Hello8Ball
how-do-you-do
8
hello
?


2:15
Hello8Ball
NuuBU4]72ch
8
password
?


2:19
Hello8Ball
1777 is Prime
8
1777
?


Activity
ViewModel
QuestionRepository
QuestionEightBall
isPrime
QuestionSynonym
QuestionPassword


Activity
Main
ViewModel
QuestionRepository
Default
I/O
QuestionEightBall
isPrime
QuestionSynonym
QuestionPassword

```
suspend fun ponder(question: String): String {
    var newAnswer = ""
    when (parseQuestion(question)) {
        QuestionType.OTHER -> withContext(contextProvider.Default) { this: CoroutineScope
            newAnswer = eightBall.getAnswer()
        }
        QuestionType.SYNONYM -> withContext(contextProvider.IO) { this: CoroutineScope
            newAnswer = synonym.getAnswer(question)
        }
    }
    return newAnswer
}
```

QuestionRepository - suspend ponder

Slow vs Fast

🐢 🐰

```kotlin
object QuestionEightBall : QuestionInterface {

    internal val answers: List<String> = listOf(...)

    override suspend fun getAnswer(question: String): String {
        // simulate a eightBall call here
        val randomMillis = (500 + 1000 * Math.random()).toLong()
        delay(randomMillis)
        return answers.shuffled().first()
    }
}
```

Slow vs Fast

```
@Test
fun `🐢 should return valid answer (delay)`() = runBlocking { this: CoroutineScope
    val answer = QuestionEightBall.getAnswer()
    assertThat(answer).isIn(QuestionEightBall.answers)
}

@Test
fun `🐰 should return valid answer (no delay)`() = runBlockingTest { this: TestCoroutineScope
    val answer = QuestionEightBall.getAnswer()
    assertThat(answer).isIn(QuestionEightBall.answers)
}
```

Slow vs Fast

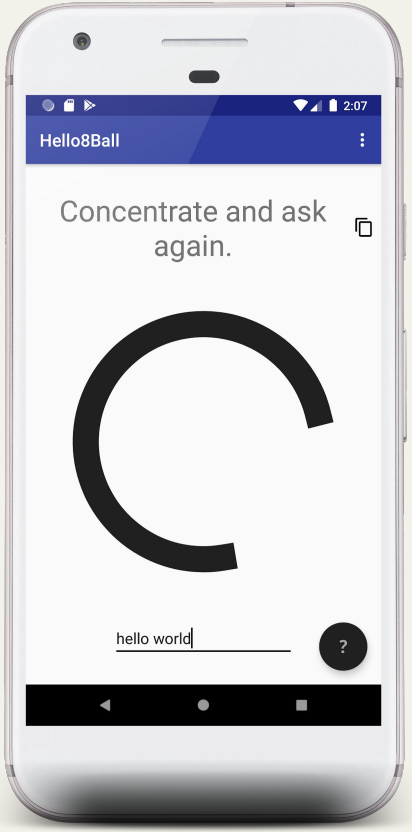
SlowFastTests (net.maiatoday.hello8ball.question)	5 s 668 ms
🐢 asking a real question returns an answer (delay)	3 s 3 ms
🐢 should return answer from 🎱 (delay)	1 s 127 ms
🐢 should return valid answer (delay)	1 s 169 ms
🐰 asking a real question returns an answer (no delay)	15 ms
🐰 should return answer from 🎱 (no delay)	353 ms
🐰 should return valid answer (no delay)	1 ms

Slow vs Fast

Flakey vs Predictable

Flakey Predictable

Testing the ViewModel progress bar



```
@Test
fun `asking a question sets is loading`() = runBlocking { this: CoroutineScope
    val mockQuestionInterface = Mockito.mock(QuestionInterface::class.java)
    val repository = QuestionRepository(mockQuestionInterface)
    val subject = MyViewModel(repository)

    subject.fetchAnswer( question: "hello world")
    delay( timeMillis: 1000) // … the test might fail ¯\_(ツ)_/¯

    Truth.assertThat(subject.isloading.getValueForTest()).isTrue()
}
```

Flakey

ViewModel tests

```kotlin
@ExperimentalCoroutinesApi
class MyViewModelTest {

    // Set the main coroutines dispatcher for unit testing.
    // We are setting the above-defined testDispatcher as the Main thread dispatcher.
    @get:Rule
    var coroutinesTestRule = CoroutinesTestRule()

    // Executes each task synchronously using Architecture Components.
    @get:Rule
    val instantTaskExecutorRule = InstantTaskExecutorRule()

    val testDispatcher = coroutinesTestRule.testDispatcher
    val contextProvider = TestDispatcherProvider(testDispatcher)
```

