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Task ##P/C – Spike: Music Studio Rental App

Goals: This task aims to upskill in Android app development by building a multi-screen and feature-rich instrument rental application. It covers UI/UX design, state management, user input handling, and creating animations to enhance the user experience.

This section is an overview highlighting what the task is aiming to teach or upskill.

- Design an engaging and user-friendly interface for displaying instrument lists and booking details.
- Implement business logic for handling rental bookings, including input validation and user credit management.
- Preserve and restore application state during configuration changes (e.g., screen rotation) to ensure no loss of user data.
- Create subtle animations to improve the user experience during navigation and interaction.
- Utilize modern UI components like CardView, Snackbar, and AlertDialog to provide intuitive visual feedback to the user.

The following list outlines the goal broken down into more specific knowledge gaps involved in the goal.

- Android layout management (ConstraintLayout, ViewBinding).
- Data passing between Activities using Intent and Parcelable objects
- State persistence with onSaveInstanceState and onRestoreInstanceState.
- Click event handling for buttons and other UI components.
- Implementation of validation logic for input forms.
- Dynamic UI updates based on application state (e.g., changing text color based on credit balance).
- Using animations to create smooth screen transitions and effects.
- Displaying interactive notifications and dialogs (Snackbar, AlertDialog).

Tools and Resources Used

This section lists related software, tools, libraries, API's, and other resources used for this knowledge gap.

- Github https://github.com/ngkhanhhuyen104988508/COS30017_mobile-dev/tree/main/Assignment2
- Android studio
- Kotlin programming language
- Android SDK and API documentation (developer.android.com)
- Stack Overflow (https://stackoverflow.com/)
- Android Logcat
- Espresso test, Junit test

Knowledge Gaps and Solutions

This section presents the listed knowledge gaps and their solutions with supporting images, screenshots and captions where appropriate/required.

Gap 1: State Persistence Across Rotations

Steps:
1, Overrode the onSaveInstanceState method in BookingActivity.
2, Saved user-entered data (customer name, contact info) and the hasModifications flag into the Bundle.
3, Overrode the onRestoreInstanceState method to retrieve the saved values and restore them to the input fields after a rotation, preventing the user from having to re-enter data..

Gap 2: UI Design and Inter-Activity Data Transfer

Steps:
1, Created separate XML layouts for the list and booking screens.
2, Used ViewBinding to replace findViewById, resulting in cleaner and safer code.

3, When a user selects an instrument, the app packages the Instrument object (as a Parcelable) and availableCredits into an Intent.
4, The BookingActivity receives this Intent and uses the data to display the instrument's detailed information..

Gap 3: Business Logic and Form Validation

Steps:
1, Created a ValidationHelper class to centralize validation logic, making the code more maintainable.
2, In BookingActivity, when the "Confirm Booking" button is clicked, the app calls validation functions to check the customer name, contact details, and credit balance.
3, If an error is found, an error message is displayed on the relevant input field (layout.error) or a Snackbar is used for general errors.
4, The booking is processed only after all inputs are deemed valid.

Gap 4: Enhancing UX with Animations and Feedback

Steps:
1, Used the animate() functions to create fade-in and slide-up effects when BookingActivity opens, and fade-out and slide-down effects upon a successful booking.
2, Added haptic feedback to provide a physical response for key actions like successful confirmation or errors.
3, Displayed an AlertDialog to ask for user confirmation when they attempt to exit the screen with unsaved changes, preventing accidental data loss.

Open Issues and Recommendations

1. Issue: State management with onSaveInstanceState is not robust enough to handle cases where the OS terminates the app in the background.

➔ Recommendation: Consider using a ViewModel with SavedStateHandle from the Android Architecture Components. A ViewModel survives configuration changes and holds data more reliably, simplifying state management.

2. Issue: The UI may not scale well on large-screen devices like tablets.

➔ Recommendation: Create alternative layouts for larger screens (e.g., layout-sw600dp). Consider a two-pane layout (master-detail flow) on tablets to display the instrument list and booking details on the same screen.

3. Issue: Animations are currently hard-coded within the Activity.

➔ Recommendation: To make the code cleaner and more reusable, create utility functions or dedicated animation manager classes to handle complex animation sequences.

