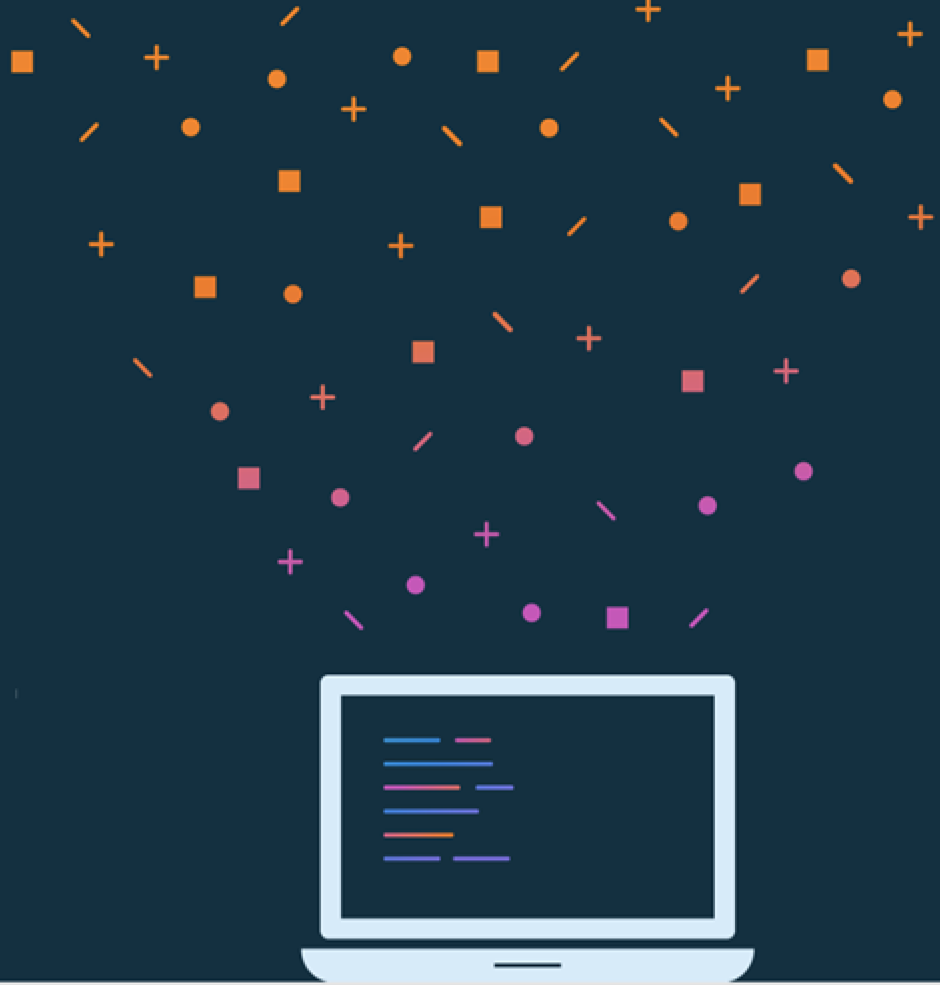
Layouts



About this lesson

Understand how the Android layouts the contents in a screen and create a simple dynamic views

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.

Size in Android

- **sp (scale independent pixel)**
  Use for text size, because it is scaled by the user's font size preference.
- **dp (density independent pixel)**
  Use for everything else than text size
- **px**
  Corresponds to actual pixels on the screen.
  Not recommended because can result different size.

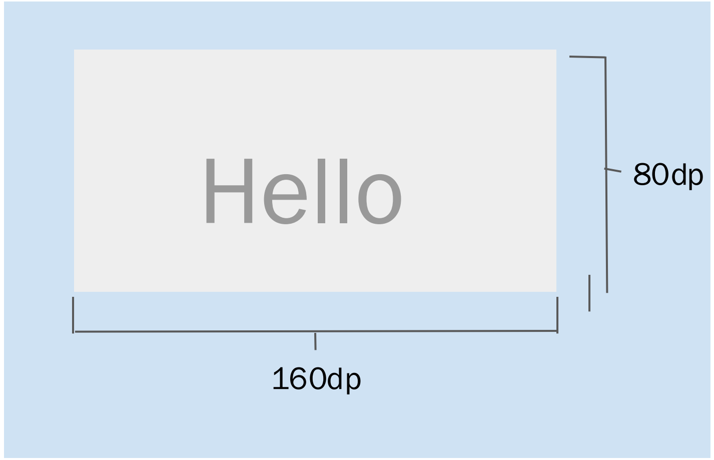
The same size; different resolution/pixel

https://developer.android.com/

Density-independent pixels (dp)

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

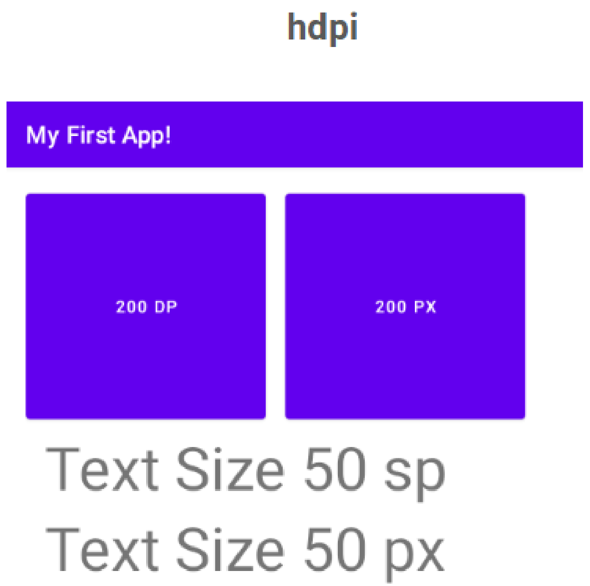
- Density-independent pixels (dp) take screen density into account.
- Android views are measured in density-independent pixels.
- dp = $\frac{\text{(width in pixels * 160)}}{\text{screen density}}$

