Getting Started with UIKit Dynamics

Session 206

Olivier Gutknecht
iOS Applications & Frameworks Engineer

Agenda

What we will cover

Agenda

What we will cover

- Core concepts

Agenda

What we will cover

- Core concepts
- Predefined behaviors

Agenda

What we will cover

- Core concepts
- Predefined behaviors
- Best practices

Animations and Interactions on iOS

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- Core Animation

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- UIView animations

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Animations and Interactions on iOS

- Core Animation
- UIView animations
- Motion effects
- Gesture driven interactions
- CADisplayLink
- All of above

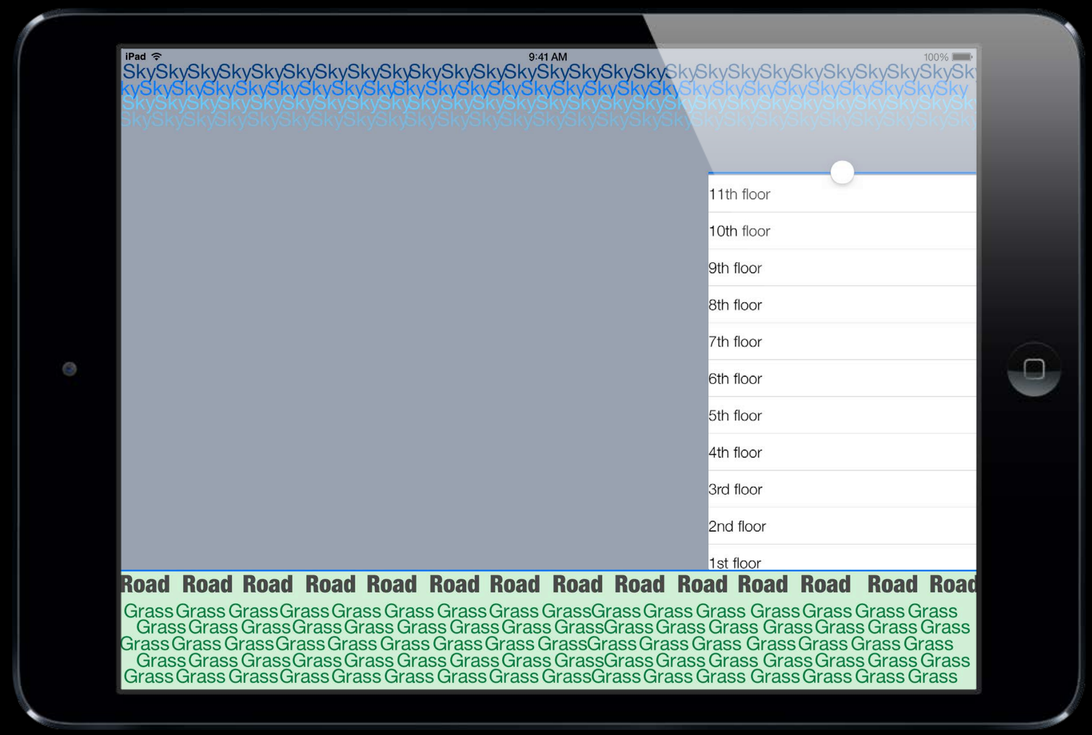
What Is UIKit Dynamics?

What Is UIKit Dynamics?

A composable, reusable, declarative,
real-world inspired animation, and interaction system

UIKit Games

UIKit Games


iPad
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100%
11th floor
10th floor
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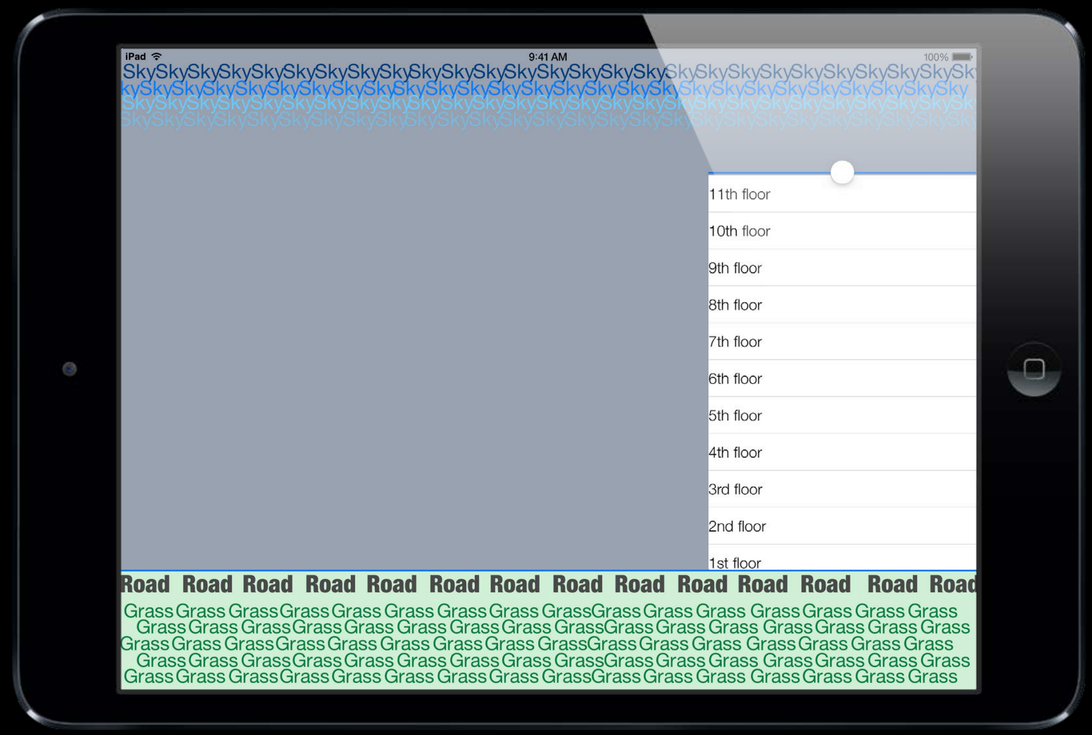
2nd floor
1st floor
Road
Grass

UIKit Games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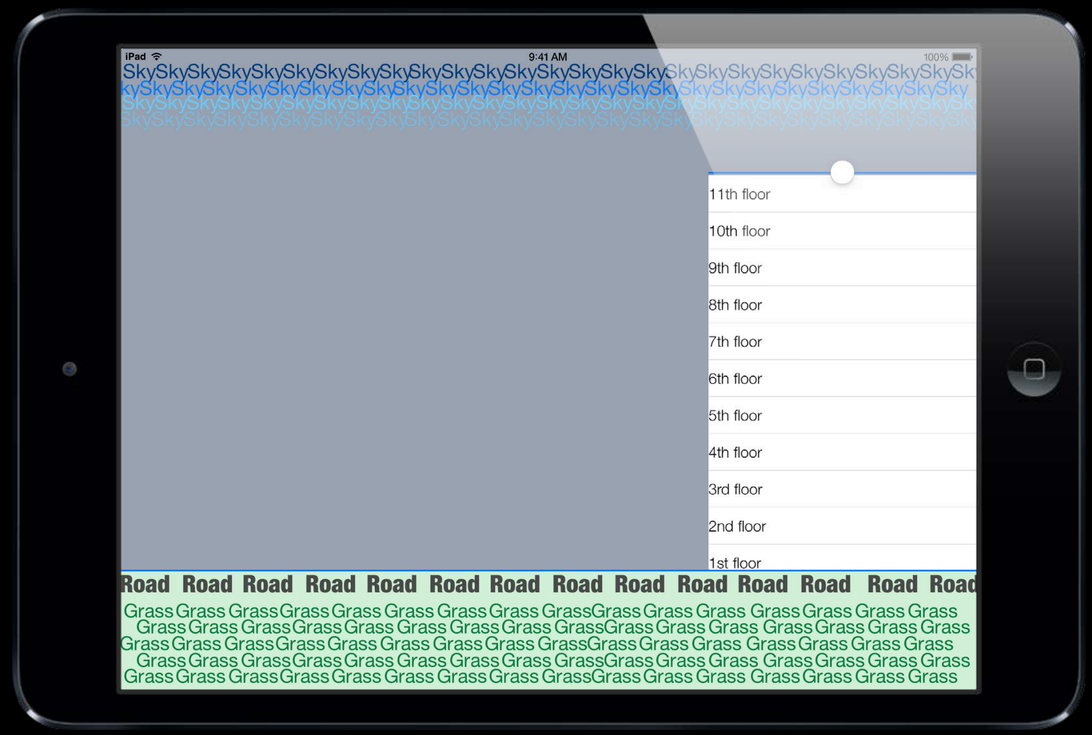
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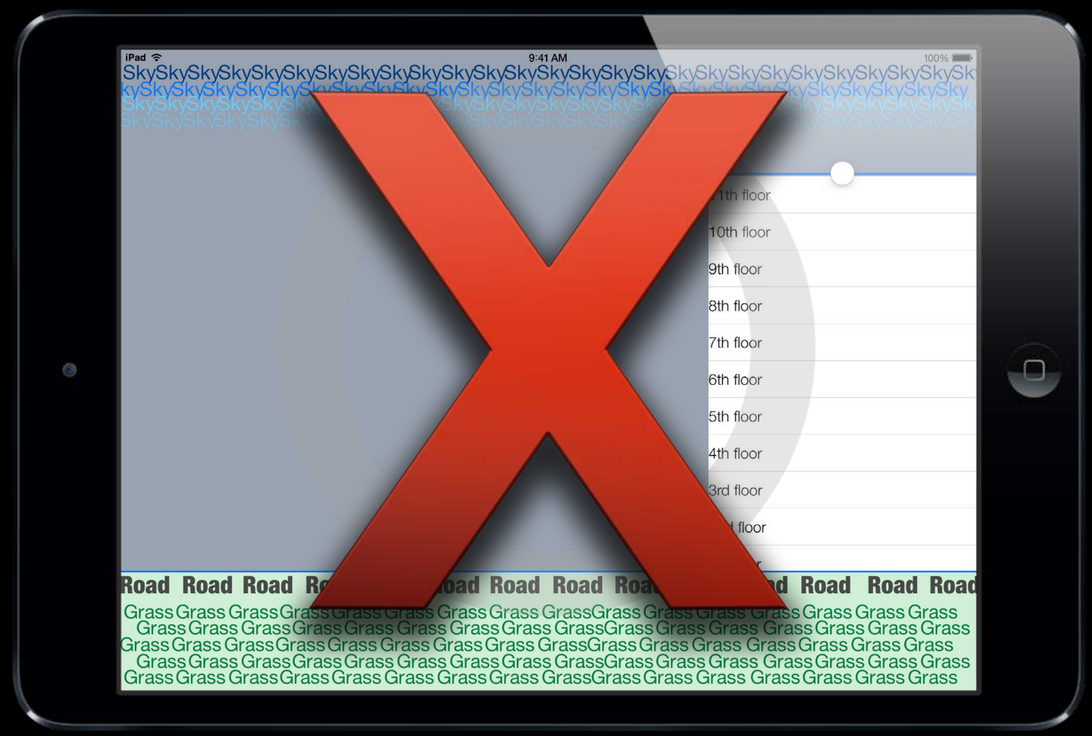
UIKit Games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NEW

Sprite Kit

Introduction to Sprite Kit

Presidio
Wednesday 11:30AM

Demo

How Complex Is This?

Entire application: 400 lines of code

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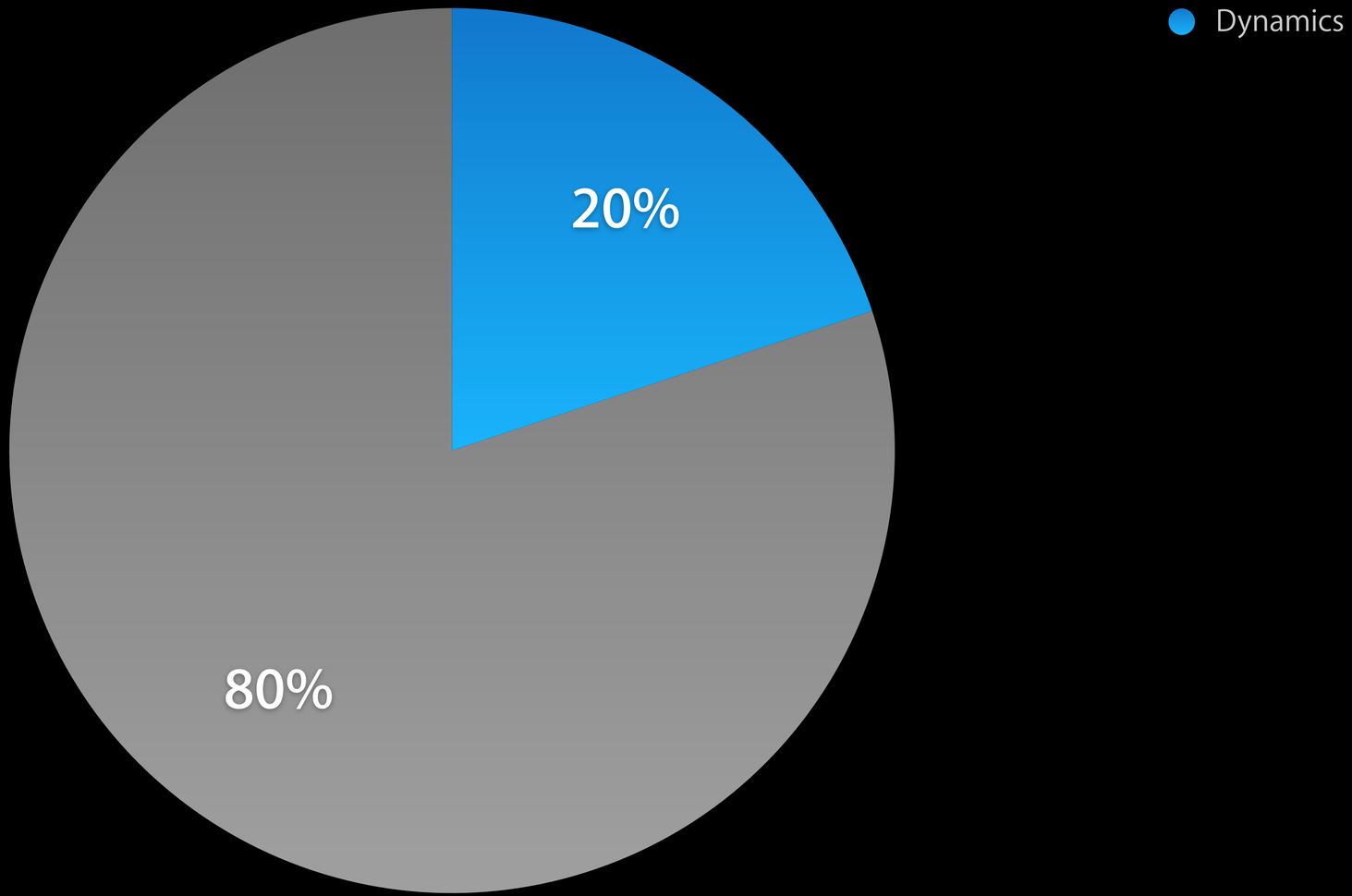
Entire application: 400 lines of code



Overview

Why?

Why?

- Real world inspired interactions

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- Real world inspired interactions
- Combining predefined
  and interactive animations

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- Designed for UI

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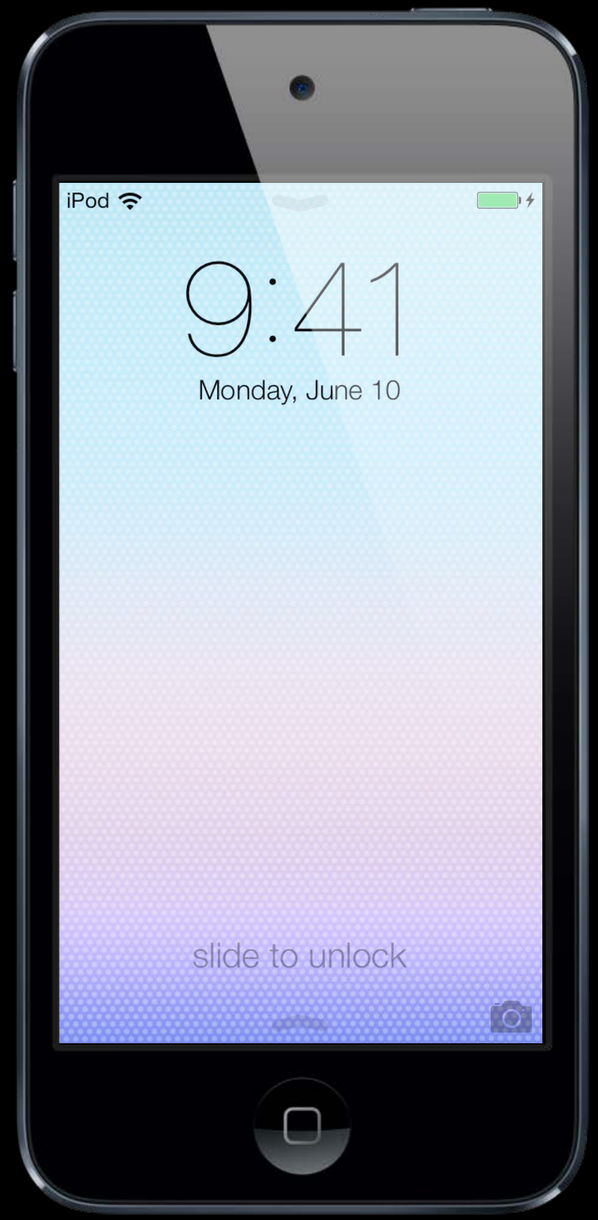
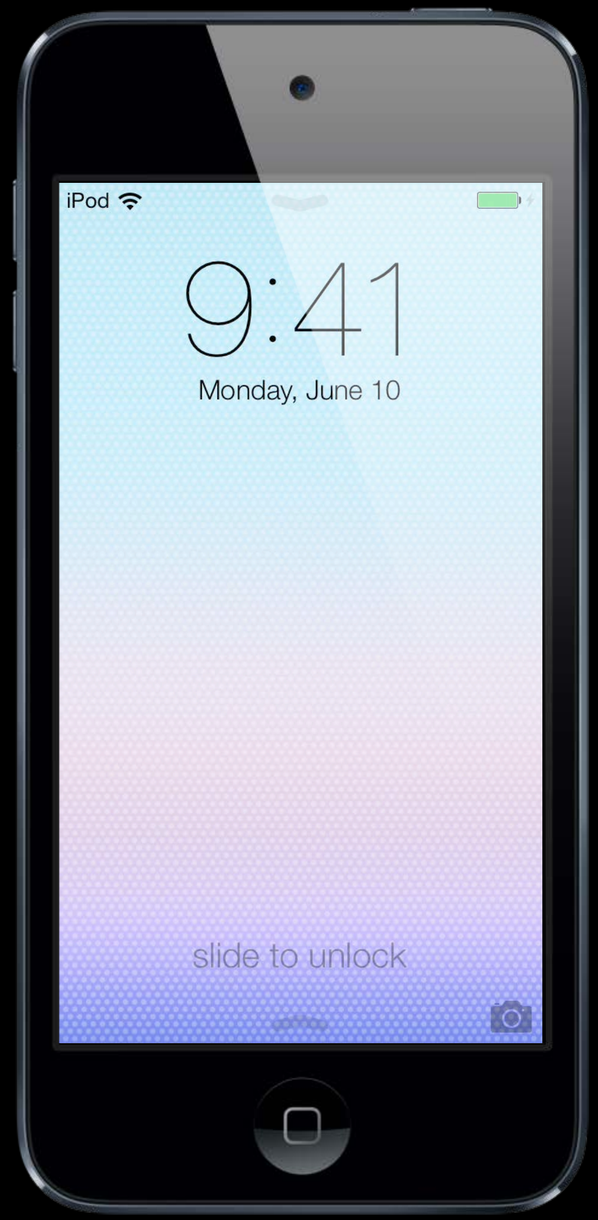


Why?

- Real world inspired interactions
- Combining predefined and interactive animations
- Designed for UI



How?

How?

- High-level expression

```
[myView setMass:0.42] ?
```

How?

- High-level expression

~~`[myView setMass:0.42] ?`~~

How?

- High-level expression
- Composition of…

How?

- High-level expression
- Composition of…
  - Primitive behaviors

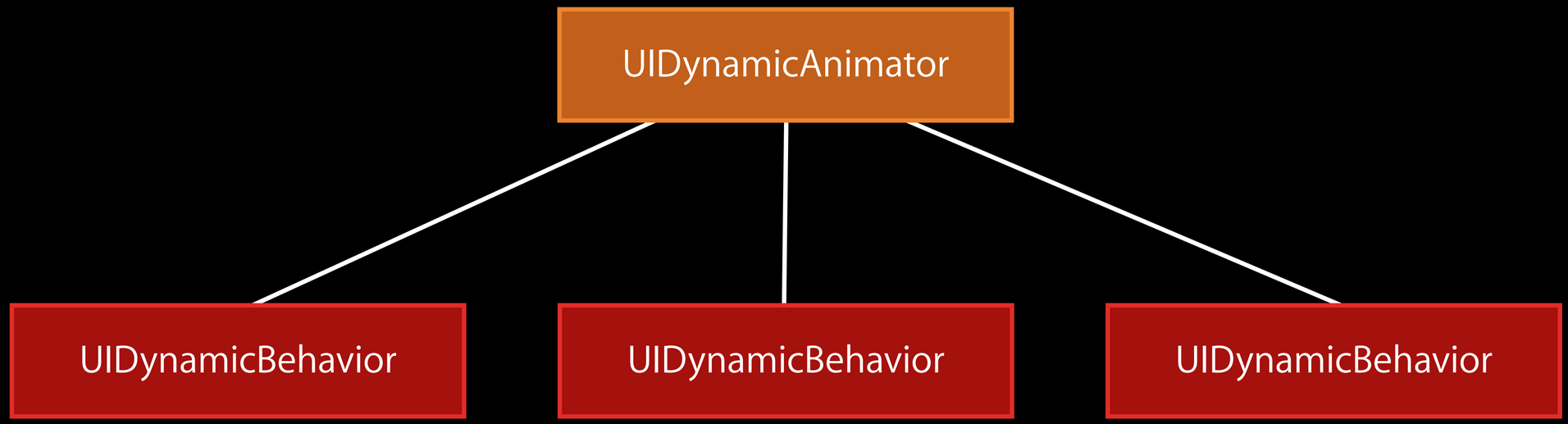
How?

- High-level expression
- Composition of…
  - Primitive behaviors
- Animation context

