Lecture #9
Animations

Mobile Applications 2018-2019

Housekeeping Notes

Valid ONLY for today
For students attending the 936/1 laboratory!

Orar C.d.asociat BARABAS Attila

Ziua	Orele	Frecventa	Sala	Anul	Formatia	Tipul	Disciplina
Luni	8-10	sapt. 2	L306	3 Informatica - in limba engleza	936/1	Laborator	Programare pentru dispozitive mobile
Luni	8-10	sapt. 1	L306	3 Informatica - in limba engleza	936/2	Laborator	Programare pentru dispozitive mobile

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~~Luni~~	~~8-10~~	~~sapt. 2~~	~~L306~~	~~3 Informatica - in limba engleza~~	~~936/1~~	~~Laborator~~	~~Programare pentru dispozitive mobile~~
Luni	8-10	sapt. 1	L306	3 Informatica - in limba engleza	936/2	Laborator	Programare pentru dispozitive mobile

Will be postponed to Wednesday December 5th, 2018 (this week)
L306 room, from 12:00.

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Ziua	Orele	Frecventa	Sala	Anul	Formatia	Tipul	Disciplina
WED	12-14	sapt. 2	L306	3 Informatica - in limba engleza	936/1	Laborator	Programare pentru dispozitive mobile
Luni	8-10	sapt. 1	L306	3 Informatica - in limba engleza	936/2	Laborator	Programare pentru dispozitive mobile

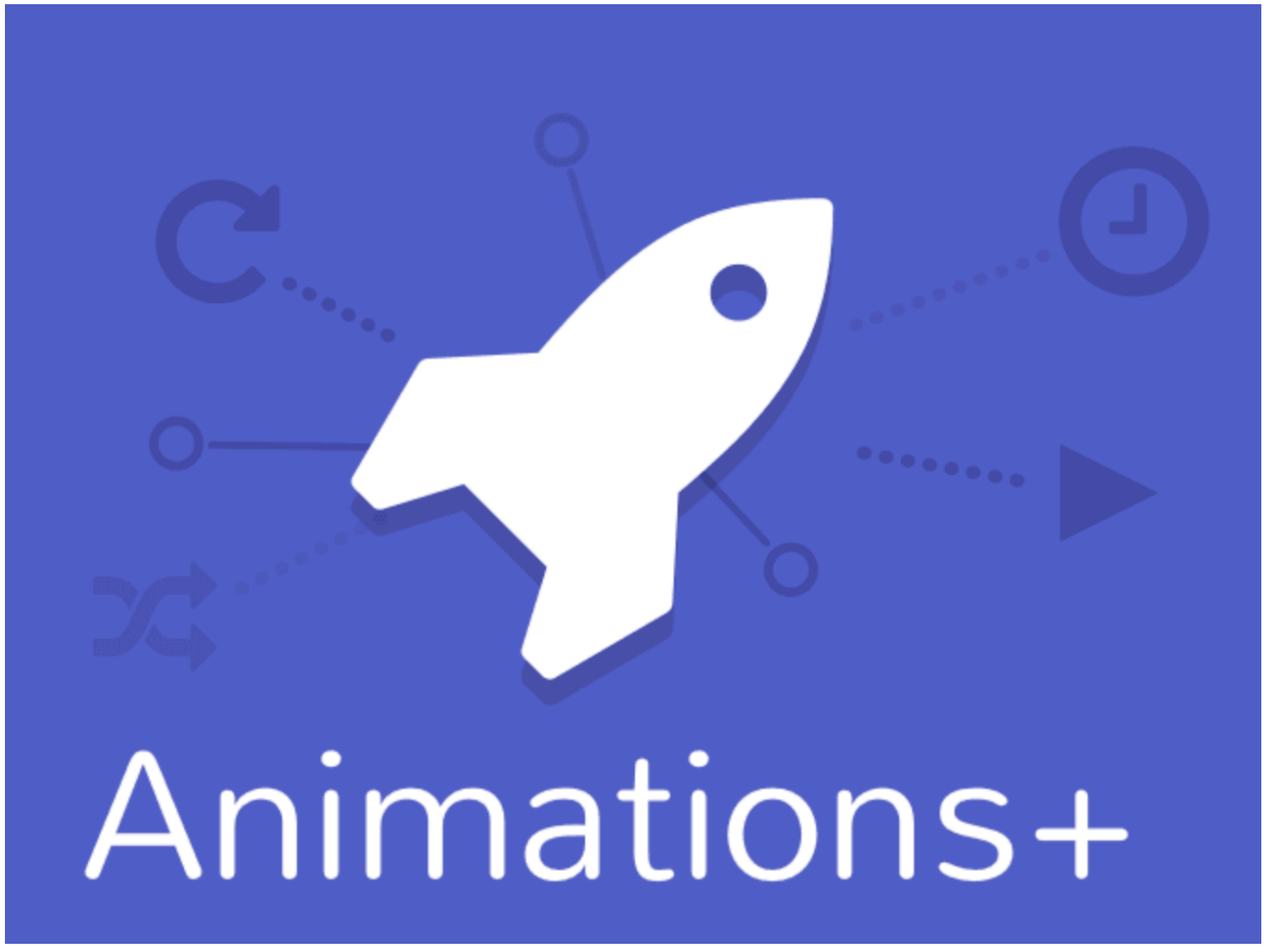
Next week on December 10th, 2018

+1p Final
Laboratory Grade

Next week on December 10th, 2018

Overview

- Add visual cues about what is going on.
- Useful when the UI changes states.
- Adding a polished look, gives 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.

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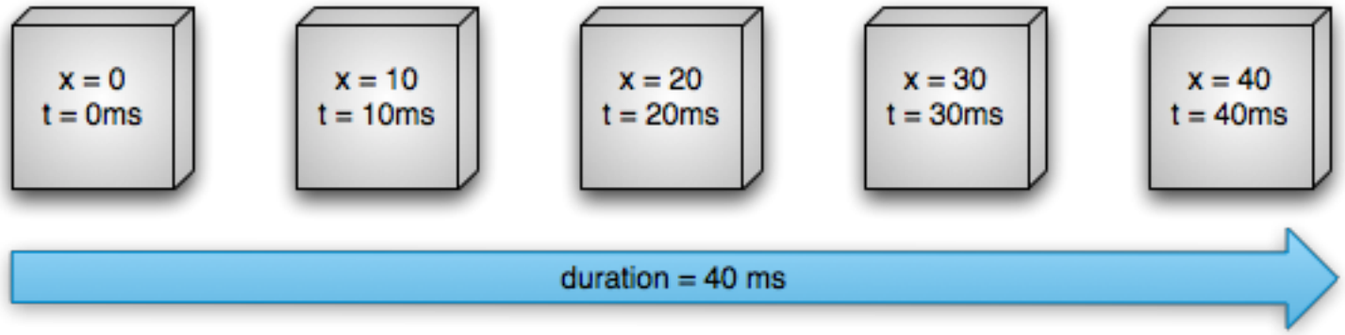
- Characteristics of an animation:
  - Duration. Default length: 300ms.
  - Time interpolation. Defines how the values for the property are calculated.
  - Repeat count and behavior.
  - Animation sets.
  - Frame refresh delay. Default value: 10ms.

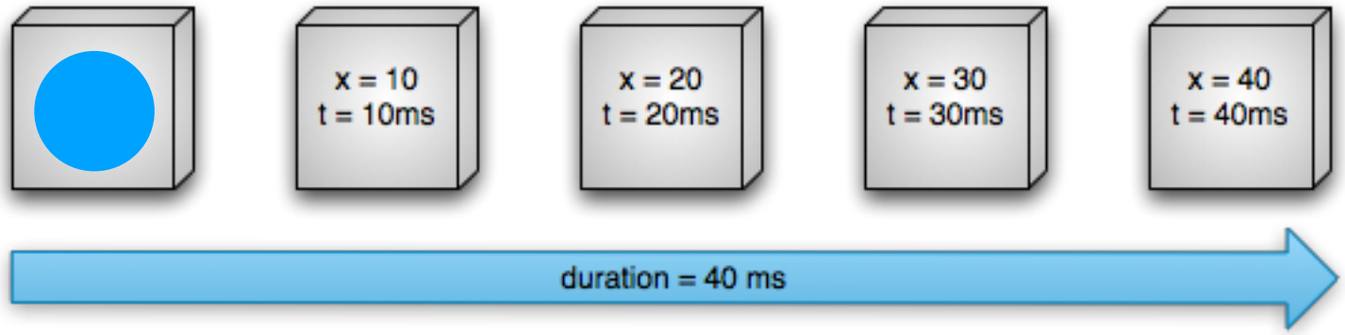
How property animation works

Linear animation



How property animation works

Linear animation



How property animation works

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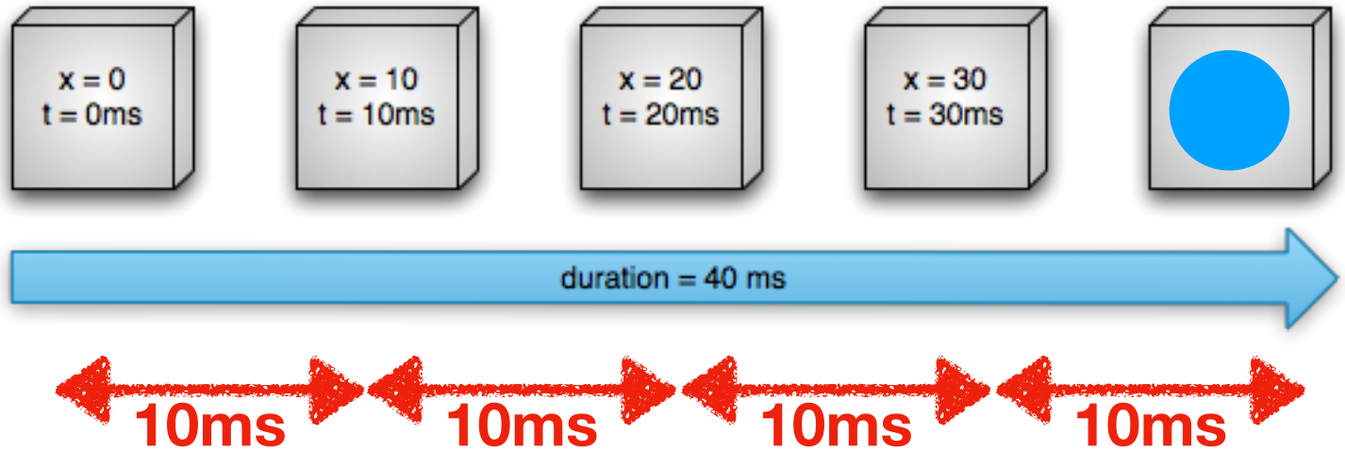
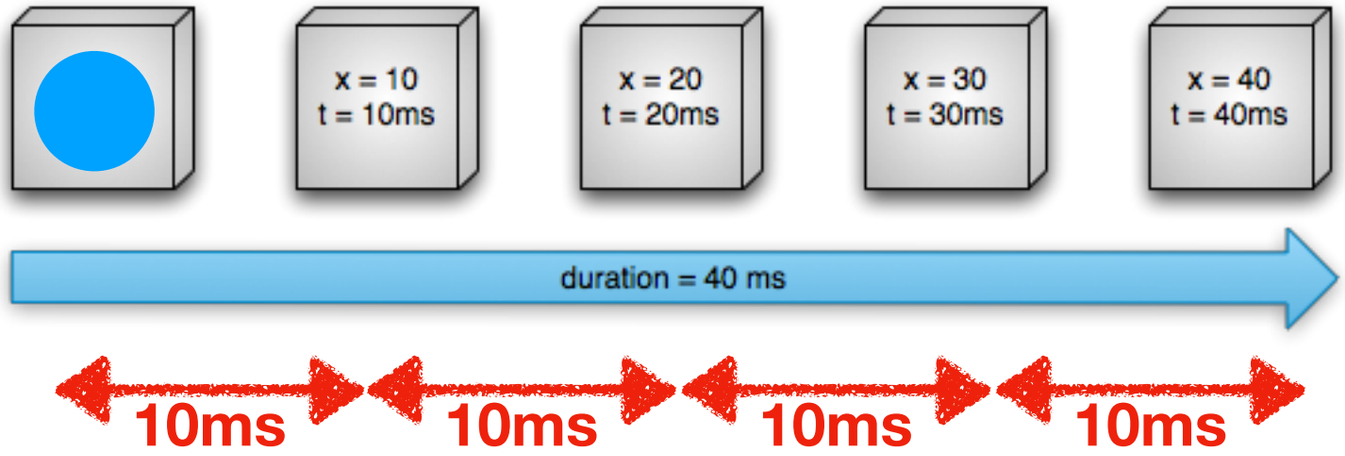


How property animation works

Linear animation



How property animation works

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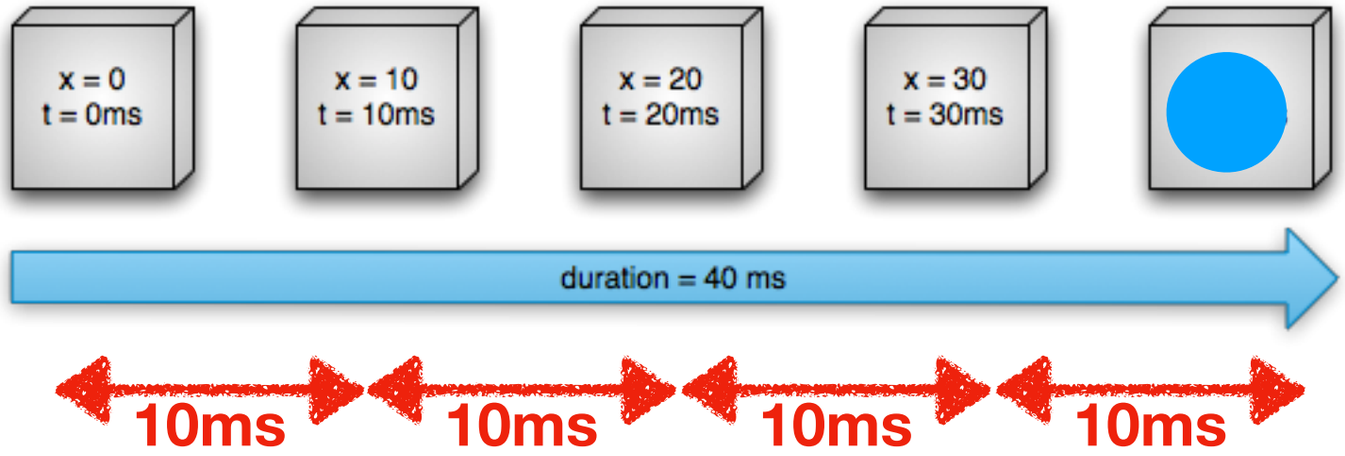
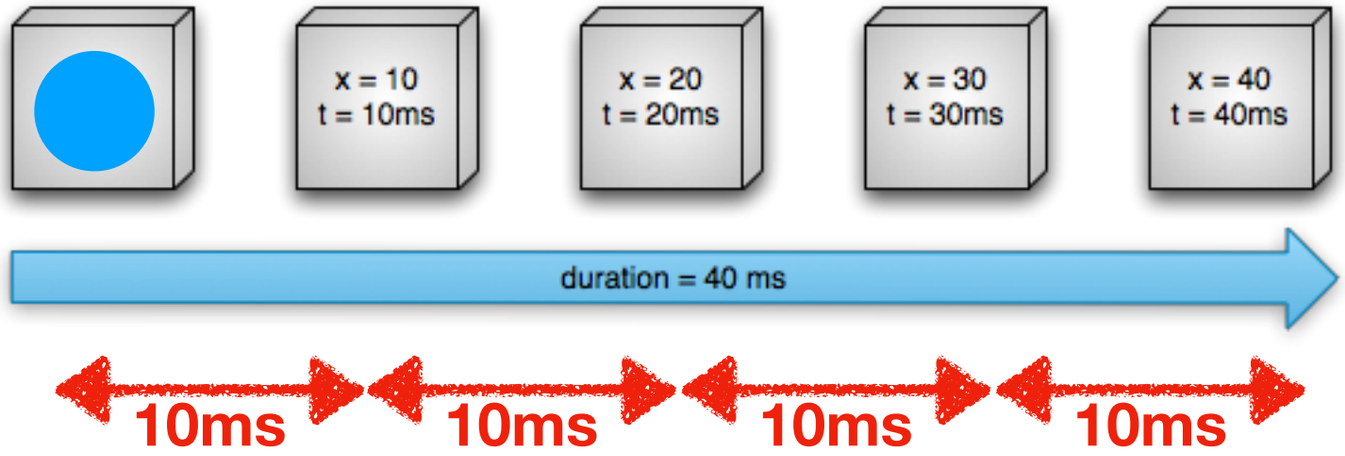


