Espresso

User Interface Testing: Goals and Approach

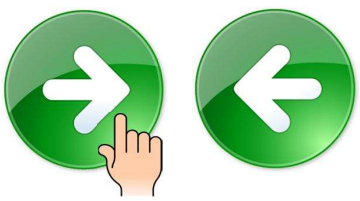
- Focuses on writing functional **end-to-end UI tests**, which is the **closest way to replicate end user behavior** and catch potential issues before a product goes live.
- Can be much slower than unit or integration tests, but they usually discover issues that were not caught during the unit and integration testing stages.

Espresso for Android

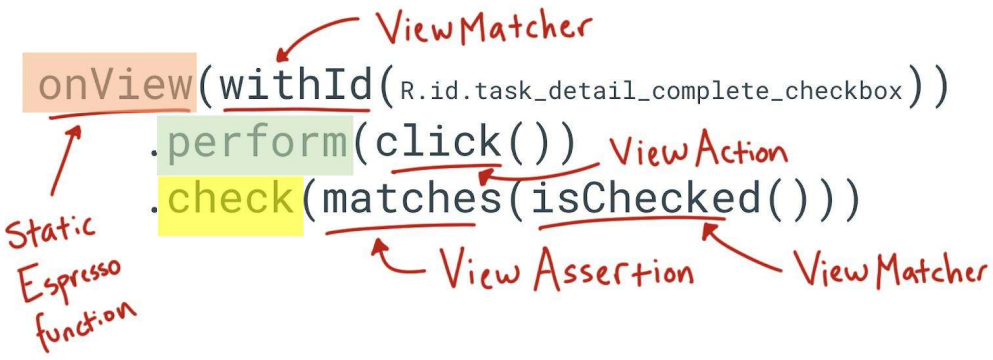
- Espresso is a lightweight, fast, customizable testing framework for reliable ***automated UI tests***
- Part of Android Test Supporting Library (ATSL) (now, **AndroidX** Library)
- First announced at 2013 by Google

You should never have to use Thread.sleep in Espresso tests.

- Simulate user interactions
- **Automatic synchronization** of test actions with app UI
  - Ensures that your activity is started before the tests run.
  - Let the test wait until all observed background activities have finished.



First Espresso Code



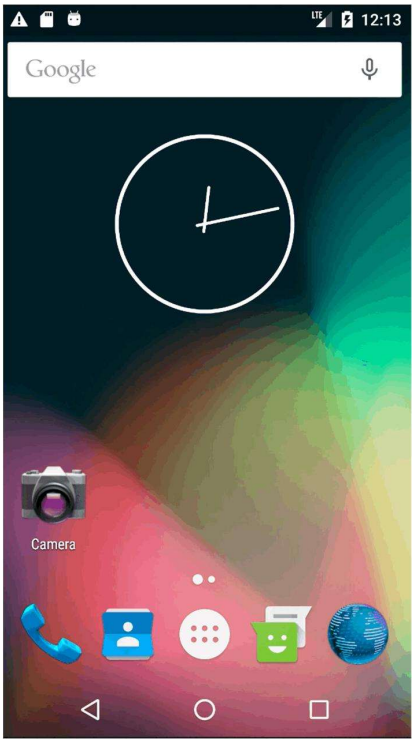
Demo

```
// navigate to second activity
onView(withId(R.id.button_next_activity))
       .perform(click());

// check the second activity visible
onView(withId(R.id.secondary))
       .check(matches(isDisplayed()));

// navigate back to main activity
onView(withId(R.id.button_back))
       .perform(click()); // method 1

// check the main activity visible
onView(withId(R.id.main))
       .check(matches(isDisplayed()));
```



Espresso Packages

- **espresso-core**
  - Contains core and basic view matchers, actions, and assertions.
- **espresso-contrib**
  - External contributions that contain DatePicker, **RecyclerView**, and Drawer actions, accessibility checks, and the CountingIdlingResource.
- **espresso-intents**
  - Extensions to validate and stub intents for hermetic testing.
- **espresso-idling-resource**
  - Espresso's mechanism for synchronizing background jobs.
- **espresso-remote**
  - Location of Espresso's multi-process functionality.
- **espresso-web**
  - Contains resources for WebView support.