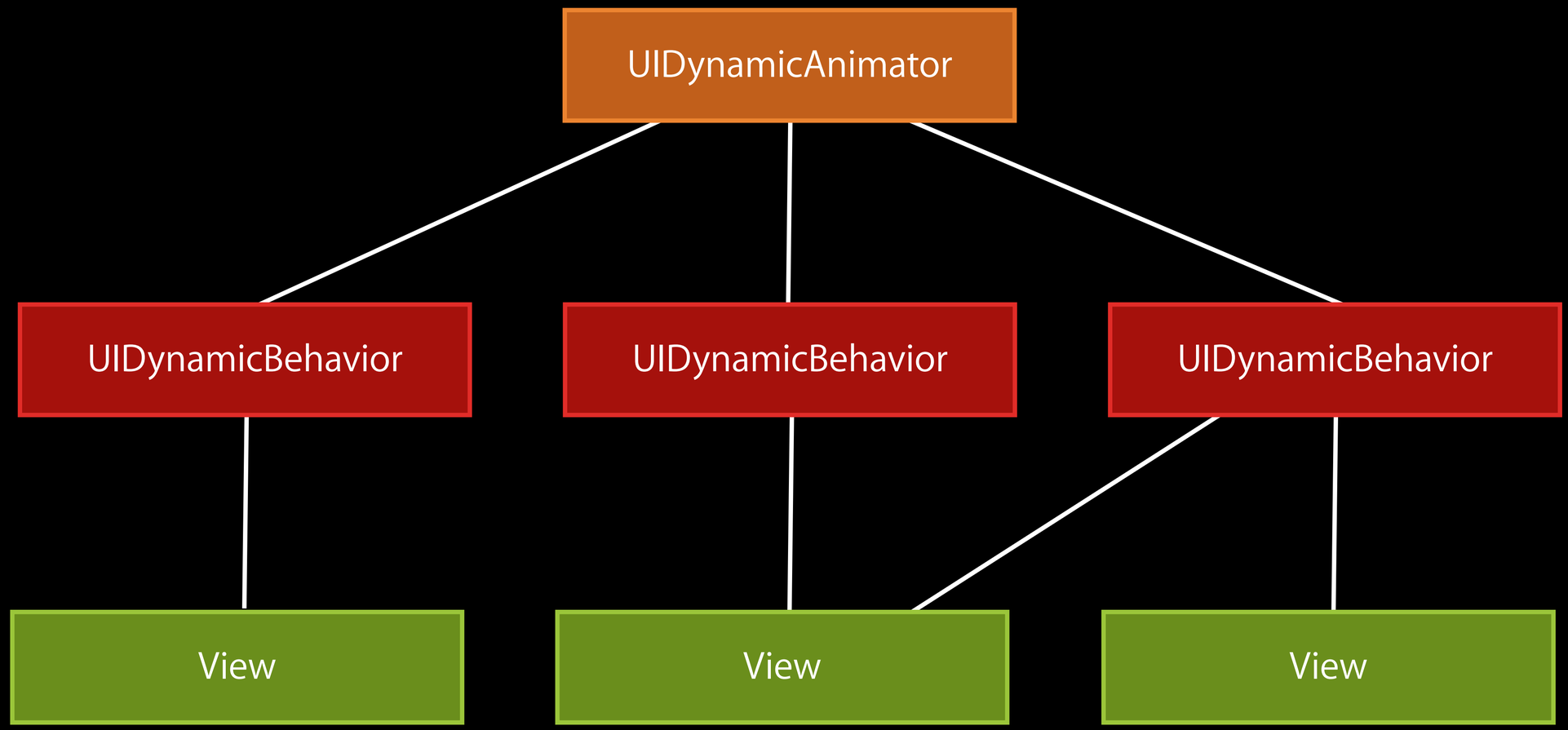
Architecture

UIDynamicAnimator

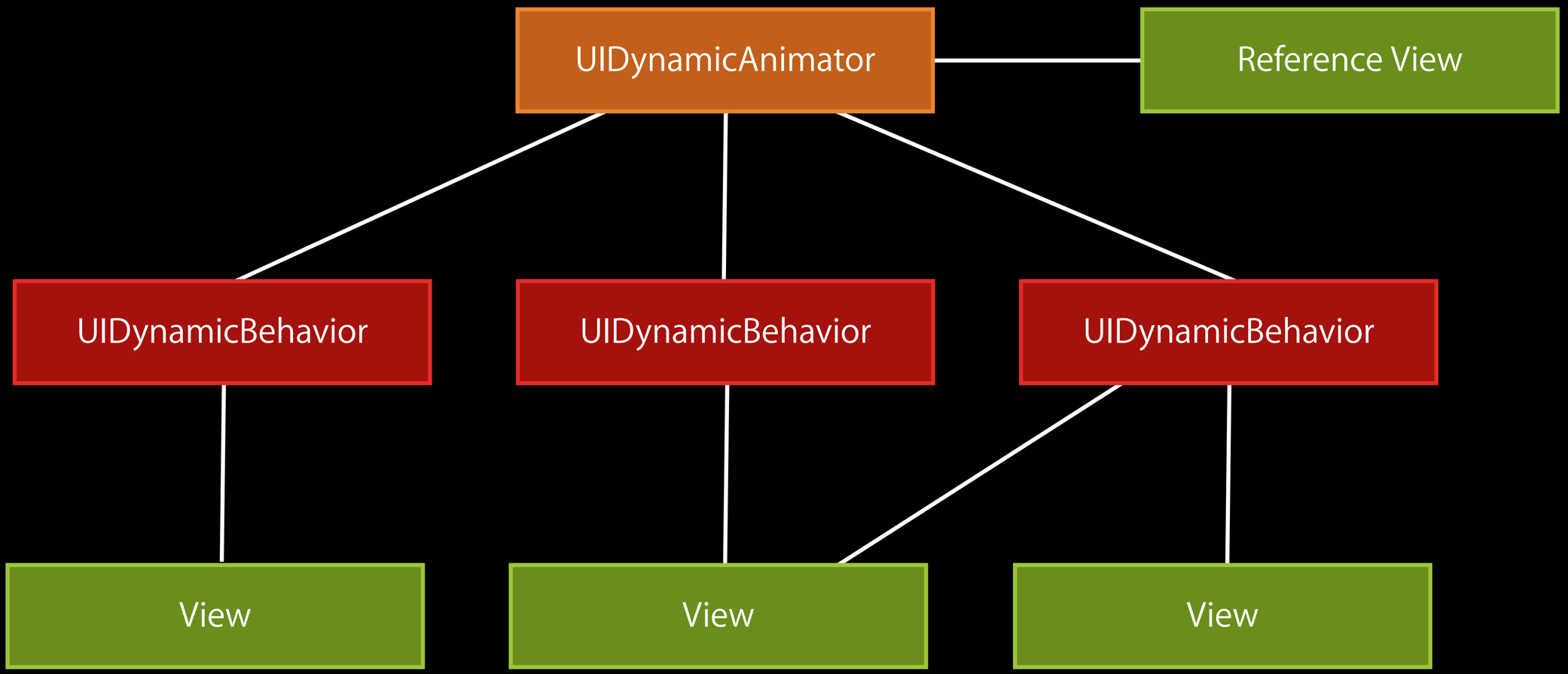
Architecture



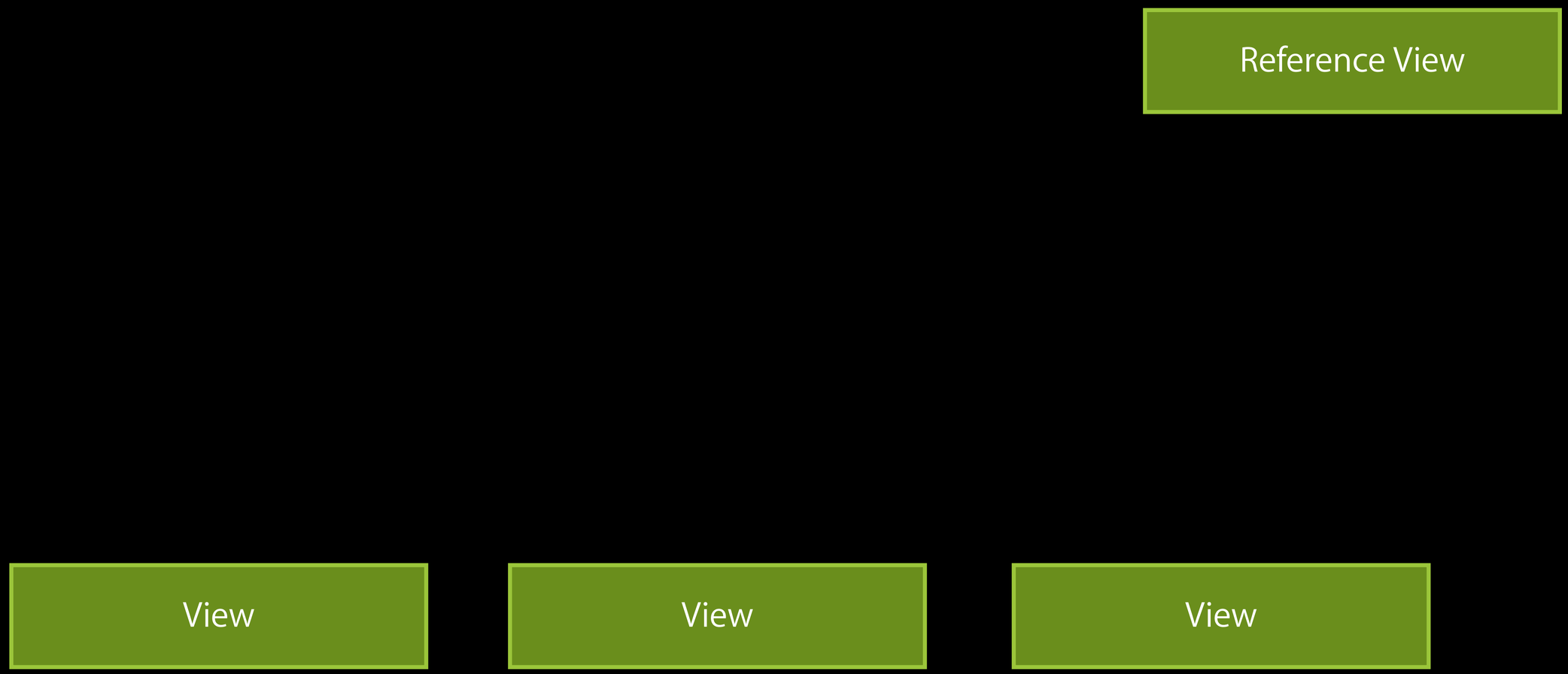
Architecture



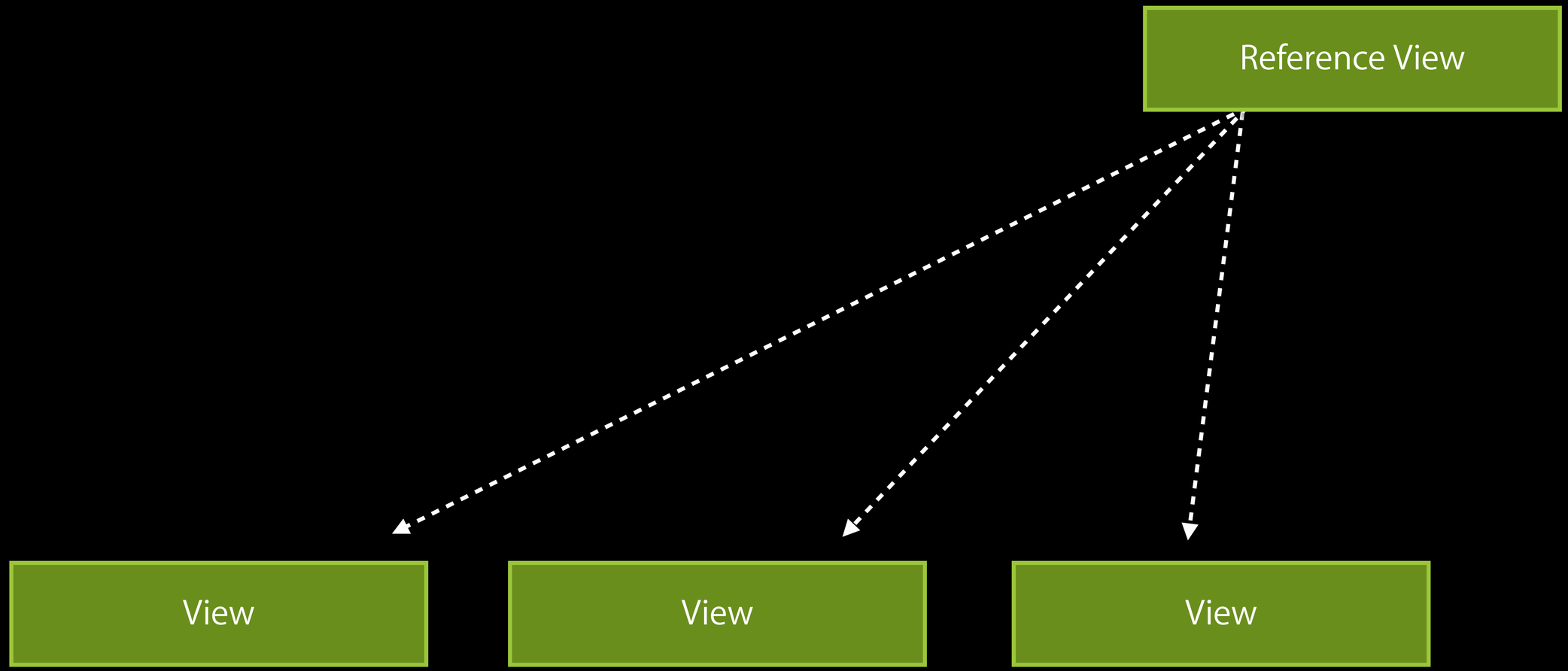
Architecture



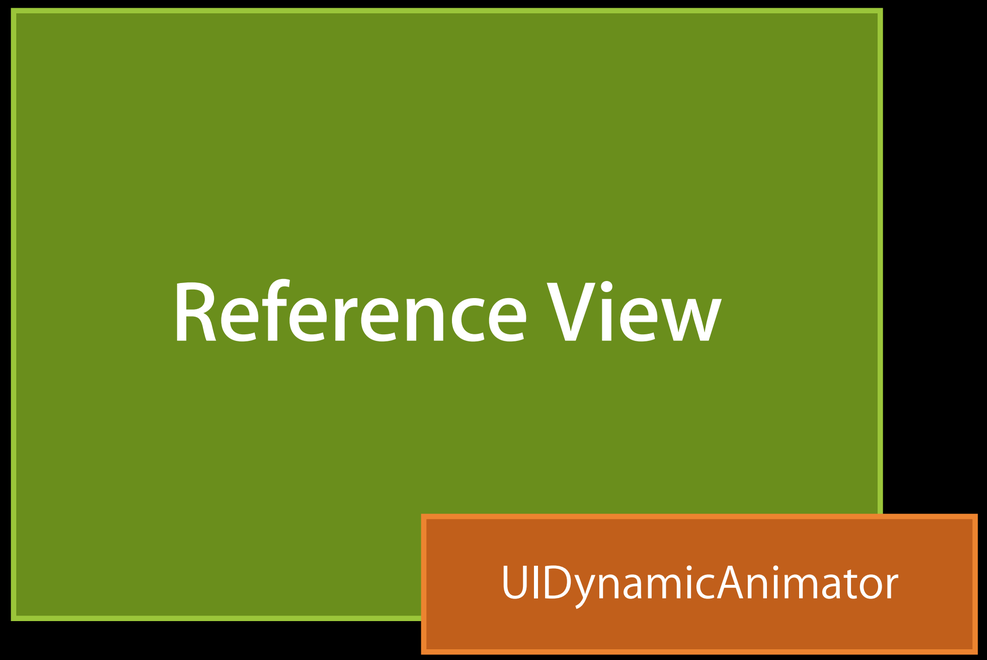
Architecture



Architecture

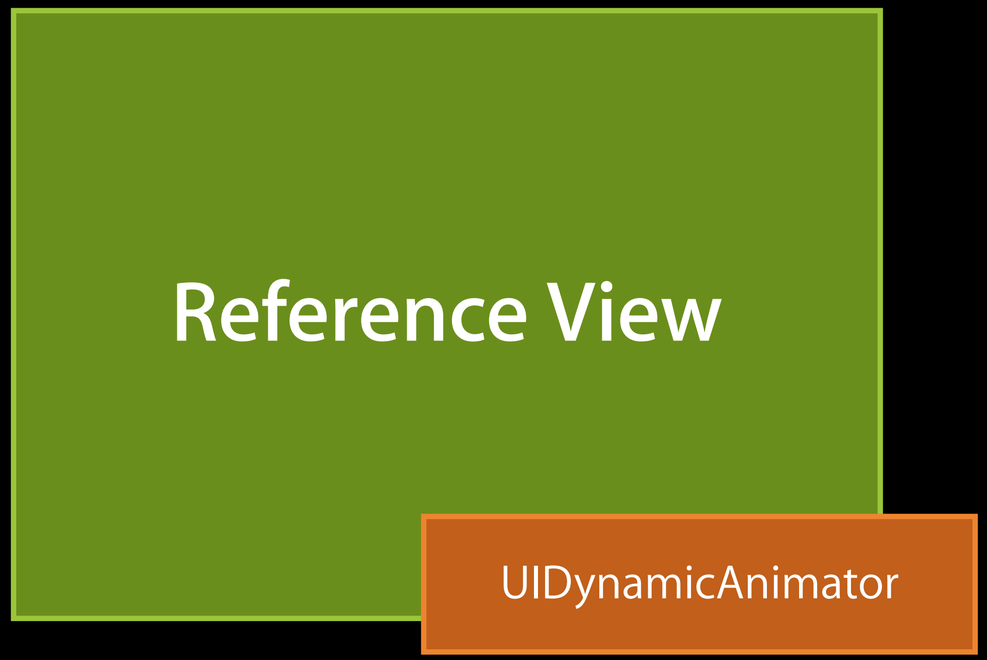


UIDynamicAnimator



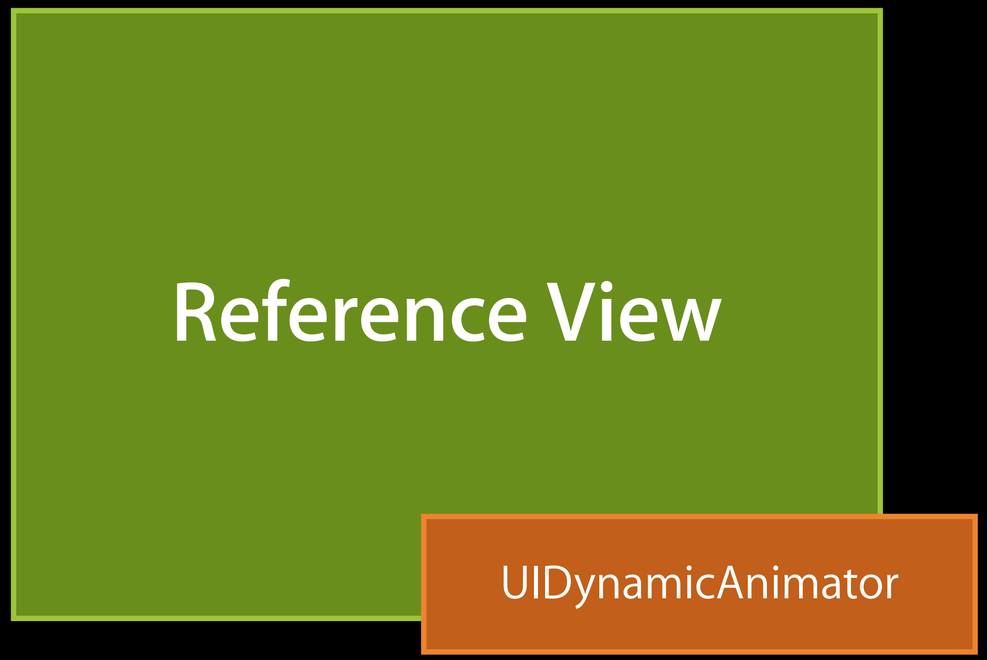
UIDynamicAnimator

- Provide the overall context



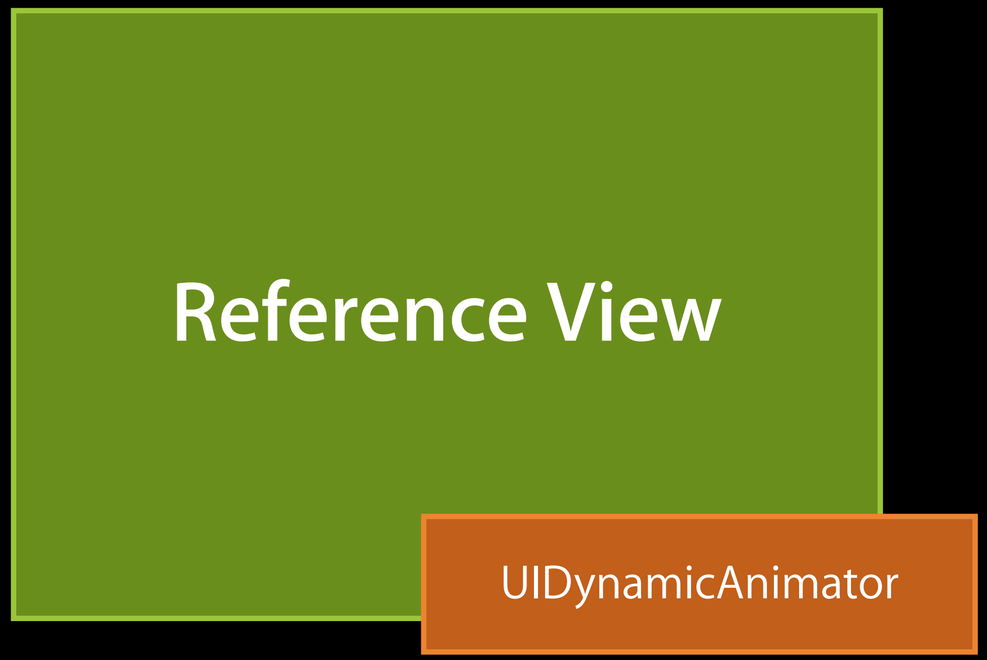
UIDynamicAnimator

- Provide the overall context
- Define the coordinate system



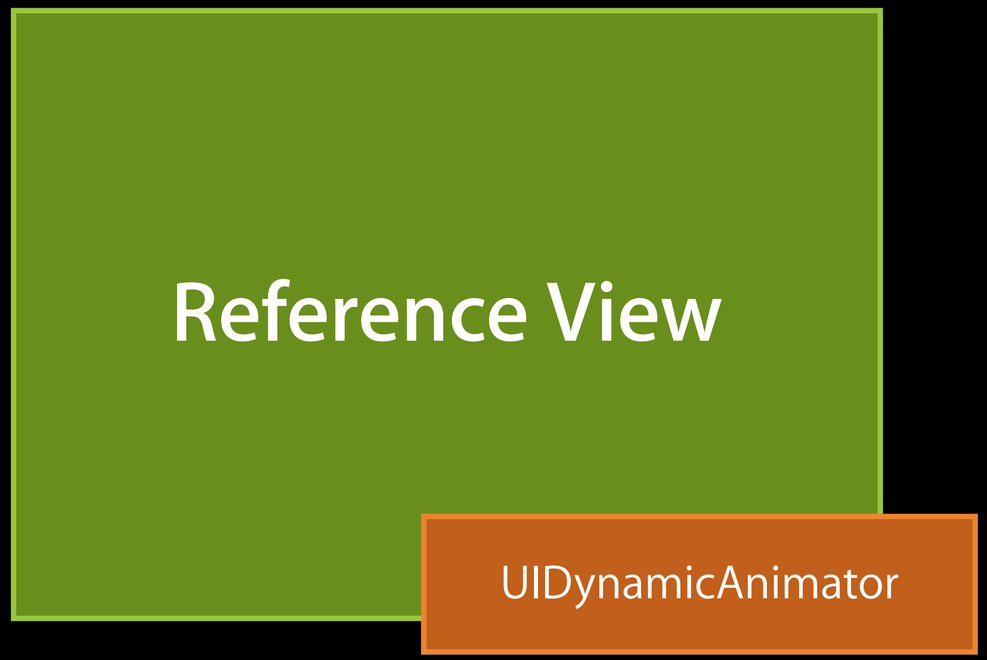
UIDynamicAnimator

- Provide the overall context
- Define the coordinate system
- Control the engine



UIDynamicAnimator

- Provide the overall context
- Define the coordinate system
- Control the engine
- Keep track of behaviors



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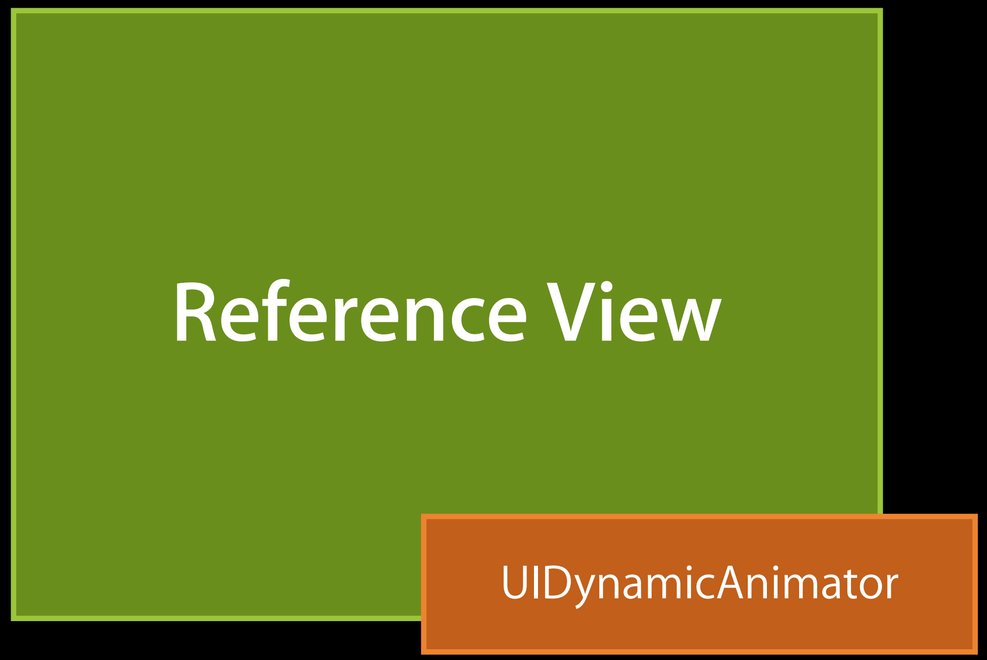
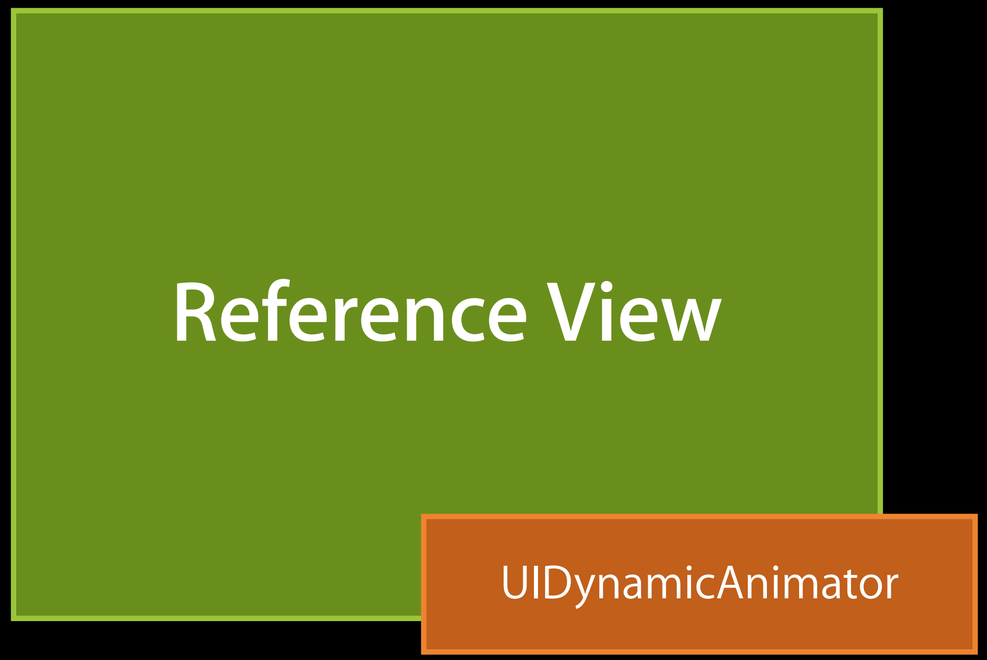



```
animator = [[UIDynamicAnimator alloc] initWithReferenceView:referenceView];

[animator addBehavior:...];
[animator addBehavior:...];
```

