Building Interruptible and Responsive Interactions

Session 236
Josh Shaffer
iOS Apps and Frameworks Engineer

Andy Matuschak
iOS Apps and Frameworks Engineer
Transitions
Gesture to Animation
Gesture to Animation

Animation to Animation
Gesture to Animation

Animation to Animation

Animation to Gesture
From Gesture to Animation
Computing Velocity
UIPanGestureRecognizer
func velocityInView(view: UIView) -> CGPoint
Computing Velocity

UIPanGestureRecognizer
func velocityInView(view: UIView) -> CGPoint

UIPinchGestureRecognizer
var velocity: CGFloat { get }
Computing Velocity

UIPanGestureRecognizer
func velocityInView(view: UIView) -> CGPoint

UIPinchGestureRecognizer
var velocity: CGFloat { get }

UIRotationGestureRecognizer
var velocity: CGFloat { get }
animateWithDuration(_:delay:options:animations:completion:)
animateWithDuration(_:delay:usingSpringWithDamping:initialSpringVelocity:options:animations:completion:)
initialSpringVelocity
initialSpringVelocity
initialSpringVelocity
initialSpringVelocity
initialSpringVelocity

50 points/second

50

150
initialSpringVelocity

50 points/second

150 - 50 = 100
initialSpringVelocity

150 - 50 = 100

50 points/second
initialSpringVelocity

150 - 50 = 100

50 points/second ÷ 100 points = 0.5 units/second
initialSpringVelocity

50 points/second \div 100 points = 0.5 units/second
$50 \text{ points/second} \div 100 \text{ points} = 0.5 \text{ units/second}$

```
UIView.animateWithDuration(1.5,
delay: 0.0,
usingSpringWithDamping: 0.7,
initialSpringVelocity: 0.5,
options: nil,
animations: { view.center.x = 150 },
completion: nil)
```
UIDynamicAnimator
UIDynamicAnimator Setup
UIDynamicAnimator Setup

var dynamicAnimator = UIDynamicAnimator?
UIDynamicAnimator Setup

```swift
var dynamicAnimator = UIDynamicAnimator?
let dynamicItemBehavior = UIDynamicItemBehavior(items: nil)
```
var dynamicAnimator = UIDynamicAnimator?
let dynamicItemBehavior = UIDynamicItemBehavior(items: nil)

override func viewDidLoad() {
    super.viewDidLoad()
}

var dynamicAnimator = UIDynamicAnimator?
let dynamicItemBehavior =UIDynamicItemBehavior(items: nil)

override func viewDidLoad() {
    super.viewDidLoad()
    dynamicAnimator = UIDynamicAnimator(referenceView: view)
}
var dynamicAnimator = UIDynamicAnimator?
let dynamicItemBehavior = UIDynamicItemBehavior(items: nil)

override func viewDidLoad() {
    super.viewDidLoad()
    dynamicAnimator = UIDynamicAnimator(referenceView: view)
    dynamicItemBehavior.resistance = 3.0
    dynamicItemBehavior.angularResistance = 3.0
}


var dynamicAnimator = UIDynamicAnimator?
let dynamicItemBehavior = UIDynamicItemBehavior(items: nil)

override func viewDidLoad() {
    super.viewDidLoad()
    dynamicAnimator = UIDynamicAnimator(referenceView: view)
    dynamicItemBehavior.resistance = 3.0
    dynamicItemBehavior.angularResistance = 3.0
    dynamicAnimator!.addBehavior(dynamicItemBehavior)
}

UIDynamicAnimator Velocity Transfer
let targetView = panGestureRecognizer.view
let targetView = panGestureRecognizer.view

switch panGestureRecognizer.state {
}

let targetView = panGestureRecognizer.view

switch panGestureRecognizer.state {
    case .Ended:

}
let targetView = panGestureRecognizer.view

switch panGestureRecognizer.state {
    case .Ended:
        let v = panGestureRecognizer.velocityInView(targetView.superview)
}
let targetView = panGestureRecognizer.view

switch panGestureRecognizer.state {
    case .Ended:
        let v = panGestureRecognizer.velocityInView(targetView.superview)
        dynamicItemBehavior.addLinearVelocity(v, forItem: targetView)
}
animateWithDuration
UIDynamicAnimator
CADisplayLink
...but what about NSTimer?
Display Frames

