

Building Advanced Gesture Recognizers

Session 233

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iOS Frameworks

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iOS Frameworks

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Building Advanced Gesture Recognizers

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- UIGestureRecognizer system

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- UIGestureRecognizer system
- Gesture interaction

Building Advanced Gesture Recognizers

- UIGestureRecognizer system
- Gesture interaction
- Subclassing fundamentals

Building Advanced Gesture Recognizers

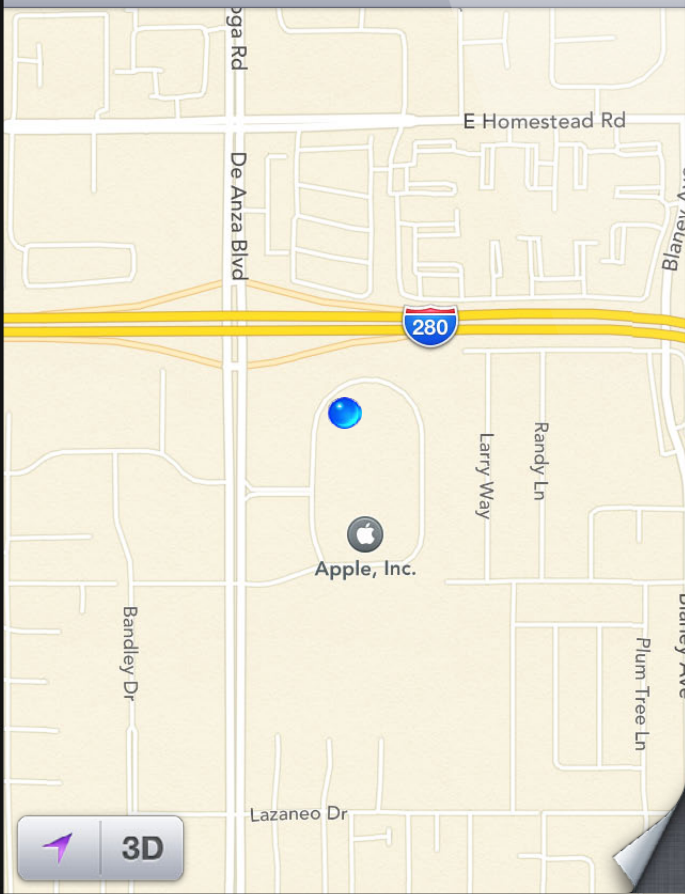
- UIGestureRecognizer system
- Gesture interaction
- Subclassing fundamentals
- Signal processing