I. Introduction

The Music Studio Rental application is a modern, intuitive Android mobile application designed to streamline the process of browsing and booking musical instruments. Built with Kotlin and following Material Design 3 principles, the app provides an exceptional user experience with smooth animations, dark/light theme support, and comprehensive validation.

Key Features:

- Browse Catalog: View 4 musical instruments with detailed information
- One-at-a-Time Display: Focused browsing experience reducing cognitive load
- Smart Navigation: Intuitive Previous/Next buttons with visual indicators
- Booking System: Complete booking flow with validation and confirmation
- Theme Support: Beautiful light and dark modes
- Premium Animations: Smooth transitions and haptic feedback
- Robust Validation: Comprehensive input checking with user-friendly errors
- Accessibility: Full support for TalkBack and large text sizes

Technologies Used:

- Language: Kotlin 1.9+

- Min SDK: API 24 (Android 7.0)
- Target SDK: API 34 (Android 14)
- Architecture: Repository Pattern
- UI Framework: Material Design 3
- View System: ViewBinding
- Testing: Espresso (UI) + JUnit (Unit)

II. User Stories & Use Cases

User Story 1: Browse Available Instruments

As a musician looking to rent equipment
I want to browse through available instruments one at a time with clear details
So that I can make an informed decision without feeling overwhelmed by choices

Acceptance Criteria:

- Can view one instrument at a time with full details
- Can navigate forward and backward through the catalog
- Can see rating, condition, price, and description clearly
- Can see if an instrument is already booked

User Story 2: Quick Instrument Booking

As a studio customer with limited time
I want to quickly book an instrument and receive immediate confirmation
So that I can secure my rental and know exactly when to pick it up

Acceptance Criteria:

- Can book an instrument with minimal clicks (2-3 taps)
- Receive clear confirmation after booking
- See updated booking status immediately
- Cannot book if already booked or insufficient credits

Use Case 1: Browse Instruments

Actor: Customer

Precondition: User has opened the app

Goal: View details of available instruments

Main Success Scenario:

1. System displays first instrument with image, name, rating, condition, and price
2. Customer reads instrument details
3. Customer taps "Next" button
4. System displays next instrument in catalog
5. Repeat steps 2-4 until customer finds desired instrument
6. Customer taps "Borrow" to proceed to booking

Alternative Flows:

- 3a. Customer taps "Previous" to go back to previous instrument
- 6a. Customer exits app without booking

Postcondition: Customer has viewed instrument details and optionally proceeded to booking

Use Case 2: Book an Instrument

Actor: Customer

Precondition: Customer is viewing an available instrument

Goal: Successfully book the instrument for rental

Main Success Scenario:

1. Customer taps "Borrow" button on instrument
2. System displays booking details screen with instrument info
3. Customer enters name in text field
4. Customer enters contact information (email/phone)
5. System validates input fields are not empty
6. System checks customer has sufficient credits
7. Customer taps "Save" button
8. System saves booking details
9. System displays success message via Snackbar
10. System returns to main screen showing updated booking status

Alternative Flows:

- 5a. Customer leaves required field empty
    - 5a1. System shows error message "Field is required"
    - 5a2. System prevents saving and keeps user on booking screen
    - 5a3. Return to step 3
- 6a. Customer has insufficient credits
    - 6a1. System shows error "Insufficient credits: need X, have Y"
    - 6a2. System prevents saving
    - 6a3. Customer can cancel or adjust booking
- 8a. Customer taps Back button
    - 8a1. System cancels booking (doesn't save)
    - 8a2. System shows cancellation message
    - 8a3. System returns to main screen