NSTimer

CADisplayLink
Display Frames

NSTimer

CADisplayLink

16 ms
Display Frames

NSTimer

CADisplayLink

8 ms

16 ms
Display Frames

NSTimer

CADisplayLink

Display Frames
Display Frames:
- NSTimer
- CADisplayLink

- 8 ms
- 8 ms

From Animation to Animation

Andy Matuschak
iOS Apps and Frameworks Engineer
Absolute (iOS 7 default)

BeginFrom CurrentState
Absolute (iOS 7 default)

BeginFrom CurrentState
Absolute (iOS 7 default)
BeginFrom CurrentState
Additive
Absolute (iOS 7 default)

BeginFrom CurrentState

Additive
Absolute (iOS 7 default)

BeginFrom CurrentState

Additive (iOS 8 default)
UIView.animateWithDuration(1) {
    circle.center.x = 300
}

# How Cocoa Touch Manages Animations

## Absolute animations

<table>
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<tr>
<td>Model</td>
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How Cocoa Touch Manages Animations

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UIView.animateWithDuration(1) {
    circle.center.x = 500
}
# How Cocoa Touch Manages Animations

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How Cocoa Touch Manages Animations

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CAAnimation

- fromValue: (0, 0)
- duration: 1.0
- beginTime: 1000.1
## How Cocoa Touch Manages Animations

### Absolute animations

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![Diagram showing model and animation changes over time](image.png)
How Cocoa Touch Manages Animations

Absolute animations

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CAAnimation

- fromValue: (0, 0)
- duration: 1.0
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# How Cocoa Touch Manages Animations

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**CAAnimation**

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**CAAnimation**

- `fromValue`: (0, 0)
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How Cocoa Touch Manages Animations

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```objective-c
CAAnimation
UIView.animateWithDuration(1) {
    circle.center.x = 0
}
```
How Cocoa Touch Manages Animations

Absolute animations

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CAAnimation

- fromValue: (0, 0)
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# How Cocoa Touch Manages Animations

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CAAnimation:
- fromValue: (500, 0)
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# How Cocoa Touch Manages Animations

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**CAAnimation**

- `fromValue`: (500, 0)
- `duration`: 1.0
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# How Cocoa Touch Manages Animations

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```caanimation```
```
fromValue (500, 0)
duration 1.0
beginTime 1000.5
```
# How Cocoa Touch Manages Animations

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**CAAnimation**

- **fromValue**: (500, 0)
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How Cocoa Touch Manages Animations

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CAAnimation

- fromValue: (500, 0)
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How Cocoa Touch Manages Animations

Absolute animations and BeginFromCurrentState
How Cocoa Touch Manages Animations

Absolute animations and BeginFromCurrentState

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CAAnimation

- fromValue: (0, 0)
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# How Cocoa Touch Manages Animations

## Absolute animations and `BeginFromCurrentState`

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```swift
UIView.animateWithDuration(1,
    delay: 0,
    options: .BeginFromCurrentState,
    animations: { circle.center.x = 0 }
    completion: nil)
```
How Cocoa Touch Manages Animations

Absolute animations and `BeginFromCurrentState`

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```c
CAAnimation
  fromValue       | (0, 0)
  duration        | 1.0
  beginTime       | 1000.1
```
### How Cocoa Touch Manages Animations

**Absolute animations and `BeginFromCurrentState`**

<table>
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How Cocoa Touch Manages Animations

Absolute animations and `BeginFromCurrentState`

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```
fromValue (150, 0)
duration 1.0
beginTime 1000.5
```
How Cocoa Touch Manages Animations