How property animation works

Linear animation



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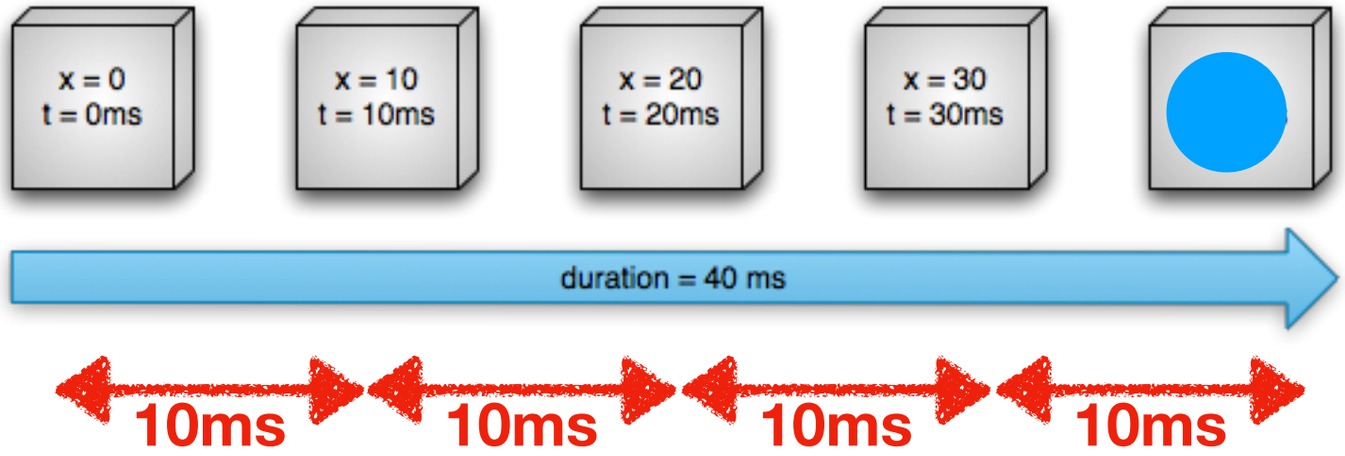

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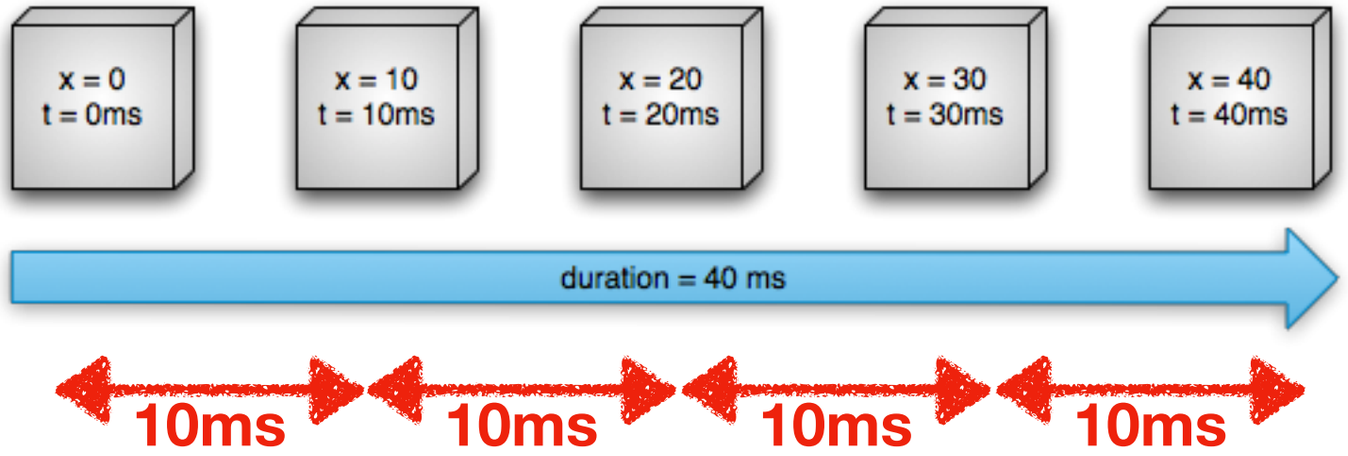
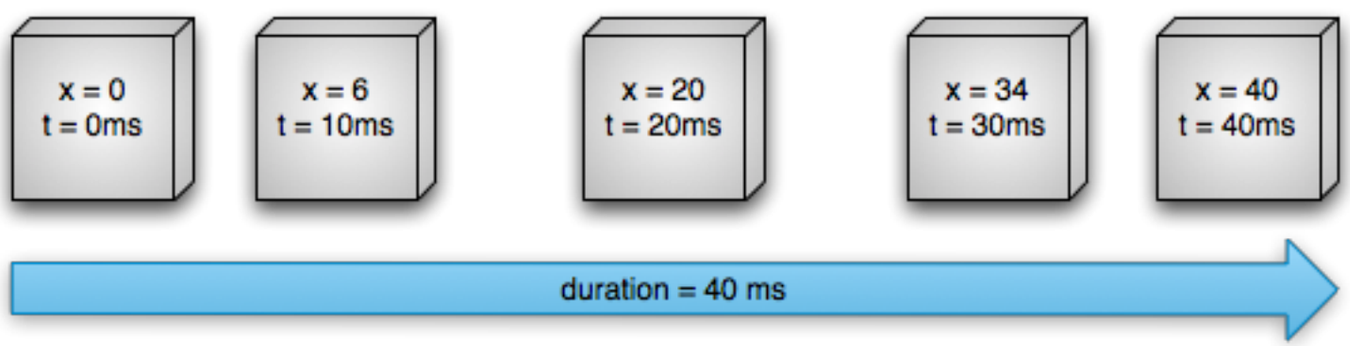


Non-linear animation



How property animation works

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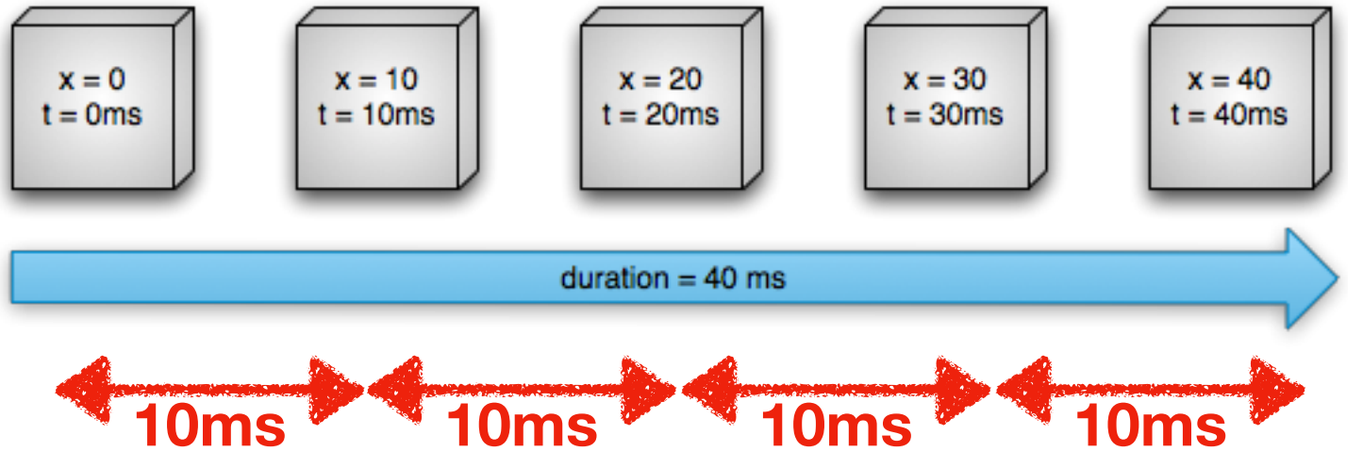

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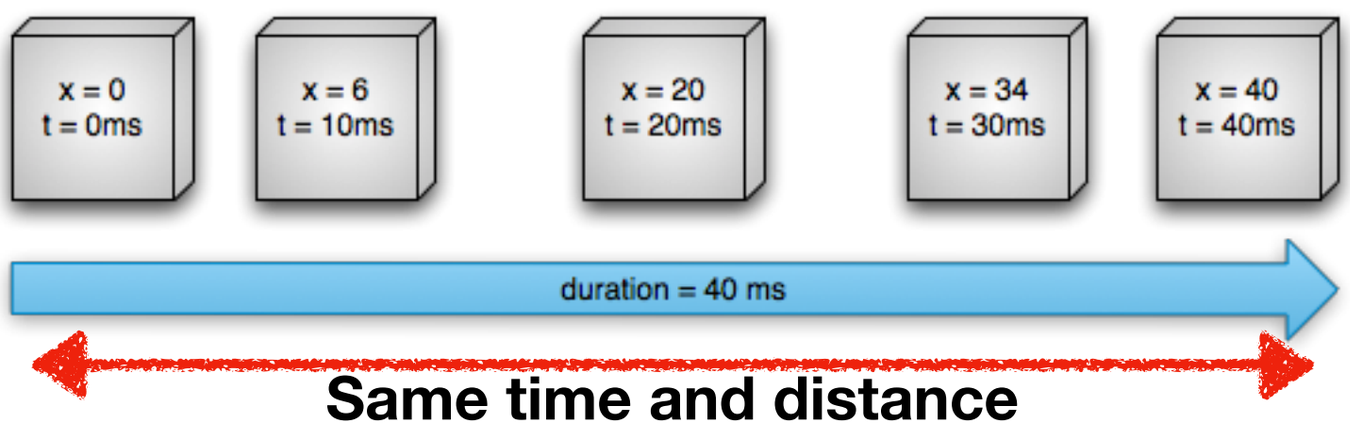
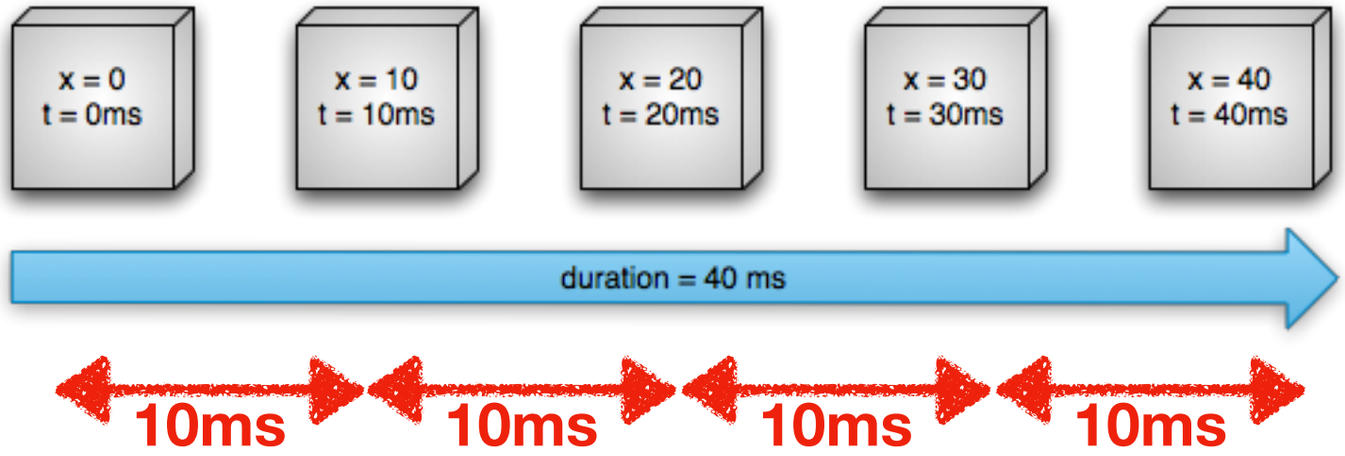


How property animation works

Linear animation



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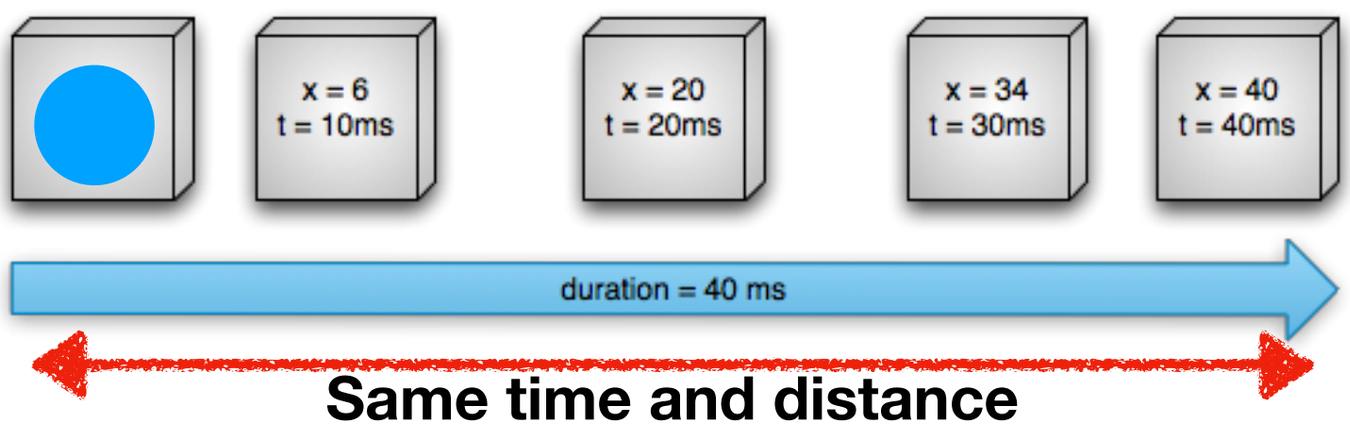

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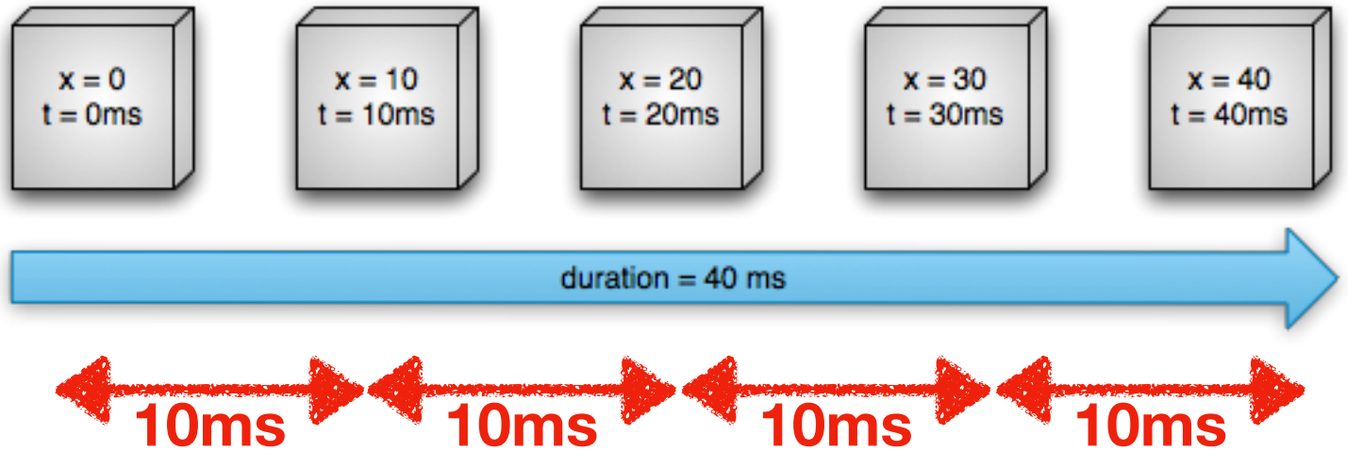