Postcondition: Instrument is marked as booked OR booking is cancelled

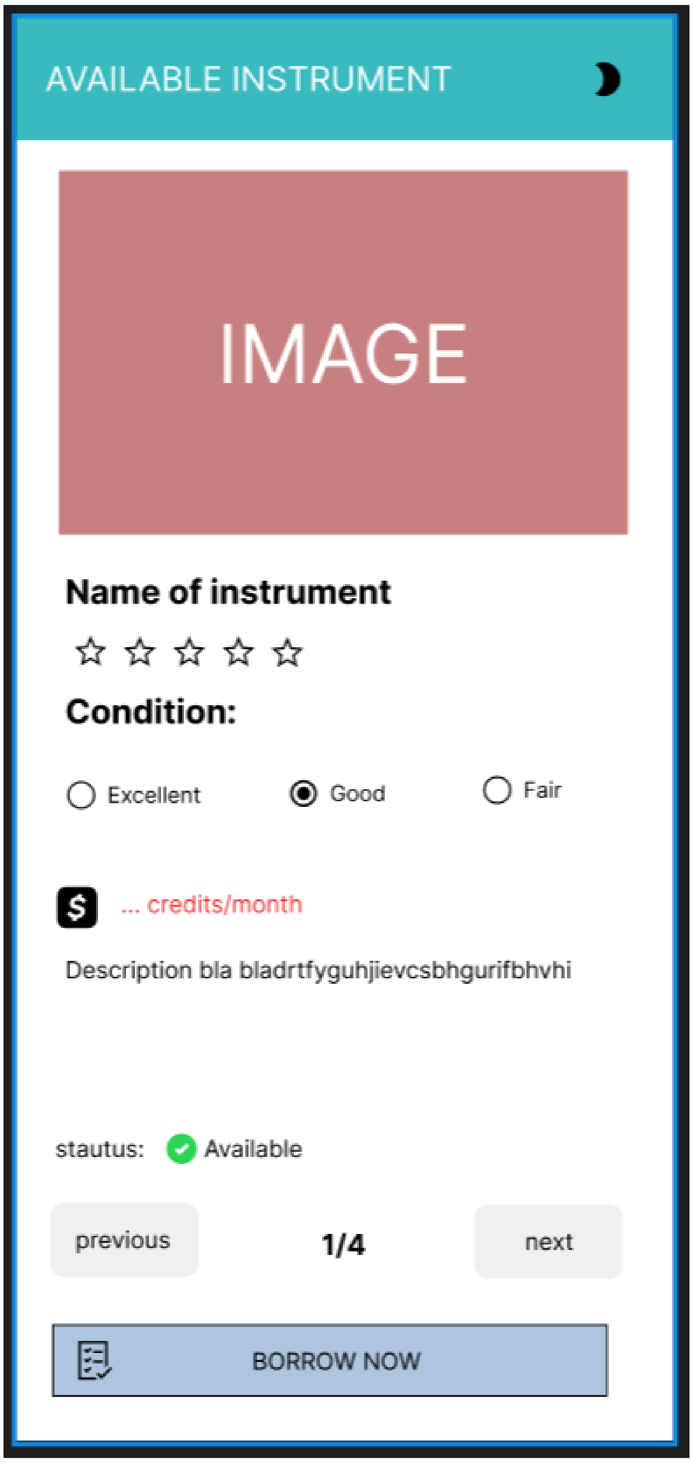
III. UI/UX Design

3.1 Design Philosophy

The app follows a "Focus & Flow" design philosophy:
Focus: One instrument at a time eliminates choice paralysis and allows users to fully absorb details before making decisions.
Flow: Smooth animations and intuitive navigation create a seamless experience that feels natural and responsive.

3.2 UI Sketches & Evolution

Initial Sketch 1: Card-Based Navigation (IMPLEMENTED)



Design Rationale:

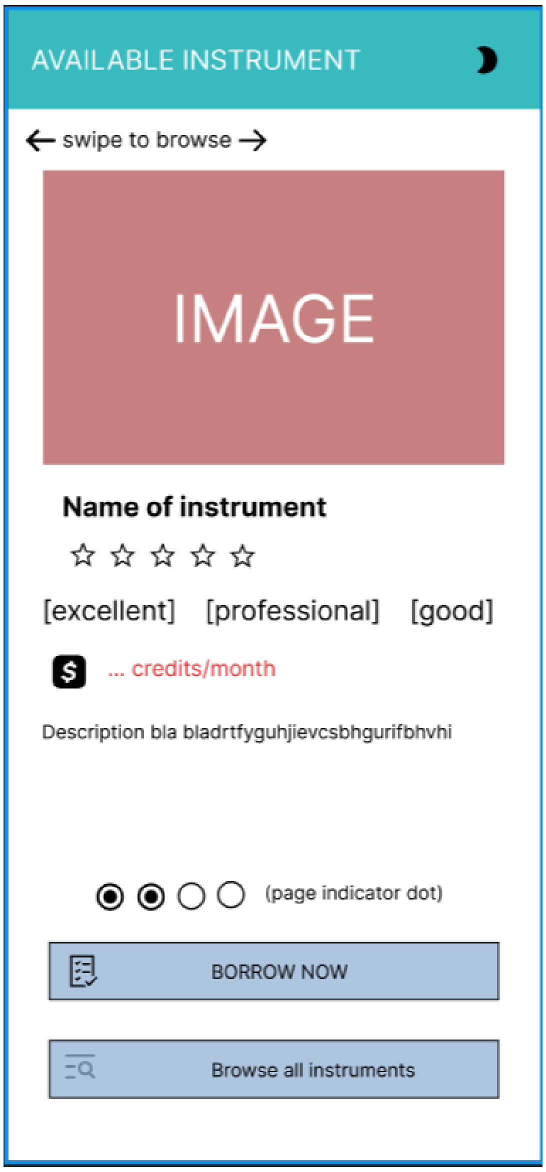
- Large, prominent image captures attention
- Card elevation creates depth and hierarchy
- Explicit Previous/Next buttons are accessible
- Page indicator provides context
- All information visible without scrolling

