MVWTF: Demystifying Architecture Patterns

Adam McNeilly - @AdamMc331

You May Have Heard These Buzzwords:

- MVC
- MVP
- MVVM
- MVI

Why Are There So Many?

What's The Difference?

Which One Should I Use?

Which One Should I Use?

Sam Edwards

Published

March 10, 2019

Updated

May 23, 2019

About Me

Public Speaking

Search …

in Android, Kotlin

“It Depends” Is The Answer To Your Android Question

Sam Edwards
@HandstandSam

Replying to @gpeal8 @brwngrldev

I need to write a blog post called:

"It depends" is the answer to every question in software.

9 3:20 PM - Mar 9, 2019 · Richmond, VA

See Sam Edwards's other Tweets

Why Do We Need Architecture Patterns?

More Buzzwords!

More Buzzwords!

- Maintainability

More Buzzwords!

- Maintainability
- Extensibility

More Buzzwords!

- Maintainability
- Extensibility
- Robust

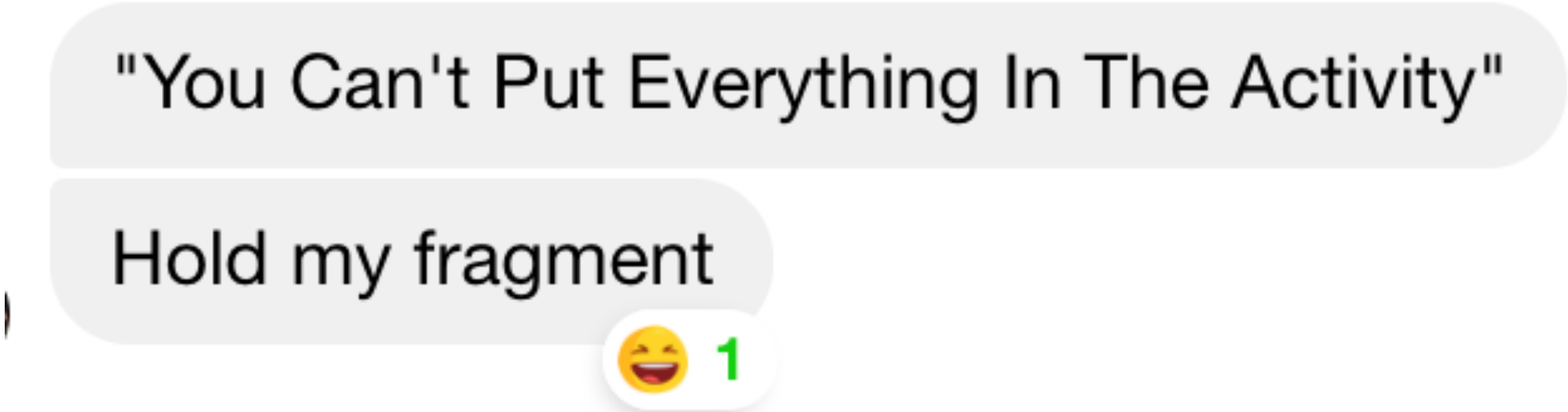
More Buzzwords!

- Maintainability
- Extensibility
- Robust
- Testable

Let's Start With One Simple Truth

You Can't Put Everything In The Activity

Or Your Fragment[1]



[1] Thanks Mauricio for proofreading

Why Not?

Why Not?

- Not readable

Why Not?

- Not readable
- Difficult to add new code

Why Not?

- Not readable
- Difficult to add new code
- Difficult to change existing code

Why Not?

- Not readable
- Difficult to add new code
- Difficult to change existing code
- Can't write Junit tests for this

We Need To Break Up Our Code

Let's Explore Some Options

Model-View-Controller

Model-View-Controller

- One of the earliest architecture patterns

Model-View-Controller

- One of the earliest architecture patterns
- Introduced in the 1970s as a way to organize code

Model-View-Controller

- One of the earliest architecture patterns
- Introduced in the 1970s as a way to organize code
- Divides application to three parts

Model

Model

- This is your data source

Model

- This is your data source
- Database, remote server, etc

Model

- This is your data source
- Database, remote server, etc
- It does not care about the view

View

View

- This is the visual representation of information

View

- This is the visual representation of information
- Does not care where this data came from

View

- This is the visual representation of information
- Does not care where this data came from
- Only responsible for displaying data

View

- This is the visual representation of information
- Does not care where this data came from
- Only responsible for displaying data
- If your view has a conditional, consider refactoring

Controller

Controller

- Handles user inputs

Controller

- Handles user inputs
- Validates if necessary

Controller

- Handles user inputs
- Validates if necessary
- Passes input to model

Controller

- Handles user inputs
- Validates if necessary
- Passes input to model
- Passes model response to view

The Model & View Components Are The Same For All Patterns

Chet Haase
@chethaase

Improv game for software geeks:
Describe the architecture for "Model-View [random word from audience]"
Winner gets applause.
Loser has to implement theirs.