Add Dependencies to build.gradle

- Android Studio templates include dependencies
- If needed, add the following dependencies:

```
dependencies {
  …
  testImplementation 'junit:junit:4.13'
  androidTestImplementation 'androidx.test:runner:1.1.0'
  androidTestImplementation 'androidx.test:core:1.1.0'
  androidTestImplementation 'androidx.test.ext:junit:1.1.1'
  androidTestImplementation 'androidx.test:rules:1.2.0'
  androidTestImplementation 'androidx.test.espresso:espresso-core:3.2.0'
  androidTestImplementation 'androidx.test.espresso:espresso-contrib:3.2.0'
  androidTestImplementation 'androidx.test.espresso:espresso-intent:3.2.0'
  androidTestImplementation 'androidx.test.espresso:espresso-idling-resource:3.2.0'
  implementation 'androidx.test.espresso:espresso-idling-resource:3.2.0'
}
```

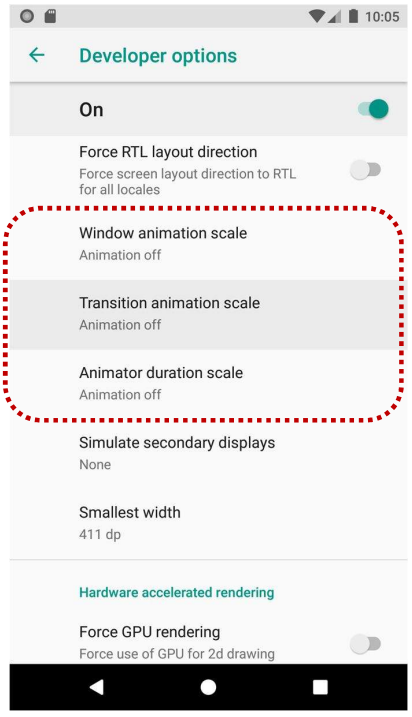
Add defaultConfig to build.gradle

- Android Studio templates include `defaultConfig` setting.
- If needed, add the following to `defaultConfig` section:

```
defaultConfig {
  …
  testInstrumentationRunner "androidx.test.runner.AndroidJUnitRunner"
}
```

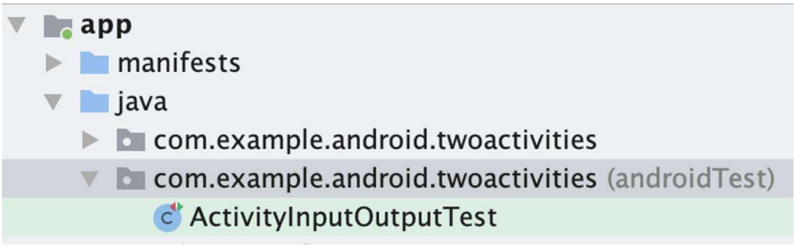

Prepare your device

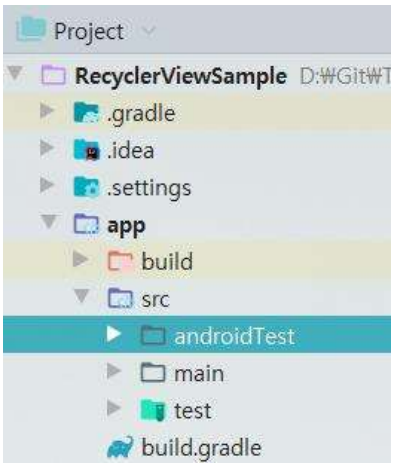
1. Turn on USB Debugging
2. Turn off all animations in **Developer Options > Drawing**
   - Window animation scale
   - Transition animation scale
   - Animator duration scale



Create Tests

- Store in ***"app/src/androidTests/java/"***
  - In Android Studio: app > java > *module-name* (androidTest)
- Create tests as JUnit classes





Five Components of Espresso

- ***ViewMatchers*** - allows to **find view** in the current view hierarchy
- ***ViewActions*** - allows to **perform actions** on the views
- ***ViewAssertions*** - allows to **assert state** of a view (i.e. **validation**)

- **JUnit Runner** - runs the espresso test cases
- **JUnit Rules** - launches an activity/fragment

JUnit Runner (*AndroidJUnitRunner*)

- Android testing framework provides a runner, *AndroidJUnitRunner* to run the espresso test cases (JUnit3 and JUnit4 test cases).
- It transparently handles
  - loading test cases and SUT both in actual device or emulator,
  - execute the test cases, and
  - report the result of the test cases.

```
@RunWith(AndroidJUnit4.class)
public class ExampleInstrumentedTest {
  …
}
```