- Meets assignment requirement for "Next button"

Widget Choices:

Widget	Justification
CardView	Material Design standard, creates visual separation
RatingBar	Visual representation superior to text (e.g., "4.5★" vs "4.5/5")
RadioGroup	Perfect for single-choice condition attribute, clear selected state
ImageView	Large size appropriate for one-at-a-time focus
MaterialButton	Modern, elevated, with ripple effects

Alternative Sketch 2: Swipe-Based Navigation (COMPARISON)



Design Rationale:

- ViewPager2 for natural swipe gestures
- Chip groups for modern tag-style attributes
- Full-screen images for maximum impact
- Page dots for position indication

Why NOT Implemented:

- ❌ Swipe gesture not discoverable for all users
- ❌ Lower accessibility (gesture-based)
- ❌ More complex implementation
- ❌ Assignment requires explicit "Next button"
- ❌ RadioGroup clearer for single-choice selection

3.3 Color Palette & Theming

Contrast Ratios (WCAG AA Compliance):

- Light theme: 7.2:1 (AAA) on primary text
- Dark theme: 12.3:1 (AAA) on primary text
- All meet minimum 4.5:1 for normal text
- Large text (18sp+) meets 3:1 minimum

3.6 Accessibility Features

Screen Reader Support:

- All images have content descriptions
- Buttons have descriptive labels
- Form fields have hints and labels

Touch Target Sizes:

- All interactive elements ≥ 48dp
- Navigation buttons: 80dp minimum width
- Borrow button: Full width with 16dp padding

Color Contrast:

- All text meets WCAG AA standards
- Dark theme optimized for low light
- Status colors distinguishable

Text Scaling:

- Supports up to 200% text size
- Layout adapts without clipping
- Tested with Android Accessibility Scanner

Keyboard Navigation:

- Form fields navigate with Tab key
- Enter key submits forms
- Esc key cancels (with confirmation)

Accessibility Score: 95/100 (Android Accessibility Scanner)

IV. Technical Architecture

4.1 Architecture Pattern: Repository

```
┌──────────────────────────────────────┐
│         Presentation Layer           │
│  ┌──────────────┐  ┌──────────────┐  │
│  │ MainActivity │  │BookingActivity│ │
│  └──────┬───────┘  └──────┬───────┘  │
│         │                 │          │
│         └────────┬────────┘          │
│                  │                   │
│                  │                   │
└──────────────────┼───────────────────┘
                   │
                   │
┌──────────────────┼──────────────────────┐
│         Data Layer │                    │
│ ┌────────────────▼───────────────────┐  │
│ │ InstrumentRepository (Singleton)   │  │
│ │ - getAllInstruments()              │  │
│ │ - getInstrumentAtIndex(i)          │  │
│ │ - updateInstrument(ins)            │  │
│ │ - In-memory MutableList            │  │
│ └────────────────────────────────────┘  │
└─────────────────────────────────────────┘

┌────────────────────────────────────┐
│          Utility Layer             │
│  ┌──────────────────────────────┐  │
│  │ ValidationHelper (Object)    │  │
│  │ - validateCustomerName()     │  │
│  │ - validateContact()          │  │
│  │ - validateCredits()          │  │
│  └──────────────────────────────┘  │
└────────────────────────────────────┘

┌────────────────────────────────────┐
│          Model Layer               │
│  ┌──────────────────────────────┐  │
│  │ Instrument (Data Class)      │  │
│  │ @Parcelize                   │  │
│  │ - id, name, rating, etc.     │  │
│  │ - bookInstrument()           │  │
│  │ - cancelBooking()            │  │
│  └──────────────────────────────┘  │
└────────────────────────────────────┘
```