From a conversation with @objcode

3:49 PM · Jul 8, 2019 · Twitter Web Client

25 Retweets **86** Likes



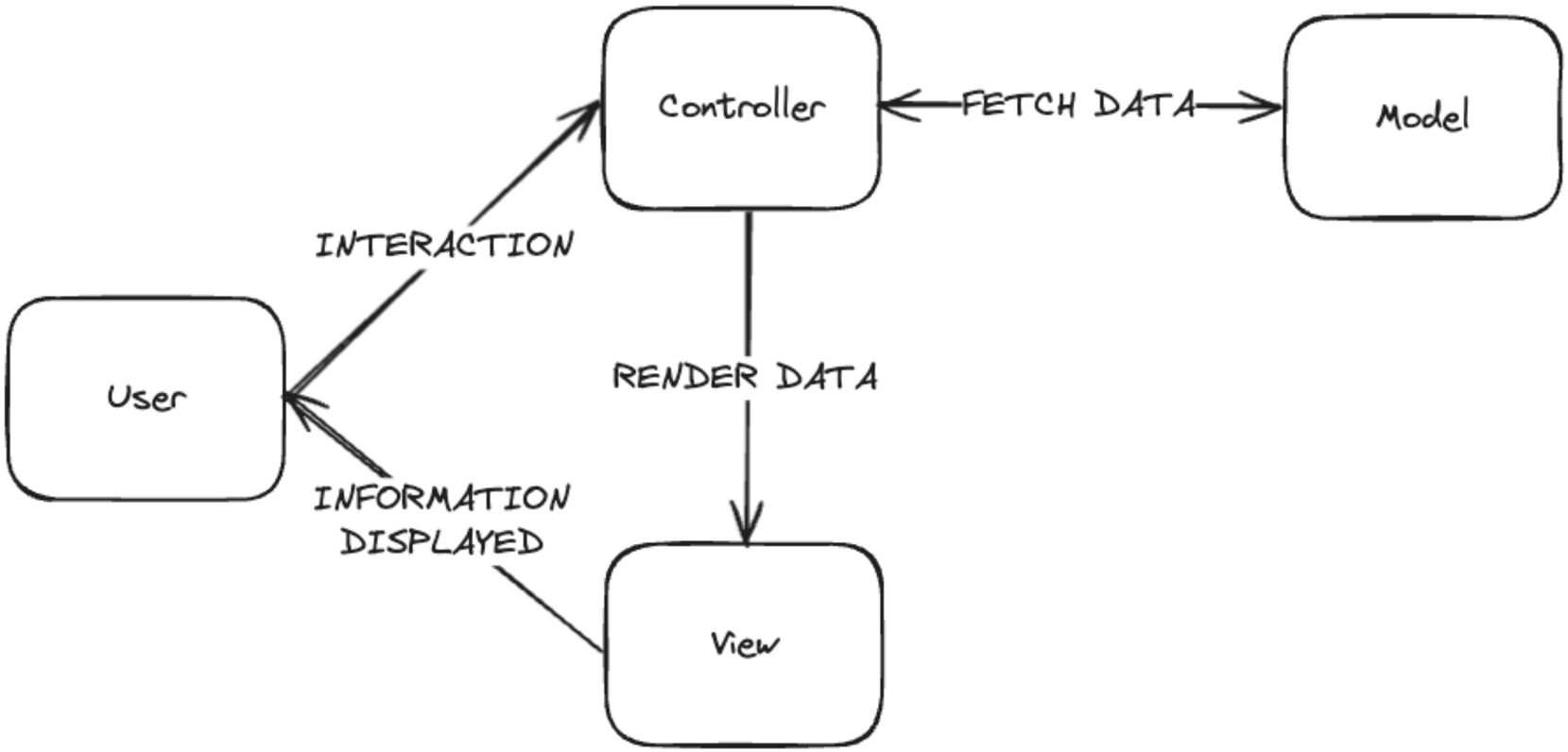

Model-View-WhateverTheFYouWant

Why Do We Have So Many Options For This Third Component?

