Android lecture 3

Fragments, Notifications, Data persistence

Agenda

- Fragments
  - Inflating
  - Lifecycle
- Notifications
- Data persistence
  - File
  - SharedPreferences
  - Database
  - Content provider

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TargetSdk requirements

Definitions

New app	An app that is not yet published on Google Play (for example, a brand new app).
Updated app	A new version of an app that is already published on Google Play.
Existing app	A published app that is not receiving updates.

Requirements

Android OS version	When are Google Play apps required to target this API level?		
	New app	Updated app **	Existing app
Android 13 (API level 33)	August 1, 2023	November 1, 2023	November 1, 2024
Android 12 (API level 31)	August 1, 2022	November 1, 2022	November 1, 2023
Android 11 (API level 30)	August 1, 2021	November 1, 2021	November 1, 2022

https://support.google.com/googleplay/android-developer/answer/11926878

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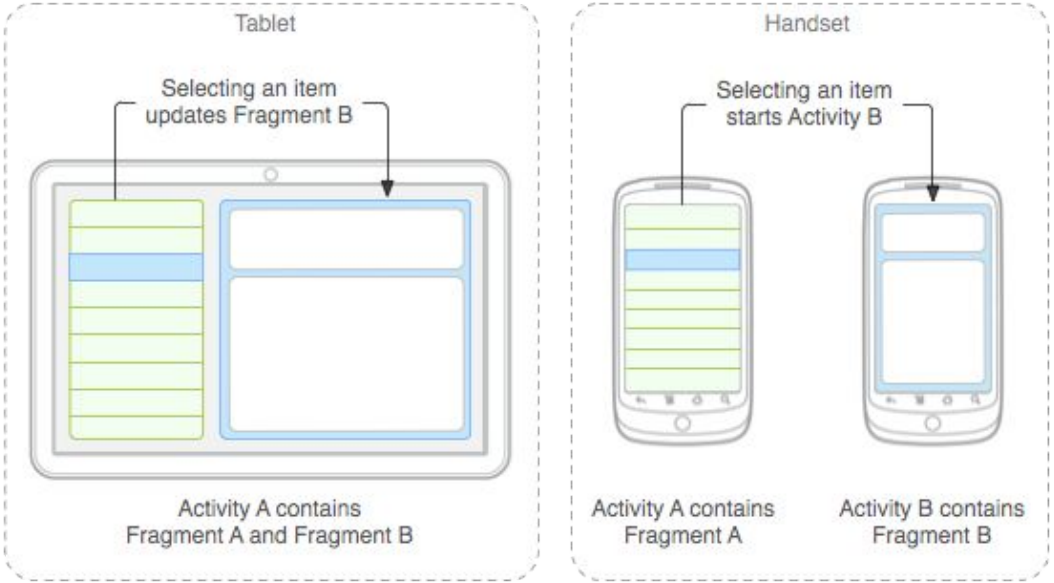
Fragment

- Simplify create UI for phones and tablets
- ~~`android.app.Fragment`~~ - Added API 11, deprecated API 28
- ~~android.support.v4.app.Fragment~~ - replaced by jetpack
- androidx.fragment.app.Fragment - jetpack



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Fragment - add statically

activity_main.xml

```
<?xml version="1.0" encoding="utf-8"?>
<FrameLayout xmlns:android="http://schemas.android.com/apk/res/android"
   xmlns:tools="http://schemas.android.com/tools"
   android:layout_width="match_parent"
   android:layout_height="match_parent">

   <androidx.fragment.app.FragmentContainerView
       android:id="@+id/fragment_id"
       android:tag="some_string"
       android:name="packagename.class"
       android:layout_width="match_parent"
       android:layout_height="match_parent" />

</FrameLayout>
```

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Fragment - Activity.kt

```
override fun onCreate(savedInstanceState: Bundle?) {
    super.onCreate(savedInstanceState)
    setContentView(R.layout.activity_user)

    supportFragmentManager.beginTransaction()
            .add(R.id.fragment_container, MyFragment.newInstance())
            .addToBackStack(null)
            .commit()
}
```

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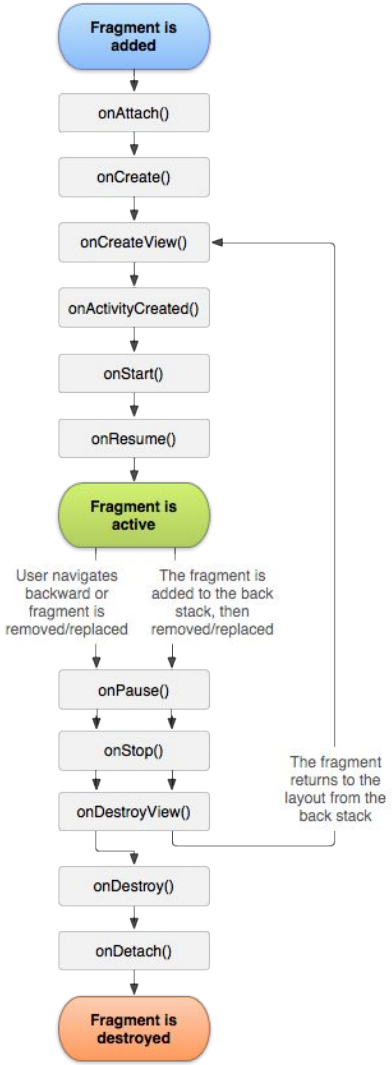
Fragment - states