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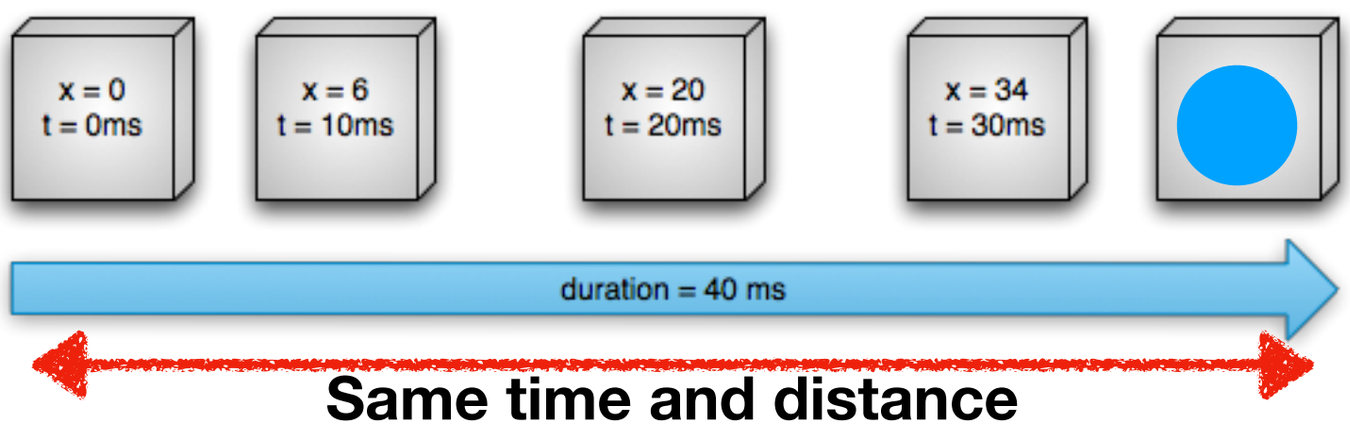

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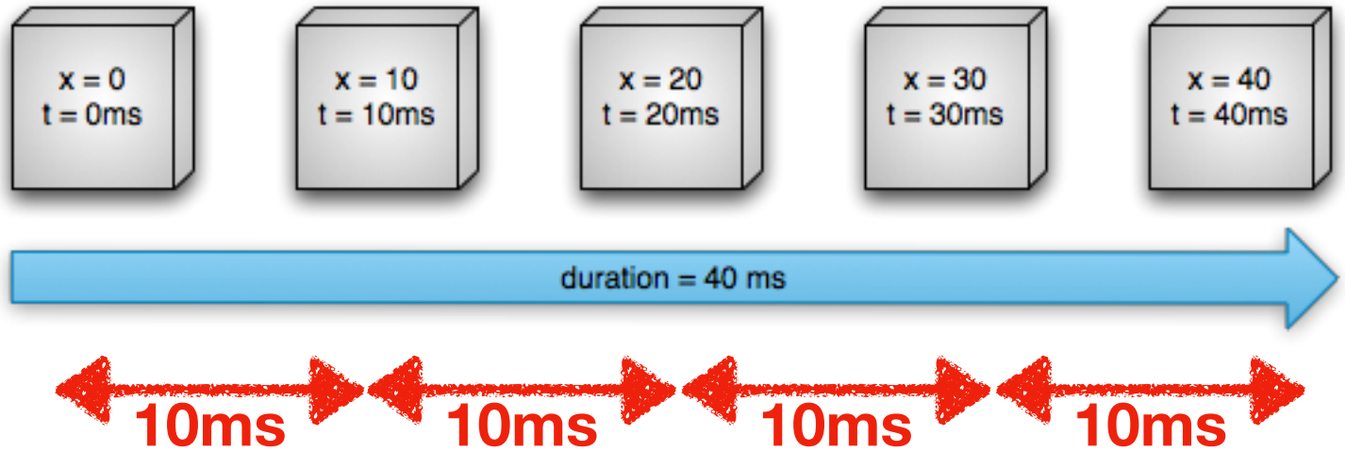

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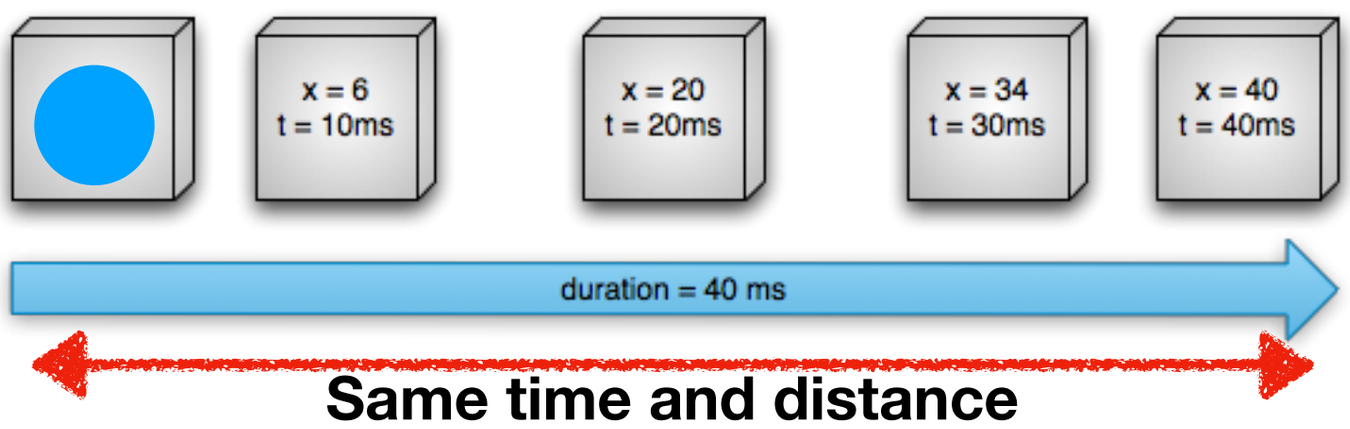

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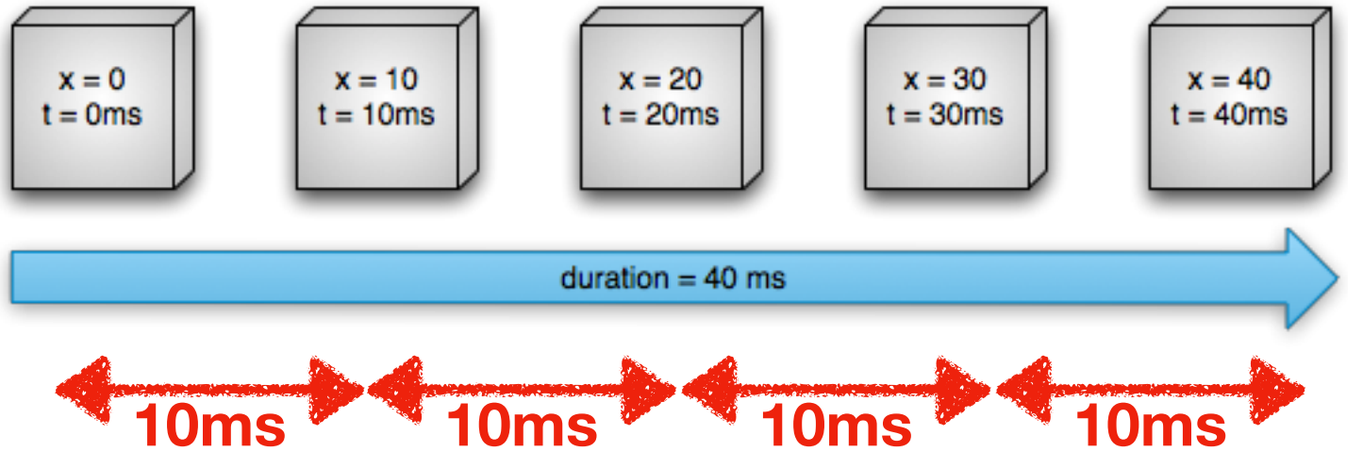

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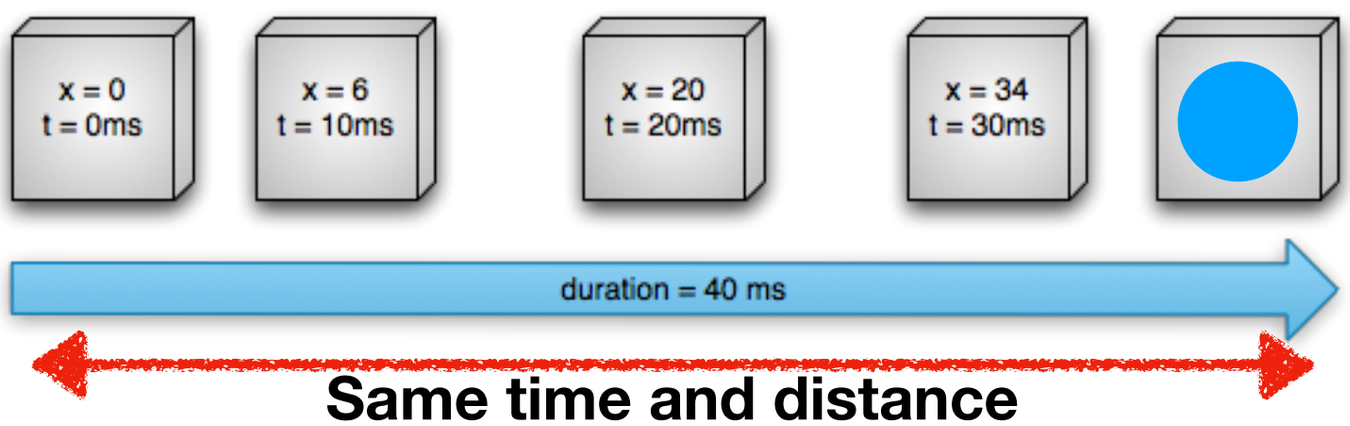

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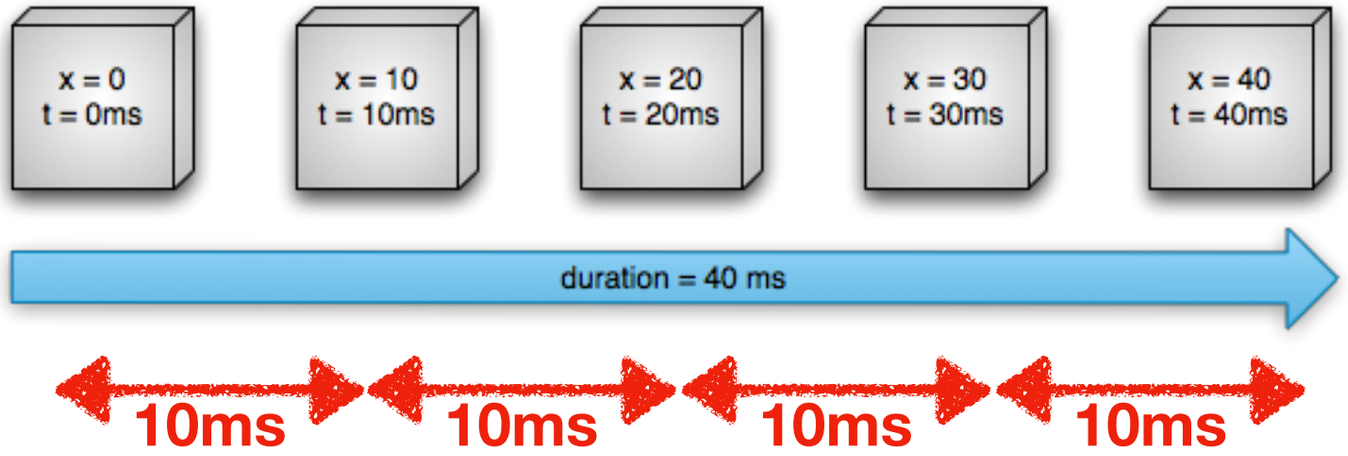

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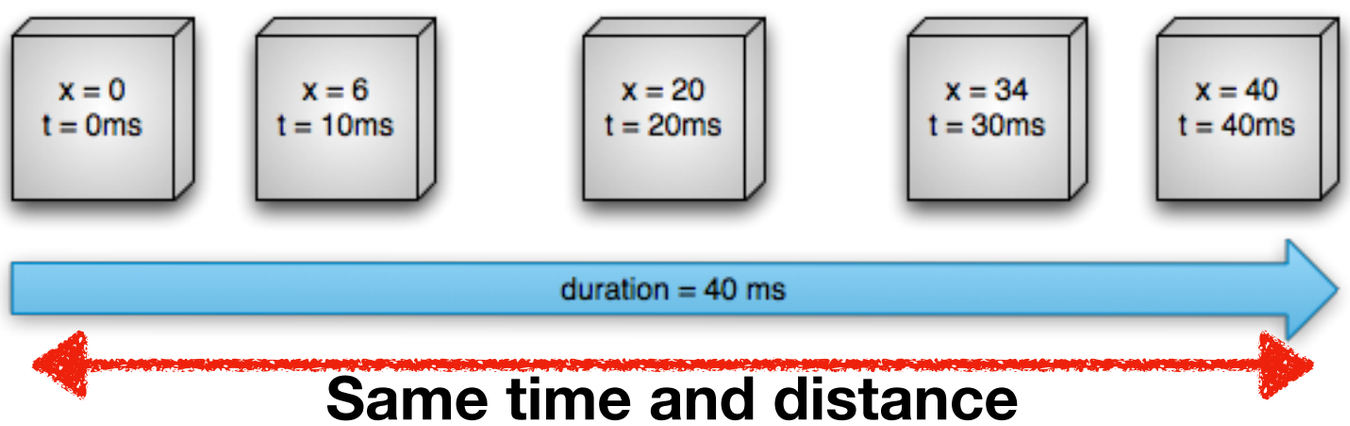

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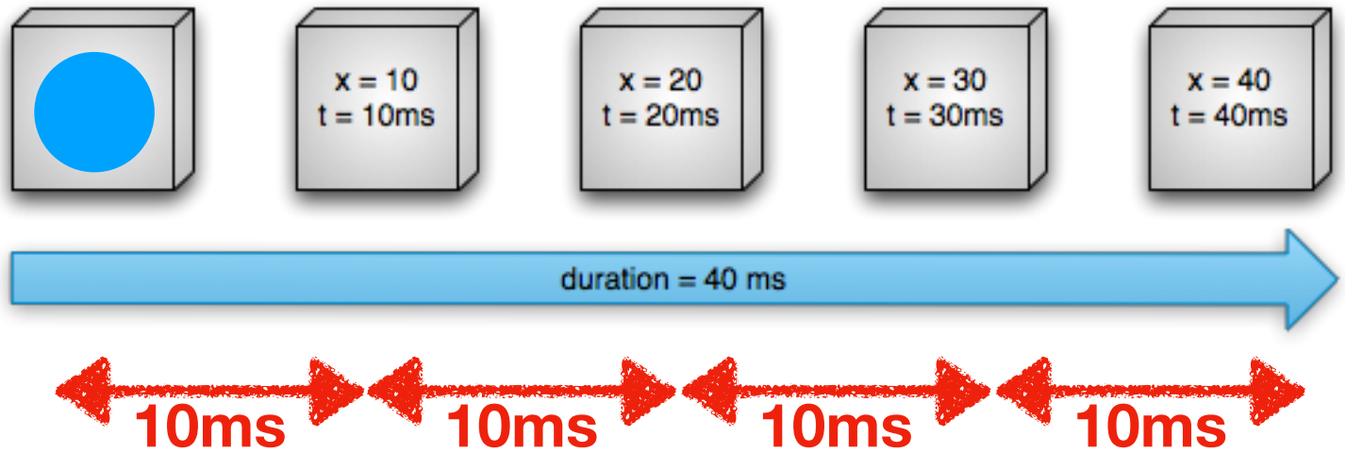

