Reuse features in Android applications

An introduction to component modularity

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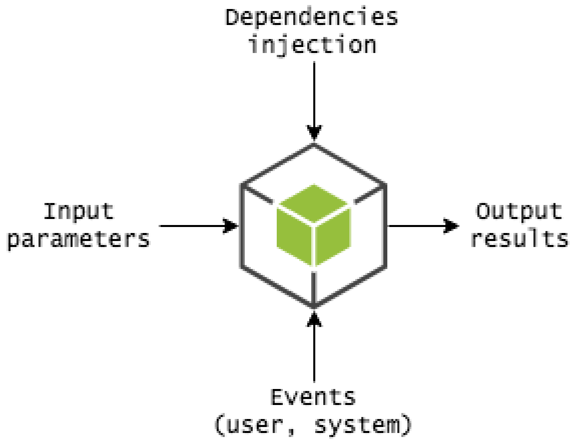
Introduction

What to reuse?

- divide a program into separated sub-programs (features)
- independent, reusable and isolated
- unit of code to compile (i.e., Android Studio *module*)
- almost like React Component



Benefits

- ease incremental builds and deliveries
- module is unit-testable
- modules can be added, modified or removed without any impact on one another
- modules can be reused

Background: Android key concepts

Activity (since API level 1)

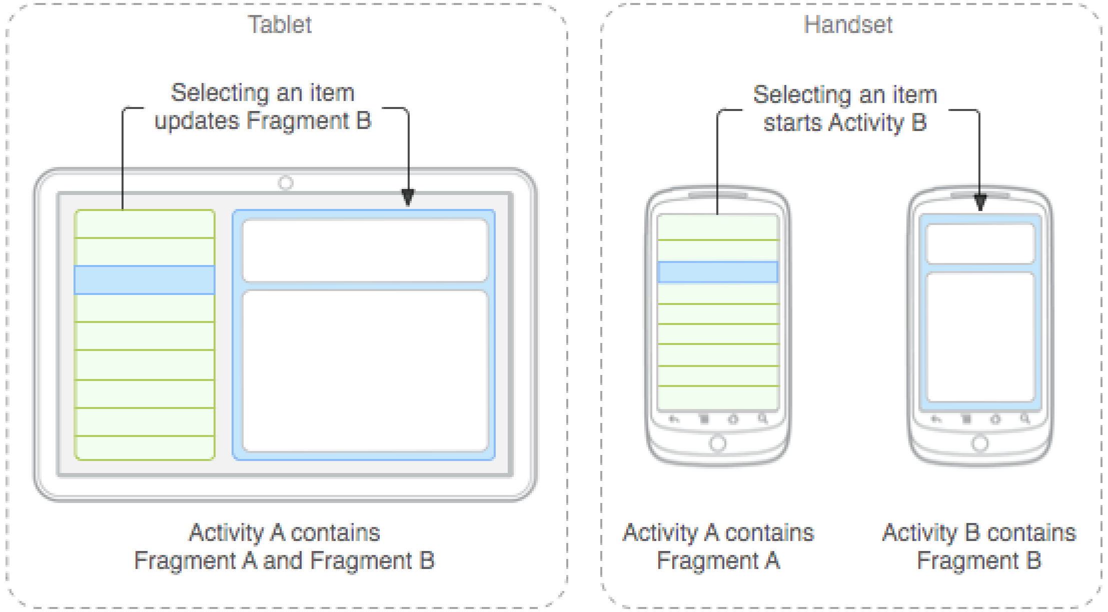
> one of the fundamental building blocks
>
> https://developer.android.com/guide/components/activities/index.html

- behind every screen stands a single `Activity`

Background: Android key concepts

Fragment (since API level 11)

