twitch.tv/dancojocar
youtube.com/dancojocar

Lecture #9
Animations

Mobile Applications
Fall 2024

Overview

- Add visual cues about what is going on.
- Useful when the UI changes states.
- Adding a polished look, gives a higher quality look and feel.
- Add motions to the UI.

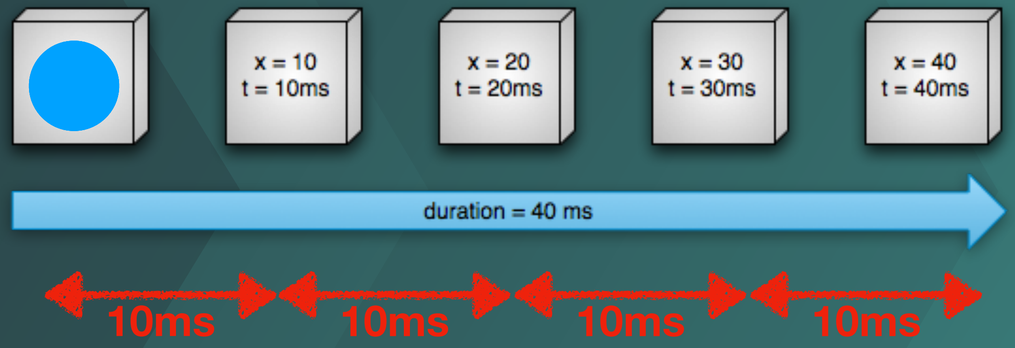
https://material.io/design/motion

Property Animation

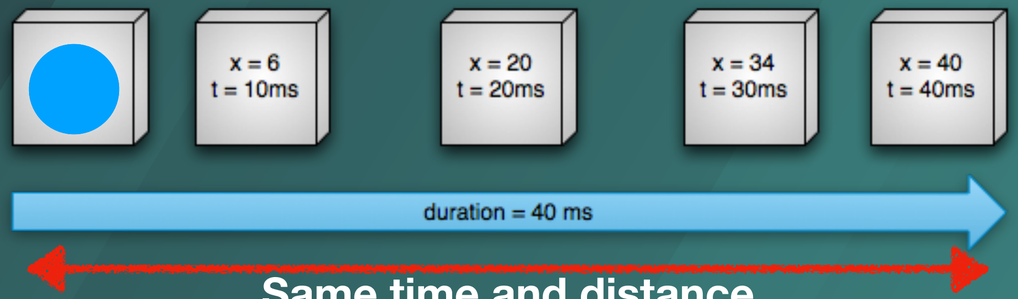
- Robust framework that allows to animate almost anything.
- Defines animation to change any object property over time.
- Characteristics of an animation:
  - Duration. Default length: 300ms.
  - Time interpolation. Defines how the values for the property are calculated.
  - Repeat count and behavior.
  - Animation sets.
  - Frame refresh delay. Default value: 10ms.