UIDynamicBehavior



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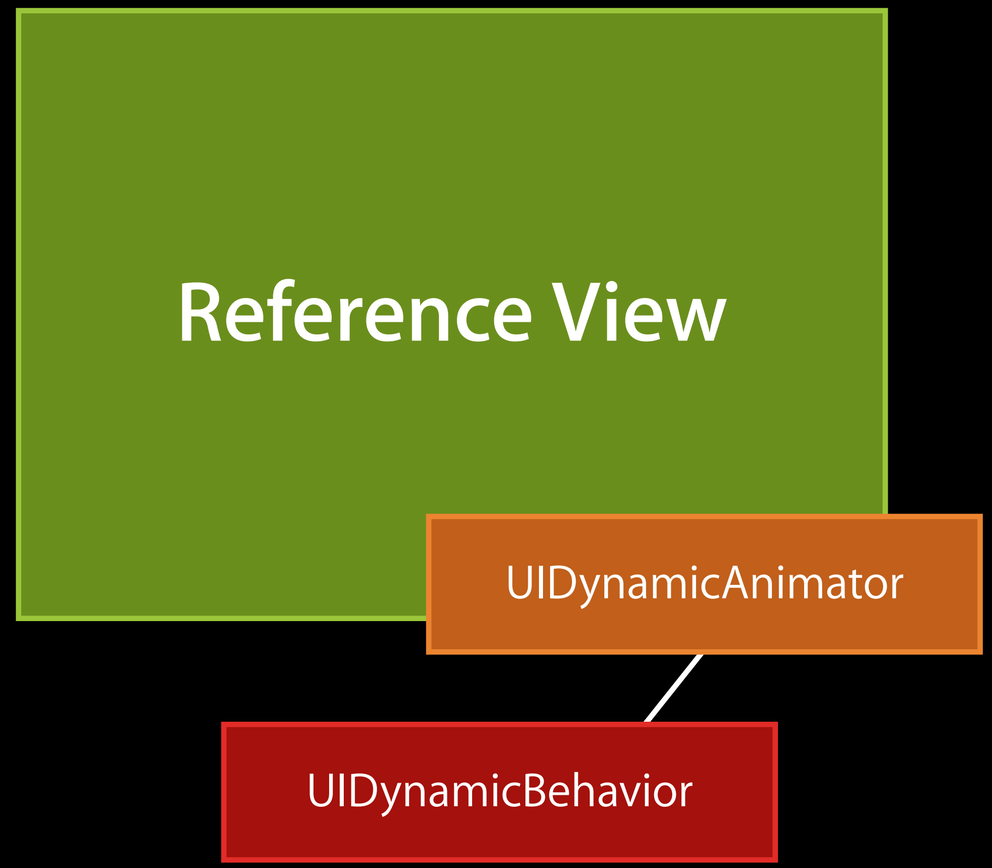
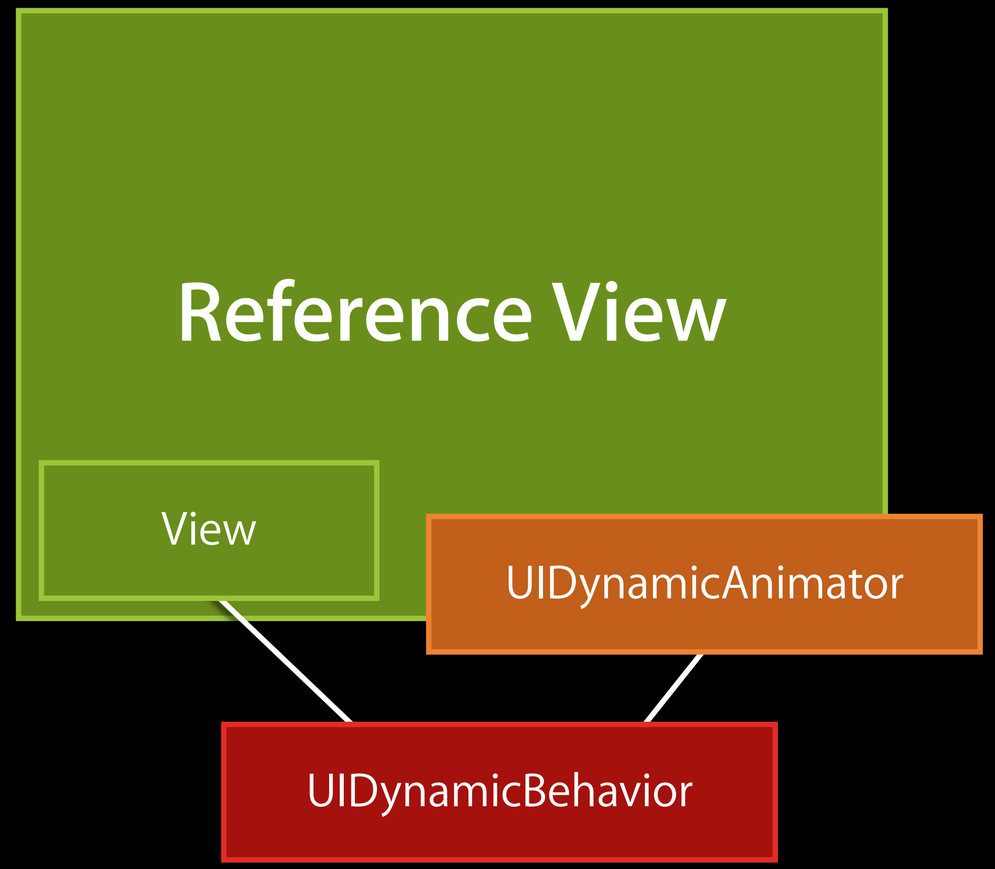
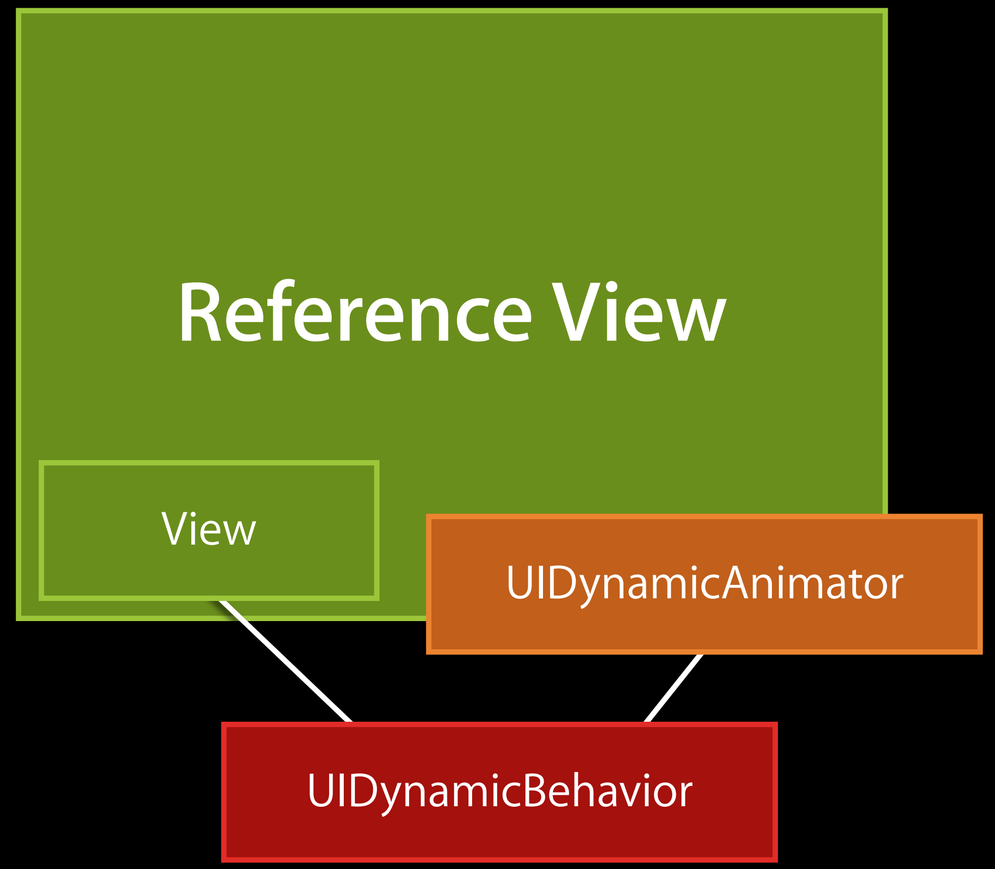


UIDynamicBehavior



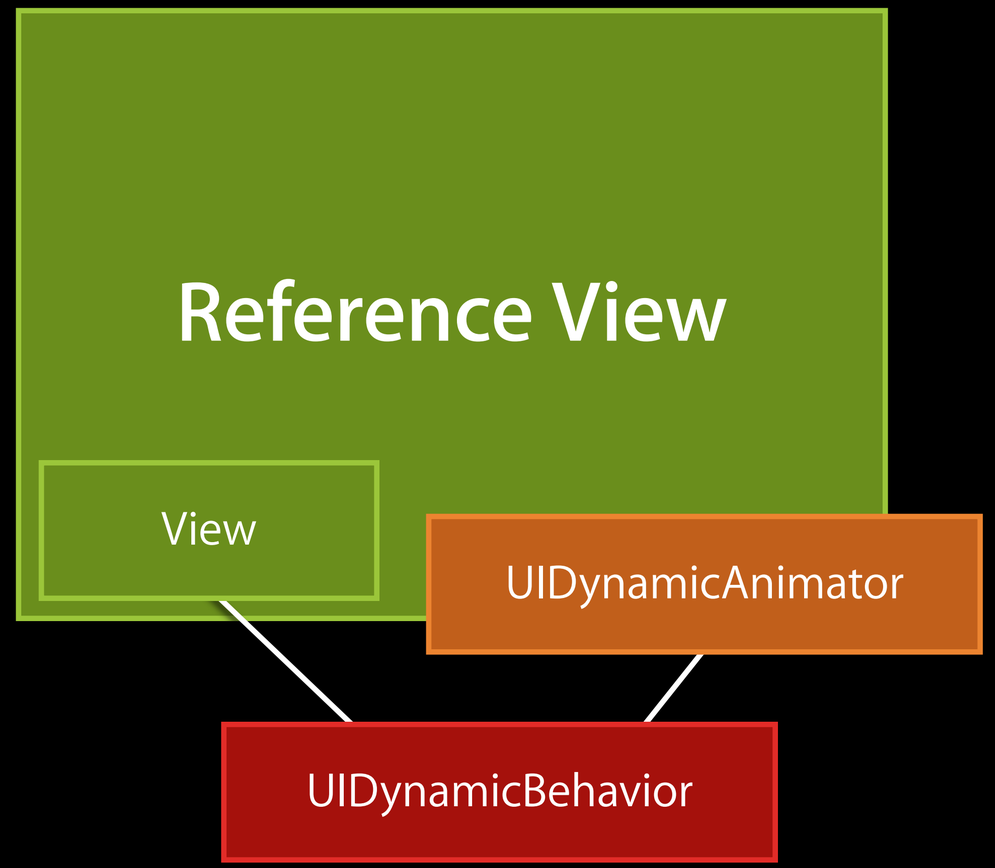
UIDynamicBehavior

- Declarative



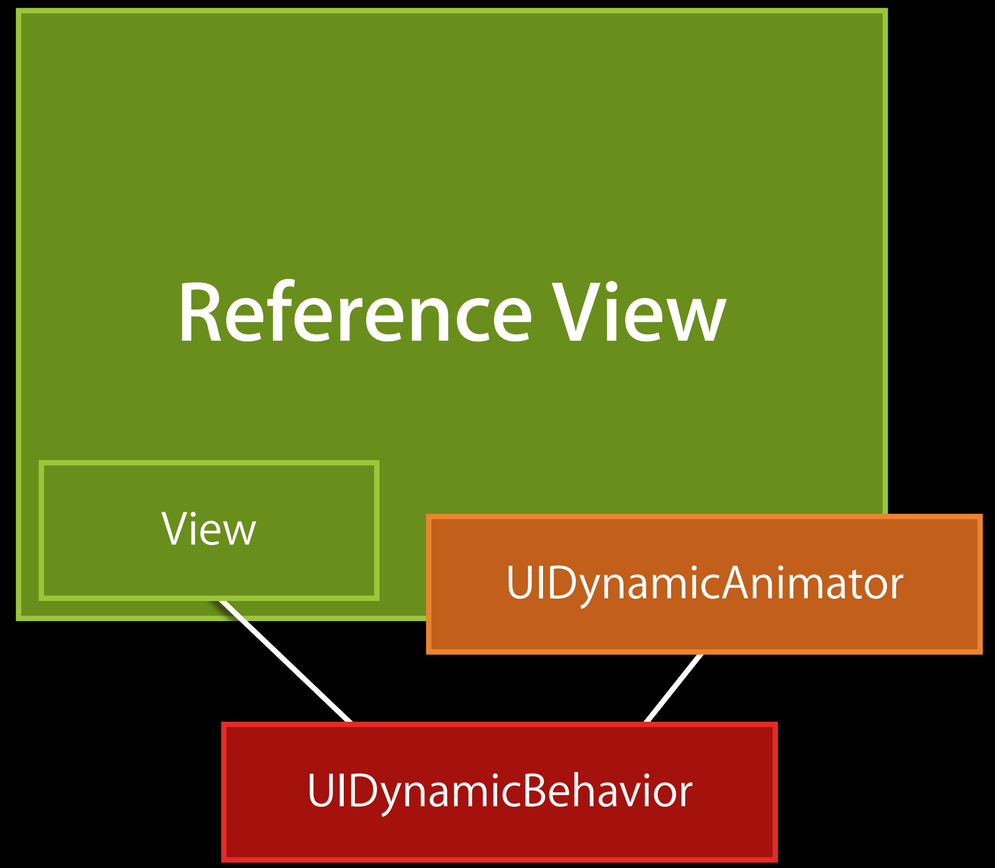
UIDynamicBehavior

- Declarative
- Describe “influences” on views



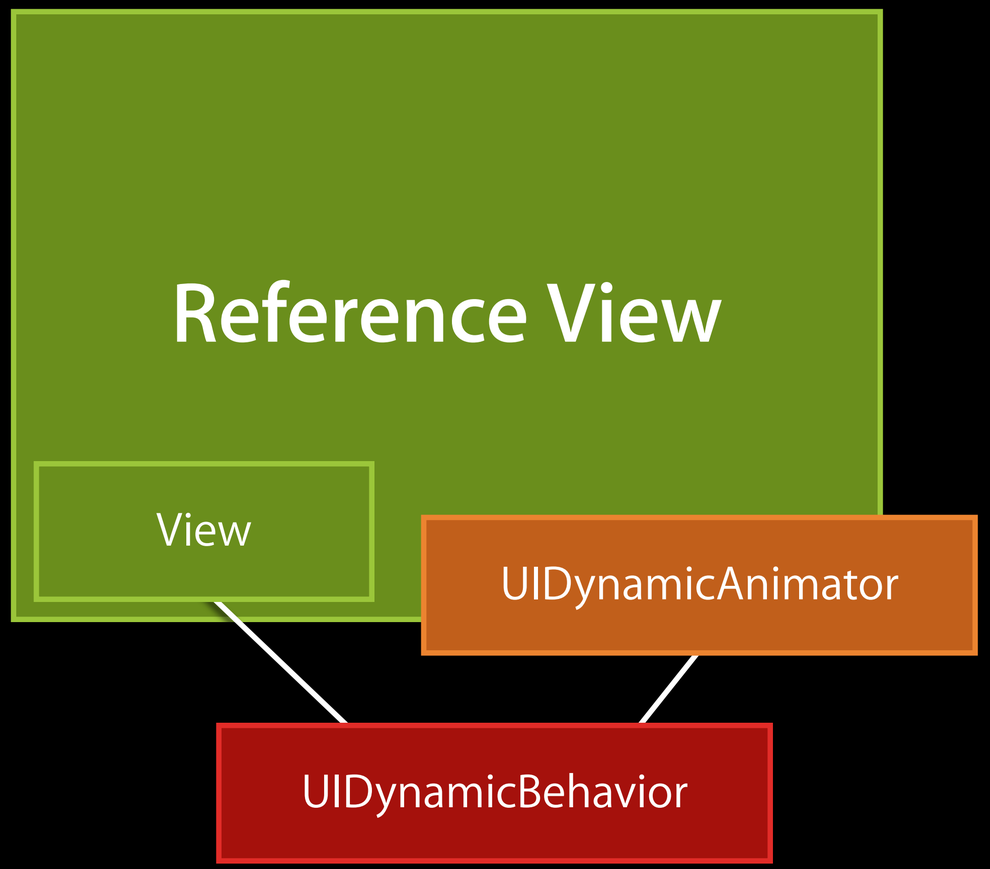
UIDynamicBehavior

- Declarative
- Describe “influences” on views
- Added and removed at any time



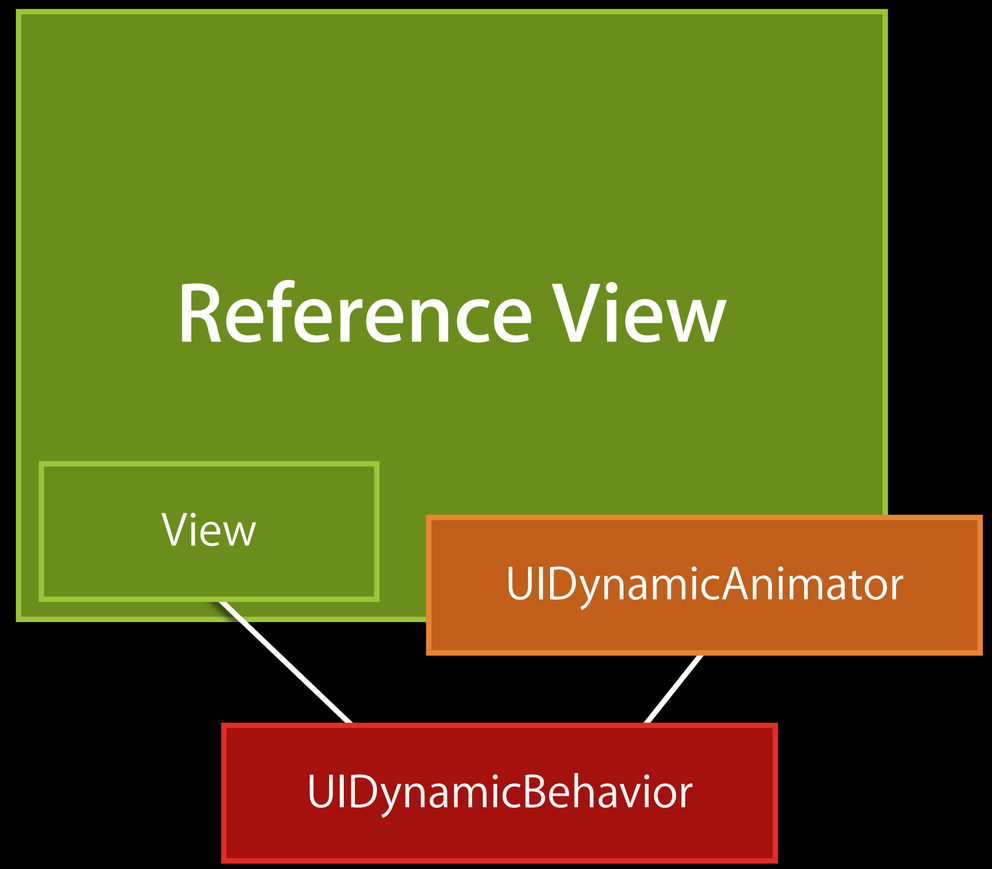
UIDynamicBehavior

- Declarative
- Describe “influences” on views
- Added and removed at any time
- Composable



UIDynamicBehavior

- Declarative
- Describe "influences" on views
- Added and removed at any time
- Composable
- Subclassable



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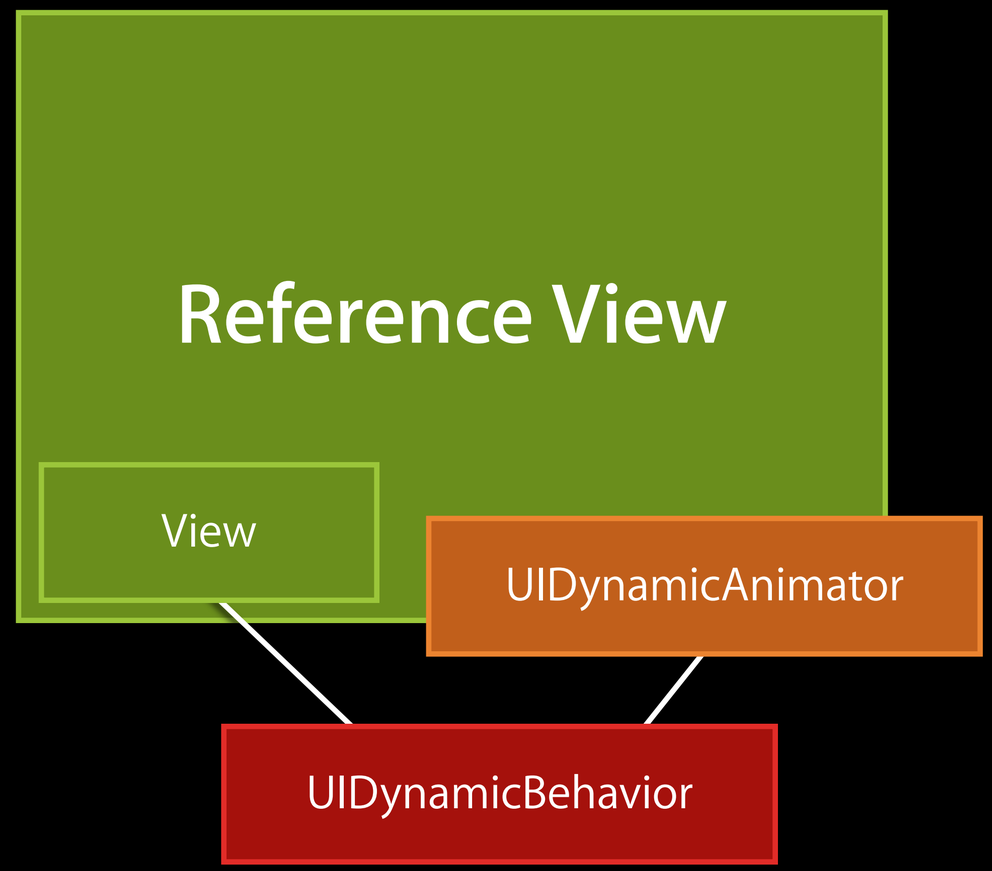


```
myBehavior = [[MyBehavior alloc] initWith...];

[animator addBehavior:myBehavior];
```

Primitive Behaviors

Common Traits

- Configured with items to animate

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- Most primitive behaviors support adding and removing items

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- Can be parametrized before adding to an animator

Common Traits

- Configured with items to animate
- Most primitive behaviors support adding and removing items
- Can be parametrized before adding to an animator
- The influence stops when the behavior is removed

Predefined Behaviors

A rich set of composable classes

Predefined Behaviors

A rich set of composable classes

- Gravity

Predefined Behaviors

A rich set of composable classes

- Gravity
- Collision

Predefined Behaviors

A rich set of composable classes

- Gravity
- Collision
- Attachments

Predefined Behaviors

A rich set of composable classes

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- Snap

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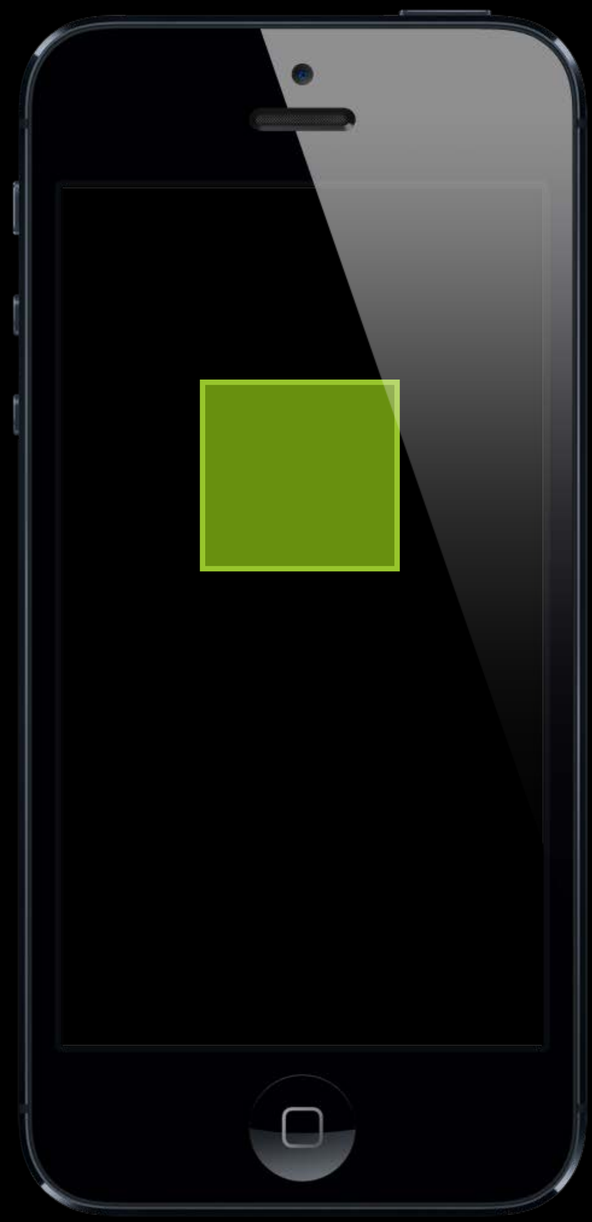
Predefined Behaviors

A rich set of composable classes

- Gravity
- Collision
- Attachments
- Snap
- Forces
- Item properties

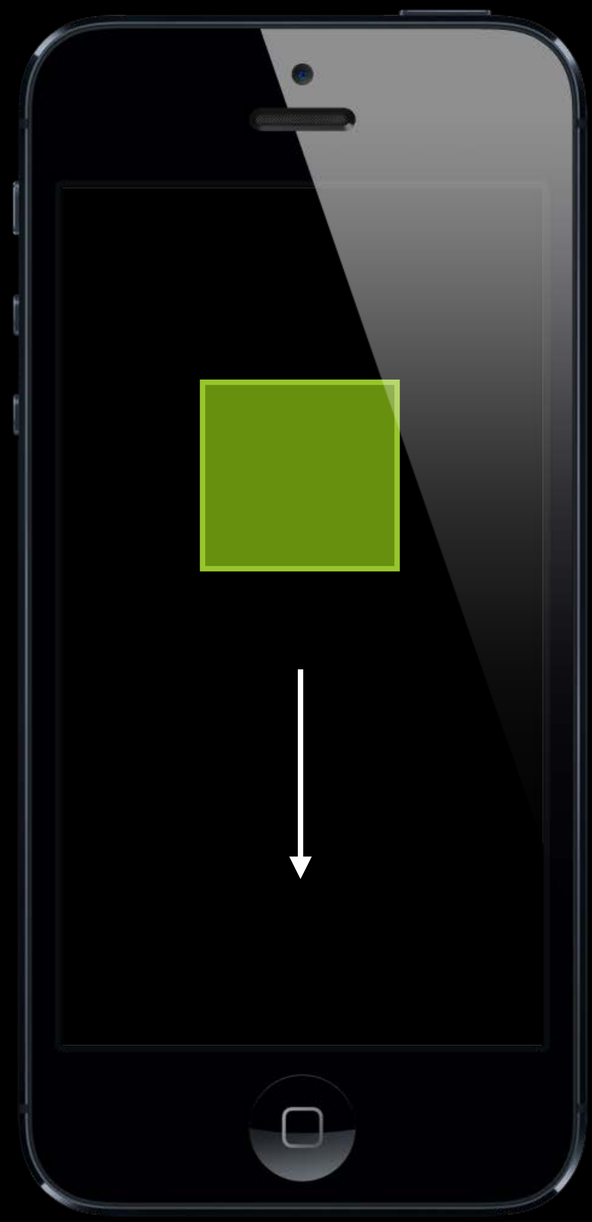
UIGravityBehavior



UIGravityBehavior

UIGravityBehavior

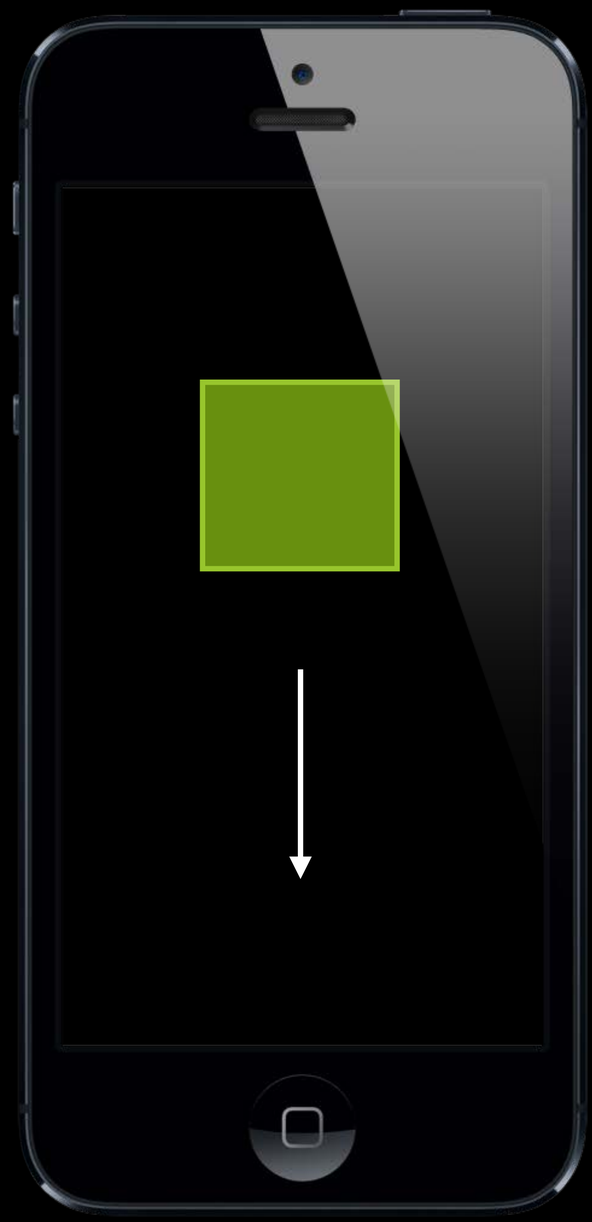
- A simple gravity vector



UIGravityBehavior

- A simple gravity vector

```
@property (readwrite,nonatomic)
CGFloat xComponent;
@property (readwrite,nonatomic)
CGFloat yComponent;
```