- Is in same state as host activity
- Resumed
  - Fragment is visible in the running activity
- Paused
  - Another activity in foreground, but hosting activity is still visible
- Stopped
  - Fragment is not visible
  - Hosting activity is stopped or fragment is removed from the activity, but added to backstack.
  - Alive, can be killed by hosting activity

Fragment - lifecycle



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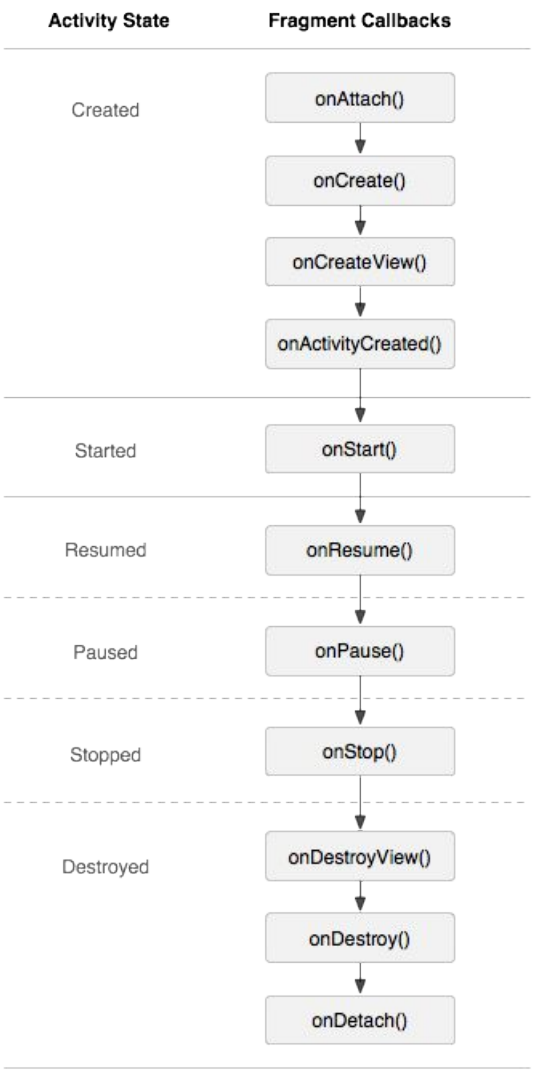
Fragment inside Activity lifecycle



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Fragment - lifecycle

- onAttach(Activity)
  - Fragment is associated with the activity
  - Set activity as a listener
- onCreate(Bundle)
  - Initial creation of fragment
  - Process fragment extras
  - Not called when fragment is retained across Activity re-creation
- onCreateView(LayoutInflater, ViewGroup, Bundle)
  - Called when view hierarchy needs to be created

Fragment - lifecycle

- onActivityCreated(Bundle)
  - Activity onCreate() completed
  - Get references to views
- onViewStateRestored(Bundle)
  - All saved state of the view hierarchy was restored
- onStart()
  - Fragment visible to user (same as Activity.onStart())
- onResume()
  - Fragment interact with user (based on hosting container)
  - Same as Activity.onResume()

Fragment - lifecycle

- onPause()
  - Not interact with user anymore
  - Paused activity or fragment manipulation
- onStop()
  - No longer visible
  - Stopped activity or fragment manipulation
- onDestroyView()
  - Disconnect fragment from view hierarchy created in onCreateView()
- onDestroy
  - Fragment going to be destroyed
  - Cleanup all resources
  - Not called for retained fragments
- onDetach
  - Detach fragment from activity
  - Remove activity listeners

Retained fragment

- Call `Fragment#setRetainInstance(true)`
- Survive configuration change
- Views needs to be recreated
- `Fragment#onCreate()` is not called for retained instances
- Usually for background work or data caching

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Headless fragment

- Fragment without UI
- Often retained fragment
- `Fragment#onCreateView()` returns null

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Fragment and Activity

- Fragment is not working without activity
- Activity can call fragment methods directly
- Fragment defines interface to be implemented by Activity to handle fragment requirements

Fragment - passing data

```
class DemoFragment: Fragment() {

    companion object {
        @JvmStatic
        fun newInstance(username: String): DemoFragment {
            val fragment = DemoFragment()
            fragment.arguments = bundleOf(
                "Username" to username,
                "id" to 1001
            )

            return fragment
        }
    }
}
```

- Android calls non-params constructor when restoring fragments
- Constructor with parameters will not be called

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Exercise

1. Inflate LoginFragment in LoginActivity statically
2. Inflate UserFragment in UserActivity dynamically
3. Fill UserFragment data

Strict mode

Strict mode

- Developer tool
- Detects application bad behaviour

```
if (DEVELOPER_MODE) {
    StrictMode.setThreadPolicy(StrictMode.ThreadPolicy.Builder()
            .detectDiskReads()
            .detectDiskWrites()
            .detectNetwork()   // or .detectAll() for all detectable problems
            .penaltyLog()
            .build())
    StrictMode.setVmPolicy(new StrictMode.VmPolicy.Builder()
            .detectLeakedSqlLiteObjects()
            .detectLeakedClosableObjects()
            .penaltyLog()
            .penaltyDeath()
            .build())
}
```