Short Answer: State Management

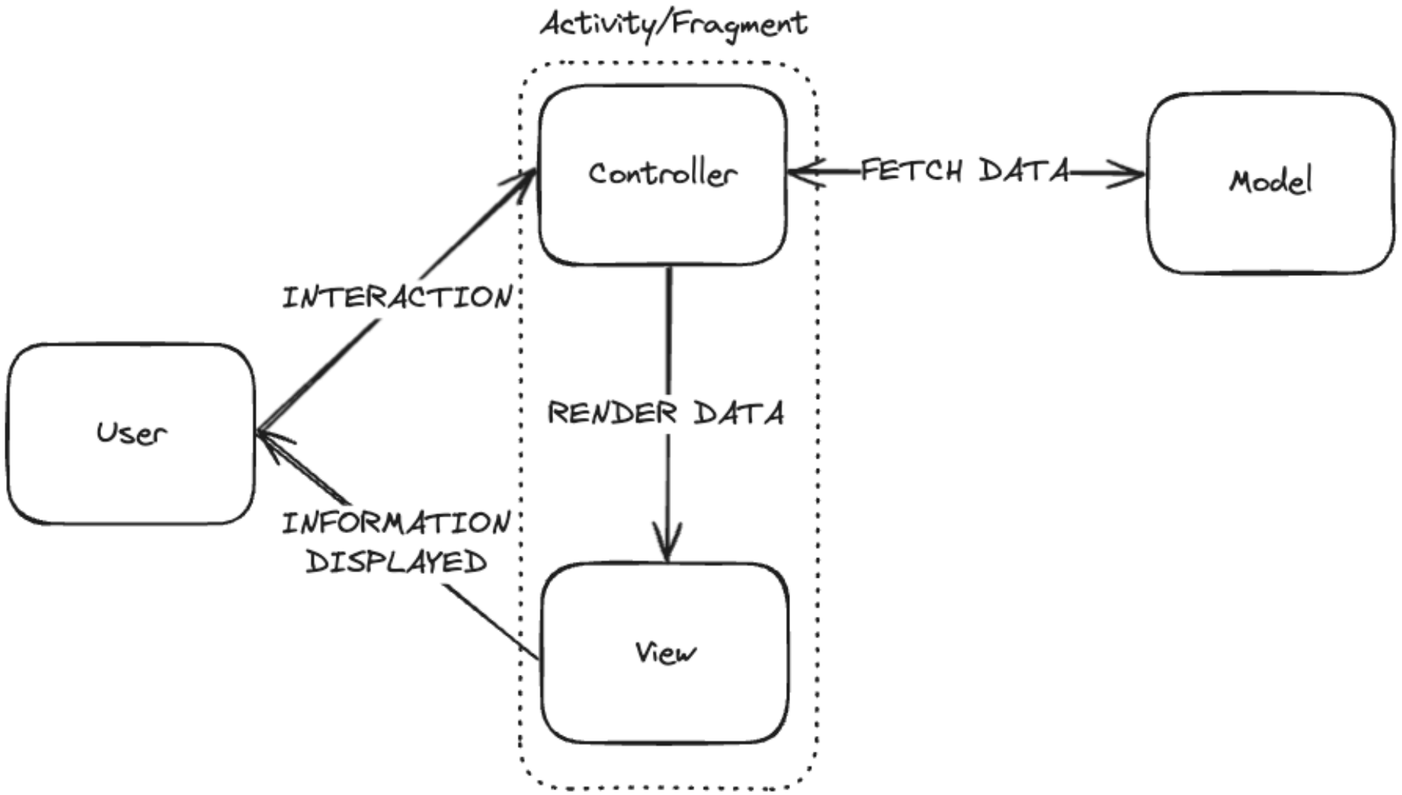
Long Answer: Let's Break Them Down

Model-View-Controller



Why Don't We Use This For Android?

Why Don't We Use This For Android?



Why Don't We Use This For Android?

Why Don't We Use This For Android?

- We can't write Junit tests for an Activity

Why Don't We Use This For Android?

- We can't write Junit tests for an Activity
  - We can't unit test our UI logic

Why Don't We Use This For Android?