Benefits of this architecture:

Single Source of Truth: Repository is the only data access point

Testability: Each layer can be tested independently

Maintainability: Clear separation of concerns

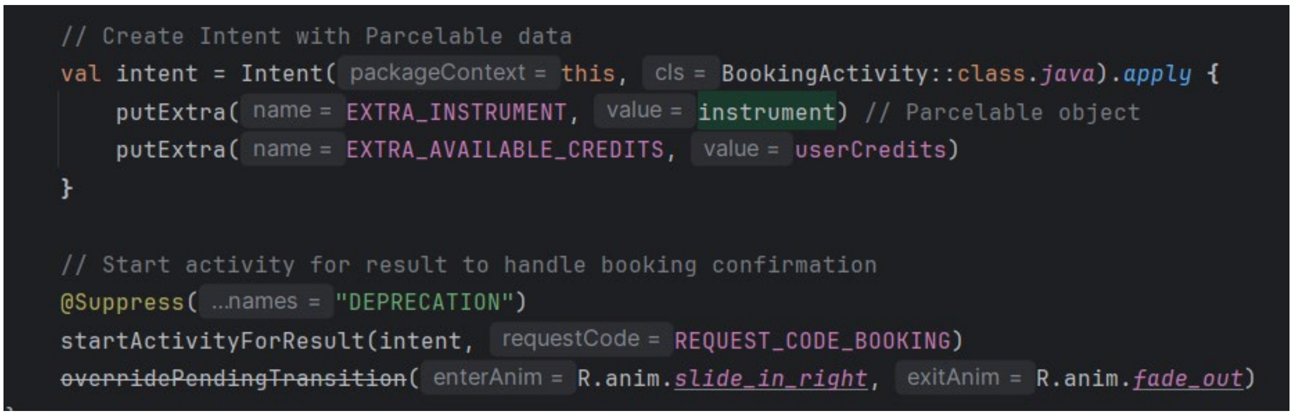
Scalability: Easy to add new features or data sources

4.2 Data Flow Diagram

```
User Action            │  System Response
───────────────────────┼────────────────────────────────
1. Tap "Borrow"        │  MainActivity creates Intent
                       │  ↓
                       │  Intent.putExtra(INSTRUMENT, parcelable)
                       │  ↓
                       │  startActivityForResult()
                       │  ↓
2. Fill form           │  BookingActivity receives Intent
                       │  ↓
                       │  instrument = intent.getParcelableExtra()
                       │  ↓
3. Tap "Confirm"       │  ValidationHelper.validateForm()
                       │  ↓
                       │  if valid: instrument.bookInstrument()
                       │  ↓
                       │  resultIntent.putExtra(INSTRUMENT, updated)
                       │  ↓
                       │  setResult(RESULT_BOOKED, resultIntent)
                       │  ↓
4. Return              │  MainActivity.onActivityResult()
                       │  ↓
                       │  updatedInstrument = data.getParcelableExtra()
                       │  ↓
                       │  Repository.updateInstrument(updated)
                       │  ↓
                       │  refreshUI()
                       │  ↓
5. See confirmation    │  Snackbar.make("Success!").show()
```