ViewModel - rule to control Main

```
@ExperimentalCoroutinesApi
class MyViewModelTest {

    // Set the main coroutines dispatcher for unit testing.
    // We are setting the above-defined testDispatcher as the Main thread dispatcher.
    @get:Rule
    var coroutinesTestRule = CoroutinesTestRule()

    // Executes each task synchronously using Architecture Components.
    @get:Rule
    val instantTaskExecutorRule = InstantTaskExecutorRule()

    val testDispatcher = coroutinesTestRule.testDispatcher
    val contextProvider = TestDispatcherProvider(testDispatcher)
```

ViewModel - rule to run synchronously

```kotlin
@ExperimentalCoroutinesApi
class MyViewModelTest {

    // Set the main coroutines dispatcher for unit testing.
    // We are setting the above-defined testDispatcher as the Main thread dispatcher.
    @get:Rule
    var coroutinesTestRule = CoroutinesTestRule()

    // Executes each task synchronously using Architecture Components.
    @get:Rule
    val instantTaskExecutorRule = InstantTaskExecutorRule()

    val testDispatcher = coroutinesTestRule.testDispatcher
    val contextProvider = TestDispatcherProvider(testDispatcher)
```

ViewModel - testDispatcher

```
@Test
fun `asking a question sets is loading ⚡🎱`() =
    testDispatcher.runBlockingTest { this: TestCoroutineScope
        pauseDispatcher {

            // setup fake that responds slowly
            val fakeInterface: QuestionInterface = SlowFakeAnswer( timeout: 5000)
            val repository = QuestionRepository(
                eightBall = fakeInterface,
                contextProvider = contextProvider
            )

            // setup subject
            val subject = MyViewModel(repository)
            subject.fetchAnswer( question: "hello world")

            // control time and test
            assertThat(subject.isloading.getValueForTest()).isFalse()
            advanceTimeBy( delayTimeMillis: 1)
```

```
            contextProvider = contextProvider
        )

        // setup subject
        val subject = MyViewModel(repository)
        subject.fetchAnswer( question: "hello world")

        // control time and test
        assertThat(subject.isloading.getValueForTest()).isFalse()
        advanceTimeBy( delayTimeMillis: 1)
        assertThat(subject.isloading.getValueForTest()).isTrue()
        advanceTimeBy( delayTimeMillis: 4998)
        assertThat(subject.isloading.getValueForTest()).isTrue()
        advanceTimeBy( delayTimeMillis: 1)
        assertThat(subject.isloading.getValueForTest()).isFalse()
    }
}
```

ViewModel

```
        contextProvider = contextProvider
    )

    // setup subject
    val subject = MyViewModel(repository)
    subject.fetchAnswer( question: "hello world")

    // control time and test
    assertThat(subject.isloading.getValueForTest()).isFalse()
    advanceTimeBy( delayTimeMillis: 1)
    assertThat(subject.isloading.getValueForTest()).isTrue()
    advanceTimeBy( delayTimeMillis: 4998)
    assertThat(subject.isloading.getValueForTest()).isTrue()
    advanceTimeBy( delayTimeMillis: 1)
    assertThat(subject.isloading.getValueForTest()).isFalse()
  }
}
```

ViewModel - step time and check loading

MyViewModelTest (net.maiatoday.hello8ball.view) 355 ms

asking a question sets is loading ⚡🕐 355 ms

ViewModel

hello8ball (net.maiatoday)	725 ms
FlakeyTests	0 ms
MyViewModelTest	581 ms
asking a question returns an answer	278 ms
asking a question sets is loading ⚡🕛	2 ms
loading is false in the beginning	1 ms
return an answer stops loading	10 ms
🚀 asking a real question returns an answer (no delay)	290 ms
ParseQuestionTest	0 ms
PasswordServiceIntegrationTest	0 ms
PrimeTest	19 ms
QuestionEightBallTest	0 ms
QuestionPasswordTest	24 ms
QuestionRepositoryTest	10 ms
QuestionSynonymTest	91 ms
🐱 valid response 202	11 ms
👹 bad response 404	8 ms
👺 bad response 500	72 ms
SlowFastTests	0 ms
SynonymServiceIntegrationTest	0 ms

All tests - CI

What Next?

🔮

What next?