JUnit Rules

- Espresso needs a rule of type `ActivityScenarioRule` to specify the activity.
- `ActivityScenarioRule` launches an activity before executing the test cases.
  - launches the activity before *@Before* and
  - will terminate it after *@After.*

```
@Rule
public ActivityScenarioRule<MainActivity> scenarioRule =
    new ActivityScenarioRule<>(MainActivity.class);
```

@Rule specifies the context of testing

- **@ActivityScenarioRule** - Testing support for a single specified activity
- **@ActivityTestRule** - Testing support for a single specified activity
  - deprecated
- **@IntentsTestRule** – Subtype of ActivityTestRule for intents
- **@ServiceTestRule -** Testing support for starting, binding, shutting down a service

Formula

```
onView(ViewMatcher)          // find a View by id, content, focus, hierarchy
    .perform(ViewAction)     // Perform an action
    .check(ViewAssertion)    // Verify action was taken, assert result

onView(withId(R.id.greet_button)
    .perform(click())
    .check(matches(not(isEnabled()))))
```

- `onView()` methods return an object of type **ViewInteraction**.

Espresso Matchers

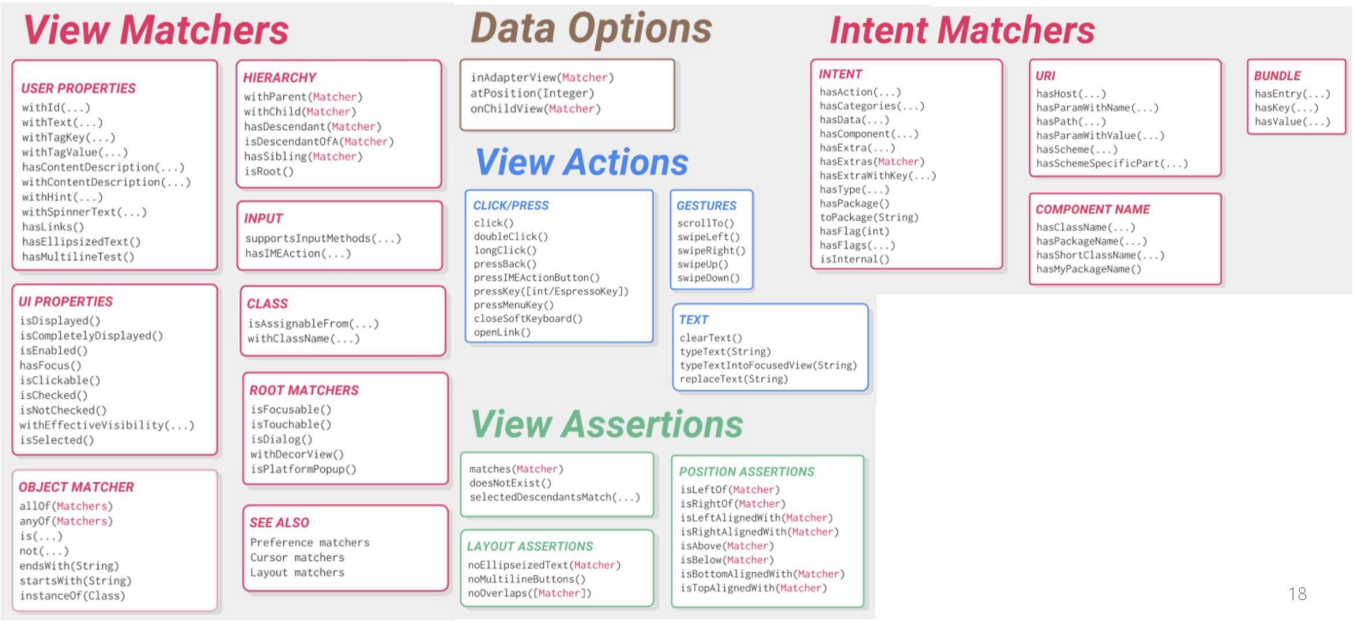
```
onView(withId(R.id.next_button)
    .perform(click())
    .check(matches(not(isDisplayed()
))
```

Hamcrest Matchers

```
onView(withId(R.id.next_button)
    .perform(click())
    .check(matches(not(isDisplayed()
))
```


Espresso cheat sheet

(https://android.github.io/android-test/downloads/espresso-cheat-sheet-2.1.0.pdf)



"Hamcrest" simplifies tests

“Hamcrest” an anagram of “Matchers”