How property animation works

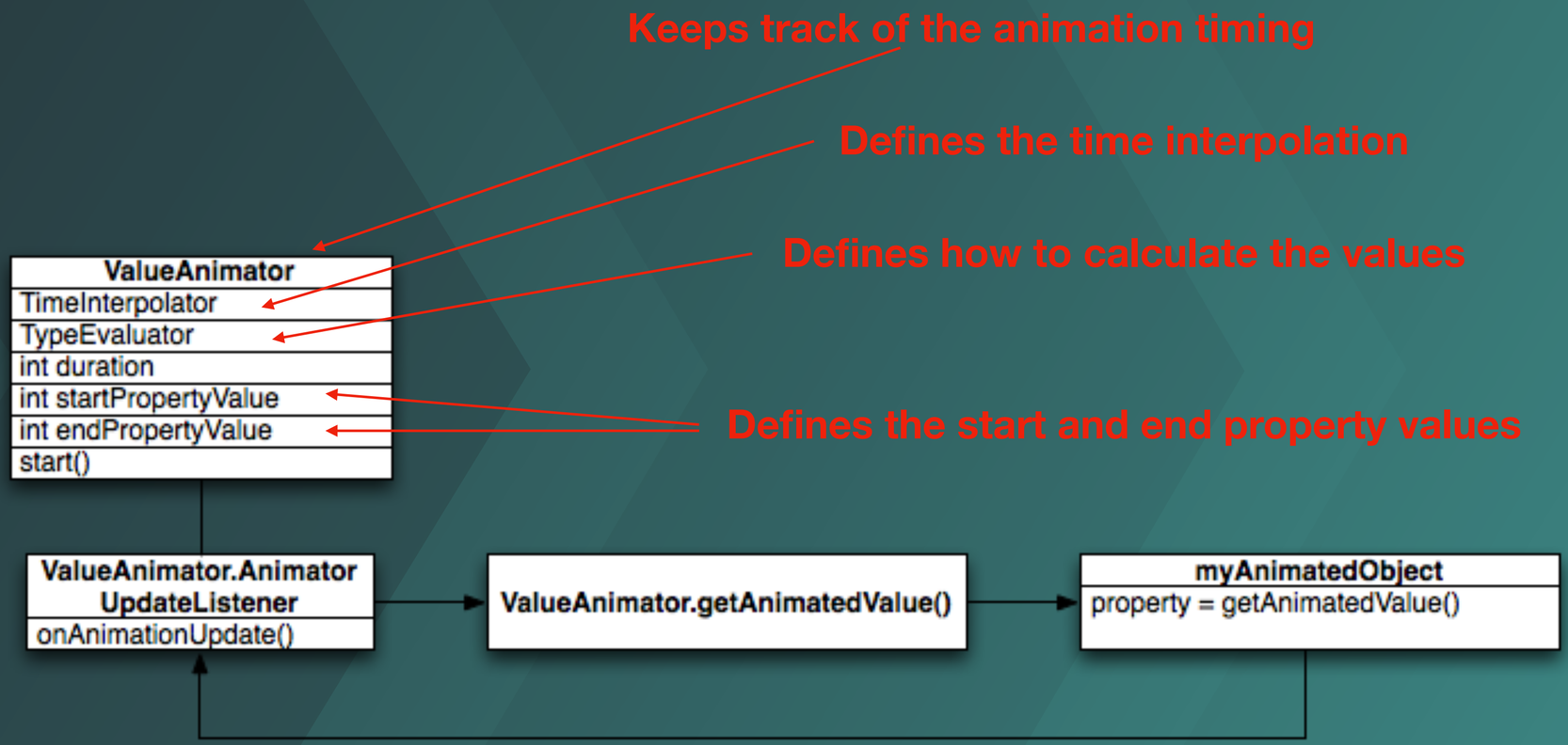
Linear animation



Non-linear animation

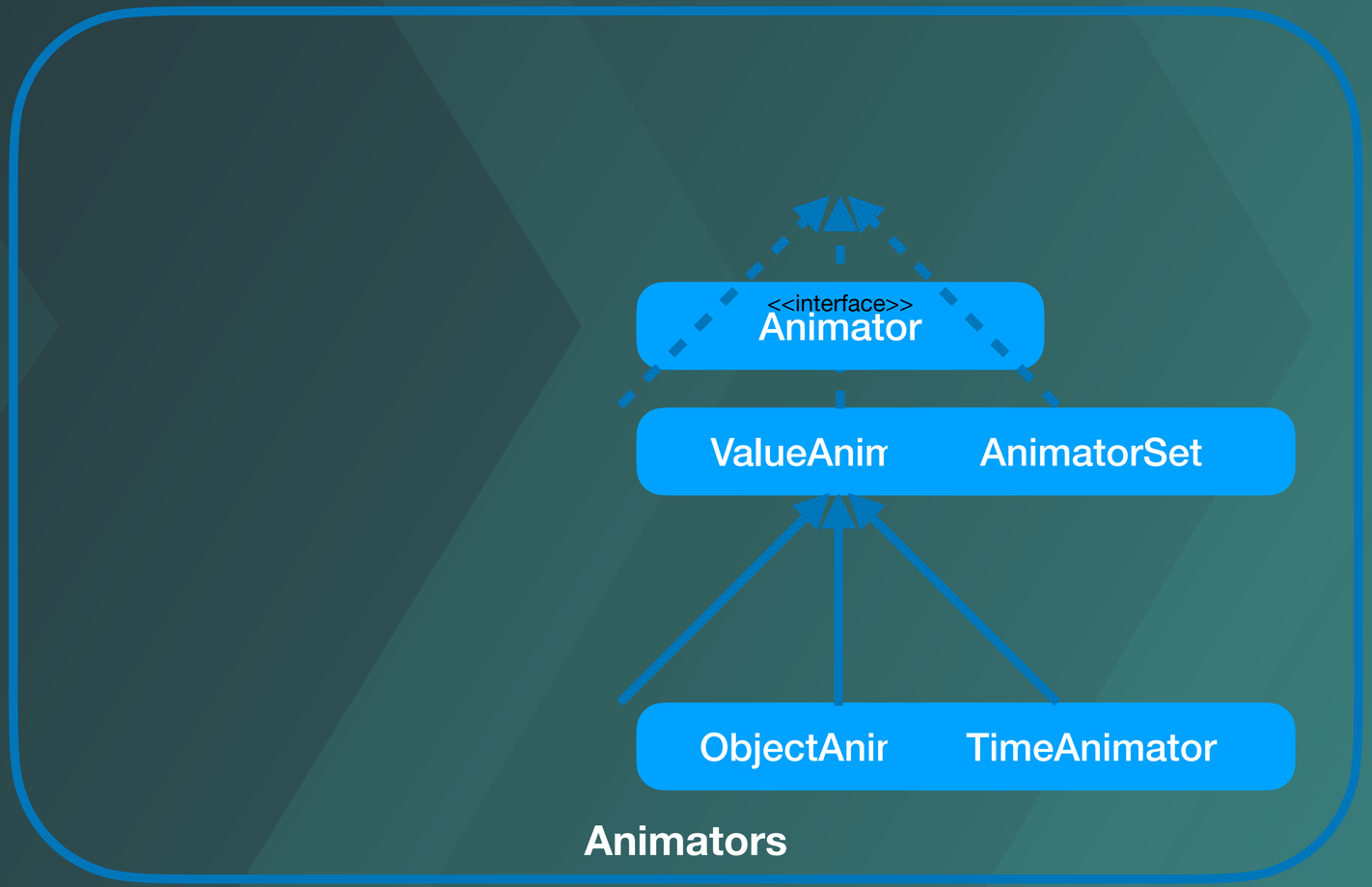


Model



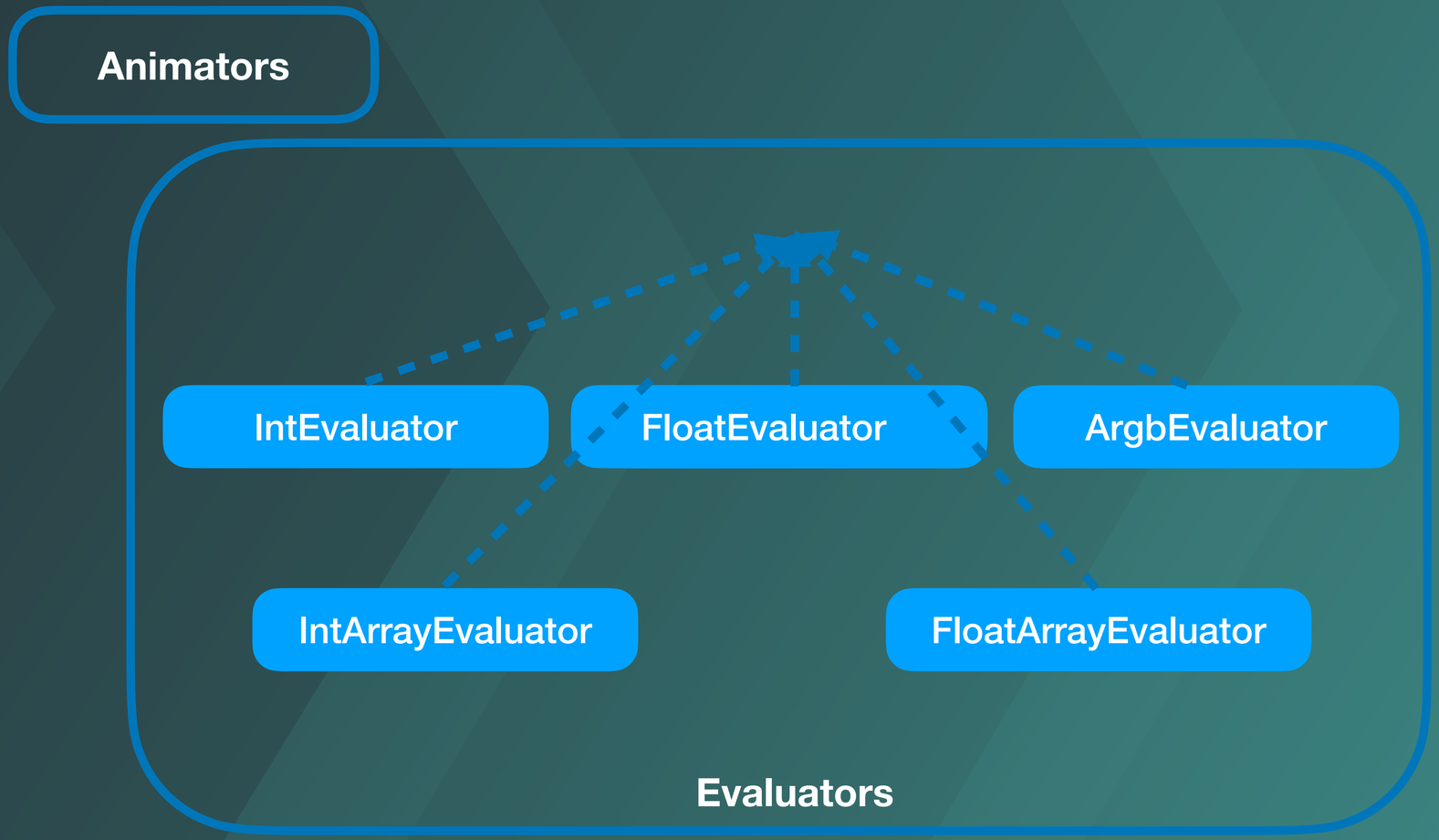
https://developer.android.com/guide/topics/graphics/prop-animation

API



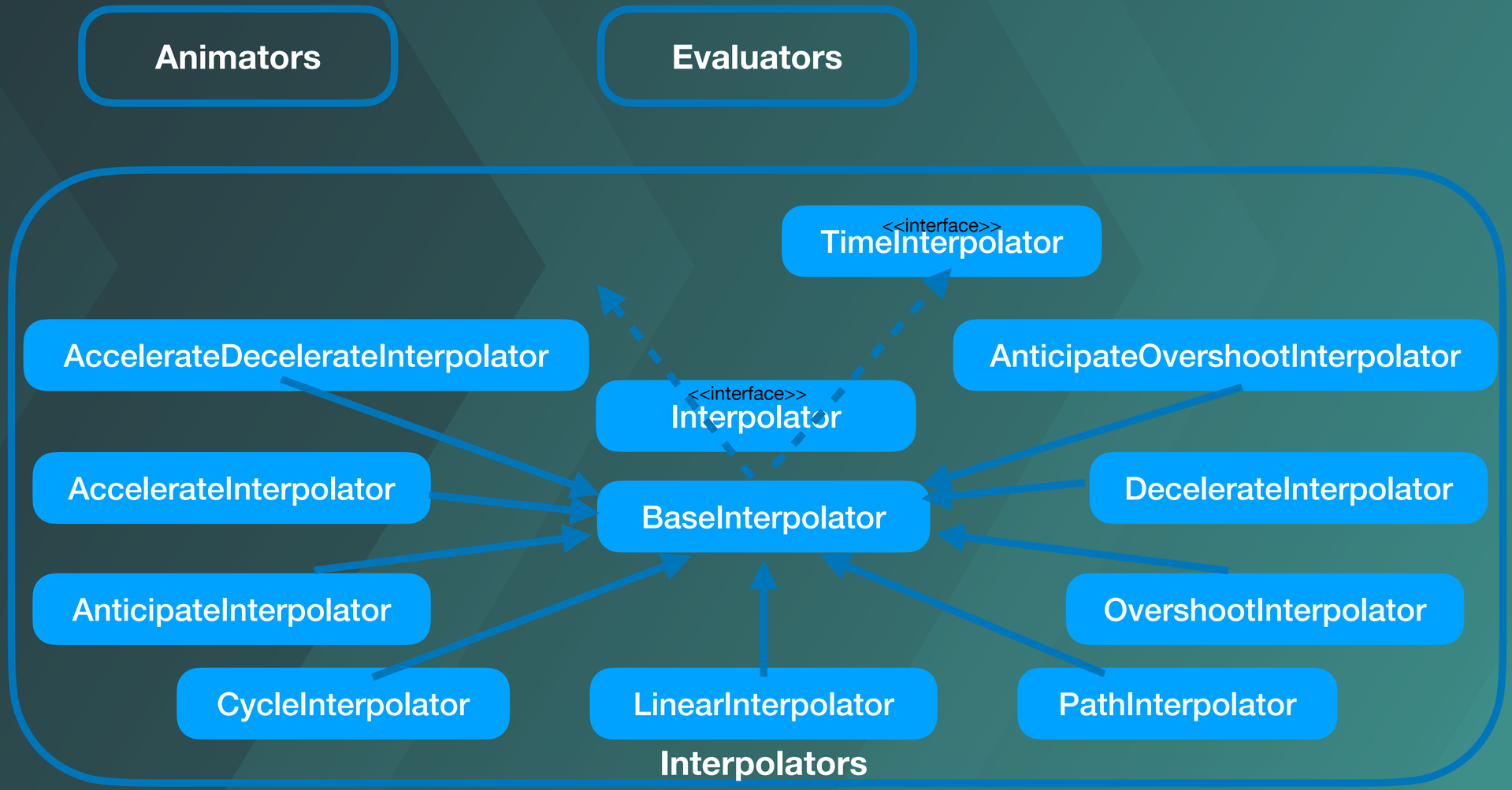
https://developer.android.com/reference/android/animation/Animator

API



https://developer.android.com/reference/android/animation/TypeEvaluator

API



https://developer.android.com/reference/android/view/animation/Interpolator

API

Animators **Evaluators** **Interpolators**

```
ValueAnimator.ofObject(...).apply {
  // ...
}

ValueAnimator.ofFloat(0f, 100f).apply {
    duration = 1000
    start()
}

ValueAnimator.ofObject(MyTypeEvaluator(),
    startPropertyValue, endPropertyValue).apply {
  }duration = 1000
  //start()
}

ObjectAnimator.ofFloat(textView, "translationX", 100f).apply {
    duration = 1000
    start()
}
```

> You can use the animated value in a property that uses the same type as the animation. In this case, you can use the

```
addUpdateListener { updatedAnimation ->
    textView.translationX = updatedAnimation.animatedValue as Float
}
```

Choreograph using an AnimatorSet

```
val bouncer = AnimatorSet().apply {
  play(bounceAnim).before(squashAnim1)
  play(squashAnim1).with(squashAnim2)
  play(squashAnim1).with(stretchAnim1)
  play(squashAnim1).with(stretchAnim2)
  play(bounceBackAnim).after(stretchAnim2)
}

val fadeAnim = ObjectAnimator.ofFloat(newBall, "alpha", 1f, 0f).apply {
  duration = 250
}

AnimatorSet().apply {
  play(bouncer).before(fadeAnim)
  start()
}
```