Absolute animations and `BeginFromCurrentState`

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```
fromValue (150, 0)
duration 1.0
beginTime 1000.5
```

CAAnimation

- fromValue: (150, 0)
- duration: 1.0
- beginTime: 1000.5
How Cocoa Touch Manages Animations

Absolute animations and BeginFromCurrentState

<table>
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<tr>
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CAAnimation

- fromValue: (150, 0)
- duration: 1.0
- beginTime: 1000.5
How Cocoa Touch Manages Animations

Absolute animations and `BeginFromCurrentState`
How Cocoa Touch Manages Animations

Absolute animations and BeginFromCurrentState
How Cocoa Touch Manages Animations

Absolute animations and **BeginFromCurrentState**
How Cocoa Touch Manages Animations

Absolute animations and `BeginFromCurrentState`

Initial animation

Reverse animation
How Cocoa Touch Manages Animations

Absolute animations and `BeginFromCurrentState`
How Cocoa Touch Manages Animations

Absolute animations and `BeginFromCurrentState`
How Cocoa Touch Manages Animations

Absolute animations and `BeginFromCurrentState`

Initial animation

Reverse animation
How Cocoa Touch Manages Animations

Absolute animations and BeginFromCurrentState

Initial animation

Reverse animation
How Cocoa Touch Manages Animations

Absolute animations and **BeginFromCurrentState**
Additive Animations
Introducing Additive Animations

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Introducing Additive Animations

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```swift
UIView.animateWithDuration(1) {
    circle.center.x = 500
}
```
Introducing Additive Animations

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**CAAnimation**
- additive: YES
- fromValue: (-500, 0)
- toValue: (0, 0)
- duration: 1.0
- beginTime: 1000.1
# Introducing Additive Animations

<table>
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<td>Presentation</td>
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**CAAnimation**

- additive: YES
- fromValue: (-500, 0)
- toValue: (0, 0)
- duration: 1.0
- beginTime: 1000.1
### Introducing Additive Animations

<table>
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**CAAnimation**

- additive: YES
- fromValue: (-500, 0)
- toValue: (0, 0)
- duration: 1.0
- beginTime: 1000.1
Introducing Additive Animations

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CAAnimation
- additive: YES
- fromValue: (-500, 0)
- toValue: (0, 0)
- duration: 1.0
- beginTime: 1000.1
# Introducing Additive Animations

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</table>

**CAAnimation**
- additive: **YES**
- fromValue: (-500, 0)
- toValue: (0, 0)
- duration: 1.0
- beginTime: 1000.1

The diagram shows the changes in the model, animation, and presentation over time.
# Introducing Additive Animations

## Table

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<th>1000.0</th>
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<td>(100, 0)</td>
<td>(150, 0)</td>
</tr>
</tbody>
</table>

## Code

```swift
UIView.animateWithDuration(0.4) {
    circle.center.x = 0
}
```
Introducing Additive Animations

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<th>Time</th>
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**CAAnimation**
- additive: YES
- fromValue: (-500, 0)
- toValue: (0, 0)
- duration: 1.0
- beginTime: 1000.1
Introducing Additive Animations

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**CAAnimation**

- additive: YES
- fromValue: (-500, 0)
- toValue: (0, 0)
- duration: 1.0
- beginTime: 1000.1

**CAAnimation**

- additive: YES
- fromValue: (500, 0)
- toValue: (0, 0)
- duration: 0.4
- beginTime: 1000.5
### Introducing Additive Animations

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**CAAnimation**

- **additive**: YES
- **fromValue**: (-500, 0)
- **toValue**: (500, 0)
- **duration**: 1.0
- **beginTime**: 1000.1

**CAAnimation**

- **additive**: YES
- **fromValue**: (500, 0)
- **toValue**: (0, 0)
- **duration**: 0.4
- **beginTime**: 1000.5
Introducing Additive Animations

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**CAAnimation**

- additive: YES
- fromValue: (-500, 0)
- toValue: (0, 0)
- duration: 1.0
- beginTime: 1000.1

**CAAnimation**

- additive: YES
- fromValue: (500, 0)
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Introducing Additive Animations

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CAAnimation
- additive: YES
- fromValue: (-500, 0)
- toValue: (0, 0)
- duration: 1.0
- beginTime: 1000.1

CAAnimation
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Introducing Additive Animations

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**CAAnimation**

- additive: YES
- fromValue: (-500, 0)
- toValue: (0, 0)
- duration: 1.0
- beginTime: 1000.1

- additive: YES
- fromValue: (500, 0)
- toValue: (0, 0)
- duration: 0.4
- beginTime: 1000.5
Introducing Additive Animations
Absolute animations and BeginFromCurrentState
Introducing Additive Animations
Smooth transitions with easing
Introducing Additive Animations