UIGestureRecognizer System

On state machines and complexity

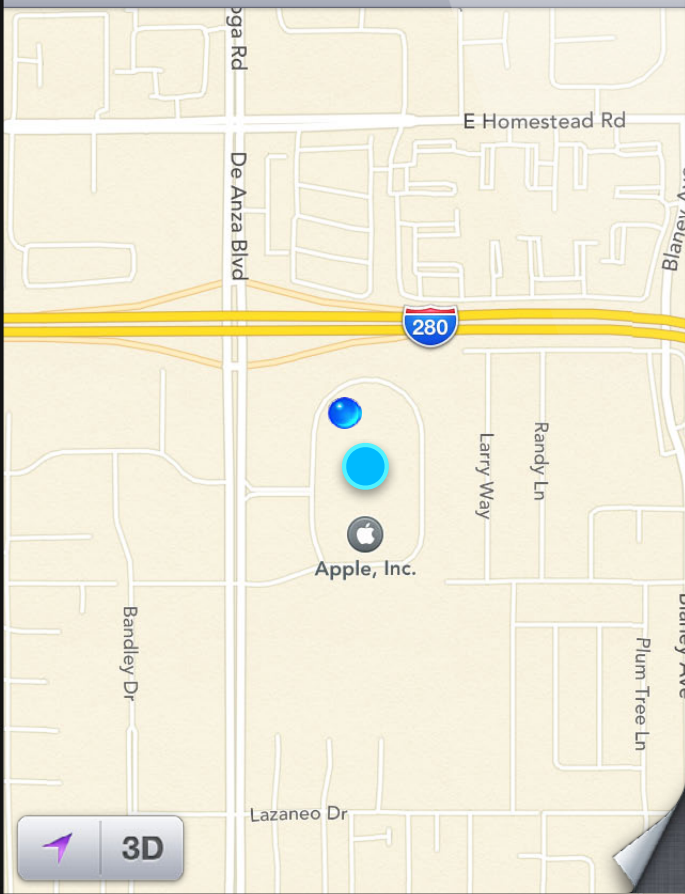
3G 9:41 AM

Search or Address



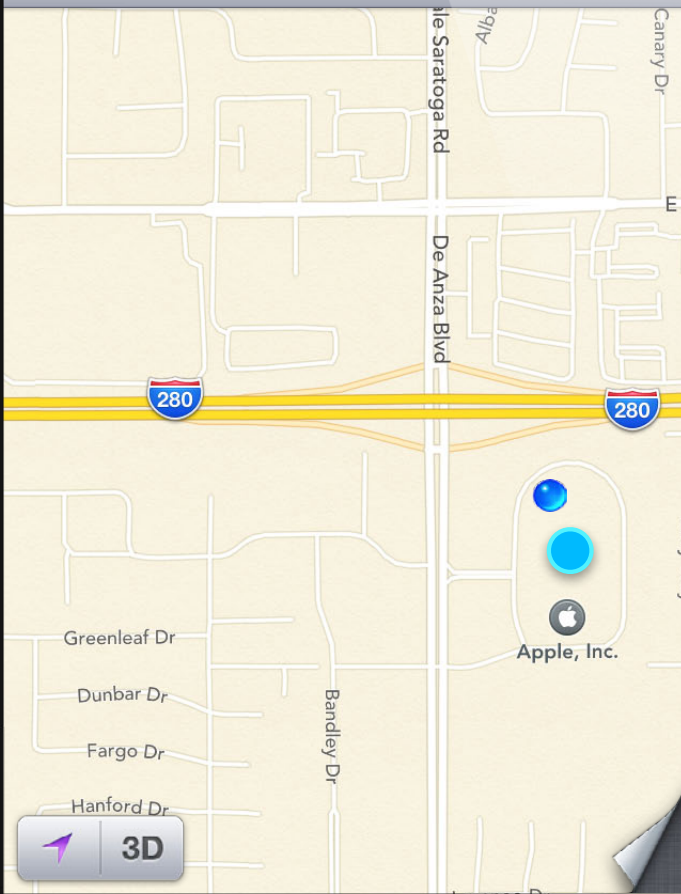
3G 9:41 AM

Search or Address



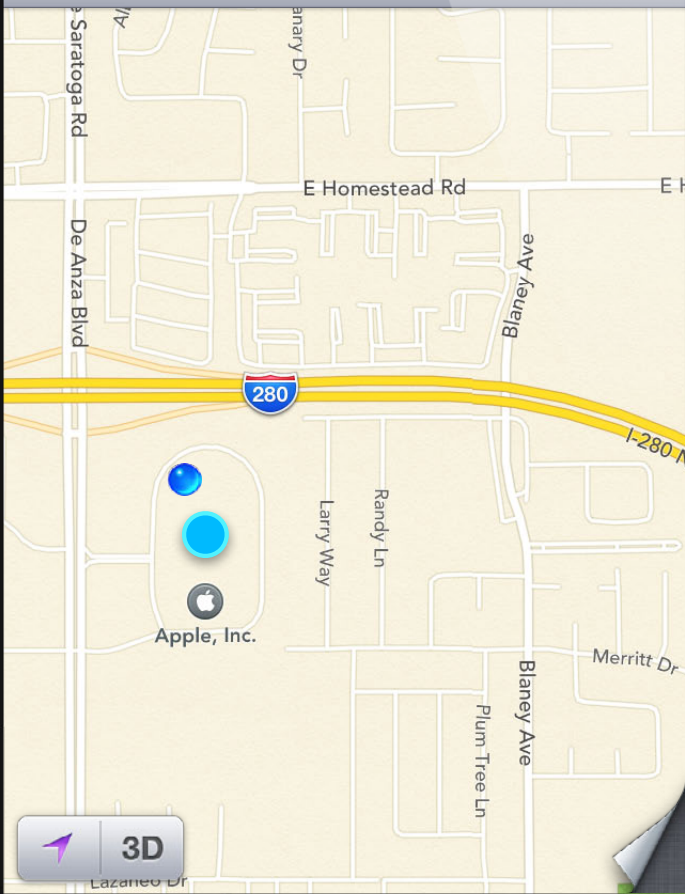
3G 9:41 AM

Search or Address



3G 9:41 AM

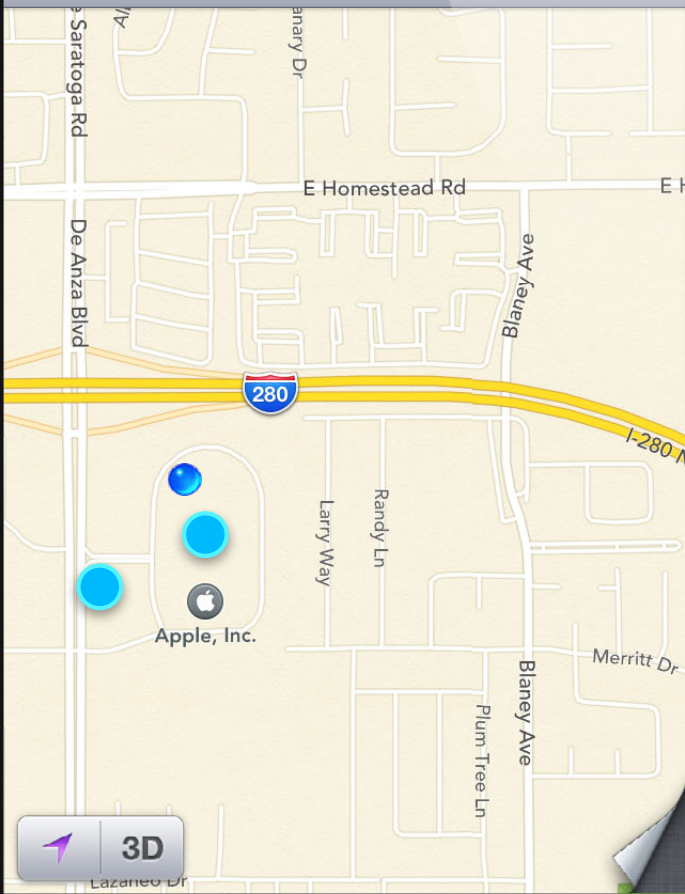
Search or Address



3D

3G 9:41 AM

Search or Address

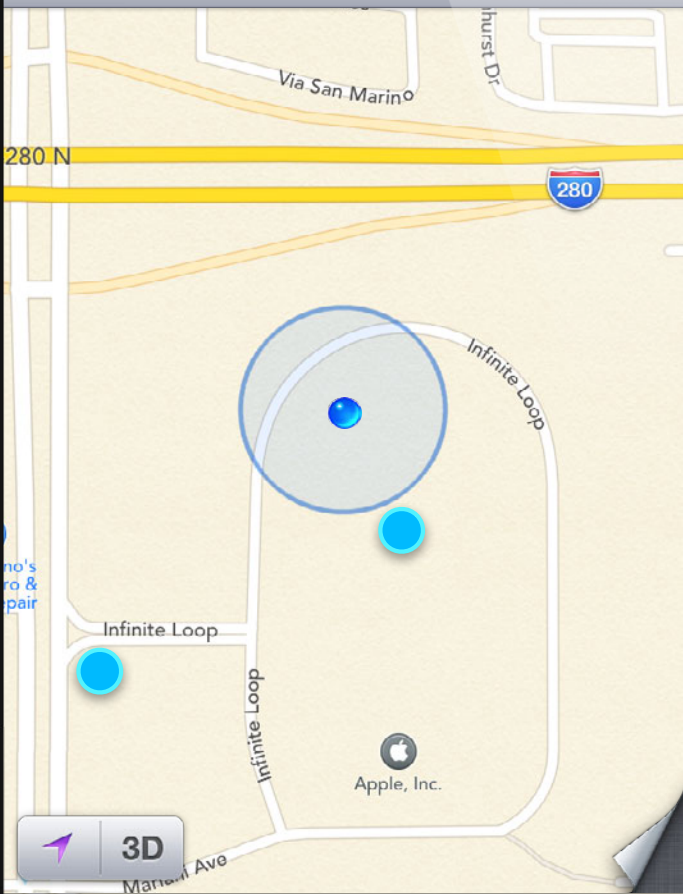


3D



3G 9:41 AM

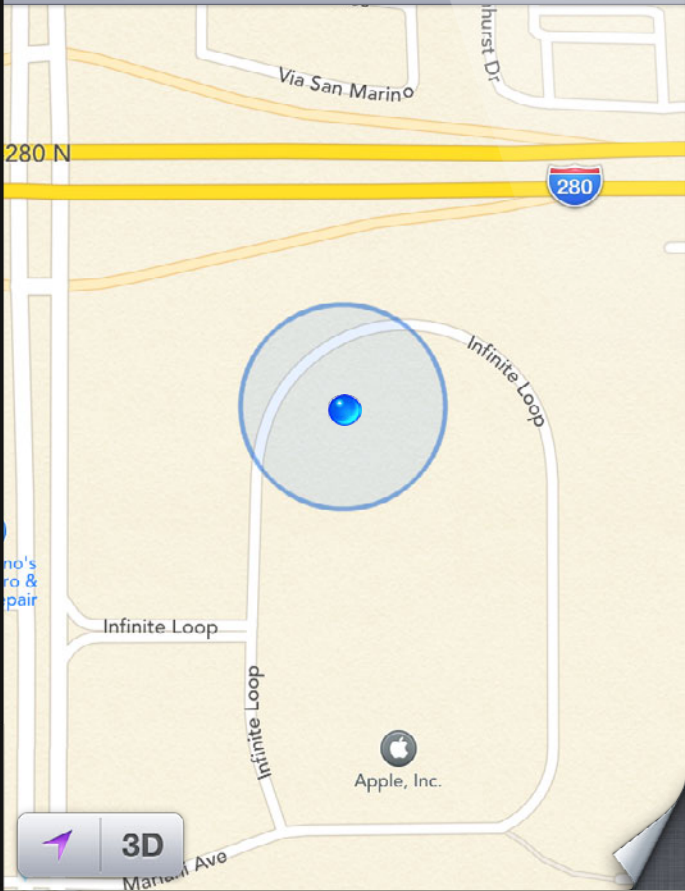
Search or Address



3D

3G 9:41 AM

Search or Address



3D



Gesture Recognition State Machines

pan

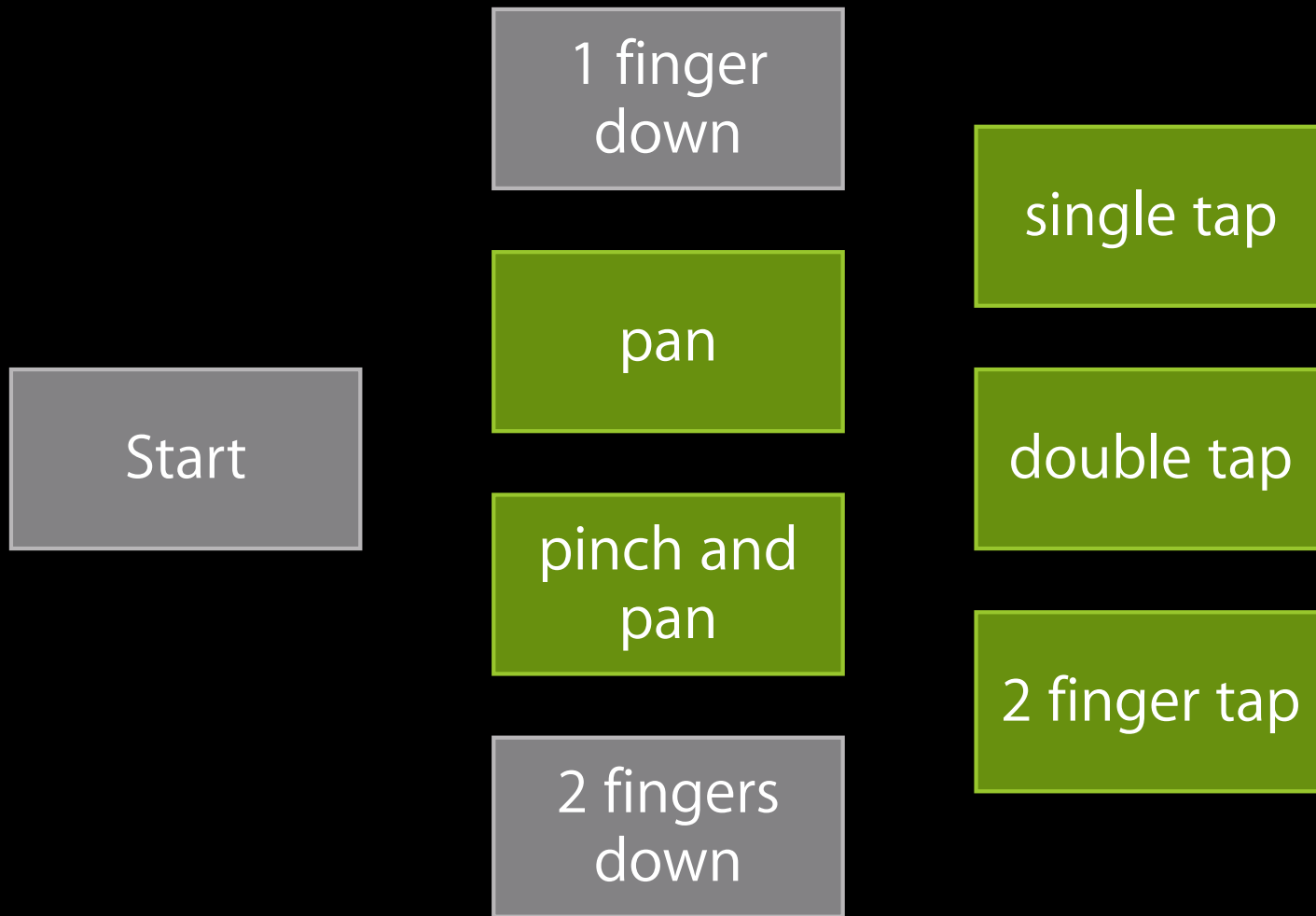
pinch and
pan

single tap

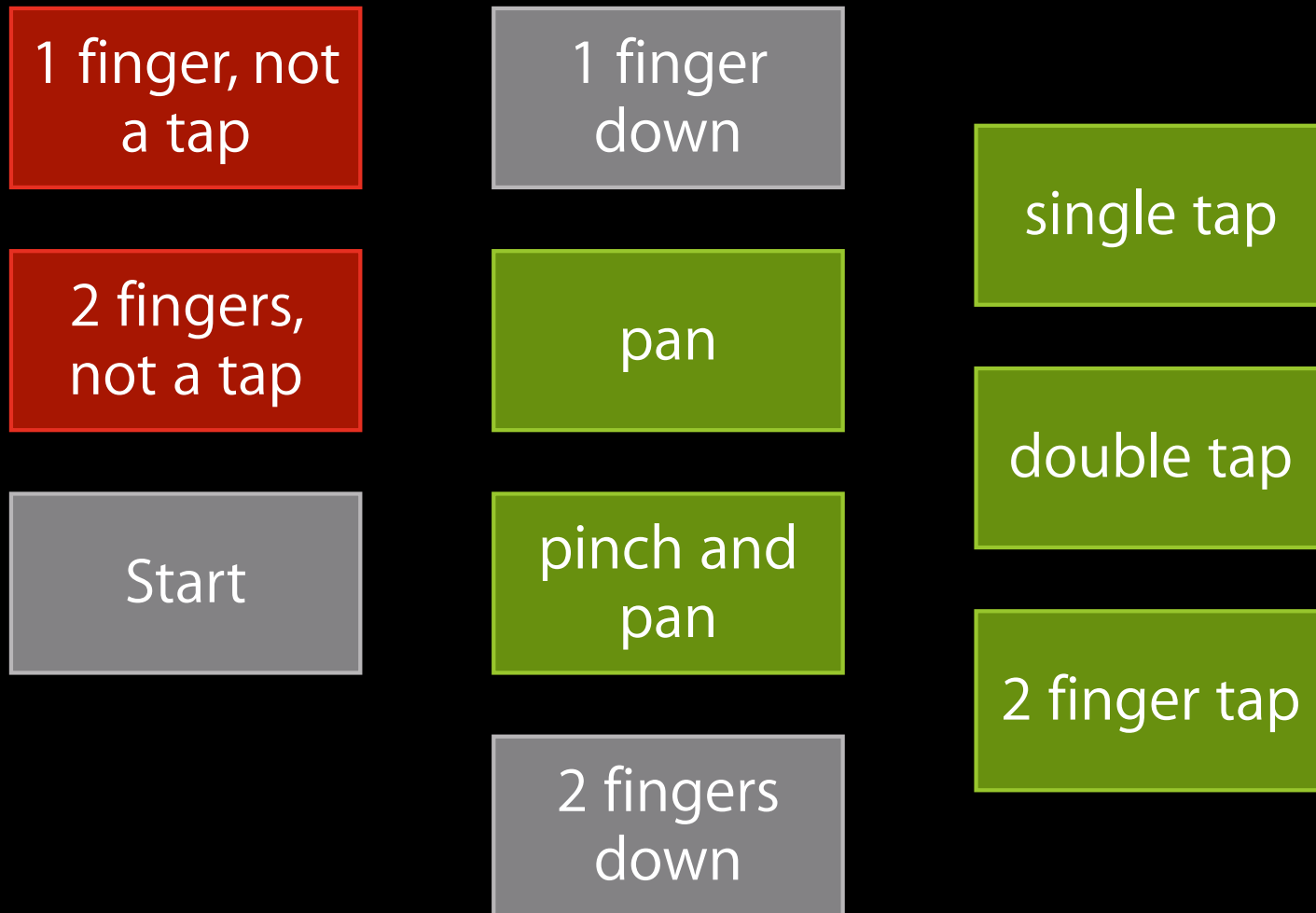
double tap

2 finger tap

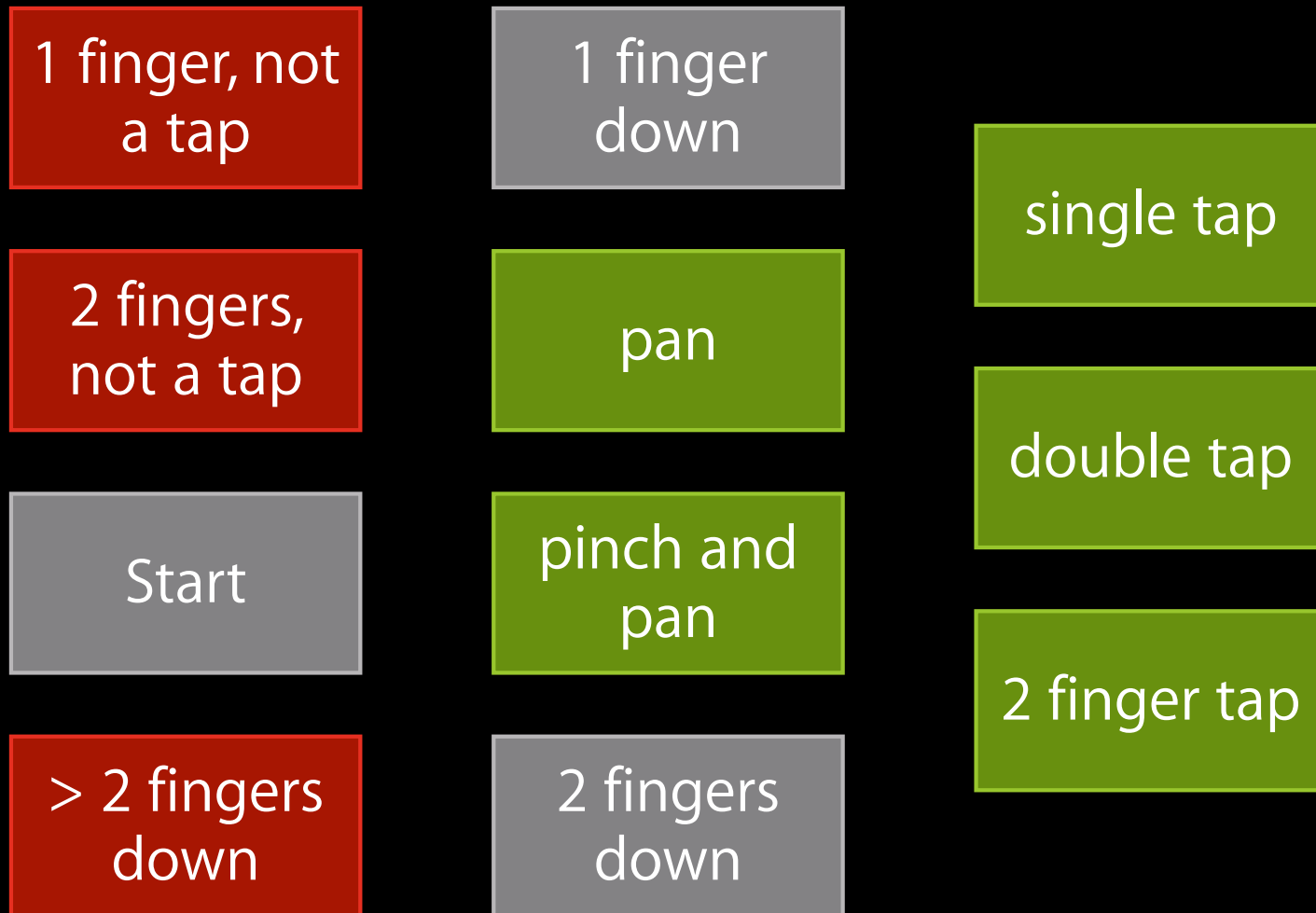
Gesture Recognition State Machines



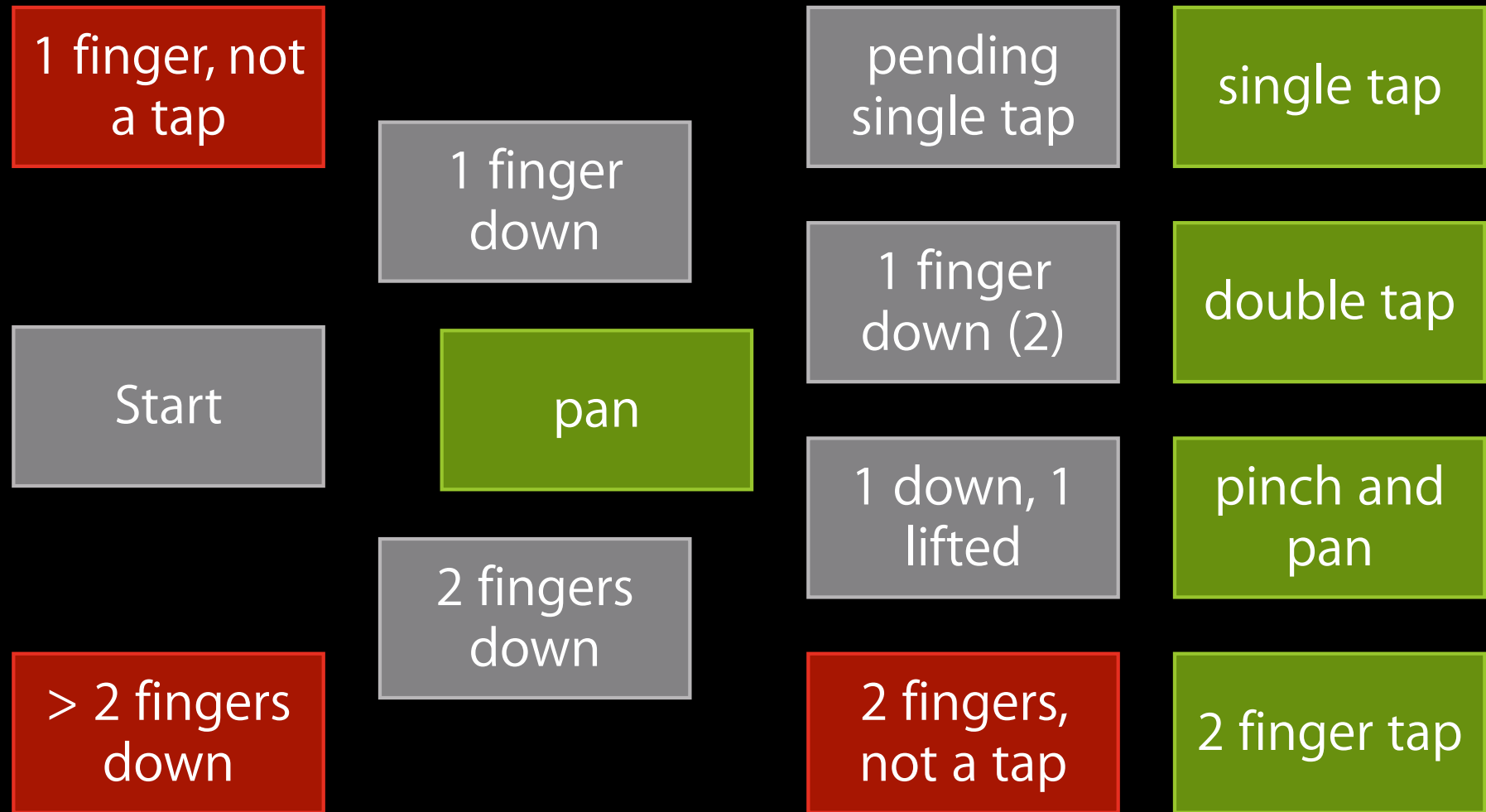