Animation Listeners

```
ObjectAnimator.ofFloat(newBall, "alpha", 1f, 0f).apply {
  duration = 250
  addListener(object : AnimatorListenerAdapter() {
    override fun onAnimationEnd(animation: Animator) {
      balls.remove((animation as ObjectAnimator).target)
    }
  })
}
```

Animate Layout Changes

```
<LinearLayout
    android:orientation="vertical"
    android:layout_width="wrap_content"
    android:layout_height="match_parent"
    android:id="@+id/verticalContainer"/>
    android:animateLayoutChanges="true" />
```

Animate View State Changes

DEMO

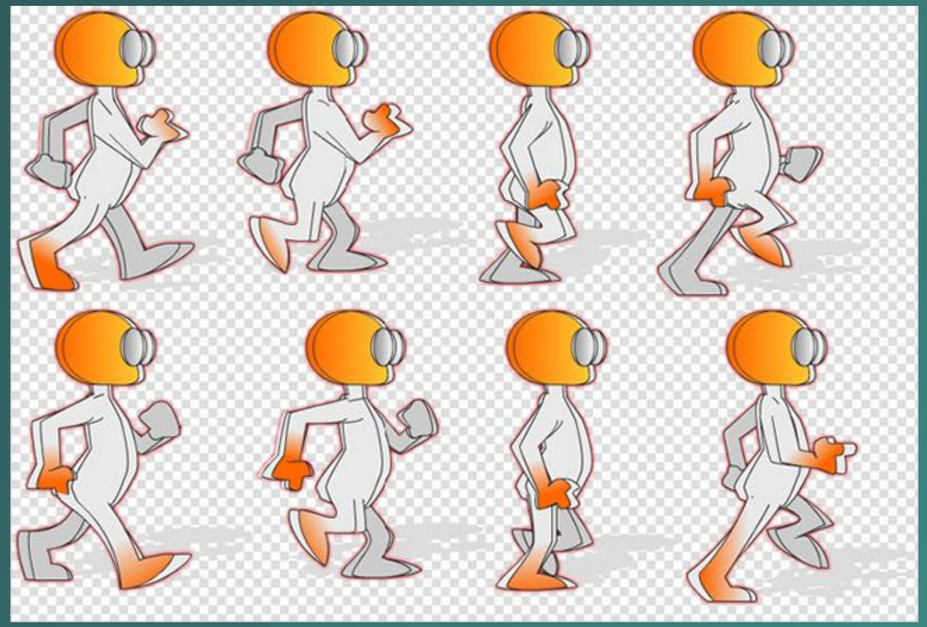
Define: `res/xml/animate_scale.xml`

```
<?xml version="1.0" encoding="utf-8"?>
<selector xmlns:android="http://schemas.android.com/apk/res/android">
 <!-- the pressed state; increase x and y size to 150% -->
 <item android:state_pressed="true">
  <set>
   <objectAnimator android:propertyName="scaleX"
    android:duration="@android:integer/config_shortAnimTime"
    android:valueTo="1.5"
    android:valueType="floatType"/>
   <objectAnimator android:propertyName="scaleY"
    android:duration="@android:integer/config_shortAnimTime"
    android:valueTo="1.5"
    android:valueType="floatType"/>
  </set>
 </item>
 <!-- the default, non-pressed state; set x and y size to 100% -->
 <item android:state_pressed="false">
  <set>
   <objectAnimator android:propertyName="scaleX"
    android:duration="@android:integer/config_shortAnimTime"
    android:valueTo="1"
    android:valueType="floatType"/>
   <objectAnimator android:propertyName="scaleY"
    android:duration="@android:integer/config_shortAnimTime"
    android:valueTo="1"
    android:valueType="floatType"/>
  </set>
 </item>
</selector>
```

Button android:stateListAnimator="@xml/animate_scale"

Animate bitmaps

- Used to animate a graphic such as:
  - An icon.
  - Illustration.
- Drawable animation API.
- Defined statically with a drawable resource or at runtime.



https://shapeshifter.design/

Using an AnimationDrawable


```
<animation-list xmlns:android="http://schemas.android.com/apk/res/android"
    android:oneshot="true">
    <item android:drawable="@drawable/rocket_thrust1" android:duration="200" />
    <item android:drawable="@drawable/rocket_thrust2" android:duration="200" />
    <item android:drawable="@drawable/rocket_thrust3" android:duration="200" />
</animation-list>
```

```
private lateinit var rocketAnimation: AnimationDrawable

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

    val rocketImage = findViewById<ImageView>(R.id.rocket_image).apply {
      setBackgroundResource(R.drawable.rocket_thrust)
      rocketAnimation = background as AnimationDrawable
    }

    rocketImage.setOnClickListener({ rocketAnimation.start() })
  }
```

https://developer.android.com/guide/topics/graphics/drawable-animation

Reveal or hide a view using animation

Create a crossfade animation

```
<FrameLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:layout_width="match_parent"
    android:layout_height="match_parent">

    <ScrollView xmlns:android="http://schemas.android.com/apk/res/android"
        android:id="@+id/content"
        android:layout_width="match_parent"
        android:layout_height="match_parent">
        <TextView style="?android:textAppearanceMedium"
            android:lineSpacingMultiplier="1.2"
            android:layout_width="match_parent"
            android:layout_height="wrap_content"
            android:text="@string/lorem_ipsum"
            android:padding="16dp" />
    </ScrollView>

    <ProgressBar android:id="@+id/loading_spinner"
        style="?android:progressBarStyleLarge"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_gravity="center" />

</FrameLayout>
```

https://developer.android.com/training/animation/reveal-or-hide-view

Reveal or hide a view using animation

Set up the crossfade animation

```
class CrossfadeActivity : Activity() {

    private lateinit var mContentView: View
    private lateinit var mLoadingView: View
    private var mShortAnimationDuration: Int = 0
    ...
    override fun onCreate(savedInstanceState: Bundle?) {
        super.onCreate(savedInstanceState)
        setContentView(R.layout.activity_crossfade)

        mContentView = findViewById(R.id.content)
        mLoadingView = findViewById(R.id.loading_spinner)

        // Initially hide the content view.
        mContentView.visibility = View.GONE

        // Retrieve and cache the system's default "short" animation time.
        mShortAnimationDuration =
            resources.getInteger(android.R.integer.config_shortAnimTime)
    }
    ...
}
```

https://developer.android.com/training/animation/reveal-or-hide-view

Reveal or hide a view using animation

Crossfade the views

```
private fun crossfade() {
 mContentView.apply {
   // Set the content view to 0% opacity but visible, so that it is visible
   // (but fully transparent) during the animation.
   alpha = 0f
   visibility = View.VISIBLE

   // Animate the content view to 100% opacity, and clear any animation
   // listener set on the view.
   animate()
     .alpha(1f)
     .setDuration(mShortAnimationDuration.toLong())
     .setListener(null)
 }
 // Animate the loading view to 0% opacity. After the animation ends,
 // set its visibility to GONE as an optimization step (it won't
 // participate in layout passes, etc.)
 mLoadingView.animate()
     .alpha(0f)
```

https://developer.android.com/training/animation/reveal-or-hide-view

Move a View with Animation

Add curved motion

```
// arcTo() and PathInterpolator only available on API 21+
if (Build.VERSION.SDK_INT >= Build.VERSION_CODES.LOLLIPOP) {
  val path = Path().apply {
    arcTo(0f, 0f, 1000f, 1000f, 270f, -180f, true)
  }
  val pathInterpolator = PathInterpolator(path)
}

val animation = ObjectAnimator.ofFloat(view, "translationX", 100f).apply {
  interpolator = pathInterpolator
  start()
}
```

```
ObjectAnimator.ofFloat(view, "translationX", 100f).apply {
  duration = 2000
  start()
}
```

```
<pathInterpolator xmlns:android="http://schemas.android.com/apk/res/android"
  android:controlX1="0.4"
  android:controlY1="0"
  android:controlX2="1"
  android:controlY2="1"/>
```

https://developer.android.com/training/animation/reposition-view

Animate Movement using Spring Physics

```
dependencies {
    implementation 'androidx.dynamicanimation:dynamicanimation-ktx:1.1.0-alpha03'
}
```

```
val springAnim = findViewById<View>(R.id.imageView).let { img ->
    // Setting up a spring animation to animate the view's translationY property with the final
    // spring position at 0.
    SpringAnimation(img, DynamicAnimation.TRANSLATION_Y, 0f)
}
```

