Lab 03
Android layout

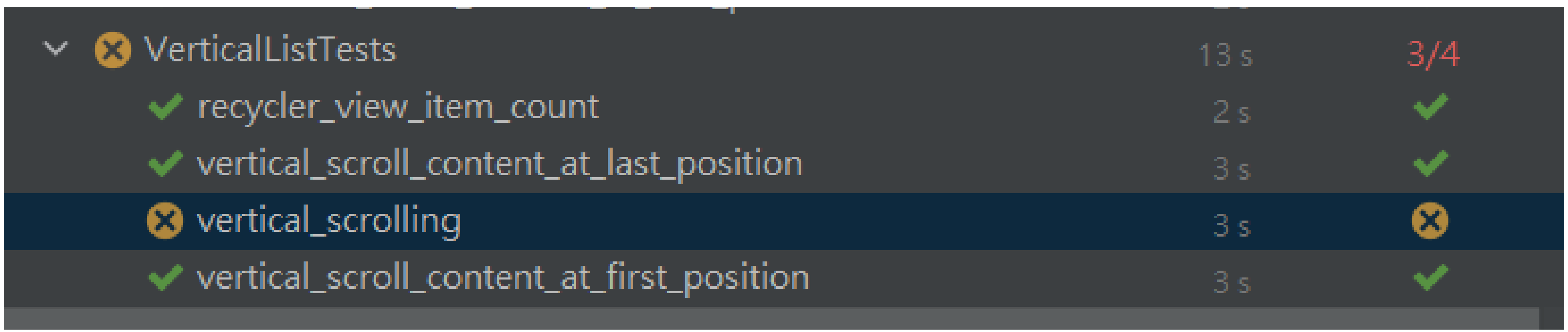
Software Studio

DataLab, CS, NTHU

2022 spring

Some concerns

- Don’t worry about it.

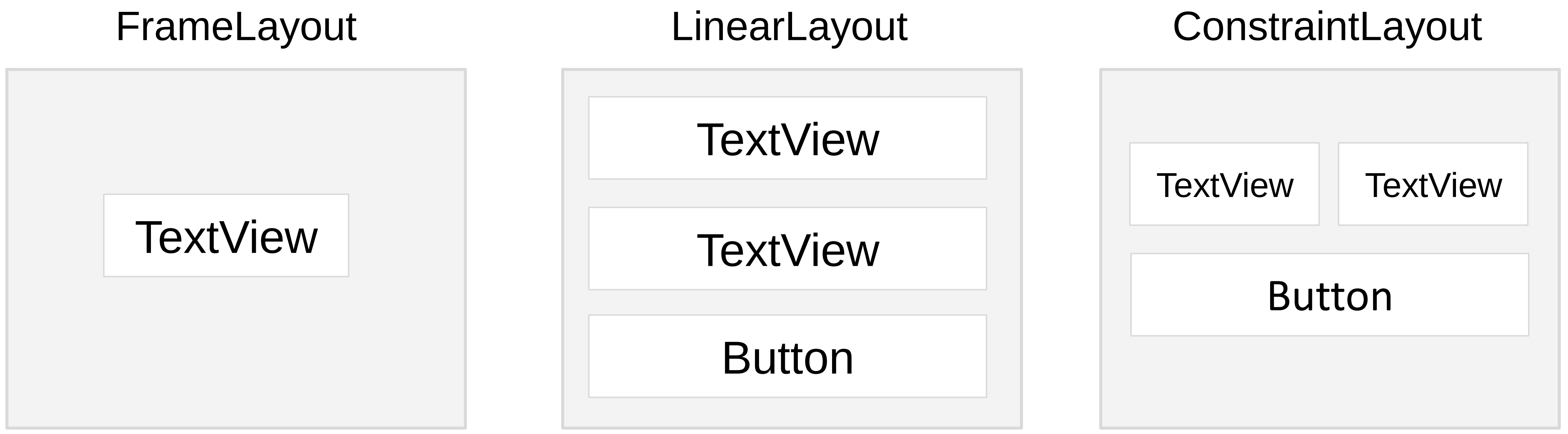


```
✗ VerticalListTests                          13 s   3/4
    ✓ recycler_view_item_count                 2 s   ✓
    ✓ vertical_scroll_content_at_last_position 3 s   ✓
    ✗ vertical_scrolling                       3 s   ✗
    ✓ vertical_scroll_content_at_first_position 3 s  ✓
```

Layouts

ViewGroups

A `ViewGroup` is a container that determines how views are displayed.

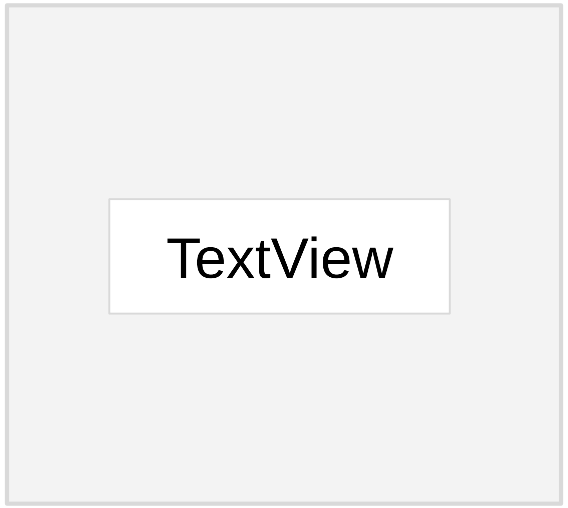


The ViewGroup is the parent and the views inside it are its children.

FrameLayout example

A `FrameLayout` generally holds a single child `View`.

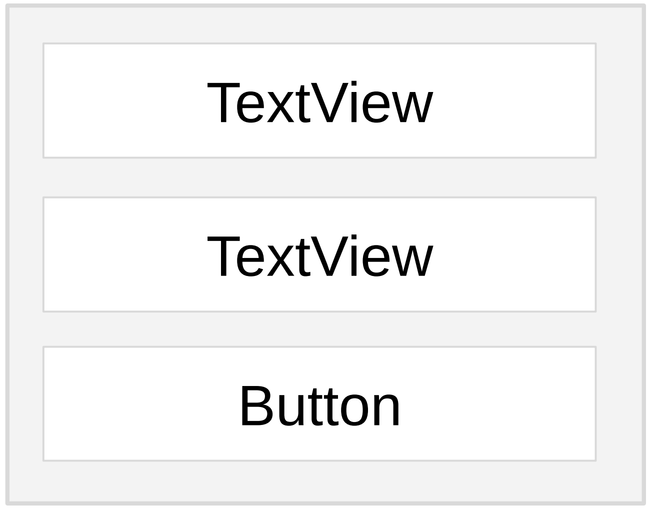
```
<FrameLayout
   android:layout_width="match_parent"
   android:layout_height="match_parent">
   <TextView
       android:layout_width="match_parent"

android:layout_height="match_parent"
       android:text="Hello World!"/>
</FrameLayout>
```



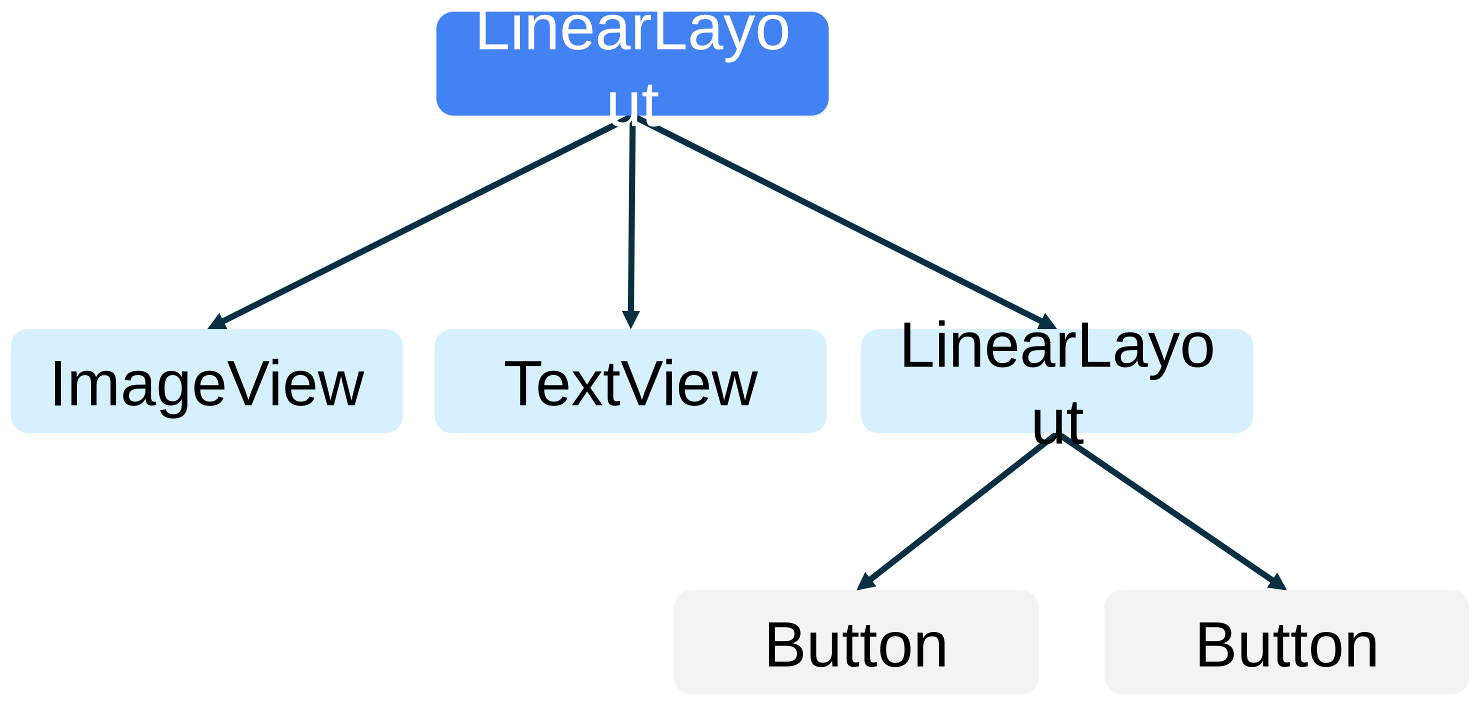
LinearLayout example

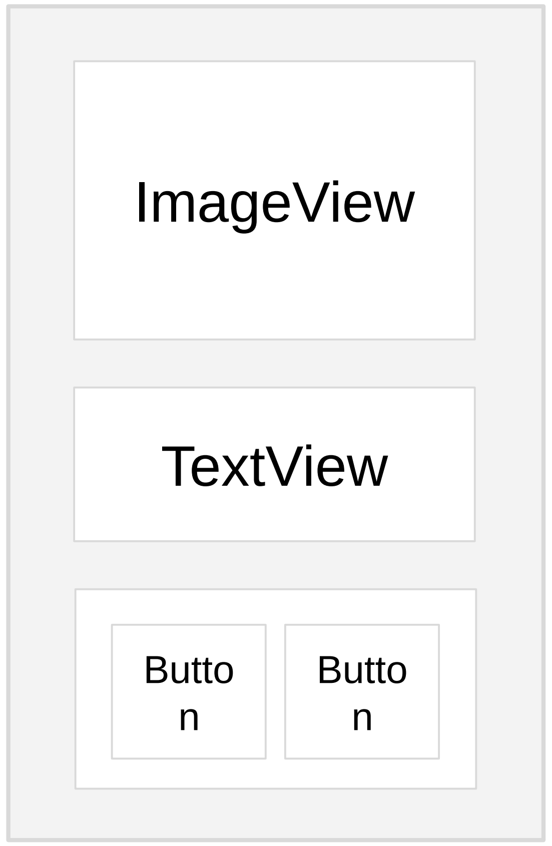
- Aligns child views in a row or column
- Set `android:orientation` to `horizontal` or `vertical`

```
<LinearLayout
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:orientation="vertical">
    <TextView ... />
    <TextView ... />
    <Button ... />
</LinearLayout>
```



View hierarchy





Common resource directories

Add resources to your app by including them in the appropriate resource directory under the parent `res` folder.

```
main
├── java
└── res
    ├── drawable
    ├── layout
    ├── mipmap
    └── values
```

Resource IDs

- Each resource has a resource ID to access it.
- When naming resources, the convention is to use all lowercase with underscores (for example, `activity_main.xml`).
- Android autogenerates a class file named `R.java` with references to all resources in the app.
- Individual items are referenced with: `R.<resource_type>.<resource_name>`

Examples:

```
R.drawable.ic_launcher (res/drawable/ic_launcher.xml)
R.layout.activity_main (res/layout/activity_main.xml)
```

Resource IDs for views

Individual views can also have resource IDs.