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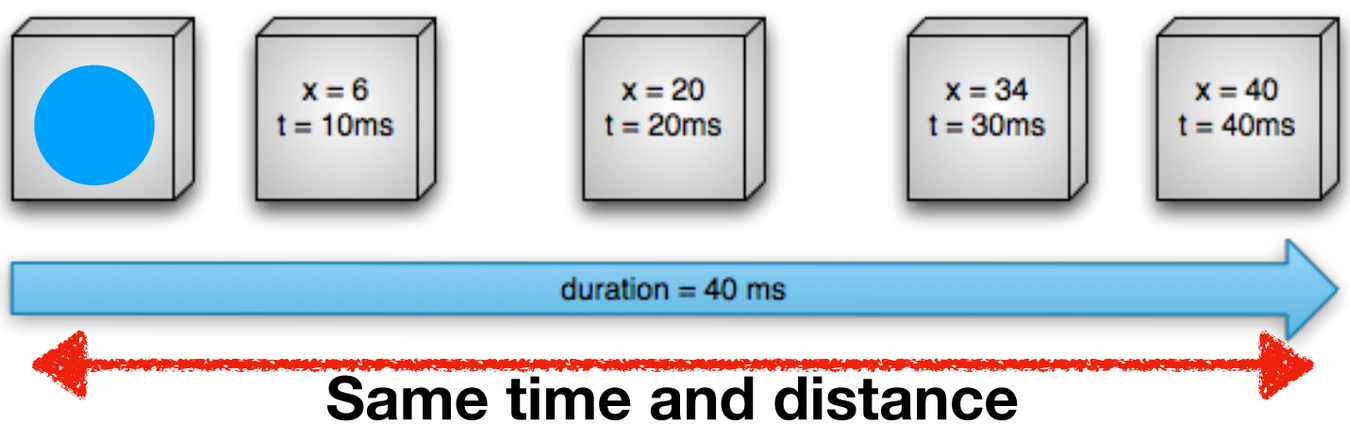

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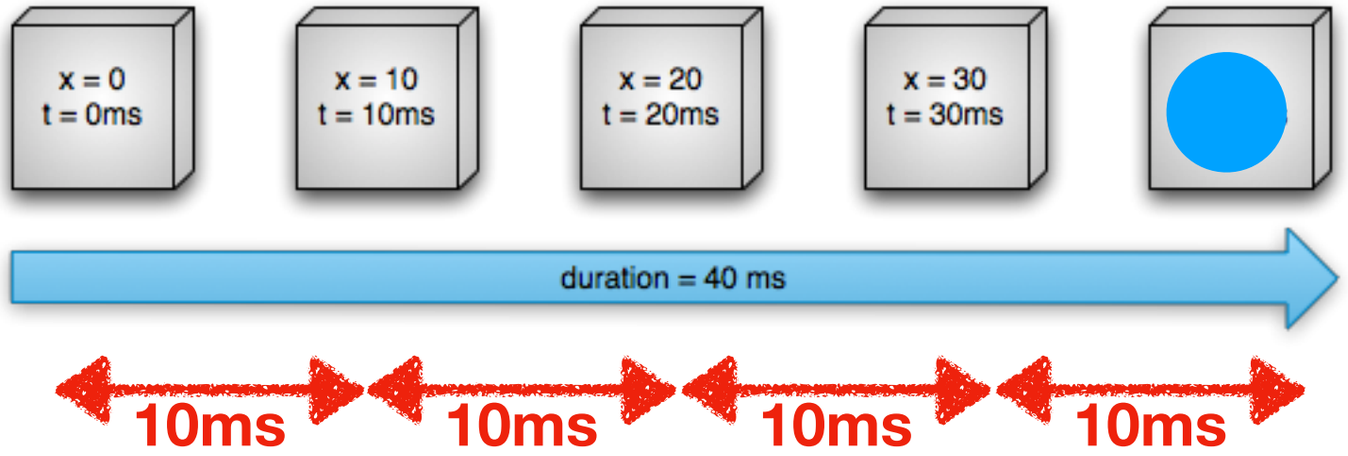

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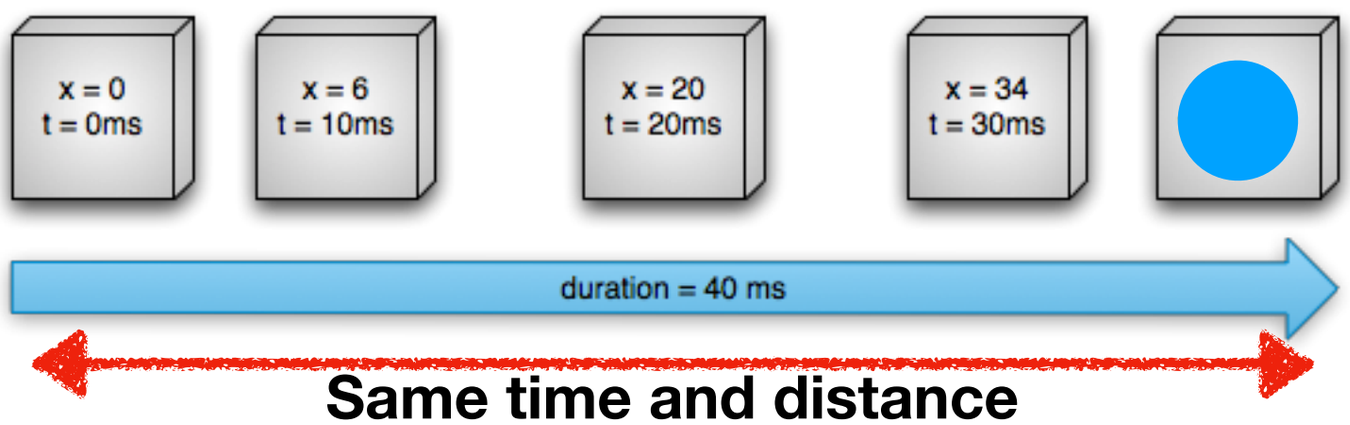
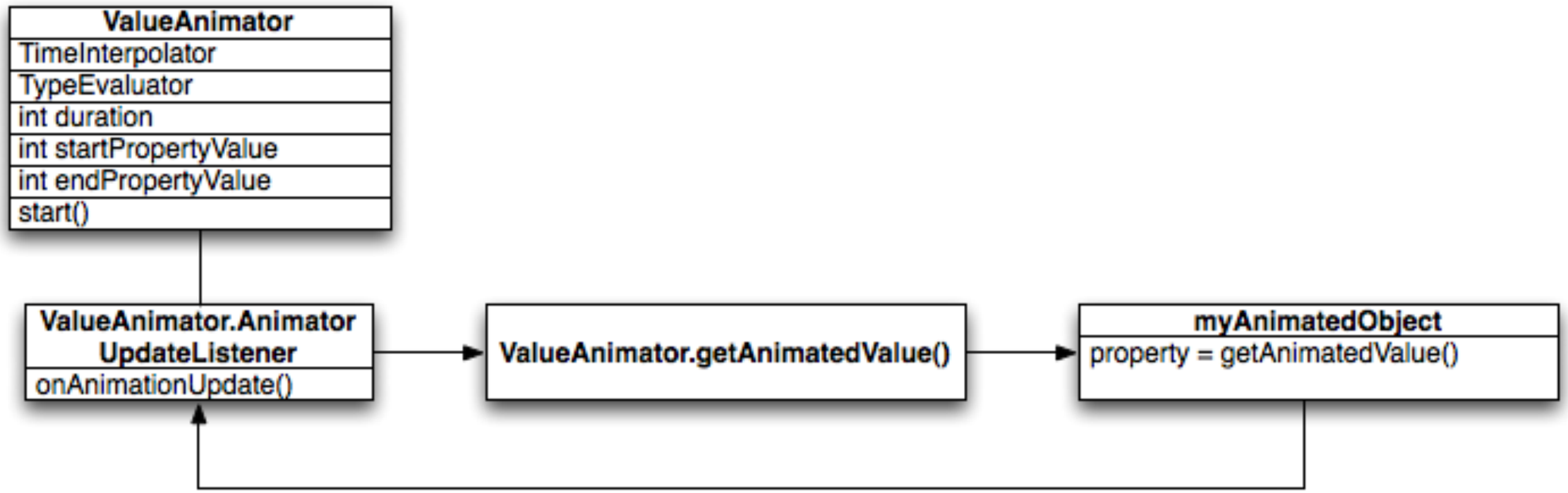
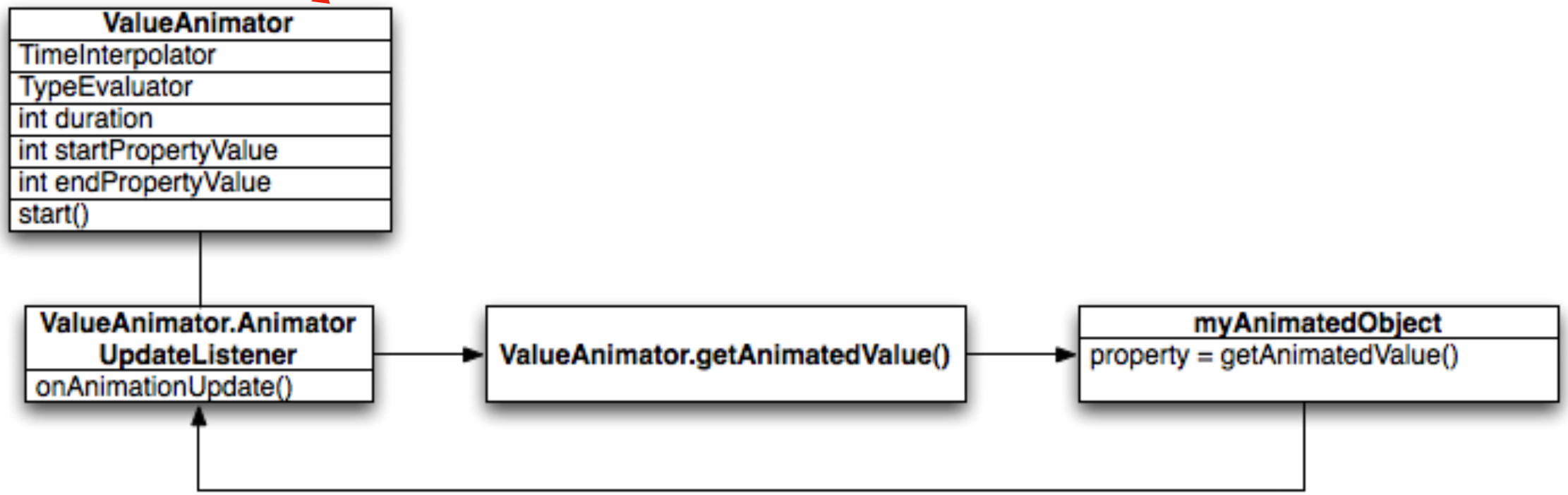


Model


ValueAnimator
TimeInterpolator
TypeEvaluator
int duration
int startPropertyValue
int endPropertyValue
start()
ValueAnimator.Animator UpdateListener
onAnimationUpdate()
ValueAnimator.getAnimatedValue()
myAnimatedObject
property = getAnimatedValue()