https://developer.android.com/reference/android/view/VelocityTracker

Stiffness

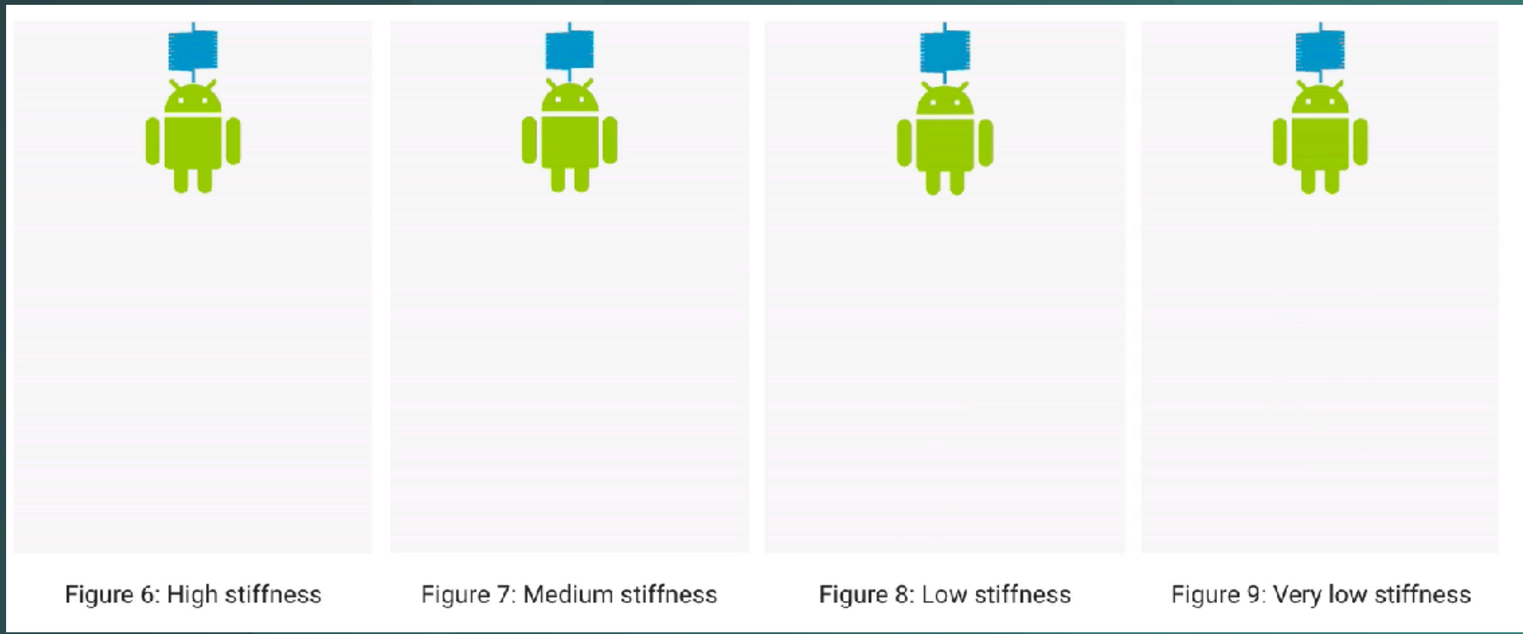


Figure 6: High stiffness

Figure 7: Medium stiffness

Figure 8: Low stiffness

Figure 9: Very low stiffness

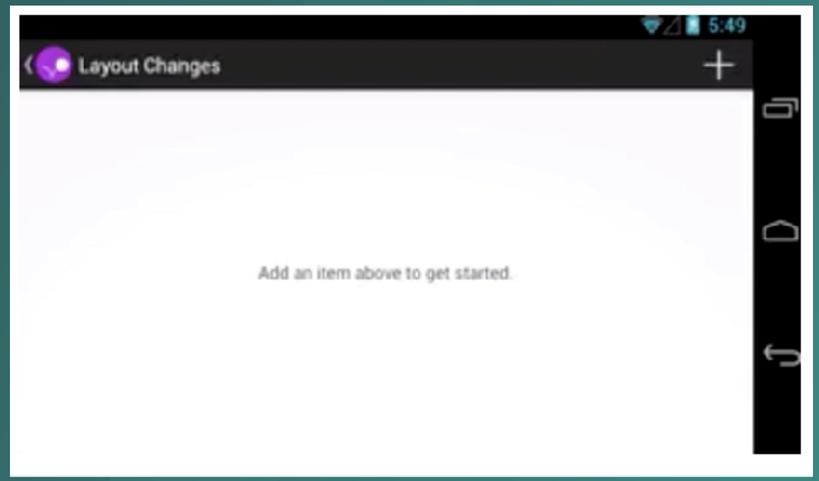
Auto Animate Layout Updates

Create the layout

```
<LinearLayout android:id="@+id/container"
    android:animateLayoutChanges="true"
    ...
/>
```

Add, update, or remove items from the layout

```
lateinit var mContainerView: ViewGroup
...
private fun addItem() {
    val newView: View = ...
    mContainerView.addView(newView, 0)
}
```



https://developer.android.com/training/animation/layout

Animate Layout Changes Using Transitions

Define layouts for scenes

```
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
  android:id="@+id/master_layout">
  <TextView
    android:id="@+id/title"
    ...
    android:text="Title"/>
  <FrameLayout
    android:id="@+id/scene_root">
    <include layout="@layout/a_scene" />
  </FrameLayout>
</LinearLayout>
```

`res/layout/another_scene.xml`

```
<RelativeLayout xmlns:android="http://schemas.android.com/apk/res/android"
  android:id="@+id/scene_container"
  android:layout_width="match_parent"
  android:layout_height="match_parent" >
  <TextView
    android:id="@+id/text_view2
    android:text="Text Line 2" />
  <TextView
    android:id="@+id/text_view1
    android:text="Text Line 1" />
</RelativeLayout>
```

`res/layout/a_scene.xml`

```
<RelativeLayout xmlns:android="http://schemas.android.com/apk/res/android"
  android:id="@+id/scene_container"
  android:layout_width="match_parent"
  android:layout_height="match_parent" >
  <TextView
    android:id="@+id/text_view1
    android:text="Text Line 1" />
  <TextView
    android:id="@+id/text_view2
    android:text="Text Line 2" />
</RelativeLayout>
```

Create the Scene

DEMO

Generate scenes from layouts

```
val mSceneRoot: ViewGroup = findViewById(R.id.scene_root)
val mAScene: Scene = Scene.getSceneForLayout(mSceneRoot, R.layout.a_scene, this)
val mAnotherScene: Scene = Scene.getSceneForLayout(mSceneRoot,
                    R.layout.another_scene, this)
```

Create a scene in your code

```
val mSceneRoot = mSomeLayoutElement as ViewGroup
val mViewHierarchy = someOtherLayoutElement as ViewGroup
val mScene: Scene = Scene(mSceneRoot, mViewHierarchy)
```

Apply a transition

```
var mFadeTransition: Transition =
   TransitionInflater.from(this)
                .inflateTransition(R.transition.fade_transition)

var mFadeTransition: Transition = Fade()

TransitionManager.go(mEndingScene, mFadeTransition)
```

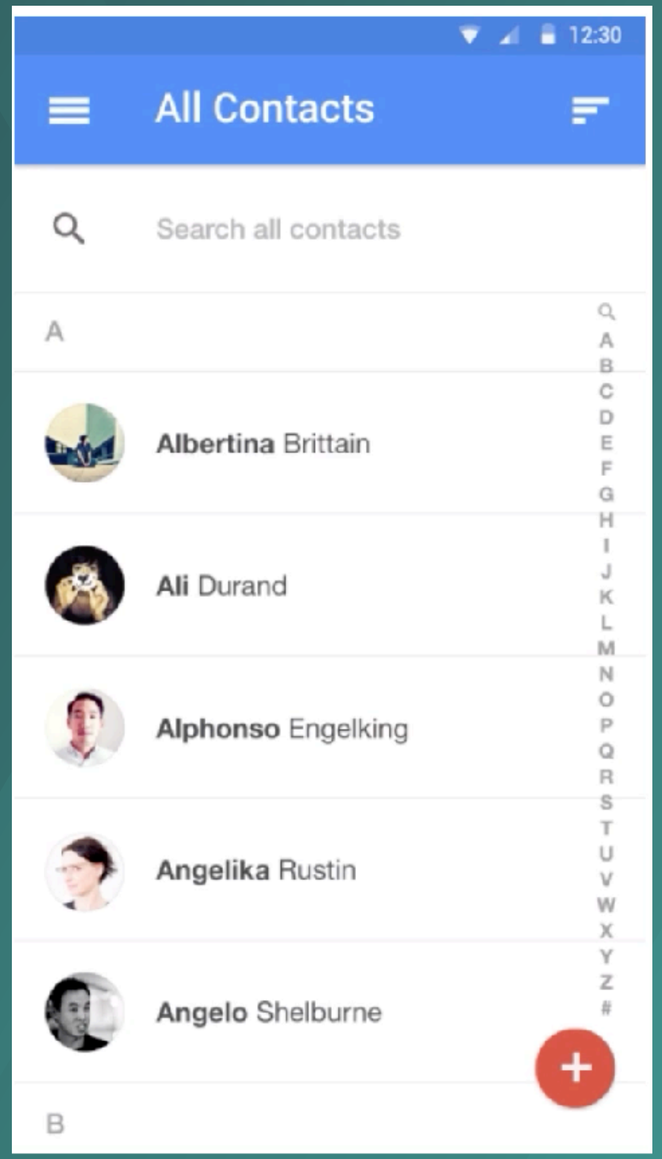
Start an Activity using an Animation

```
// get the element that receives the click event
val imgContainerView =
        findViewById<View>(R.id.img_container)

// get the common element for the
// transition in this activity
val androidRobotView =
        findViewById<View>(R.id.image_small)

// define a click listener
imgContainerView.setOnClickListener({
    val intent = Intent(this, Activity2::class.java)
    // create the transition animation
    // - the images in the layouts
    // of both activities are defined
    // with android:transitionName="robot"
    val options = ActivityOptions
            .makeSceneTransitionAnimation(
                this, androidRobotView, "robot")
    // start the new activity
    startActivity(intent, options.toBundle())
})
```

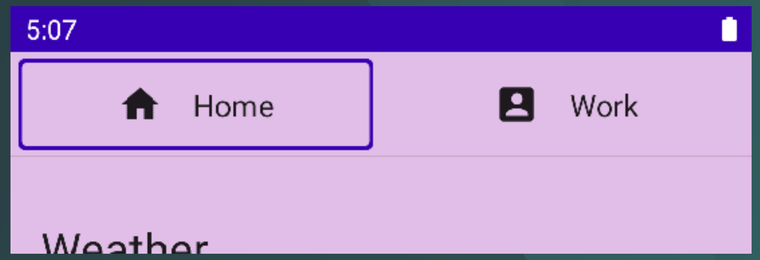
Rename the Pair class from the Android framework to avoid a name clash

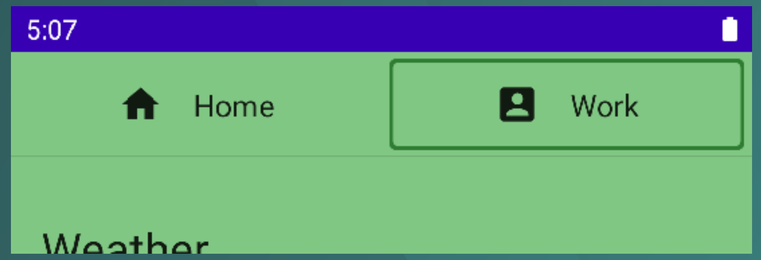
```
import android.util.Pair as UtilPair
...
    UtilPair.create(view1, "agreedName1"),
    UtilPair.create(view2, "agreedName2")
```