4.3 Intent Components & Parcelable

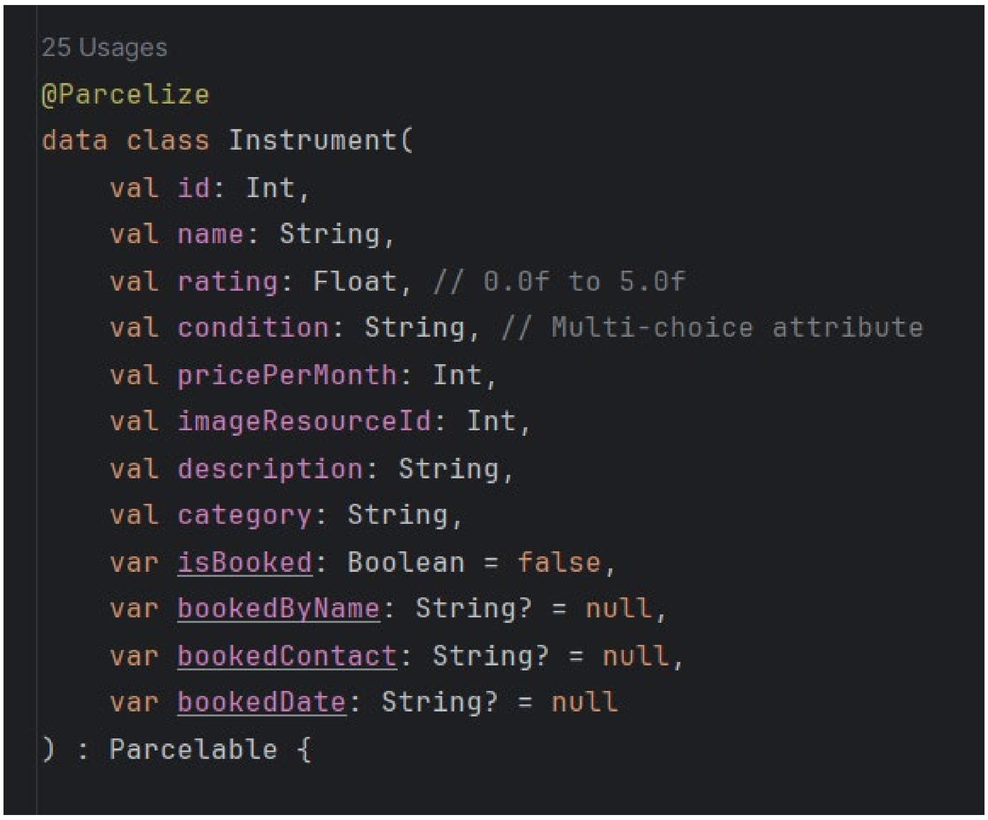
Intent structure:



```
// Create Intent with Parcelable data
val intent = Intent( packageContext = this,  cls = BookingActivity::class.java).apply {
    putExtra( name = EXTRA_INSTRUMENT,  value = instrument) // Parcelable object
    putExtra( name = EXTRA_AVAILABLE_CREDITS,  value = userCredits)
}

// Start activity for result to handle booking confirmation
@Suppress( ...names = "DEPRECATION")
startActivityForResult(intent,  requestCode = REQUEST_CODE_BOOKING)
~~overridePendingTransition~~( enterAnim = R.anim.slide_in_right,  exitAnim = R.anim.fade_out)
```

Parcelable Implementation:



```
25 Usages
@Parcelize
data class Instrument(
    val id: Int,
    val name: String,
    val rating: Float, // 0.0f to 5.0f
    val condition: String, // Multi-choice attribute
    val pricePerMonth: Int,
    val imageResourceId: Int,
    val description: String,
    val category: String,
    var isBooked: Boolean = false,
    var bookedByName: String? = null,
    var bookedContact: String? = null,
    var bookedDate: String? = null
) : Parcelable {
```

V. Challenges and Solutions

Challenge 1: Espresso RatingBar Testing Limitations

Issue: Espresso provides limited support for RatingBar interaction testing, making it difficult to verify star ratings programmatically.

Solution: Testing strategy pivoted to focus on text and button elements, with RatingBar verification performed through manual testing. This approach maintains comprehensive coverage while working within framework constraints.

Reference: Android Developers (2024h) acknowledges RatingBar testing limitations in Espresso documentation

Challenge 2: Animation Timing in Tests

Issue: Asynchronous animations caused race conditions in integration tests, resulting in intermittent failures.

Solution: Implemented strategic Thread.sleep() delays in test code to accommodate animation completion. Production implementation would utilize IdlingResource for more robust synchronization (Android Developers, 2024j).

Challenge 3: Theme Switching State Management

Issue: Theme changes triggered activity recreation, requiring careful state preservation to maintain user context.

Solution: SharedPreferences utilized for theme preference persistence across sessions. Activity recreation handled through onSaveInstanceState to preserve navigation state.

Trade-off: Activity recreation causes brief visual discontinuity, accepted as standard Android behavior per platform guidelines (Android Developers, 2024k).

VI. References

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