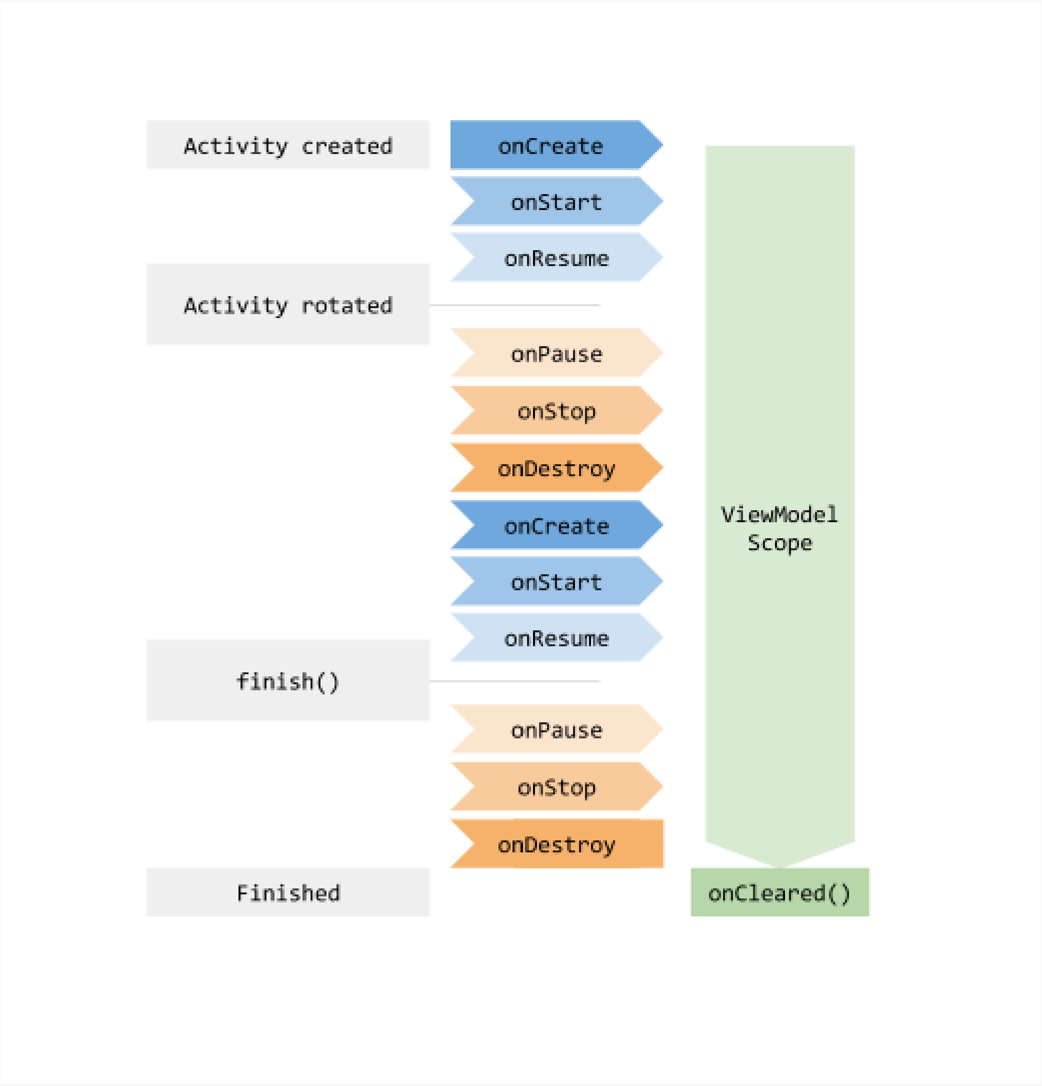
> portion of user interface in an `Activity`
>
> https://android-developers.googleblog.com/2011/02/android-30-fragments-api.html


Tablet
Selecting an item updates Fragment B
Activity A contains Fragment A and Fragment B
Handset
Selecting an item starts Activity B
Activity A contains Fragment A
Activity B contains Fragment B

Background: Android key concepts

ViewModel (since ACC)