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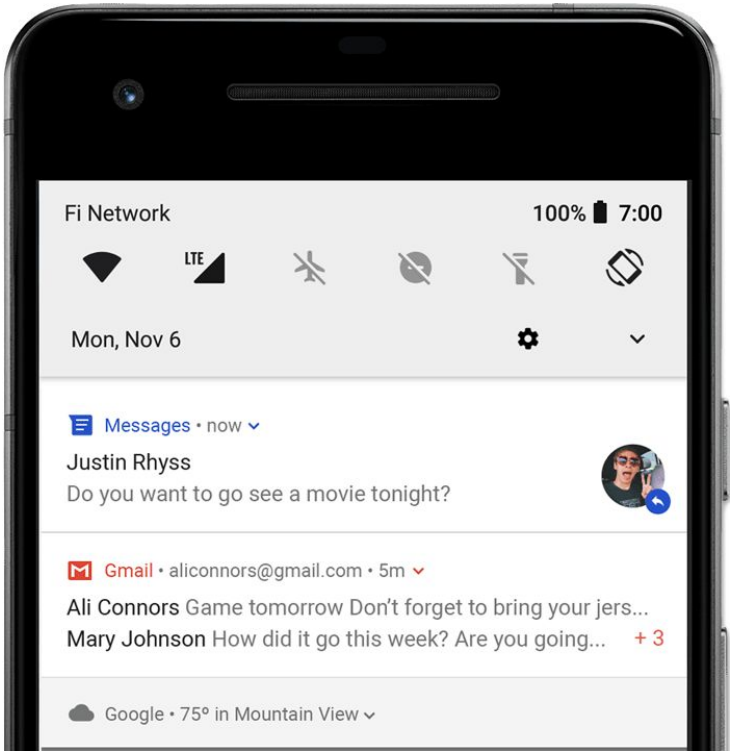
Notifications

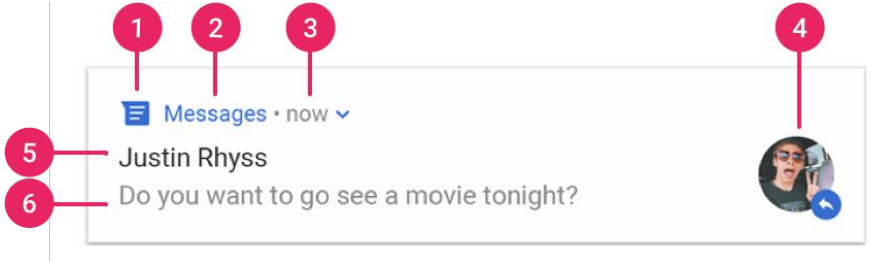
Notifications

- Notify user, when not use your app
- Mandatory
  - Small icon
  - Content title
  - Content text
  - Notification channel - Android 8.0+



Notification

1. Small icon - mandatory parameter
2. App name - provided by system
3. Time stamp: provided by system,
   - override by setWhen()
   - Hide setShowWhen(false)
4. Large icon - optional
5. Title - optional
6. Text - optional



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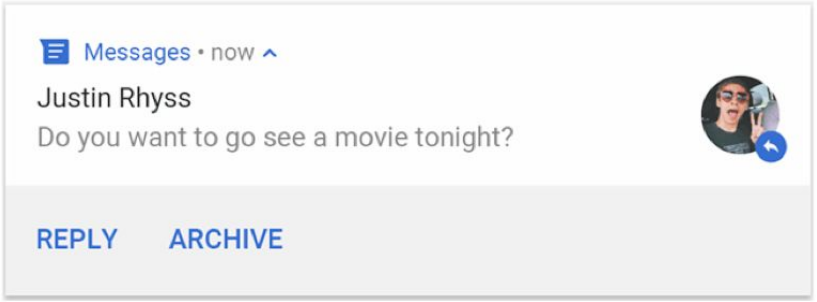
Notification actions

- Quick actions
- Inline reply action Android 7.0+



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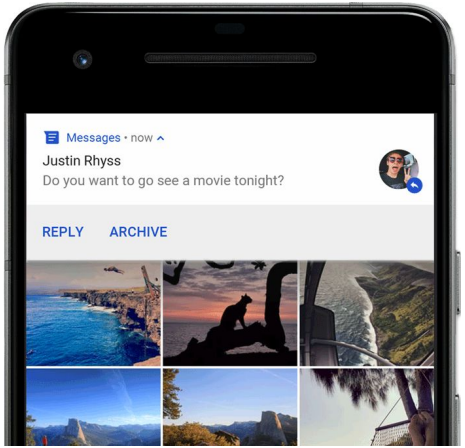
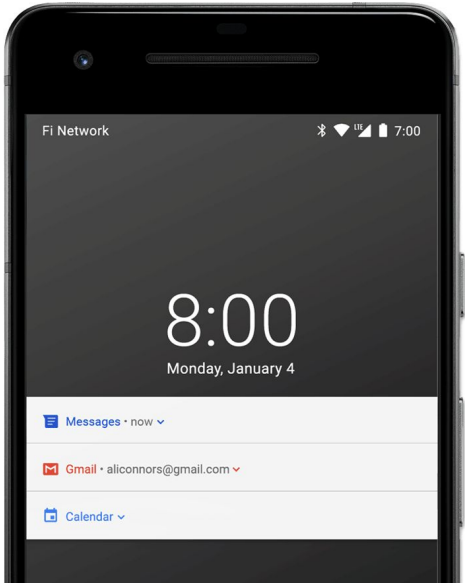
Heads-up notifications