Framework for creating custom matchers and assertions

Match rules defined declaratively

Enables precise testing

The Hamcrest Tutorial

`http://hamcrest.org/JavaHamcrest/tutorial`

Hamcrest 1.3 *Quick Reference*

General purpose

```
is(T)
equalTo(T)
not(T)                                  : Matcher<T>

anything()
anything(String)                        : Matcher<Object>

any(Class<T>)
instanceOf(Class<?>)
isA(Class<T>)                           : Matcher<T>

nullValue()                             : Matcher<Object>
nullValue(Class<T>)                     : Matcher<T>
notNullValue()                          : Matcher<Object>
notNullValue(Class<T>)                  : Matcher<T>

sameInstance(T)
theInstance(T)                          : Matcher<T>

isIn(Collection<T>)
isIn(T[])
isOneOf(T...)
hasToString(String)
hasToString(Matcher<? super String>)    : Matcher<T>
```

Iterables

```
everyItem(Matcher<U>)                   : Matcher<Iterable<U>>

hasItem(T)
hasItem(Matcher<? super T>)  : Matcher<Iterable<? super T>>

hasItems(T...)
hasItems(Matcher<? super T>...)     : Matcher<Iterable<T>>

emptyIterable()            : Matcher<Iterable<? extends E>>
emptyIterableOf(Class<E>)           : Matcher<Iterable<E>>

contains(E...)
contains(Matcher<? super E>...)
contains(Matcher<? super E>)
contains(List<Matcher<? super E>>)
                           : Matcher<Iterable<? extends E>>

containsInAnyOrder(T...)
containsInAnyOrder(Collection<Matcher<? super T>>)
containsInAnyOrder(Matcher<? super T>...)
containsInAnyOrder(Matcher<? super E>)
                           : Matcher<Iterable<? extends E>>

iterableWithSize(Matcher<? super Integer>)
iterableWithSize(int)               : Matcher<Iterable<E>>
```

Basic example test

```
@Test
public void changeText_sameActivity() {
    // 1: Find view by id
    onView(withId(R.id.editTextUserInput))

    // 2: Perform action-type string and click button
    .perform(typeText(mStringToBeTyped), closeSoftKeyboard());

    onView(withId(R.id.changeTextButton)).perform(click());

    // 3: Check that the text was changed
    onView(withId(R.id.textToBeChanged))
        .check(matches(withText(mStringToBeTyped)));
}
```


Finding views with onView

withId() - find a view with the specified Android id

```
onView(withId(R.id.editTextUserInput))
```

withText() - find a view with specific text

```
onView(withText("Espresso"))
```

onView returns ViewInteraction object

If you need to reuse the `View` returned by `onView`

Make code more readable or explicit

`check()` and `perform()` methods

```
ViewInteraction textView = onView(
    allOf(withId(R.id.word), withText("Clicked! Word 15"),
isDisplayed()));
textView.check(matches(withText("Clicked! Word 15 ")));
```


Perform actions

Perform an action on the `View` found by a `ViewMatcher`

Can be any action you can perform on the `View`

```
// 1: Find view by id
onView(withId(R.id.editTextUserInput))
// 2: Perform action - type string and click button
.perform(typeText(mStringToBeTyped), closeSoftKeyboard());
onView(withId(R.id.changeTextButton)).perform(click());
```

Check result

Asserts or checks the state of the View

```
// 3: Check that the text was changed
onView(withId(R.id.textToBeChanged))
    .check(matches(withText(mStringToBeTyped)));
```

ViewAssertion

Note: `check()` and `perform()` also returns ViewInteration object.

Cascading checks and actions

```
// check button is displayed, and then click the button
onView(withId(R.id.searchActionButton))
    .check(matches(isDisplayed()))
    .perfom(click(), closeSoftKeyboard());
```

When a test fails

Test

```
onView(withId(R.id.text_message))
    .check(matches(withText("This is a failing test.")));
```

Result snippet

```
androidx.test.espresso.base.DefaultFailureHandler$Assertion
FailedWithCauseError: 'with text: is "This is a failing test."'
does't match the selected view.
Expected: with text: is "This is a failing test."
Got: "AppCompatTextView{id=2131165359, res-name=text_message, …
```