1. Add one test and make it run on CI
2. Inject the dispatchers and/or add the kotlin testing library
3. Migrate architecture to separate Android/coroutine code/other code
4. Add a more coroutine tests

References

- Library: Kotlinx coroutines test
- Video: Coroutines +Testing = <3
- Video: Writing awesome tests
- Book: Learning Concurrency in Kotlin
- Repo: Codelab Kotlin Coroutines

code slides

https://github.com/maiatoday/Hello8Ball
Slides in /slides

Bonus : lint, detekt, coverage, circle ci

Questions 🎱

Reply hazy, try again.

Api tests

```
interface PasswordService {
    @GET( value: "query")
    fun getPasswordAsync(
        @Query( value: "command") command: String = "password",
        @Query( value: "format") format: String = "json",
        @Query( value: "count") count: Int = 1
    ): Deferred<PasswordResponse>
```

API

```kotlin
class QuestionPassword(private val service: PasswordService = PasswordService.instance) :
    QuestionInterface {
    override suspend fun getAnswer(question: String): String {
        return try {
            val response = service.getPasswordAsync().await()
            val passwords = response.char
            passwords[0]
        } catch (e: HttpException) {
            "Oops no password"
        }
    }
}
```

API

```
@Before
fun setUp() {
    service = PasswordService.passwordService(server.url( path: "/"))
    subject = QuestionPassword(service)
}

@Test
fun `🐞 bad response 404`() = runBlocking { this: CoroutineScope
    server.enqueue(MockResponse().setResponseCode(404))
    val answer = subject.getAnswer( question: "password")
    assertThat(answer).isEqualTo( expected: "Oops no password")
}
```

API

```
@Test
fun `success password service access`() = runBlocking { this: CoroutineScope
    val response = passwordService.getPasswordAsync().await()
    val passwords = response.char
    assertThat(passwords.size).isEqualTo( expected: 1)
    assertThat(passwords[0]).isNotEmpty()
}
```

API

Kotlin coroutines

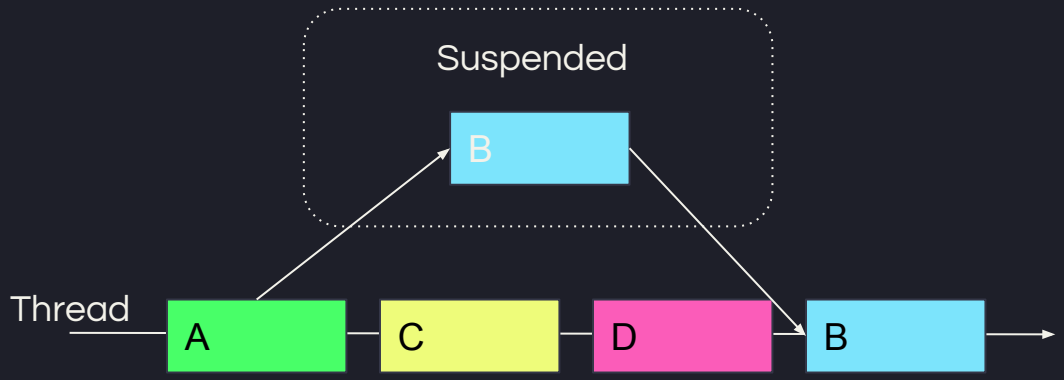
A speed run

Buzz words

Lightweight threads

Suspend not block

Structured concurrency



Coroutine Scope - lifecycle

Structured concurrency

Nested

Waits for children

Cancels children

Children inherit outer context

Context - threads and exceptions

Scope has a context

Can specify thread(s) Dispatcher Main IO Default

Can specify exception handler

Other flags

suspend

```
suspend fun runIt(delayTime: Long = 1000, message: String = "Hello world") {
    delay(delayTime)
    println("$message after $delayTime ms")
}
```

Coroutine builder - runBlocking

```
fun main(args: Array<String>) {
    println("Hello")
    runBlocking { this: CoroutineScope
        runIt( delayTime: 1000,  message: "from blocking ")
    }
    println("World")
}
```

```
Hello
from blocking  after 1000 ms
World
```

Coroutine builder - launch - fire and forget

```
fun main(args: Array<String>) {
    println("Hello")
    GlobalScope.launch { this: CoroutineScope
        runIt()
    }
    println("World")
}
```

```
Hello
World

Process finished with exit code 0
```

Coroutine builder - *async* and *Deferred*

```
suspend fun asyncExample() {
    val deferred = GlobalScope.async { this: CoroutineScope
        runIt( delayTime: 1000,  message: "Hello async")
    }
    deferred.await()
    println("after await")
}
```

More *async* and *Deferred*

```
fun main(args: Array<String>) {
    println("Hello")
    runBlocking { this: CoroutineScope
        asyncExample()
    }
    println("World")
}
```

```
Hello
Hello async after 1000 ms
after await
World
```