Add the `android:id` attribute to the View in XML. Use `@+id/name` syntax.

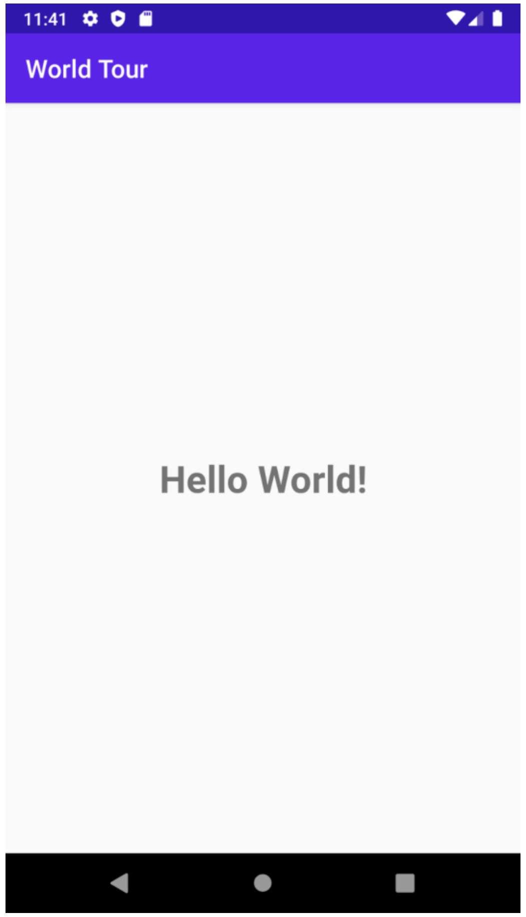
```
<TextView
     android:id="@+id/helloTextView"
     android:layout_width="wrap_content"
     android:layout_height="wrap_content"
     android:text="Hello World!"/>
```

Within your app, you can now refer to this specific TextView using:

`R.id.helloTextView`

Activities

What's an Activity?

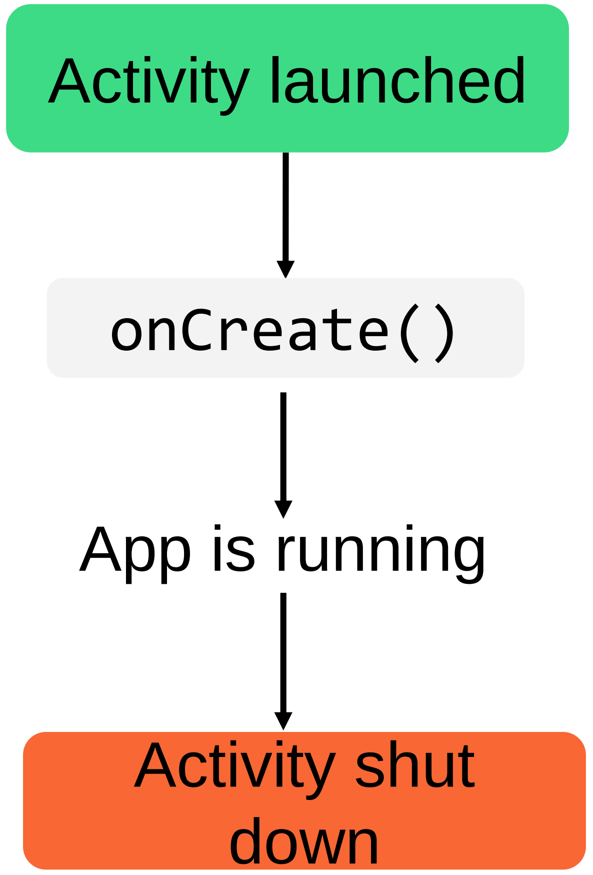


- An Activity is a means for the user to accomplish one main goal.
- An Android app is composed of one or more activities.

MainActivity.kt

```kotlin
class MainActivity : AppCompatActivity() {

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

How an Activity runs

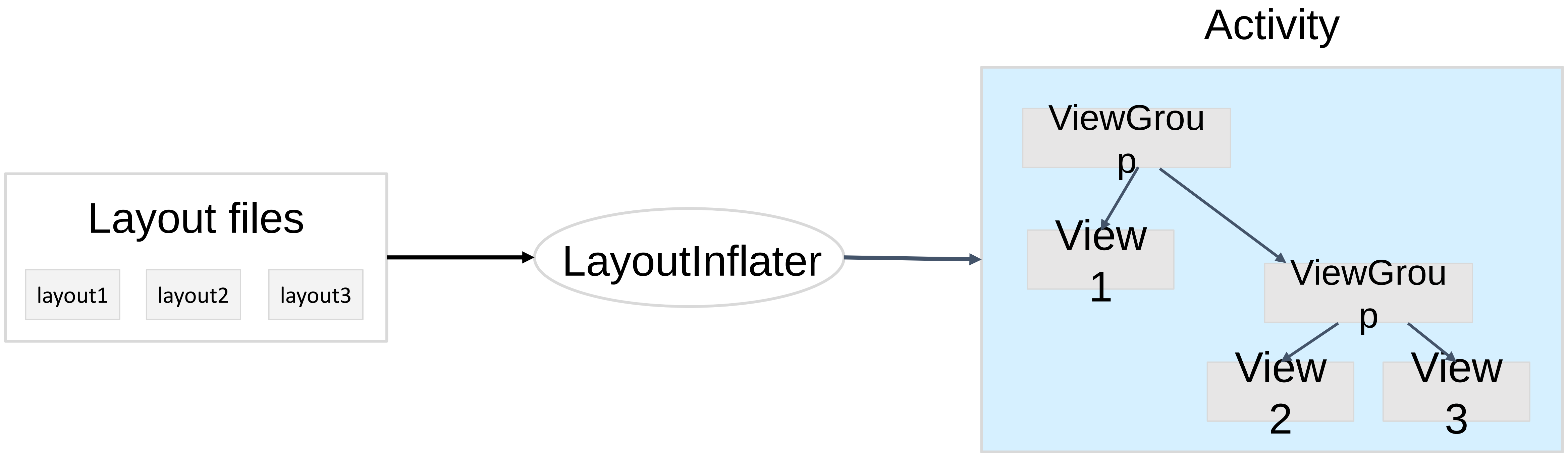


Implement the onCreate() callback

Called when the system creates your Activity

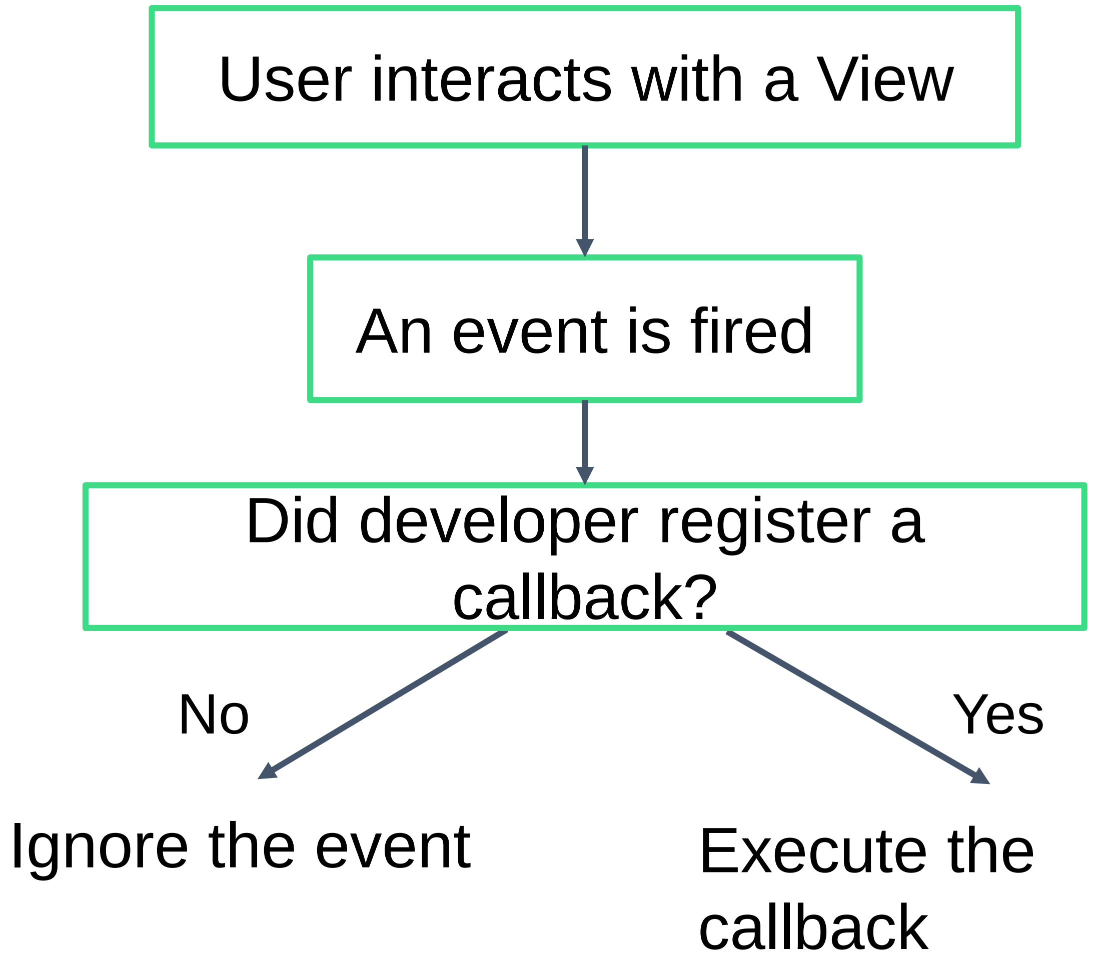
```
override fun onCreate(savedInstanceState: Bundle?) {
    super.onCreate(savedInstanceState)
    setContentView(R.layout.activity_main)
}
```

Layout inflation



Make an app interactive

Set up listeners for specific events


User interacts with a View
An event is fired
Did developer register a callback?
No
Yes
Ignore the event
Execute the callback

View.OnClickListener