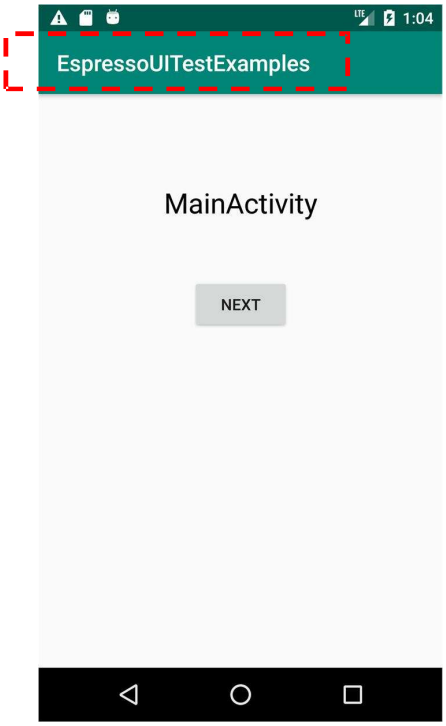

Access to the Instrumentation API

- Via the `ApplicationProvider.getApplicationContext()` you have access to the target context of your application.

```
@Test
public void buttonShouldUpdateText(){
    onView(withId(R.id.update)).perform(click());
    onView(withId(getResourceId("Click"))).check(matches(withText("Done")));
}

private static int getResourceId(String s) {
    Context targetContext = ApplicationProvider.getApplicationContext();
    String packageName = targetContext.getPackageName();
    return targetContext.getResources().getIdentifier(s, "id", packageName);
}
```

Combining Matchers



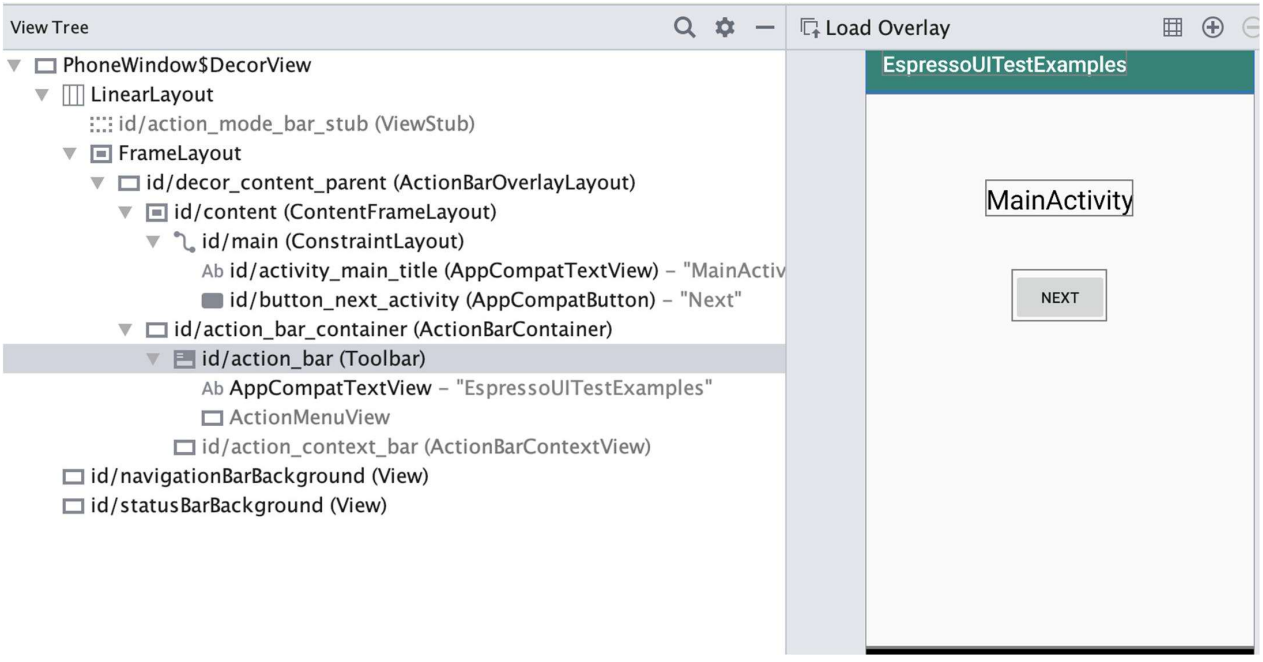
- **Example**: Find a visible list item with the given text:

  allOf() - find a view to that matches multiple conditions

```
onView(allOf(withId(R.id.word),
             withText("Clicked! Word 15"),
             isDisplayed()));
```

- **Another Example**: Toolbar title

Layout Inspector (Hierarchy Viewer)