> The `ViewModel` class
>
> - is designed to store and manage UI-related data in a lifecycle conscious way.
> - allows data to survive configuration changes such as screen rotations.
>
> https://developer.android.com/topic/libraries/architecture/viewmodel.html



```kotlin
fun onCreate(savedInstanceState: Bundle) {
    // Create a ViewModel the first time the system calls an activity's onCreate
    // Re-created activities receive the same MyViewModel instance
    val viewModel = ViewModelProviders.of(this).get(MyViewModel::class.java)
}
```

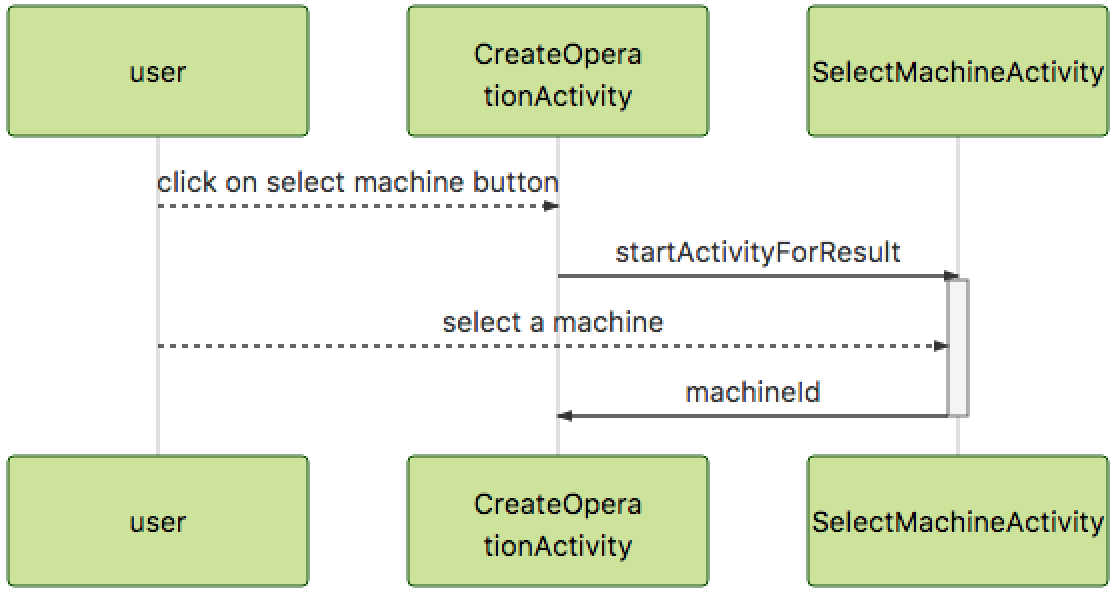
1. Native solutions

Activity + result code

> Getting a Result from an Activity

Example

- First activity: fill a form to create a new operation
- Second activity: select a capable machine



> With the help of Anko

CreateOperationActivity.kt

```
findViewById<Button>(R.id.button_select_machine).setOnClickListener {
    startActivityForResult<SelectMachineActivity>(
        SELECT_MACHINE,
        SelectMachineActivity.CAPABILITY to typeOfOperation
    )
}
```

`SelectMachineActivity.kt`

```kotlin
class SelectMachineActivity : AppCompatActivity() {

    findViewById<Button>(R.id.select_machine_a).setOnClickListener {
        val intent = Intent()
        intent.putExtra(MACHINE_ID, 1L)
        setResult(
            Activity.RESULT_OK,
            intent
        )
        finish()
    }

    companion object Params {
        val CAPABILITY = "SelectMachineActivity:capability"
        val MACHINE_ID = "SelectMachineActivity:machineId"
    }
}
```