- Heads-up notifications
  - Small floating window
  - Shows action buttons to handle action without leaving app
  - Only for high priority notifications
    - If the user's activity is in full screen mode (app uses fullScreenIntent)
    - Notification has high priority and uses ringtones or vibrations
- Android 5.0+



Lock screen notifications

- Possibility to set which informations when device is locked
  - VISIBILITY_PUBLIC - Shows full content
  - VISIBILITY_SECRET - Do not show at all
  - VISIBILITY_PRIVATE - Show icon and title, hide content
- Android 5.0+



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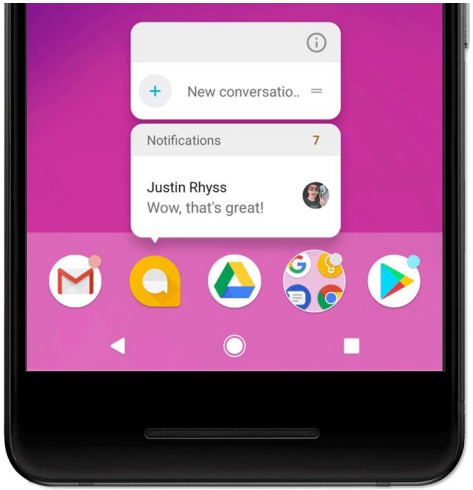
Notifications dots

- Dots on launcher app icons
- Shows notification content on long click
- Android 8.0+



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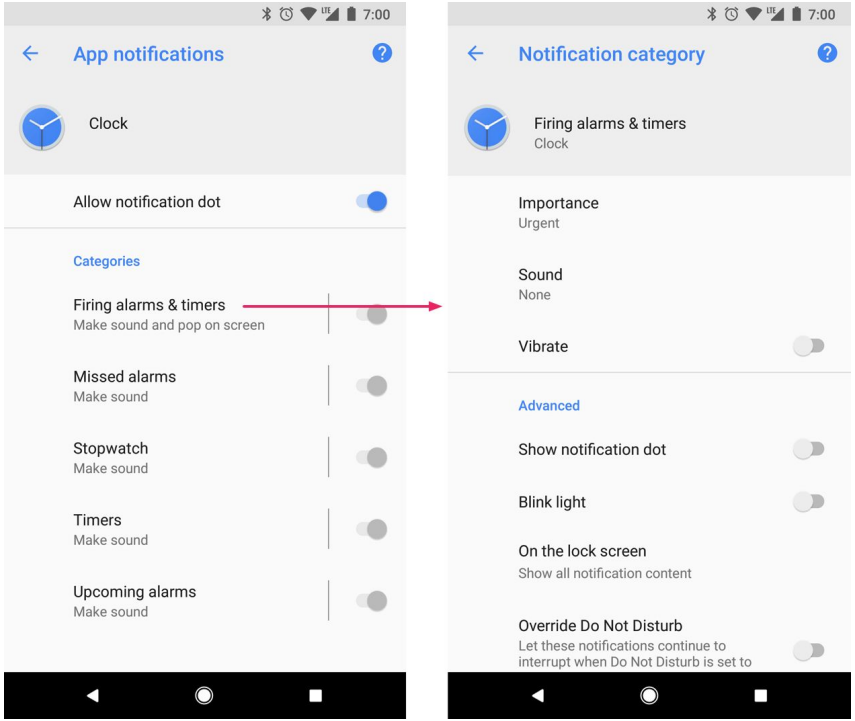
Notification channels

- Notification categories
- User can manage notifications in single category
- Override DnD
- System show number of deleted channels
- Android 8.0+



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Key classes

- android.app.Notification
- ~~android.support.v4.app.NotificationCompat~~
  - ~~Action~~
  - ~~Builder~~
  - ~~*Style~~
- androidx.core.app.NotificationCompat
  - Action
  - Builder
  - *Style
- android.app.NotificationManager
- ~~android.support.v4.app.NotificationManagerCompat~~
- androidx.core.app.NotificationManagerCompat
- android.app.NotificationChannel

Notification

- Use `NotificationCompat.Builder`
  - Handles compatibility
- `NotificationManagerCompat.notify(int id, Notification)`
- Possible to set pending intent for actions
- Priority affects position in drawer
- Developer responsibility to handle navigation when user opens application from notification

Create notification

```
var builder = NotificationCompat.Builder(this, CHANNEL_ID)
        .setSmallIcon(R.drawable.notification_icon)
        .setContentTitle("My notification")
        .setContentText("Much longer text that cannot fit one line...")
        .setStyle(NotificationCompat.BigTextStyle()
                .bigText("Much longer text that cannot fit one line..."))
        .setPriority(NotificationCompat.PRIORITY_DEFAULT)
```