Combining Matchers

```
@Test
public void testToolbarTitle() throws Exception {
    CharSequence title =
InstrumentationRegistry.getInstrumentation()
            .getTargetContext().getString(R.string.app_name);
    matchToolbarTitle(title);
}

private ViewInteraction matchToolbarTitle(CharSequence title) {
    return onView(
        allOf(
            isAssignableFrom(TextView.class),
            withParent(isAssignableFrom(Toolbar.class)))
        ).check(matches(withText(title.toString())));

}
```


Custom Matchers

```
private ViewInteraction matchToolbarTitle(CharSequence title) {
    return onView(allOf(isAssignableFrom(TextView.class),
                        withParent(isAssignableFrom(Toolbar.class))
           )).check(matches(withText(title.toString())));
}
```

```
private ViewInteraction matchToolbarTitle(CharSequence title) {
        return onView(isAssignableFrom(Toolbar.class))
                .check(matches(withToolbarTitle(is(title))));
}
```

Custom Matcher (using Toolbar.getTitle())

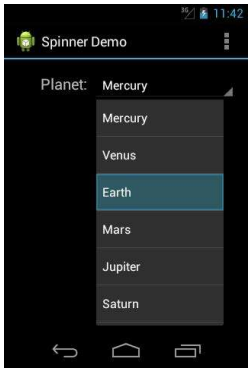
```
public static Matcher<View> withToolbarTitle(Matcher<CharSequence> textMatcher) {
    return new BoundedMatcher<View, Toolbar>(Toolbar.class) {
        @Override public boolean matchesSafely(Toolbar toolbar) {
            return textMatcher.matches(toolbar.getTitle().toString());
        }

        @Override public void describeTo(Description description) {
            description.appendText("with toolbar title: ");
            textMatcher.describeTo(description);
        }
    };
}

public static Matcher<View> withToolbarTitle(CharSequence title) {
    return withToolbarTitle(is(title));
}
```

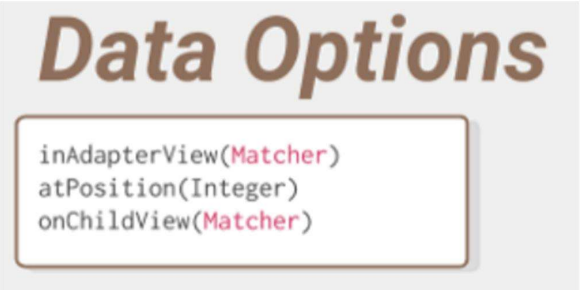

Adapter Views

- Use **`onData()`** instead of `onView()` when working with **AdapterViews**.
  - `ListView`, `GridView` and `Spinner`



Formula

```
onData(ObjectMatcher)
      .dataOptions
      .perform(ViewAction)
      .check(ViewAssertion)
```



- If you are using an **AdapterView**, use the `onData()` instead of `onView()`.
- The `onData()` method returns an object of type **DataInteraction**.

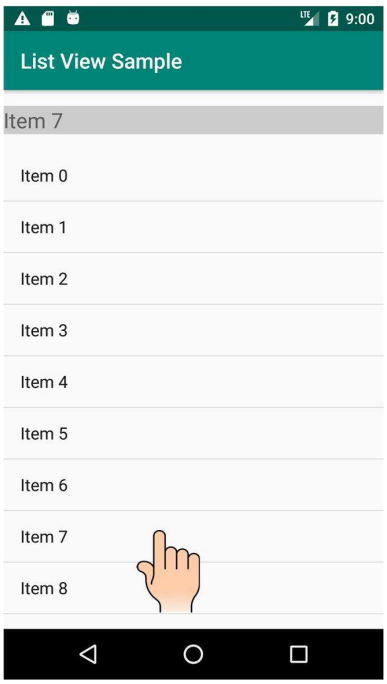
App

```
TextView textMsg = findViewById(R.id.textMsg);
textMsg.setBackgroundColor(Color.LTGRAY);
textMsg.setVisibility(View.GONE);
ListView listView = findViewById(R.id.myList);

String[] items = new String[COUNT];
for (int i = 0; i < COUNT; i++) {
    items[i] = "Item " + i;
}

listView.setAdapter(new ArrayAdapter<>(this,
        android.R.layout.simple_list_item_1,
items));

listView.setOnItemClickListener(
    (parent, view, position, id) -> {
        textMsg.setText(items[position]);
        textMsg.setVisibility(View.VISIBLE);
});
```