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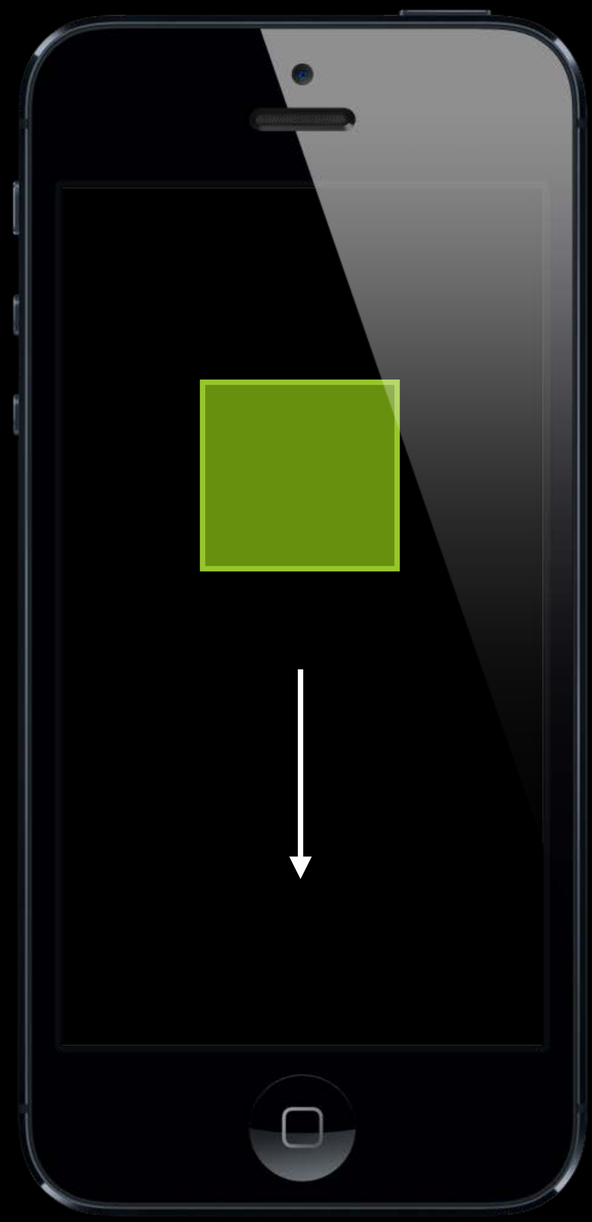
- UIKit coordinate system



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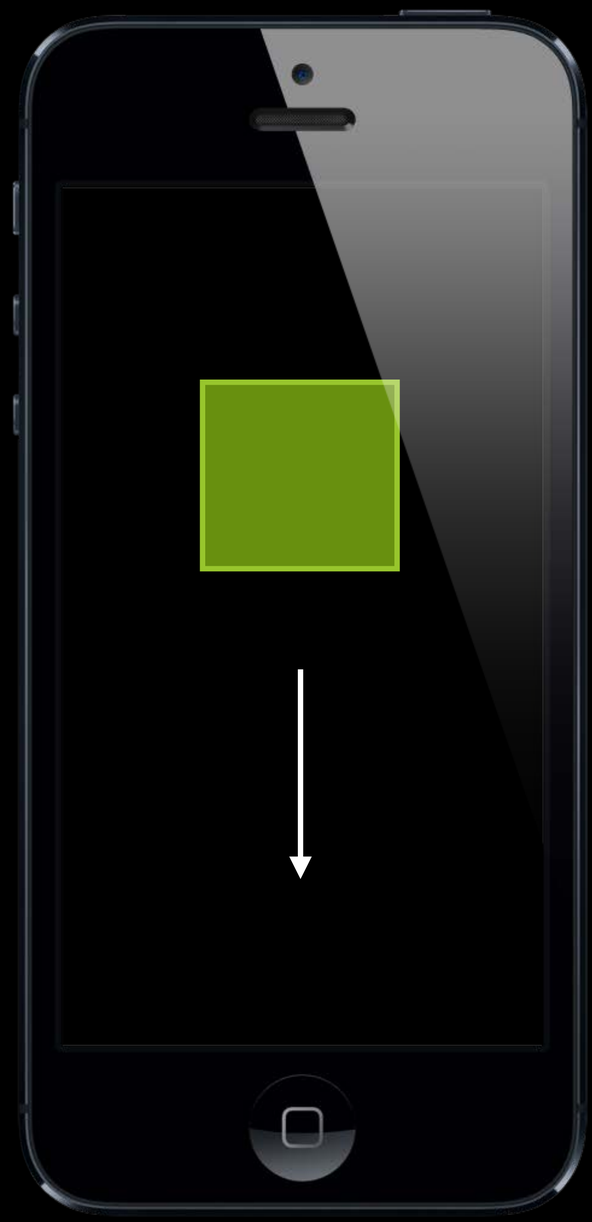

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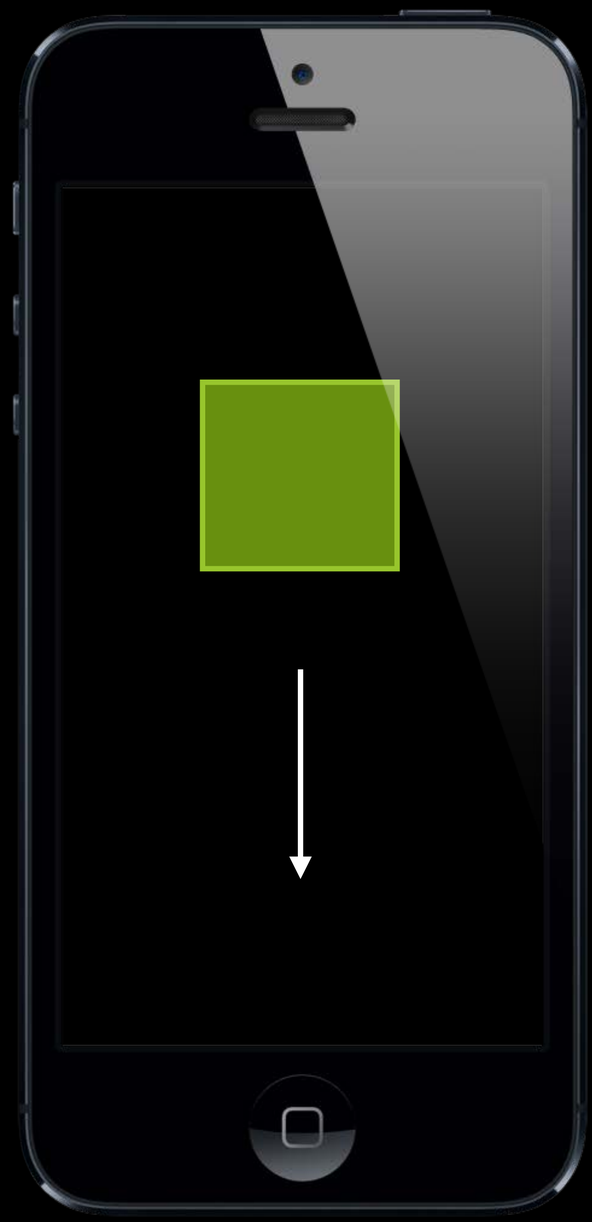

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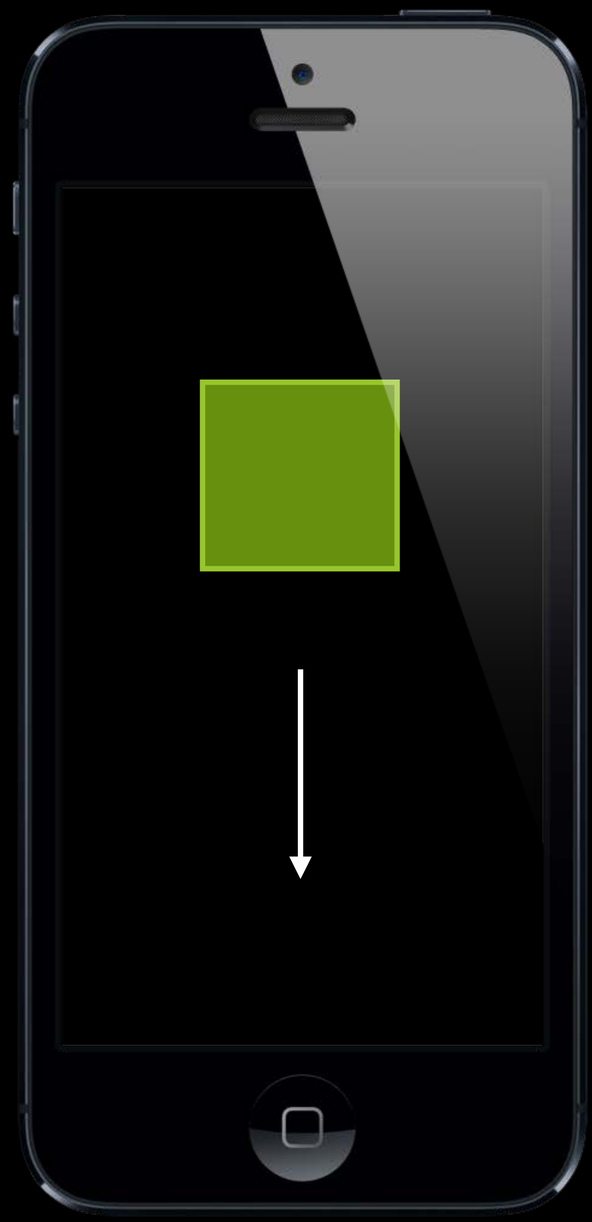
```
g = [[UIGravityBehavior alloc] initWithItems:@[v]];

[animator addBehavior:g];
```



A Well-known Constant…

Earth Gravity

A Well-known Constant…

Earth Gravity
$9.80665\ m/s^2$

Introducing…

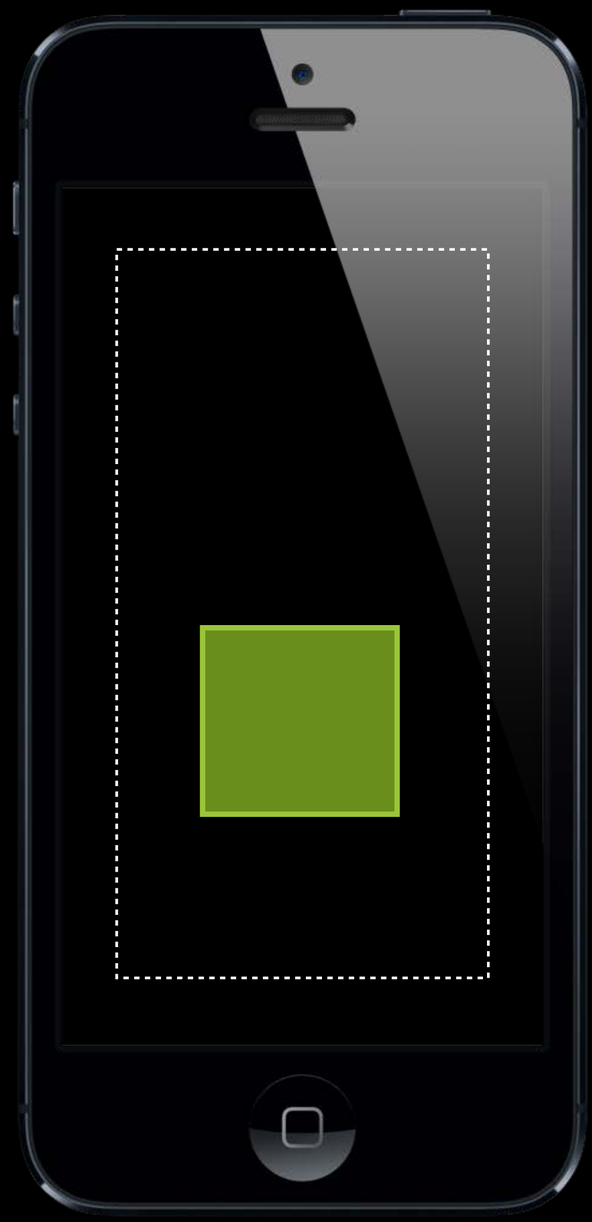
UIKit Gravity

Introducing…

UIKit Gravity

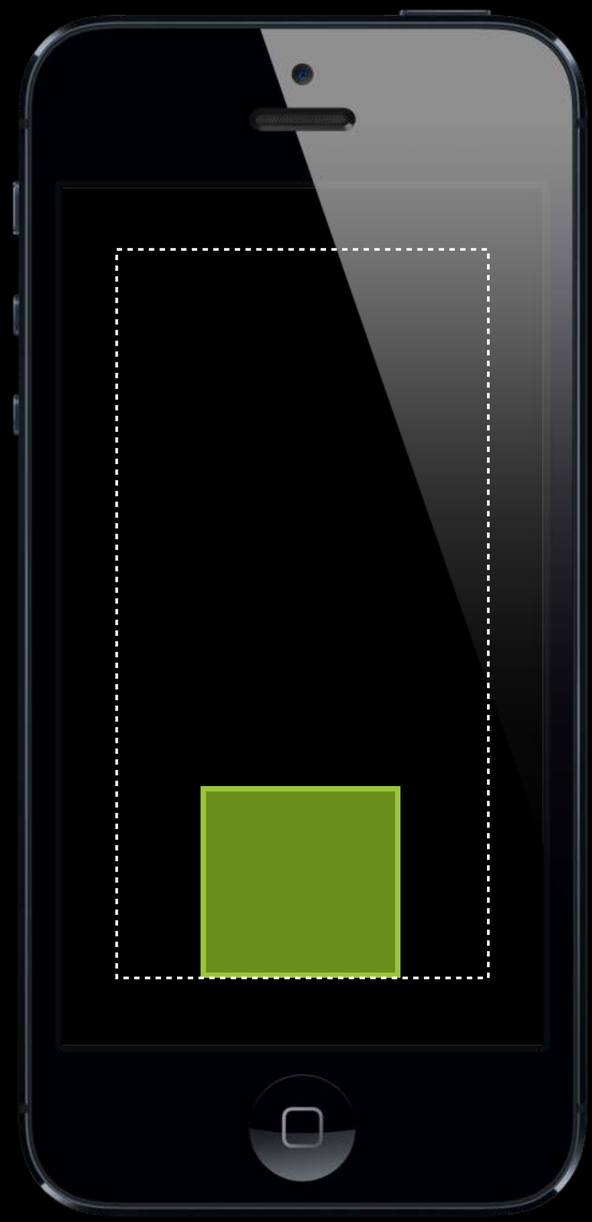
1000 p/s²

UICollisionBehavior



UICollisionBehavior

- Between a view and a boundary



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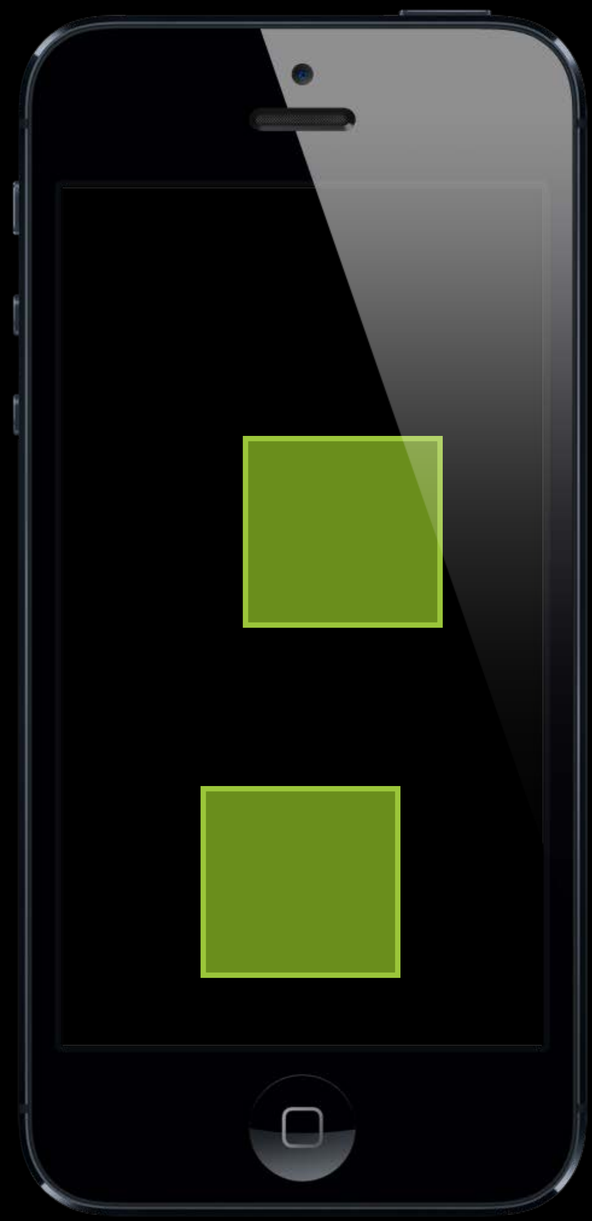
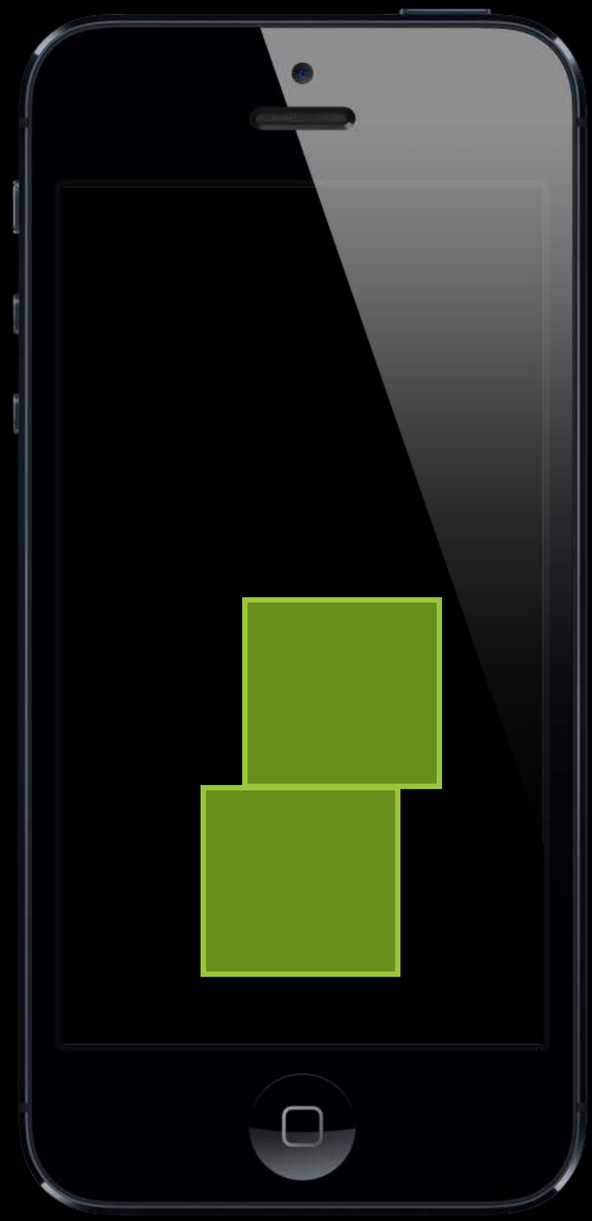


UICollisionBehavior

- Between a view and a boundary
- Or between views associated to the same behavior



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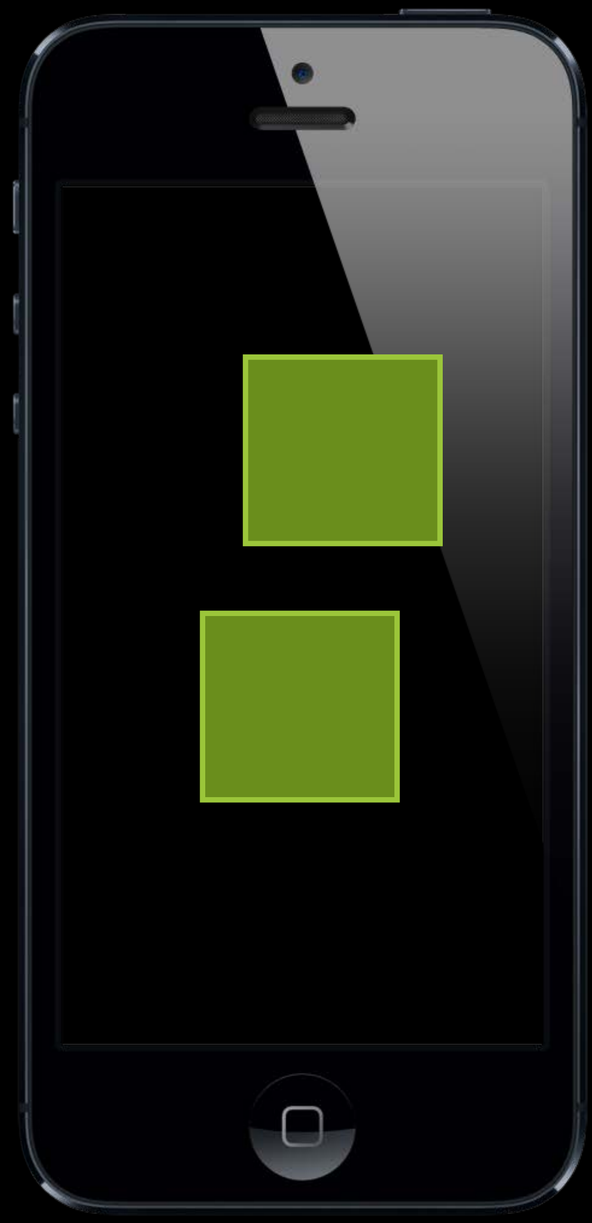

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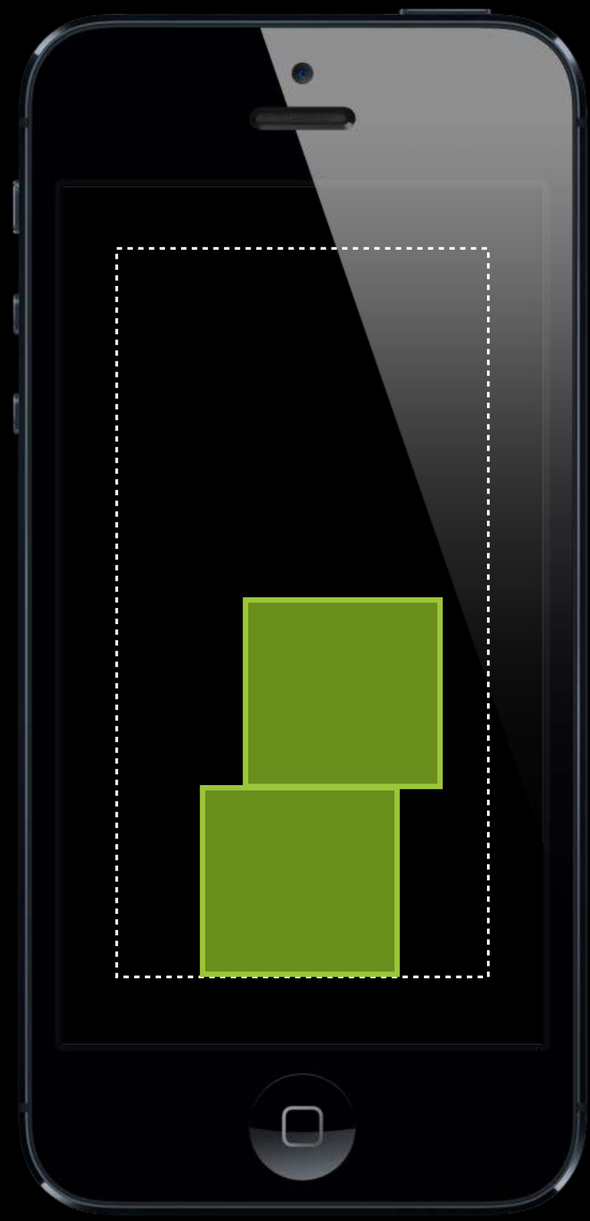
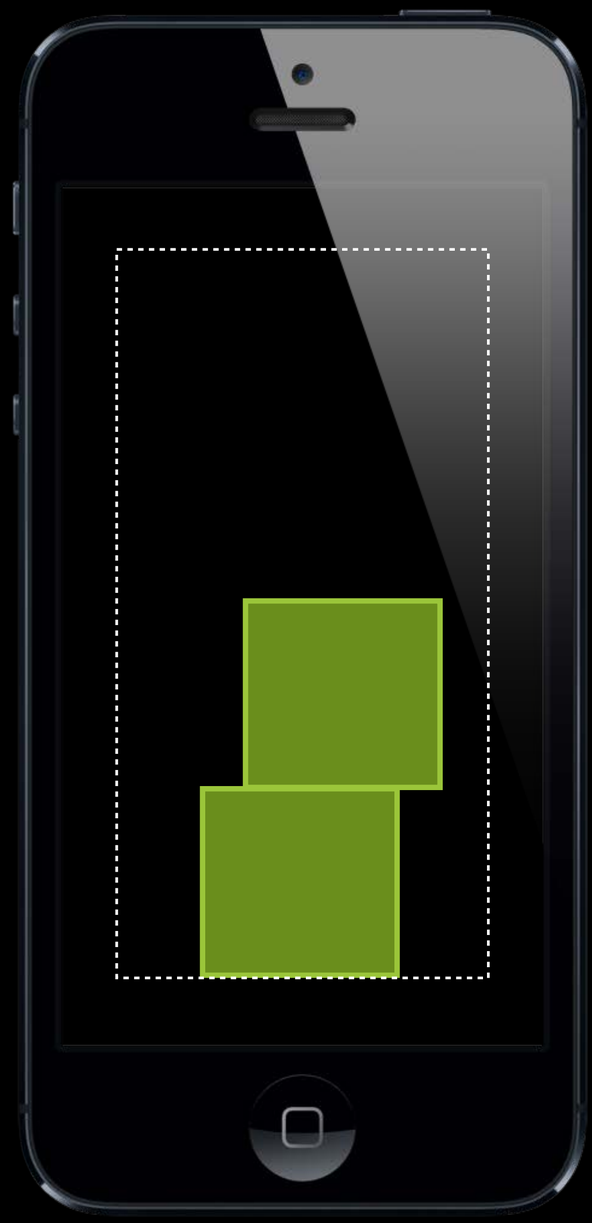


UICollisionBehavior

- Collision mode

```
@property (nonatomic, readwrite)
UICollisionBehaviorMode collisionMode;
    UICollisionBehaviorModeItems
    UICollisionBehaviorModeBoundaries
    UICollisionBehaviorModeEverything
```



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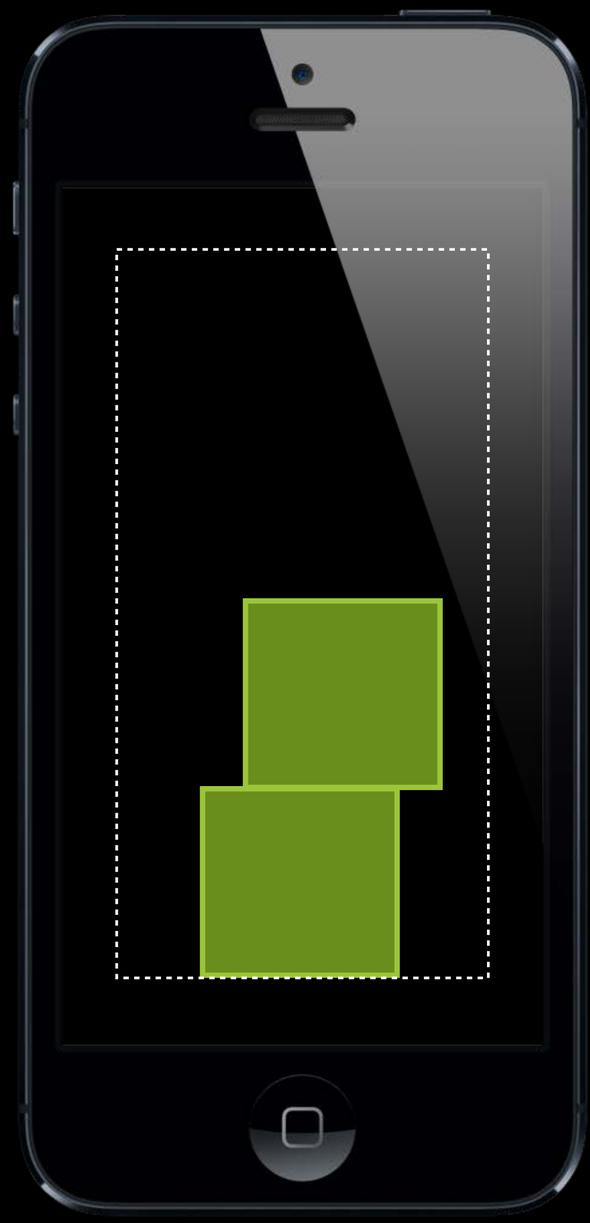
- Items can be added or removed at any time