```
class MainActivity : AppCompatActivity(), View.OnClickListener {

   override fun onCreate(savedInstanceState: Bundle?) {
       ...
       val button: Button = findViewById(R.id.button)
       button.setOnClickListener(this)
   }

   override fun onClick(v: View?) {
       TODO("not implemented")
   }
}
```

SAM (single abstract method)

Converts a function into an implementation of an interface

Format: `InterfaceName { lambda body }`

```
val runnable = Runnable { println("Hi there") }
```

is equivalent to

```
val runnable = (object: Runnable {
    override fun run() {
        println("Hi there")
    }
})
```

View.OnClickListener as a SAM

A more concise way to declare a click listener

```
class MainActivity : AppCompatActivity() {

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

       val button: Button = findViewById(R.id.button)
       button.setOnClickListener({ view -> /* do something*/ })
   }
}
```

https://developer.android.com/reference/kotlin/android/view/View.OnClickListener

Late initialization

```
class Student(val id: String) {

    lateinit var records: HashSet<Any>

    init {
        // retrieve records given an id
    }
}
```

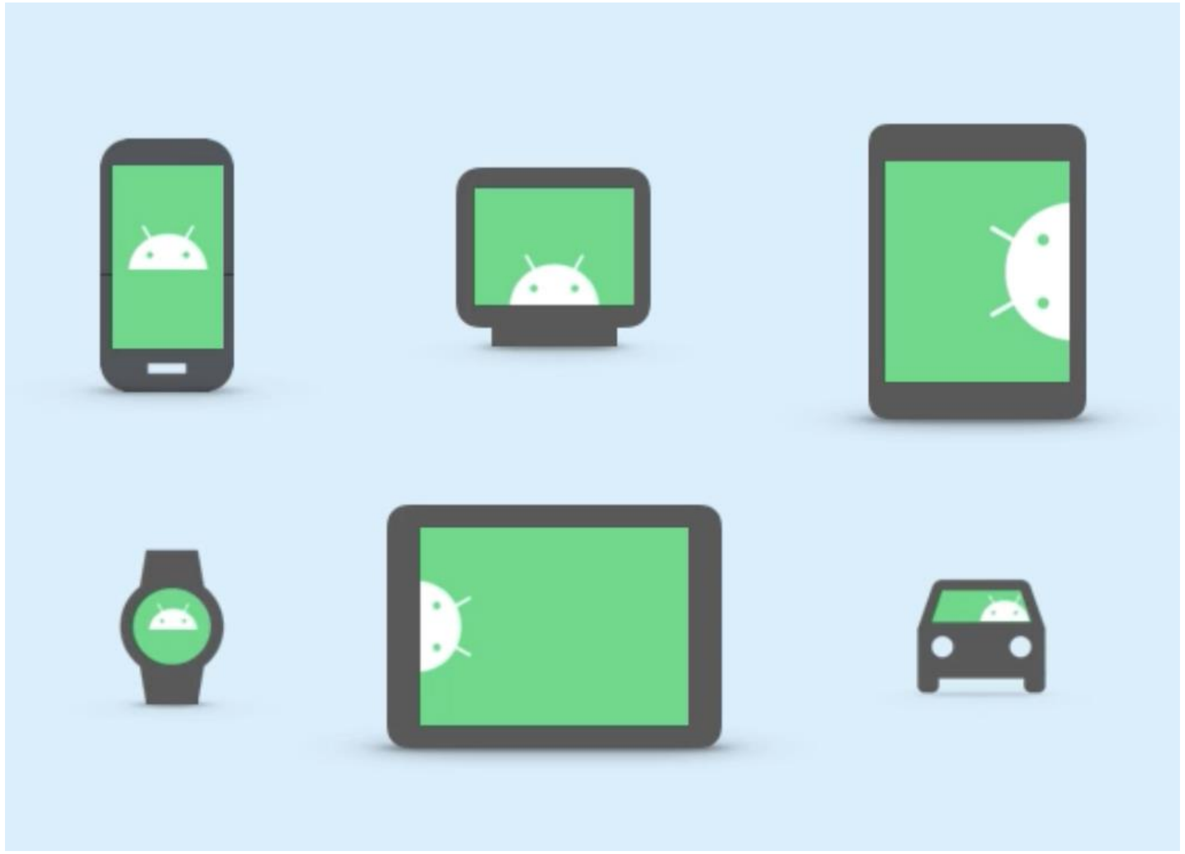
Lateinit example in Activity