Model

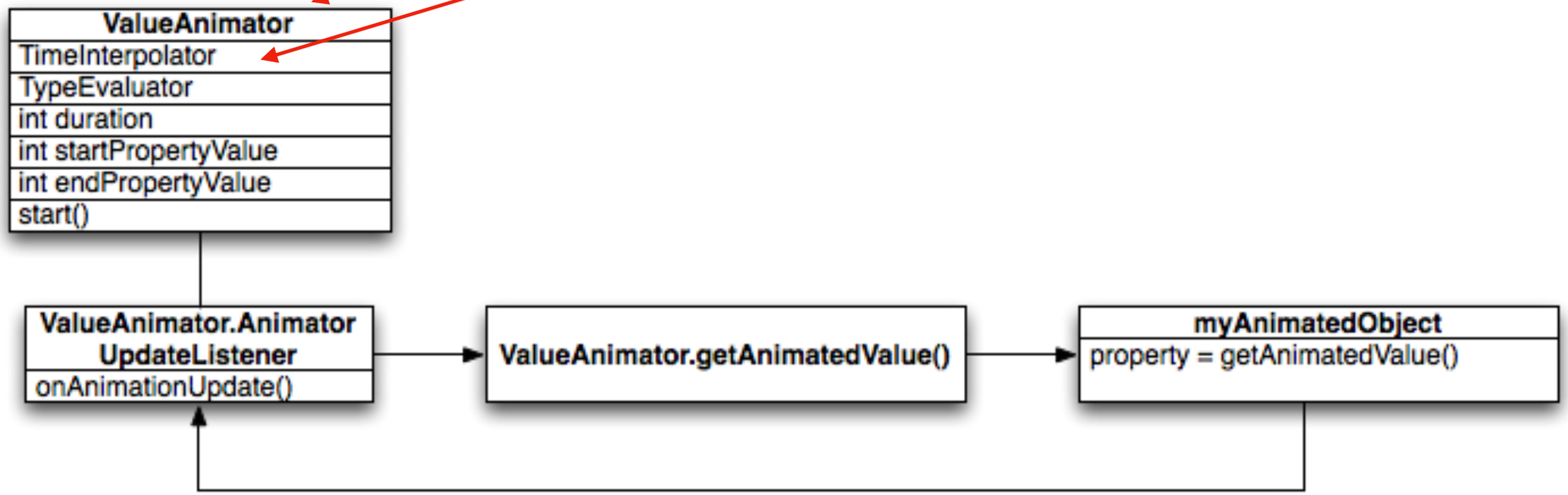
Keeps track of the animation timing



Model

Keeps track of the animation timing

Defines the time interpolation

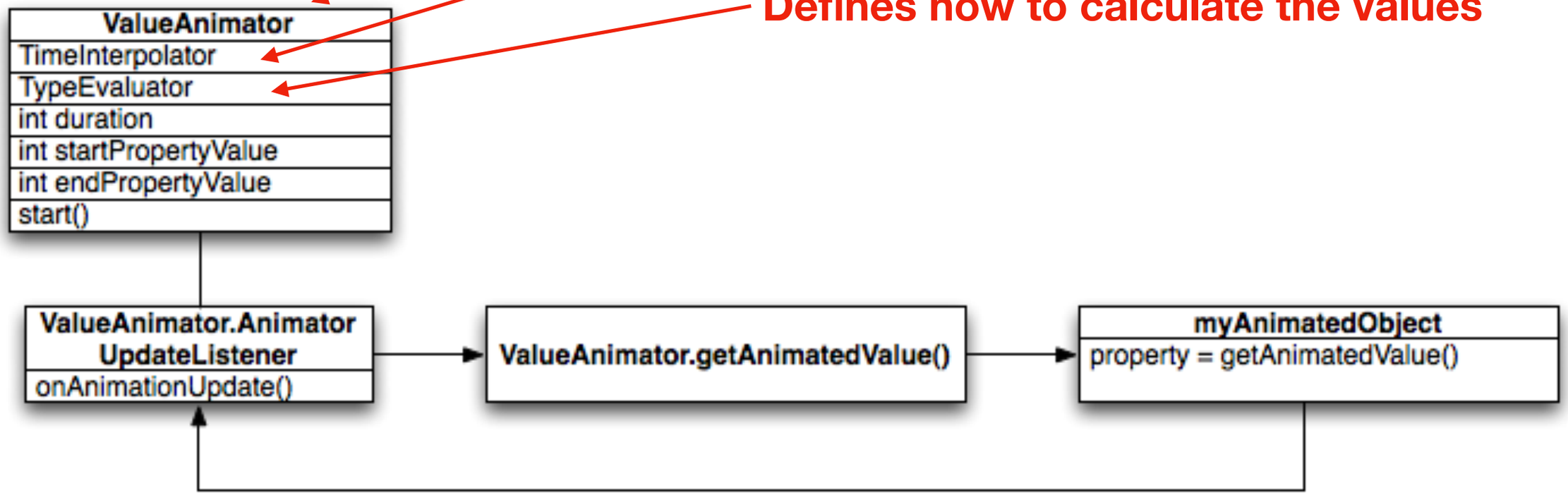


Model

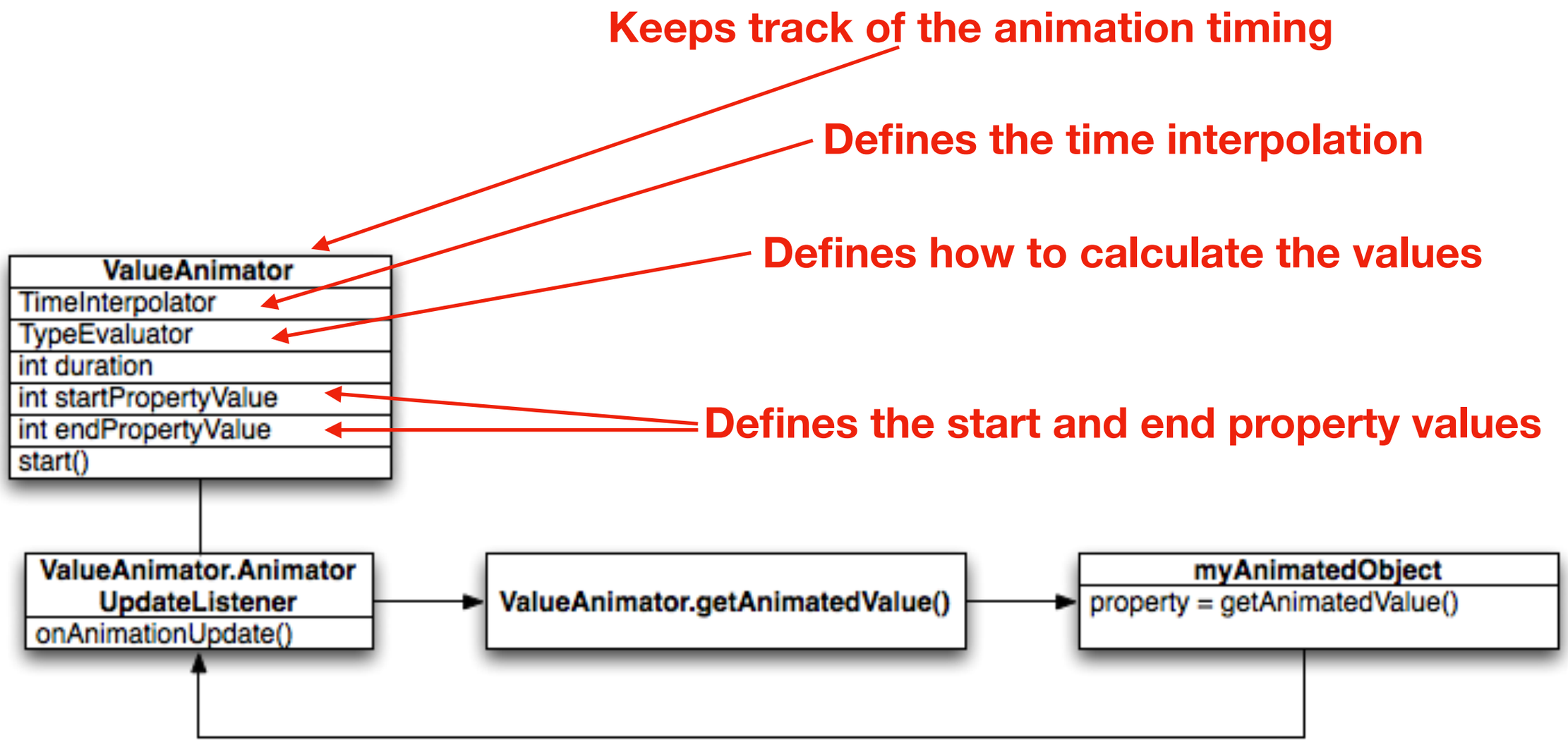
Keeps track of the animation timing

Defines the time interpolation

Defines how to calculate the values



Model



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

API

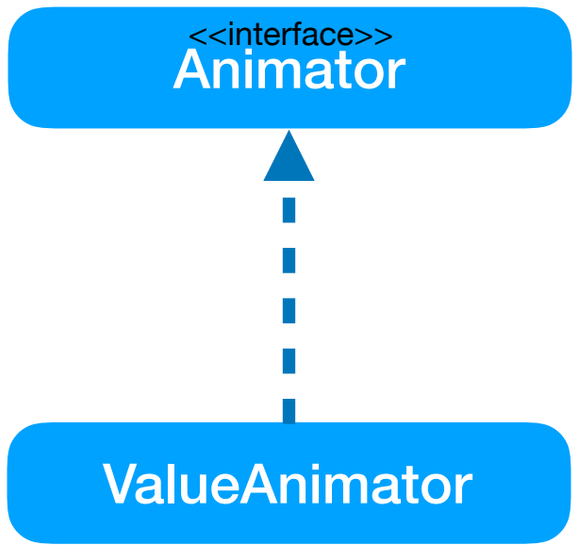
ValueAnimator

API

<<interface>>
Animator

ValueAnimator

API



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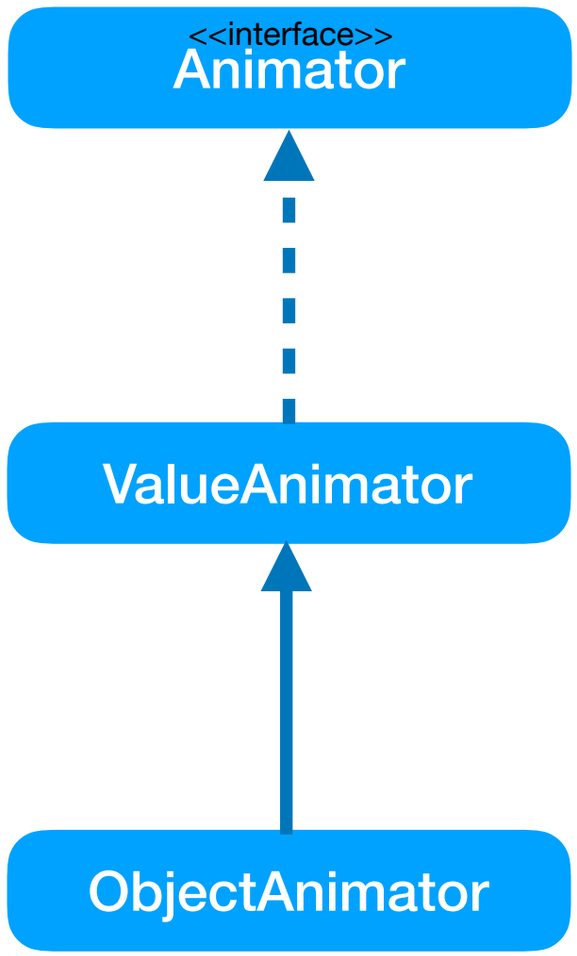
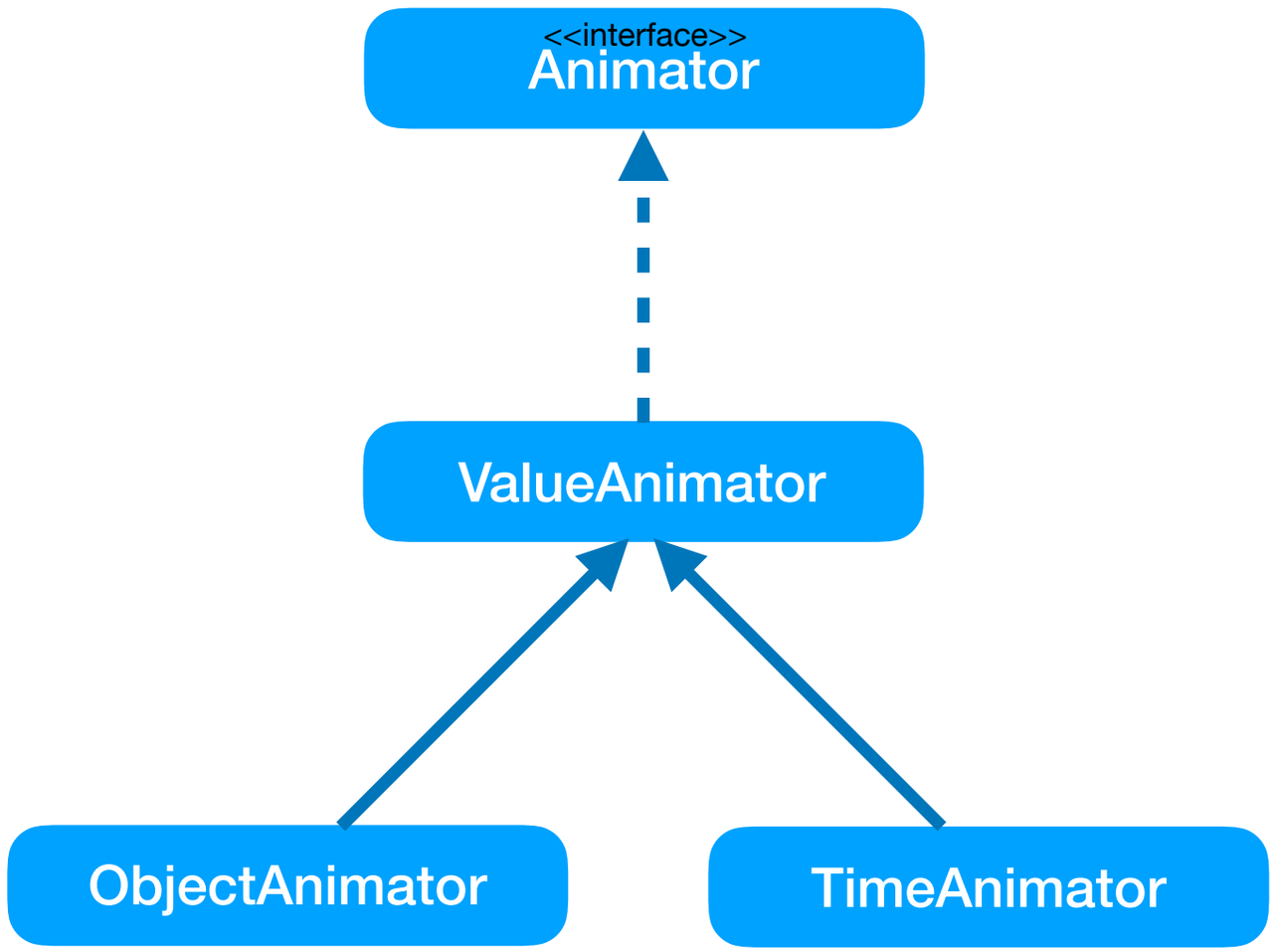
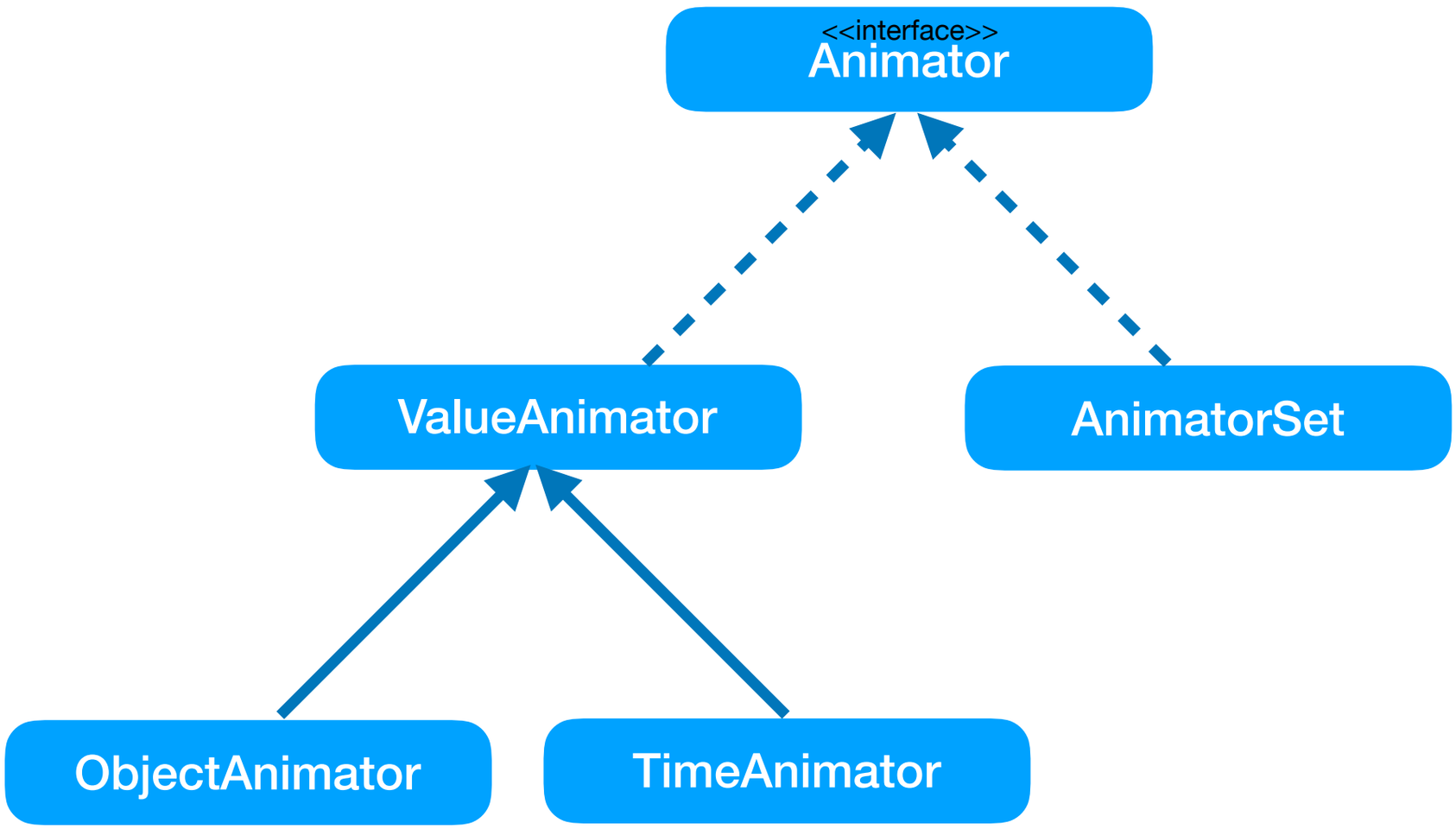