Gesture Recognition State Machines



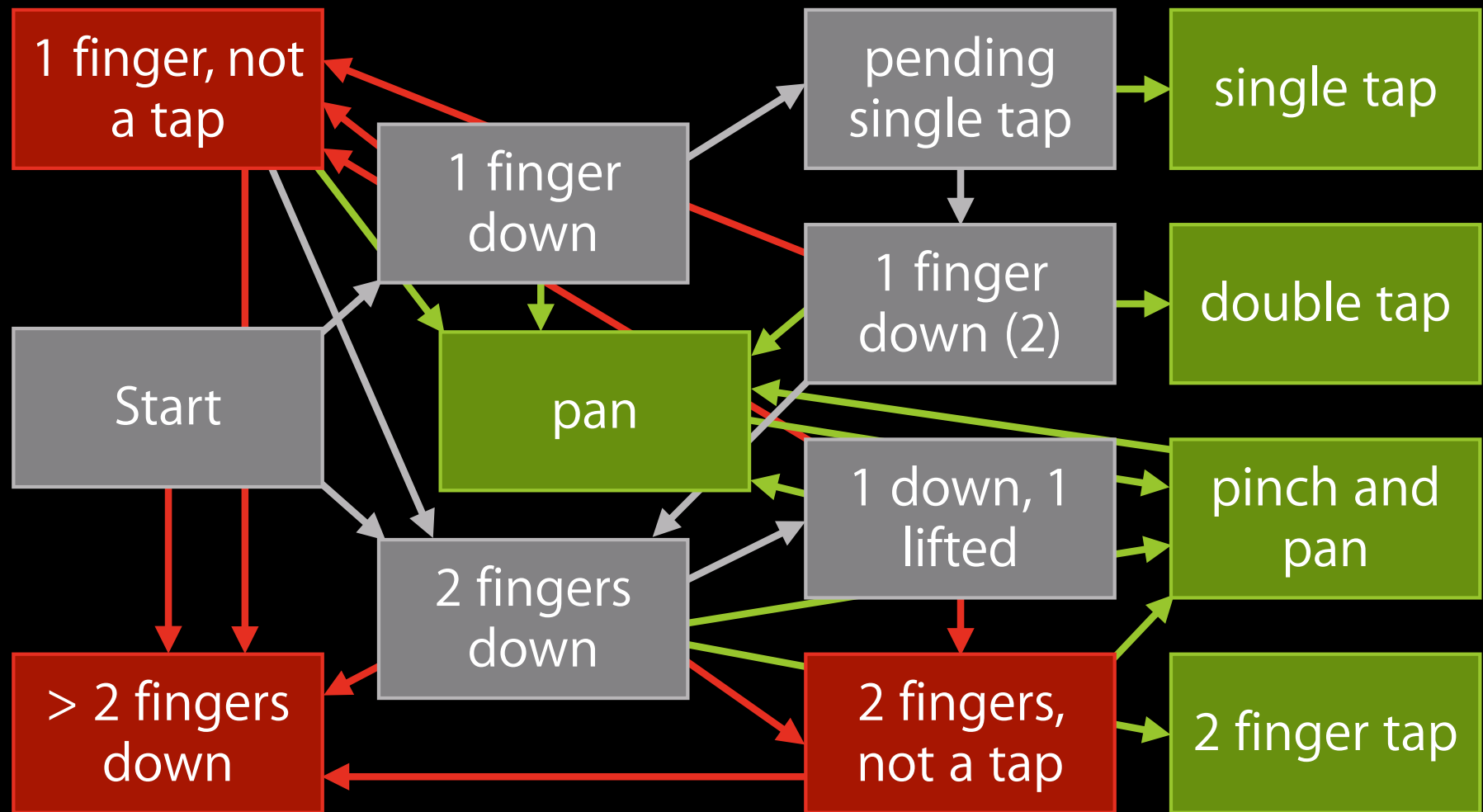
Gesture Recognition State Machines



Gesture Recognition State Machines



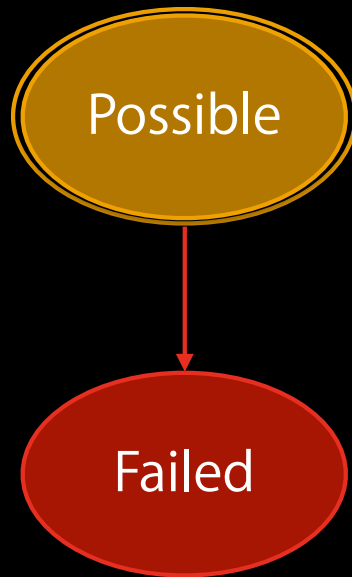
Gesture Recognition State Machines



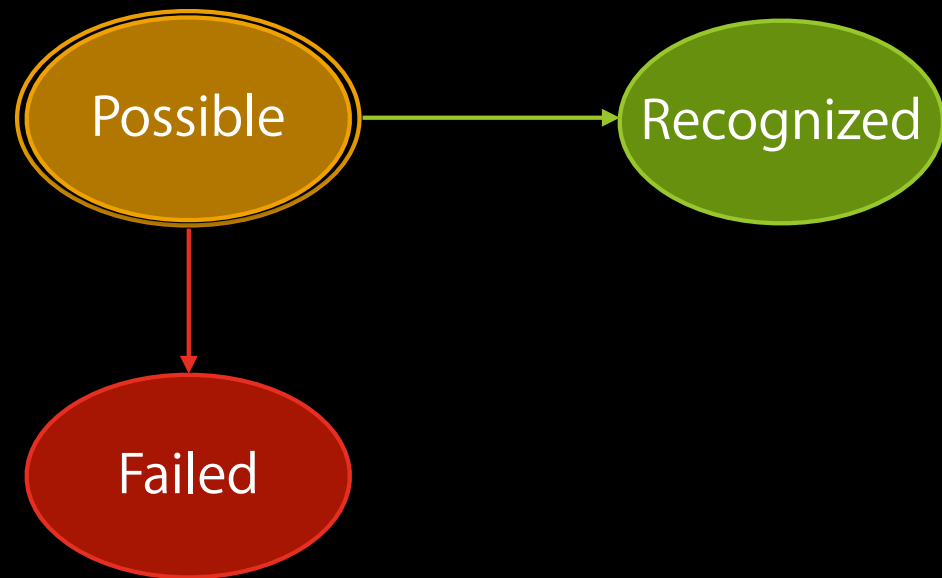
UIGestureRecognizer State Machine



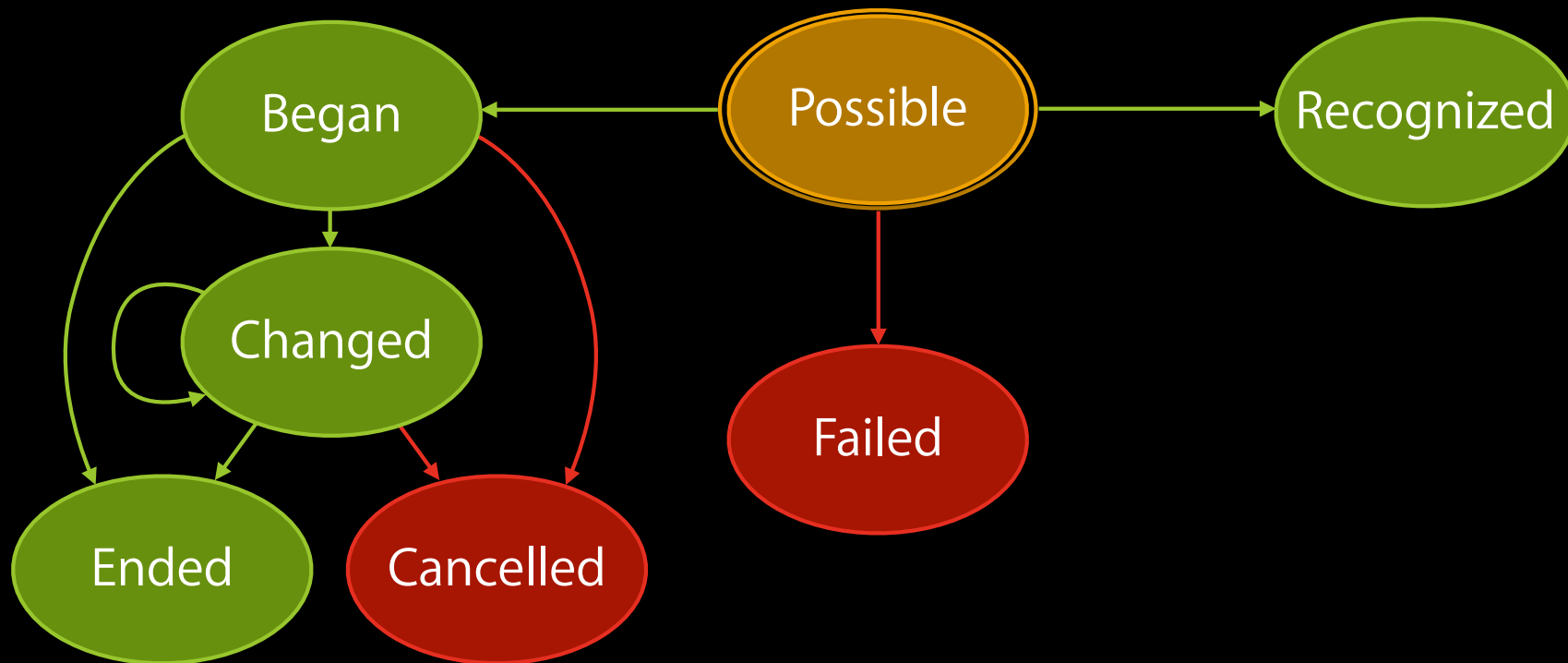
UIGestureRecognizer State Machine



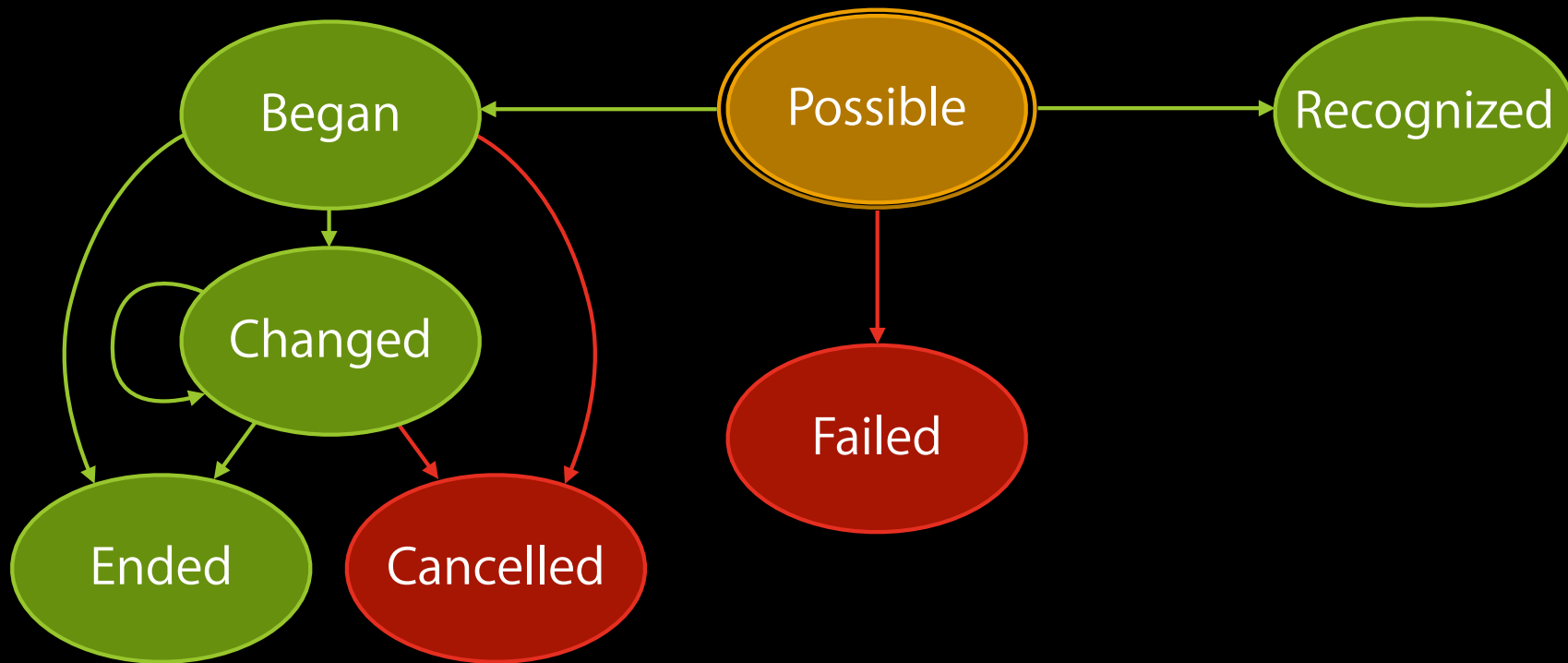
UIGestureRecognizer State Machine



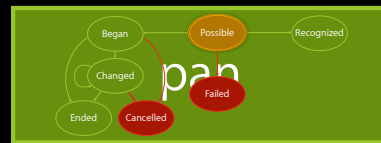
UIGestureRecognizer State Machine



UIGestureRecognizer State Machine



UIGestureRecognizer State Machine



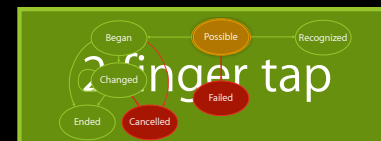
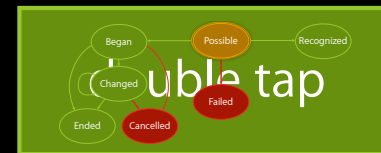
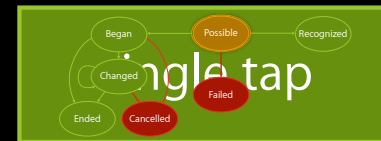
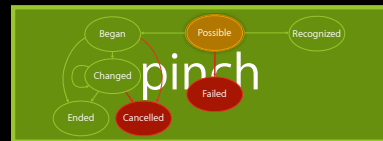
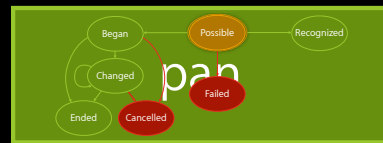
single tap