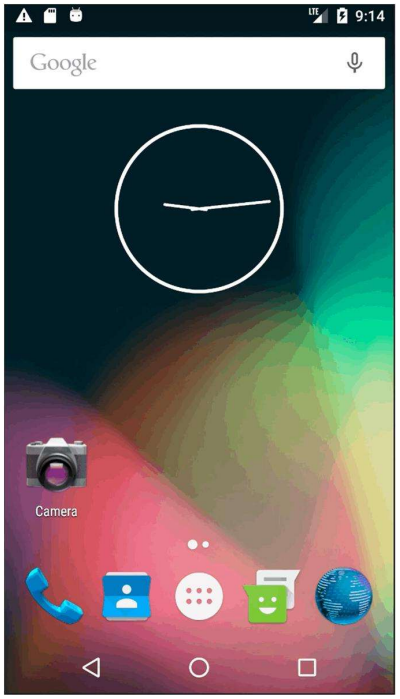


Test

```
onView(withId(R.id.textMsg))
    .check(matches(not(isDisplayed())));

// select view with text "Item 15"
onData(is("Item 15"))
    .inAdapterView(withId(R.id.myList))
    .perform(click());
// or …
// onData(allOf(is(instanceOf(String.class)),
//              is("Item 15"))).perform(click());

onView(withId(R.id.textMsg))
    .check(matches(withText("Item 15")))
    .check(matches(isDisplayed());
```



Useful Data Interactions

```
onData(withBookTitle("Effective Java"))
    .inAdapterView(allOf(
         isAssignableFrom(AdapterView.class),
         isDisplayed()))
    .perform(click());


onData(anything()).atPosition(2).perform(click());


onData(withBookTitle("Espresso Tutorial"))
    .onChildView(withId(R.id.book_delete)).perform(click());
```

Custom Data Matchers

```
public static Matcher<Object> withBookTitle(final String bookTitle)
{
    return new BoundedMatcher<Object, Book>(Book.class) {
        @Override
        protected boolean matchesSafely(Book book) {
            return bookTitle.equals(book.getTitle());
        }

        @Override
        public void describeTo(Description description) {
            description.appendText("with title: " + bookTitle);
        }
    };
}
```


Recycler Views

- You cannot use `onData()` for `RecyclerView`.
- Use **`onView`**(*`R.id.recyclerview_id`*) together with **`RecyclerViewActions`**.

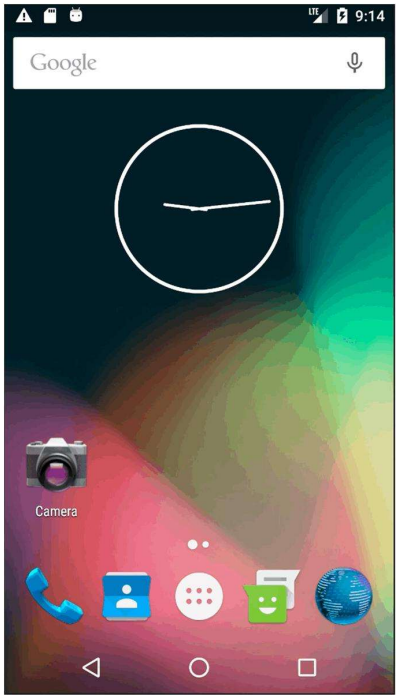
java.lang.Object
↳ android.view.View
↳ android.view.ViewGroup
↳ androidx.recyclerview.widget.RecyclerView

RecyclerViewActions

```
onView(withId(R.id.textMsg))
  .check(matches(not(isDisplayed())));

// select view at position 15
onView(withId(R.id.recycler_view))
  .perform(
    RecyclerViewActions.actionOnItemAtPosition(
        15, click())
  );

onView(withId(R.id.textMsg))
    .check(matches(withText("Item 15")))
    .check(matches(isDisplayed());
```

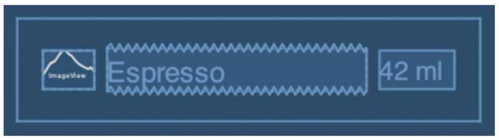


RecyclerViewActions (espresso-contrib)

- actionOnItemAtPosition(*int*, *ViewAction*)
- actionOnItem(*Matcher<View>*, *ViewAction*)
- scrollToPosition(*int*)
- scrollTo(*Matcher<View>*)
- actionOnHolderItem(*Matcher<ViewHolder>*, *ViewAction*)
- scrollToHolder(*Matcher<ViewHolder>*)