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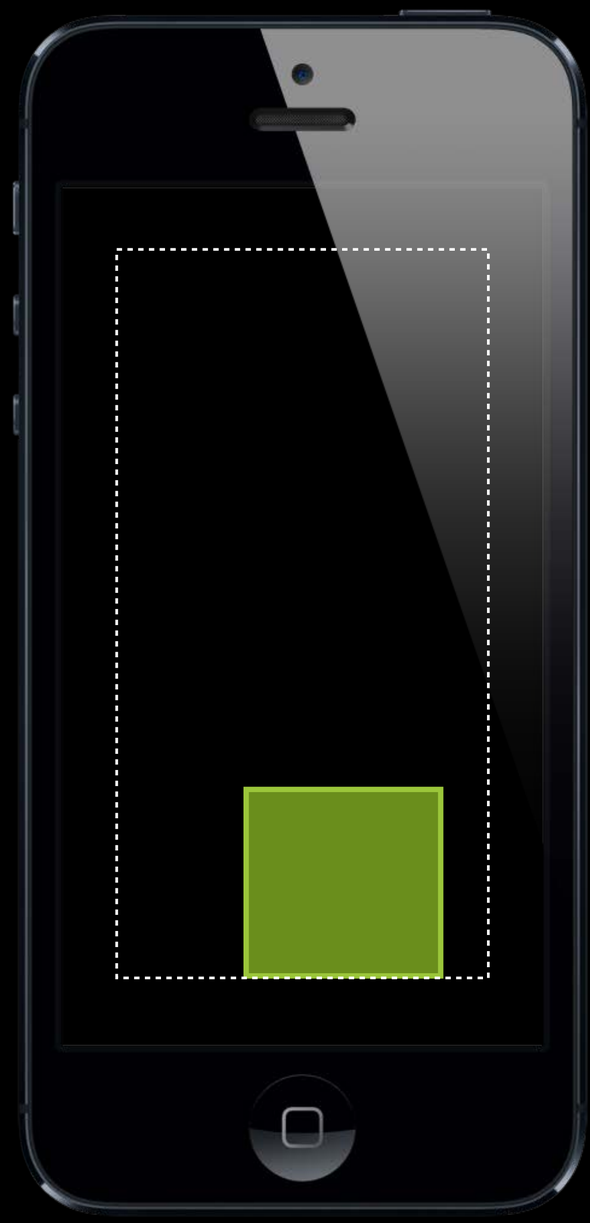
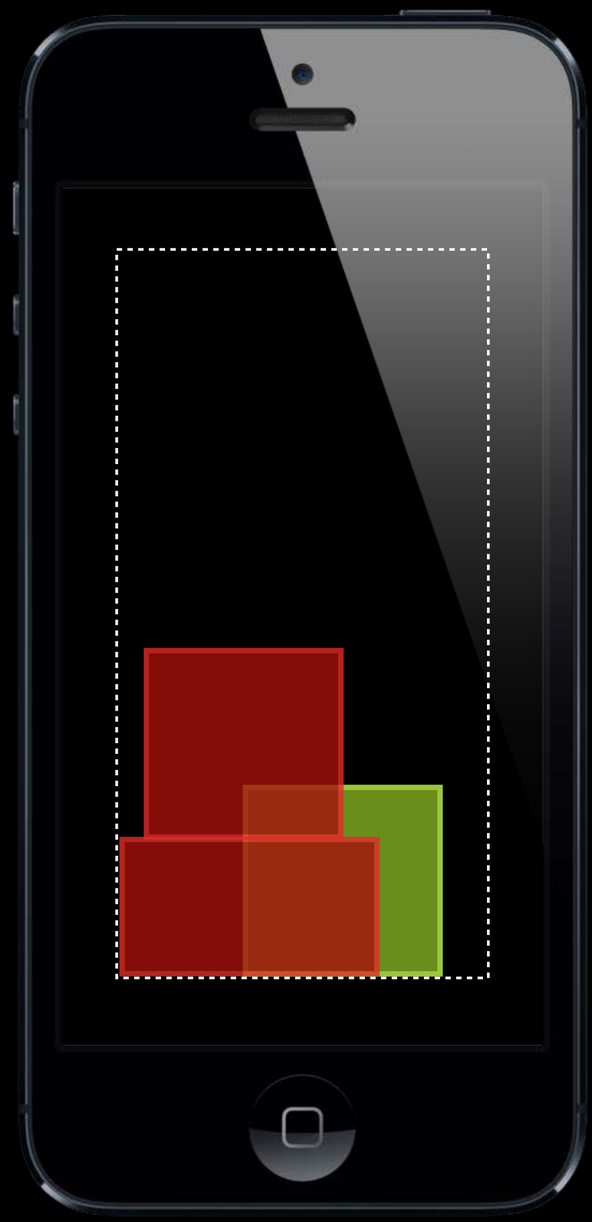


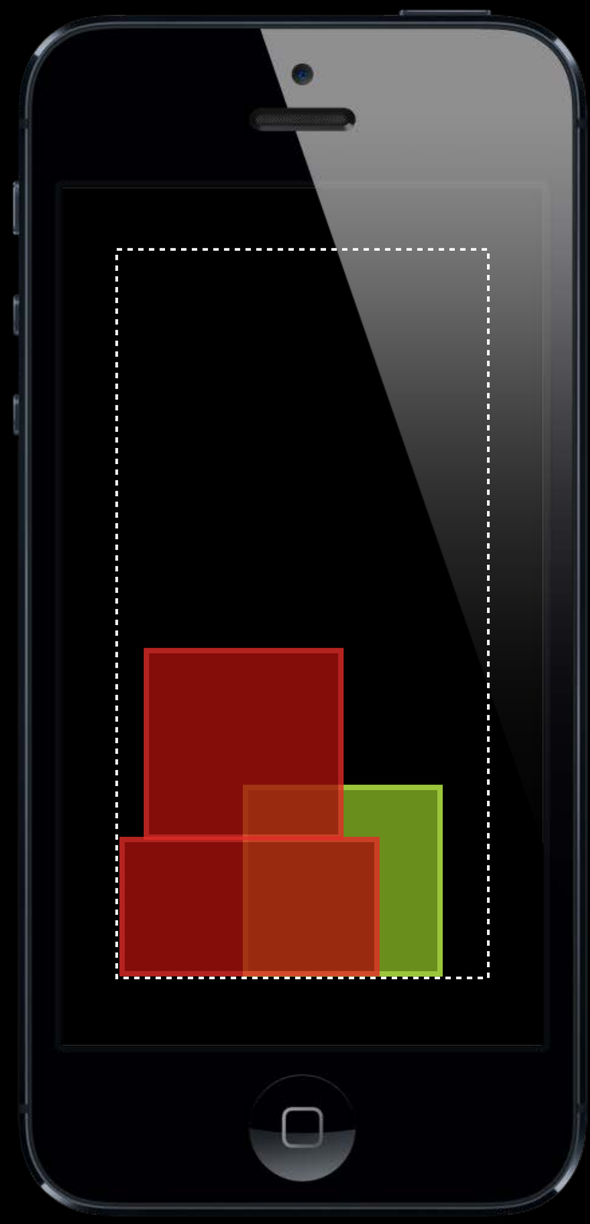
UICollisionBehavior

- You can create multiple collision behaviors
  - “red views collide with red views, green views with green views”



UICollisionBehavior

- You can create multiple collision behaviors
  - "red views collide with red views, green views with green views"
- A word of warning: collisions have a CPU cost

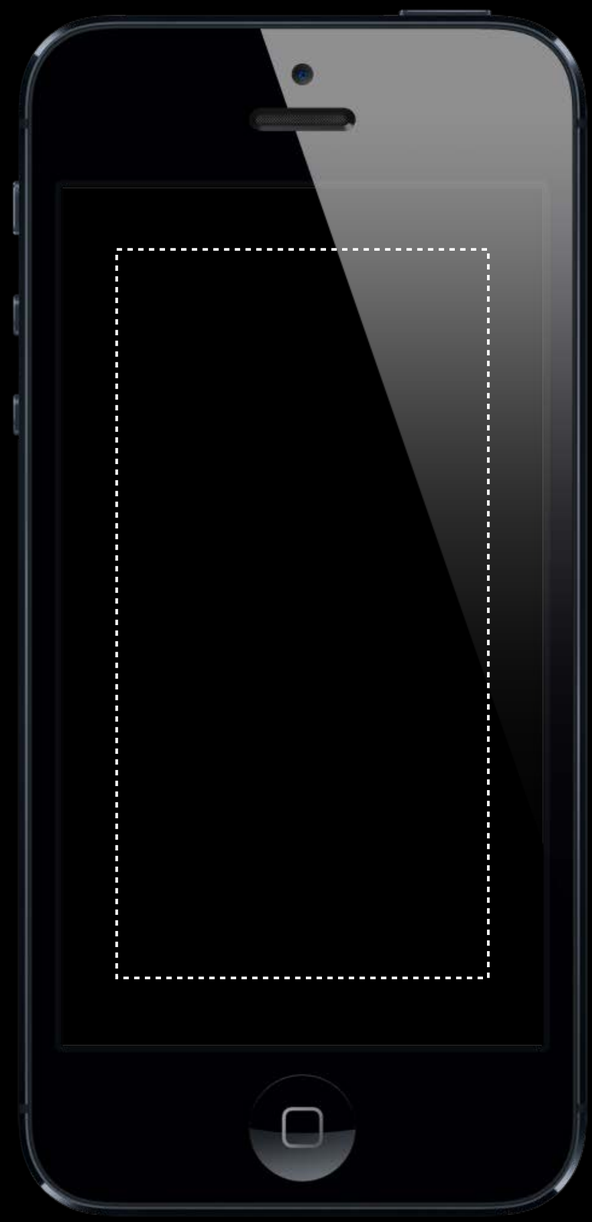


UICollisionBehavior

Boundaries

- Easy setup using the reference view

```
@property (nonatomic, readwrite) BOOL
translatesReferenceBoundsIntoBoundary;
```



UICollisionBehavior

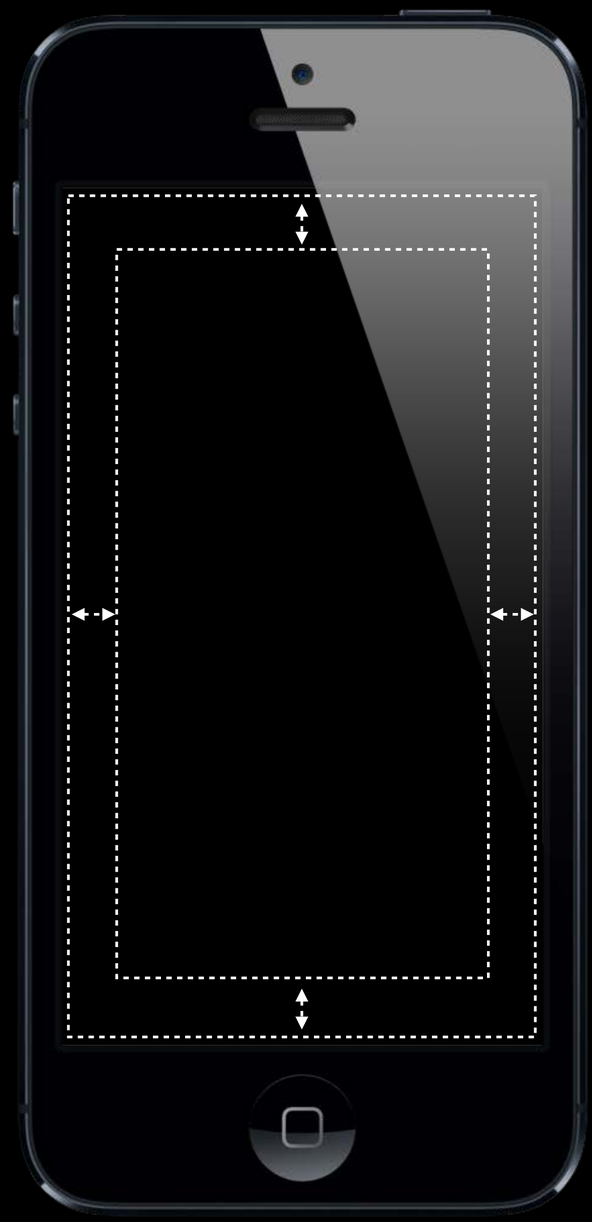
Boundaries

- Easy setup using the reference view

```
@property (nonatomic, readwrite) BOOL
translatesReferenceBoundsIntoBoundary;
```

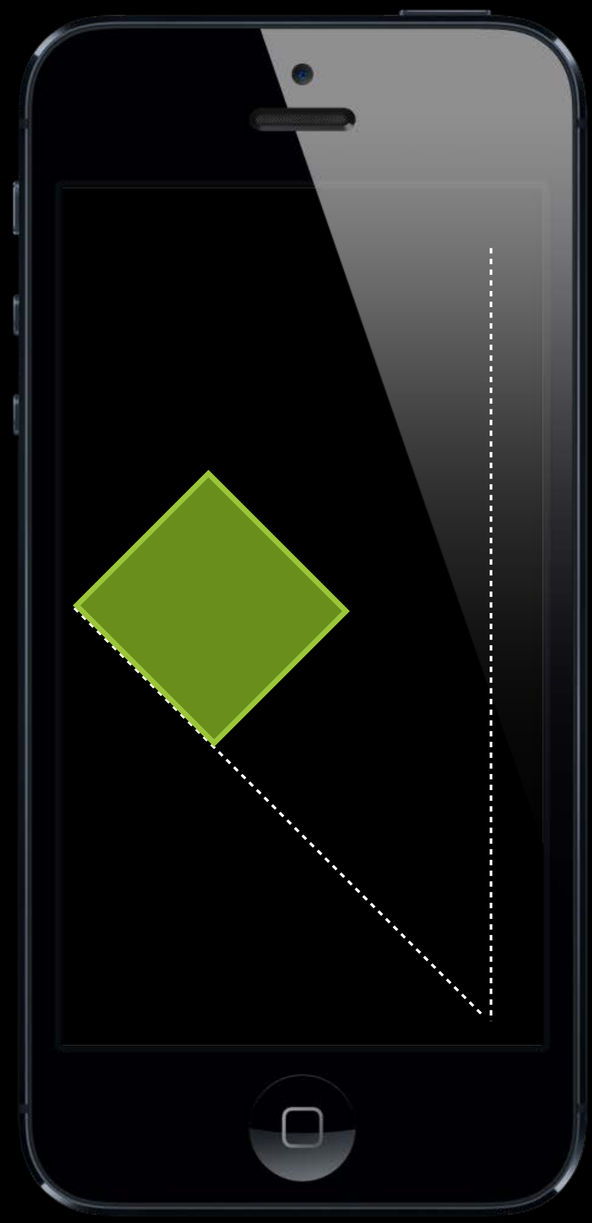
- Or with insets

```
-(void)setTranslatesReferenceBoundsIntoBoundaryWithInsets:
(UIEdgeInsets)insets;
```



UICollisionBehavior

Boundaries

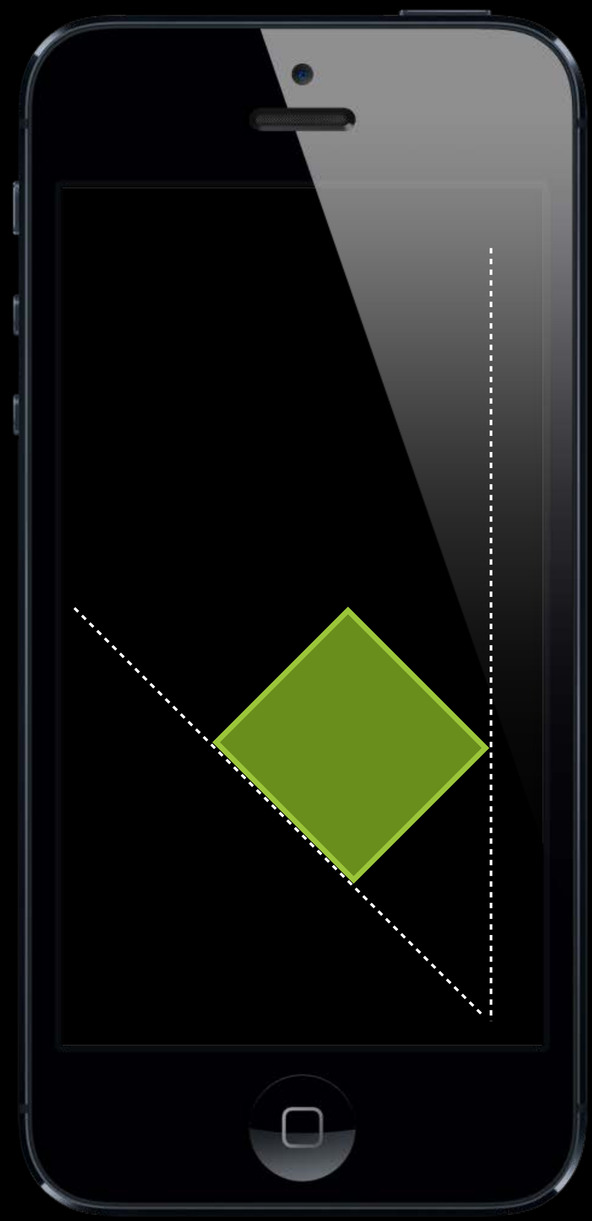


UICollisionBehavior

Boundaries

- Explicitly with segments

```
– (void)addBoundaryWithIdentifier:(id)identifier
fromPoint:(CGPoint)p1 toPoint:(CGPoint)p2;
```



UICollisionBehavior

Boundaries

- Explicitly with segments

```
- (void)addBoundaryWithIdentifier:(id)identifier
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```
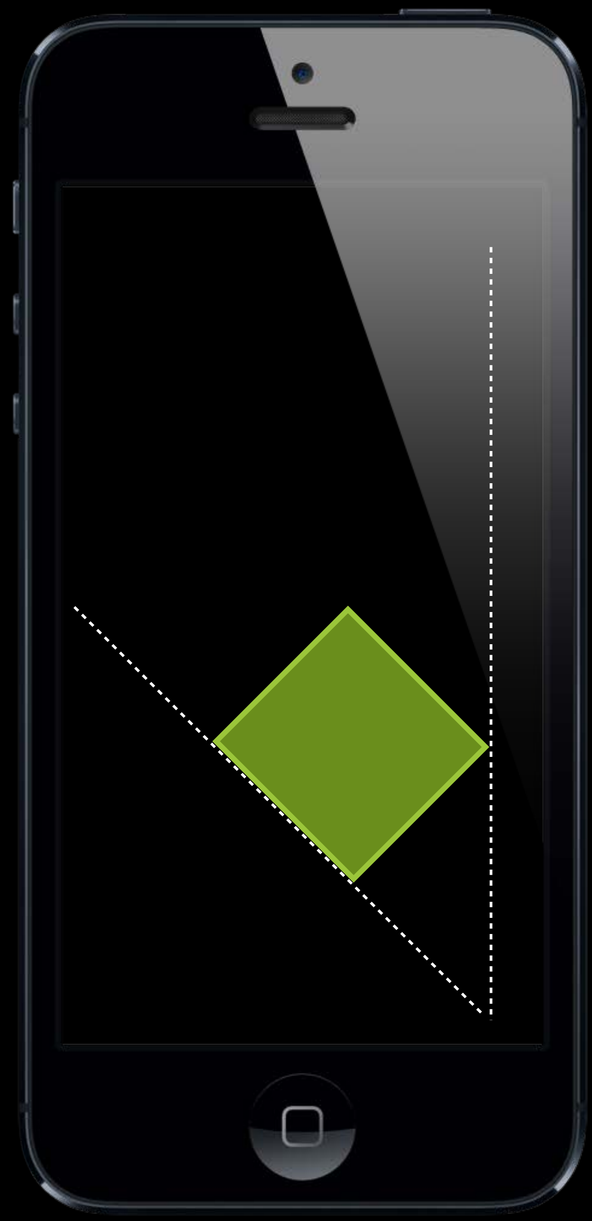

- Or paths (approximated)

```
- (void)addBoundaryWithIdentifier:(id)identifier
forPath:(UIBezierPath*)p;
```



UICollisionBehavior

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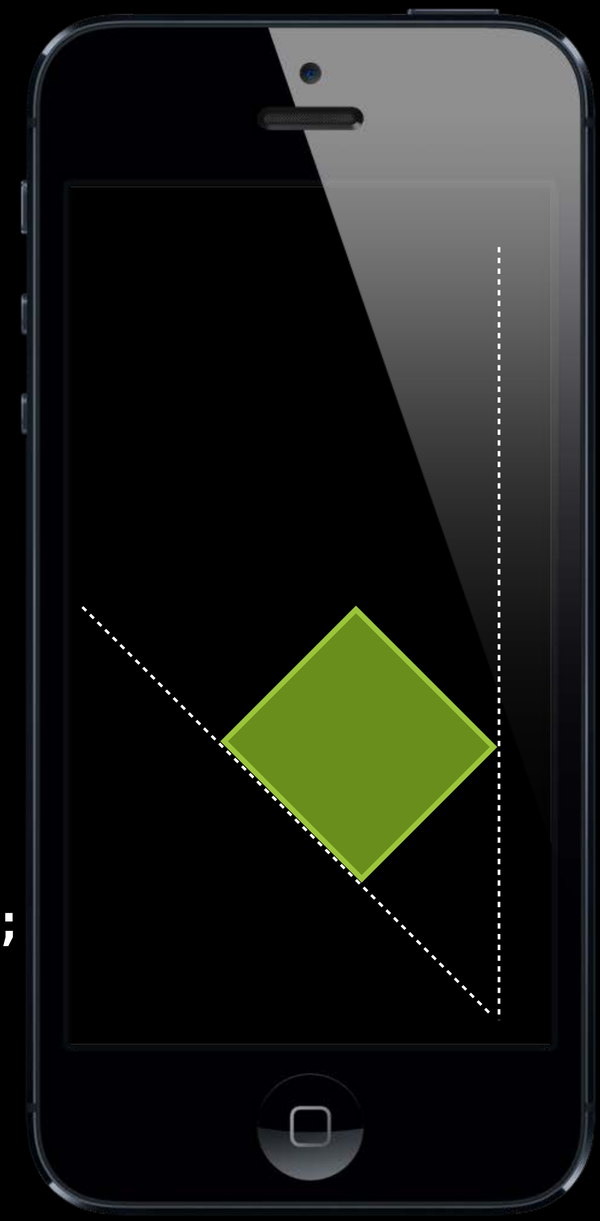

```
c = [[UICollisionBehavior alloc] initWithItems:@[view];

[c addBoundaryWithIdentifier:@”Wall1”
                   fromPoint:p1 toPoint:p2];
[c addBoundaryWithIdentifier:@”Wall2”
                   fromPoint:p3 toPoint:p4];
```

UICollisionBehaviorDelegate

- Callback on begin and end of contact

UICollisionBehaviorDelegate

- Callback on begin and end of contact
- Between views
  - `collisionBehavior: beganContactForItem: withItem: atPoint:`
  - `collisionBehavior: endedContactForItem: withItem:`

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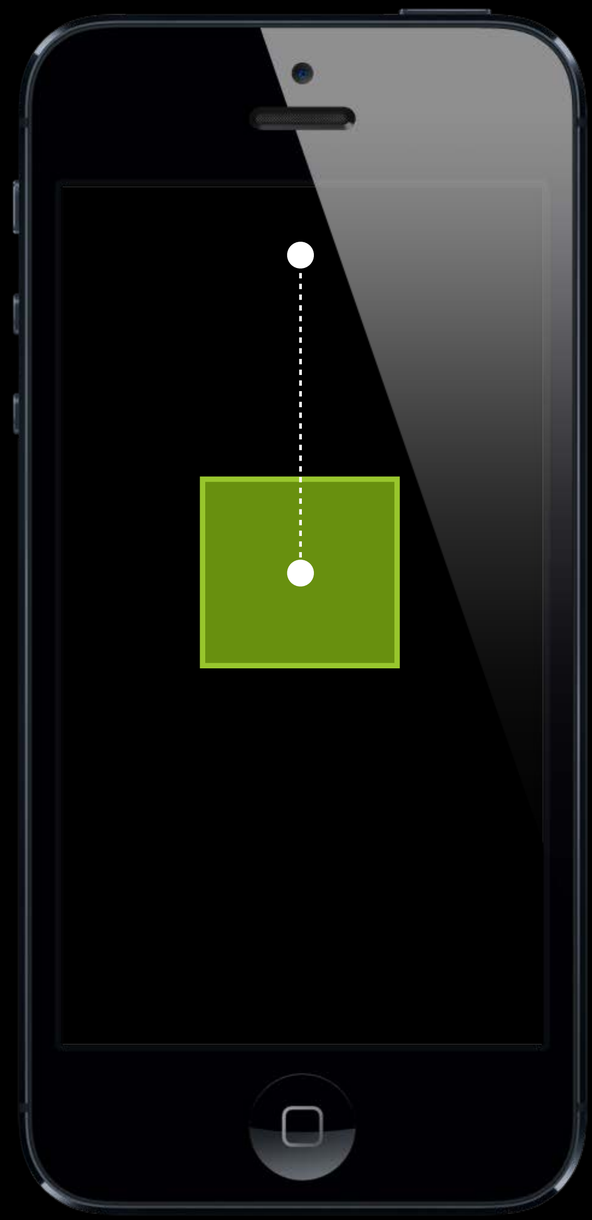
  - `collisionBehavior: beganContactForItem: withBoundaryIdentifier: atPoint:`
  - `collisionBehavior: endedContactForItem: withBoundaryIdentifier:`
- The reference boundary identifier is always nil

UIAttachmentBehavior

UIAttachmentBehavior

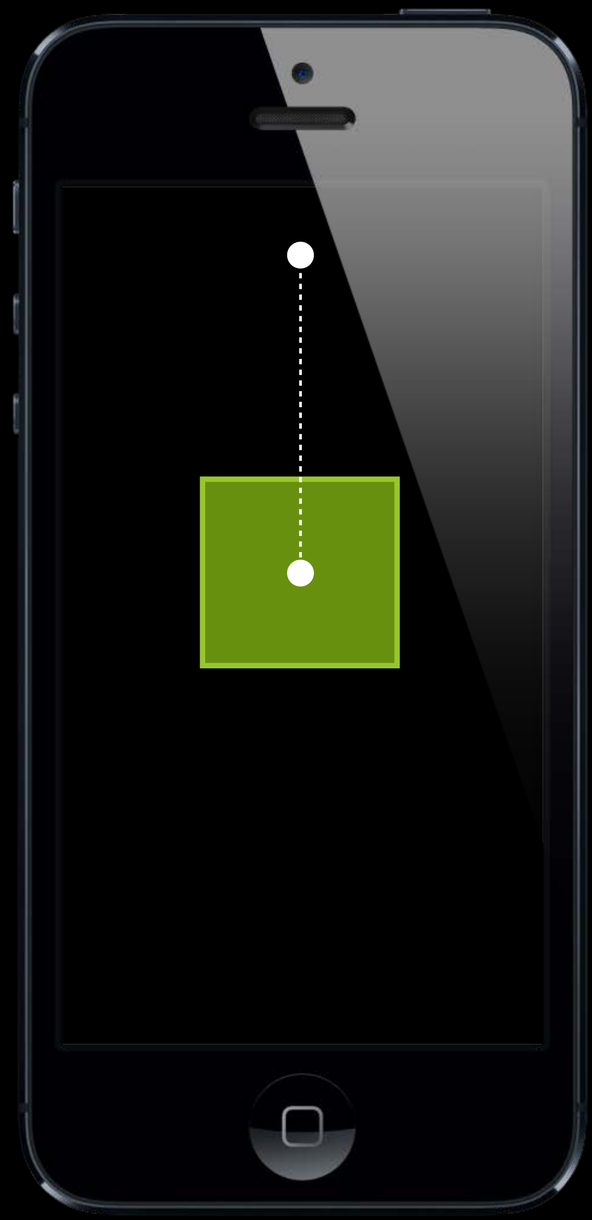
- Between a view and an anchor point



UIAttachmentBehavior

- Between a view and an anchor point