DEMO



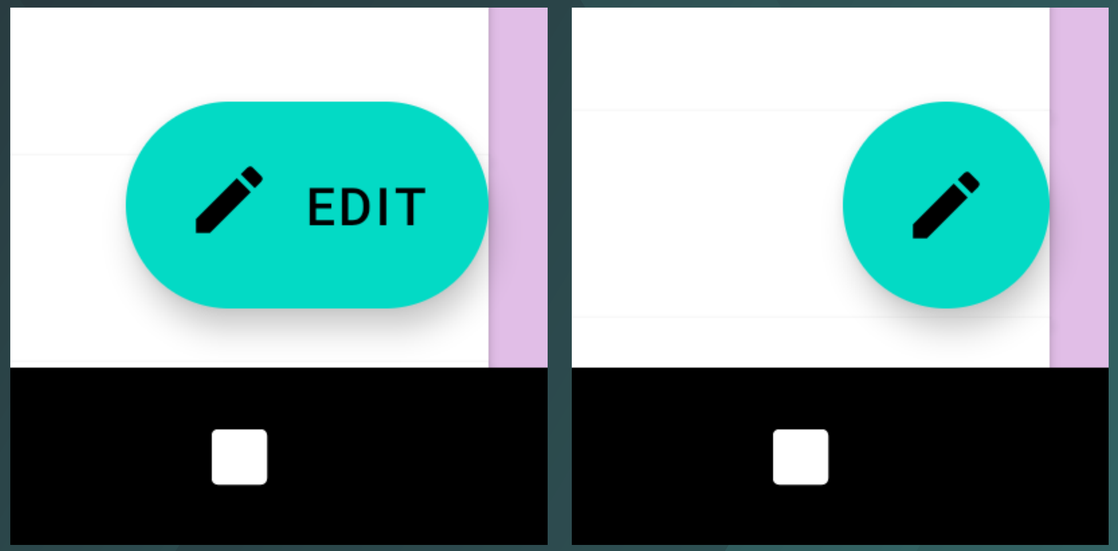
Animating a simple value change






```
val backgroundColor by animateColorAsState(if (tabPage == TabPage.Home) Purple100 else Green300)
```

Animating visibility



```
AnimatedVisibility(extended) {
    Text(
        text = stringResource(R.string.edit),
        modifier = Modifier
            .padding(start = 8.dp, top = 3.dp)
    )
}
```

Animating visibility

Topics

- 2 new packages arrived
- DIY project recommendation
- Festival next month
- New flower seeds available

Topics

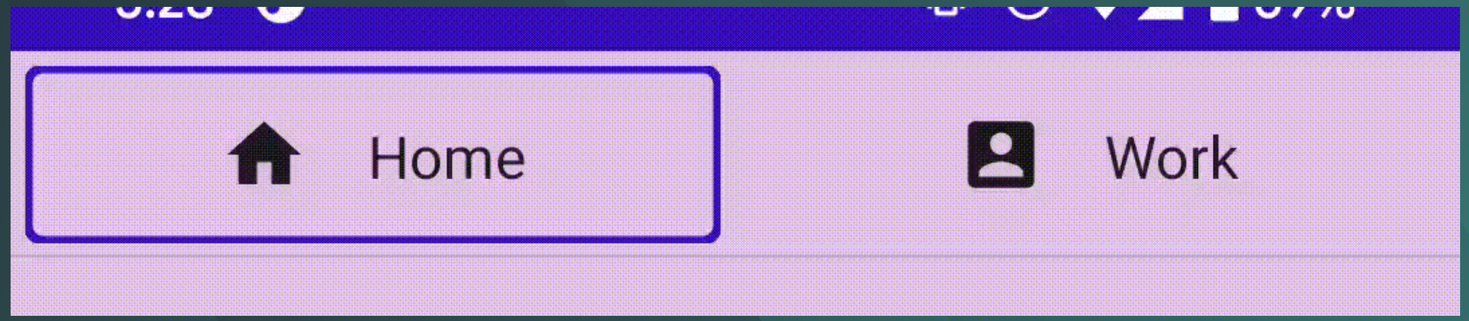
2 new packages arrived

DIY project recommendation

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

```
Column(
    modifier = Modifier
        .fillMaxWidth()
        .padding(16.dp)
        .animateContentSize()
) {
) {// ... the title and the body
}  // ... the title and the body
}
```

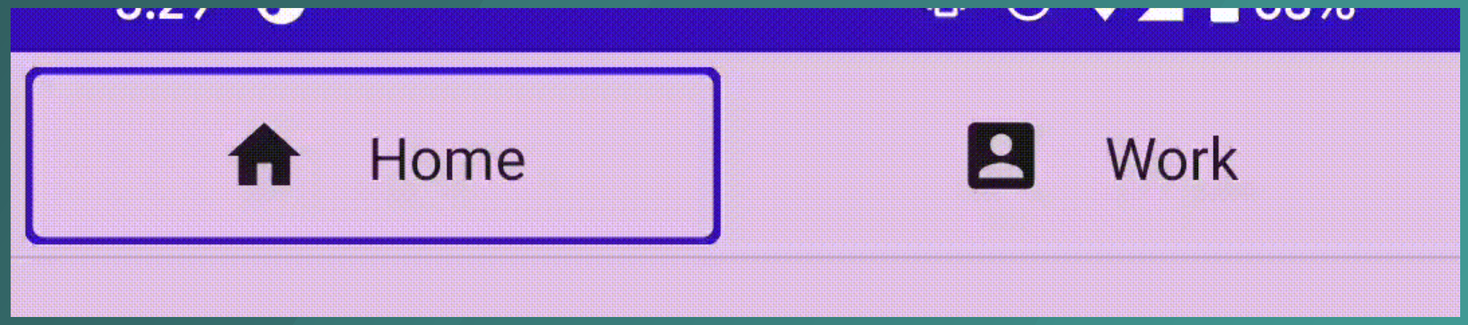
Multiple value animation




```
val transition = updateTransition(
    tabPage,
    label = "Tab indicator"
)
val indicatorLeft by transition.animateDp { page ->  tabPositions[page.ordinal].left }
val indicatorRight by transition.animateDp { page -> tabPositions[page.ordinal].right}
val color by transition.animateColor { page ->
    if (page == TabPage.Home) Purple700 else Green800
}
```

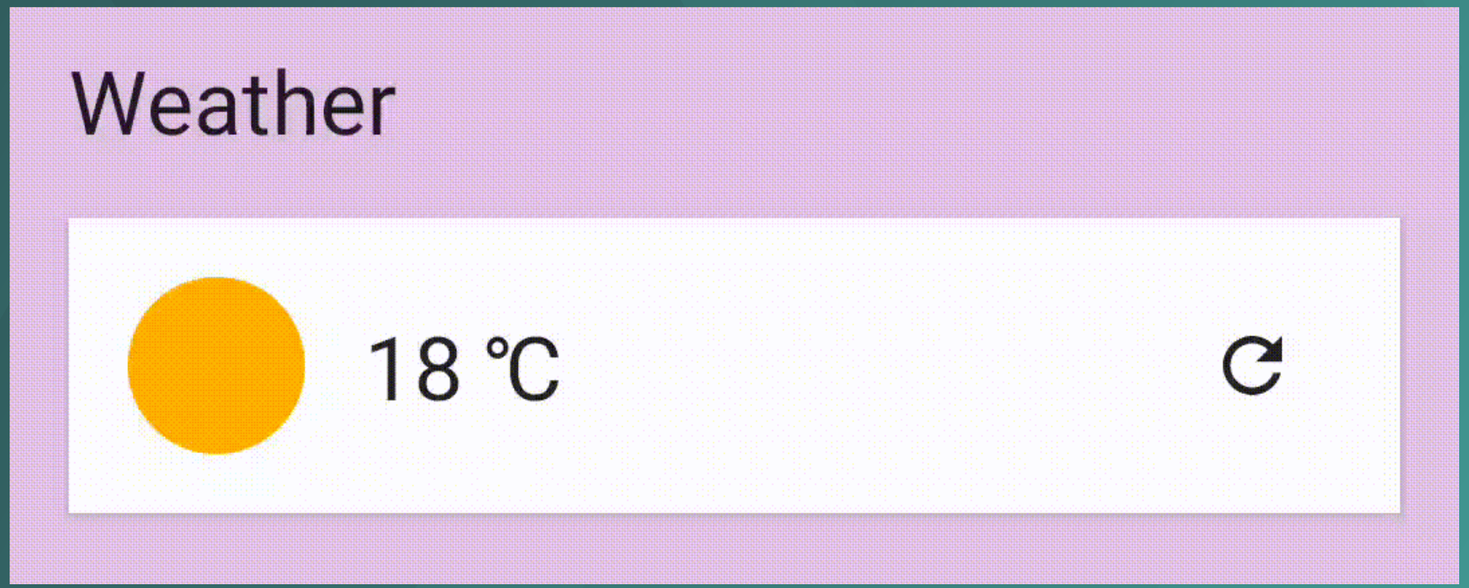
Multiple value animation

```
val indicatorLeft by transition.animateDp(
    transitionSpec = {
        if (TabPage.Home isTransitioningTo TabPage.Work) {
            // Indicator moves to the right.
            // The left edge moves slower than the right edge.
            spring(stiffness = Spring.StiffnessVeryLow)
        } else {
            // Indicator moves to the left.
            // The left edge moves faster than the right edge.
            spring(stiffness = Spring.StiffnessMedium)
        }
    },
    label = "Indicator left"
) { page -> tabPositions[page.ordinal].left}
```