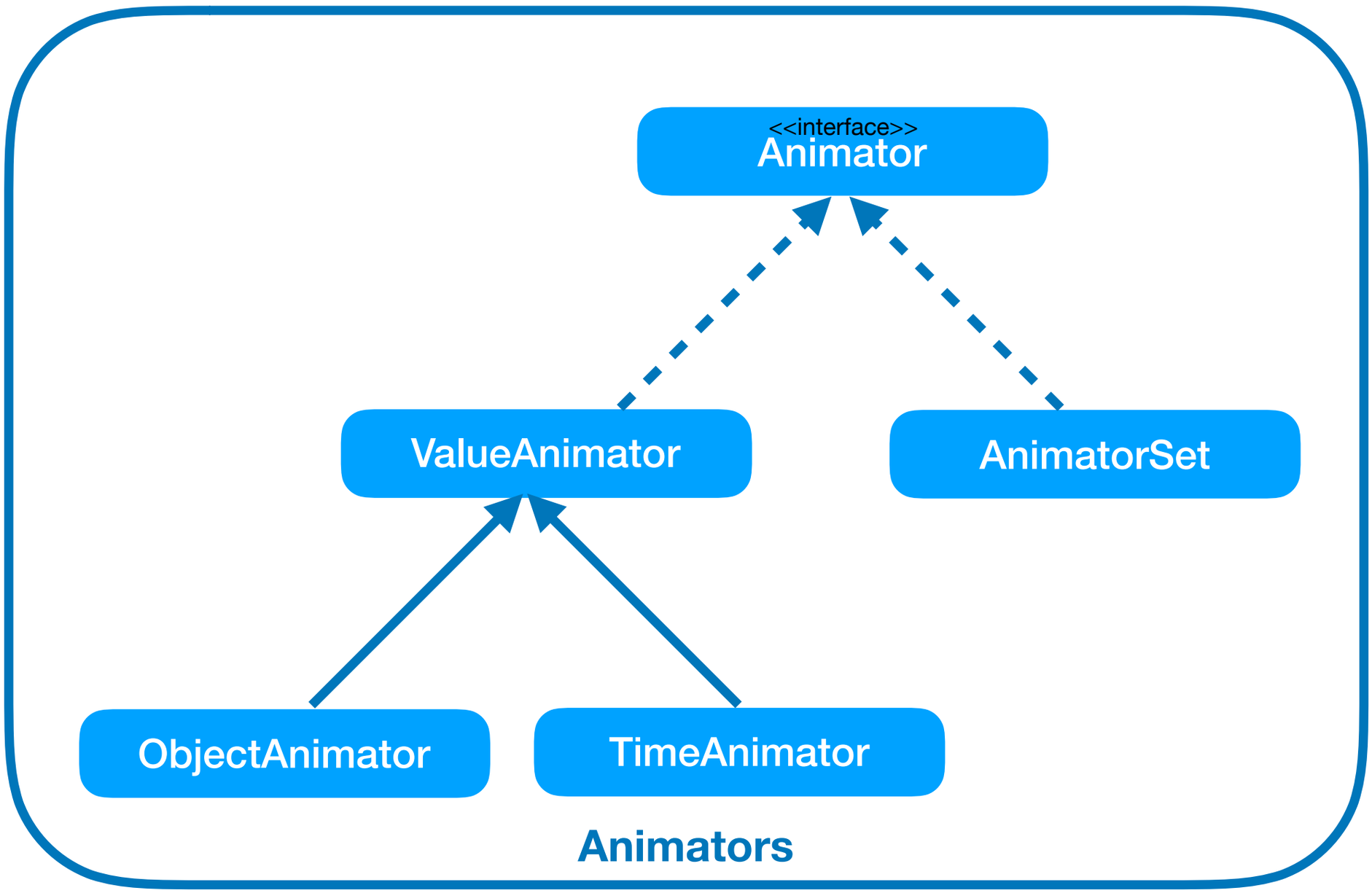
API


<<interface>>
Animator
ValueAnimator
ObjectAnimator
TimeAnimator

API


<<interface>>
Animator
ValueAnimator
AnimatorSet
ObjectAnimator
TimeAnimator

API



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

API

Animators

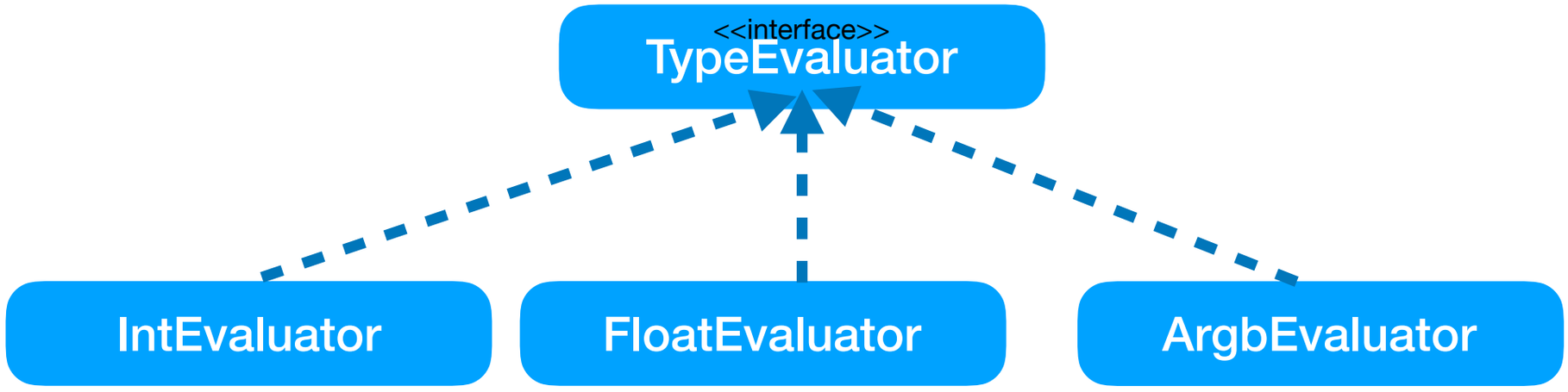
API

Animators

<<interface>>
TypeEvaluator

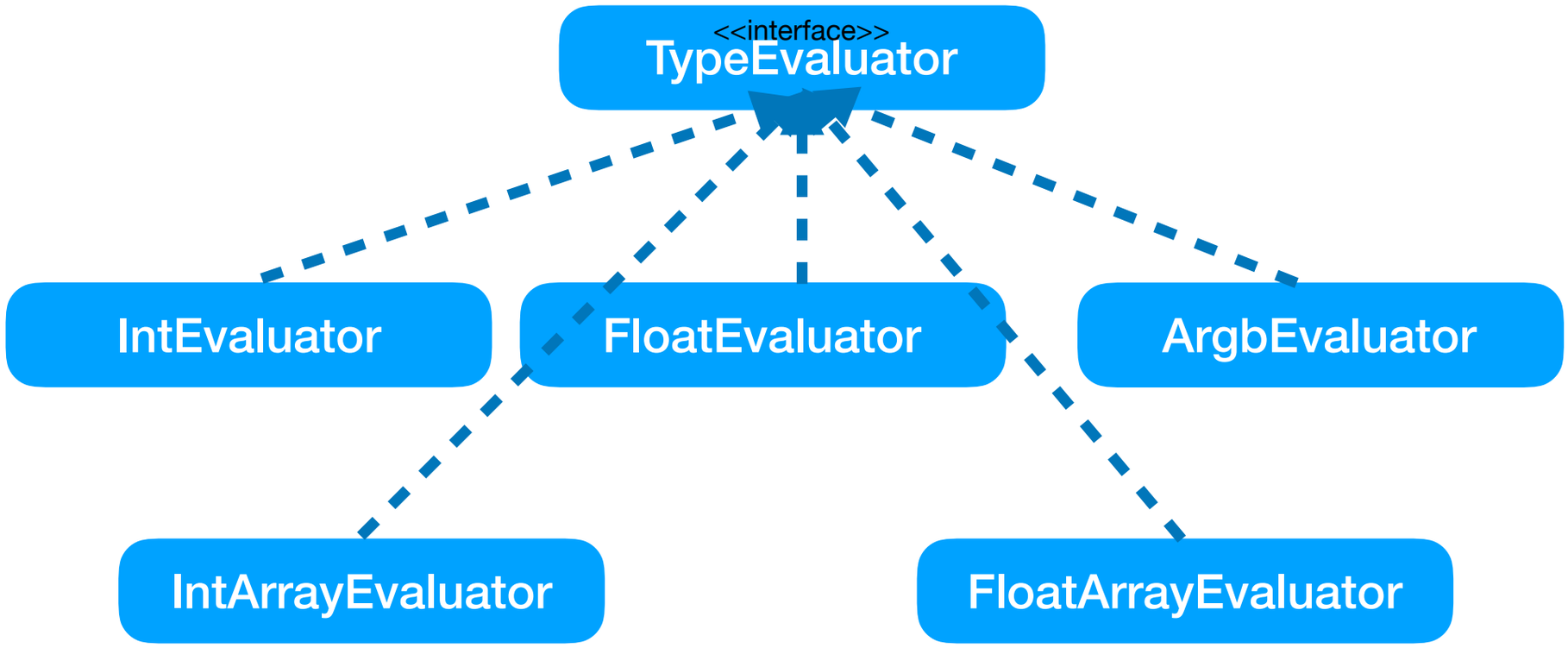
API

Animators



API

Animators



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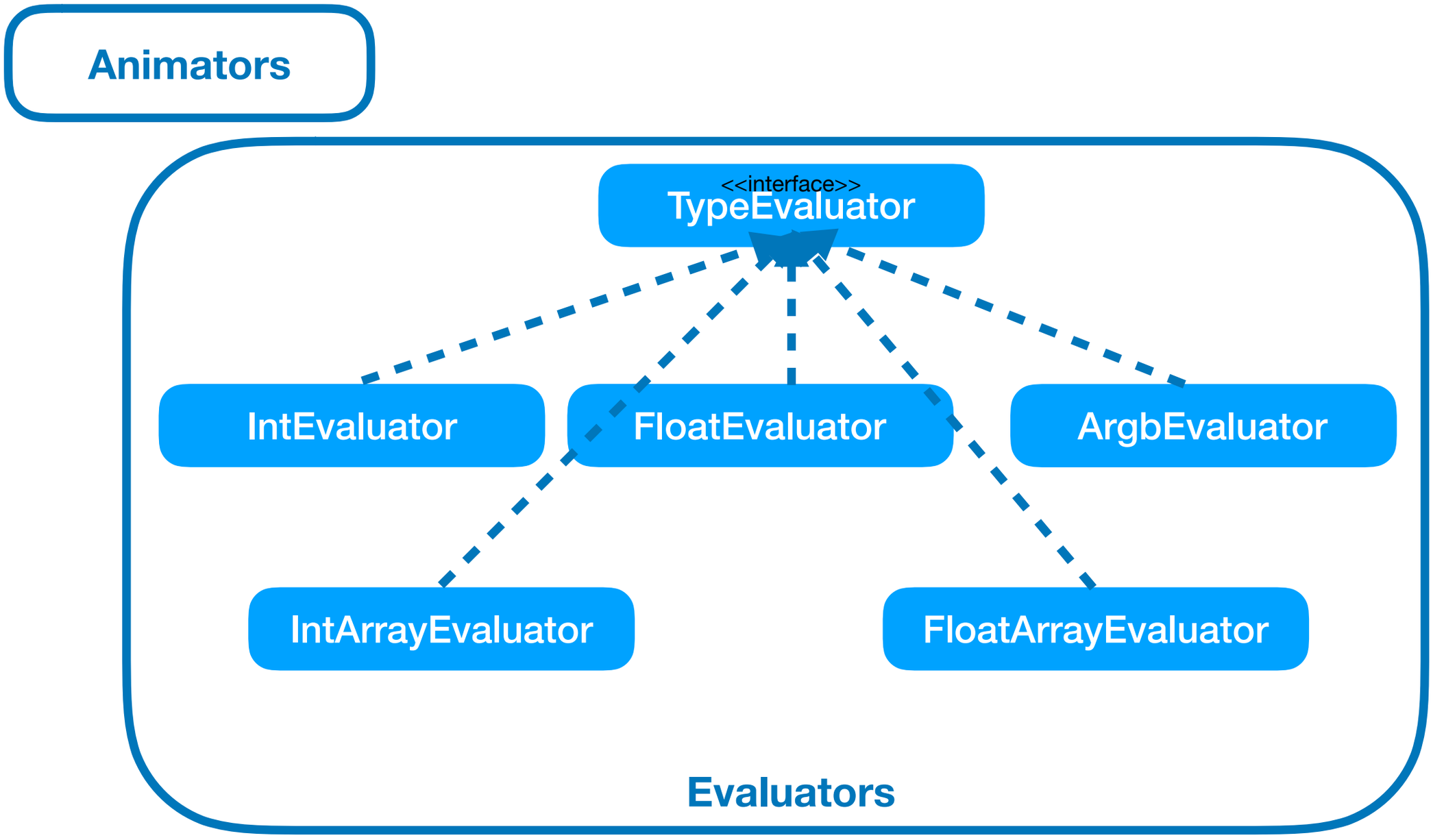


https://developer.android.com/reference/android/animation/TypeEvaluator

API

Animators

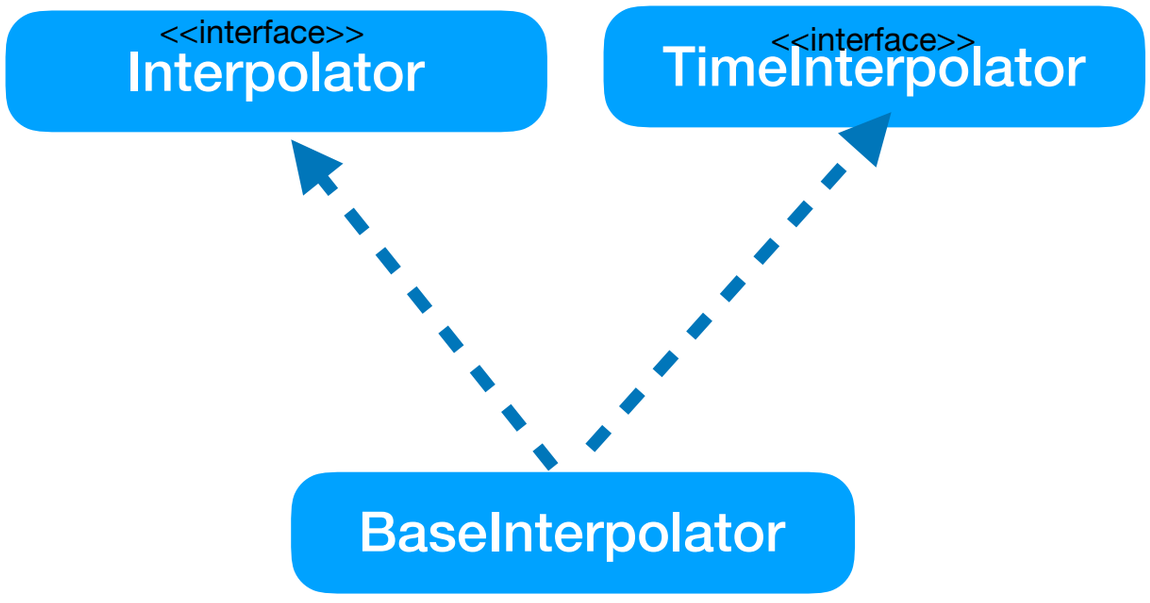
Evaluators

<<interface>>
Interpolator

API

Animators

Evaluators



API

Animators

Evaluators

<<interface>>
Interpolator

<<interface>>
TimeInterpolator

AccelerateDecelerateInterpolator

AccelerateInterpolator

AnticipateInterpolator

CycleInterpolator

BaseInterpolator

LinearInterpolator

AnticipateOvershootInterpolator

DecelerateInterpolator

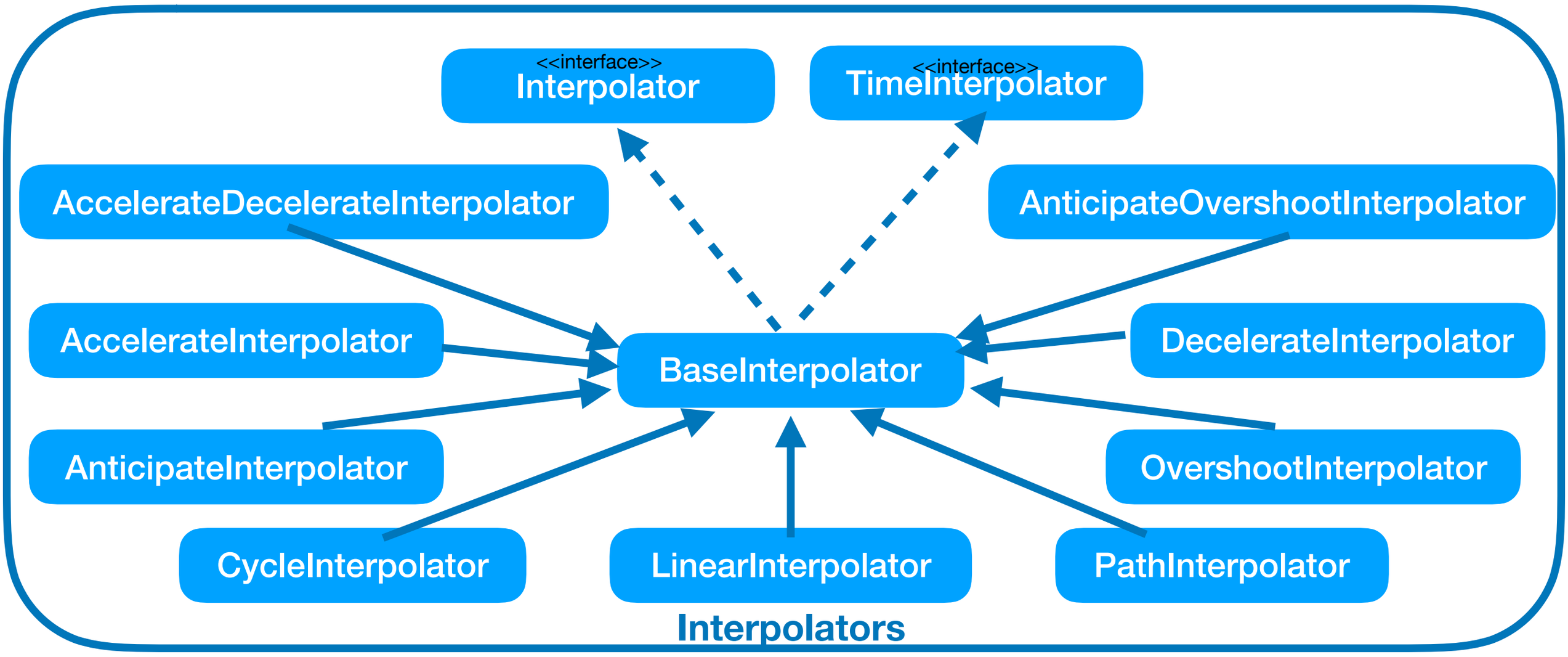
OvershootInterpolator

PathInterpolator

API

Animators

Evaluators



Interpolators

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

API

Animators

Evaluators

Interpolators

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

API

Animators

Evaluators

Interpolators

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

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

API

Animators

Evaluators

Interpolators

```
ValueAnimator.ofObject(...).apply {
  // ...
  addUpdateListener { updatedAnimation ->
    // You can use the animated value in a property that uses the
    // same type as the animation. In this case, you can use the
    // float value in the translationX property.
    textView.translationX = updatedAnimation.animatedValue as Float
  }
  // ...
}
```