Create channel

```
private fun createNotificationChannel() {
    // Create the NotificationChannel, but only on API 26+ because
    // the NotificationChannel class is new and not in the support library
    if (Build.VERSION.SDK_INT >= Build.VERSION_CODES.O) {
        val name = getString(R.string.channel_name)
        val descriptionText = getString(R.string.channel_description)
        val importance = NotificationManager.IMPORTANCE_DEFAULT
        val channel = NotificationChannel(CHANNEL_ID, name, importance).apply {
            description = descriptionText
        }
        // Register the channel within the system
        val notificationManager: NotificationManager =
            getSystemService(Context.NOTIFICATION_SERVICE) as NotificationManager
        notificationManager.createNotificationChannel(channel)
    }
}
```

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Setup notification action

```
// Create an explicit intent for an Activity in your app
val intent = Intent(this, AlertDetails::class.java).apply {
    flags = Intent.FLAG_ACTIVITY_NEW_TASK or Intent.FLAG_ACTIVITY_CLEAR_TASK
}
// Create the TaskStackBuilder
val resultPendingIntent: PendingIntent? = TaskStackBuilder.create(this).run {
    // Add the intent, which inflates the back stack
    addNextIntentWithParentStack(intent)
    // Get the PendingIntent containing the entire back stack
    getPendingIntent(0, PendingIntent.FLAG_UPDATE_CURRENT)
}
val builder = NotificationCompat.Builder(this, CHANNEL_ID)
        ....
        // Set the intent that will fire when the user taps the notification
        .setContentIntent(pendingIntent)
        .setAutoCancel(true)
```

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Fire notification

```
with(NotificationManagerCompat.from(this)) {
    // notificationId is a unique int for each notification that you must define
    notify(notificationId, mBuilder.build())
}
```

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Notifications - Android 12

- No longer possible to control full content of notification
- https://developer.android.com/about/versions/12/behavior-changes-12#custom-notifications

Notifications - Android 13

- Requires runtime permission - POST_NOTIFICATIONS
- Foreground services still available in Foreground service task manager, but not visible in notification drawer
- Exemptions
  - Media sessions
  - App for managing phone calls

Persistence

Persisting data - files

- Standard Java API for file operations

Internal storage

- Always available
- For private data
- Removed with application uninstall
  - https://medium.com/inloopx/samsung-tablets-are-not-removing-application-files-after-uninstall-45cc22ace56a
- Cache

Internal storage

- `Context.getFilesDir()`
  - File representing internal directory for your app
- `Context.openFileOutput(filename: String, mode: Int)`
  - Filename - name of file
  - Mode - specify access to file
    - `MODE_PRIVATE` - accessible by apps with same UID
    - `MODE_APPEND` - append data instead of erasing file
    - `MODE_WORLD_READABLE` - Deprecated API 17, SecurityException API 24
    - `MODE_WORLD_WRITEABLE` - Deprecated API 17, SecurityException API 24
- `Context.openFileInput(filename: String)`
  - Filename - name of file

Internal storage - cache

- `Context.getCacheDir()`
  - File representing internal directory for app temporary files
  - System can delete these files, when is running low on storage
  - 3rd party cleaner apps often clear cache
  - Delete these files when are not longer needed
  - Presence of these files should not affect your application
    - It can just slow down app, need to download some resources

Internal storage - sharing data

- Data can be shared via `FileProvider`
  - Allows to specify shared directories
  - Implicit intent to pick specific files

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External storage

- External storage != SD Card
- Not always available
- World readable
- Uninstall remove files in `Context.getExternalFilesDir()`
- Lot of API changes between android versions
- Often modified by vendors

External storage

- Requires permissions
  - `android.permission.WRITE_EXTERNAL_STORAGE`
  - `android.permission.READ_EXTERNAL_STORAGE`
  - Since API 19 permissions are not needed for private files
- Developer responsibility to check if the external storage is available
- Public files
  - Available to the other apps and user
  - Downloaded files
- Private files
  - Files to be deleted with app uninstall
  - Accessible to other, but no value for them
  - Temp downloaded files, ringtones, ….