- We can't write Junit tests for an Activity
  - We can't unit test our UI logic
- We don't really have a separation of concerns here

Model-View-Presenter

Model-View-Presenter

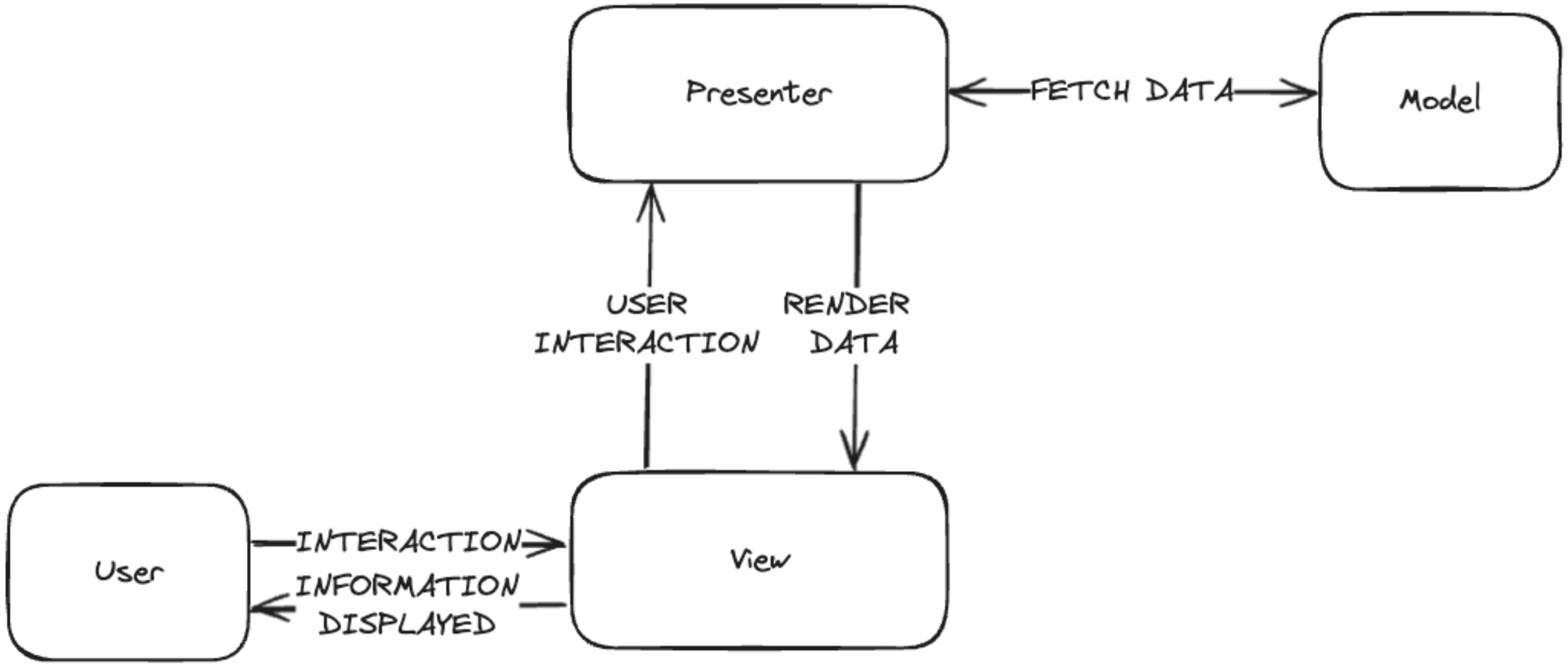
Model-View-Presenter

- Similar to the last pattern

Model-View-Presenter

- Similar to the last pattern
- Moves our presentation logic out of the Activity class

Model-View-Presenter



Why Is This Better?

Why Is This Better?

- UI logic is outside of the Activity, and now supports Junit tests

Why Is This Better?

- UI logic is outside of the Activity, and now supports Junit tests
- Our concerns are separated again

MVP Implementation

Contract Class

```
object TaskListContract {
    interface Model {
        // ...
    }

    interface View {
        // ...
    }

    interface Presenter {
        // ...
    }
}
```

Contract Class

```
object TaskListContract {
    interface Model {
        suspend fun getTasks(): List<Task>
    }

    // ...
}
```

Contract Class

```
object TaskListContract {
    interface View {
        fun render(tasks: List<Task>)
    }

    // ...
}
```

Contract Class

```
object TaskListContract {
    interface Presenter {
        fun viewCreated()

        fun viewDestroyed()
    }

    // ...
}
```

Model

```
class InMemoryTaskRepository : TaskListContract.Model {
    override suspend fun getTasks(): List<Task> {
        return listOf(
            Task("Test Task 1"),
            Task("Test Task 2"),
            Task("Test Task 3"),
        )
    }
}
```

View

```
class MainActivity : TaskListContract.View {
    private val presenter = TaskListPresenter(
        view = this,
        model = InMemoryTaskRepository(),
    )

    // ...
}
```