double tap

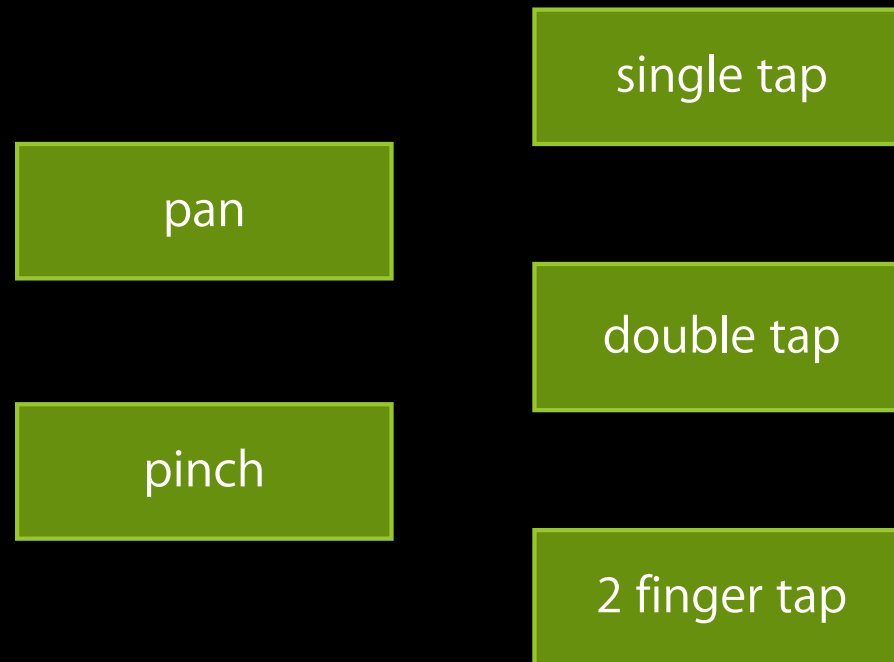
pinch

2 finger tap

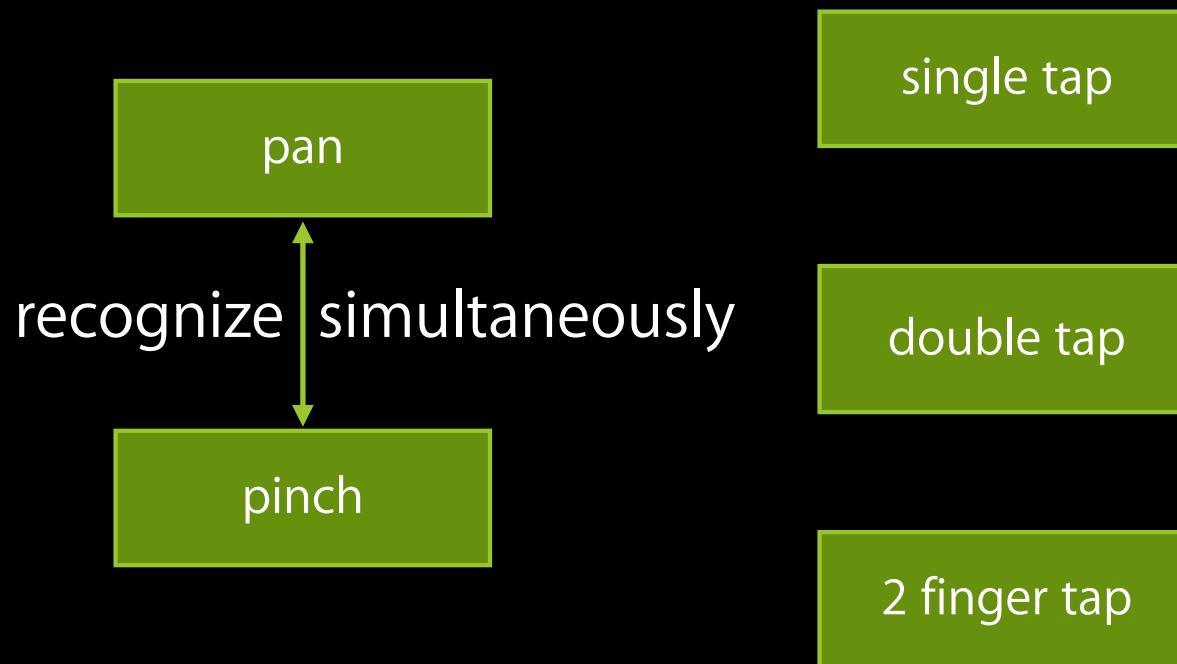
UIGestureRecognizer State Machine



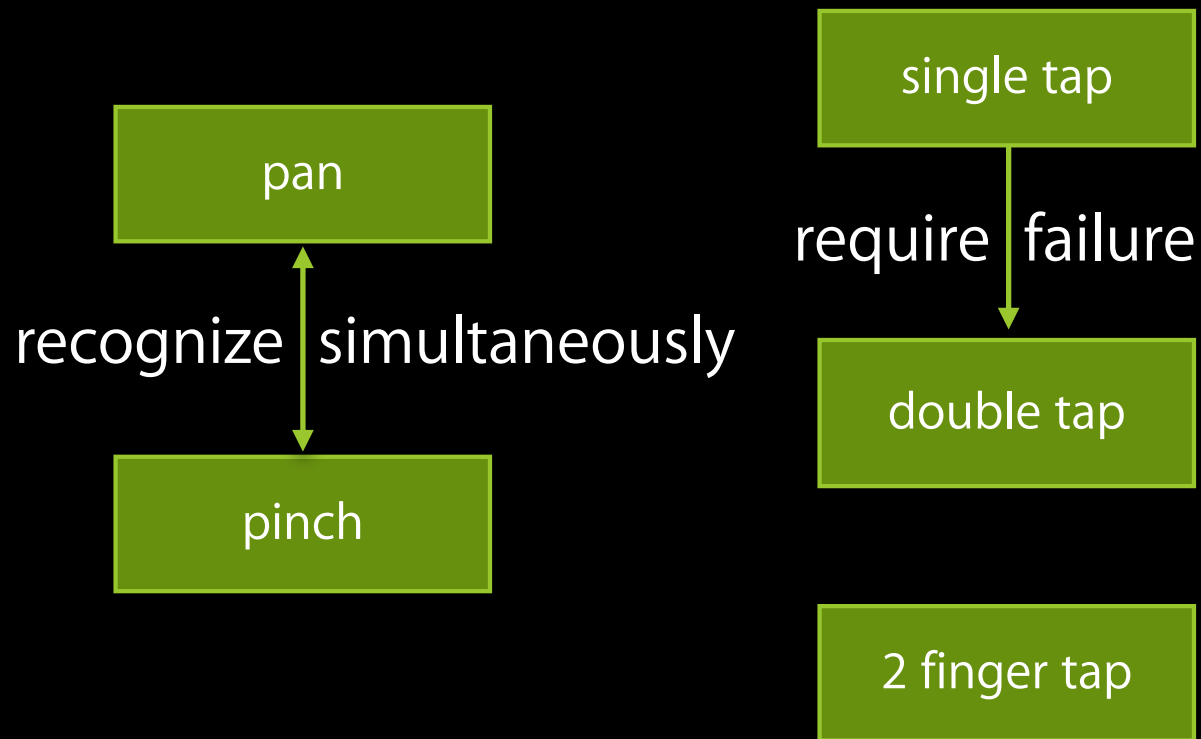
UIGestureRecognizer State Machine

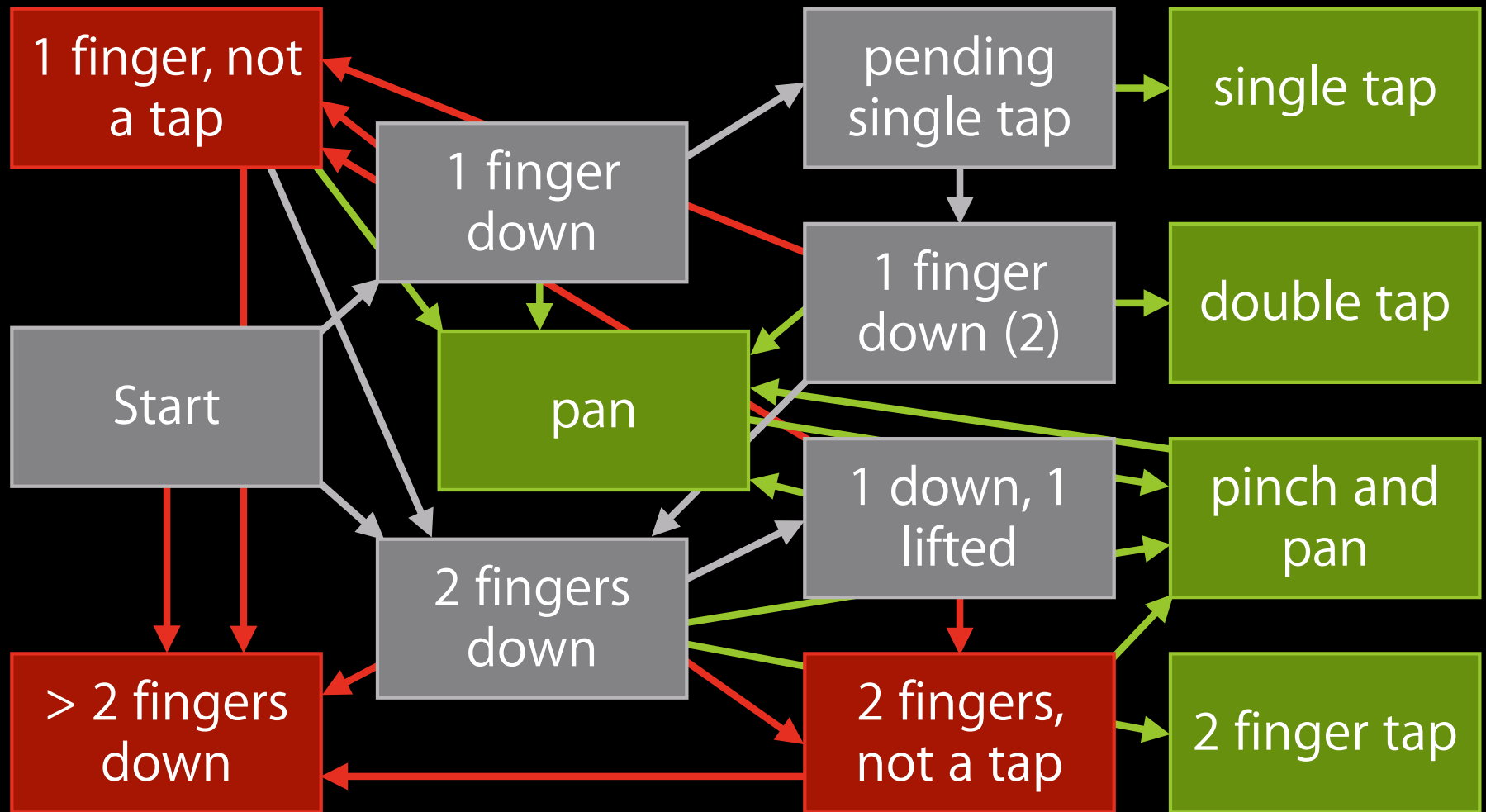


UIGestureRecognizerRecognizers



UIGestureRecognizerRecognizers

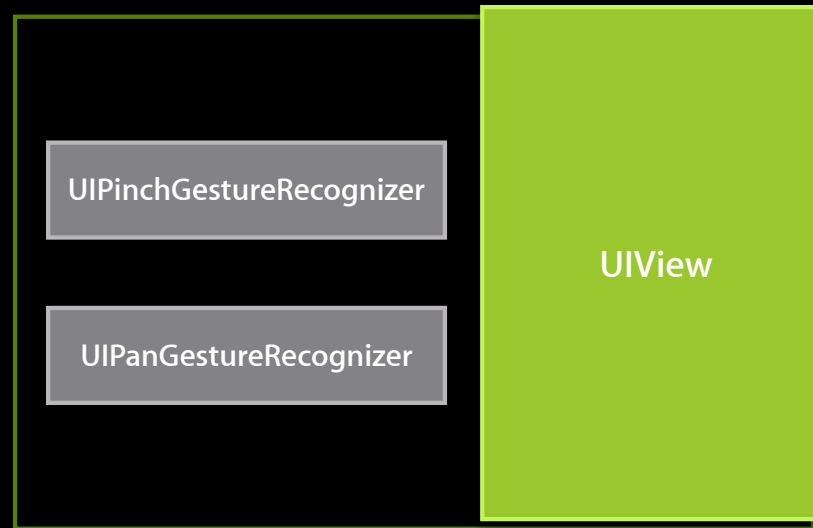




Gesture Interaction

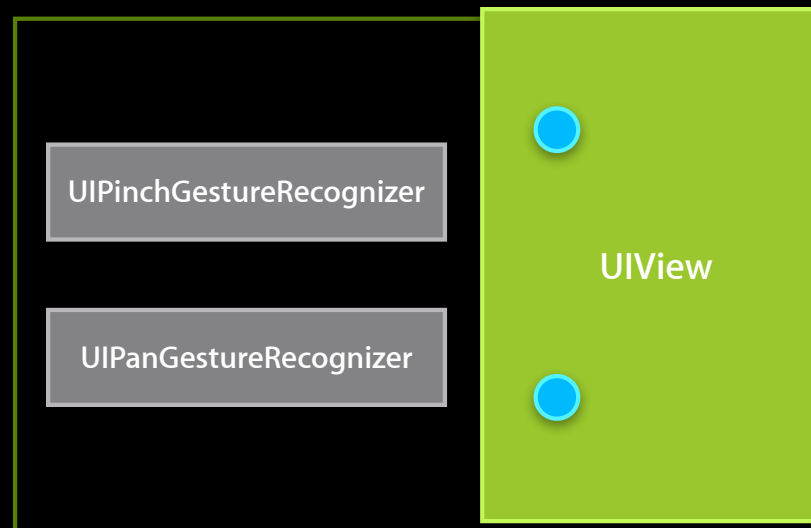
Gesture Interaction

Simultaneous recognition



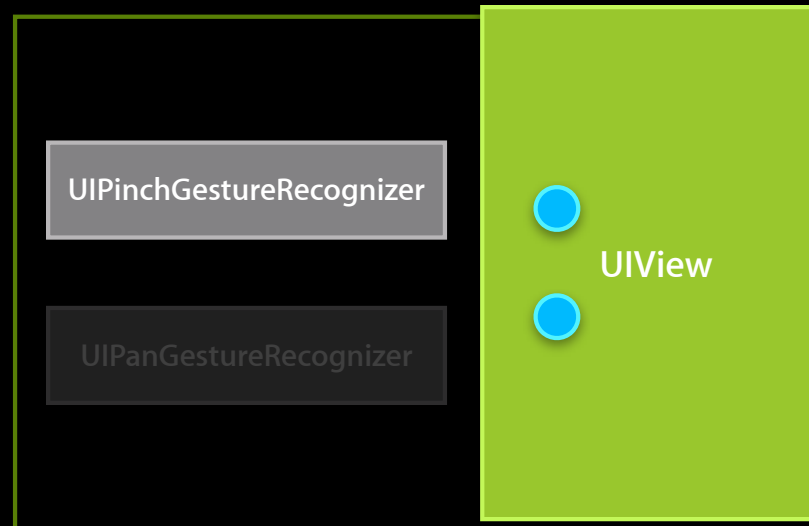
Gesture Interaction

Simultaneous recognition



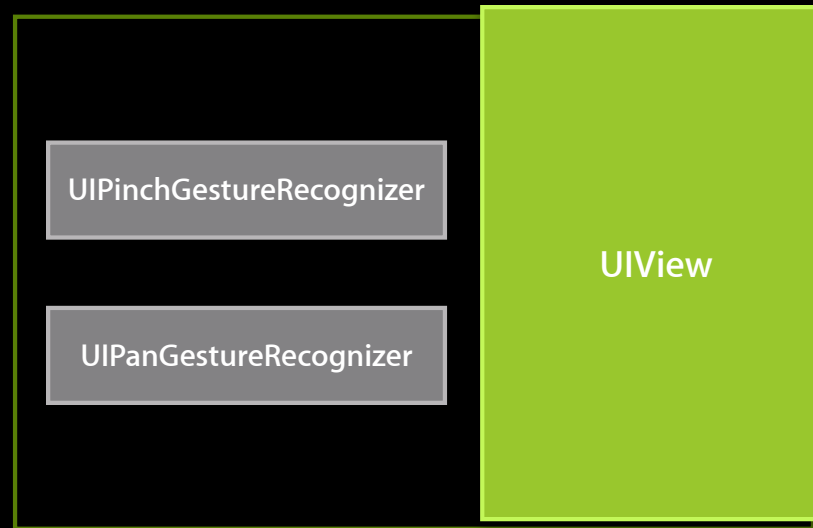
Gesture Interaction

Simultaneous recognition



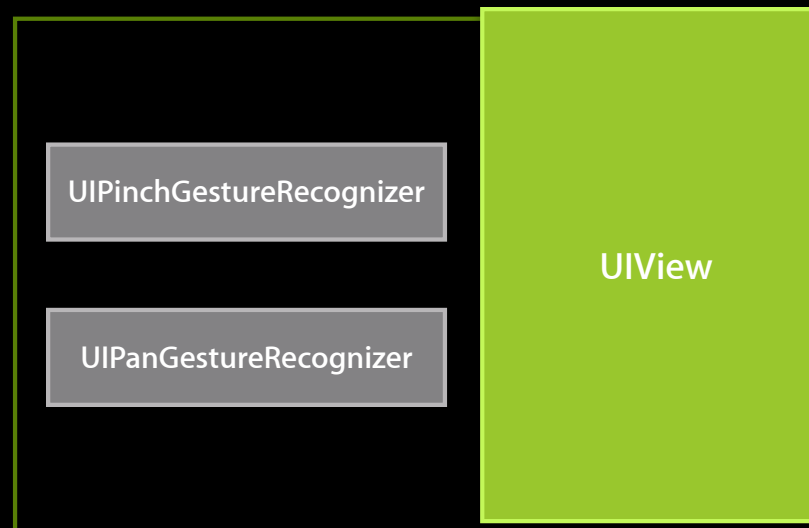
Gesture Interaction

Simultaneous recognition



Gesture Interaction

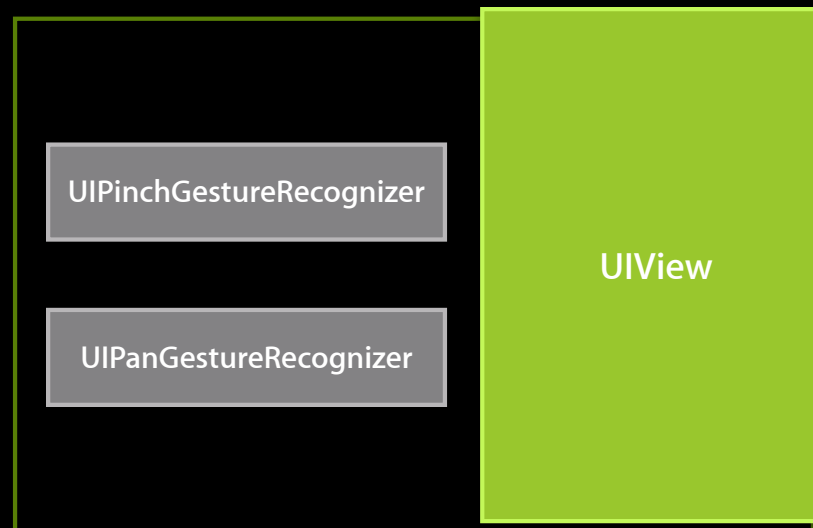
Simultaneous recognition



```
-[UIGestureRecognizerDelegate gestureRecognizer:  
    shouldRecognizeSimultaneouslyWithGestureRecognizer:]
```