```
a1 = [[UIAttachmentBehavior alloc]
                initWithItem:v1 attachedToAnchor:ap];
```



UIAttachmentBehavior

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```
a1 = [[UIAttachmentBehavior alloc]
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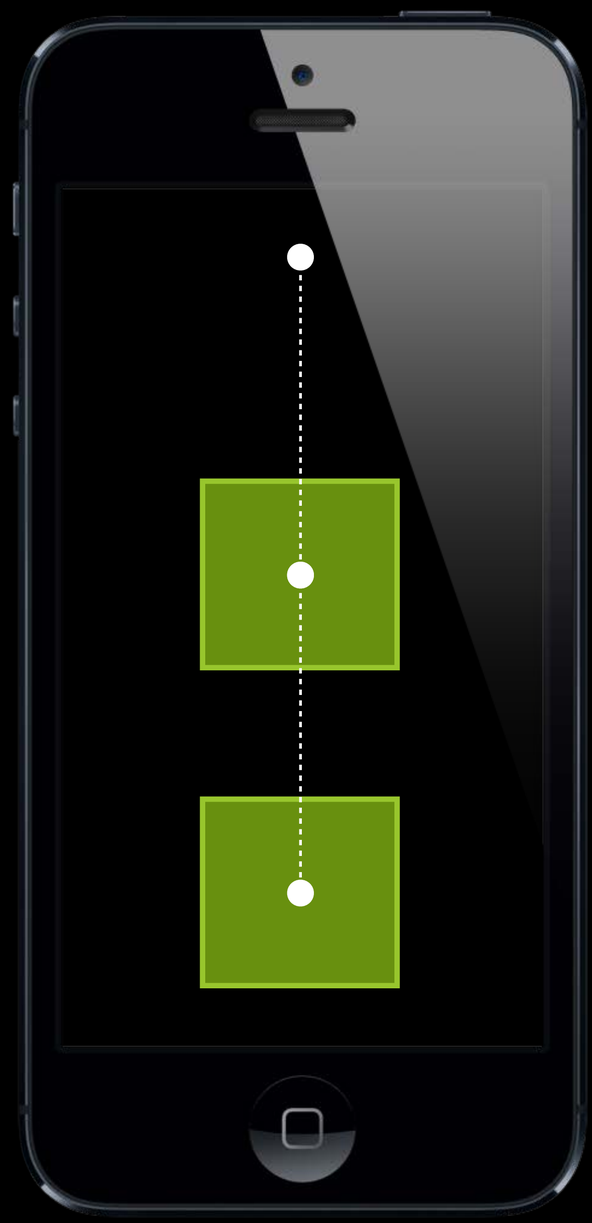
- Between two views



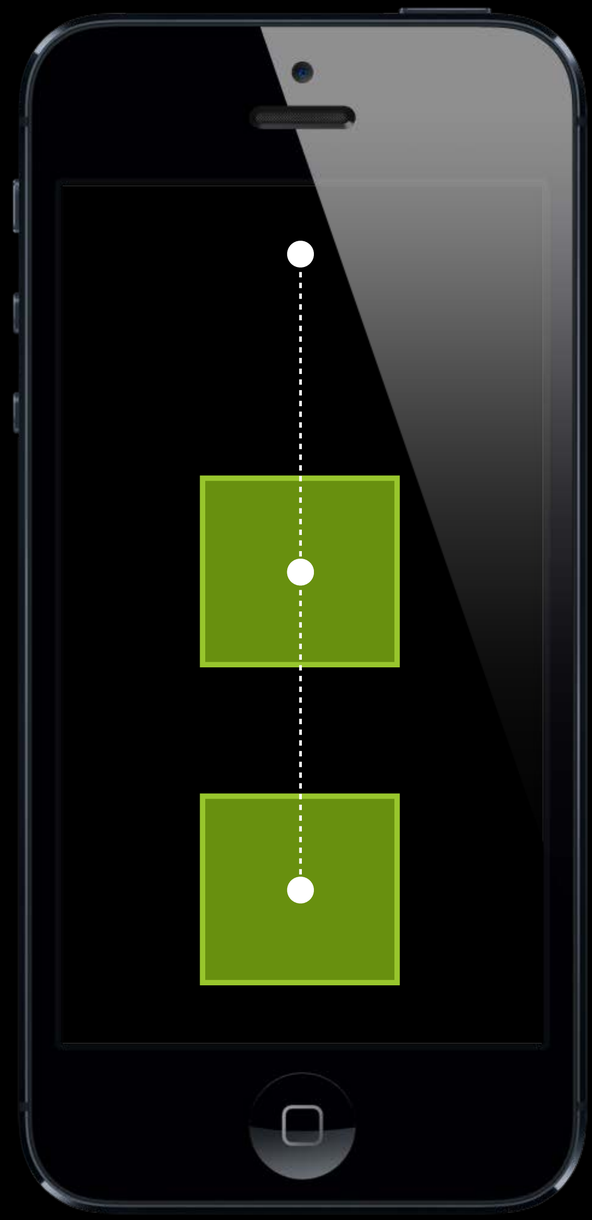
UIAttachmentBehavior

- Between a view and an anchor point

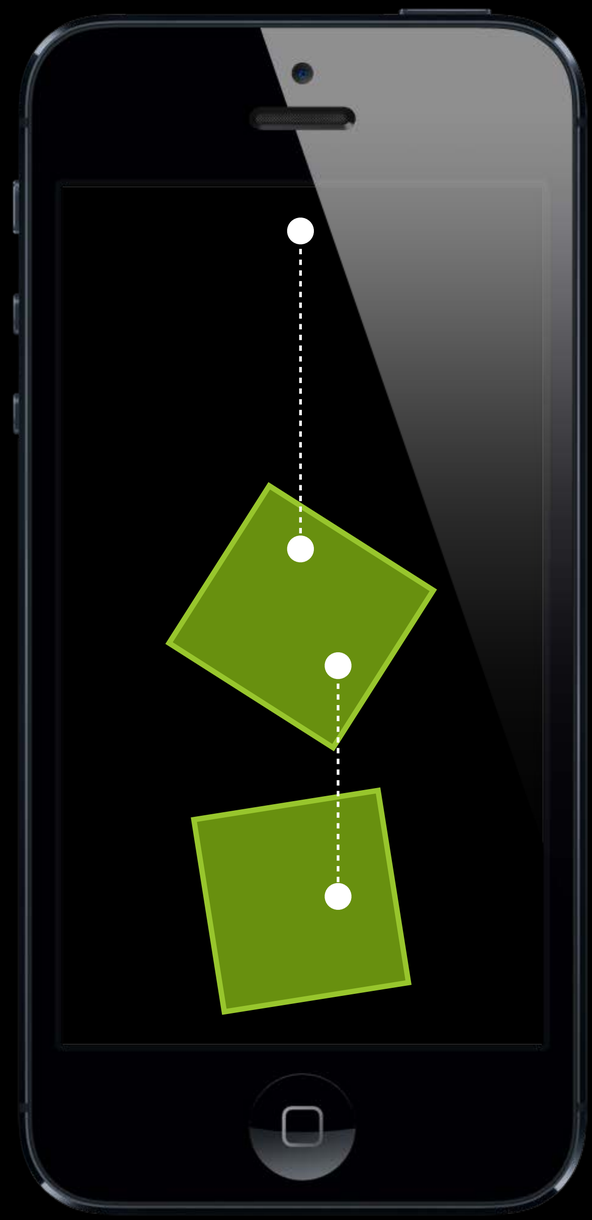
```
a1 = [[UIAttachmentBehavior alloc]
                initWithItem:v1 attachedToAnchor:ap];
```

- Between two views

```
a2 = [[UIAttachmentBehavior alloc]
                initWithItem:v1 attachedToItem:v2];
```



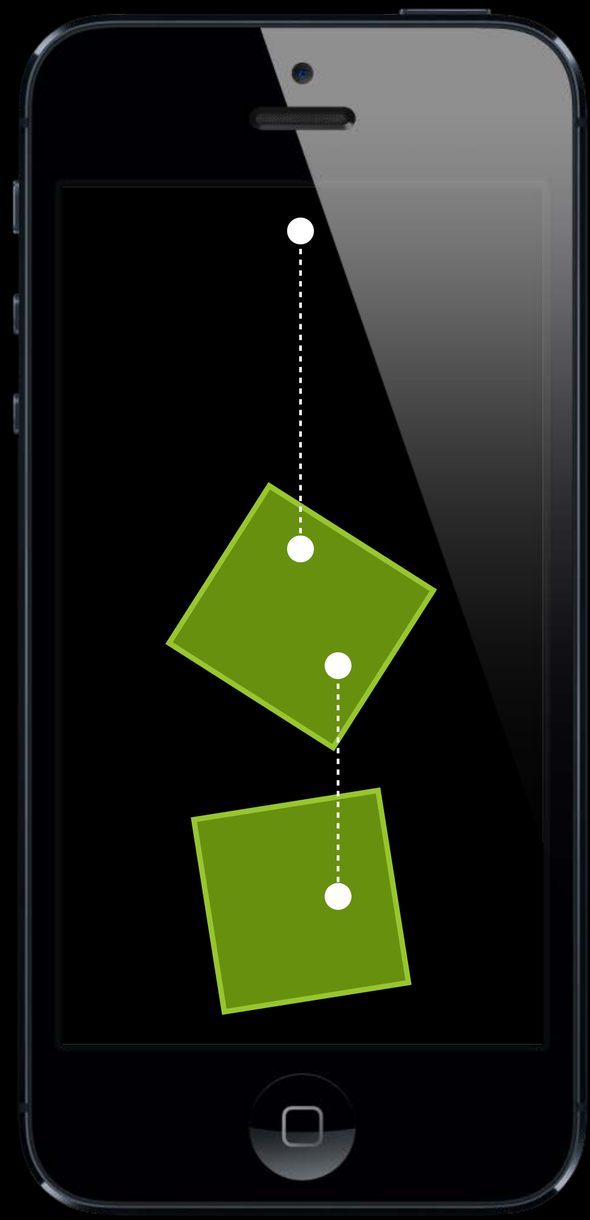
UIAttachmentBehavior



UIAttachmentBehavior

- The view attachment point can be an offset from the center

```
a1 = [[UIAttachmentBehavior alloc]
                initWithItem:v1 point:p1
                attachedToAnchor:ap];
a2 = [[UIAttachmentBehavior alloc]
                initWithItem:v1 point:p2
                attachedToItem:v2];
```



UIAttachmentBehavior

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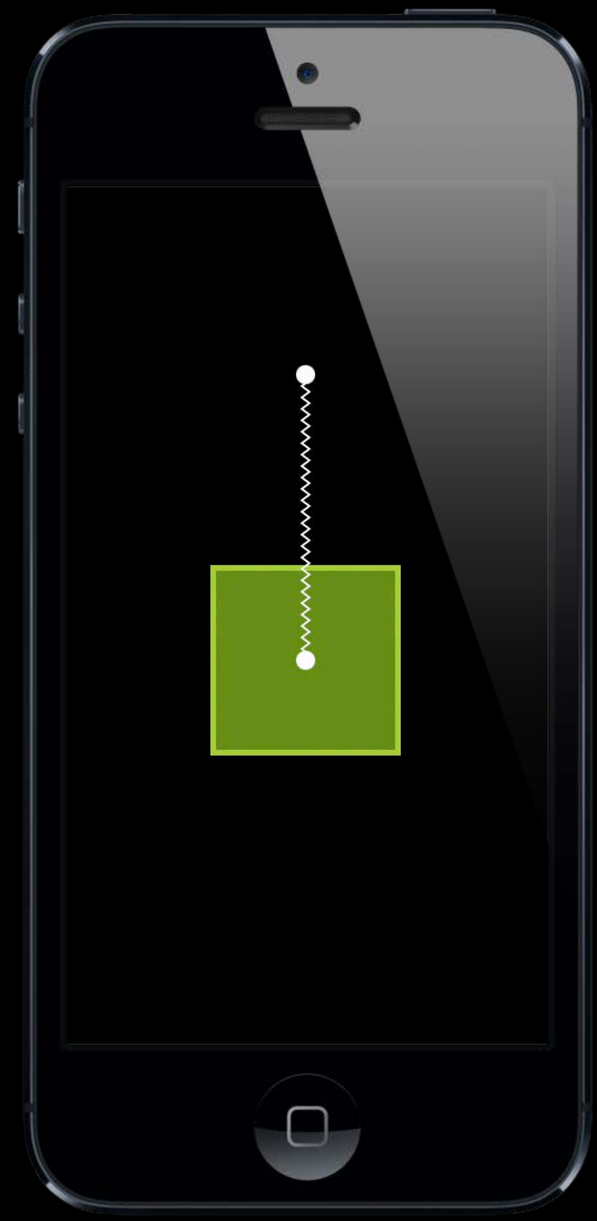
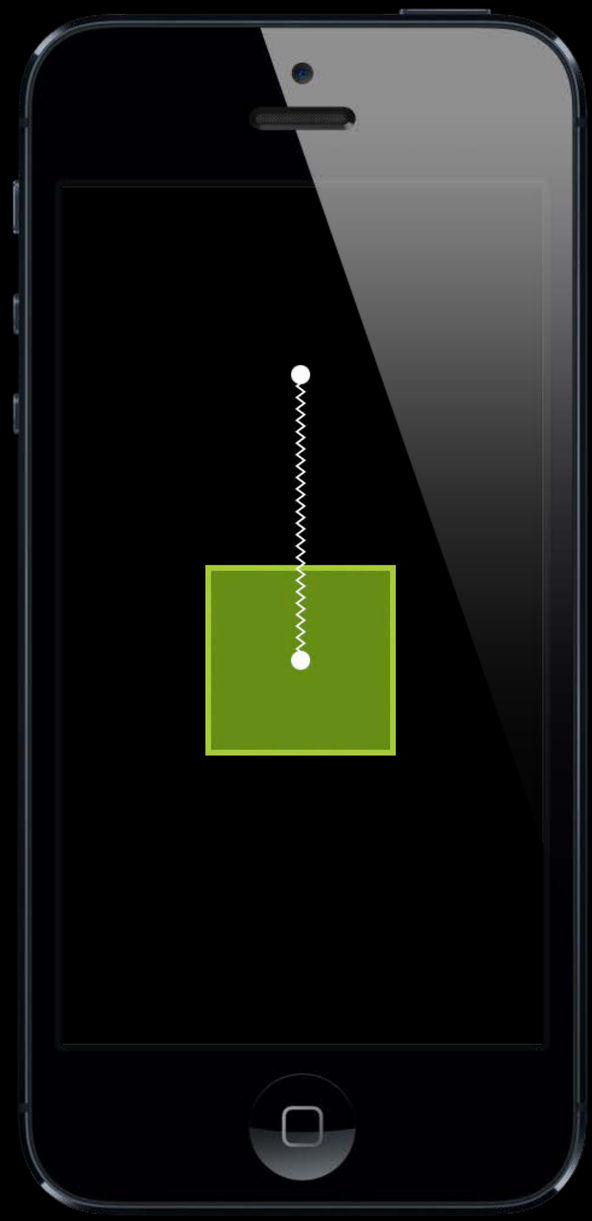


UIAttachmentBehavior

- An attachment can act as a spring

```
[a setFrequency:4.0];
[a setDamping:0.5];
```



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[a setFrequency:4.0];
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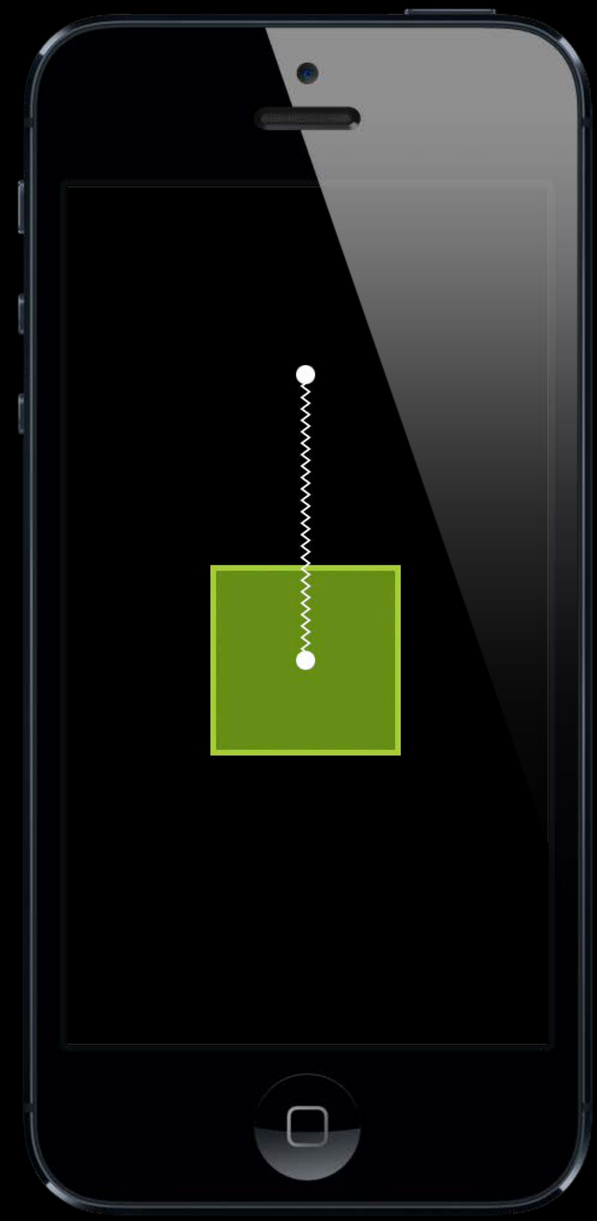

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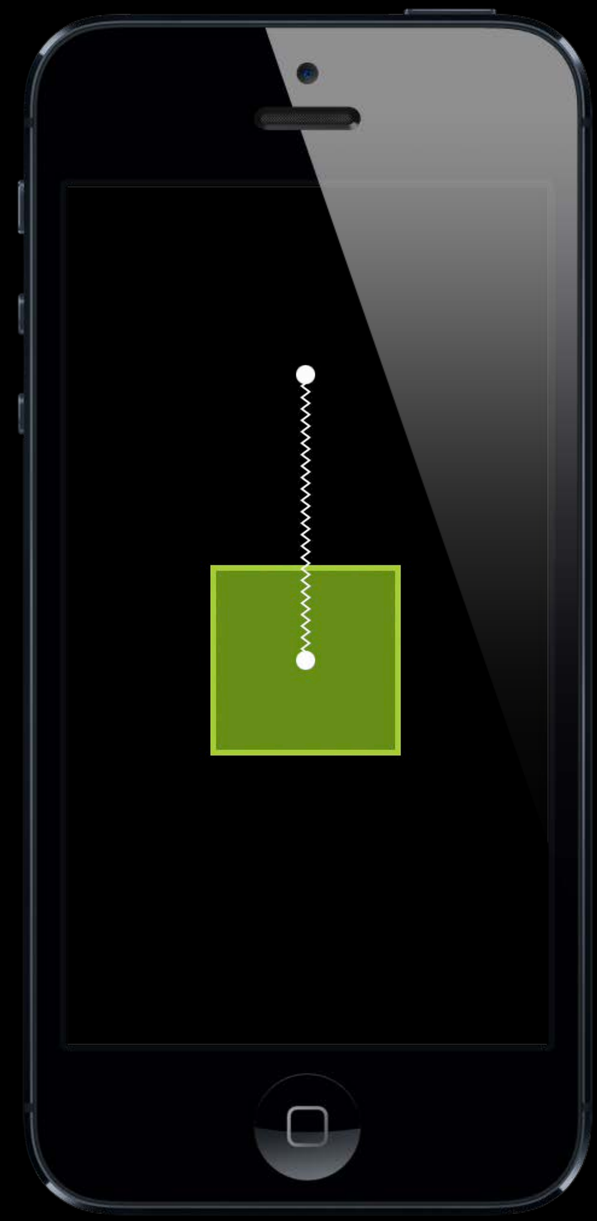
- Only use `length` if to change the distance after setup



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```
[a setFrequency:4.0];
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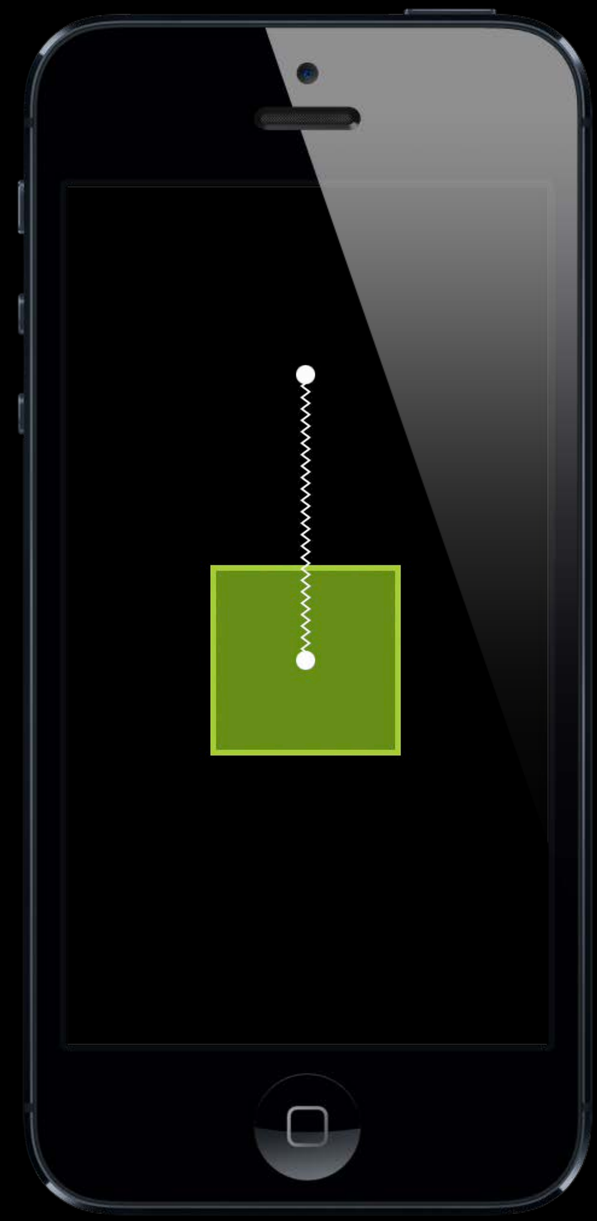
```

- An anchor point can be modified later
- Only use `length` if to change the distance after setup
- Attachments are invisible!



Demo

UISnapBehavior

UISnapBehavior

- Snap a view in place

UISnapBehavior

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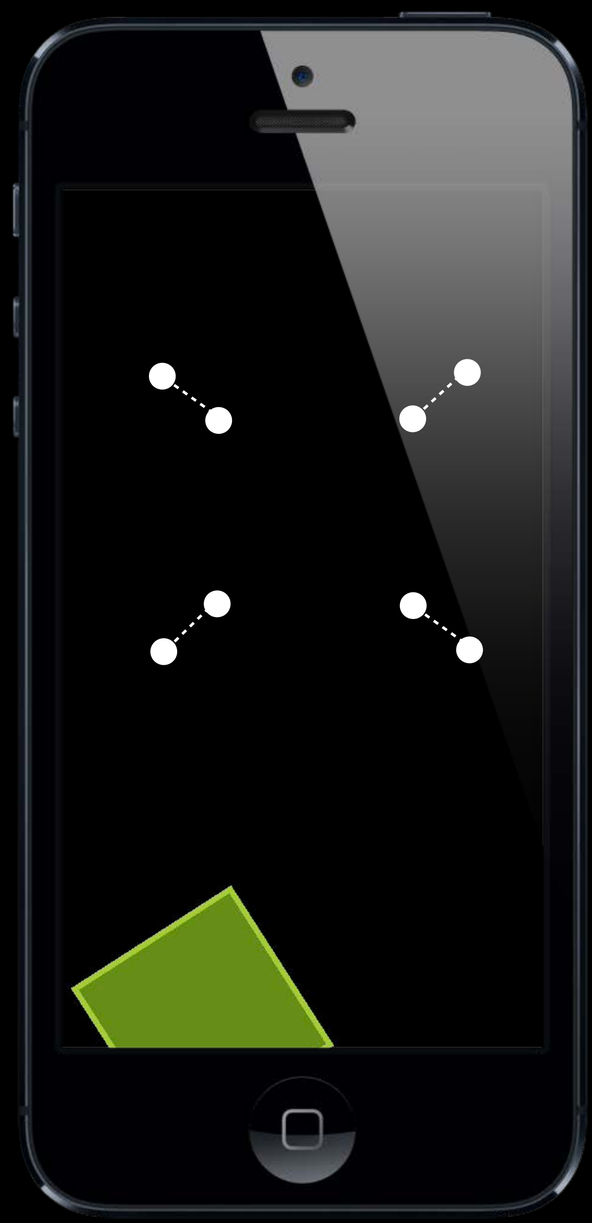
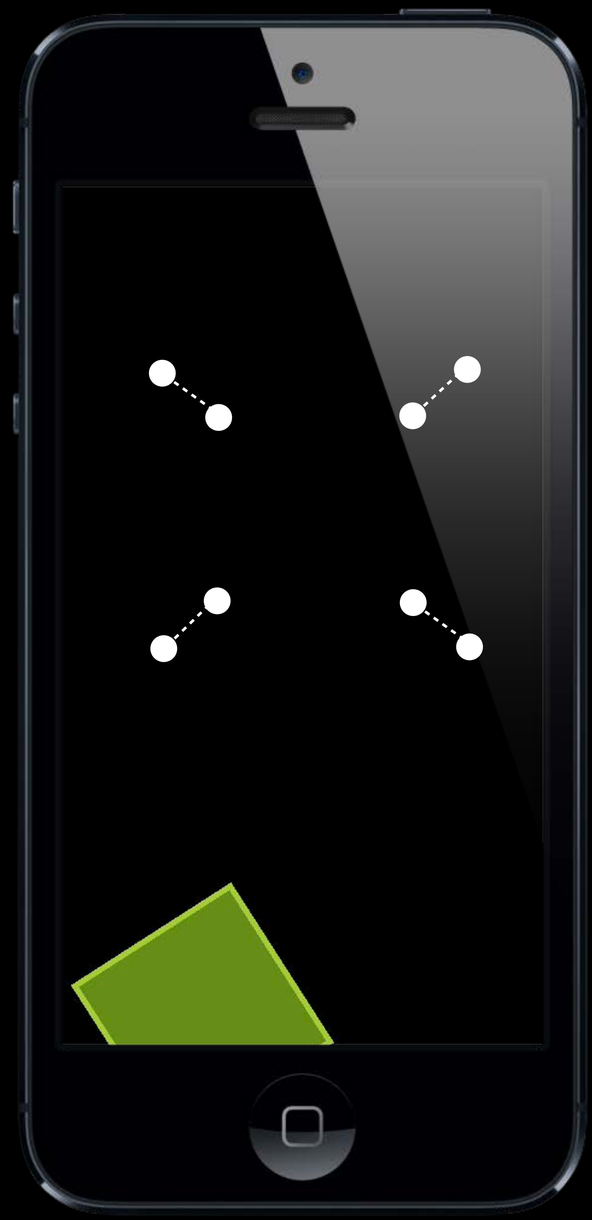
UISnapBehavior