Supported keys
Introducing Additive Animations

Supported keys

center
frame
bounds
transform
Introducing Additive Animations

Supported keys

center
frame
bounds
transform
layer.transform
Introducing Additive Animations

Affine transforms
Introducing Additive Animations

Affine transforms
Introducing Additive Animations
Affine transforms
Introducing Additive Animations

Compatibility requirements
Introducing Additive Animations

Compatibility requirements

No keyframe animations
Introducing Additive Animations

Compatibility requirements

No keyframe animations
No pre-existing repeating animations
Introducing Additive Animations

Compatibility requirements

No keyframe animations
No pre-existing repeating animations
No pre-existing absolute animations
Introducing Additive Animations

Use `BeginFromCurrentState` defensively

```swift
UIView.animateWithDuration(1) {
    circle.center.x = finalValue
    circle.alpha = 0
    circle.tintColor = UIColor.redColor
}
```
Introducing Additive Animations
Use BeginFromCurrentState defensively

UIView.animateWithDuration(1,
    delay: 0,
    options: .BeginFromCurrentState,
    animations: {
        circle.center.x = finalValue
        circle.alpha = 0
        circle.tintColor = UIColor.redColor
    },
    completion: nil)
Introducing Additive Animations

Canceling animations
Introducing Additive Animations

Canceling animations

```swift
UIView.animateWithDuration(0) {
    circle.center.x = finalValue
}
```
Introducing Additive Animations

Canceling animations

```
UIView.animateWithDuration(0) { 
    circle.center.x = finalValue
}
```

```
circle.layer.removeAnimation(animation)
```
Introducing Additive Animations
Completion handlers
Introducing Additive Animations

Completion handlers (then)

<table>
<thead>
<tr>
<th>Time</th>
<th>1000.0</th>
<th>1000.1</th>
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</tr>
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<td>n/a</td>
<td>(0, 0)</td>
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</tbody>
</table>

CAAnimation

fromValue | (0, 0) |
duration | 1.0 |
beginTime | 1000.1 |
completion | {...} |
Introducing Additive Animations

Completion handlers (then)

<table>
<thead>
<tr>
<th>Time</th>
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```swift
UIView.animateWithDuration(1) {
    circle.center.x = 0
}
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Introducing Additive Animations

Completion handlers (then)

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CAAnimation

- fromValue: (0, 0)
- duration: 1.0
- beginTime: 1000.1
- completion: {...}
Introducing Additive Animations

Completion handlers (then)

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CAAnimation

- fromValue: (0, 0)
- duration: 1.0
- beginTime: 1000.1
- completion: {...}
## Introducing Additive Animations

### Completion handlers (then)

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Introducing Additive Animations

Completion handlers (now)

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CAAnimation

- additive: YES
- fromValue: (-500, 0)
- toValue: (0, 0)
- duration: 1.0
- beginTime: 1000.1
- completion: {...}
Introducing Additive Animations

**Completion handlers (now)**

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<td>(0, 0)</td>
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</table>

```swift
UIView.animateWithDuration(0.4) {
    circle.center.x = 0
}
```
Introducing Additive Animations

Completion handlers (now)

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CAAnimation

- additive: YES
- fromValue: (-500, 0)
- toValue: (0, 0)
- duration: 1.0
- beginTime: 1000.1
- completion: {...}
Introducing Additive Animations

Completion handlers (now)

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- **CAAnimation**
  - additive: YES
  - fromValue: (-500, 0)
  - toValue: (0, 0)
  - duration: 1.0
  - beginTime: 1000.1
  - completion: {...}

- **CAAnimation**
  - additive: YES
  - fromValue: (500, 0)
  - toValue: (0, 0)
  - duration: 0.4
  - beginTime: 1000.5
## Introducing Additive Animations

### Completion handlers (now)

<table>
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<td>(-300, 0)</td>
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<td>n/a</td>
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</table>

### CAAnimation

- **additive**: YES
- **fromValue**: (-500, 0)
- **toValue**: (0, 0)
- **duration**: 1.0
- **beginTime**: 1000.1
- **completion**: {...}