Repeated animation


```
val infiniteTransition = rememberInfiniteTransition()
val alpha by infiniteTransition.animateFloat(
    initialValue = 0f,
    targetValue = 1f,
    animationSpec = infiniteRepeatable(
        animation = keyframes {
            durationMillis = 1000
            0.7f at 500
        },
        repeatMode = RepeatMode.Reverse
    )
)
```



Flutter Animations

Implicitly animated widgets

- **AnimatedContainer <-> Container**
- **AnimatedPositioned <-> Positioned**
- **…**
- **AnimatedGrid <-> Grid**
- **AnimatedList <-> List**

```
@override
Widget build(BuildContext context) {
 return Column(
   mainAxisAlignment: MainAxisAlignment.center,
   children: <Widget>[
    Container(
      width: _bigger ? 100 : 500,
      child: Image.asset('assets/star.png'),
    ),
    RaisedButton(
      onPressed: () => setState(() {
        _bigger = !_bigger;
      }),
      child: Icon(Icons.star),
    ),
   ],
 );
}
```

Flutter Animations

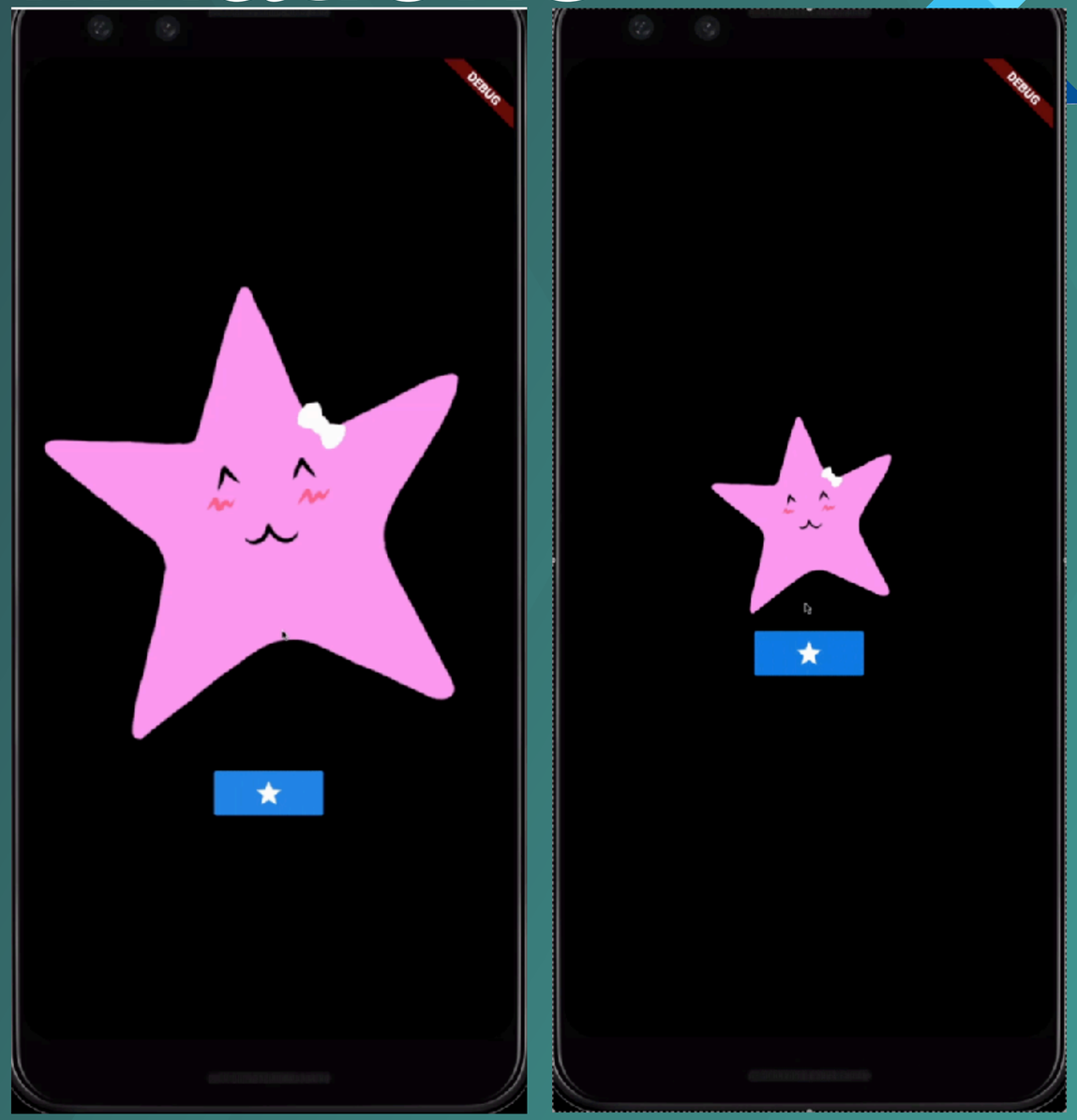
```
@override
Widget build(BuildContext context) {
  return Column(
    mainAxisAlignment: MainAxisAlignment.center,
    children: <Widget>[
      Container(
        width: _bigger ? 100 : 500,
        child: Image.asset('assets/star.png'),
      ),
      RaisedButton(
        onPressed: () => setState(() {
          _bigger = !_bigger;
        }),
        child: Icon(Icons.star),
      ),
    ],
  );
}
```

Flutter Animations

```
@override
Widget build(BuildContext context) {
  return Column(
    mainAxisAlignment: MainAxisAlignment.center,
    children: <Widget>[
      AnimatedContainer(
          width: _bigger ? 100 : 500,
          child: Image.asset('assets/star.png'),
          duration: Duration(seconds: 1),
      ),
      RaisedButton(
        onPressed: () => setState(() {
          _bigger = !_bigger;
        }),
        child: Icon(Icons.star),
      ),
    ],
  );
}
```

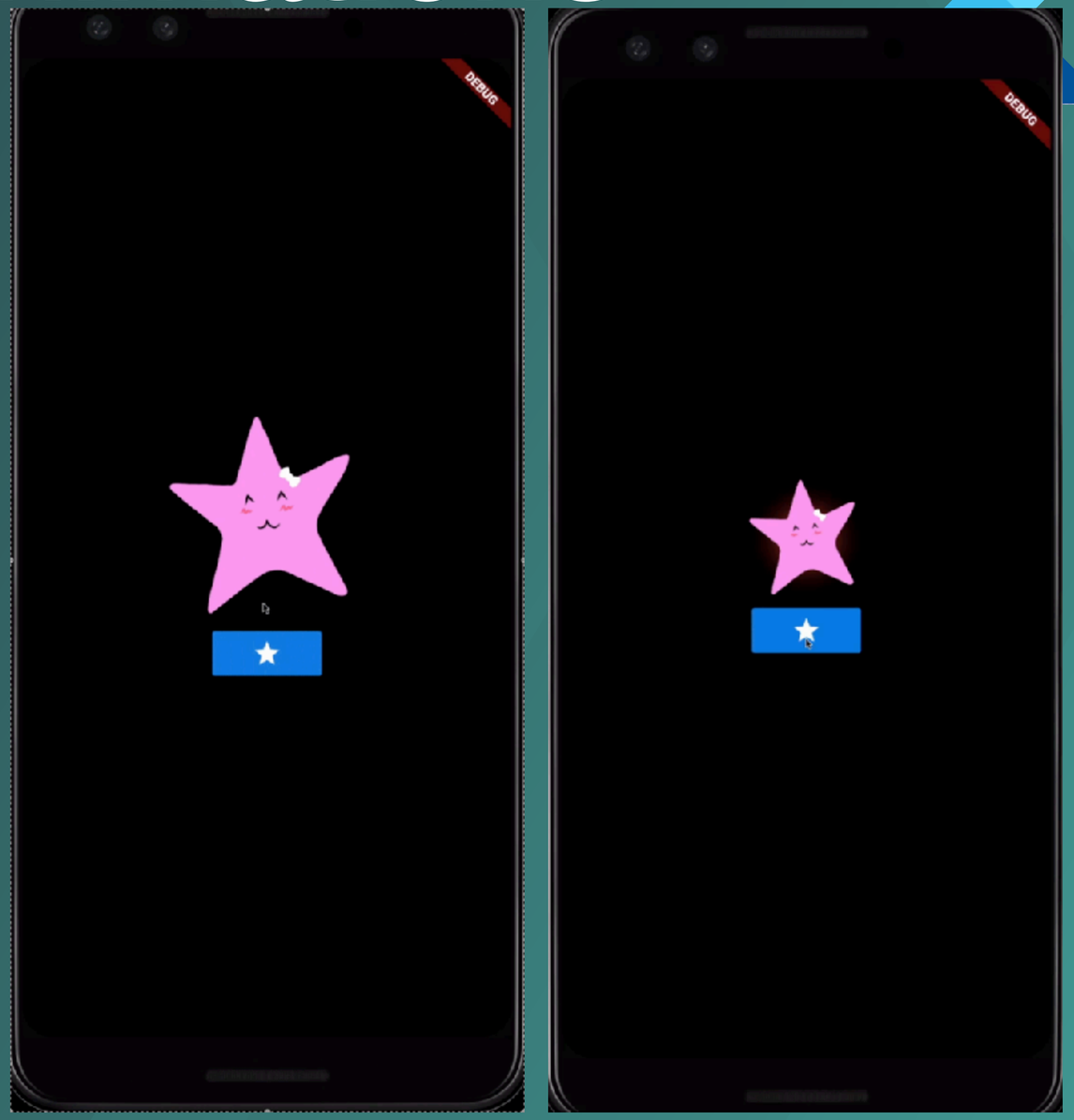
Flutter Animations

```
@override
Widget build(BuildContext context) {
  return Column(
    mainAxisAlignment: MainAxisAlignment.center,
    children: <Widget>[
      AnimatedContainer(
          width: _bigger ? 100 : 500,
          child: Image.asset('assets/star.png'),
          duration: Duration(seconds: 1),
      ),
      RaisedButton(
        onPressed: () => setState(() {
          _bigger = !_bigger;
        }),
        child: Icon(Icons.star),
      ),
    ],
  );
}
```