- Snap a view in place
- Ensure position and angle



UISnapBehavior

- Snap a view in place
- Ensure position and angle
- Damping is customizable



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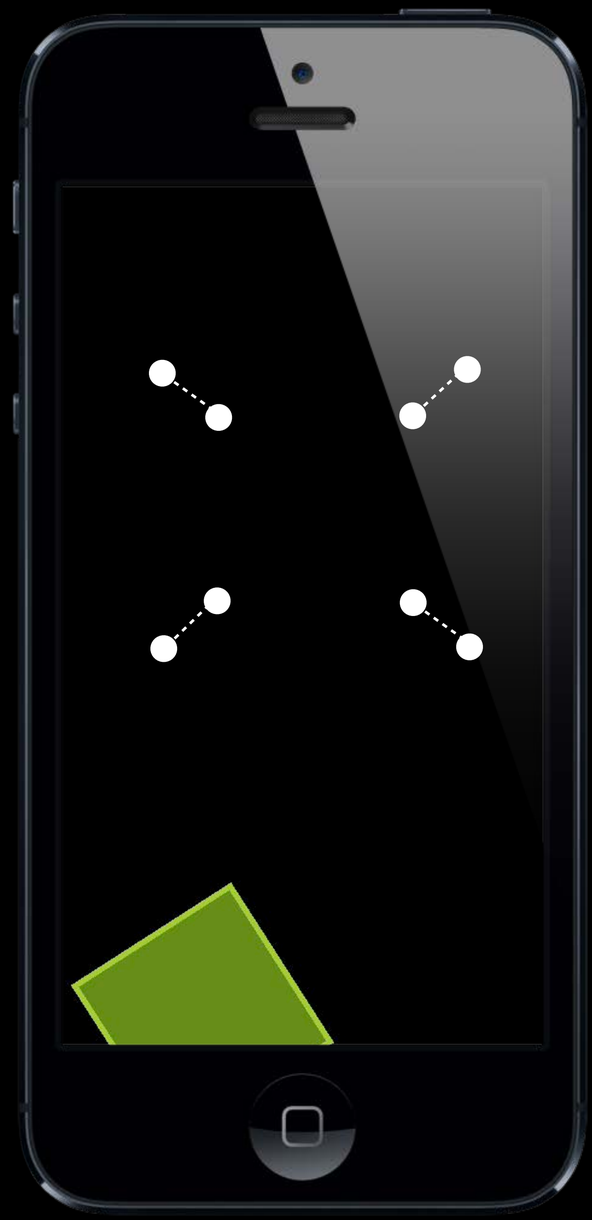
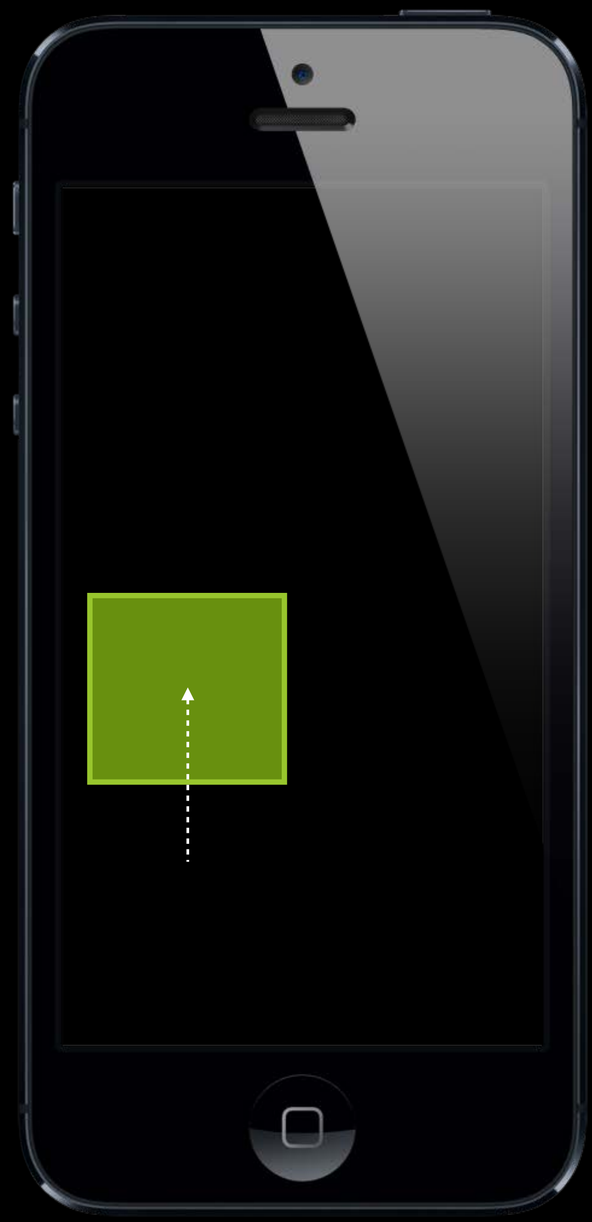
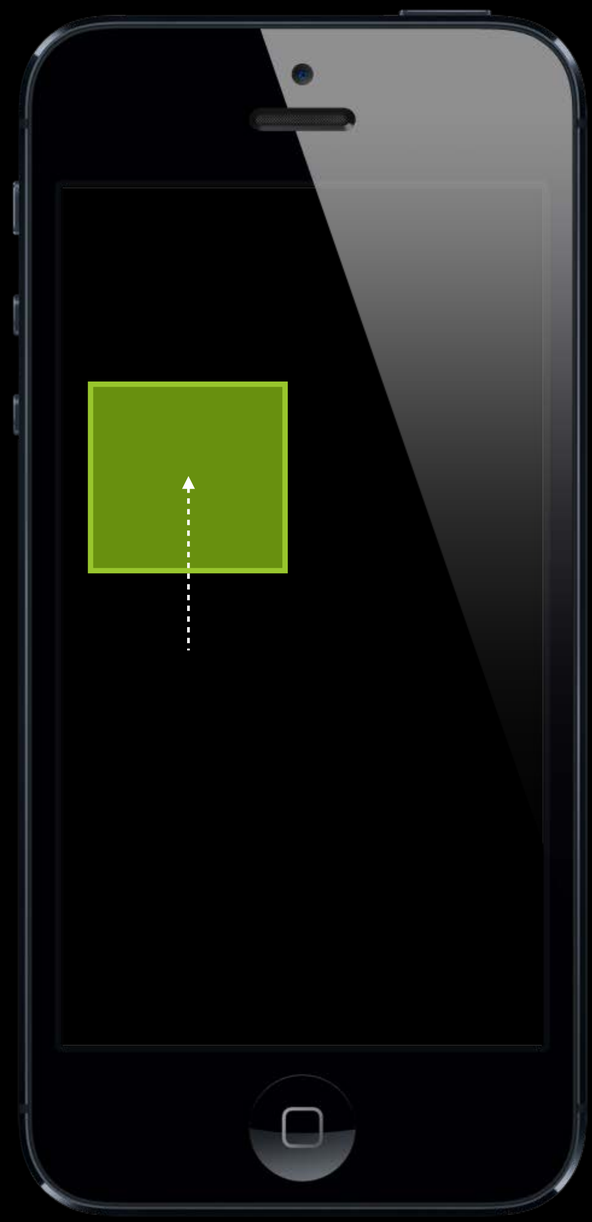


```
s = [[UISnapBehavior alloc] initWithItem:v
                            snapToPoint:p];
[animator addBehavior:s];
```

UIPushBehavior



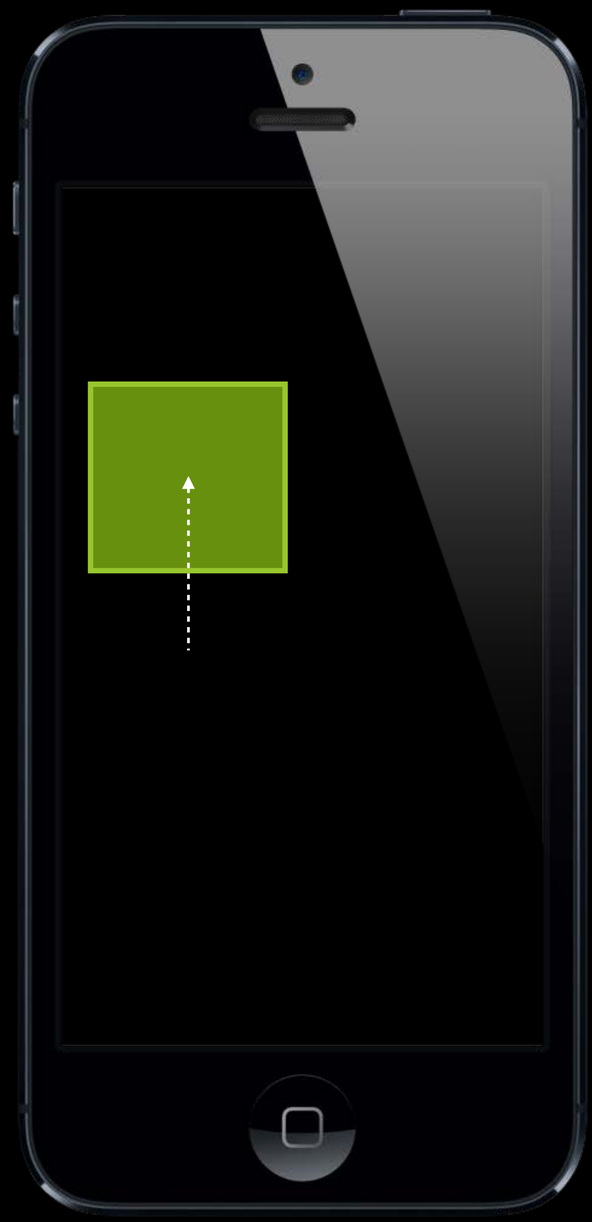
UIPushBehavior



UIPushBehavior

- Apply a force to a view (or views)

```
p = [[UIPushBehavior alloc]
                  initWithItems:@[view]
                  mode:UIPushBehaviorModeContinuous];
```



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- A simple force vector

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@property (readwrite,nonatomic) CGFloat angle;
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```

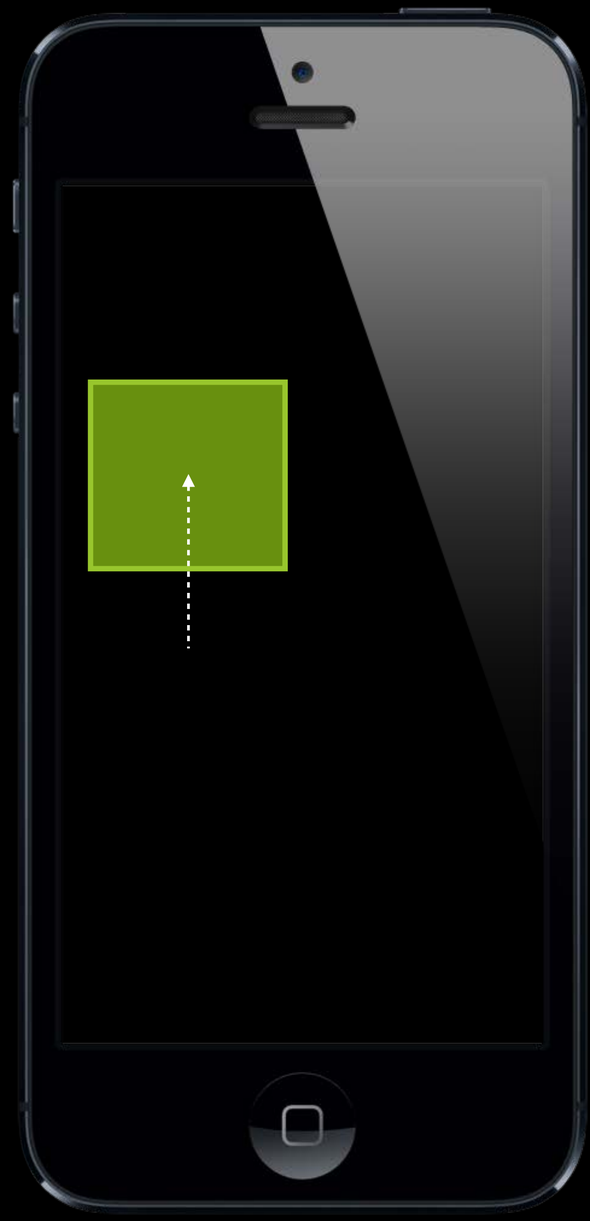

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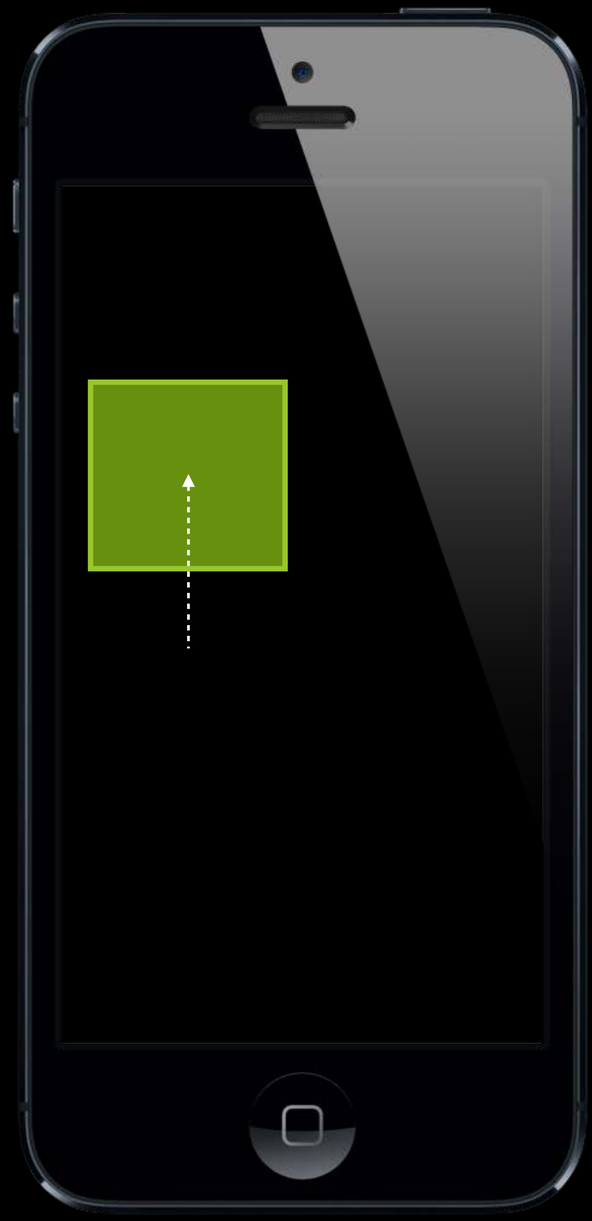
```

- The target point can be customized

```
[p setTargetPoint:x forItem:view];
```



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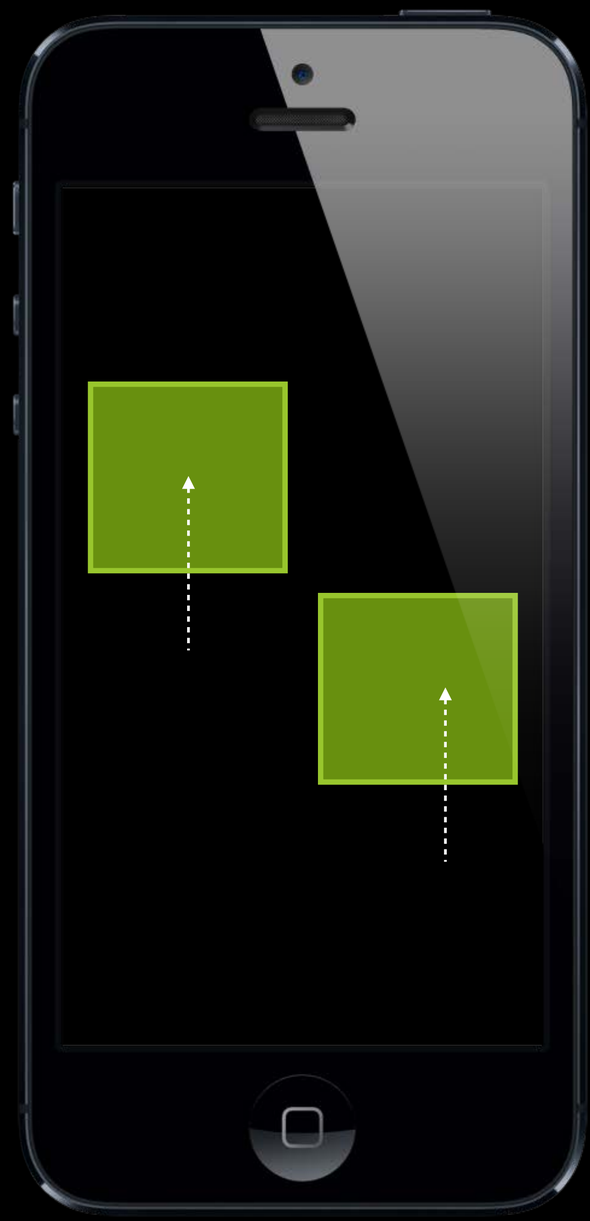

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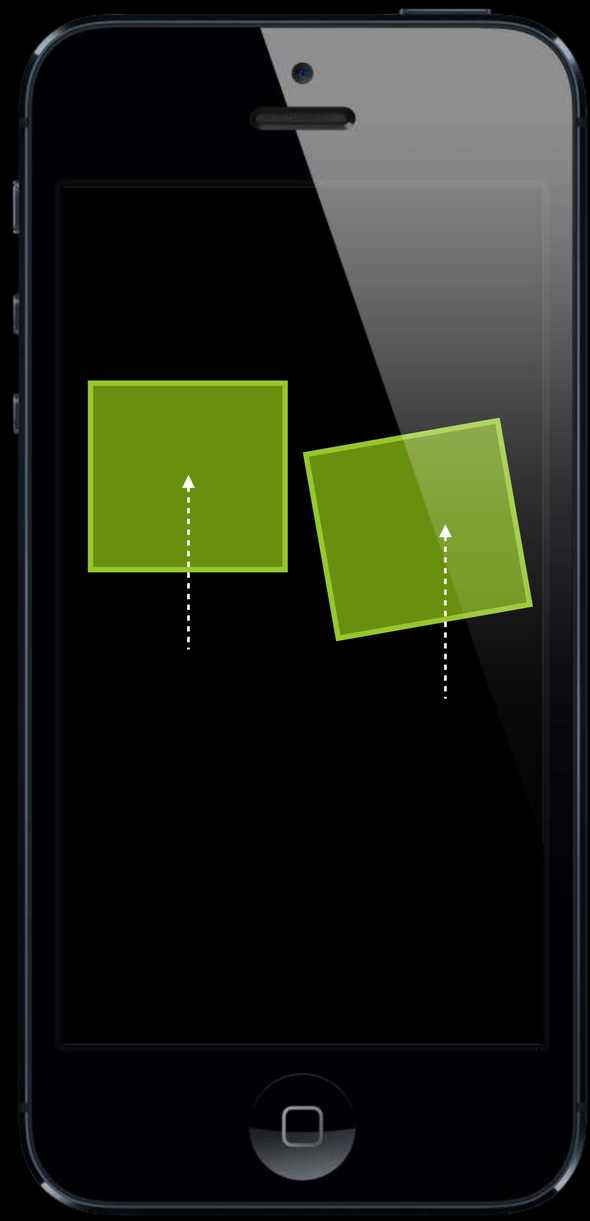


A Well-known Unit…

The Newton

A Well-known Unit...

The Newton
Accelerate 1kg at a rate of 1m/s²

Introducing…

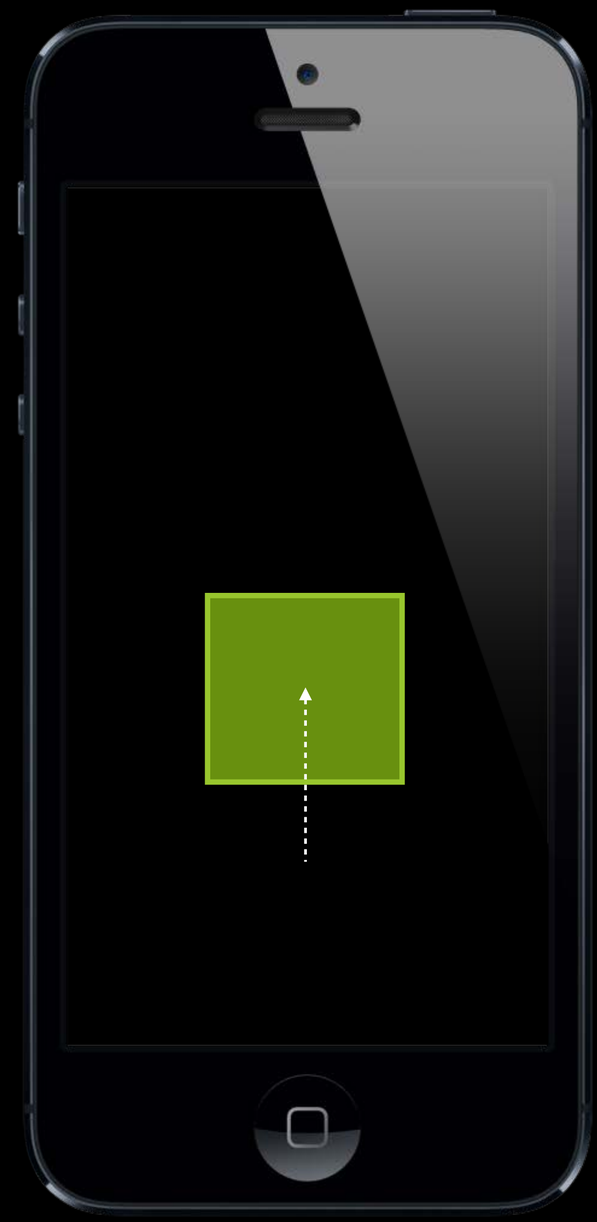
The UIKit Newton

Introducing…

The UIKit Newton

Accelerate a (100,100) view to 100 p/s²

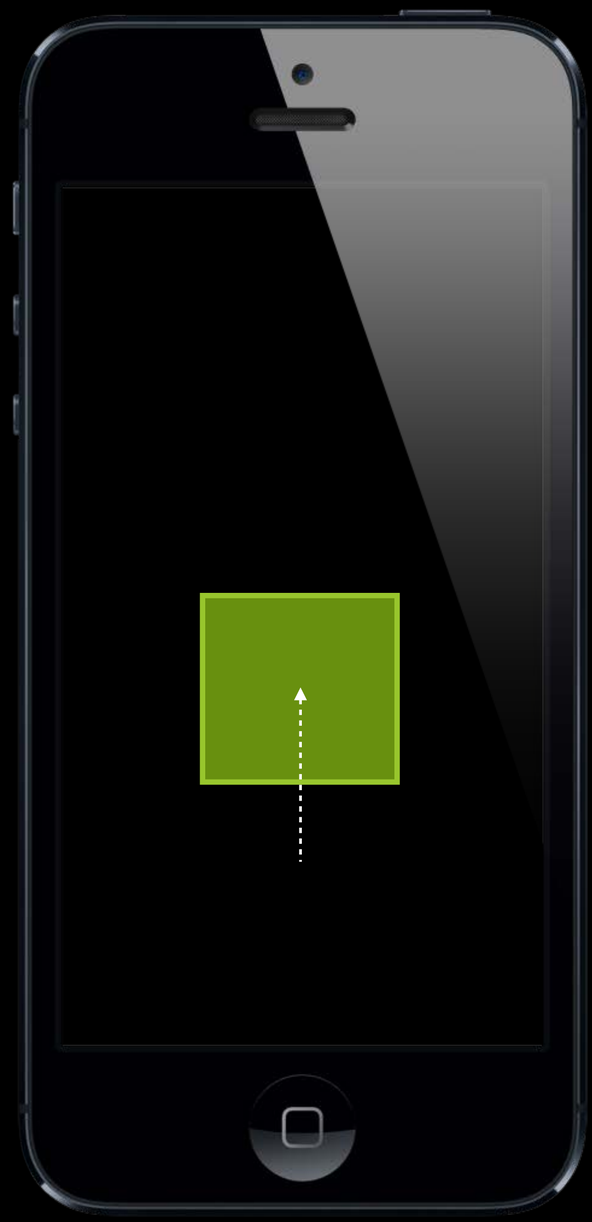
UIPushBehavior



UIPushBehavior

- Instantaneous mode

```
p2 = [[UIPushBehavior alloc]
            initWithItems:@[view]
            mode:UIPushBehaviorModeInstantaneous];
```



UIPushBehavior

- Instantaneous mode

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p2 = [[UIPushBehavior alloc]
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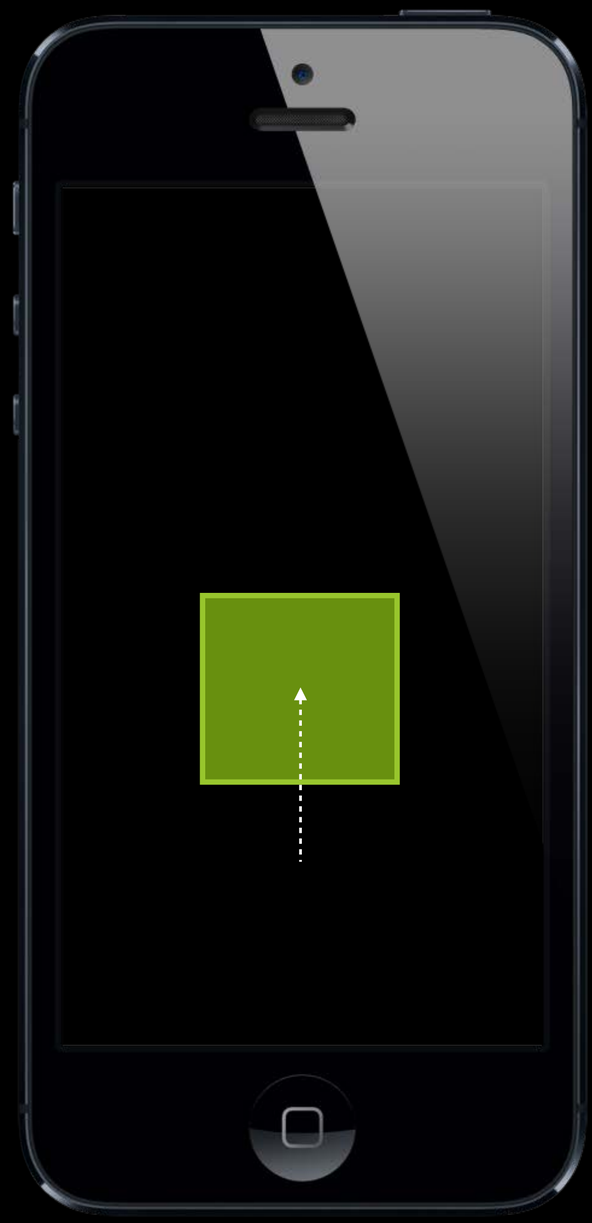
- Velocity change is instantaneous



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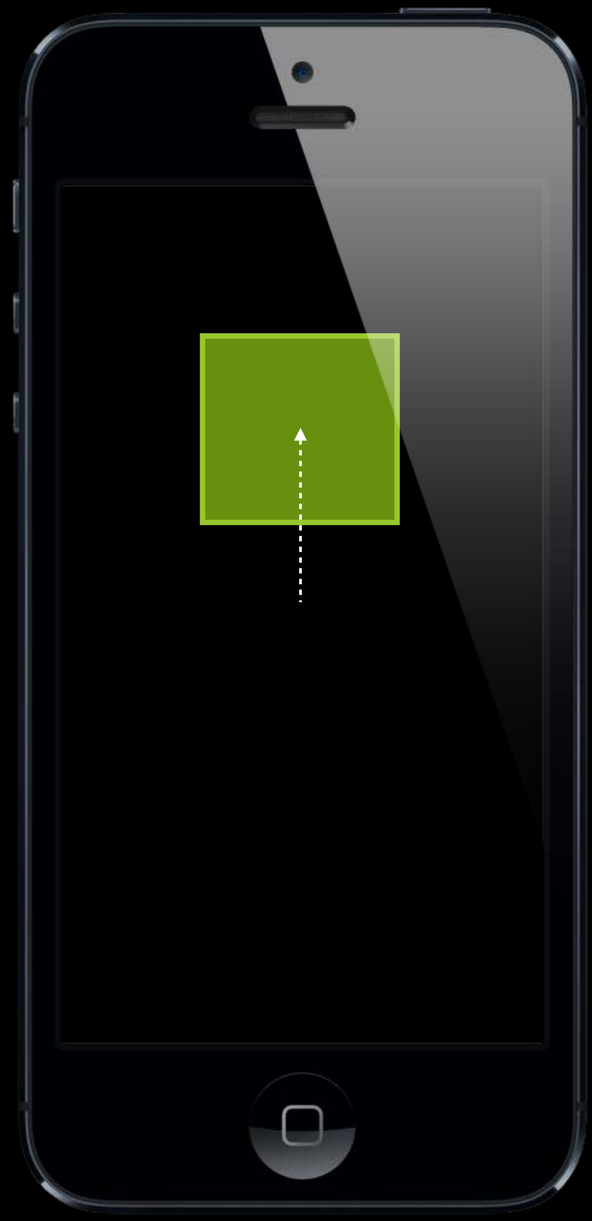

UIPushBehavior

- Instantaneous mode