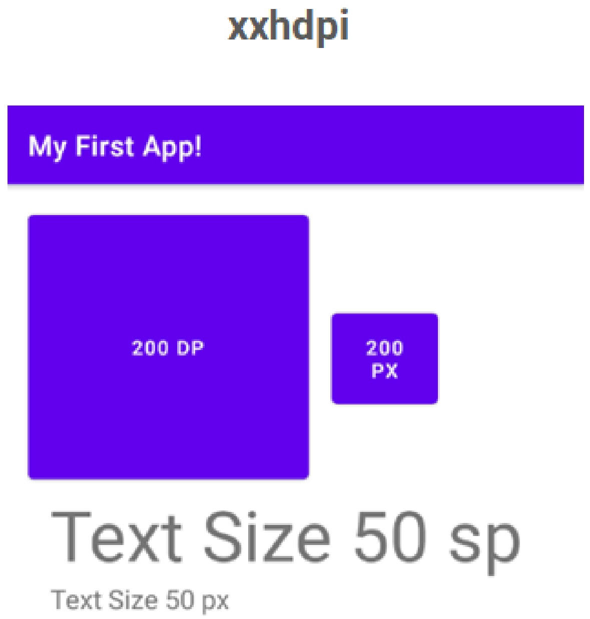


Screen-density buckets

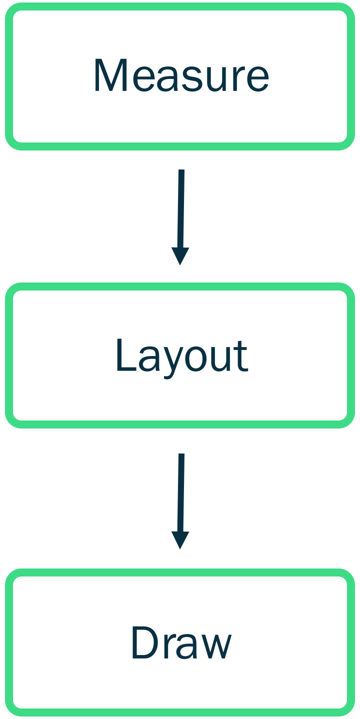
Density qualifier	Description	DPI estimate
ldpi (mostly unused)	Low density	~120dpi
mdpi (baseline density)	Medium density	~160dpi
hdpi	High density	~240dpi
xhdpi	Extra-high density	~320dpi
xxhdpi	Extra-extra-high density	~480dpi
xxxhdpi	Extra-extra-extra-high density	~640dpi

Size Comparison



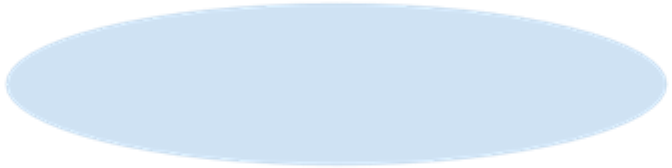


Android View rendering cycle

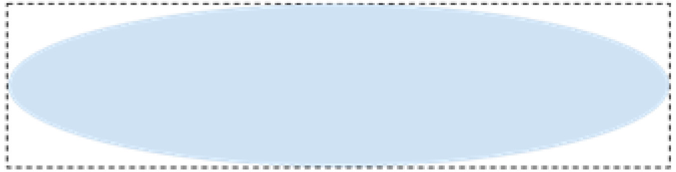


Drawing region

What we see:

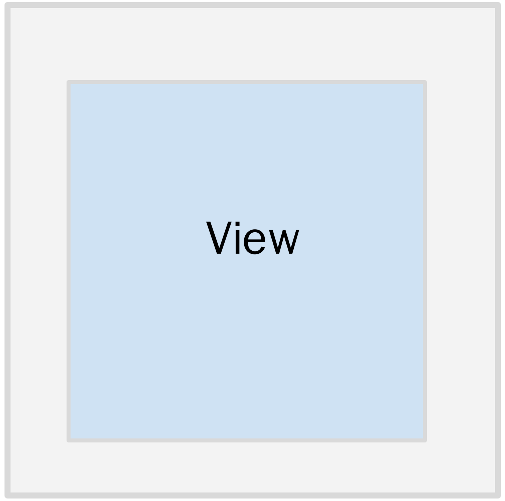


How it's drawn:

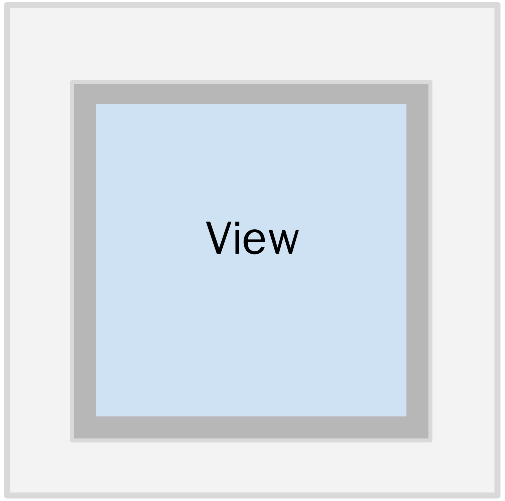


View margins and padding

View with margin



View with margin and padding



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

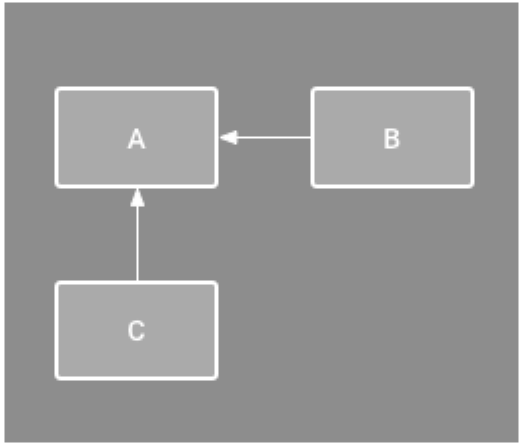
Use ConstraintLayout to avoid some of these issues!

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

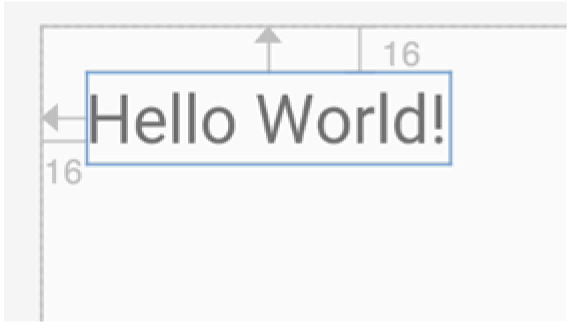


Relative positioning constraints

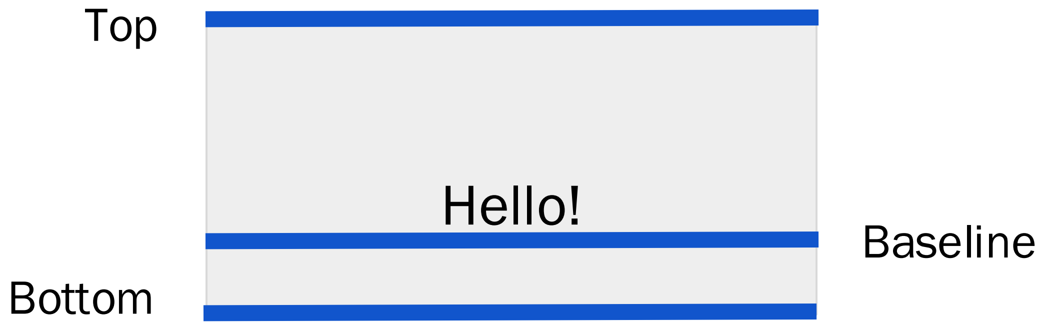
Can set up a constraint relative to the parent container

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

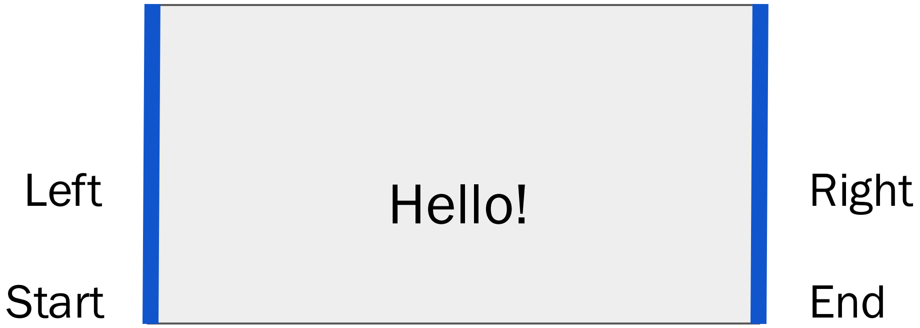
```
Example attributes on a TextView:

app:layout_constraintTop_toTopOf="parent"

app:layout_constraintLeft_toLeftOf="parent"
```