CreateOperationActivity.kt

```
override fun onActivityResult(requestCode: Int, resultCode: Int, data: Intent?) {
    if (requestCode == SELECT_MACHINE) {
        if (resultCode == Activity.RESULT_OK) {
            selectedMachineId = data?.getLongExtra(SelectMachineActivity.MACHINE_ID, -1)
        }
    } else {
        super.onActivityResult(requestCode, resultCode, data)
    }
}
```

Activity + result code: assessments

- Pros:
  - stable
  - many libraries written this way
- Cons:
  - not composable (1 activity per screen)
  - break the code flow (but rx to the rescue)

Fragment + callbacks

> Communicating with Other Fragments

The embedded `Fragment` defines a callback interface

```
class SelectMachineFragment : Fragment() {
    interface OnFragmentInteractionListener {
        fun onSelectedMachine(selectedMachineId: Long)
    }
}
```

The `Activity` must implement this callback

```
class CreateOperationActivity :
        AppCompatActivity(),
        SelectMachineFragment.OnFragmentInteractionListener {

    override fun onSelectedMachine(selectedMachineId: Long) {
        this.selectedMachineId = selectedMachineId
    }
}
```

The `Fragment` handles a reference to its callback

```kotlin
class SelectMachineFragment : Fragment() {
    private var listener: OnFragmentInteractionListener? = null

    override fun onAttach(context: Context) {
        super.onAttach(context)
        if (context is OnFragmentInteractionListener) {
            listener = context
        } else {
            throw RuntimeException(context.toString() +
                " must implement OnFragmentInteractionListener")
        }
    }

    override fun onDetach() {
        super.onDetach()
        listener = null
    }
}
```

The `Fragment` uses the callback interface to deliver the event to the parent activity

```
override fun onCreateView(inflater: LayoutInflater,
                          container: ViewGroup?,
                          savedInstanceState: Bundle?): View? {
    val view = inflater.inflate(
        R.layout.fragment_select_machine,
        container,
        false
    )
    view.findViewById<Button>(R.id.select_machine_a).setOnClickListener {
        listener?.onSelectedMachine(1L)
    }
    return view
}
```

The `Activity` can deliver a message to another `Fragment`

```
class AnotherFragment : Fragment() {
    fun updateUi(selectedMachineId: Long) {
        TODO("update UI with selectedMachineId")
    }
}
```

```kotlin
class CreateOperationActivity :
        AppCompatActivity(),
        SelectMachineFragment.OnFragmentInteractionListener {

    override fun onSelectedMachine(selectedMachineId: Long) {

        val anotherFragment = supportFragmentManager.findFragmentById(
            R.id.another_fragment_container_id
        ) as AnotherFragment

        if (anotherFragment == null) {
            anotherFragment.updateUi(selectedMachineId)
        } else {
            TODO("create and display AnotherFragment with selectedMachineId")
        }
    }
}
```

Fragment + callbacks: assessments

- Pros:
  - composable
  - now compatible with the ACC ViewModel
- Cons:
  - boilerplate code
  - no compile-time checking

Native solutions: assessments

- Pros:
  - native solutions are possible
  - tried and tested
- Cons:
  - troublesome to setup
  - difficult to compose
  - no navigation concerns

2. Use of a finite state machine (FSM)

Background: FSM key concepts

- sequential logic circuits
- finite number of states
- one state at a time (the current state)
- change from one state to another by triggering an event (a transition)

Event-driven programming

- the module fires an event,
- the hosting application receives this event and acts accordingly
- the flow is determined by events
    - user actions, network requests, sensors, timer, other threads, etc.