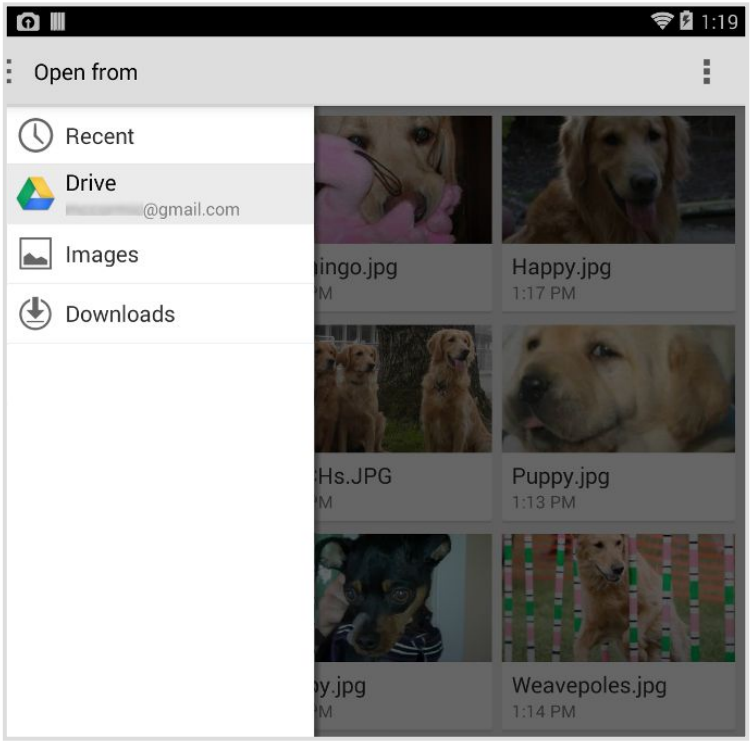
External storage

- `Environment.getExternalStoragePublicDirectory(type: String): File`
  - Type - type of files to access `Environment.DIRECTORY_*`
  - File representing top-level shared/external directory for files of particular type
  - Multi user devices - access only to current user
- `Environment.getExternalFilesDir(type: String): File`
  - Type - type of files to access `Environment.DIRECTORY_*`
  - `File` representing where app place internal files
  - Files are deleted after app uninstall
- `Environment.isExternalStorageEmulated(): Boolean`
- `Environment.isExternalStorageRemovable(): Boolean`
- `Environment.getExternalStorageState(): String`

External storage - SD card

- < API-19 guess where the sdcard is mounted
- = API-19 not possible write shared data on sd card, when primary external storage is available
  - Or using storage access framework, but access is granted per file
- >=API-21 Storage access framework allows to grant access for directories
  - New APIs for accessing media folders on SD card
  - Context.getExternalMediaDirs(): Array<File>

Storage access framework



- Let user pick a file
- Allows to plug-in custom service (cloud services like Dropbox, Google drive, …)
- Since API 19

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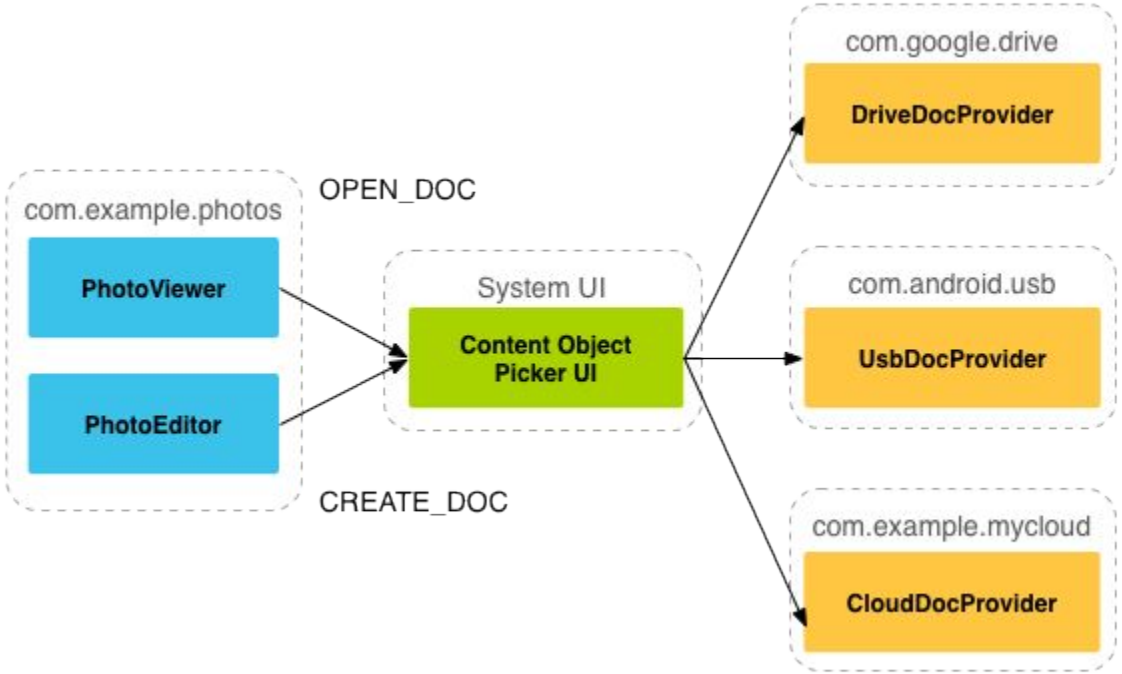
Storage access framework



Scoped storage - Android 10 (API-29)

- Restrict access to files on external storage
- App has access to app-specific directory
- Files are in collections - no permission needed for contribution
  - Pictures
  - Videos
  - Music/Audio
  - Download
- Modify/Delete files created by other app requires explicit user consent

Scoped storage - Android 10 (API-29)

- Access to documents, downloaded file use storage access framework
- Read/write outside of the collections requires storage access framework
- Photo location metadata permission

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Scoped storage - Android 10 (API-29)

- Possible to opt-out by AndroidManifest.xml flag

Scoped storage - Android 11 (API-30)

- Files API for files accessible through MediaStore API
  - 3rd party libraries, C/C++ code
- API for bulk options over media files
- Special app access for selected use case
  - Antivirus
  - Backup&Restore
  - File managers
  - ...
  - Manually reviewed by google
  - User have to explicitly grant the access in Android settings
- Managed by TargetSdk