View

```
class MainActivity {

    override fun onCreate(savedInstanceState: Bundle?) {
        super.onCreate(savedInstanceState)

        presenter.viewCreated()
    }

    // ...
}
```

View

```
class MainActivity {

    override fun render(tasks: List<Task>) {
        setContent {
            TaskList(tasks)
        }
    }

    // ...
}
```

Presenter

```
class TaskListPresenter(
    private var view: TaskListContract.View?,
    private val model: TaskListContract.Model,
) : TaskListContract.Presenter {

    // ...
}
```

Presenter

```
class TaskListPresenter {

    private var tasks: List<Task> = emptyList()
        set(value) {
            field = value
            view?.render(value)
        }

    // ...
}
```

Presenter

```
class TaskListPresenter {

    override fun viewCreated() {
        presenterScope.launch {
            tasks = model.getTasks()
        }
    }

    // ...
}
```

Presenter

```
class TaskListPresenter {

    override fun viewDestroyed() {
        view = null
    }

    // ...
}
```

State Restoration

State Restoration

```
object TaskListContract {
    interface Presenter {
        // New:
        fun getTasks(): List<Task>
        fun restoreTasks(tasks: List<Task>)
    }
}
```

Persist State

```
class MainActivity {

    override fun onSaveInstanceState(outState: Bundle) {
        outState.putParcelableArrayList("tasks", presenter.getTasks())
        super.onSaveInstanceState(outState)
    }

    // ...
}
```

Restore State

```
class MainActivity {
    override fun onCreate(savedInstanceState: Bundle?) {
        super.onCreate(savedInstanceState)

        val tasks = savedInstanceState?.getParcelableArrayList("tasks")

        if (tasks != null) {
            presenter.restoreTasks(tasks)
        }
    }

    // ...
}
```

MVP Recap

MVP Recap

- View does nothing but display data

MVP Recap

- View does nothing but display data
- Data fetching is all handled by model

MVP Recap

- View does nothing but display data
- Data fetching is all handled by model
- Presentation of data is handled by presenter

MVP Recap

- View does nothing but display data
- Data fetching is all handled by model
- Presentation of data is handled by presenter
- Everything is separated, everything is testable