Gesture Interaction

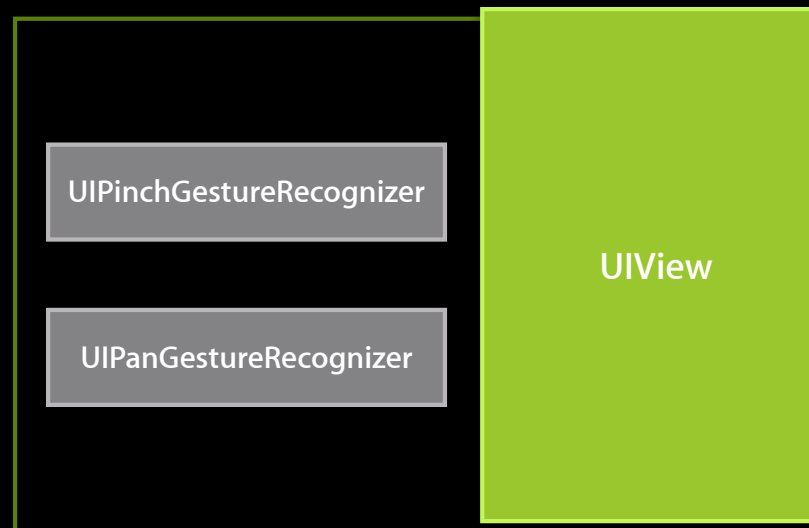
Simultaneous recognition



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Gesture Interaction

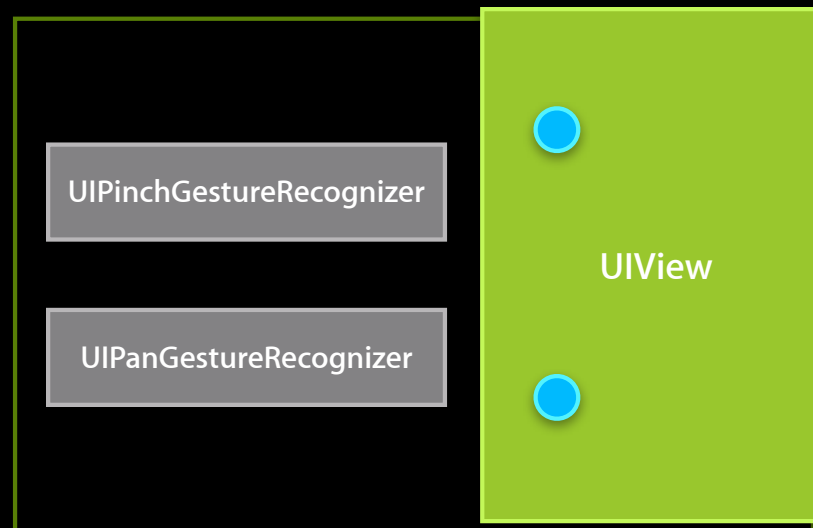
Simultaneous recognition



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Gesture Interaction

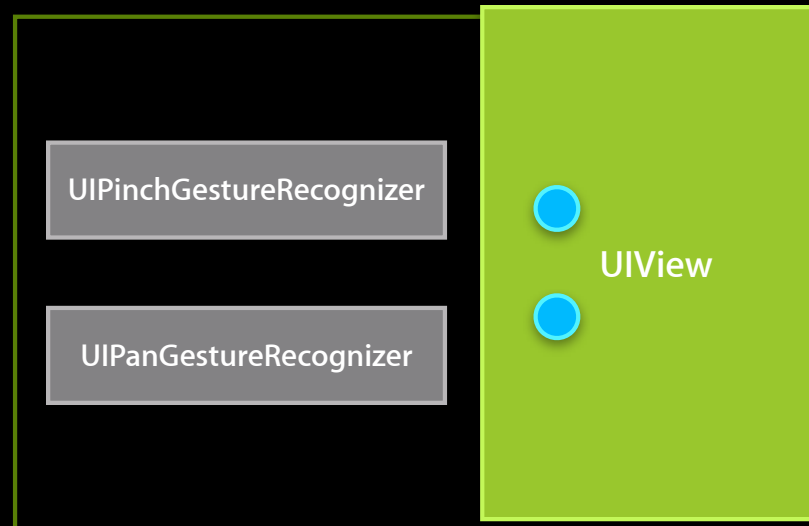
Simultaneous recognition



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Gesture Interaction

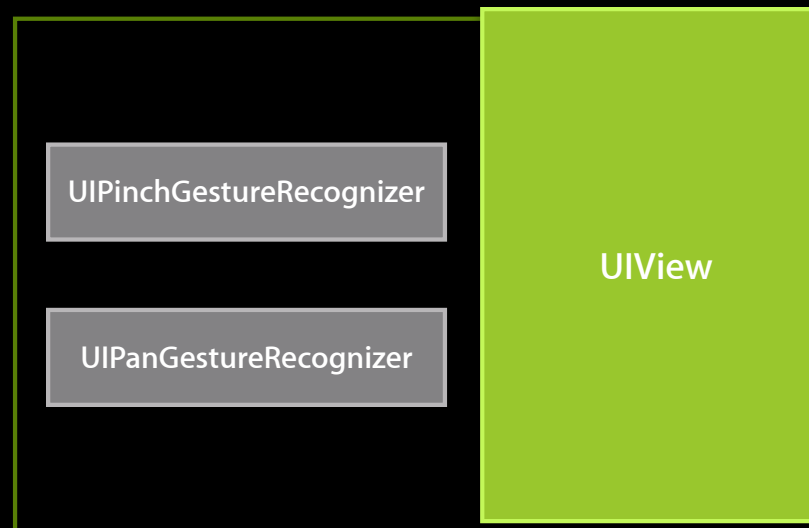
Simultaneous recognition



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Gesture Interaction

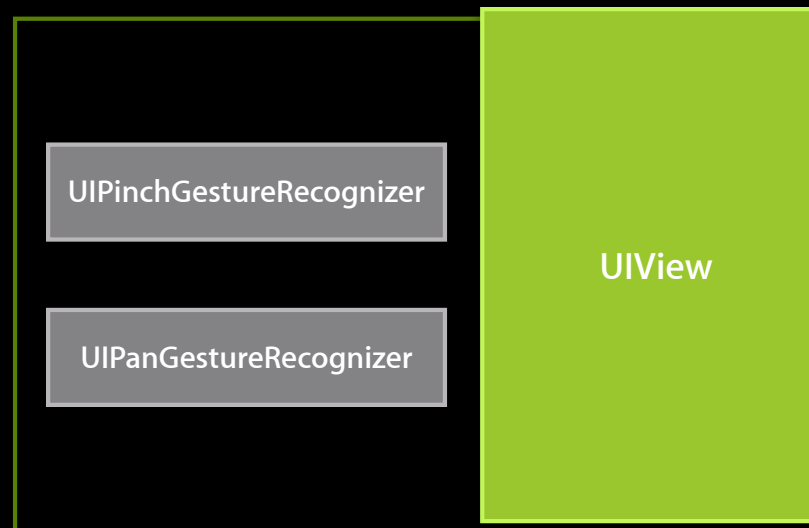
Simultaneous recognition



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```

Gesture Interaction

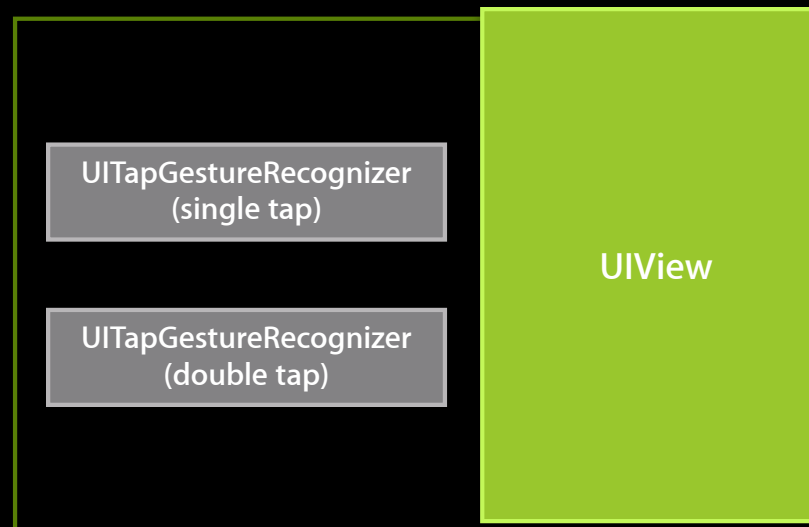
Simultaneous recognition



- [UIGestureRecognizerDelegate gestureRecognizer:
shouldRecognizeSimultaneouslyWithGestureRecognizer:]
- [UIGestureRecognizer shouldPreventGestureRecognizer:]
- [UIGestureRecognizer shouldBePreventedByGestureRecognizer:]

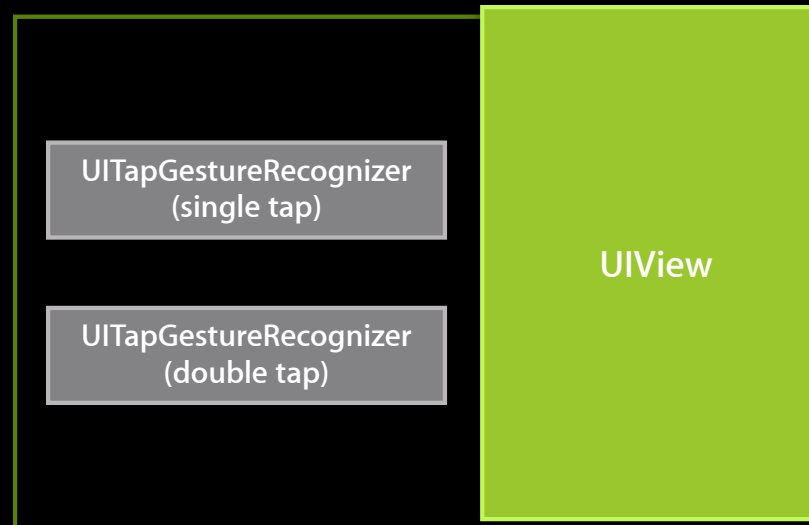
Gesture Interaction

Failure requirements



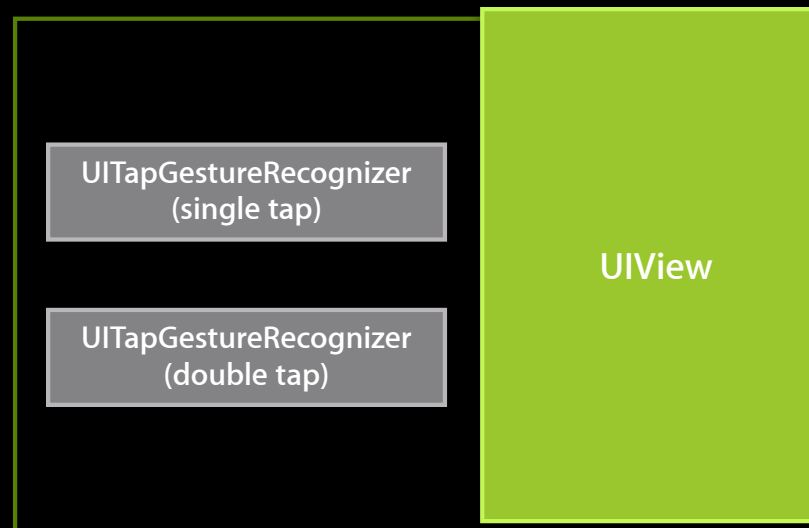
Gesture Interaction

Failure requirements



Gesture Interaction

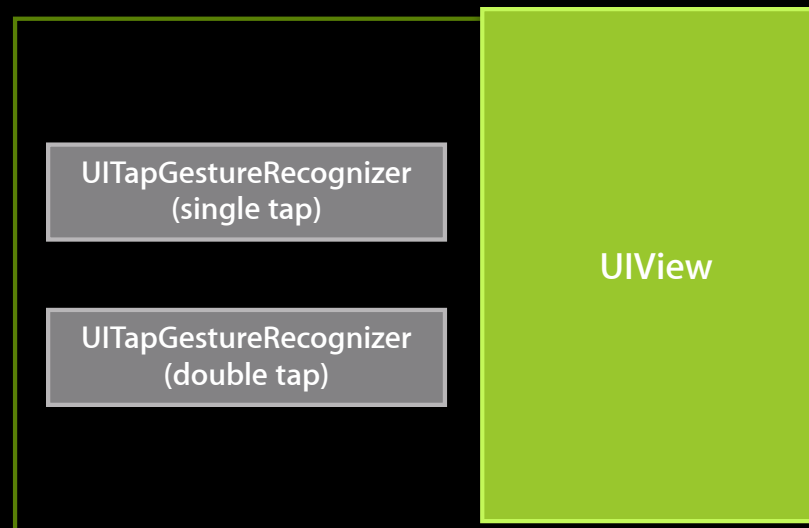
Failure requirements



```
[singleTap requireGestureRecognizerToFail:doubleTap]
```

Gesture Interaction

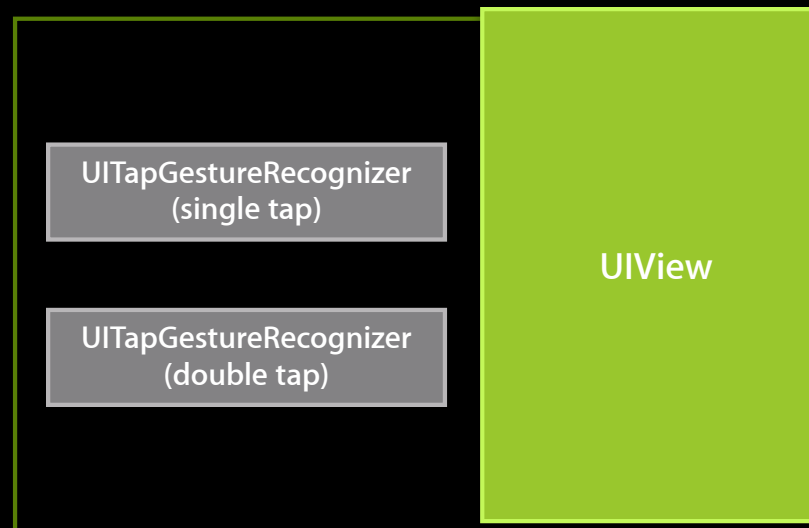
Failure requirements



```
[singleTap requireGestureRecognizerToFail:doubleTap]
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Gesture Interaction

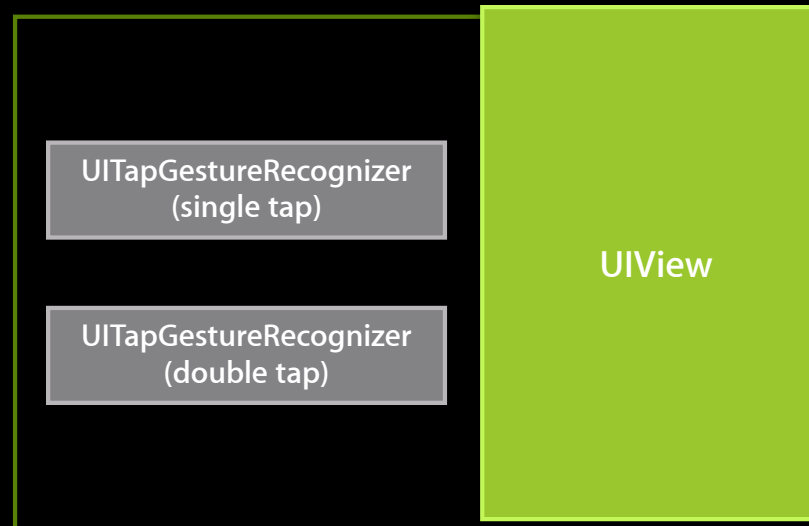
Failure requirements



```
[singleTap requireGestureRecognizerToFail:doubleTap]
```


Gesture Interaction

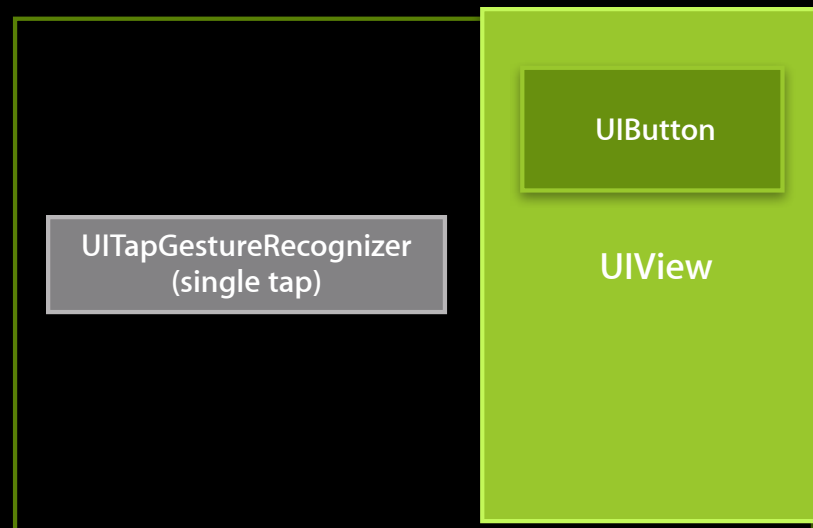
Failure requirements



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[singleTap requireGestureRecognizerToFail:doubleTap]
```

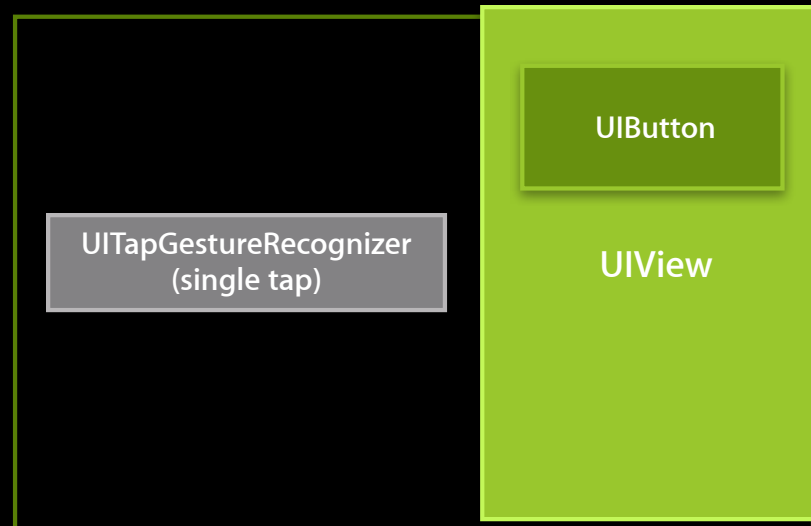
Gesture Interaction

UIView interaction



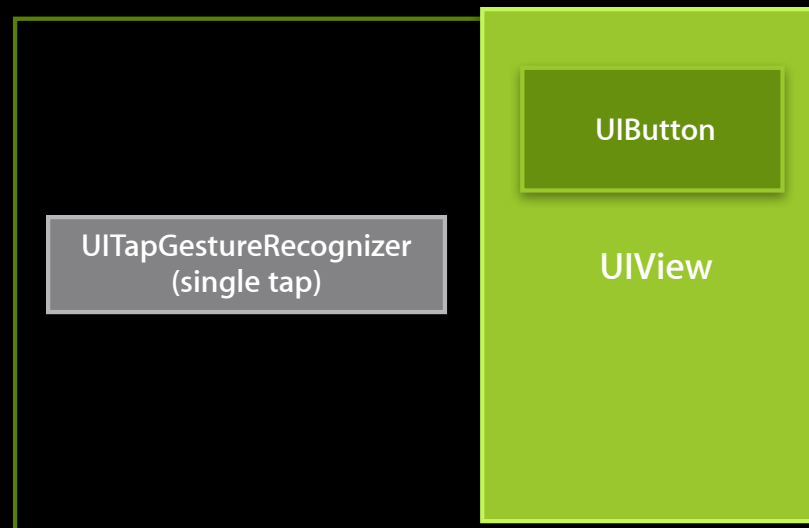
Gesture Interaction

UIView interaction



Gesture Interaction

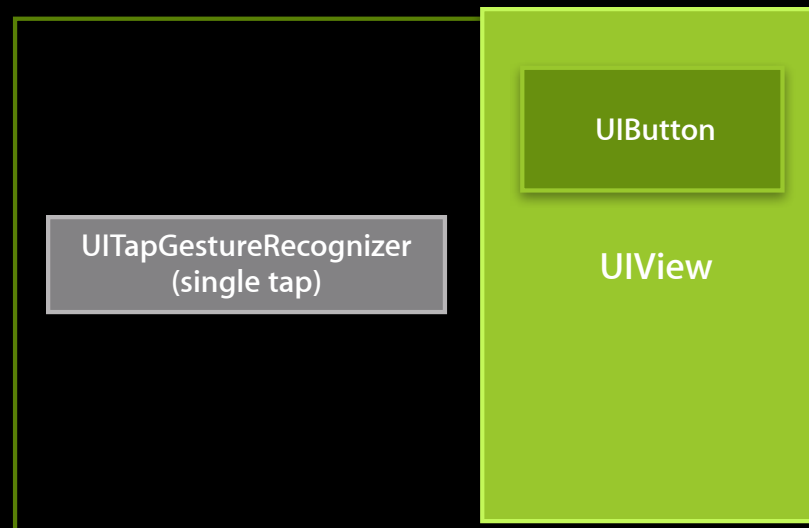
UIView interaction



```
-[UIView gestureRecognizerShouldBegin:]
```