### CAAnimation

- **additive**: YES
- **fromValue**: (500, 0)
- **toValue**: (0, 0)
- **duration**: 0.4
- **beginTime**: 1000.5
### Introducing Additive Animations

#### Completion handlers (now)

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<td>(0, 0)</td>
</tr>
</tbody>
</table>

#### CAAnimation

| additive | YES | fromValue | (-500, 0) | toValue | (0, 0) | duration | 1.0 | beginTime | 1000.1 | completion | {...} |

| additive | YES | fromValue | (500, 0) | toValue | (0, 0) | duration | 0.4 | beginTime | 1000.5 | completion | true |

#### Diagram

- Completion (true)
Introducing Additive Animations

Summary
Introducing Additive Animations

Summary

Smotherer transitions by default
Introducing Additive Animations

Summary

Smooother transitions by default
Still use BeginFromCurrentState if unsure
Introducing Additive Animations

Summary

Smother transitions by default
Still use BeginFromCurrentState if unsure
Completion handlers may stack
From Animation to Gesture

Josh Shaffer
iOS Apps and Frameworks Engineer
.AllowsUserInteraction
.AllowsUserInteraction
.AllowsUserInteraction
.AllowsUserInteraction
Presentation Layer Hit Test
override func hitTest(point: CGPoint, withEvent event: UIEvent!) -> UIView! {
}

Presentation Layer Hit Test
override func hitTest(point: CGPoint, withEvent event: UIEvent!) -> UIView! {
    let superviewPoint = convertPoint(point, toView: superview)
}

override func hitTest(point: CGPoint, withEvent event: UIEvent!) -> UIView! {
    let superviewPoint = convertPoint(point, toView: superview)
    let point = layer.presentationLayer.convertPoint(superviewPoint, fromLayer: superview.layer)
}
override func hitTest(point: CGPoint, withEvent event: UIEvent!) -> UIView! {
    let superviewPoint = convertPoint(point, toView: superview)
    let point = layer.presentationLayer.convertPoint(superviewPoint, fromLayer: superview.layer)

    return super.hitTest(point, withEvent: event)
}
AllowsUserInteraction
touch.locationInView
Stop Animating
Stop Animating

let presentationPosition = view.layer.presentationLayer().position
Stop Animating

let presentationPosition = view.layer.presentationLayer().position
view.center = presentationPosition
Stop Animating

```swift
let presentationPosition = view.layer.presentationLayer().position
view.center = presentationPosition
view.layer.removeAllAnimations()
```
switch (panGestureRecognizer.state) {
    case .Ended:
        let v = panGestureRecognizer.velocityInView(targetView.superview)

        dynamicItemBehavior.addLinearVelocity(v, forItem: targetView)
    
}
switch (panGestureRecognizer.state) {
    case .Began:

    case .Ended:
        let v = panGestureRecognizer.velocityInView(targetView.superview)
        dynamicItemBehavior.addLinearVelocity(v, forItem: targetView)
}
switch (panGestureRecognizer.state) {
    case .Began:
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        let v = panGestureRecognizer.velocityInView(targetView.superview)
        dynamicItemBehavior.addLinearVelocity(v, forItem: targetView)
}
switch (panGestureRecognizer.state) {
    case .Began:
        dynamicItemBehavior.removeItem(targetView)
    case .Ended:
        let v = panGestureRecognizer.velocityInView(targetView.superview)
        dynamicItemBehavior.addItem(targetView)
        dynamicItemBehavior.addLinearVelocity(v, forItem: targetView)
}
Gesture to Animation

Animation to Animation

Animation to Gesture
Transient Animation State
Demo

Andy Matuschak
Summary

Use gesture velocity in animations
Summary

Use gesture velocity in animations
Smoothly transition between animations
Summary

Use gesture velocity in animations
Smoothly transition between animations
Make animations interruptible
Summary

Use gesture velocity in animations
Smoothly transition between animations
Make animations interruptible
Mind your state
More Information

Jake Behrens
App Frameworks Evangelist
behrens@apple.com

Documentation
Core Animation Programming Guide
http://developer.apple.com

Apple Developer Forums
http://devforums.apple.com
## Labs

<table>
<thead>
<tr>
<th>Open Hours</th>
<th>Frameworks Lab A and B</th>
<th>Friday 2:00PM</th>
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