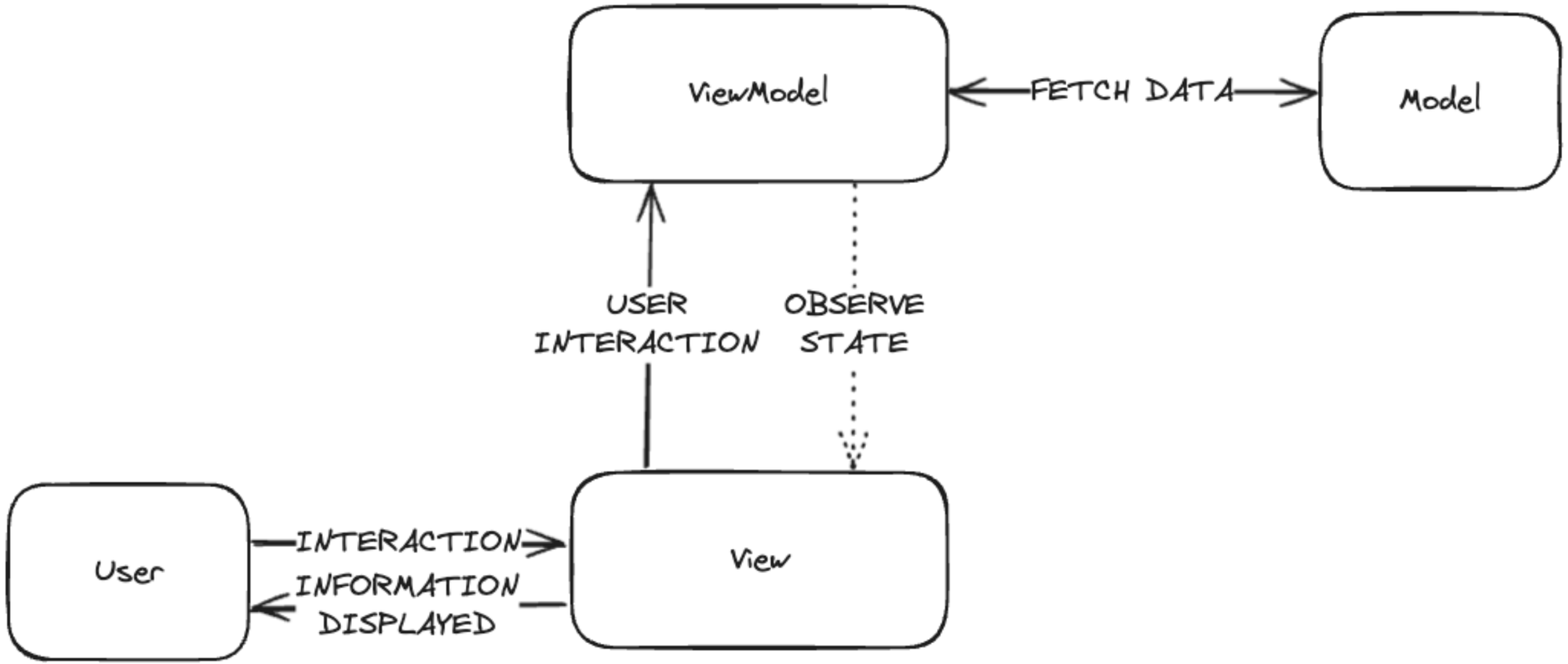
MVP Recap

- View does nothing but display data
- Data fetching is all handled by model
- Presentation of data is handled by presenter
- Everything is separated, everything is testable
- State can be fetched/restored as necessary

What's Different About MVVM?

The Presenter Doesn't Need To Care About The View

Model-View-ViewModel



MVVM Implementation

Model Doesn't Change (much)

```
interface TaskRepository {
    fun getTasks(): List<Task>
}

class InMemoryTaskService : TaskRepository {

    override fun getTasks(): List<Task> {
        return listOf(...)
    }
}
```

ViewModel

```
class TaskListViewModel(
    taskRepository: TaskRepository,
) {
    private val mutableTasks = MutableStateFlow(emptyList<Task>())
    val tasks = mutableTasks.asStateFlow()

    // ...
}
```

ViewModel

```
class TaskListViewModel {

    init {
        viewModelScope.launch {
            tasks.value = taskRepository.getTasks()
        }
    }

    // ...
}
```

View

```
class MainActivity {

    override fun onCreate(savedInstanceState: Bundle?) {
        super.onCreate(savedInstanceState)

        setContent {
            val tasks by viewModel.tasks.collectAsState()

            TaskList(tasks)
        }
    }

    // ...
}
```

This Is Pretty Close To MVP, With One New Benefit

Since ViewModel Doesn't Reference View, We Can Leverage Android Architecture Component ViewModel To Outlast Config Changes

State Restoration In MVVM

State Restoration In MVVM

1. Have ViewModel class extend the AndroidX ViewModel class

State Restoration In MVVM

1. Have ViewModel class extend the AndroidX ViewModel class
2. Update Activity to use ViewModelProviders

State Restoration In MVVM

1. Have ViewModel class extend the AndroidX ViewModel class
2. Update Activity to use ViewModelProviders
3. Since Android's ViewModel outlasts config changes, no need to save/restore state, just re-subscribe

State Restoration In MVVM

```
class TaskListViewModel(
        private val repository: TaskRepository
) : ViewModel() {
    // ...
}
```

State Restoration In MVVM

```
class MainActivity {
    private val viewModel: TaskListViewModel by viewModels {
        // ...
    }

    override fun onCreate(savedInstanceState: Bundle?) {
        super.onCreate(savedInstanceState)

        setContent {
            val tasks by viewModel.tasks.collectAsState()

            TaskList(tasks)
        }
    }
}
```

MVVM Recap

MVVM Recap

- All the benefits of MVP

MVVM Recap

- All the benefits of MVP
- Decoupled view and presentation layer

MVVM Recap

- All the benefits of MVP
- Decoupled view and presentation layer
- Easier support for configuration changes

Where Does MVVM Fall Short?

Let's Consider A More Complicated State

Let's Consider A More Complicated State

```
sealed interface TaskListState {
    object Loading : TaskListState
    data class Loaded(val tasks: List<Task>) : TaskListState
    data class Error(val message: String) : TaskListState
}
```

Let's Consider A More Complicated State

```
class TaskListViewModel(private val repository: TaskRepository) : ViewModel() {
    // ...

    private fun showLoading() {
        state.value = TaskListState.Loading
    }

    private fun fetchTasks() {
        val tasks = repository.getItems()
        state.value = TaskListState.Loaded(tasks)
    }

    private fun showError() {
        state.value = TaskListState.Error("Unable to fetch tasks.")
    }
}
```

What Are The Risks Of These Methods?

```
private fun showLoading() {
    state.value = TaskListState.Loading
}

private fun fetchTasks() {
    val tasks = repository.getItems()
    state.value = TaskListState.Loaded(tasks)
}

private fun showError() {
    state.value = TaskListState.Error("Unable to fetch tasks.")
}
```

What Are The Risks Of These Methods?