Why EasyFlow

- simple to set up
- possible definition of a global context
- states definition through the `StateEnum` interface
- events definition through the `EventEnum` interface
- fluent API
- callbacks to perform specific jobs when entering or leaving a state

Setup with Android components

- `Fragment` to define a state of the application (i.e., a use case) and output event(s)
- `Activity` to manage states and how to navigate (i.e., the flow of events to change application state)

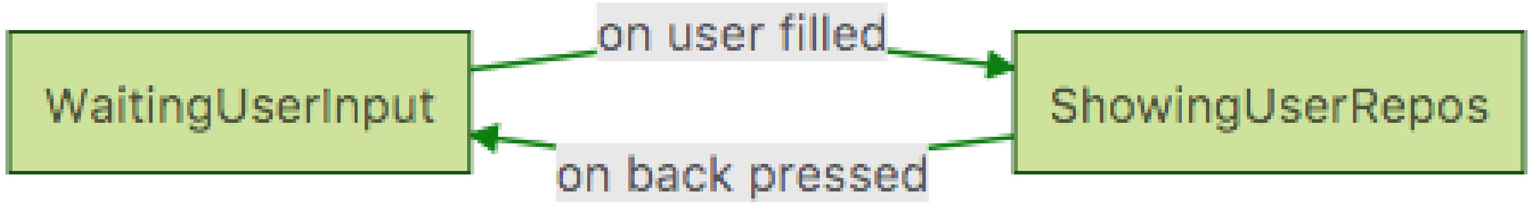
Constraint 1: orientation changes

- Use of the ACC `ViewModel`
    - Define and share a specific `ViewModel` between `Fragment`s

Constraint 2: dependency injection

- The hard case of Dagger 2
    - Pros: code generation, hosted by Google
    - Cons: many concepts to know and huge amount of code to write
- A nice way with Koin

Example


WaitingUserInput
on user filled
ShowingUserRepos
on back pressed

Common things

- The global context of the FSM

```
class FsmContext : StatefulContext() {
    val args = Bundle()
}
```

Common things

- The shared `ViewModel`

```kotlin
class FsmViewModel : ViewModel() {
    val fsmModel: MutableLiveData<FsmModel> = MutableLiveData()

    init {
        fsmModel.value = FsmModel()
    }

    val flowContext: FsmContext
        get() = fsmModel.value?.flowContext!!

    fun trigger(event: EventEnum) {
        flowContext.safeTrigger(event)
    }
}
```

Common things

- The FSM module

```
val fsmModule = applicationContext {
    viewModel {
        FsmViewModel()
    }
}

object BackPressed : FsmEvent
```

Focus on "user input"

The *Model*

```
class UserInputModel {
    val user: ObservableField<String> = ObservableField()
}
```

The *ViewModel*

```
class UserInputViewModel: ViewModel() {
    val model: UserInputModel = UserInputModel()
    val onSelectEvent = SingleLiveEvent<String>()

    fun onSelectButtonClicked() {
        onSelectEvent.postValue(model.user.get())
    }
}
```

```
<layout xmlns:android="http://schemas.android.com/apk/res/android">
    <data>
        <variable
            name="model"
            type="fr.guddy.kandroidmodular.userinput.mvvm.UserInputModel" />
        <variable
            name="viewModel"
            type="fr.guddy.kandroidmodular.userinput.mvvm.UserInputViewModel" />
    </data>
    <LinearLayout
        android:layout_width="match_parent"
        android:layout_height="match_parent">

        <EditText
            android:id="@+id/editTextUser"
            android:layout_width="match_parent"
            android:layout_height="wrap_content"
            android:text="@={model.user}" />

        <android.support.v7.widget.AppCompatButton
            android:id="@+id/buttonSelect"
            android:layout_width="match_parent"
            android:layout_height="wrap_content"
            android:onClick="@{() -> viewModel.onSelectButtonClicked()}"
            android:text="@string/user_input_button" />
```

```kotlin
class UserInputFragment : Fragment() {
    /*...*/

    override fun onCreateView(/*...*/): View? {
        binding = DataBindingUtil.inflate(/*...*/)
        return binding.root
    }

    override fun onActivityCreated(savedInstanceState: Bundle?) {
        super.onActivityCreated(savedInstanceState)
        viewModel = getViewModel()
        fsmViewModel = getViewModelFromActivity()
        binding.viewModel = viewModel
        binding.model = viewModel.model
        viewModel.onSelectEvent.observe(this) { user -> onSelect(user) }
    }

    private fun onSelect(user: String) {
        if (TextUtils.isEmpty(user)) {
            binding.editTextUser.error = getString(R.string.empty_user)
        } else {
            fsmViewModel.flowContext.userInputResult = UserInputResult(user)
            fsmViewModel.trigger(UserFilled)
        }
    }
}
```