Comments on `actionOnItem()`

- You have to create a matcher that matches the **whole item**.




```
onView(withId(R.id.RecyclerView))
  .perform(actionOnItem(withText("Espresso"), click()));
```

```
onView(withId(R.id.RecyclerView))
   .perform(actionOnItem(hasDescendant(withText("Espresso")),
click()));
```

Mocking intents with Espresso Intents

- Espressos intents is provided by the com.android.support.test.espresso:espresso-intents library.
- Use the IntentsTestRule instead of ActivityTestRule.

```
androidTestCompile 'com.android.support.test.espresso:espresso-intent
s:2.2.1'
```

(1) Intent Stub

Intending(Matcher<Intent> matcher)

- A fake response to an intent call during a test.

  Intending(Matcher<Intent> matcher)

1. *@Rule* - **IntentsTestRule**
2. *@before* - stubbing an intent must be set up and we need to make sure all external intents are blocked. In android 6 (M) and later on we also need to grant for permission.
3. *@Test*

```
intending(hasComponent(hasShortClassName(".ContactsActivity")))
    .respondWith(new ActivityResult(Activity.RESULT_OK,
            ContactsActivity.createResultData(VALID_PHONE_NUMBER)));
```


(2) Intent Verification

- Make sure that the information that was intended to be sent was what actually sent, by using a hardcoded matcher.

  intended(*Matcher<Intent> matcher,*
  VerificationMode verification)

- @Test

```
intended(allOf(hasAction(Intent.ACTION_CALL),
               hasData(INTENT_DATA_PHONE_NUMBER),
               toPackage(PACKAGE_ANDROID_DIALER)));
```

IdlingResource Basics

On each time invocation of **onView()** or **onData()**, Espresso waits until the following synchronization conditions are met:

1. The message queue is empty.
2. There are no instances of **AsyncTask** currently executing a task.
3. All developer-defined idling resources are idle.

Espresso doesn't know about:

- Animations
- Background operations
- Other mechanisms to schedule updates
  - For example, Data Binding uses the Choreographer to post updates instead of the main Looper queue (what Espresso monitors).

Registration and Unregistration

```
@Before
public void registerIdlingResource() {
    ...
    IdlingRegistry.getInstance().register(myIdlingResource);
}

@After
public void unregisterIdlingResource() {
    ...
    IdlingRegistry.getInstance().unregister(myIdlingResource);
}
```

```
dependencies {
    implementation "androidx.test.espresso:espresso-idling-resource:3.2.0"
}
```


IdlingResource Basics

The common use cases in which **IdlingResource** can be used are when your app is:

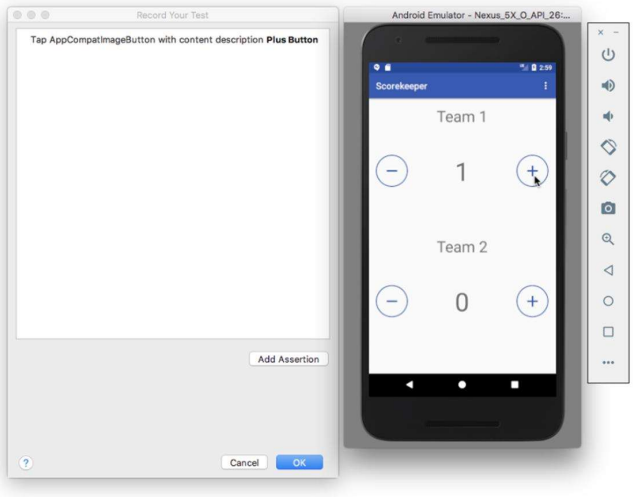
- **Loading data** from the internet or a local data source.
- **Establishing connections** with databases and callbacks.
- **Managing services**, either using a system service or an instance of `IntentService`.
- **Performing complex business logic**, such as bitmap transformations.

It is important to register **IdlingResource** when these operations update the application UI you would like to further validate.

Recording Tests

Start recording an Espresso test

1. **Run > Record Espresso Test**
2. Click **Restart app**, select target, and click **OK**
3. Interact with the app to do what you want to test



Add assertion to Espresso test recording

4. Click **Add Assertion** and select a UI element
5. Choose **text is** and enter the text you expect to see
6. Click **Save Assertion** and click **Complete Recording**