Scoped storage

https://developer.android.com/training/data-storage/use-cases

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SharedPreferences

- Key value storage
- Backed by XML
- `Context.getSharedPreferences(name: String, mode: Int)`
  - Name - name of file with preferences
  - Mode - operating mode
    - `MODE_PRIVATE` - only apps with same UID have access
    - `MODE_WORLD_READABLE` - API 17 Deprecated, API 24 SecurityException
    - `MODE_WORLD_WRITEABLE` - API 17 Deprecated, API 24 SecurityException
- `Activity.getPreferences(int mode)`
  - Preferences associated with activity
- `PreferenceManager.getDefaultSharedPreferences (Context)`
  - Default preferences used by Preference framework

SharedPreferences

```
val sharedPrefs = getSharedPreferences("preferences",
Context.MODE_PRIVATE)
val intVal = sharedPrefs.getInt("int_key", 42)
val stringVal = sharedPrefs.getString("string_key", "Default")
```

```
val editor = sharedPrefs.edit()
editor.putString("string_key", "new value")
editor.commit() //Synchronous
editor.apply()  // Async
```

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SharedPreferences

- Editor.commit()
  - Notifies about result
  - Synchronous operation, waits until changes are written to disk
- Editor.apply()
  - Async variant
  - Atomically stores values
  - ANRs bugs (fsync() on main thread)
- If multiple editors modifying preferences at she same time, last calling apply() wins
- Debugging - rooted device or flipper/stetho

http://facebook.github.io/stetho/ - old, not maintained
https://fbflipper.com/ - new, multiplatform

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Data store

- Shared preferences replacement
- Shared preferences async API has some design flaws
  https://engineering.avast.io/how-we-fought-with-anr-rate-in-android-vitals/

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Data store

Feature	SharedPreferences	Preferences DataStore	Proto DataStore
Async API	✅ (only for reading changed values, via listener)	✅ (via `Flow`)	✅ (via `Flow`)
Synchronous API	✅ (but not safe to call on UI thread)	❌	❌
Safe to call on UI thread	❌*	✅ (work is moved to `Dispatchers.IO` under the hood)	✅ (work is moved to `Dispatchers.IO` under the hood)
Can signal errors	❌	✅	✅
Safe from runtime exceptions	❌**	✅	✅
Has a transactional API with strong consistency guarantees	❌	✅	✅
Handles data migration	❌	✅ (from SharedPreferences)	✅ (from SharedPreferences)
Type safety	❌	❌	✅ with Protocol Buffers

https://android-developers.googleblog.com/2020/09/prefer-storing-data-with-jetpack.html

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Data store

- Completely asynchronous approach
- RxJava/Kotlin coroutines API
- Google protocol buffer type safe API
- API for migration from shared preferences

Exercise

6. Count app launches
7. Prefill login with last used one

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Database -SQLite

- Full-featured SQL
- Single-file database
- Source code is just 1 file
- Small footprint
- ACID transactions
- Well documented
- Supports most of the SQL92 standard

SQLite on Android

- Foreign keys disabled by default
- Internal storage
- Collation
  - BINARY - SQLite default
  - LOCALIZED - changes with system locale
  - UNICODE - Unicode collation algorithm
- Thread safe
- Create/upgrade on background thread
- Take care about opening/closing from different threads
- Use `BaseColumn._ID` for primary keys, some components rely on it
- Stetho tool for debugging

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Database

- `android.database.sqlite.SQLiteOpenHelper`
  - Database creation
  - Version management
  - Sqlite configuration
    - Enable write ahead log
    - Enable support for foreign keys
- `android.database.sqlite.SQLiteDatabase`
  - Exposes methods to manage a SQLite databases
  - CRUD methods
  - Manage transactions

SQLiteOpenHelper

- `onCreate(db: SQLiteDatabase)`
  - Called when the database is created for the first time
- `onUpgrade(db: SQLiteDatabase, oldVersion: Int, newVersion: Int)`
  - Upgrade logic
- `getReadableDatabase/getWriteableDatabase`
  - creates/open database
- `close()`
  - Close open database object

SQLiteDatabase

- `insert(table: String, nullColumnHack: String, values: ContentValues)`
  - Table - name of table
  - nullColumnHack - optional, allows to insert empty row
  - Values - inserted values
  - Returns ID of newly inserted row
- `long insertOrThrow`
- `long insertWithOnConflict`

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SQLiteDatabase

- ```
  query(boolean distinct,
        table: String,
        columns: Array<String>,
        selection: String,
        selectionArgs: Array<String>,
        groupBy: String,
        having: String,
        orderBy: String,
        limit: String): Cursor
  ```
  - `Selection` - WHERE clausule, values replaced by ?
  - `selectionArgs` - values to replace ? in selection
- Multiple variants of query, with different possibilities
- `rawQuery(sql: String, selectionArgs: Array<String>): Cursor`
- Close returned cursors

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  ```

SQLiteDatabase

- `update(table: String,`
  `values: ContentValues,`
  `whereClause: String,`
  `whereArgs: Array<String>): Int`