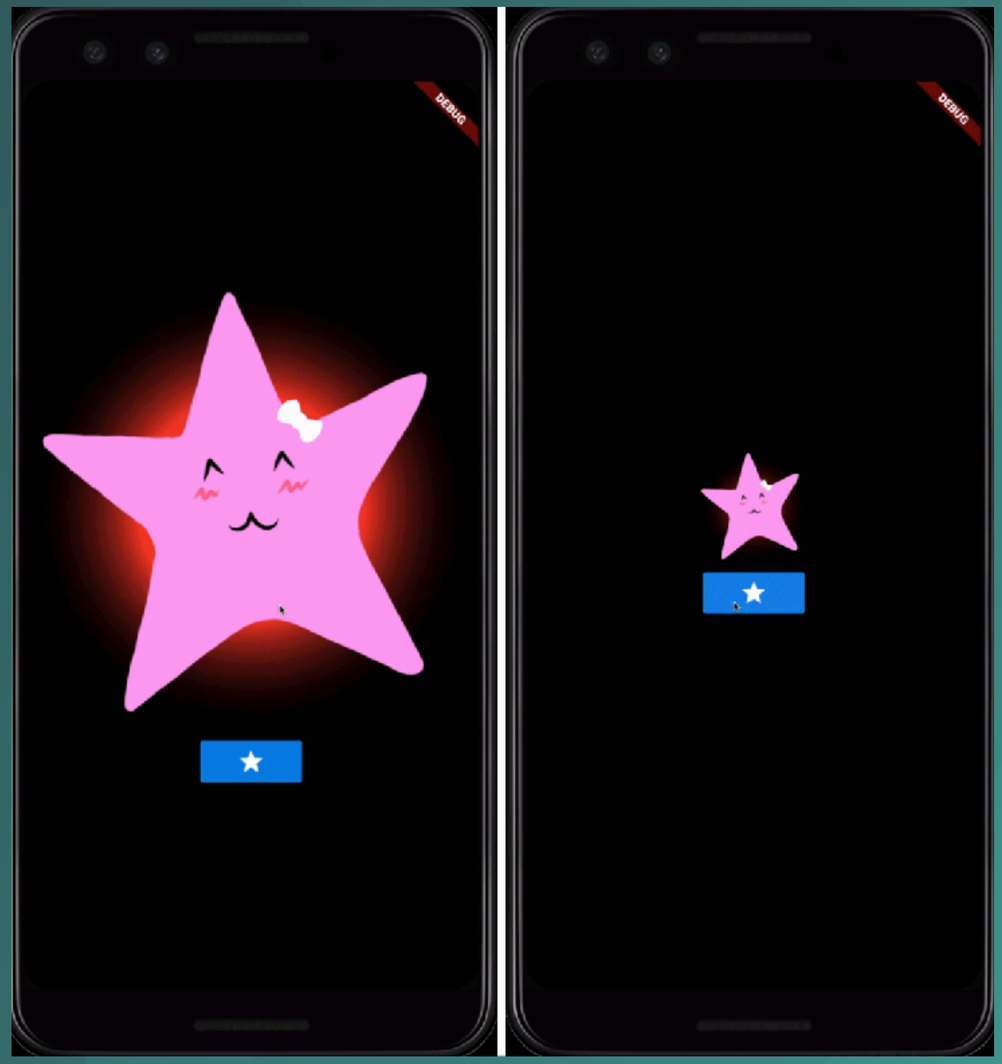
Flutter Animations

```
@override
Widget build(BuildContext context) {
  return Column(
    mainAxisAlignment: MainAxisAlignment.center,
    children: <Widget>[
      AnimatedContainer(
        decoration: BoxDecoration(
        gradient: RadialGradient(
          colors: [Colors.purple, Colors.transparent],
          stops: [ _bigger ? 0.2 : 0.5, 1.0])
        ),
      ),
      RaisedButton(
        onPressed: () => setState(() {
          _bigger = !_bigger;
        }),
        child: Icon(Icons.star),
      ),
    ],
  );
}
```



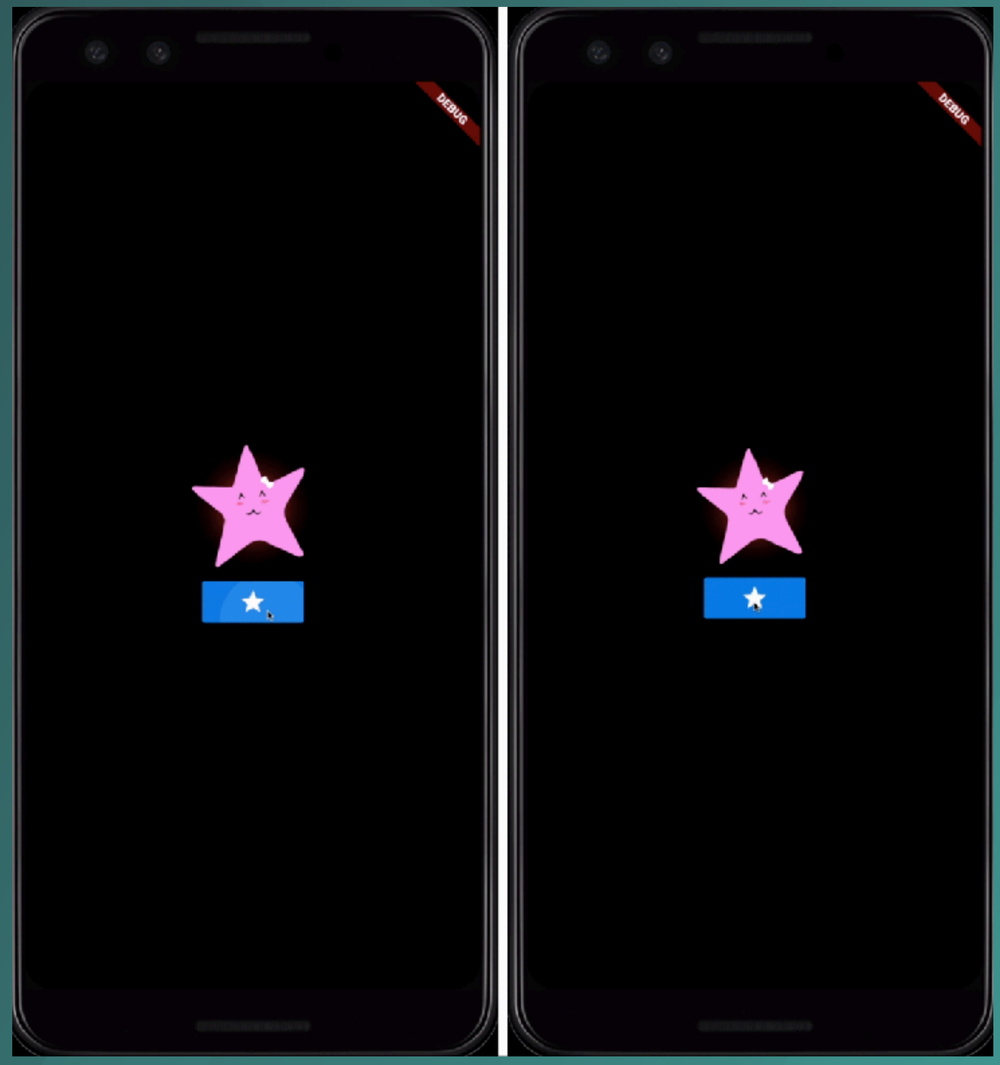
Controlling the animation with duration and curves

```
@override
Widget build(BuildContext context) {
  return Column(
    mainAxisAlignment: MainAxisAlignment.center,
    children: <Widget>[
      AnimatedContainer(
        width: _bigger ? 100 : 500,
        child: Image.asset('assets/star.png'),
        duration: Duration(seconds: 5),
      ),
      RaisedButton(
        onPressed: () => setState(() {
          _bigger = !_bigger;
        }),
        child: Icon(Icons.star),
      ),
    ],
  );
}
```



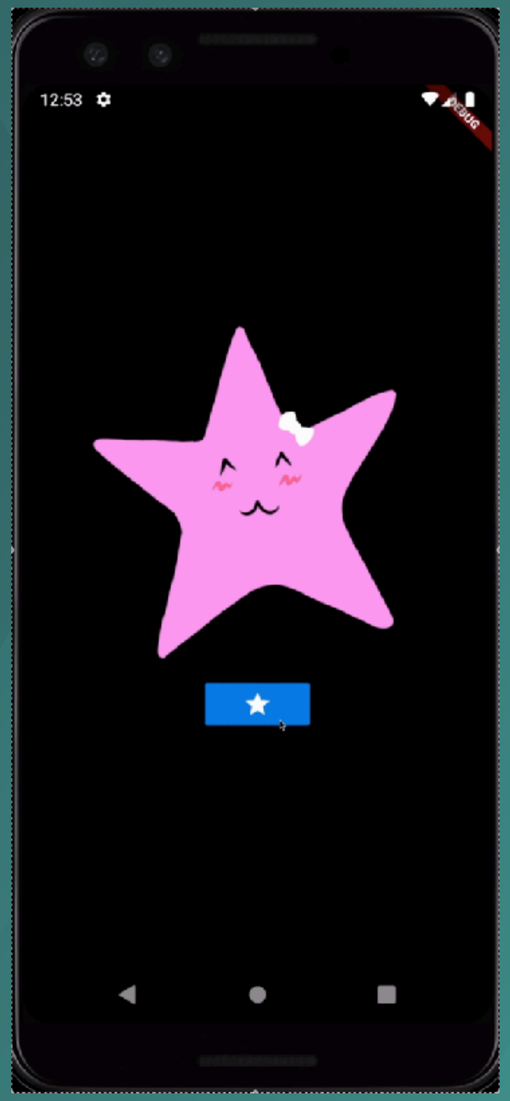
Controlling the animation with duration and curves

```
@override
Widget build(BuildContext context) {
  return Column(
    mainAxisAlignment: MainAxisAlignment.center,
    children: <Widget>[
      AnimatedContainer(
        width: _bigger ? 100 : 500,
        child: Image.asset('assets/star.png'),
        duration: Duration(seconds: 1),
        curve: Curves.easeInOutQuint,
      ),
      RaisedButton(
        onPressed: () => setState(() {
          _bigger = !_bigger;
        }),
        child: Icon(Icons.star),
      ),
    ],
  );
}
```