```kotlin
class MainActivity : AppCompatActivity() {

    lateinit var result: TextView

    override fun onCreate(savedInstanceState: Bundle?) {
        ...
        result = findViewById(R.id.result_text_view)
    }
}
```

Layouts in Android

Android devices

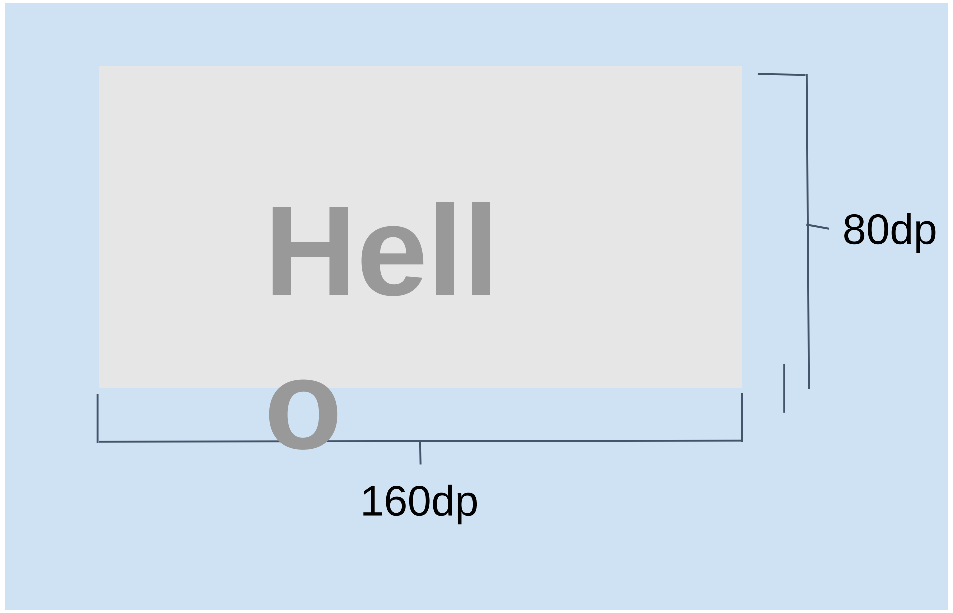
- Android devices come in many different form factors.
- More and more pixels per inch are being packed into device screens.
- Developers need the ability to specify layout dimensions that are consistent across devices.



Density-independent pixels (dp)

Use dp when specifying sizes in your layout, such as the width or height of views.

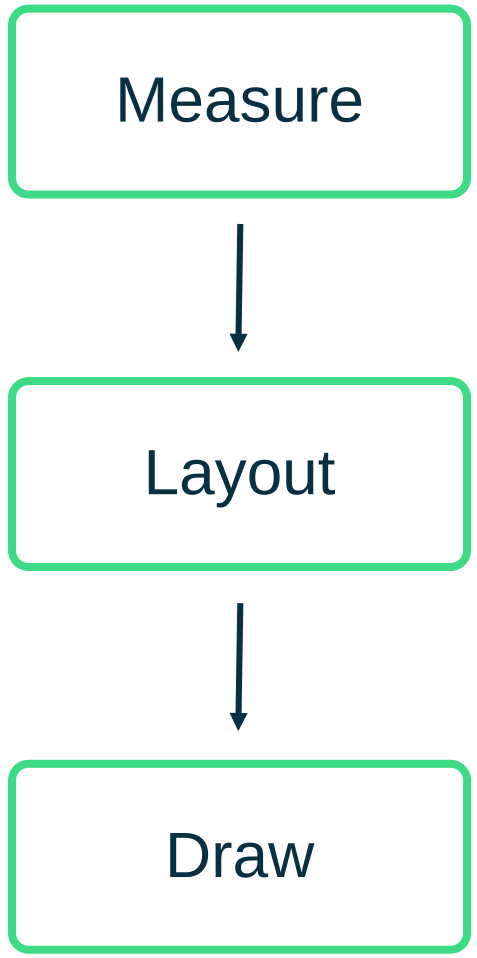
- Density-independent pixels (dp) take screen density into account.
- Android views are measured in density-independent pixels.
- $$\text{dp} = \frac{\text{(width in pixels * 160)}}{\text{screen density}}$$



Screen-density buckets

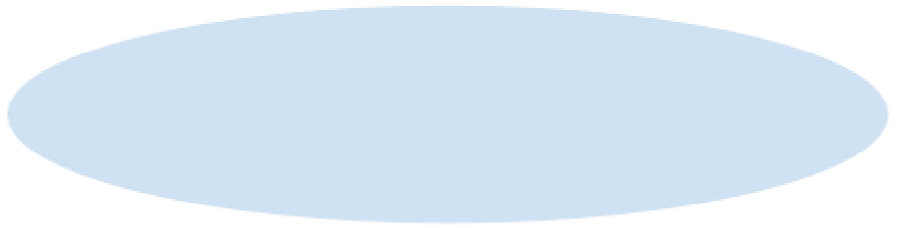
Density qualifier	Description	DPI estimate
ldpi (mostly unused)	Low density	~120dpi
mdpi (baseline density)	Medium density	~160dpi
hdpi	High density	~240dpi
xhdpi	Extra-high density	~320dpi
xxhdpi	Extra-extra-high density	~480dpi
xxxhdpi	Extra-extra-extra-high density	~640dpi

Android View rendering cycle

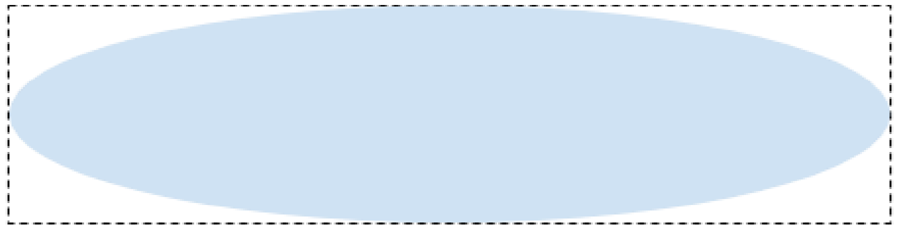


Drawing region

What we see:

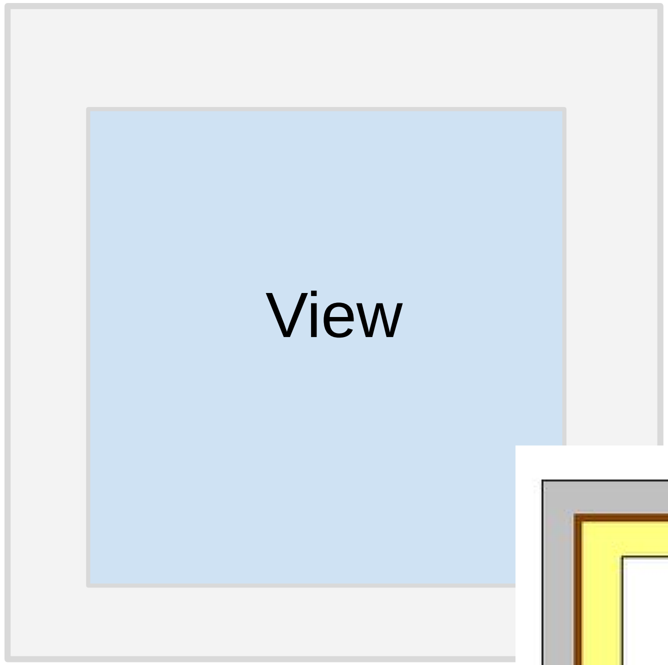


How it's drawn:

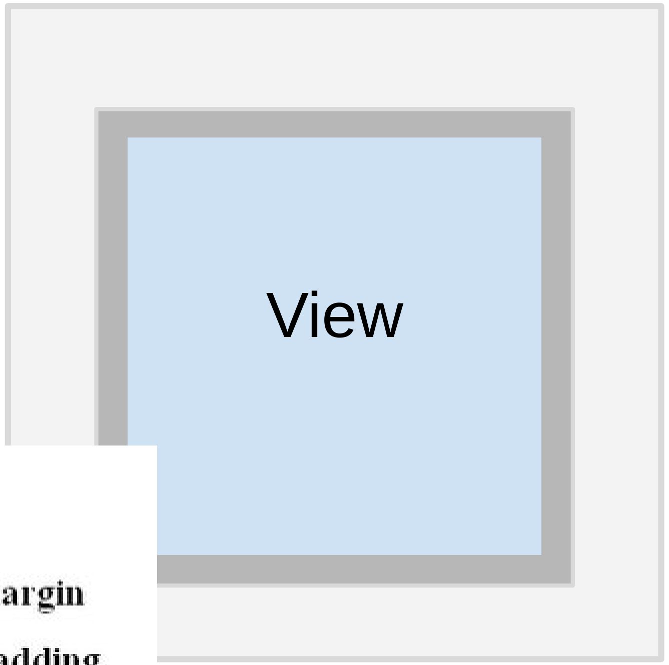


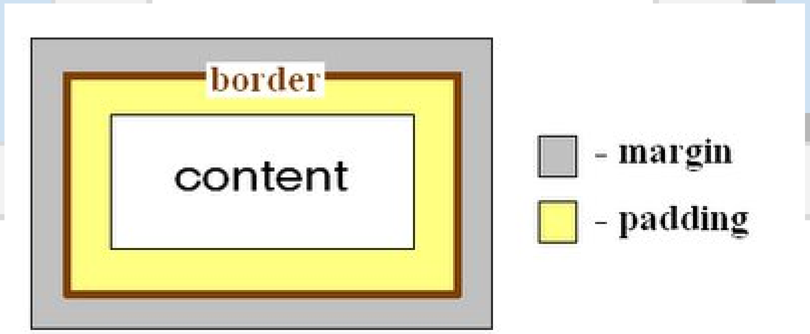
View margins and padding

View with margin

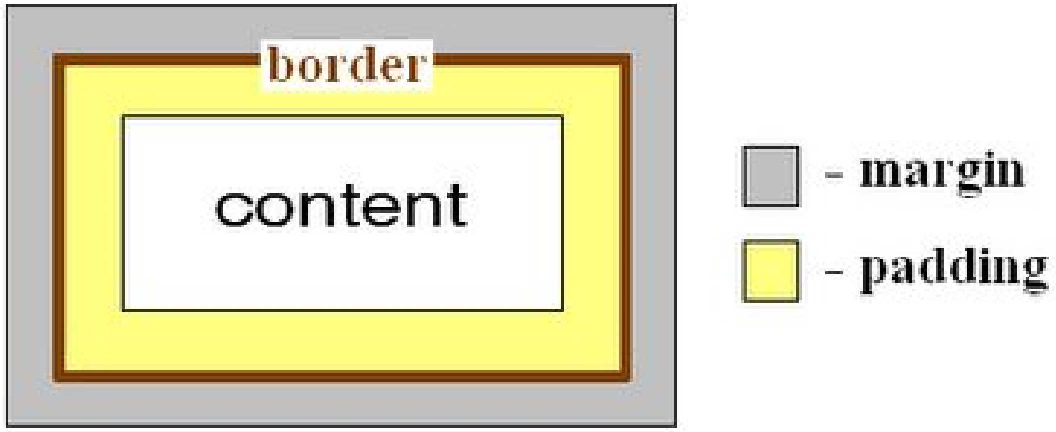


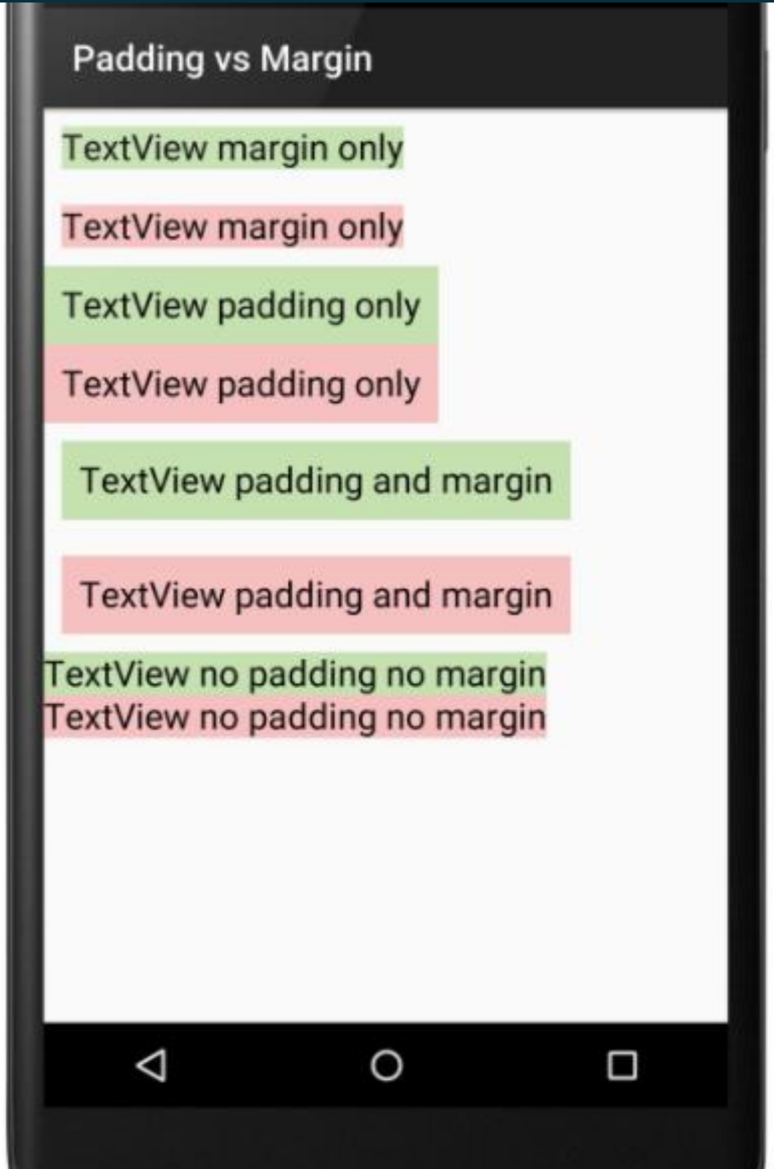
View with margin and padding





View margins and padding





TextView margin only
TextView margin only
TextView padding only
TextView padding only
TextView padding and margin
TextView padding and margin
TextView no padding no margin
TextView no padding no margin

ConstraintLayout

Deeply nested layouts are costly

- Deeply nested ViewGroups require more computation
- Views may be measured multiple times
- Can cause UI slowdown and lack of responsiveness

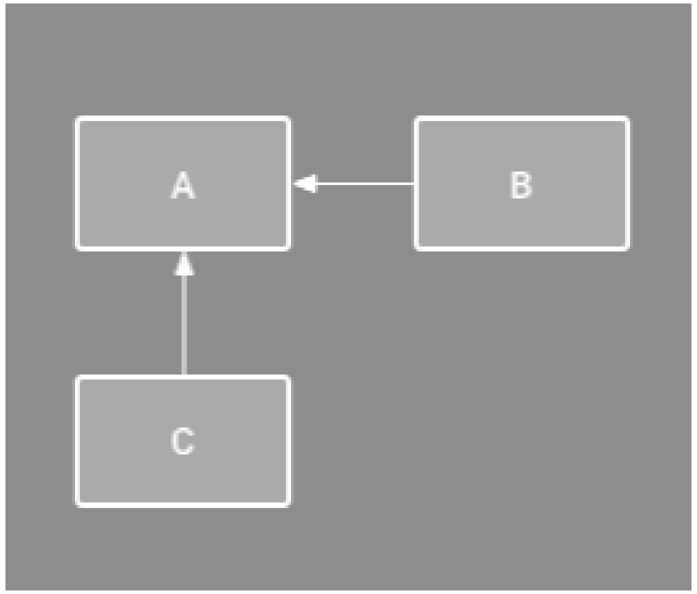
Use ConstraintLayout to avoid some of these issues!

What is ConstraintLayout?

- Recommended default layout for Android
- Solves costly issue of too many nested layouts, while allowing complex behavior
- Position and size views within it using a set of constraints

What is a constraint?

A restriction or limitation on the properties of a View that the layout attempts to respect

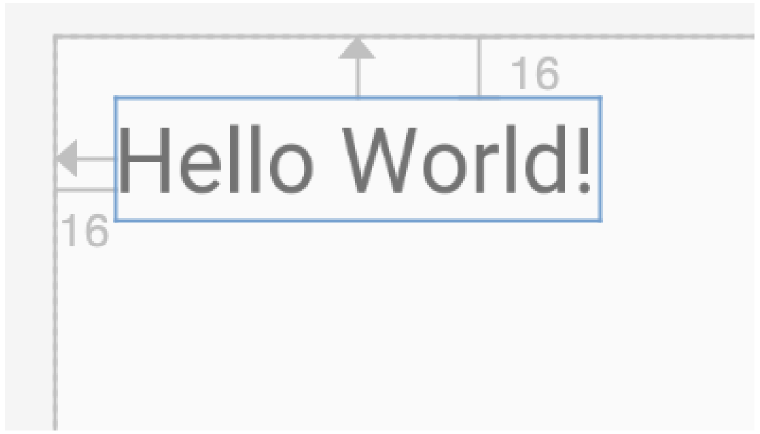


Relative positioning constraints

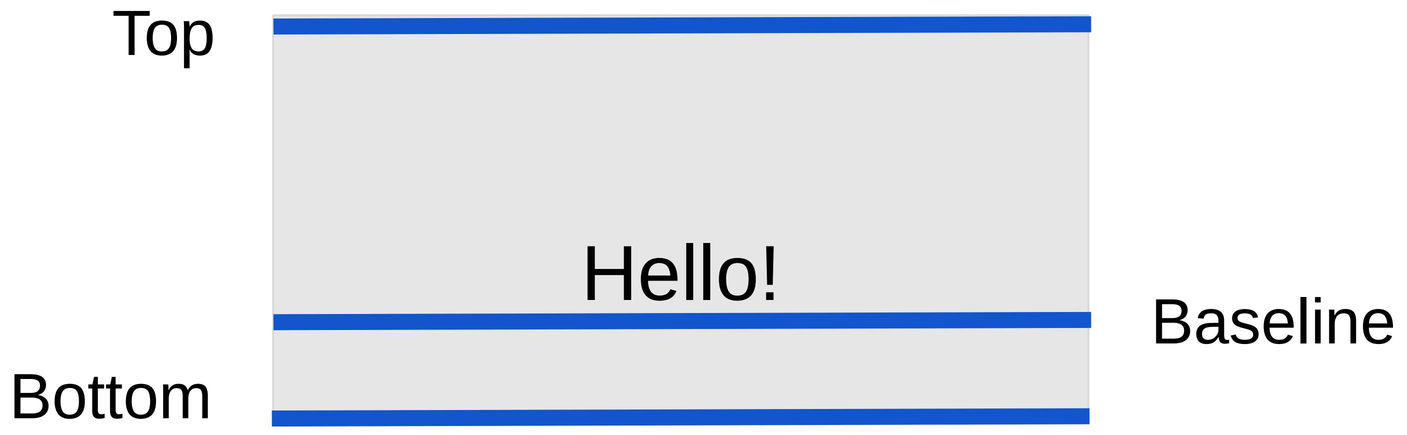
Can set up a constraint relative to the parent container

Format: `layout_constraint<`**`SourceConstraint`**`>_to<`**`TargetConstraint`**`>Of`

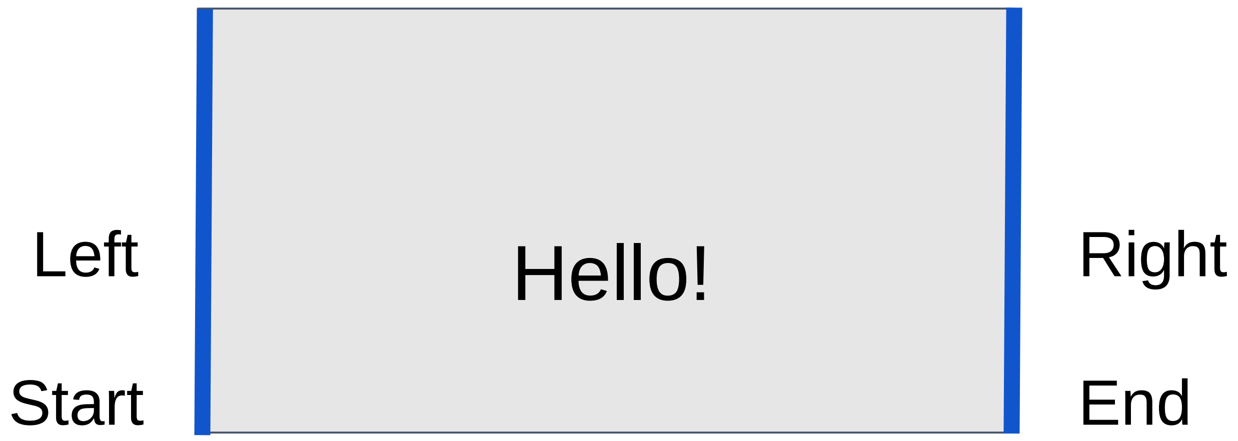
```
Example attributes on a TextView:
app:layout_constraintTop_toTopOf="parent"
app:layout_constraintLeft_toLeftOf="parent"
```



Relative positioning constraints

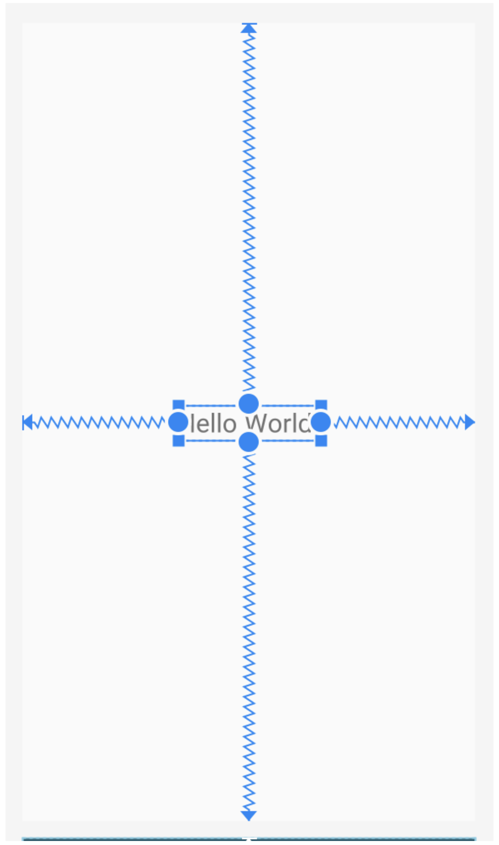


Relative positioning constraints



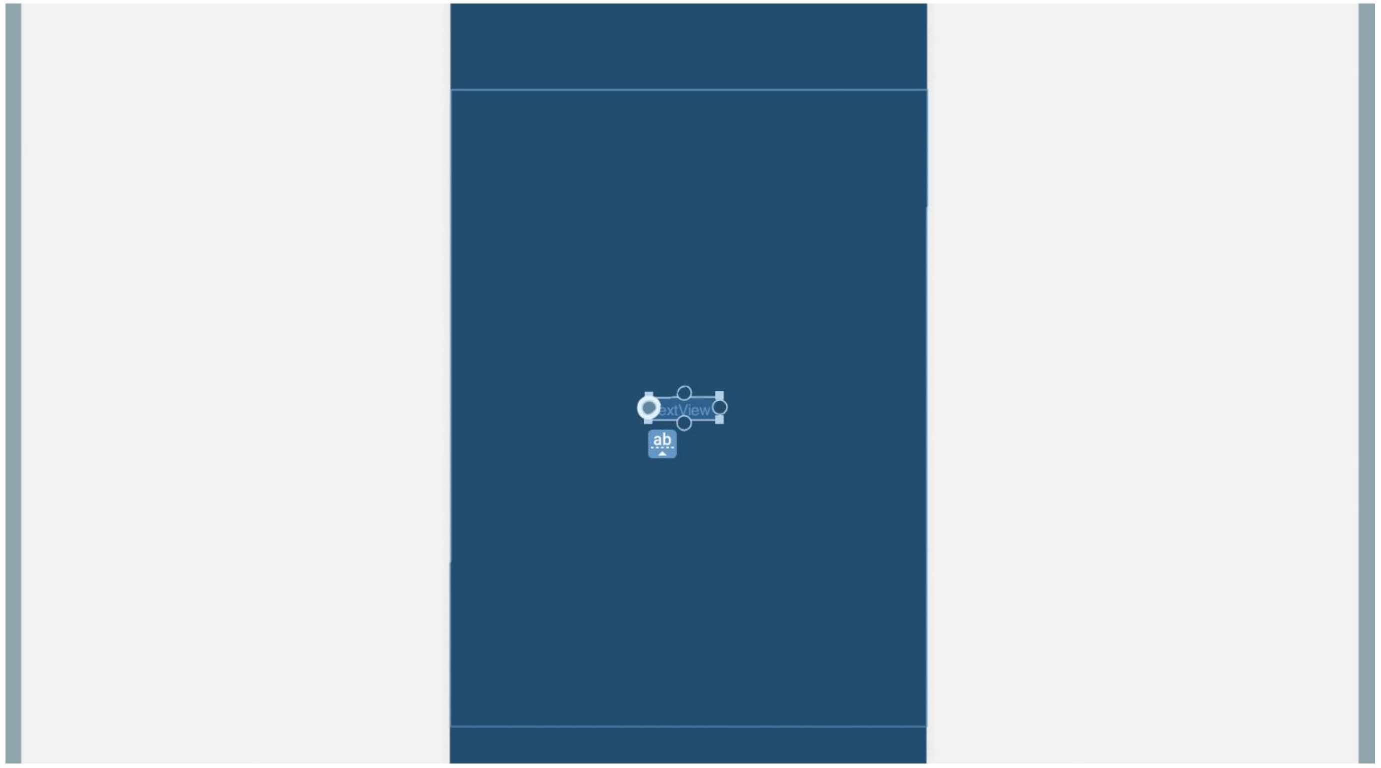
Simple ConstraintLayout example