Gesture Interaction

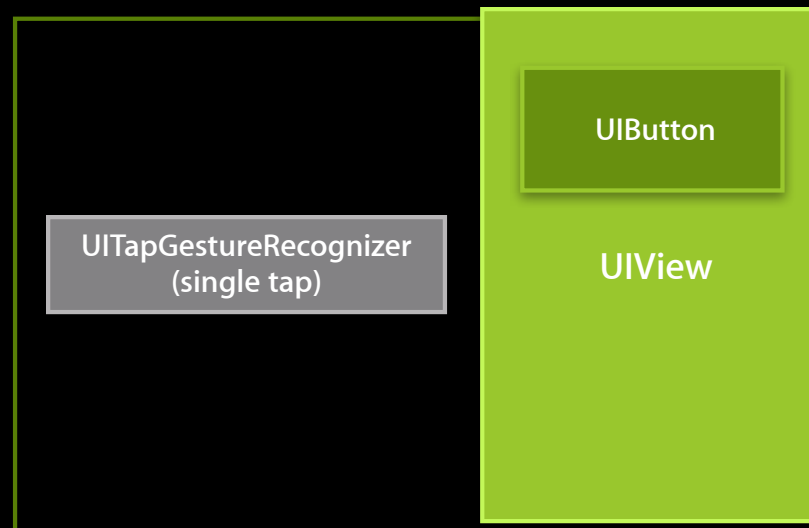
UIView interaction



```
-[UIView gestureRecognizerShouldBegin:]
```

Gesture Interaction

UIView interaction



```
-[UIView gestureRecognizerShouldBegin:]
```

Gesture Interaction

Default interaction with UIControls



Gesture Interaction

Default interaction with UIControls

- UIButton, UIPageControl, UISegmentedControl, UIStepper



Gesture Interaction

Default interaction with UIControls

- UIButton, UIPageControl, UISegmentedControl, UIStepper
 - Prevents single taps using one finger



Gesture Interaction

Default interaction with UIControls



- UIButton, UIPageControl, UISegmentedControl, UIStepper
 - Prevents single taps using one finger
- UISlider

Gesture Interaction

Default interaction with UIControls



- UIButton, UIPageControl, UISegmentedControl, UIStepper
 - Prevents single taps using one finger
- UISlider
 - Prevents swipes and pans using one finger

Subclassing Fundamentals

Common gotchas

Andy Matuschak

When Your Gesture Recognizes...

When Your Gesture Recognizes...

```
@implementation CircleRecognizer
- (void)touchesMoved:(NSSet *)touches withEvent:(UIEvent *)event {
    if ([self _userDrewACircleWithNewTouches:touches]) {
        [[self delegate] circleRecognizerDidFindCircle:self];
    }
}
@end
```

When Your Gesture Recognizes...

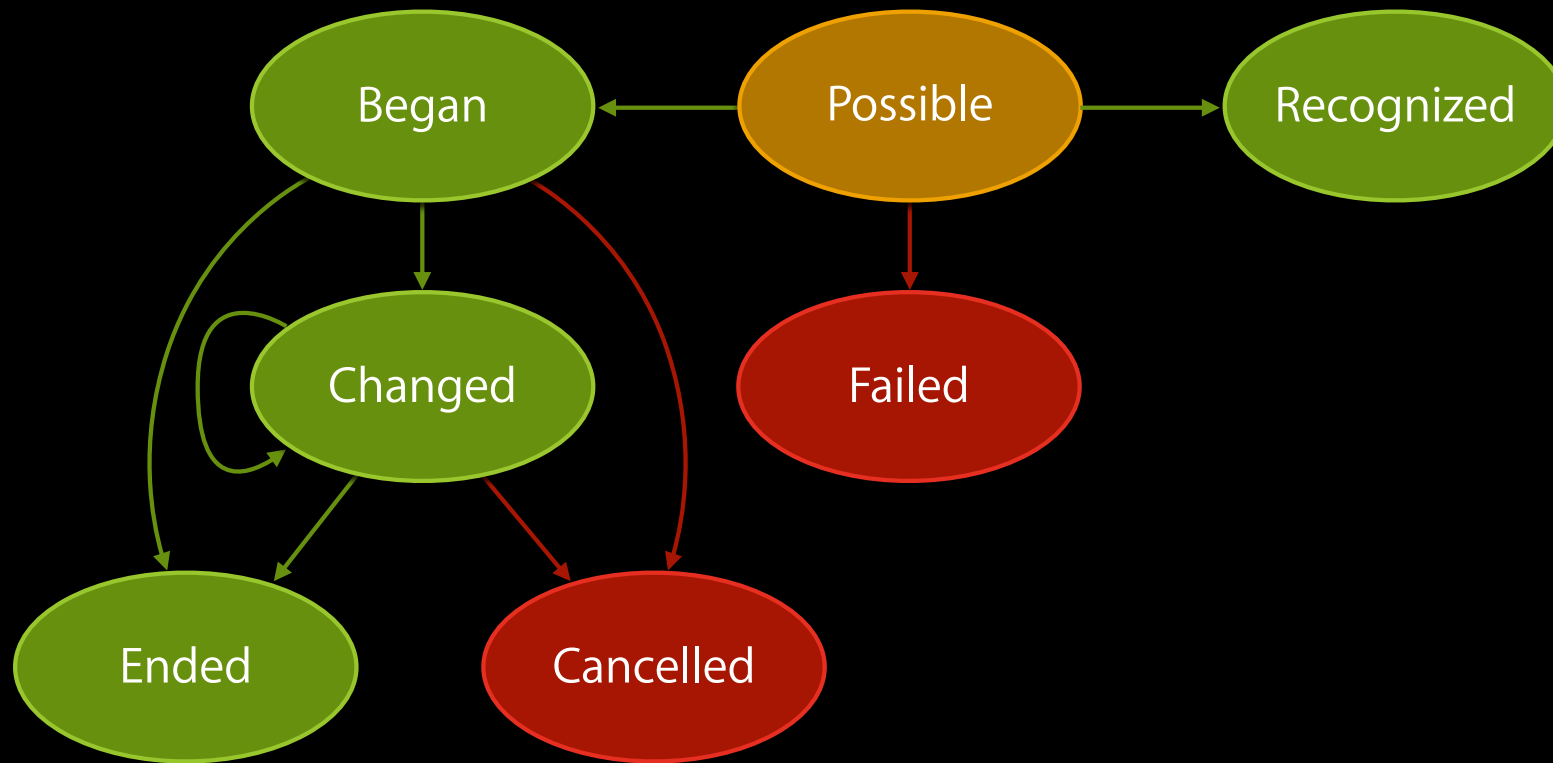
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- (void)touchesMoved:(NSSet *)touches withEvent:(UIEvent *)event {
    if ([self _userDrewACircleWithNewTouches:touches]) {
        [[self delegate] circleRecognizerDidFindCircle:self];
    }
}
@end
```

When Your Gesture Recognizes...



```
@implementation CircleRecognizer
- (void)touchesMoved:(NSSet *)touches withEvent:(UIEvent *)event {
    if ([self _userDrewACircleWithNewTouches:touches]) {
        [[self delegate] circleRecognizerDidFindCircle:self];
    }
}
@end
```


When Your Gesture Recognizes...



When Your Gesture Recognizes...



```
#import <UIKit/UITapGestureRecognizerSubclass.h>
@implementation CircleRecognizer
- (void)touchesMoved:(NSSet *)touches withEvent:(UIEvent *)event {
    if ([self _userDrewACircleWithNewTouches:touches]) {
        [self setState:UITapGestureRecognizerStateRecognized];
    }
}
@end
```

When Your Gesture Recognizes...



```
- (void)touchesEnded:(NSSet *)touches {
    [self handlePrerecognitionFailureForRemovedTouches:touches];
}

- (void)touchesCancelled:(NSSet *)touches {
    [self handlePrerecognitionFailureForRemovedTouches:touches];
}

- (void)handlePrerecognitionFailureForRemovedTouches:(NSSet *)touches {
    if ([self numberOfTouches] == [touches count] &&
        [self state] != UIGestureRecognizerStateRecognized) {
        [self setState:UIGestureRecognizerStateFailed];
    }
}
```

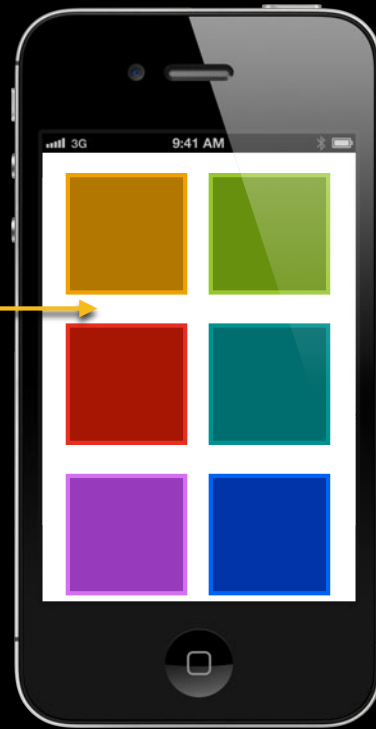
Choosing a Coordinate Space

Choosing a Coordinate Space



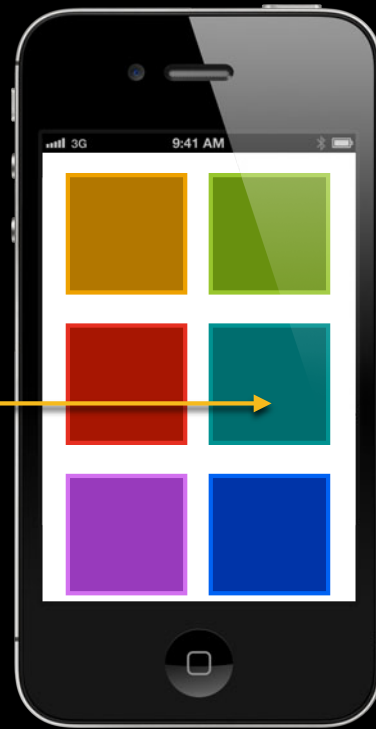
Choosing a Coordinate Space

UIScrollView



Choosing a Coordinate Space

UITapGestureRecognizer



Choosing a Coordinate Space

```
[touch locationInView:[self view]]
```

Down

Up



Choosing a Coordinate Space

```
[touch locationInView:[self view]]
```

Down

Up

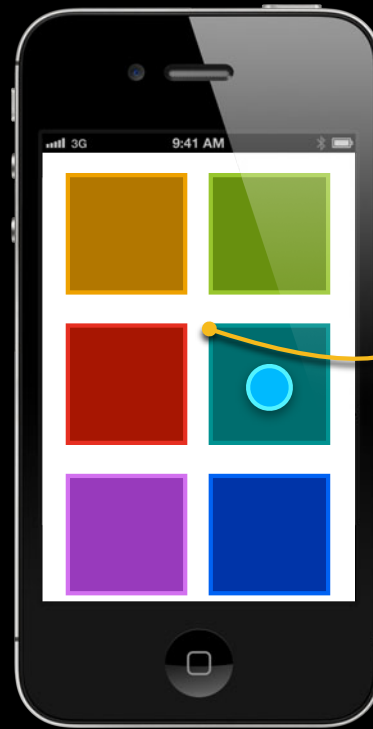


Choosing a Coordinate Space

```
[touch locationInView:[self view]]
```

Down

Up



(0, 0)

Choosing a Coordinate Space

```
[touch locationInView:[self view]]
```

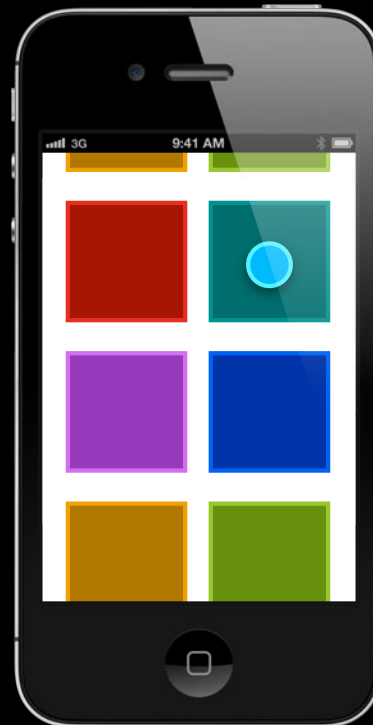
Down	(60, 60)
Up	



Choosing a Coordinate Space

```
[touch locationInView:[self view]]
```

Down	(60, 60)
Up	



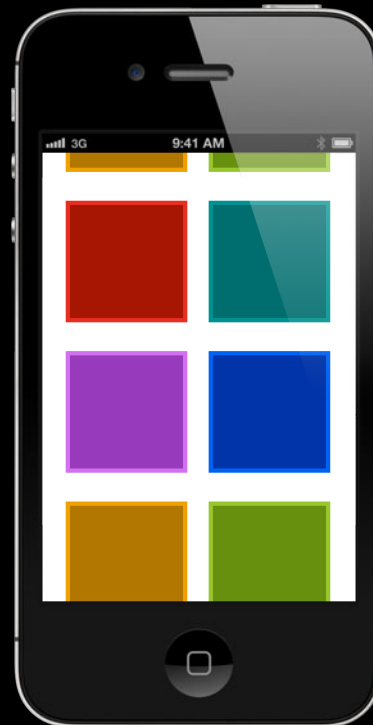
Choosing a Coordinate Space

```
[touch locationInView:[self view]]
```

Down

(60, 60)

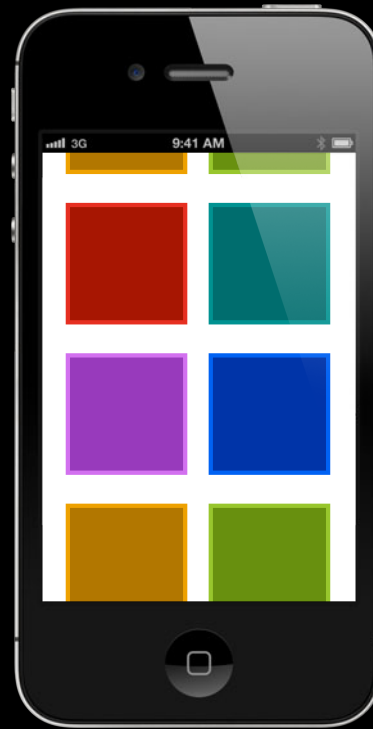
Up



Choosing a Coordinate Space

```
[touch locationInView:[self view]]
```

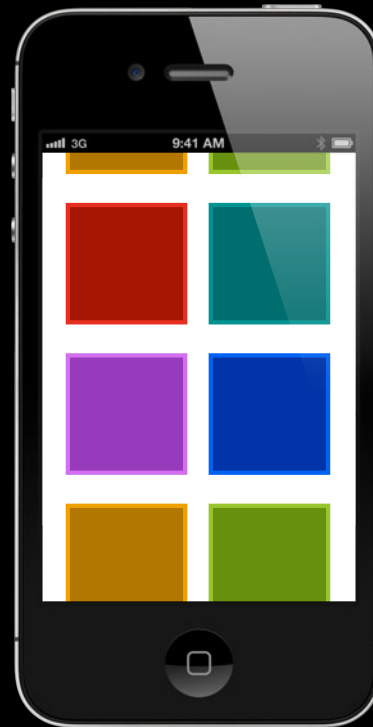
Down	(60, 60)
Up	(60, 60)



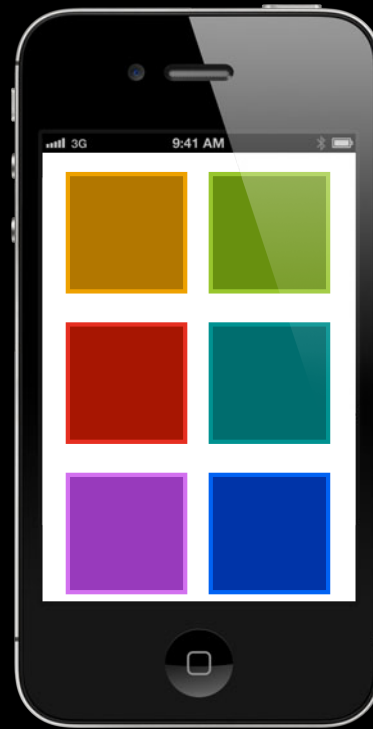
Choosing a Coordinate Space