SQLiteDatabase

- ```
  delete(table: String,
         values: ContentValues,
         whereClause: String,
         whereArgs: Array<String>): Int
  ```
  ```

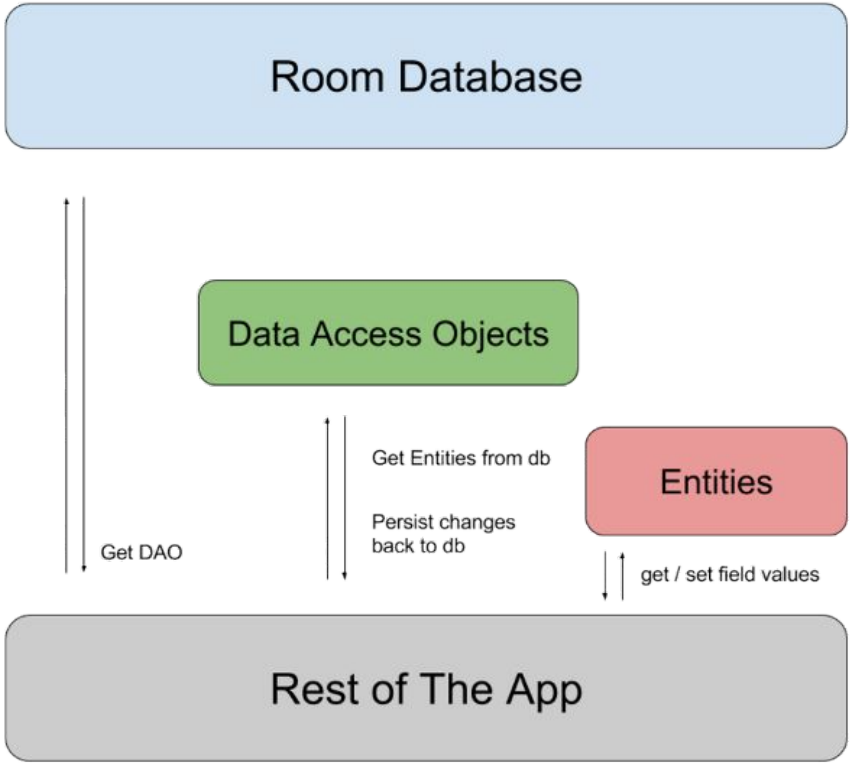
SQLiteDatabase

- Every CRUD operation is a transaction
- For inserting more rows in one time use transactions
- `beginTransaction()`
- `endTransaction()`
- `setTransactionSuccessful()`

Room

- Part of the Android Jetpack
- Abstraction over SQLite
- Compile time validation of SQL queries
- Full integration with other Architecture components (LiveData, LifecycleObserver)
- RxJava bindings

Room


Room Database
Data Access Objects
Get DAO
Get Entities from db
Persist changes
back to db
Entities
get / set field values
Rest of The App

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Room - entities

- Represents a table

```
@Entity
data class Car(
    @PrimaryKey val id: Int,
    @ColumnInfo(name = "manufacturer") val manufacturer: String?,
    @ColumnInfo(name = "model") val model: String?,
    @ColumnInfo(name = "nubmer_of_wheels") val numberOfWheels: String?
)
```

Room - DAO

- Defines operations on top of entities

```
@Dao
interface CarDao {
    @Query("SELECT * FROM car")
    fun getAll(): List<Car>

    @Query("SELECT * FROM car WHERE id IN (:carIds)")
    fun loadAllByIds(carIds: IntArray): List<Car>

    @Query("SELECT * FROM car WHERE manufacturer LIKE :manufacturer AND " +
           "model LIKE :model LIMIT 1")
    fun findByModel(manufacturer: String, model: String): Car

    @Insert
    fun insertAll(vararg cars: Car)

    @Delete
    fun delete(car: Car)
}
```

Avast

Room database

- Defines database

```
@Database(entities = arrayOf(Car::class), version = 1)
abstract class CarDatabase : RoomDatabase() {
    abstract fun carDao(): CarDao
}


val db = Room.databaseBuilder(
            applicationContext,
            CarDatabase::class.java, "car-database"
        )
    .addMigrations(...)
    .build()
```

Avast

ContentProvider

- Access to structured set of data
- Define data security
  - Via permissions
    - Global
    - Read/Write permissions
    - For single URI
- Connects data from one process to code running in another process
- ContentResolver for access data

ContentProvider

- Used by system aps
  - SMS
  - Contacts
  - Calendar
- Allows to share data between apps
- Data specified via Uri
- Allows to use CursorLoader

ContentProvider

- Can be backed up by different data sources
  - SQLite database
  - Network
  - Files
  - …

ContentProvider

- Initializes early
  - In priority order
- Application component start order
  - Content resolvers
  - Application
  - Invoked component by intent
- https://firebase.googleblog.com/2016/12/how-does-firebase-initialize-on-android.html

ContentProvider - implementation

- Design data storage
- Design content URIs
  - `content://com.example.app.provider/table1`
  - `content://com.example.app.provider/table2/dataset1`
  - `content://com.example.app.provider/table3/#`
- Define UriMatcher
  - Translates Uris to number constant
- Extend ContentProvider class
  - query(), insert(), update(), delete()
  - getType()
  - onCreate() - fast operations, postpone db creation
- Register provider in manifest

ContentResolver

- `context.getContentResolver()`
- CRUD operations similar params as SQLiteDatabase
- Specify data by URI

Thank you
Q&A

Feedback is appreciated

lukas.prokop@avast.com

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