```
p2 = [[UIPushBehavior alloc]
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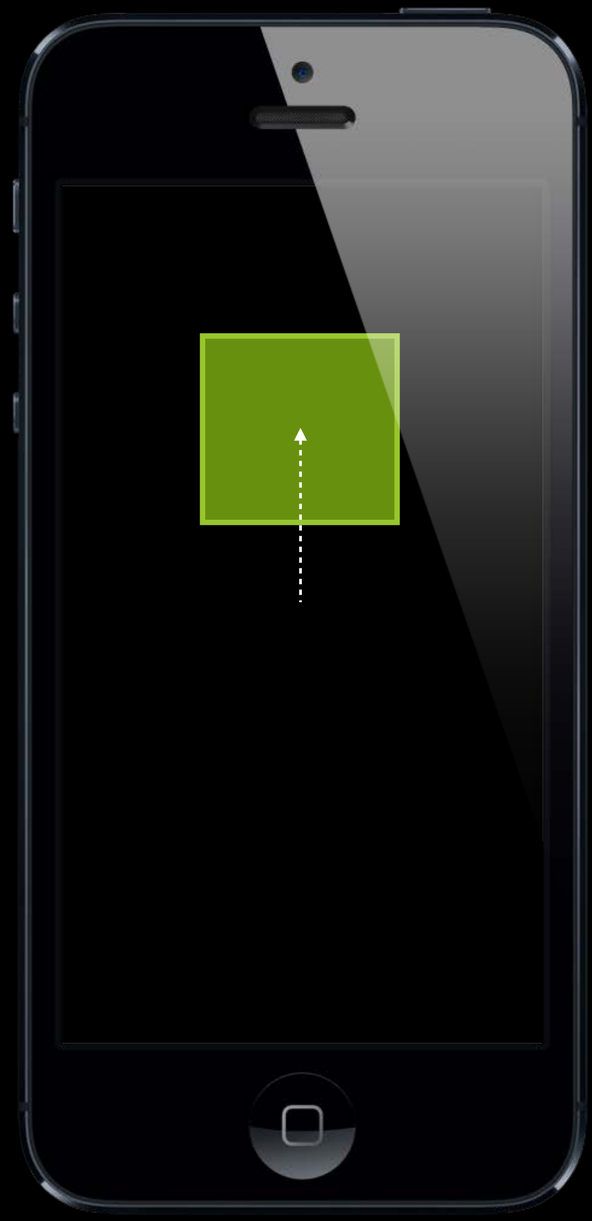
```

- Velocity change is instantaneous
- Automatically disables itself after
  - Reenable with `[p setActive:TRUE]`

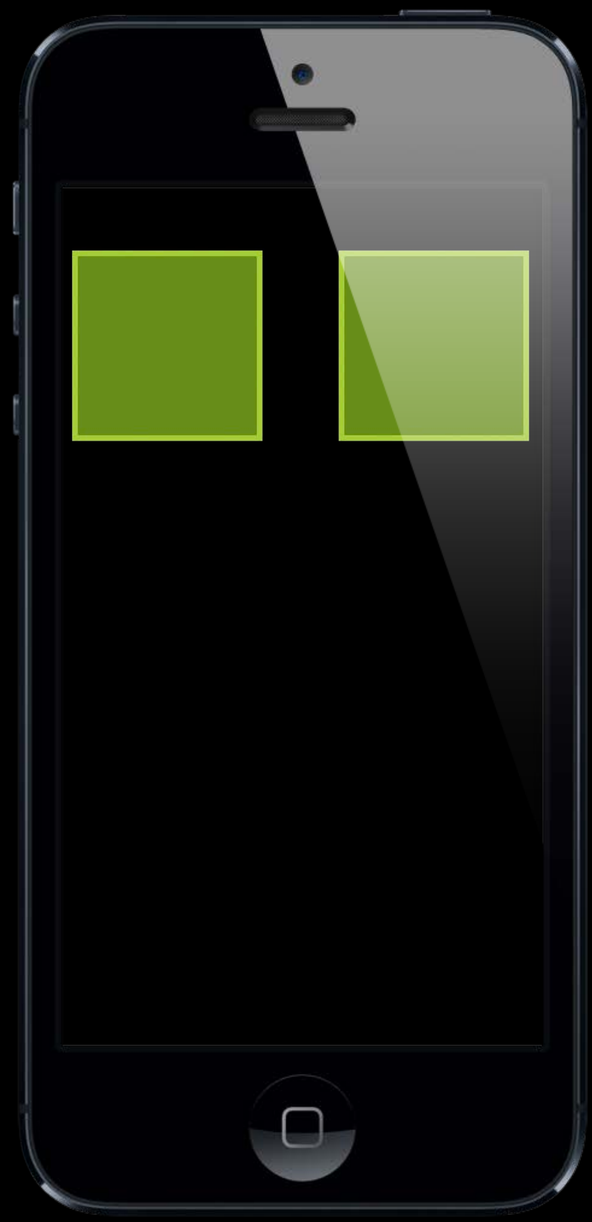


Demo

UIDynamicItemBehavior

UIDynamicItemBehavior

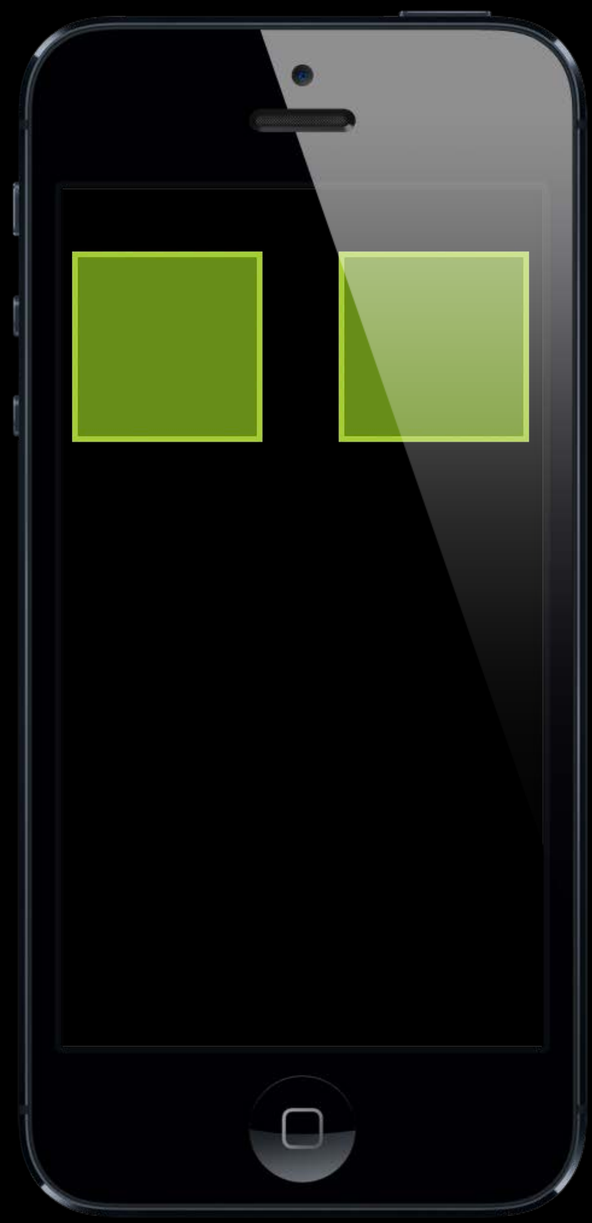
- Applied to one or many items



UIDynamicItemBehavior

- Applied to one or many items
- Change item-level properties

```
friction
resistance
angularResistance
elasticity
density
allowsRotation
```



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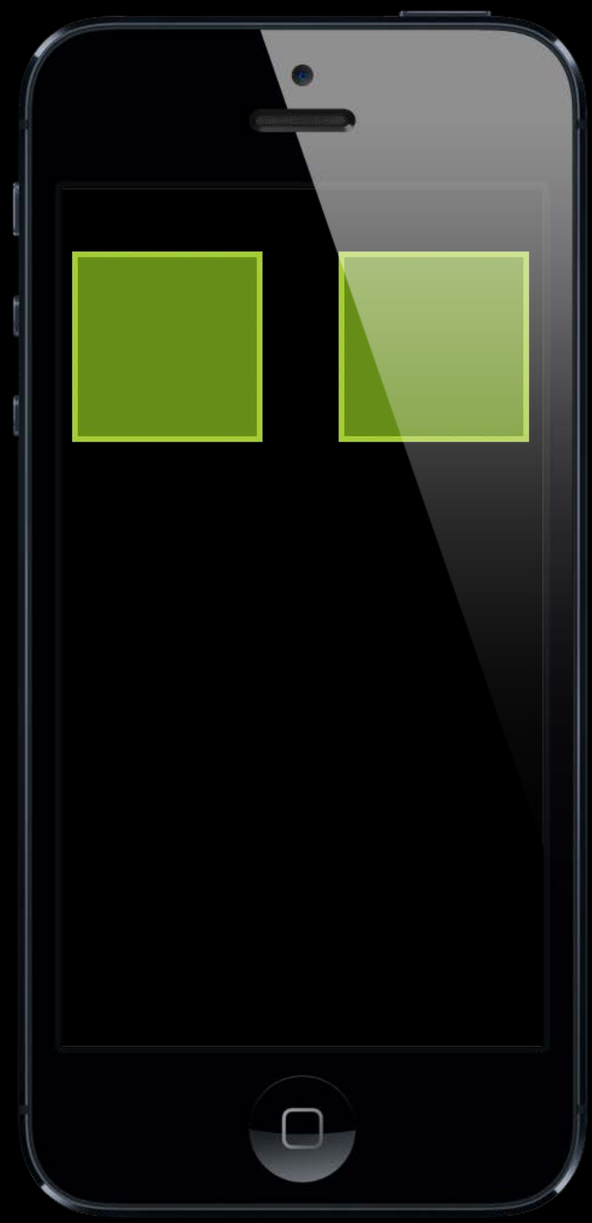

UIDynamicItemBehavior

- Applied to one or many items
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resistance
angularResistance
elasticity
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```
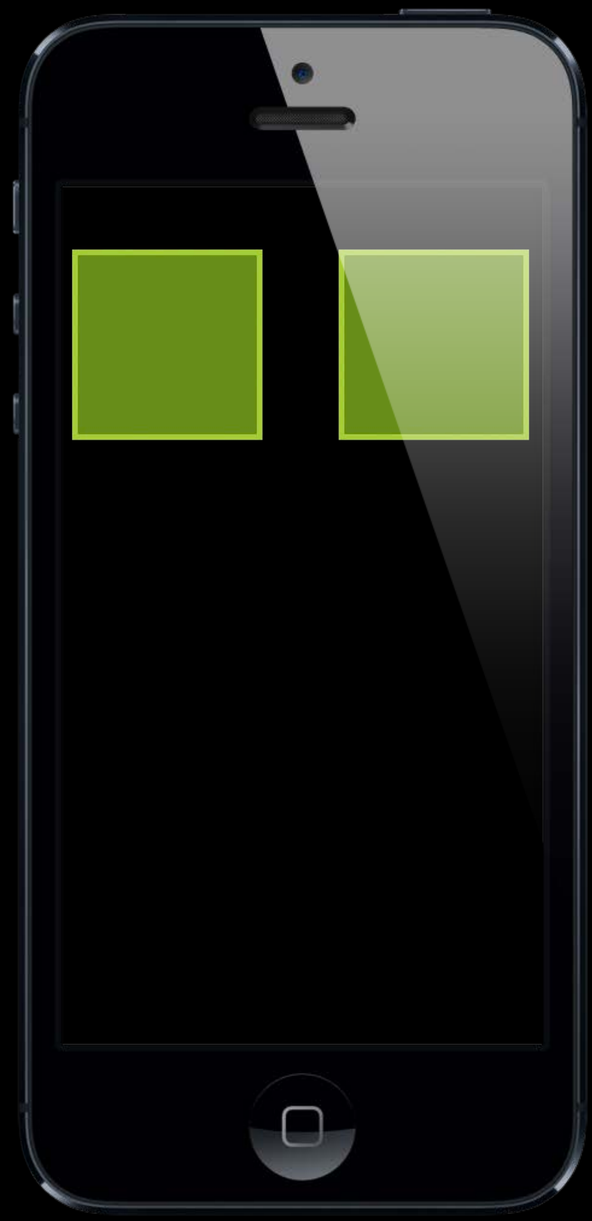

- Directly add angular or linear velocities
  - i.e. map with a previous gesture



Applying Dynamics

Applying Dynamics

- Add and remove views to behaviors

Applying Dynamics

- Add and remove views to behaviors
- Configure, add, and remove behaviors to an animator

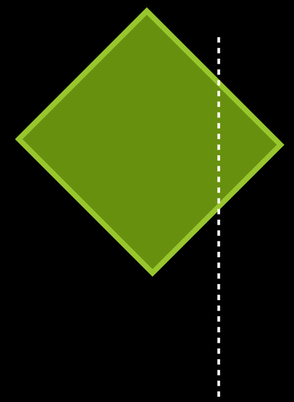
Applying Dynamics

- Add and remove views to behaviors
- Configure, add, and remove behaviors to an animator
- There is no step 3

Don’t Expect the Impossible

- You can create setups which don’t have solutions
- Build your system iteratively
- Not a physics-accurate tool

Don’t Expect the Impossible



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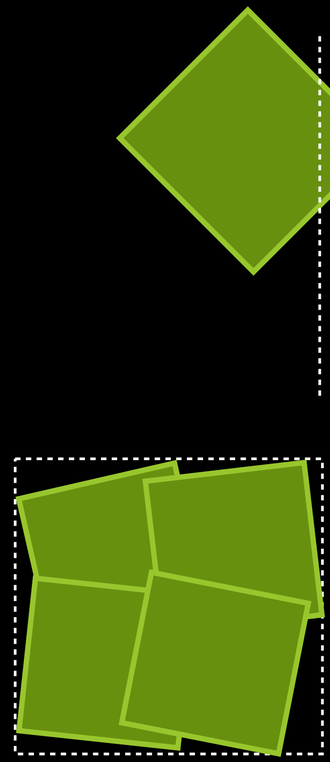

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- You can create setups which don’t have solutions
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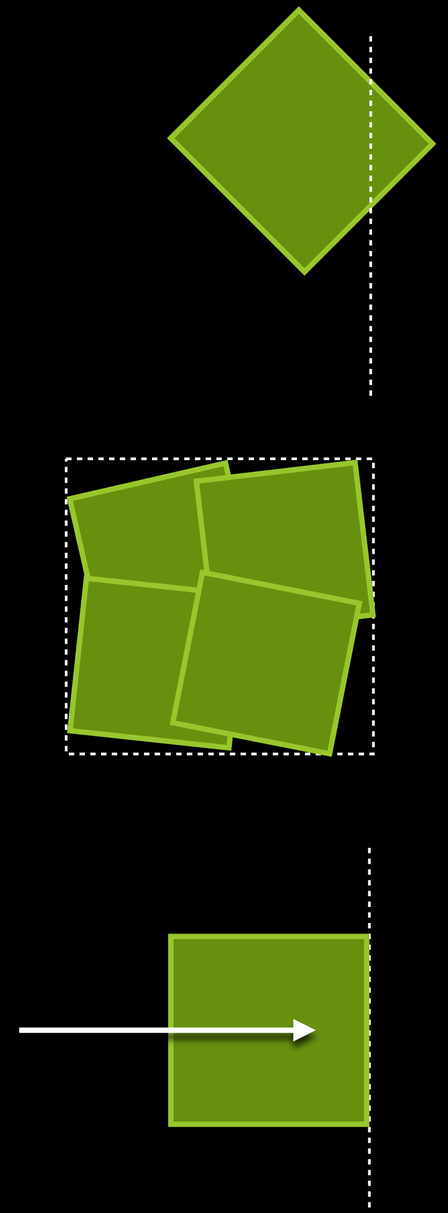

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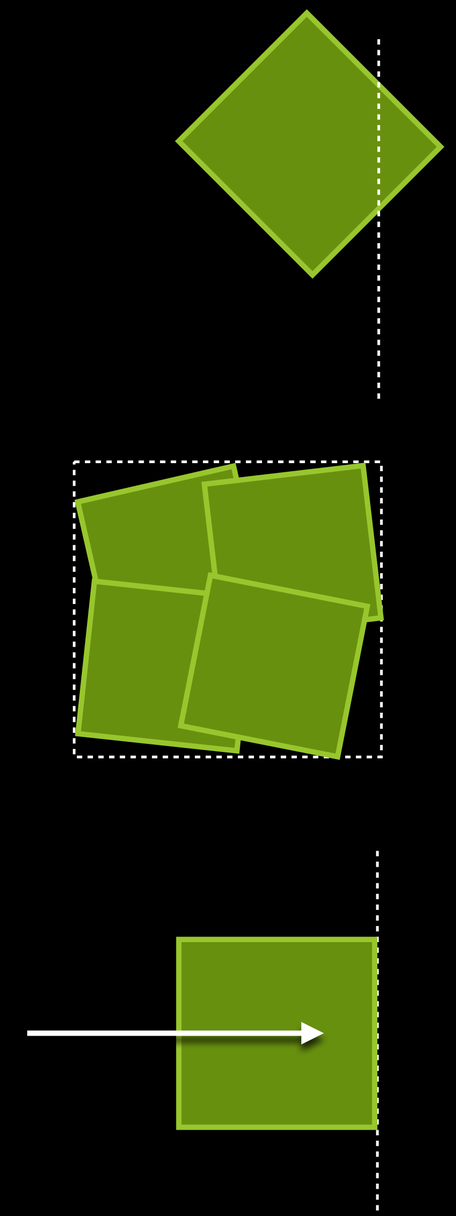

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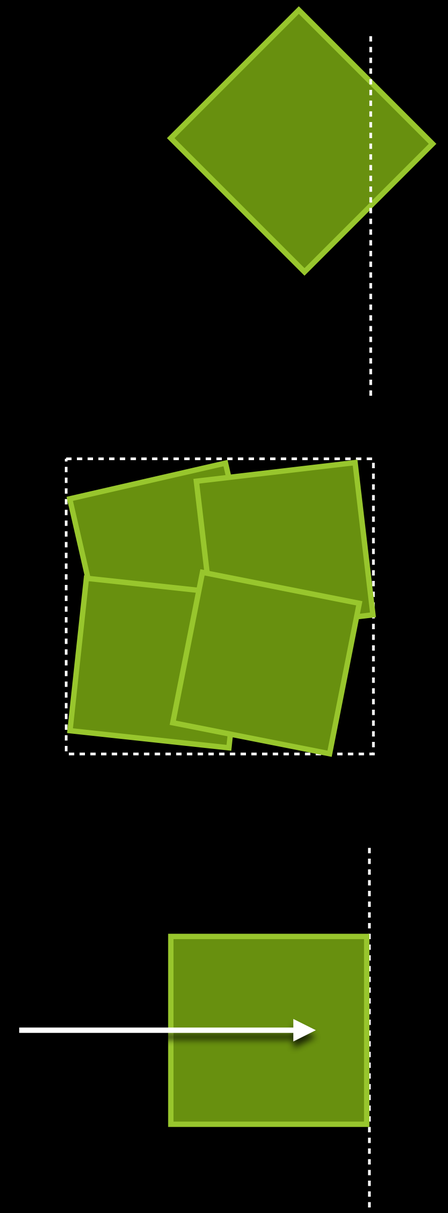

Dynamic Items

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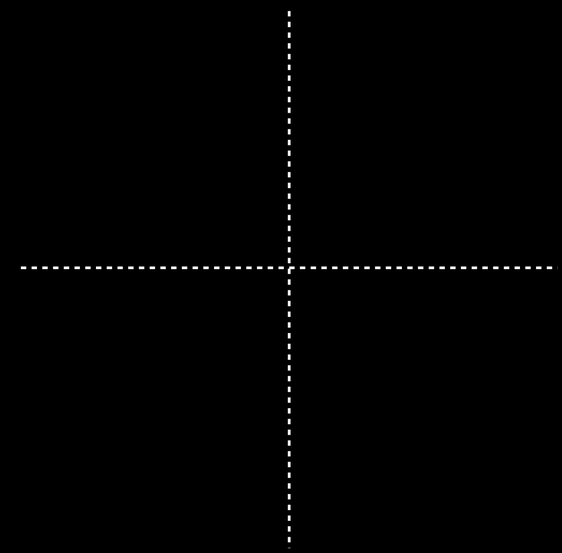

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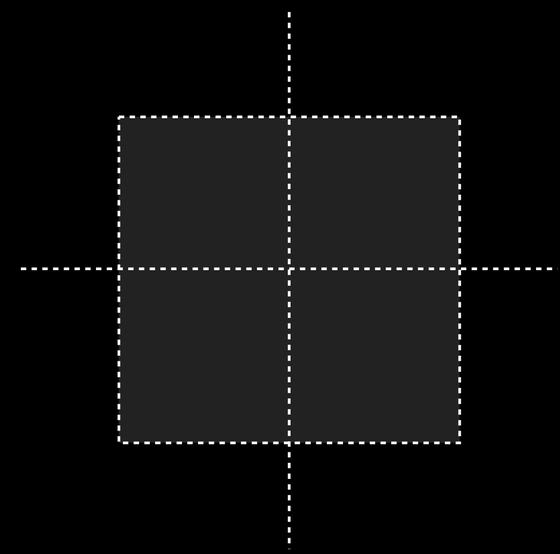

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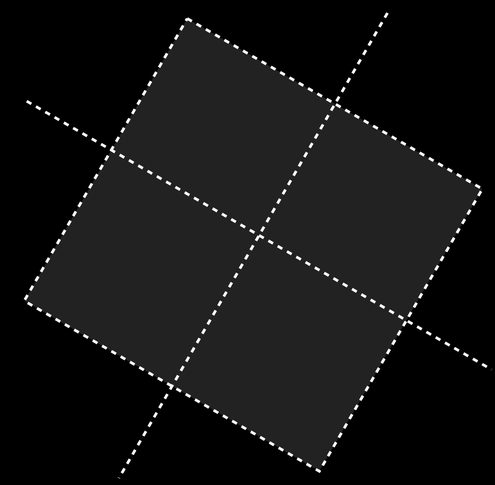

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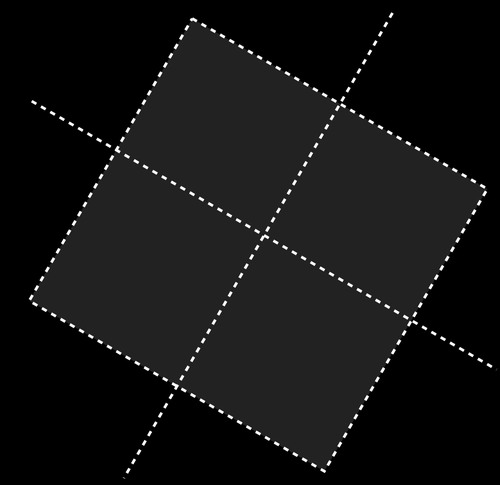

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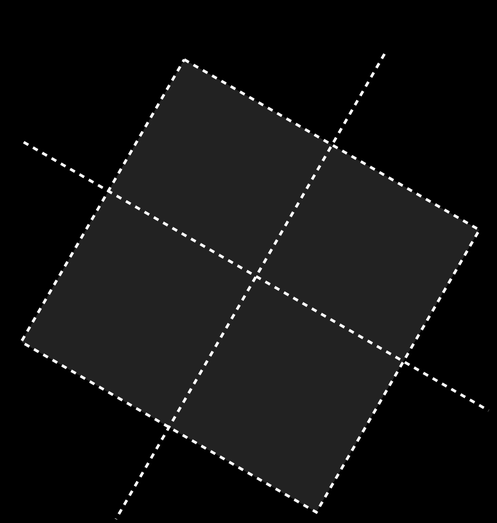

UIDynamicItem

```
@protocol UIDynamicItem <NSObject>

@property (nonatomic, readwrite) CGPoint center;
@property (nonatomic, readonly)  CGRect bounds;
@property (nonatomic, readwrite) CGAffineTransform transform;

@end
```

Collection View

Layout Attributes

Dynamics and UICollectionView

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animator = [[UIDynamicAnimator alloc] initWithCollectionViewLayout:myLayout]
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- UIKit will invalidate the layout as needed

Demo

Summary

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- An interaction-oriented animation system

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- Animate key elements

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- An interaction-oriented animation system
- Animate key elements
- Focus on the user experience

More Information

Jake Behrens
UI Frameworks Evangelist
behrens@apple.com

Documentation
UIKit Framework Reference
http://developer.apple.com/library/ios

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

Related Sessions

Advanced Techniques with UIKit Dynamics	Presidio Thursday 3:15PM
Custom Transitions Using View Controllers	Pacific Heights Thursday 11:30AM
Introduction to Sprite Kit	Presidio Wednesday 11:30AM
Designing Games with Sprite Kit	Mission Wednesday 2:00PM

Labs

UIKit Dynamics Lab	Frameworks Lab A Wednesday 4:30PM	
Scroll View, Collection View, and Table View on iOS Lab	Frameworks Lab B Wednesday 2:00PM	
Scroll View, Collection View, and Table View on iOS Lab	Frameworks Lab B Thursday 11:30AM	
Cocoa Touch Animation Lab	Frameworks Lab B Thursday 2:00PM	
Cocoa Touch Lab	Frameworks Lab A Wednesday 9:00AM	
Cocoa Touch Lab	Frameworks Lab B Friday 9:00AM	
Sprite Kit Lab	Graphics and Games Lab B Wednesday 3:15PM	

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