```
<androidx.constraintlayout.widget.ConstraintLayout
    android:layout_width="match_parent"
    android:layout_height="match_parent">

    <TextView
        ...

app:layout_constraintBottom_toBottomOf="parent"
        app:layout_constraintEnd_toEndOf="parent"
        app:layout_constraintStart_toStartOf="parent"
        app:layout_constraintTop_toTopOf="parent" />

</androidx.constraintlayout.widget.ConstraintLayout>
```



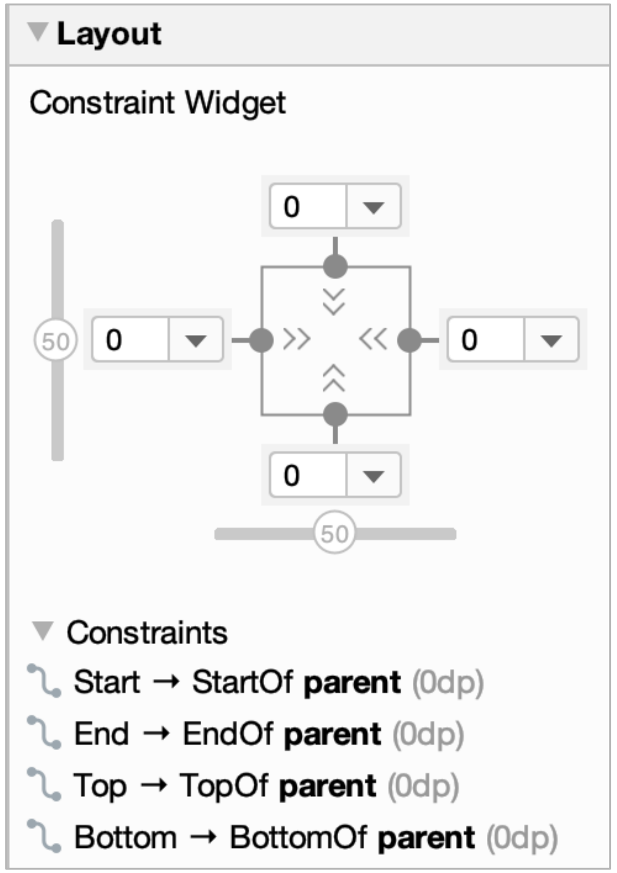
Layout Editor in Android Studio

You can click and drag to add constraints to a View.



Constraint Widget in Layout Editor

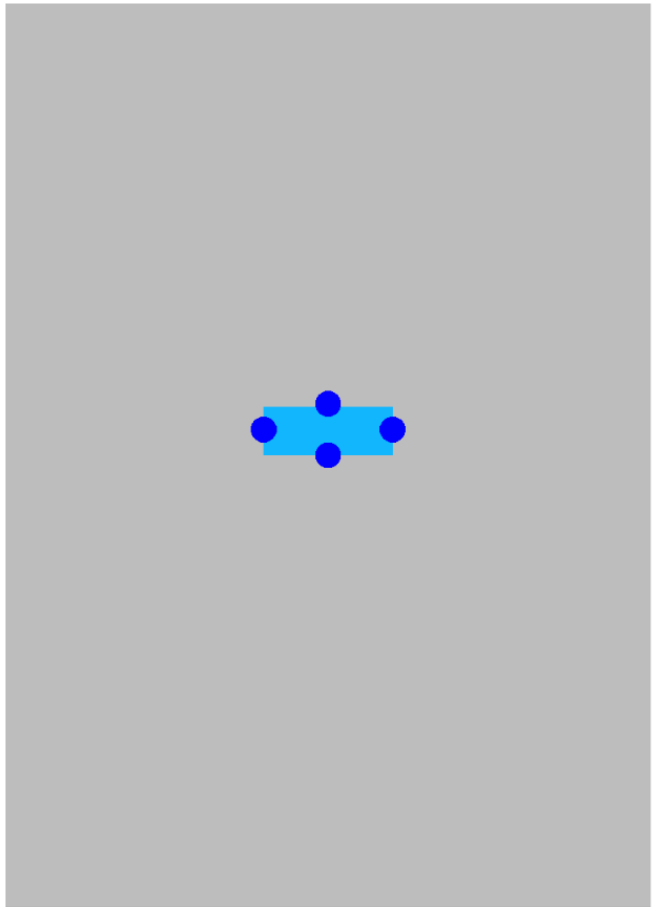
⊢⊣	Fixed
>>>	Wrap content
⊢⩘⊣	Match constraints

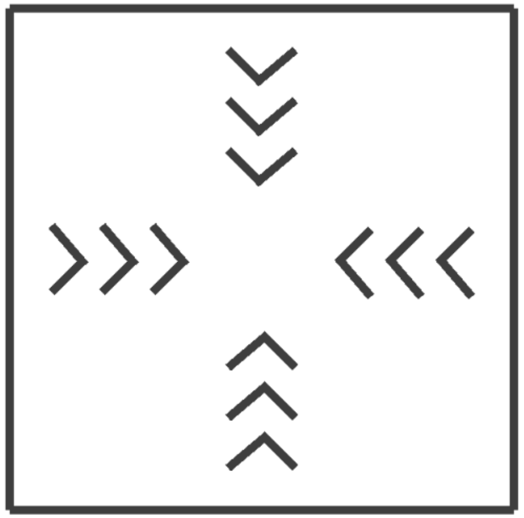


Constraints

- Start → StartOf **parent** (0dp)
- End → EndOf **parent** (0dp)
- Top → TopOf **parent** (0dp)
- Bottom → BottomOf **parent** (0dp)

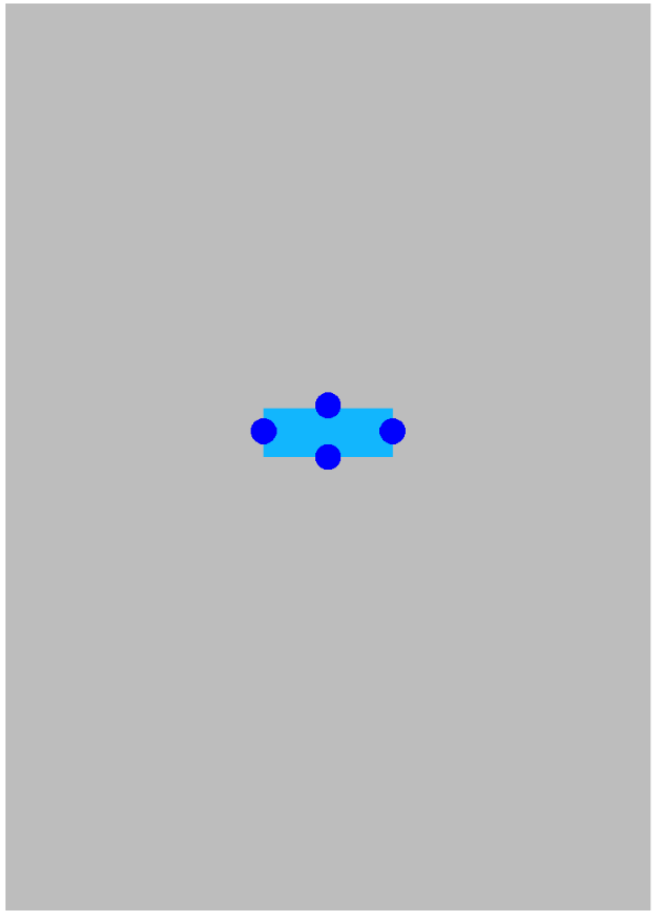
Wrap content for width and height

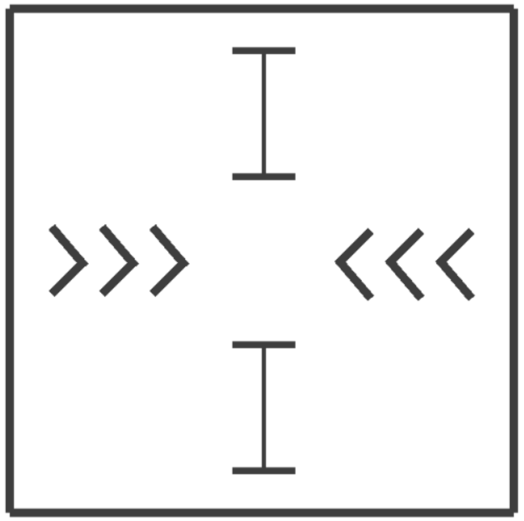




layout_width	wrap_content
layout_height	wrap_content

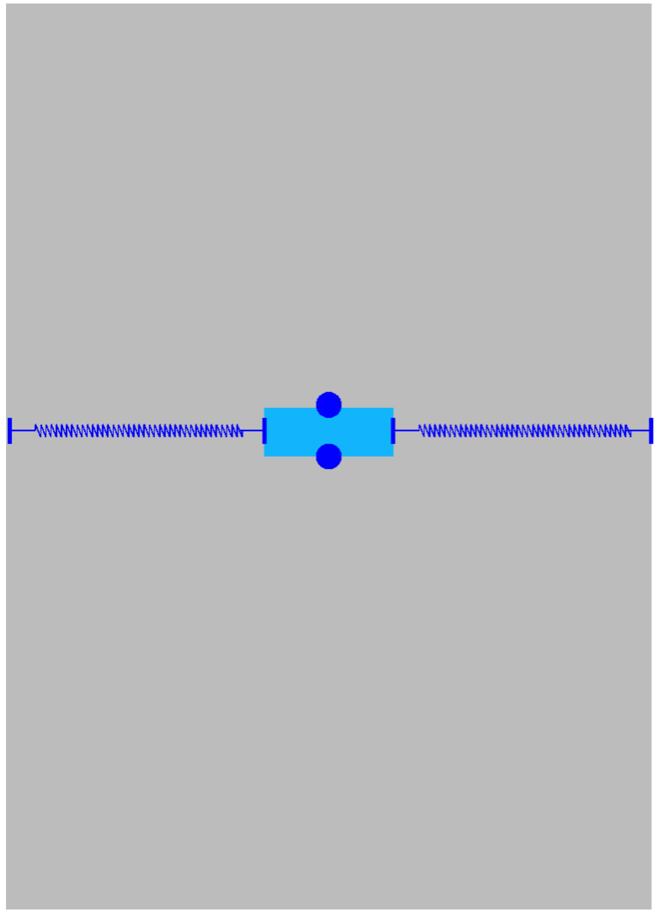
Wrap content for width, fixed height

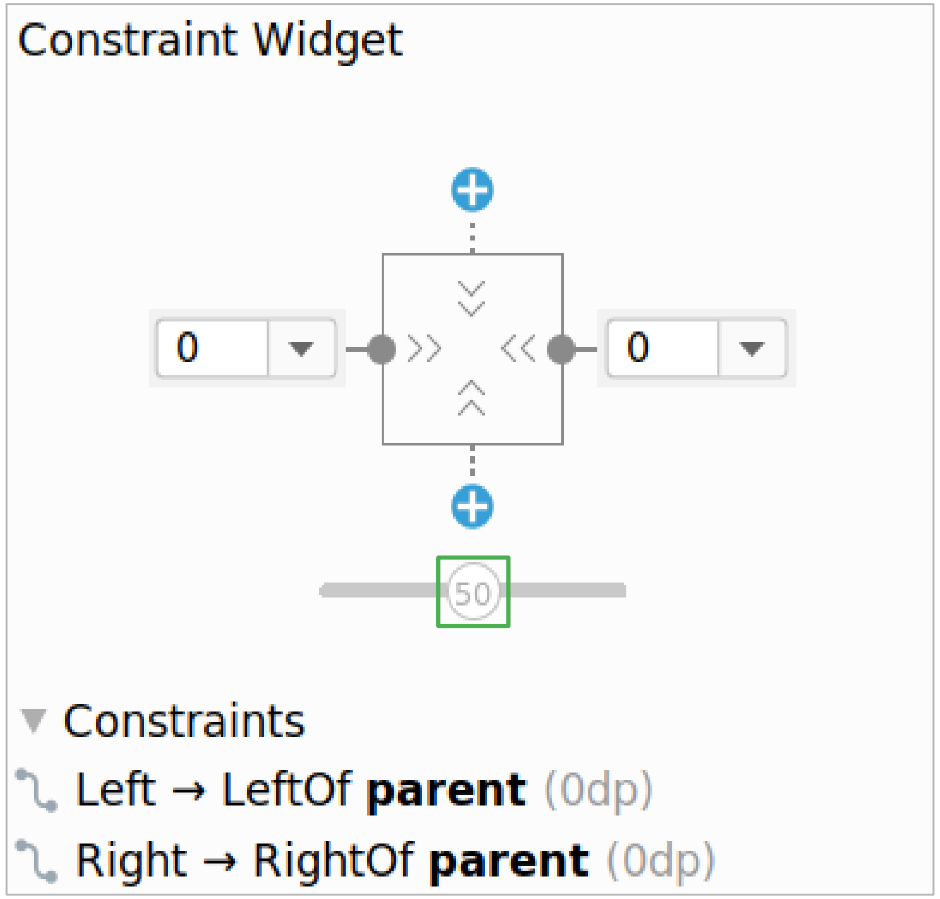




layout_width	wrap_content
layout_height	48dp

Center a view horizontally





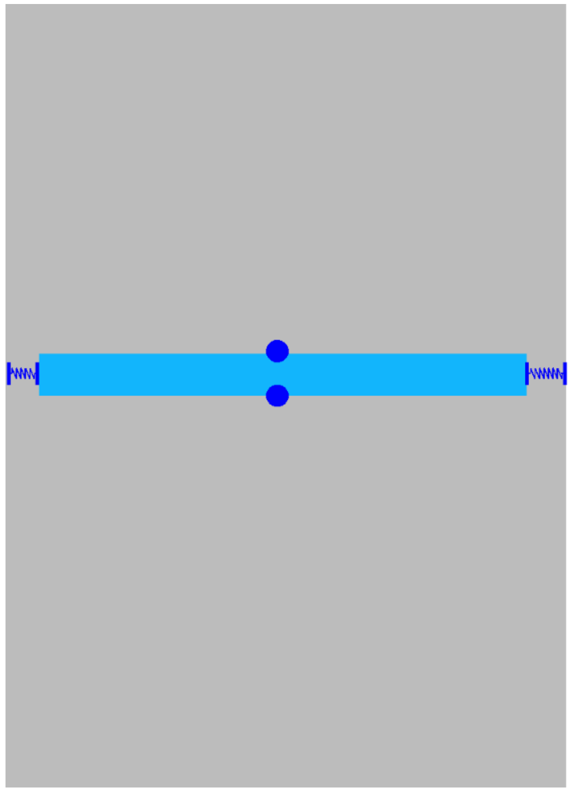
▼ Constraints

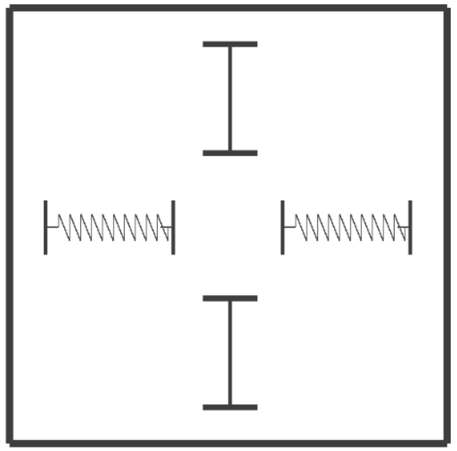
Left → LeftOf **parent** (0dp)

Right → RightOf **parent** (0dp)

Use match_constraint

Can't use `match_parent` on a child view, use `match_constraint` instead





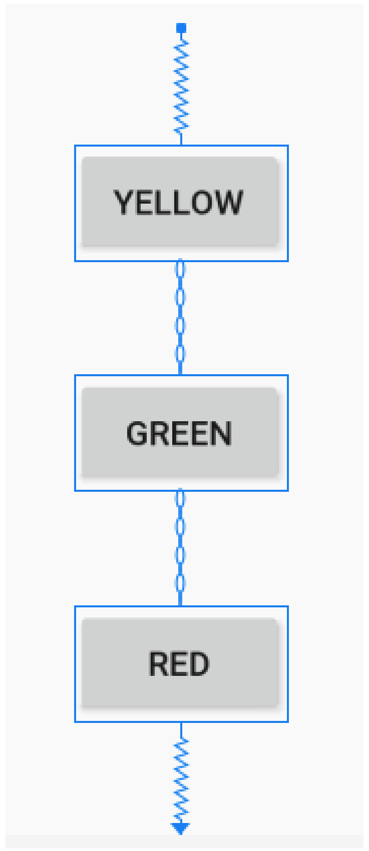