What Are The Risks Of These Methods?

- Any methods in the class can call them

What Are The Risks Of These Methods?

- Any methods in the class can call them
- We can't guarantee they're associated with a specific action or intent

What Are The Risks Of These Methods?

- Any methods in the class can call them
- We can't guarantee they're associated with a specific action or intent
- We have multiple methods manipulating our state that we have to ensure don't conflict with each other

How Can We Mitigate This Risk?

How Can We Mitigate This Risk?

- Have one single source of truth for our state

How Can We Mitigate This Risk?

- Have one single source of truth for our state
- Do this through a single pipeline where every action causes a specific change in the state

How Can We Mitigate This Risk?

- Have one single source of truth for our state
- Do this through a single pipeline where every action causes a specific change in the state
- This makes state changes predictable, and therefore highly testable as well

Model-View-Intent

Model-View-Intent

Model-View-Intent

- Unlike the previous patterns, "Intent" isn't used to reference a specific kind of component, but rather the *intention* of doing something that we want to capture in our state.

The First Goal Is To Make Our State Changes Predictable

We Can Achieve This With A State Machine

```
class StateMachine(
    initialState: State,
    private val eventProcessor: (State, StateUpdateEvent) -> State,
) {
    private val mutableState = MutableStateFlow(initialState)
    val state = mutableState.asStateFlow()

    fun processEvent(event: StateUpdateEvent) {
        mutableState.update { currentState ->
            val newState = eventProcessor(currentState, event)
            newState
        }
    }
}
```

We Can Achieve This With A State Machine

```
class StateMachine(
    initialState: State,
    private val eventProcessor: (State, StateUpdateEvent) -> State,
) {
    private val mutableState = MutableStateFlow(initialState)
    val state = mutableState.asStateFlow()

    fun processEvent(event: StateUpdateEvent) {
        mutableState.update { currentState ->
            val newState = eventProcessor(currentState, event)
            newState
        }
    }
}
```

We Can Achieve This With A State Machine

```
class StateMachine(
    initialState: State,
    private val eventProcessor: (State, StateUpdateEvent) -> State,
) {
    private val mutableState = MutableStateFlow(initialState)
    val state = mutableState.asStateFlow()

    fun processEvent(event: StateUpdateEvent) {
        mutableState.update { currentState ->
            val newState = eventProcessor(currentState, event)
            newState
        }
    }
}
```

Clearly Defined Inputs

```
sealed class TaskListStateUpdateEvent : StateUpdateEvent {
    data object SetLoading : TaskListStateUpdateEvent()

    data class SetTasks(val tasks: List<Task>) : TaskListStateUpdateEvent()

    data class SetError(val error: String) : TaskListStateUpdateEvent()
}
```

Clearly Defined Outputs

```
private val stateMachine = StateMachine<TaskListViewState, TaskListStateUpdateEvent>(
    initialState = TaskListViewState.Loading,
    eventProcessor = { currentState, event ->
        when (event) {
            is TaskListStateUpdateEvent.SetError -> {
                TaskListViewState.Error(event.error)
            }

            TaskListStateUpdateEvent.SetLoading -> {
                TaskListViewState.Loading
            }

            is TaskListStateUpdateEvent.SetTasks -> {
                TaskListViewState.Loaded(event.tasks)
            }
        }
    },
)
```

Clearly Defined Outputs

```
private val stateMachine = StateMachine<TaskListViewState, TaskListStateUpdateEvent>(
    initialState = TaskListViewState.Loading,
    eventProcessor = { currentState, event ->
        when (event) {
            is TaskListStateUpdateEvent.SetError -> {
                TaskListViewState.Error(event.error)
            }

            TaskListStateUpdateEvent.SetLoading -> {
                TaskListViewState.Loading
            }

            is TaskListStateUpdateEvent.SetTasks -> {
                TaskListViewState.Loaded(event.tasks)
            }
        }
    },
)
```

This State Machine Is Our Source Of Truth

```
class TaskListViewModel {
    private val stateMachine = // ...

    val state = stateMachine.state
}
```