API

Animators

Evaluators

Interpolators

```
ValueAnimator.ofObject(...).apply {
  // ...
  addUpdateListener { updatedAnimation ->
    // You can use the animated value in a property that uses the
    // same type as the animation. In this case, you can use the
    // float value in the translationX property.
    textView.translationX = updatedAnimation.animatedValue as Float
  }
  // ...
}
```

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

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"/>
```

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

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"
```

DEMO

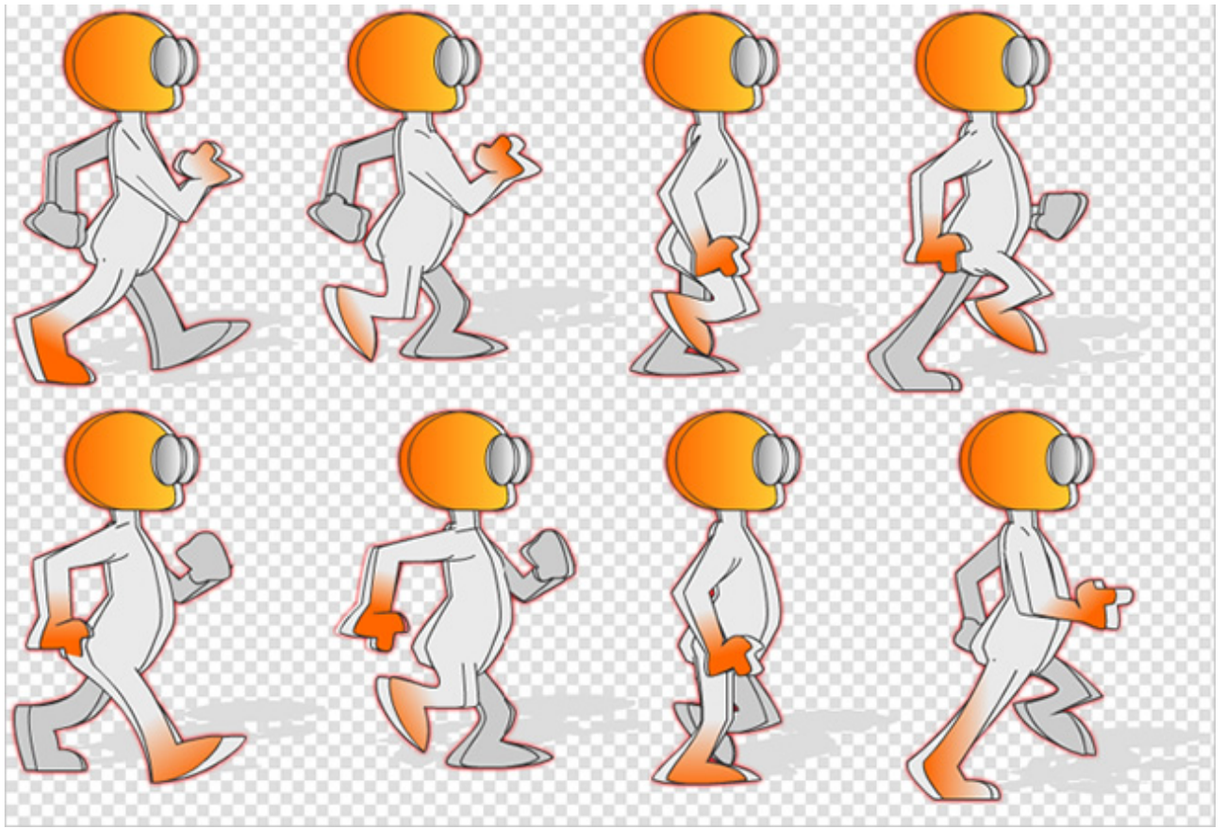
```xml
<?xml version="1.0" encoding="utf-8"?>
<selector xmlns:android="http://schemas.android.com/apk/res/android">
  <!-- the pressed state; increase x and y size to 150% -->
  <item android:state_pressed="true">
    <set>
      <objectAnimator android:propertyName="scaleX"
        android:duration="@android:integer/config_shortAnimTime"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

```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>
```

```xml
<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>
```

DEMO

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>
```

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)
    }
    ...
}
```

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)
    .setDuration(mShortAnimationDuration.toLong())
    .setListener(object : AnimatorListenerAdapter() {
       override fun onAnimationEnd(animation: Animator) {
```

```
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)
    .setDuration(mShortAnimationDuration.toLong())
    .setListener(object : AnimatorListenerAdapter() {
       override fun onAnimationEnd(animation: Animator) {
          mLoadingView.visibility = View.GONE
       }
    })
}
```

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

Move a View with Animation

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

Move a View with Animation

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

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)
}
```

Move a View with Animation

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

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)
    }
```

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

DEMO

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)
}
```

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

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

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

Animate Movement using Spring Physics

```
dependencies {
  implementation 'com.android.support:support-dynamic-animation:28.0.0'
}
```

Animate Movement using Spring Physics

```
dependencies {
    implementation 'com.android.support:support-dynamic-animation:28.0.0'
}
```

```
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)
}
```

Animate Movement using Spring Physics

```
findViewById<View>(R.id.imageView).also { img ->
    SpringAnimation(img, DynamicAnimation.TRANSLATION_Y).apply {
        …
        // Compute velocity in the unit pixel/second
        vt.computeCurrentVelocity(1000)
        val velocity = vt.yVelocity
        setStartVelocity(velocity)
    }
}
```

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

Animate Movement using Spring Physics

```
findViewById<View>(R.id.imageView).also { img ->
    SpringAnimation(img, DynamicAnimation.TRANSLATION_Y).apply {
            …
            //Setting the spring with a low stiffness.
            spring.stiffness = SpringForce.STIFFNESS_LOW
            …
        }
}
```

Stiffness

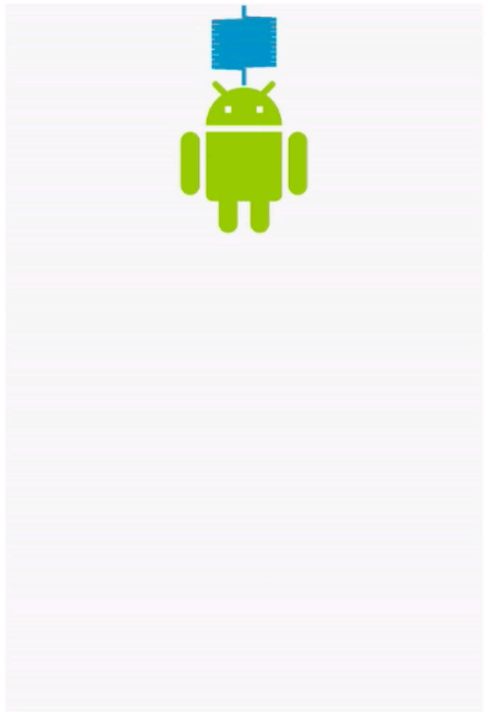


Figure 6: High stiffness

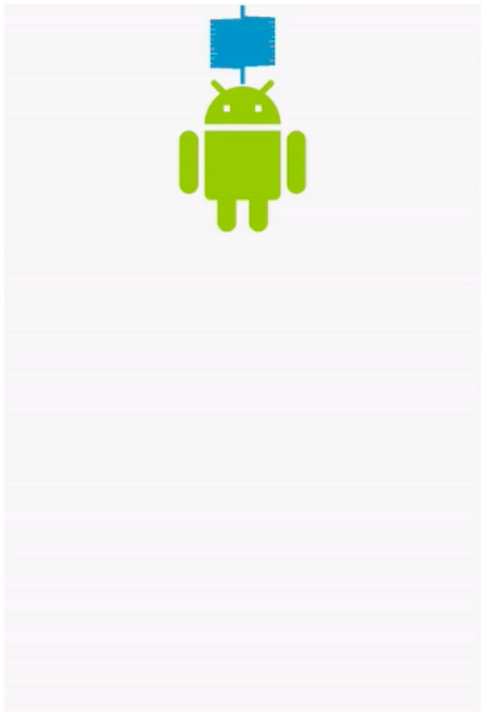


Figure 7: Medium stiffness

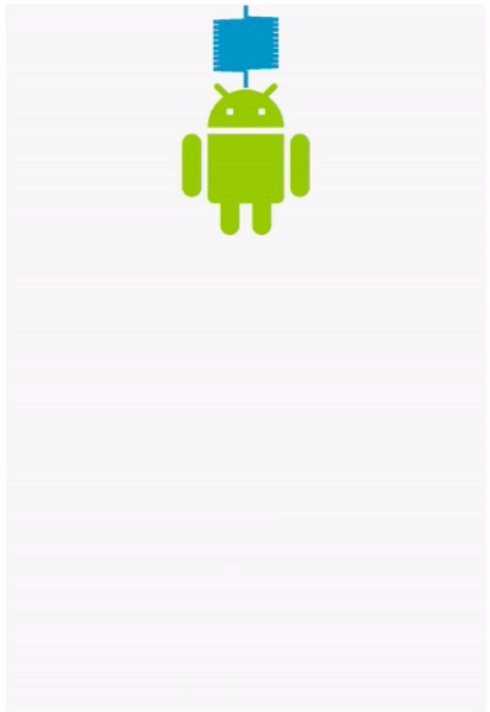


Figure 8: Low stiffness

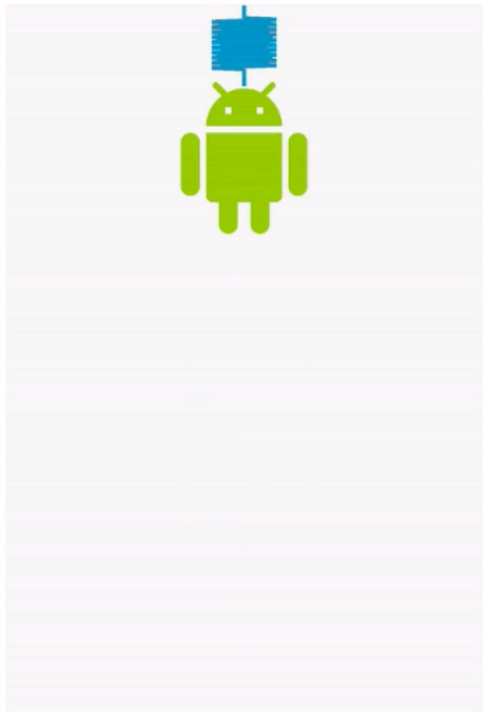


Figure 9: Very low stiffness

Stiffness

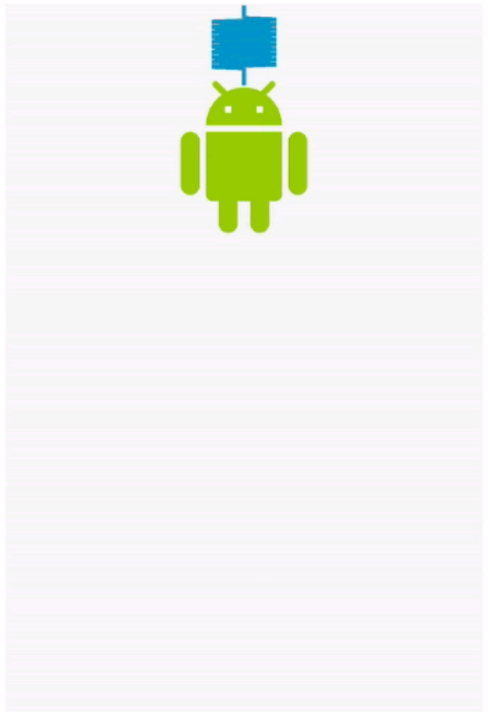


Figure 6: High stiffness

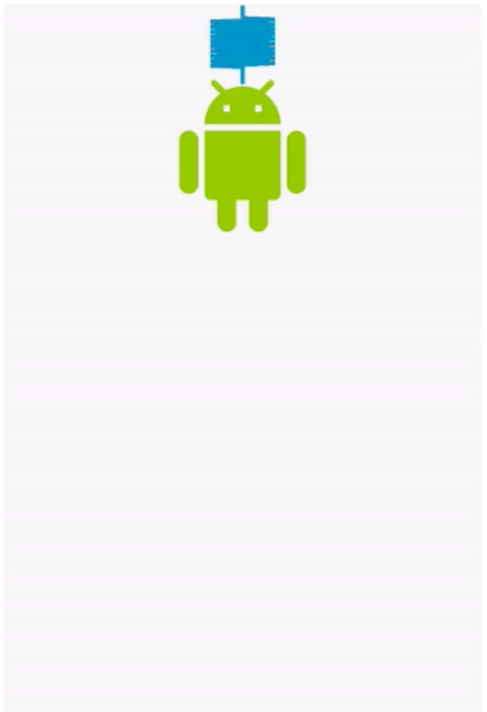


Figure 7: Medium stiffness

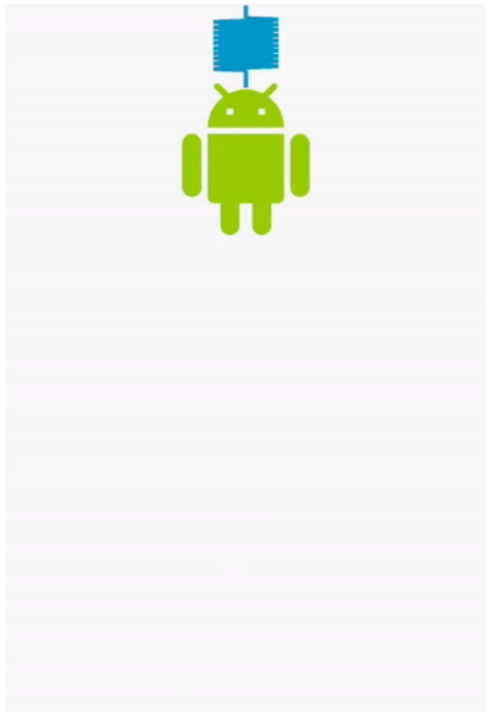


Figure 8: Low stiffness

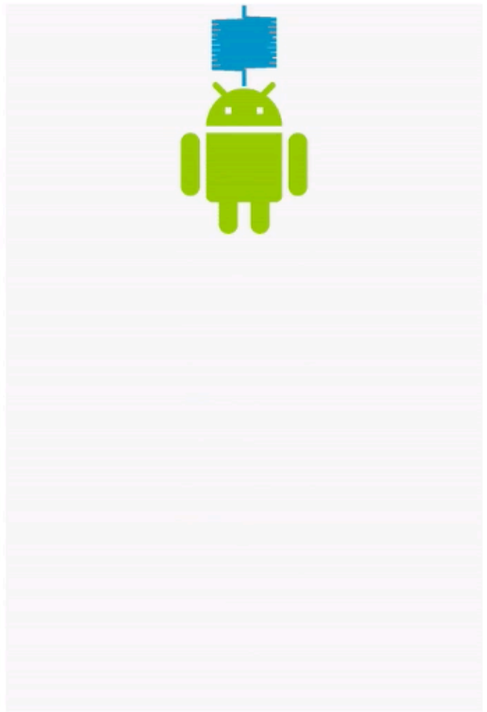


Figure 9: Very low stiffness

DEMO

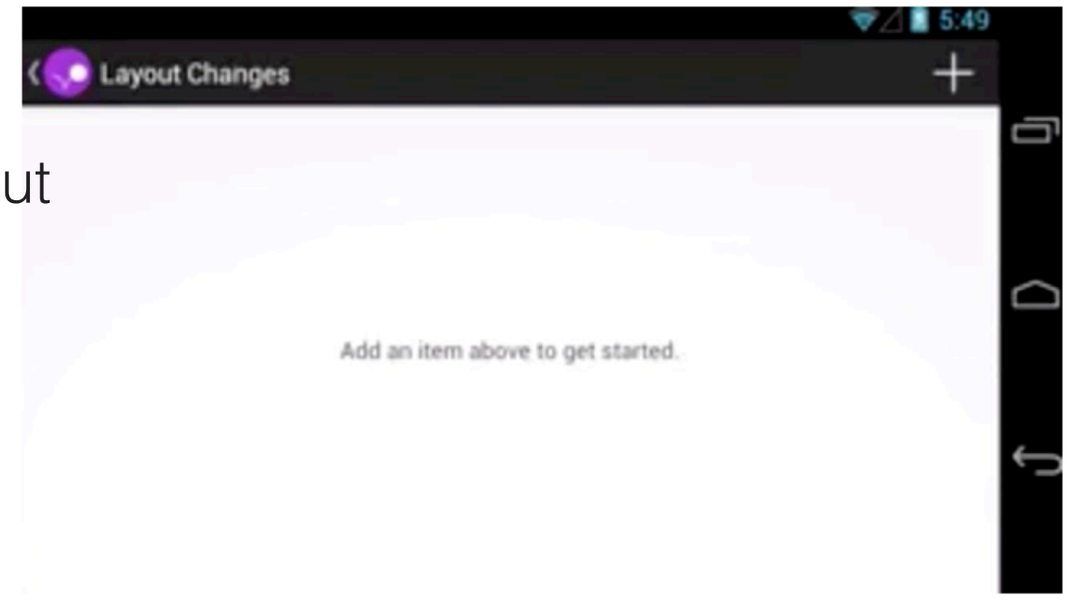
Auto Animate Layout Updates

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

DEMO

Auto Animate Layout Updates

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```
<LinearLayout android:id="@+id/container"
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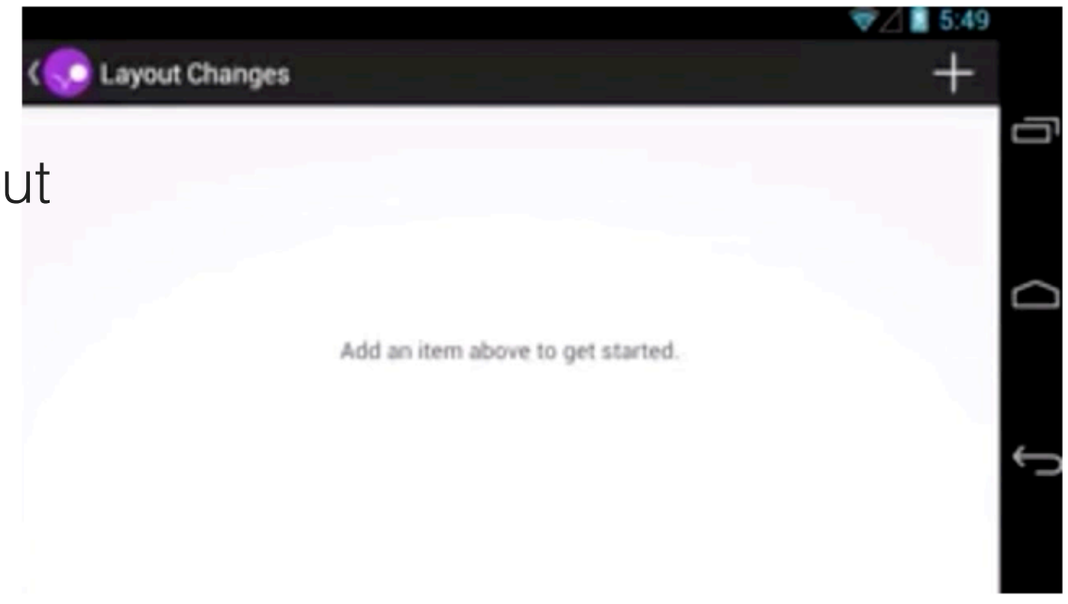


https://developer.android.com/training/animation/layout

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/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>
```