Relative positioning constraints

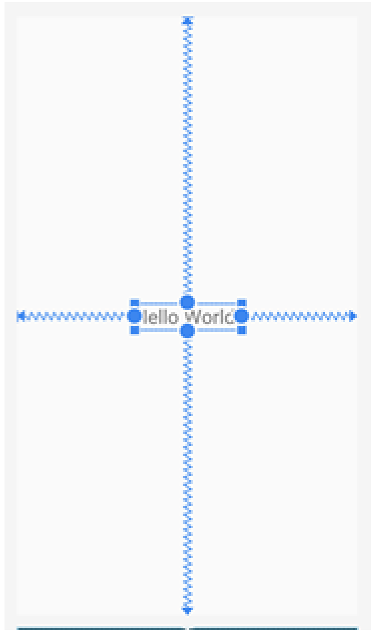


Relative positioning constraints



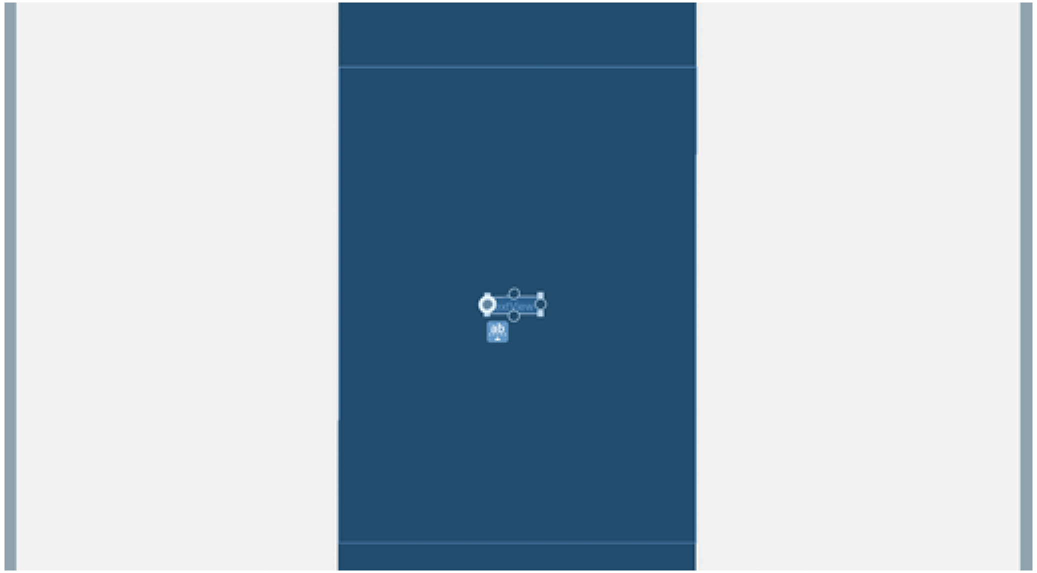
Simple ConstraintLayout example

```
<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>
```



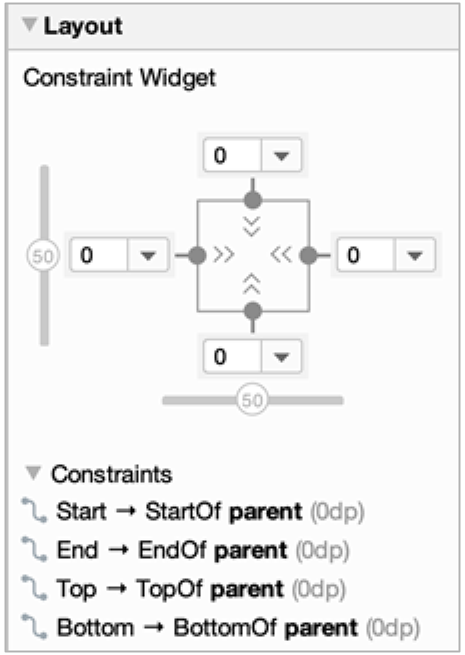
Layout Editor in Android Studio

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



Constraint Widget in Layout Editor

├─┤	Fixed
>>>	Wrap content
├WW┤	Match constraints


Layout

Constraint Widget

0 0 0 0

50 50

Constraints

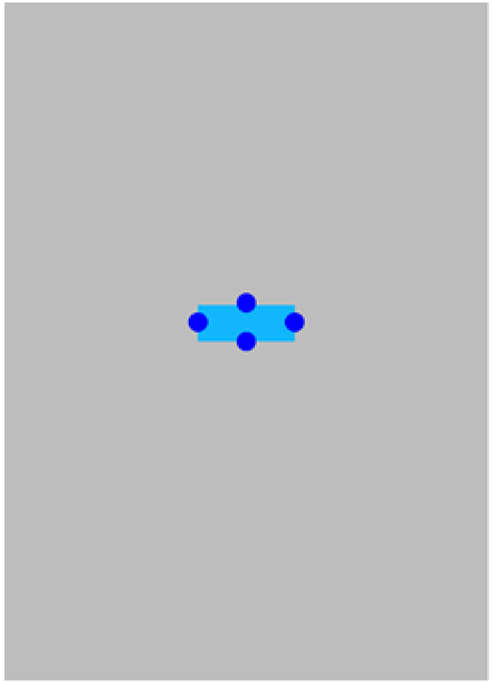
Start → StartOf **parent** (0dp)

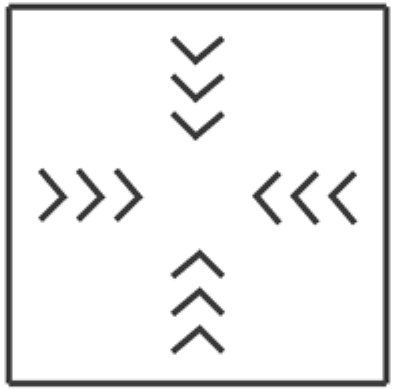
End → EndOf **parent** (0dp)

Top → TopOf **parent** (0dp)

Bottom → BottomOf **parent** (0dp)