Side Effects

Side Effects

```
class StateMachine(
    // ...
    private val eventProcessor: (State, StateUpdateEvent) -> StateAndSideEffects,
    private val sideEffectProcessor: (SideEffect) -> Unit,
)

data class StateAndSideEffects(
    val state: State,
    val sideEffects: List<SideEffect>,
)
```

Task List Flow In MVI

ViewModel Initialization

```
class TaskListViewModel {

    init {
        stateMachine.processEvent(TaskListStateUpdateEvent.SetLoading)
    }
}
```

Process Loading Event

```
private val stateMachine = StateMachine(
    eventProcessor = { currentState, event ->
        when (event) {
            TaskListStateUpdateEvent.SetLoading -> {
                TaskListViewState.Loading + TaskListSideEffect.FetchTasks
            }

            // ...
        }
    },
)
```

Process Side Effect

```
private val stateMachine = StateMachine(
    // ...
    sideEffectProcessor = { sideEffect ->
        when (sideEffect) {
            TaskListSideEffect.FetchTasks -> {
                fetchTasks()
            }
        }
    },
)
```

Process Side Effect

```
private fun fetchTasks() {
    viewModelScope.launch {
        val event = try {
            val tasks = taskRepository.getTasks()

            TaskListStateUpdateEvent.SetTasks(tasks)
        } catch (e: Exception) {
            TaskListStateUpdateEvent.SetError(e.message)
        }

        stateMachine.processEvent(event)
    }
}
```

Process Resulting Events

```
private val stateMachine = StateMachine(
    eventProcessor = { currentState, event ->
         when (event) {
            is TaskListStateUpdateEvent.SetError -> {
                TaskListViewState.Error(event.error).noSideEffects()
            }

            is TaskListStateUpdateEvent.SetTasks -> {
                TaskListViewState.Loaded(event.tasks).noSideEffects()
            }

            // ...
        }
    }
)
```

MVI Recap

MVI Recap

- All benefits of previous patterns

MVI Recap

- All benefits of previous patterns
- State management is clear and predictable

Is MVI The Best We Can Do?

Is MVI The Best We Can Do?

- State management is pretty solid

Is MVI The Best We Can Do?

- State management is pretty solid
- But, we have 22 letters that weren't covered yet

What Should I Take Away From This?

Model-View-Presenter

Model-View-Presenter

- Seperated concerns and testing support

Model-View-Presenter

- Seperated concerns and testing support
- Okay for quick prototyping

Model-View-Presenter

- Seperated concerns and testing support
- Okay for quick prototyping
- Managing state across config changes requires work

Model-View-Presenter

- Seperated concerns and testing support
- Okay for quick prototyping
- Managing state across config changes requires work
- State management is unpredictable

Model-View-ViewModel

Model-View-ViewModel

- Seperated concerns and testing support

Model-View-ViewModel

- Seperated concerns and testing support
- Even better for quick prototyping

Model-View-ViewModel

- Seperated concerns and testing support
- Even better for quick prototyping
- Can handle config changes easily if we use Android's architecture components

Model-View-ViewModel

- Seperated concerns and testing support
- Even better for quick prototyping
- Can handle config changes easily if we use Android's architecture components
- State management is unpredictable

Model-View-Intent

Model-View-Intent

- Seperated concerns and testing support

Model-View-Intent

- Seperated concerns and testing support
- Works with both a Presenter and a ViewModel

Model-View-Intent

- Seperated concerns and testing support
- Works with both a Presenter and a ViewModel
- Not good for quick prototyping

Model-View-Intent

- Seperated concerns and testing support
- Works with both a Presenter and a ViewModel
- Not good for quick prototyping
- State management is clear and predictable

Model-View-Intent

- Seperated concerns and testing support
- Works with both a Presenter and a ViewModel
- Not good for quick prototyping
- State management is clear and predictable
- Has a steeper learning curve due to state machine logic

General Suggestions

General Suggestions

- MVP can get you up and running quickly, but due to the boilerplate and config changes work I wouldn't recommend it

General Suggestions

- MVP can get you up and running quickly, but due to the boilerplate and config changes work I wouldn't recommend it
- MVVM is what I'd recommend the most. It allows for separation of concerns and unit test support without a major learning curve

General Suggestions

- MVP can get you up and running quickly, but due to the boilerplate and config changes work I wouldn't recommend it
- MVVM is what I'd recommend the most. It allows for separation of concerns and unit test support without a major learning curve
- If your app handles complex user flows or states, MVI can give you more support for state management

What's Most Important

What's Most Important

- Be consistent

What's Most Important

- Be consistent
- Be comfortable

Thank you!

https://github.com/adammc331/mvwtf2024