Animate Layout Changes Using Transitions

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>
```

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>
```

Create the Scene

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()

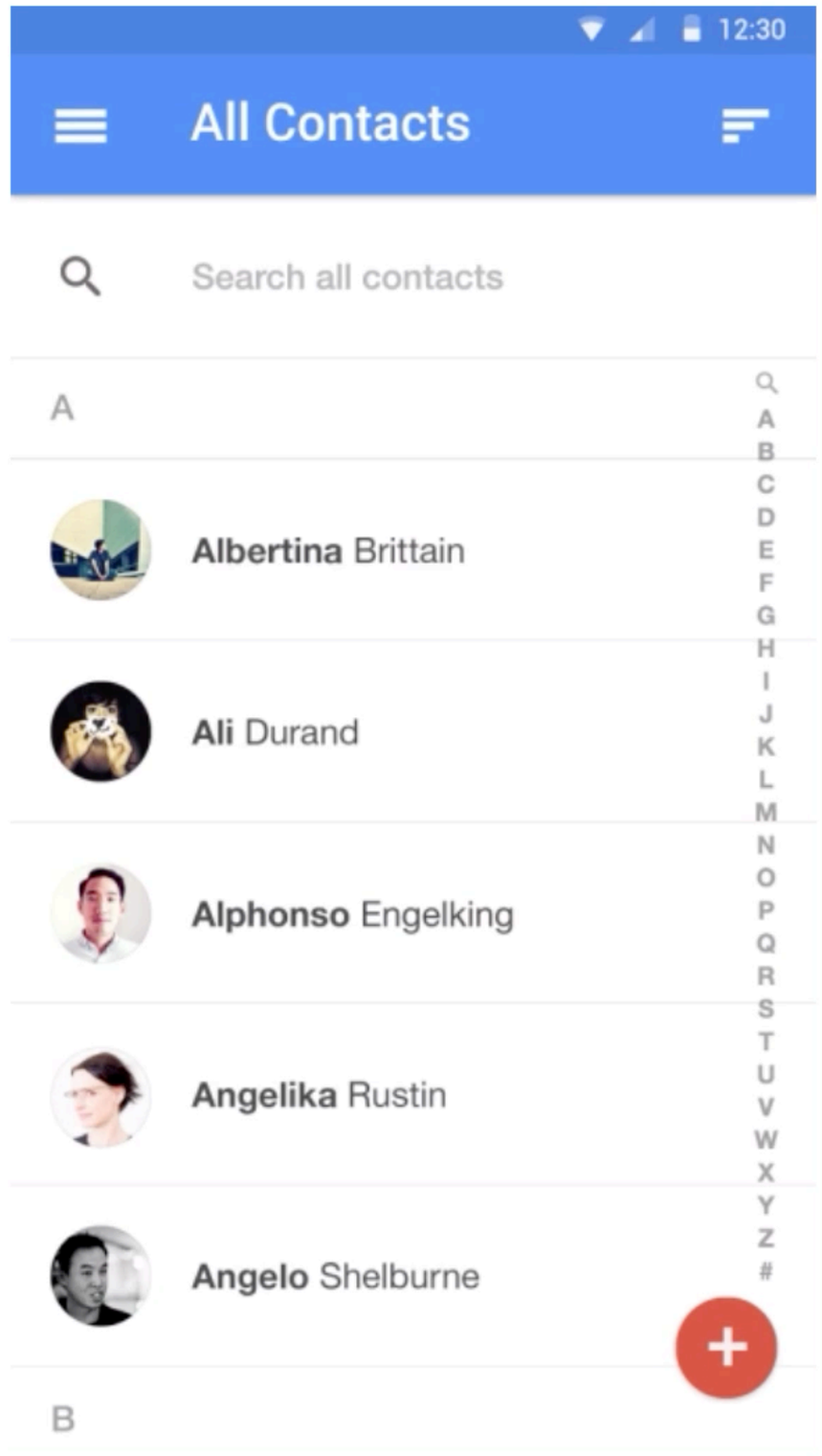
TransitionManager.go(mEndingScene, mFadeTransition)
```

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())
})
```



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    startActivity(intent, options.toBundle())
})
```
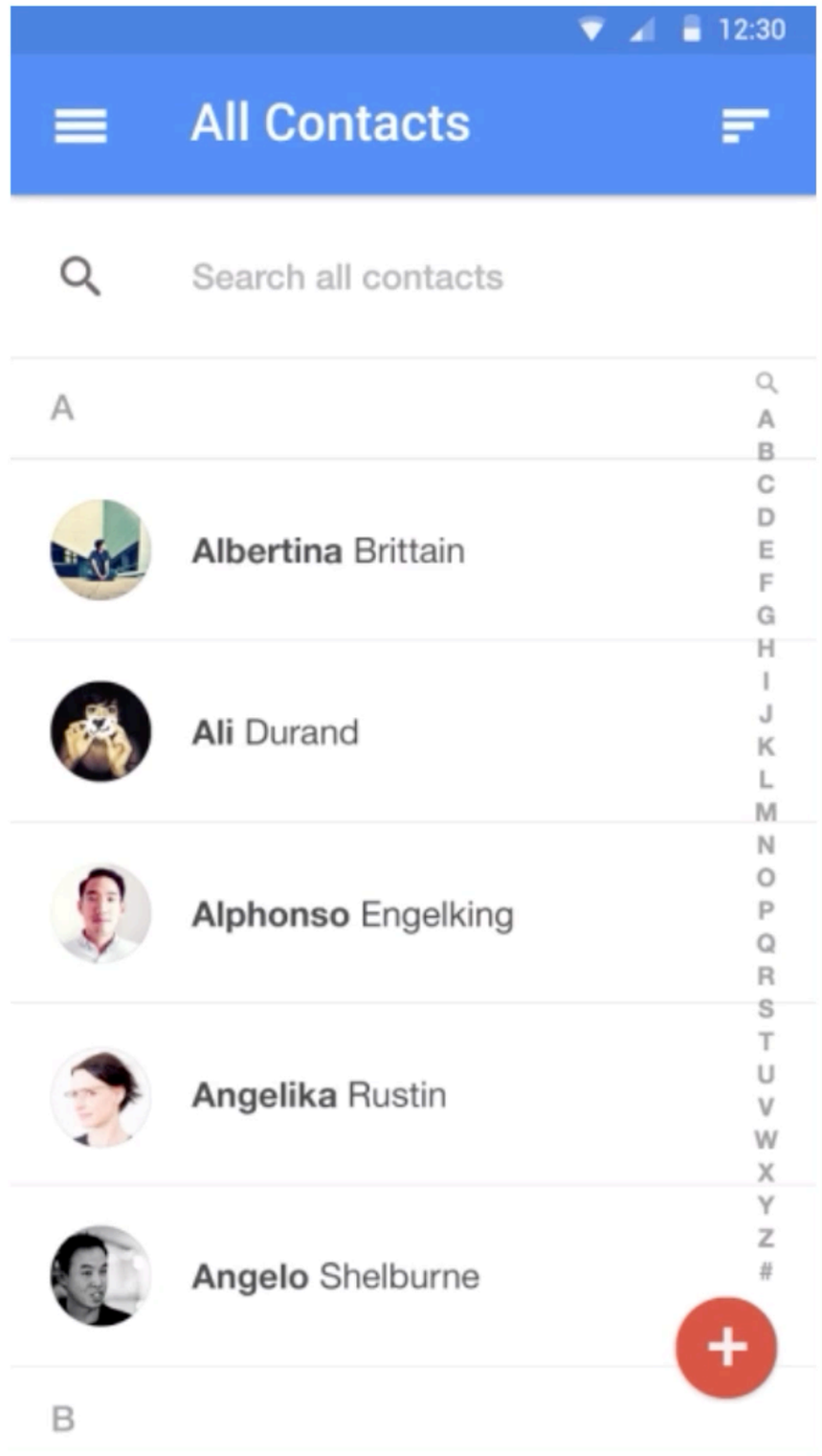
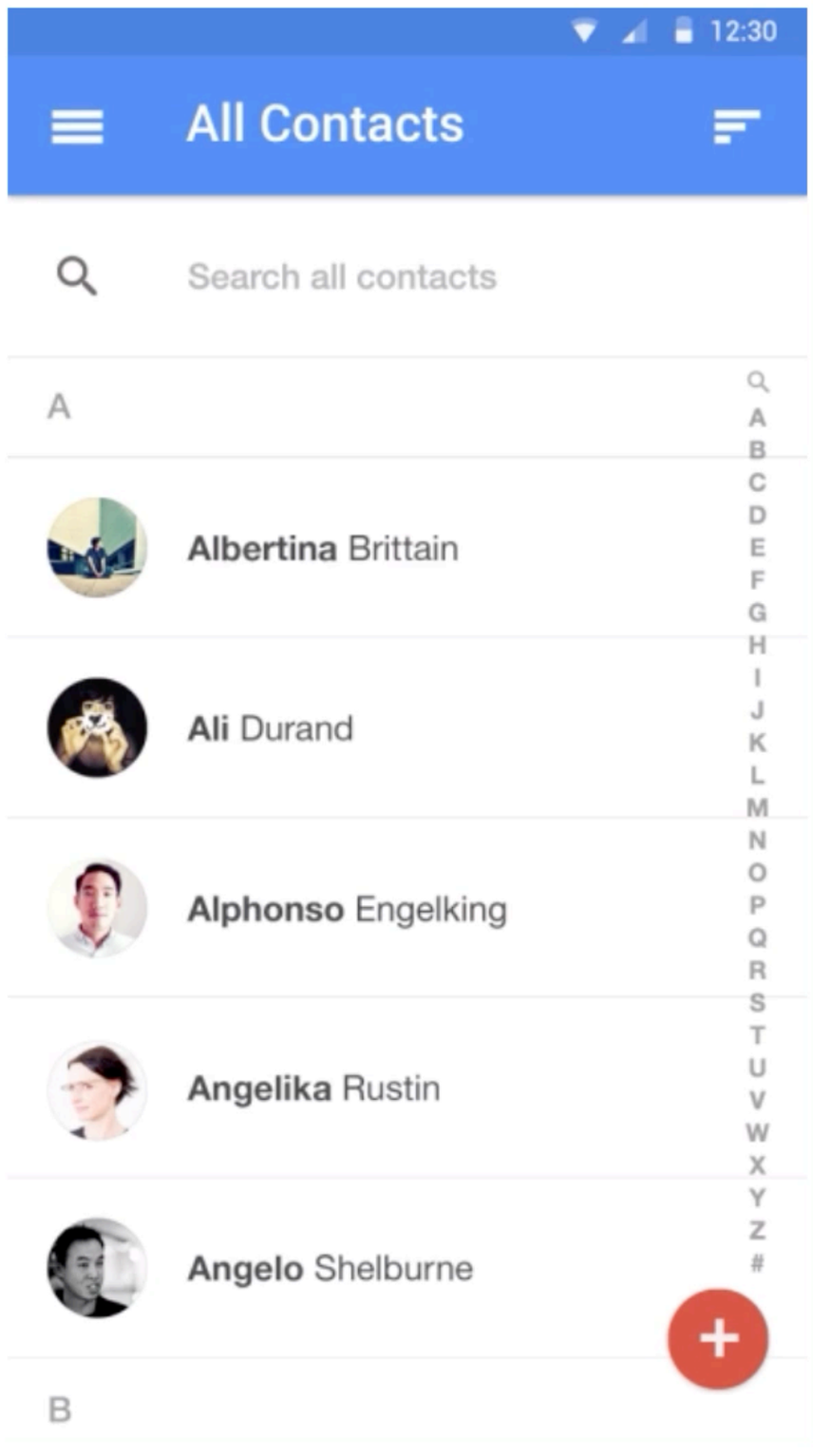



Start an Activity using an Animation

DEMO

```
// Rename the Pair class from the
// Android framework to avoid a name clash
import android.util.Pair as UtilPair
...
val options =
    ActivityOptions.makeSceneTransitionAnimation(
          this,
          UtilPair.create(view1, "agreedName1"),
          UtilPair.create(view2, "agreedName2")
    )
```



Lecture outcomes

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