```
[touch locationInView:[self view]]
```

Down	(60, 60)
Up	(60, 60)



Choosing a Coordinate Space



```
[touch locationInView:[self view]]
```

Down

(60, 60)

Up

(60, 60)



```
UIWindow *win = [[self view] window];  
CGPoint winLoc =  
    [touch locationInView:win];
```

```
[win convertPoint:winLoc toWindow:nil]
```

Down

Up

Choosing a Coordinate Space



```
[touch locationInView:[self view]]
```

Down

(60, 60)

Up

(60, 60)



```
UIWindow *win = [[self view] window];  
CGPoint winLoc =  
    [touch locationInView:win];
```

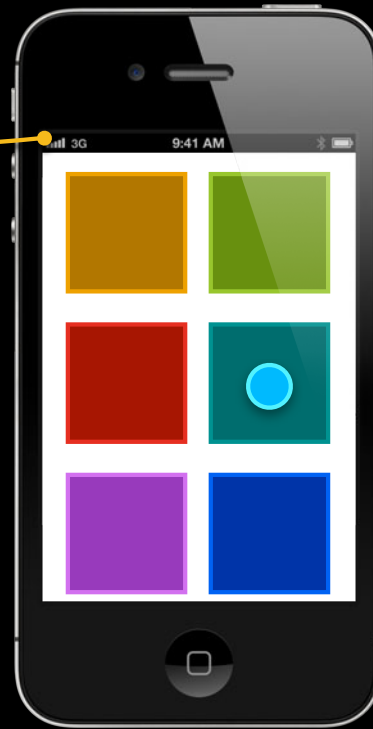
```
[win convertPoint:winLoc toWindow:nil]
```

Down

Up

Choosing a Coordinate Space

(0, 0)



```
[touch locationInView:[self view]]
```

Down

(60, 60)

Up

(60, 60)



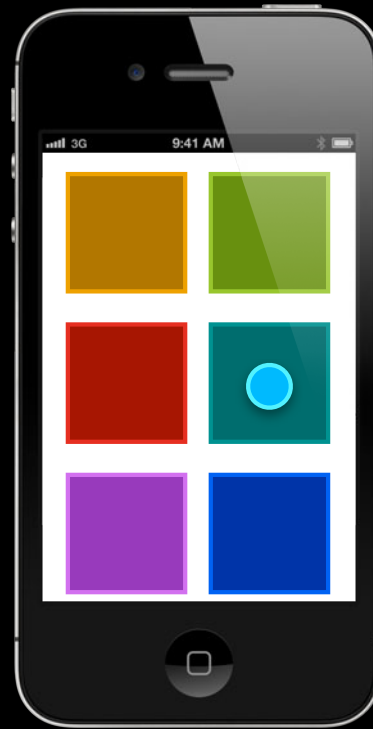
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UIWindow *win = [[self view] window];  
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```

```
[win convertPoint:winLoc toWindow:nil]
```

Down

Up

Choosing a Coordinate Space



```
[touch locationInView:[self view]]
```

Down	(60, 60)
------	----------

Up	(60, 60)
----	----------

```
UIWindow *win = [[self view] window];  
CGPoint winLoc =  
    [touch locationInView:win];
```

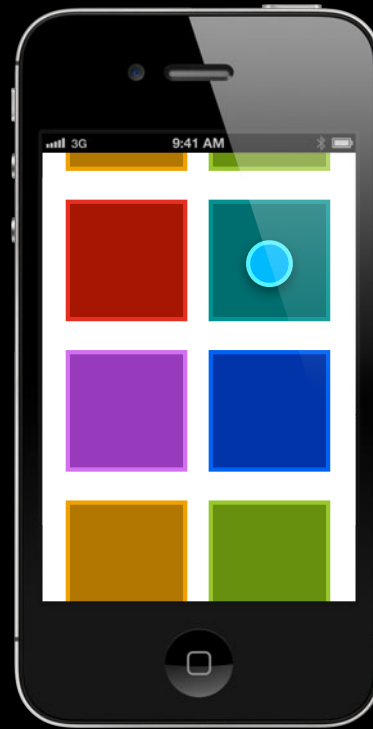
```
[win convertPoint:winLoc toWindow:nil]
```

Down	(160, 250)
------	------------

Up	
----	--



Choosing a Coordinate Space



```
[touch locationInView:[self view]]
```

Down	(60, 60)
------	----------

Up	(60, 60)
----	----------

```
UIWindow *win = [[self view] window];  
CGPoint winLoc =  
    [touch locationInView:win];
```

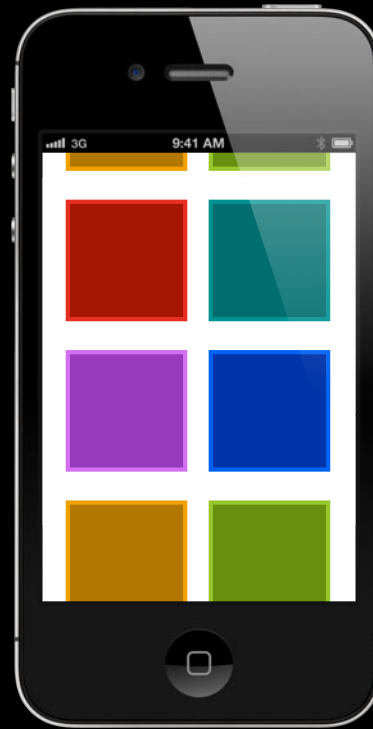
```
[win convertPoint:winLoc toWindow:nil]
```

Down	(160, 250)
------	------------

Up	
----	--



Choosing a Coordinate Space



```
[touch locationInView:[self view]]
```

Down

(60, 60)

Up

(60, 60)

```
UIWindow *win = [[self view] window];  
CGPoint winLoc =  
    [touch locationInView:win];
```

```
[win convertPoint:winLoc toWindow:nil]
```

Down

(160, 250)

Up



Choosing a Coordinate Space



```
[touch locationInView:[self view]]
```

Down	(60, 60)
Up	(60, 60)

```
UIWindow *win = [[self view] window];  
CGPoint winLoc =  
    [touch locationInView:win];  
[win convertPoint:winLoc toWindow:nil]
```

Down	(160, 250)
Up	(160, 70)



Choosing a Coordinate Space



```
[touch locationInView:[self view]]
```

Down	(60, 60)
------	----------

Up	(60, 60)
----	----------



```
UIWindow *win = [[self view] window];  
CGPoint winLoc =  
    [touch locationInView:win];
```

```
[win convertPoint:winLoc toWindow:nil]
```

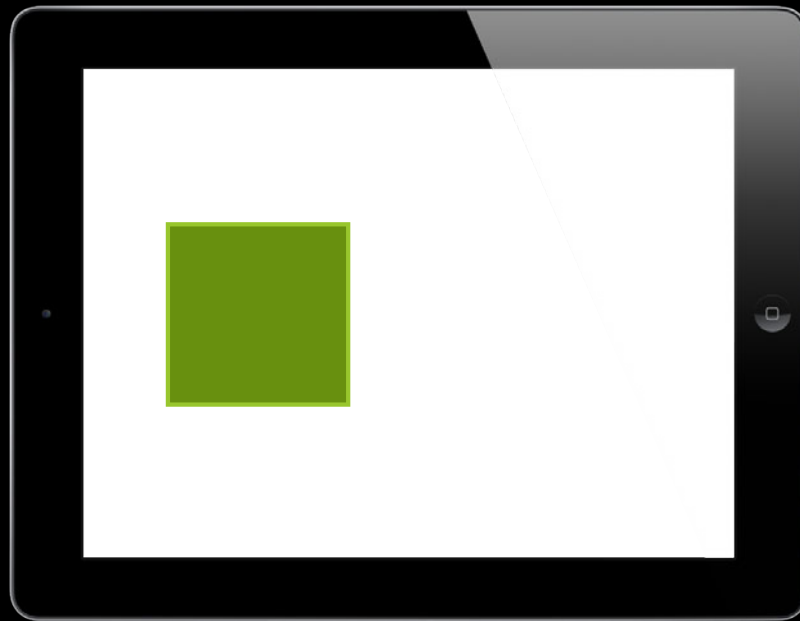
Down	(160, 250)
------	------------

Up	(160, 70)
----	-----------

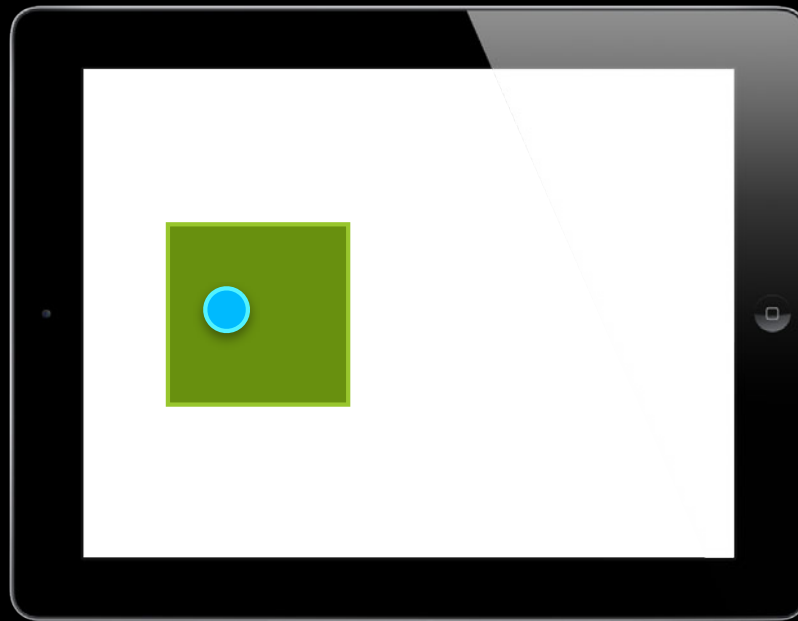


Dealing with Shifting Touch Sets

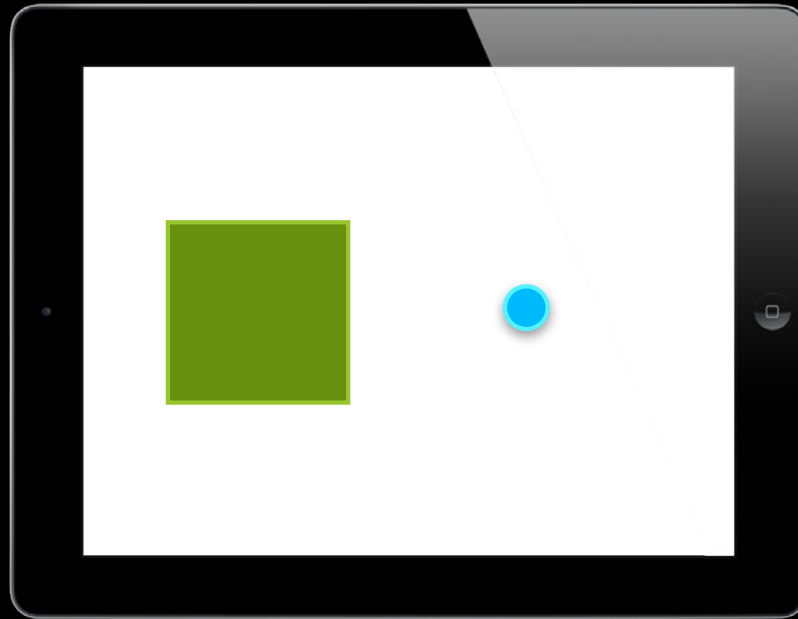
Dealing with Shifting Touch Sets



Dealing with Shifting Touch Sets

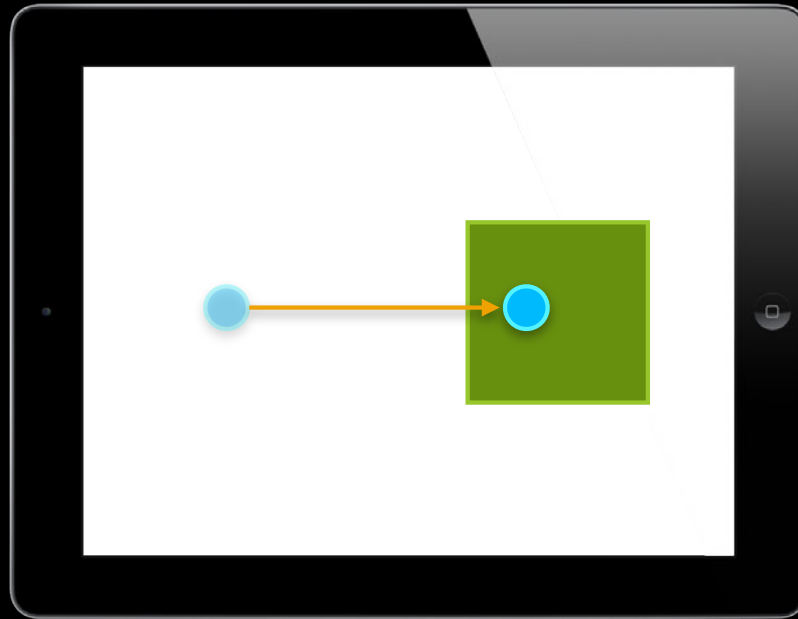


Dealing with Shifting Touch Sets



Dealing with Shifting Touch Sets

```
translation = currentPoint - startPoint
```



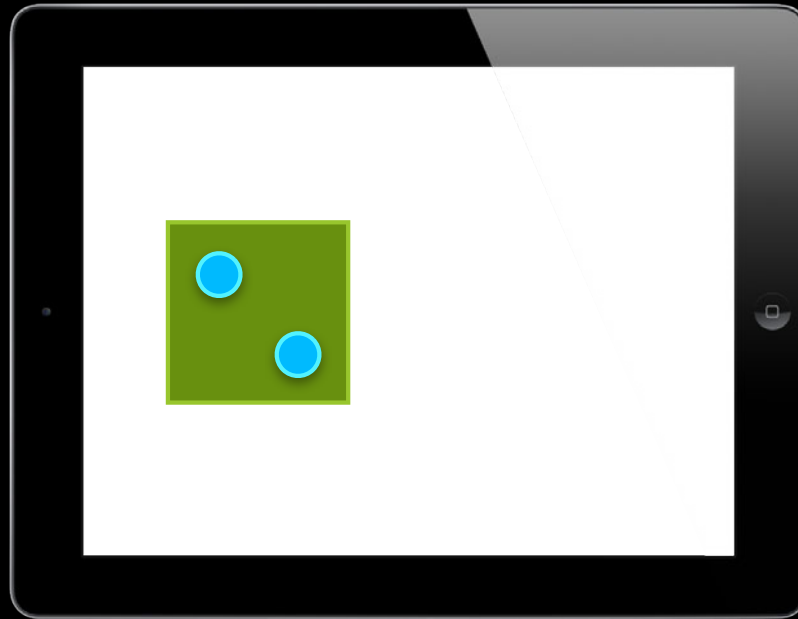
Dealing with Shifting Touch Sets