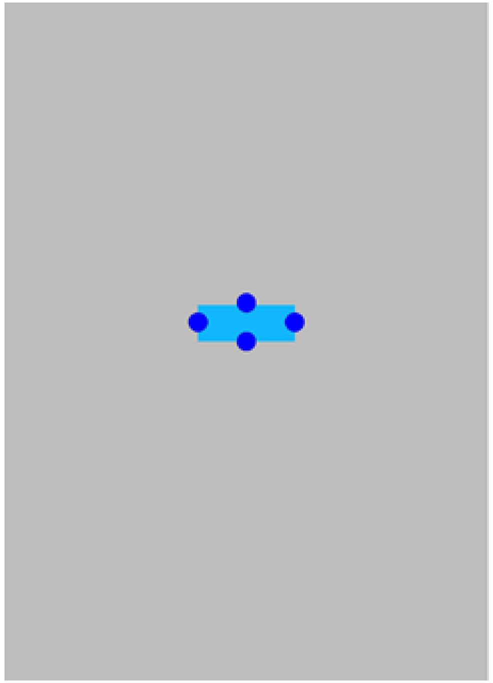
Wrap content for width and height

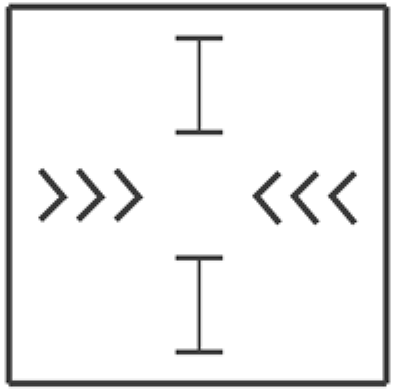




layout_width	wrap_content
layout_height	wrap_content

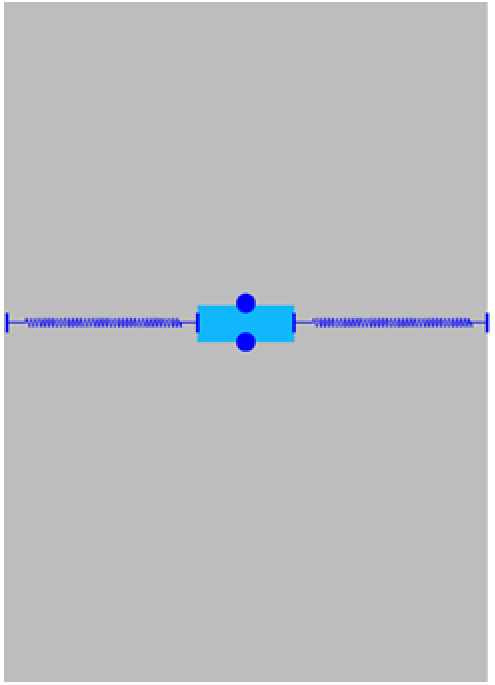
Wrap content for width, fixed height

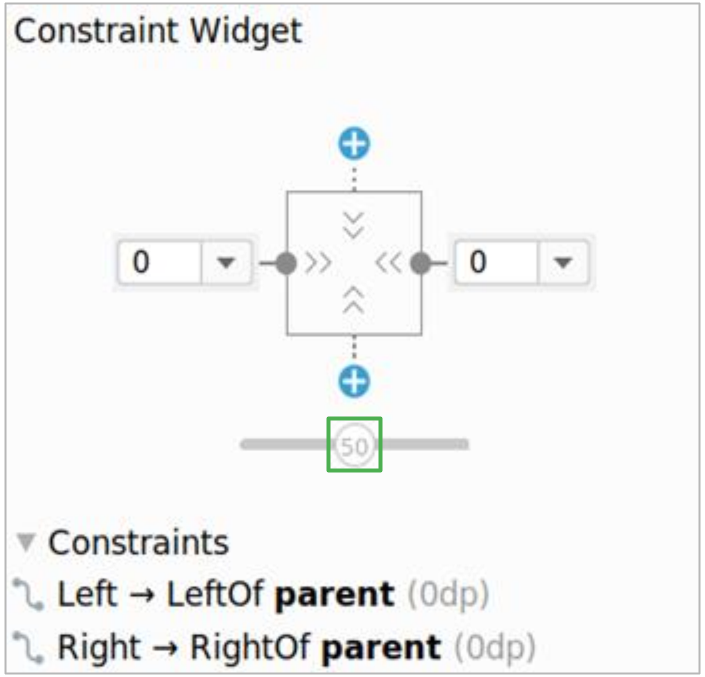




layout_width	wrap_content
layout_height	48dp

Center a view horizontally




Constraint Widget

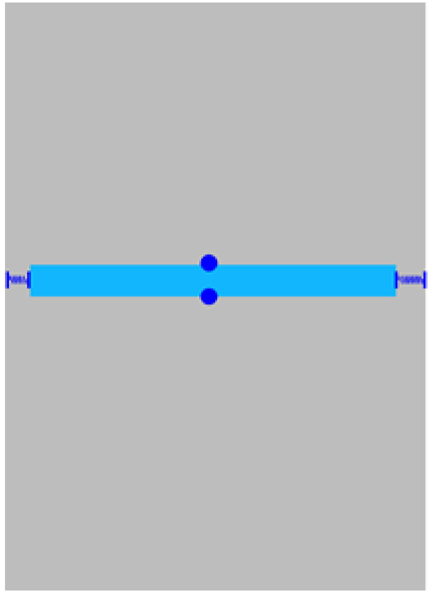
Constraints

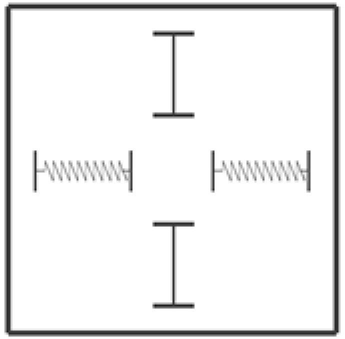
Left → LeftOf **parent** (0dp)