```
layout_width     0dp(match_constraint)
layout_height    48dp
```

Chains

- Let you position views in relation to each other
- Can be linked horizontally or vertically
- Provide much of LinearLayout functionality

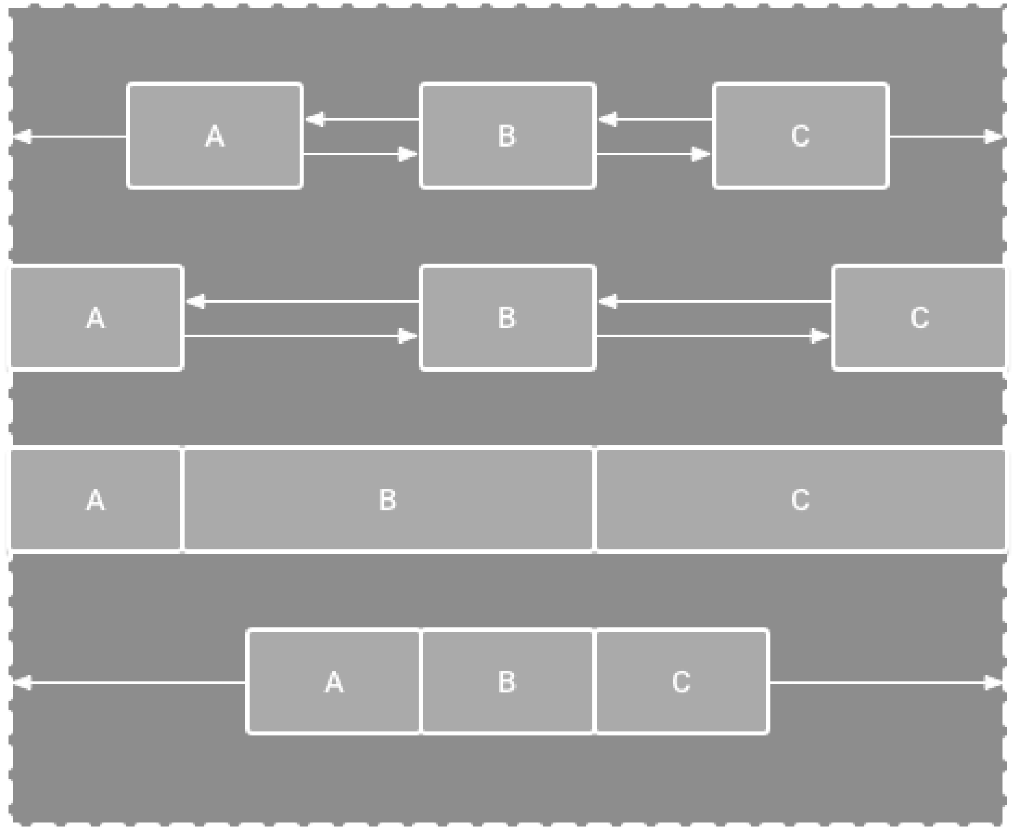
Create a Chain in Layout Editor

1. Select the objects you want to be in the chain.
2. Right-click and select **Chains.**
3. Create a horizontal or vertical chain.



Chain styles

Adjust space between views with these different chain styles.



Spread Chain

Spread Inside Chain

Weighted Chain

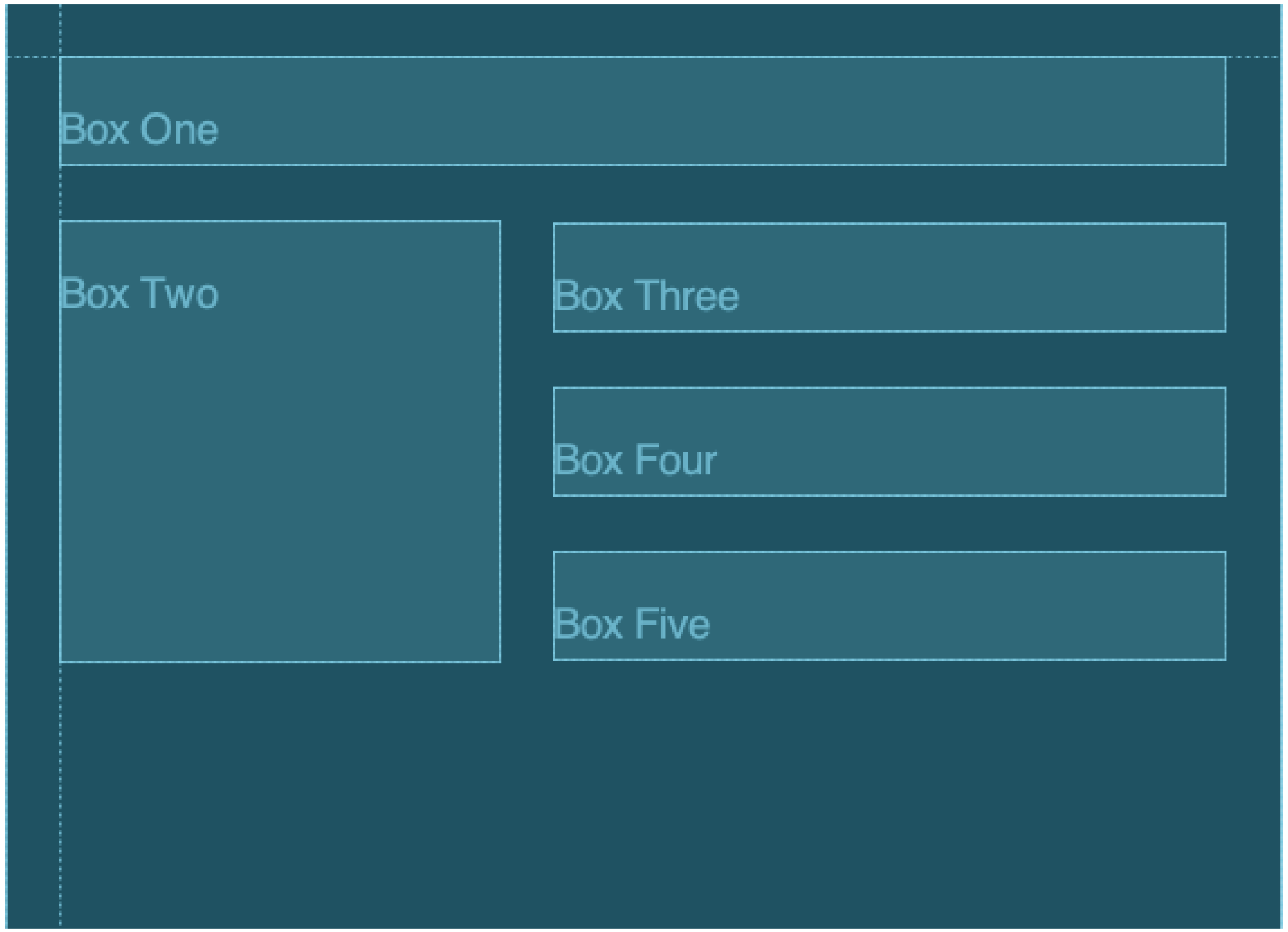
Packed Chain

Additional topics for ConstraintLayout

Guidelines

- Let you position multiple views relative to a single guide
- Can be vertical or horizontal
- Allow for greater collaboration with design/UX teams
- Aren't drawn on the device

Guidelines in Android Studio



Example Guideline

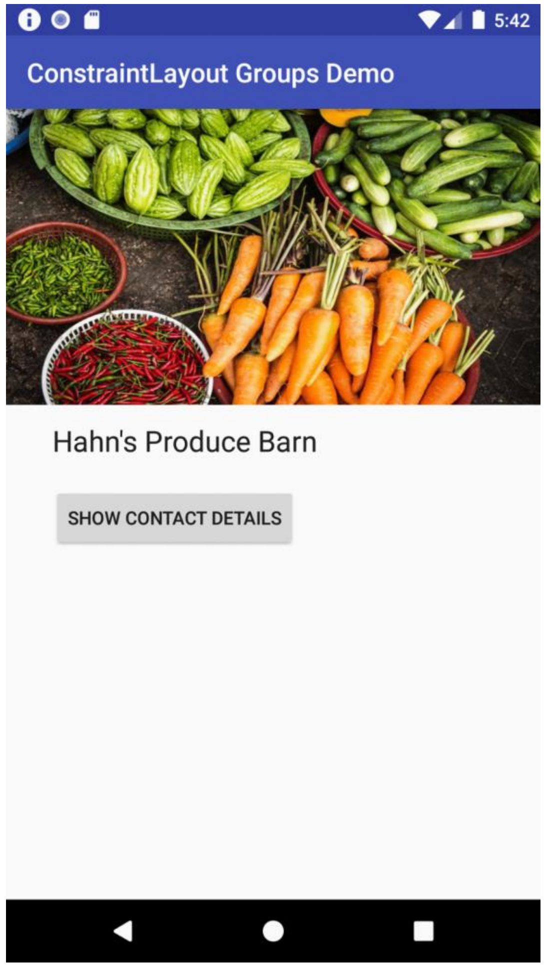
```
<ConstraintLayout>
   <androidx.constraintlayout.widget.Guideline
       android:id="@+id/start_guideline"
       android:layout_width="wrap_content"
       android:layout_height="wrap_content"
       android:orientation="vertical"
       app:layout_constraintGuide_begin="16dp" />
   <TextView ...
       app:layout_constraintStart_toEndOf="@id/start_guideline" />
</ConstraintLayout>
```

Creating Guidelines

- `layout_constraintGuide_begin`
- `layout_constraintGuide_end`
- `layout_constraintGuide_percent`

Groups

- Control the visibility of a set of widgets
- Group visibility can be toggled in code



Example group