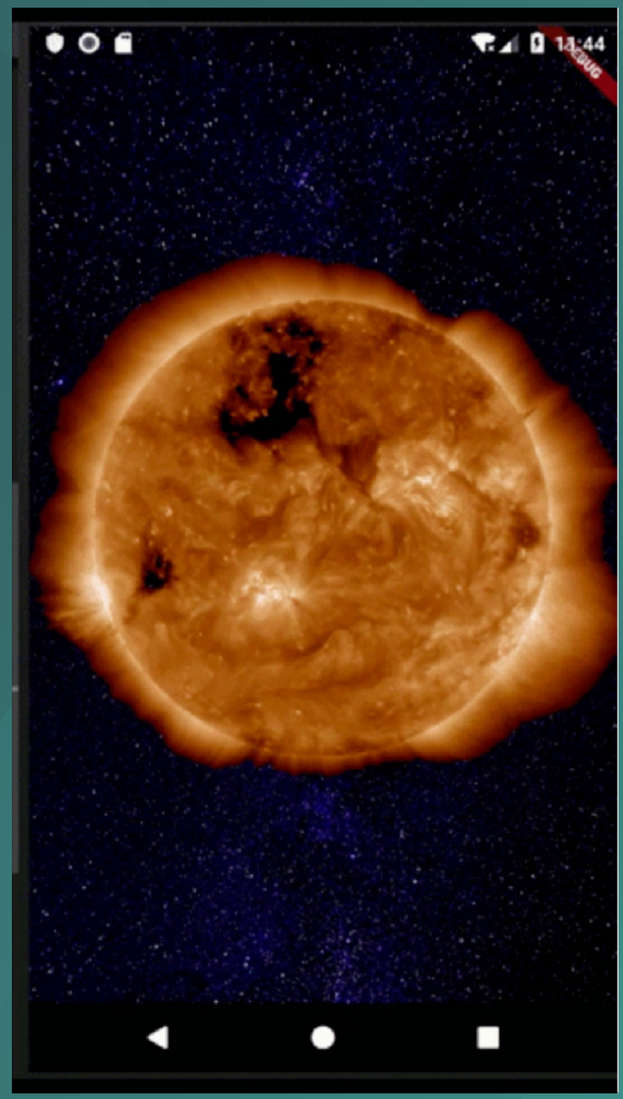
Controlling the animation with duration and curves

```
class SineCurve extends Curve {
  final double count;

  SineCurve({this.count = 1});

  @override
  double transformInternal(double t) {
    return sin(count * 2 * pi * t) * 0.5 + 0.5;
  }
}
```



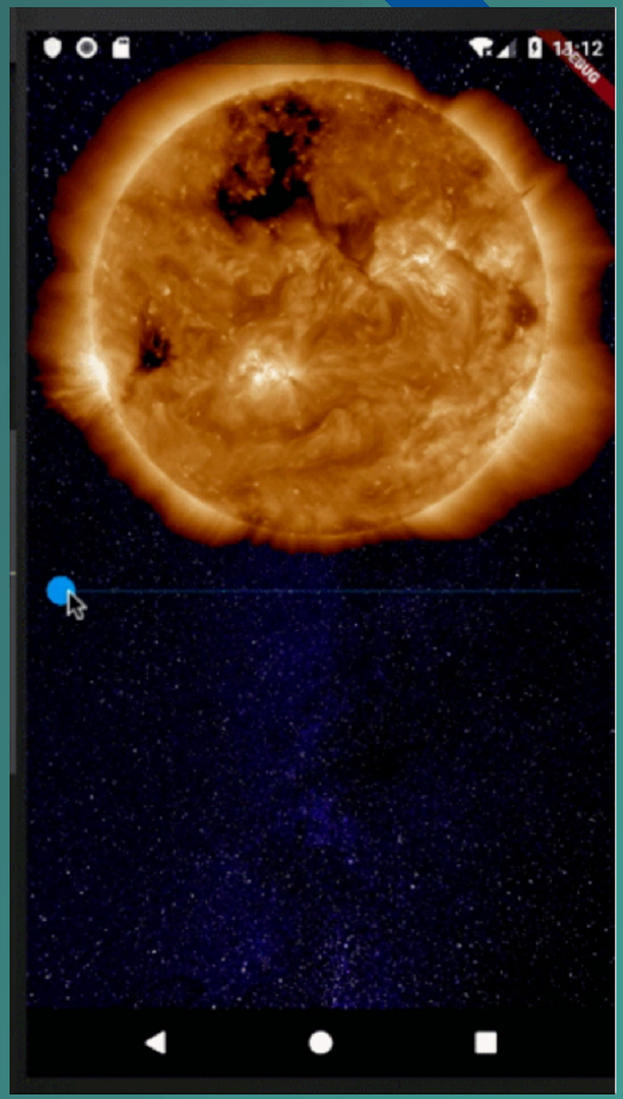
TweenAnimationBuilder

```
TweenAnimationBuilder(
  tween: ColorTween(begin: Colors.white, end: Colors.red),
  duration: Duration(seconds: 2),
  builder: (_, Color color, __) {
    return ColorFiltered(
      child: Image.asset('assets/sun.png'),
      colorFilter: ColorFilter.mode(color, BlendMode.modulate),
    );
  },
)
```

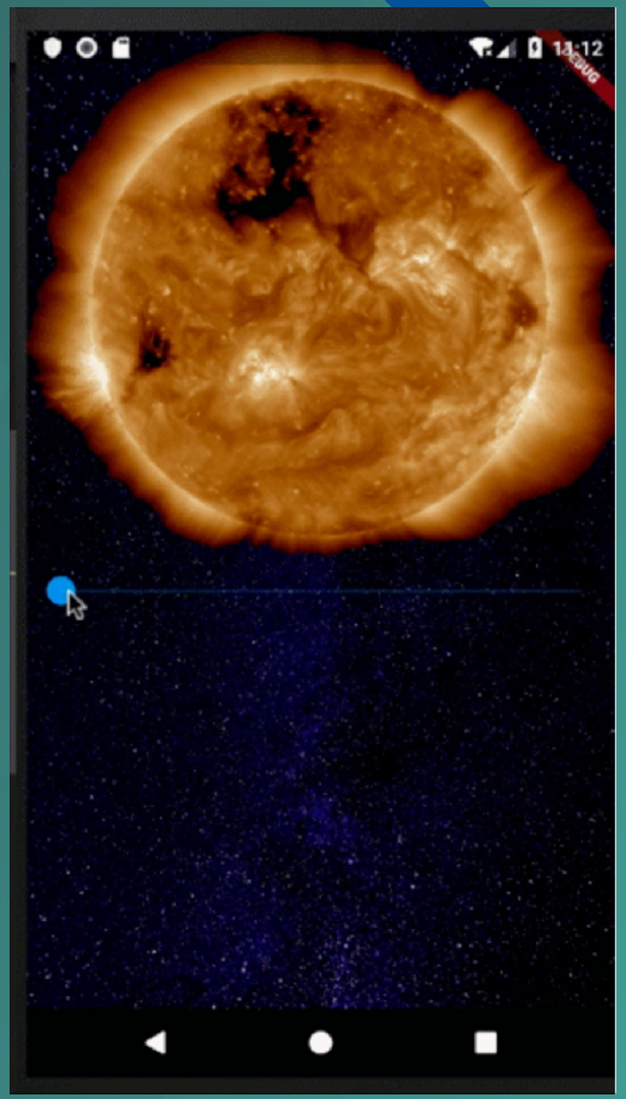


TweenAnimationBuilder

```
class OngoingAnimationByModifyingEndTweenValue extends StatefulWidget {
  @override
  _OngoingAnimationState createState() => _OngoingAnimationState();
}

class _OngoingAnimationState extends State<OngoingAnimationByModifyingEndTweenValue> {
  double _newValue = .4;
  Color _newColor = Colors.white;

  @override
  Widget build(BuildContext context) {
    return Stack(
      children: <Widget>[
        starsBackground,
        Column(
          children: <Widget>[
            Center(
              child: TweenAnimationBuilder(
                tween: ColorTween(begin: Colors.white, end: _newColor),
                duration: Duration(seconds: 2),
                builder: (_, Color color, __) {
                  return ColorFiltered(
```



```
double _newValue = .4;
Color _newColor = Colors.white;

@override
Widget build(BuildContext context) {
 return Stack(
  children: <Widget>[
   starsBackground,
   Column(
    children: <Widget>[
     Center(
      child: TweenAnimationBuilder(
       tween: ColorTween(begin: Colors.white, end: _newColor),
       duration: Duration(seconds: 2),
       builder: (_, Color color, __) {
        return ColorFiltered(
         child: Image.asset('assets/sun.png'),
         colorFilter: ColorFilter.mode(color, BlendMode.modulate),
        );
       },
      ),
     ),
     Slider.adaptive(
      value: _newValue,
      onChanged: (double value) {
       setState(() {
        _newValue = value;
        _newColor = Color.lerp(Colors.white, Colors.red, value);
       });
```



Lecture outcomes

- Animate bitmaps.
- Animate UI visibility and motion.
- Physics-based motion.
- Animate layout changes.
- Animate between activities.