Right → RightOf **parent** (0dp)

Use match_constraint

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





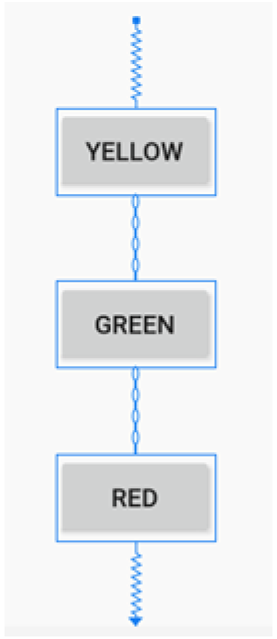
layout_width	0dp(match_constraint)
layout_height	48dp

Chains

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

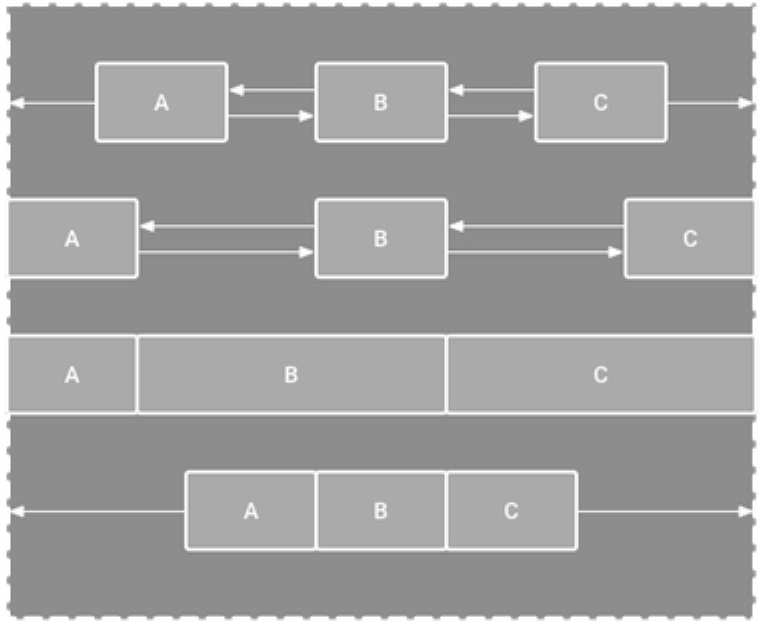
Create a Chain in Layout Editor

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

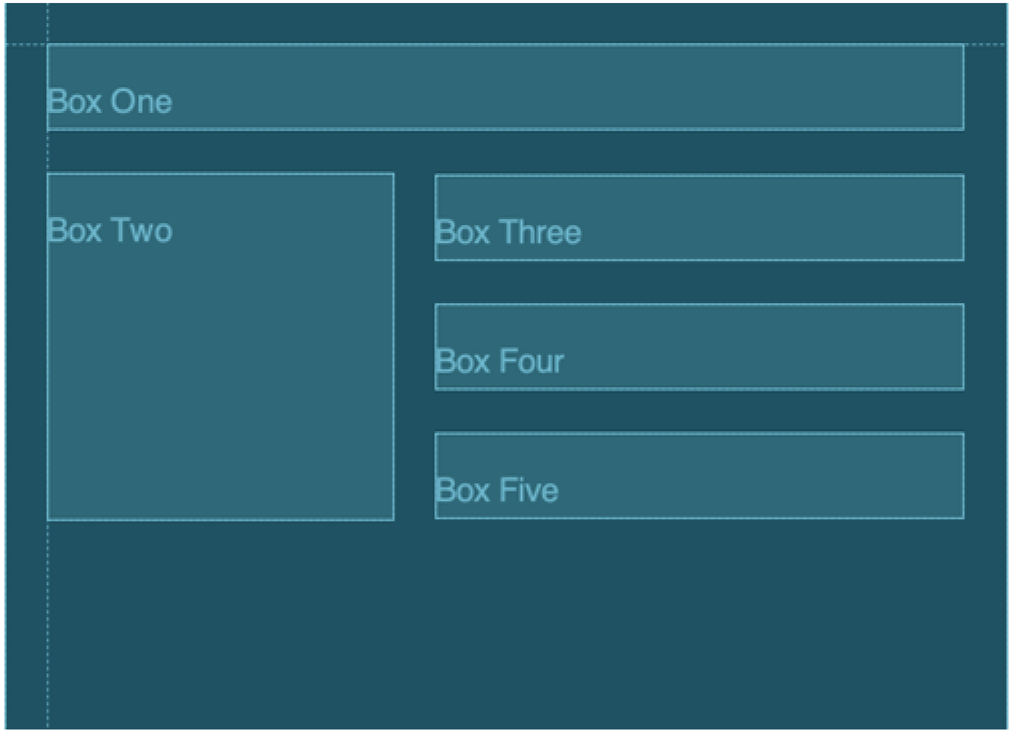
Packed Chain

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>
```

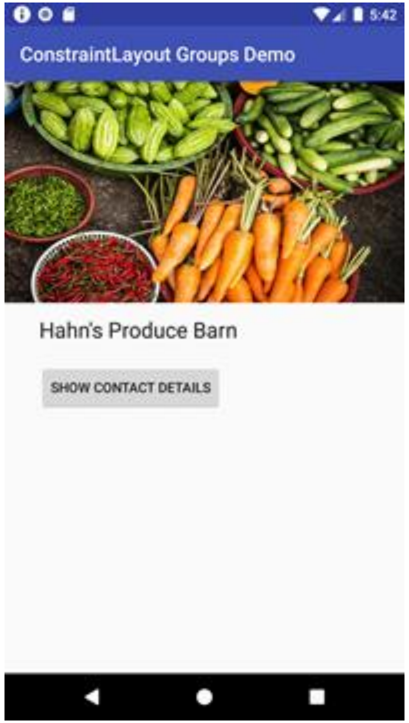
Creating Guidelines

Specify one of these:

- `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)
    }
}
```

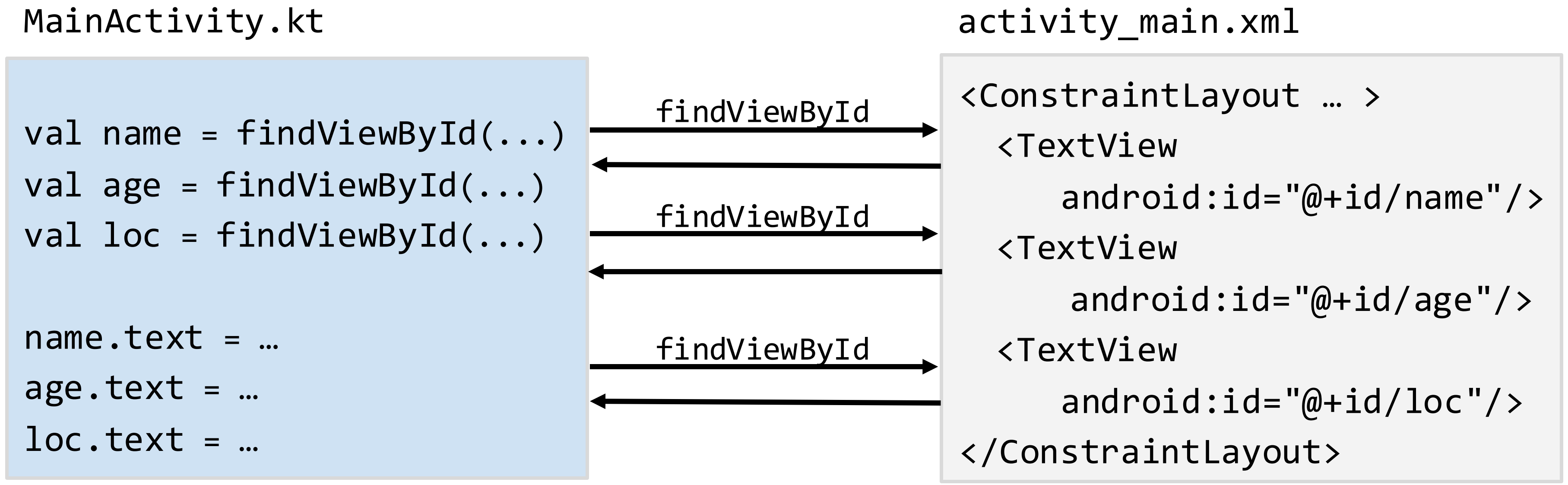
.visibility property can be used for view (not just groups) with these constants:

- VISIBLE: Shown
- INVISIBLE: not shown but still taking space
- GONE: not shown and does not take space

Data binding

Current approach: findViewById()

Traverses the `View` hierarchy each time



`MainActivity.kt`

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

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

`activity_main.xml`

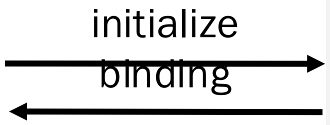
```xml
<ConstraintLayout … >
  <TextView
      android:id="@+id/name"/>
  <TextView
      android:id="@+id/age"/>
  <TextView
      android:id="@+id/loc"/>
</ConstraintLayout>
```

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 = …
```



`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>
```

Note

- Similar (and simpler) functionality of Data Binding also exist in ViewBinding
- ViewBinding ties View to a Binding Class, providing static access to view, but does not tie a variable / data to view.
- For reactive, two ways binding approach, use Data Binding with LiveData or Observable objects
- You don’t have to worry about binding if using Jetpack Compose as it’s already providing reactive framework on its own