```
<androidx.constraintlayout.widget.Group
    android:id="@+id/group"
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
    app:constraint_referenced_ids="locationLabel,locationDetails"/>
```

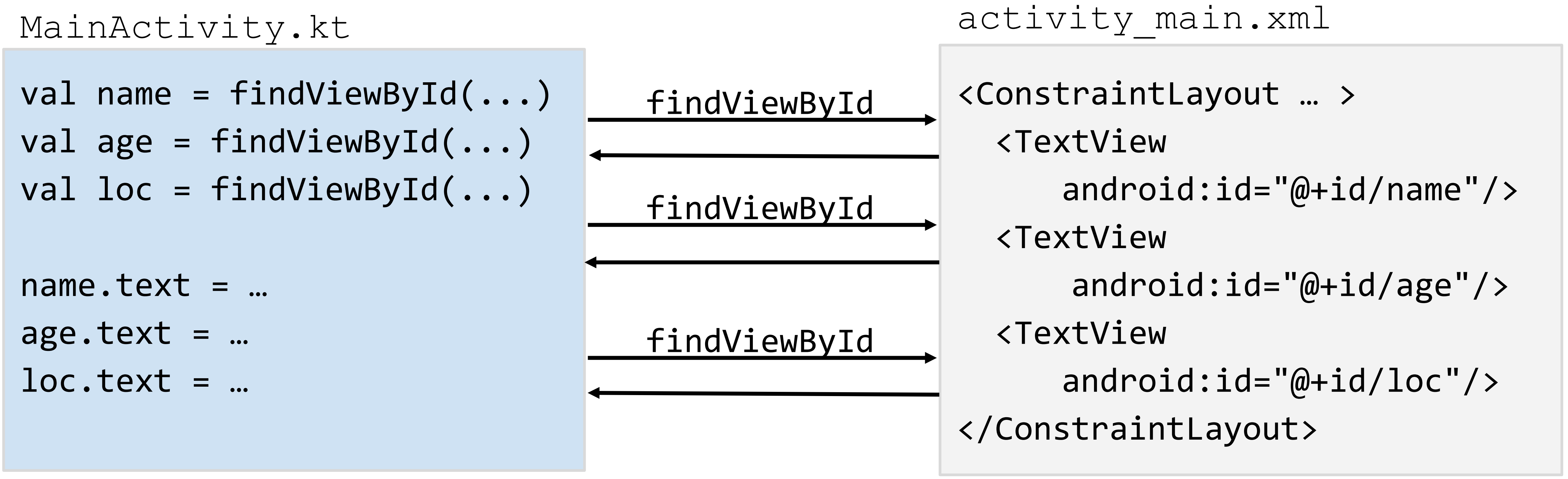
Groups app code