Koin setup for DI

- Define the module:

```
val userInputModule = applicationContext {
    viewModel { UserInputViewModel() }
}
```

- Start DI:

```
val allModules = listOf(
        /*...*/
        userInputModule
)

class MyApplication : Application() {
    override fun onCreate() {
        super.onCreate()

        startKoin(this, allModules)
    }
}
```

FSM configuration

- The result data

```
@PaperParcel
data class UserInputResult(val user: String) : PaperParcelable {
    companion object {
        @JvmField
        val CREATOR = PaperParcelUserInputResult.CREATOR
    }
}
```

> With the help of paperparcel

- The module setup

```
object WaitingUserInput : FsmState

object UserFilled : FsmEvent

var FsmContext.userInputResult: UserInputResult
    get() = args.getParcelable("UserInputResult")
    set(value) {
        args.putParcelable("UserInputResult", value)
    }

fun FsmContext.clearUserInputResult() {
    args.remove(_resultKey)
}
```

Integration in the hosting application

```kotlin
class MainActivity : AppCompatActivity() {

    private lateinit var fsmViewModel: FsmViewModel
    private lateinit var flow: EasyFlow<FsmContext>

    override fun onCreate(savedInstanceState: Bundle?) {
        super.onCreate(savedInstanceState)
        setContentView(R.layout.activity_main)
        fsmViewModel = getViewModel()
        buildFsm()
    }
```

```kotlin
// MainActivity.kt
private fun buildFsm() {
    flow = from<FsmContext>(WaitingUserInput).transit(
            on(UserFilled).to(ShowingUserRepos).transit(
                    on(BackPressed).to(WaitingUserInput)
            )
    )
    // callbacks
    flow.whenEnter(WaitingUserInput) { showUserInputFragment() }
    flow.whenEnter(ShowingUserRepos) { context ->
        showUserReposFragment(context.userInputResult.user)
    }
    flow.whenLeave(ShowingUserRepos) { context ->
        context.clearUserInputResult()
    }
    // start with first state
    flow.start(WaitingUserInput)
}

private fun showUserInputFragment() { /*...*/ }

private fun showUserReposFragment(user: String) { /*...*/ }
```

```kotlin
// MainActivity.kt

override fun onBackPressed() {
    if (supportFragmentManager.backStackEntryCount > 0) {
        fsmViewModel.trigger(BackPressed)
        supportFragmentManager.popBackStack()
    } else {
        super.onBackPressed()
    }
}
```

Conclusion

Benefits

- relevant MVVM architecture
- power of the Kotlin language
- an elegant way to define the application flow
- no explicit coupling between screens
- increase testability
  - test at module level (easy to stub injected dependencies thanks to Koin)
  - test at application level
- adjustable to technical stack

Main used Kotlin concepts

- Extensions (functions, properties)
- Object declarations
- Delegated Properties
- Data classes
- Default and named arguments

To go further

- https://roroche.github.io/AndroidModularSample/
- https://github.com/RoRoche/kAndroidModular

What's next?

Practical

- Syntax enhancement thanks to Kotlin
- Group redundant concerns in Java/Android libraries
- Expose features through a repository

Ideal

- Front-end with drag&drop feature to build application flow?
- Kotlin: build iOS application and share common modules?
- React-native: write and share common modules (mobile and desktop)?

Thanks

- Macoscope for many relevant articles
  - Applications as State Machines
  - Introducing SwiftyStateMachine
- Nicolas Chassagneux for many enriching discussions