Displaying lists with RecyclerView

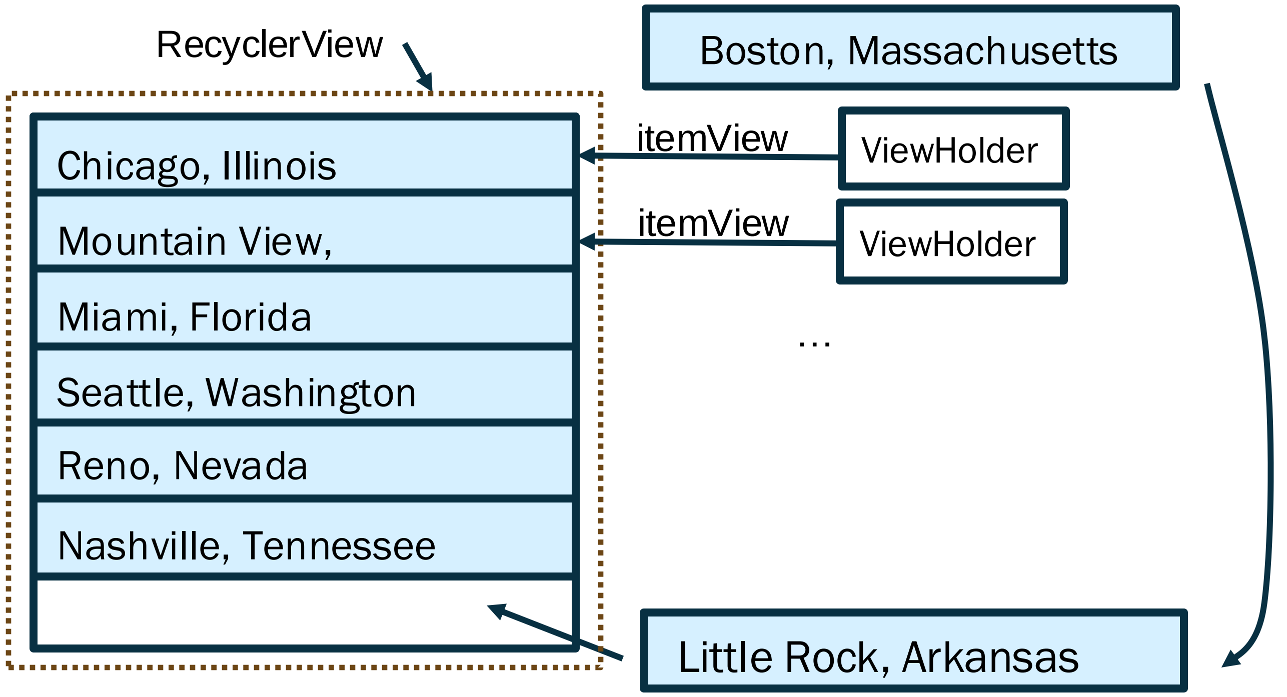
RecyclerView

- 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

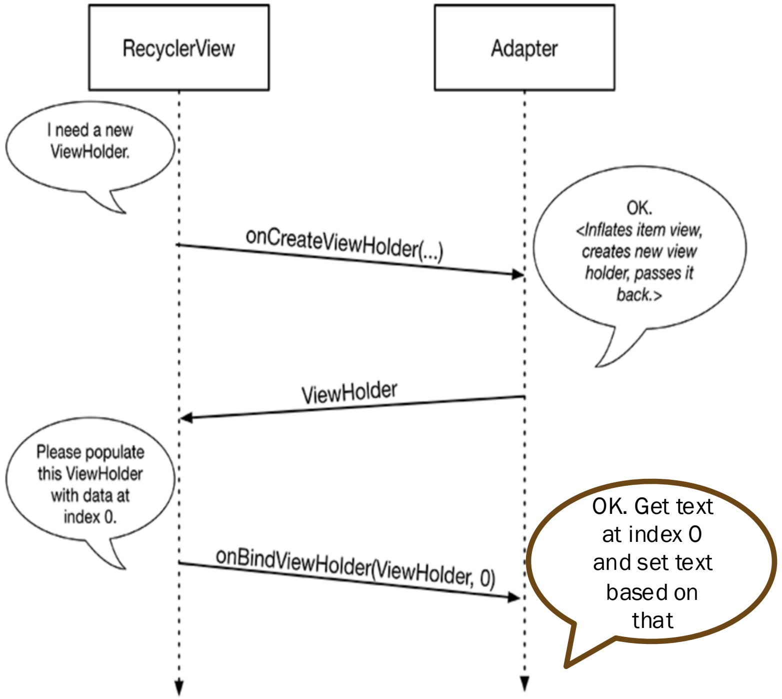
res/layout/item_view.xml

```
<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 (1)

RecyclerView does not create ViewHolders itself , instead it ask for Adapter. Adapter is a controller object that sits Between RecyclerView and the dataset that it should display.
The adapter is responsible for:
1. creating the necessary ViewHolders when asked
2. binding data to ViewHolders from the model layer when asked

The recycler view is responsible for:
1. asking the adapter to create a new ViewHolder
2. asking the adapter to bind a ViewHolder to the item from the backing data at a given position


RecyclerView
Adapter
I need a new ViewHolder.
onCreateViewHolder(...)
OK. <Inflates item view, creates new view holder, passes it back.>
ViewHolder
Please populate this ViewHolder with data at index 0.
onBindViewHolder(ViewHolder, 0)
OK. Get text at index 0 and set text based on that

Create a list adapter (2)

```
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())
}
```

Summary

Summary

In this lesson, you learned how to:

- Specify lengths in dp for your layout
- Work with screen densities for different Android devices
- Render Views to the screen of your app
- Layout views within a ConstraintLayout using constraints
- Simplify getting View references from layout with data binding
- Display a list of text items using a RecyclerView and custom adapter

Learn more

- Pixel density on Android
- Spacing
- Device metrics
- Type scale
- Build a Responsive UI with ConstraintLayout
- Data Binding Library
- Create dynamic lists with RecyclerView

Pathway

Practice what you’ve learned by completing the pathway:

[Layouts]