```
override fun onClick(v: View?) {
    if (group.visibility == View.GONE) {
        group.visibility = View.VISIBLE
        button.setText(R.string.hide_details)
    } else {
        group.visibility = View.GONE
        button.setText(R.string.show_details)
    }
}
```

Data binding

Current approach: findViewById()

Traverses the `View` hierarchy each time



MainActivity.kt

```
val name = findViewById(...)
val age = findViewById(...)
val loc = findViewById(...)

name.text = …
age.text = …
loc.text = …
```

activity_main.xml

```
<ConstraintLayout … >
  <TextView
       android:id="@+id/name"/>
  <TextView
        android:id="@+id/age"/>
  <TextView
       android:id="@+id/loc"/>
</ConstraintLayout>
```

Use data binding instead

Bind UI components in your layouts to data sources in your app.

`MainActivity.kt`

```
Val binding:ActivityMainBinding

binding.name.text = …
binding.age.text = …
binding.loc.text = …
```

initialize binding

`activity_main.xml`

```
<layout>
   <ConstraintLayout … >
       <TextView
           android:id="@+id/name"/>
        <TextView
           android:id="@+id/age"/>
         <TextView
           android:id="@+id/loc"/>
   </ConstraintLayout>
</layout>
```

Modify build.gradle file

```
android {
    ...
    buildFeatures {
        dataBinding true
    }
}
```

Add layout tag

```
<layout>
    <androidx.constraintlayout.widget.ConstraintLayout>
        <TextView ... android:id="@+id/username" />
        <EditText ... android:id="@+id/password" />
    </androidx.constraintlayout.widget.ConstraintLayout>
</layout>
```

Layout inflation with data binding

Replace this

```
setContentView(R.layout.activity_main)
```

with this

```
val binding: ActivityMainBinding = DataBindingUtil.setContentView(
    this, R.layout.activity_main)

binding.username = "Melissa"
```

Data binding layout variables

```
<layout>
   <data>
       <variable name="name" type="String"/>
   </data>
   <androidx.constraintlayout.widget.ConstraintLayout>
       <TextView
           android:id="@+id/textView"
           android:text="@{name}" />
   </androidx.constraintlayout.widget.ConstraintLayout>
</layout>
```

In `MainActivity.kt`:

```
binding.name = "John"
```

Data binding layout expressions

```
<layout>
   <data>
       <variable name="name" type="String"/>
   </data>

   <androidx.constraintlayout.widget.ConstraintLayout>
       <TextView
           android:id="@+id/textView"
           android:text="@{name.toUpperCase()}" />
   </androidx.constraintlayout.widget.ConstraintLayout>
</layout>
```

Displaying lists with RecyclerView

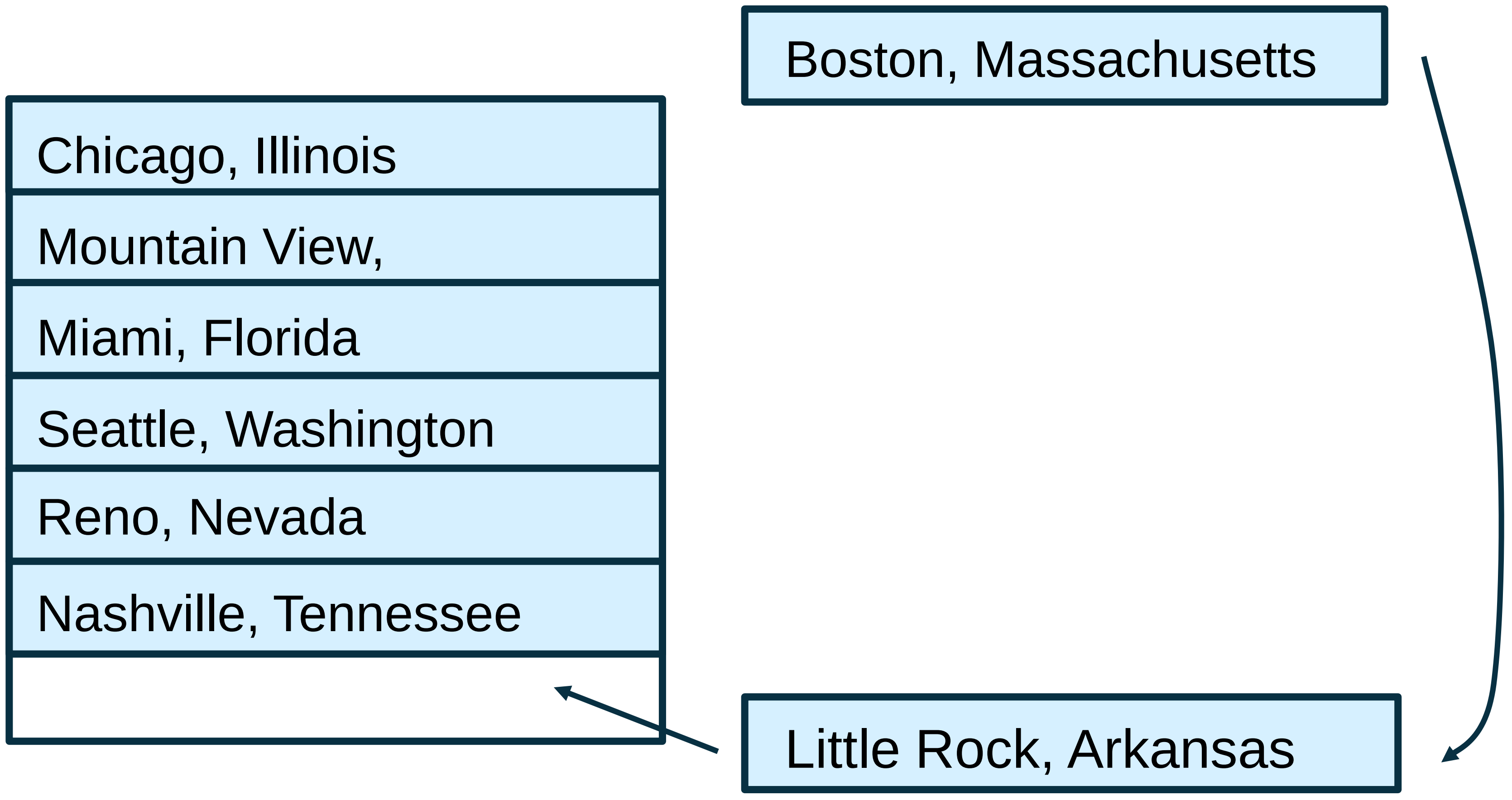
RecyclerView

- Widget for displaying lists of data
- "Recycles" (reuses) item views to make scrolling more performant
- Can specify a list item layout for each item in the dataset
- Supports animations and transitions

RecyclerView.Adapter

- Supplies data and layouts that the RecyclerView displays
- A custom Adapter extends from `RecyclerView.Adapter` and overrides these three functions:
  - `getItemCount`
  - `onCreateViewHolder`
  - `onBindViewHolder`

View recycling in RecyclerView



If item is scrolled offscreen, it isn’t destroyed. Item is put in a pool to be recycled.

onBindViewHolder binds the view with the new values, and then the view gets reinserted in the list.

Add RecyclerView to your layout

```
<androidx.recyclerview.widget.RecyclerView
    android:id="@+id/rv"
    android:scrollbars="vertical"
    android:layout_width="match_parent"
    android:layout_height="match_parent"/>
```

Create a list item layout

`res/layout/item_view.xml`

```
<FrameLayout
   android:layout_width="match_parent"
   android:layout_height="wrap_content">
   <TextView
       android:id="@+id/number"
       android:layout_width="match_parent"
       android:layout_height="wrap_content" />
</FrameLayout>
```

Create a list adapter

```
class MyAdapter(val data: List<Int>) : RecyclerView.Adapter<MyAdapter.MyViewHolder>() {

    class MyViewHolder(val row: View) : RecyclerView.ViewHolder(row) {
        val textView = row.findViewById<TextView>(R.id.number)
    }

   override fun onCreateViewHolder(parent: ViewGroup, viewType: Int): MyViewHolder {
        val layout = LayoutInflater.from(parent.context).inflate(R.layout.item_view,
                     parent, false)
        return MyViewHolder(layout)
    }
    override fun onBindViewHolder(holder: MyViewHolder, position: Int) {
        holder.textView.text = data.get(position).toString()
    }
    override fun getItemCount(): Int = data.size
```

Set the adapter on the RecyclerView

In `MainActivity.kt`:

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

    val rv: RecyclerView = findViewById(R.id.rv)
    rv.layoutManager = LinearLayoutManager(this)

    rv.adapter = MyAdapter(IntRange(0, 100).toList())
}
```