```
translation = currentPoint - startPoint
```

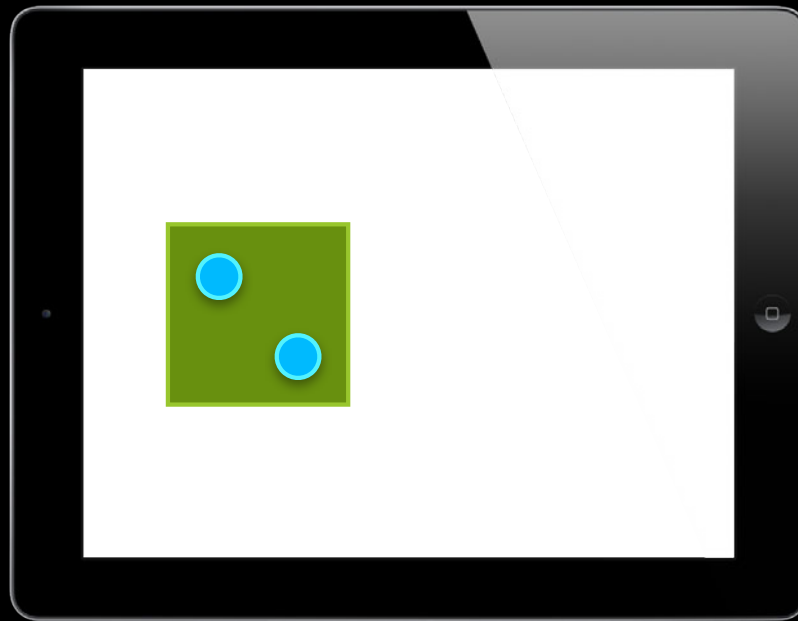


Dealing with Shifting Touch Sets

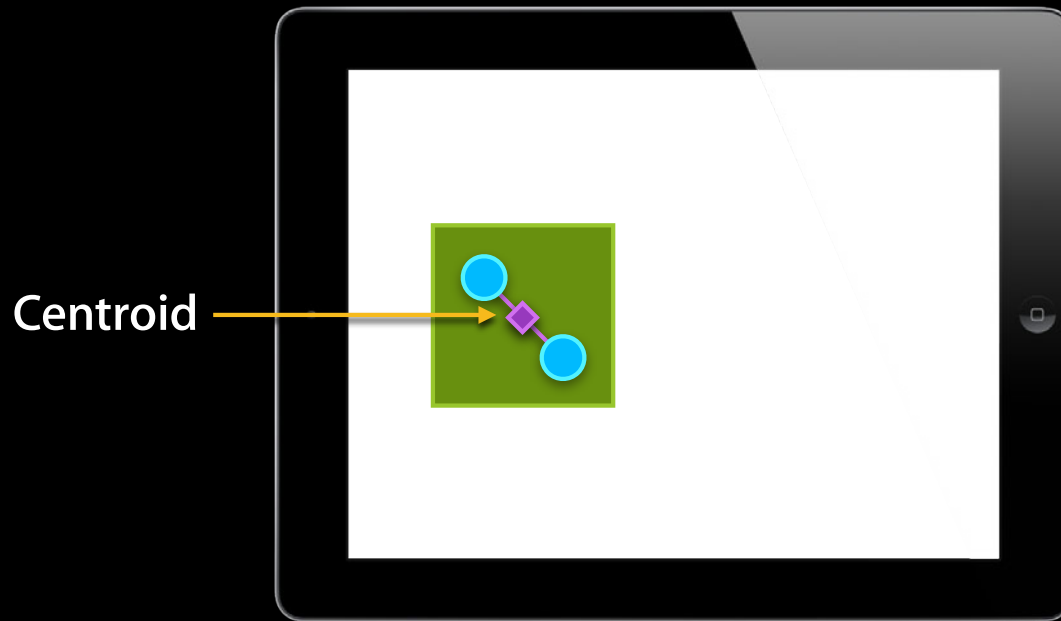
```
translation = currentPoint - startPoint
```



Dealing with Shifting Touch Sets

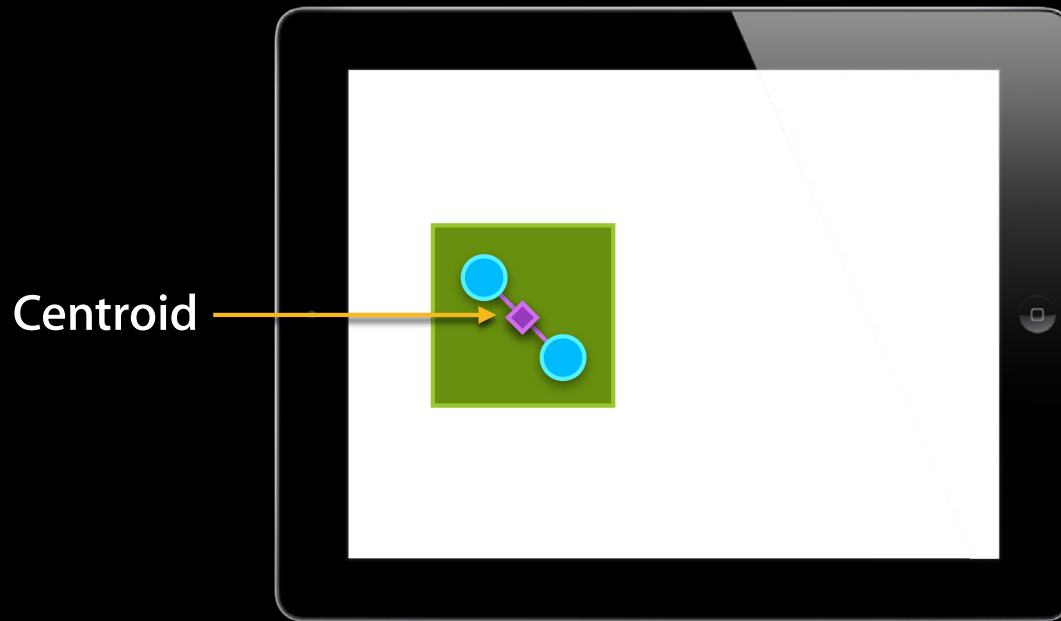


Dealing with Shifting Touch Sets



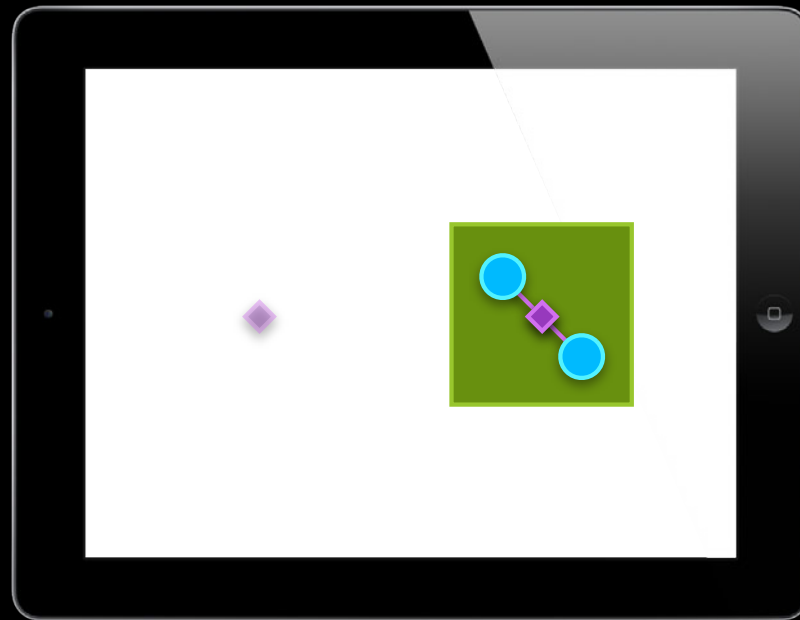
Dealing with Shifting Touch Sets

```
translation = currentCentroid - startCentroid
```



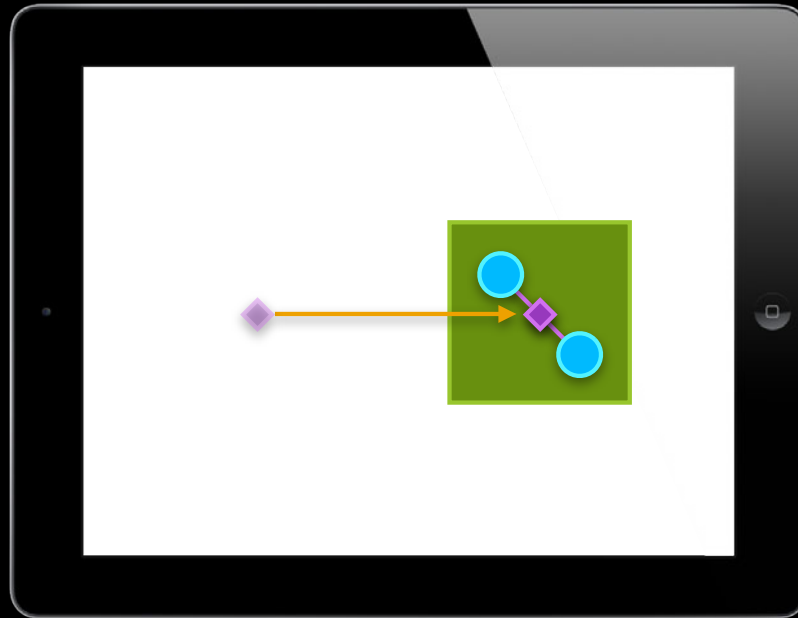
Dealing with Shifting Touch Sets

```
translation = currentCentroid - startCentroid
```



Dealing with Shifting Touch Sets

```
translation = currentCentroid - startCentroid
```



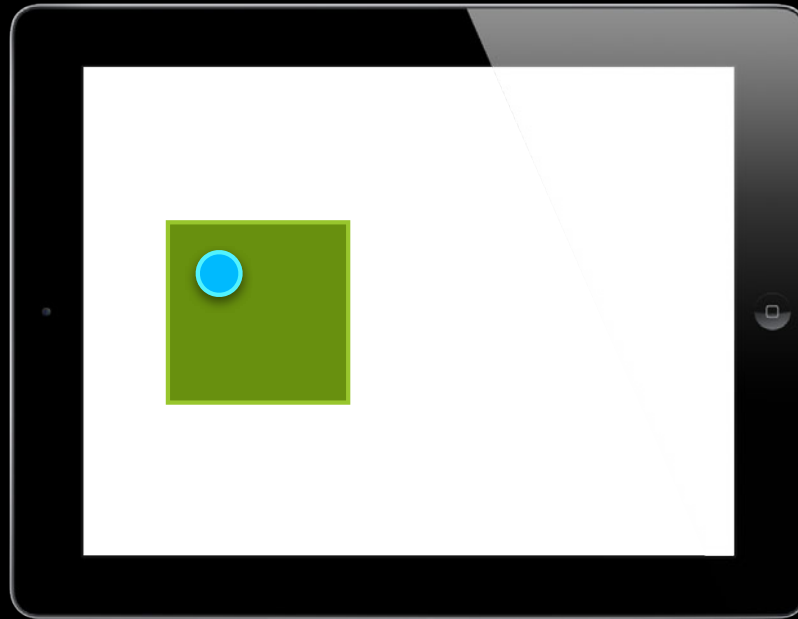
Dealing with Shifting Touch Sets

```
translation = currentCentroid - startCentroid
```



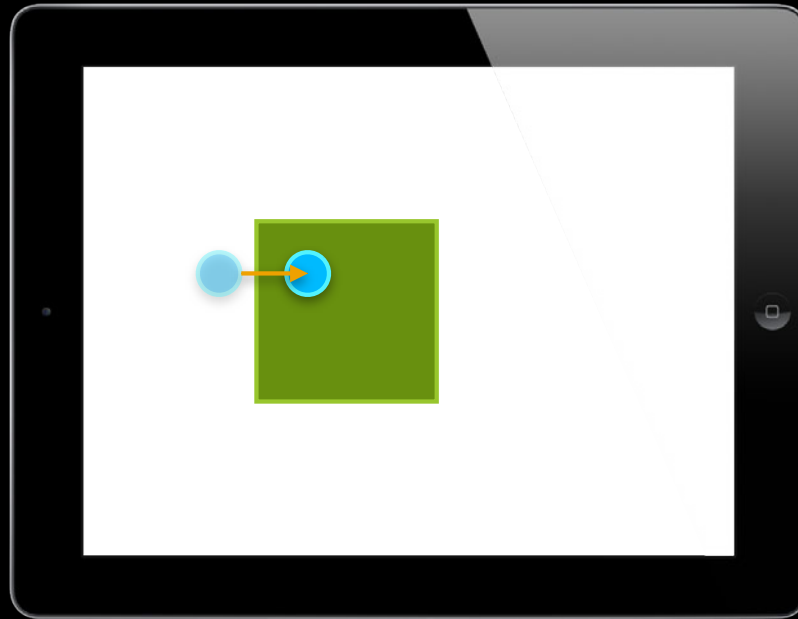
Dealing with Shifting Touch Sets

```
translation = currentCentroid - startCentroid
```



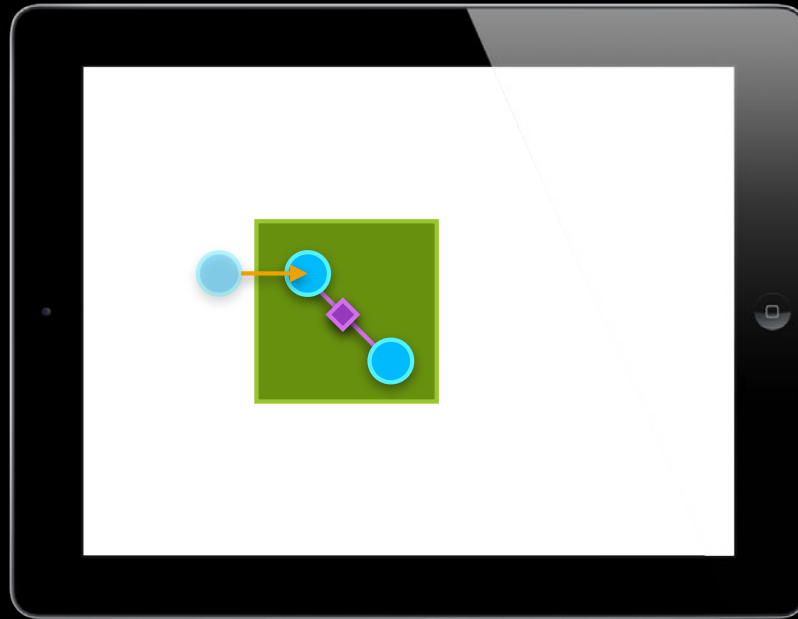
Dealing with Shifting Touch Sets

```
translation = currentCentroid - startCentroid
```



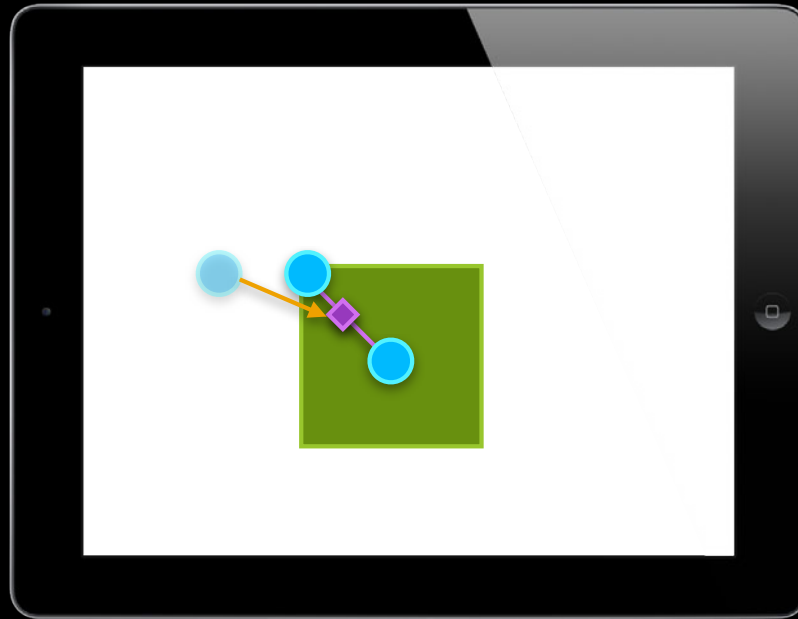
Dealing with Shifting Touch Sets

```
translation = currentCentroid - startCentroid
```



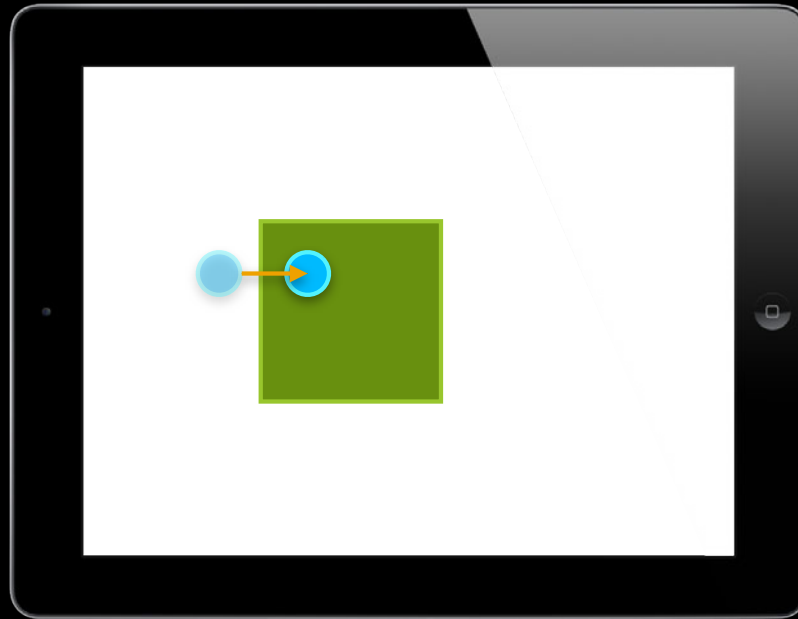
Dealing with Shifting Touch Sets

```
translation = currentCentroid - startCentroid
```



Dealing with Shifting Touch Sets

```
translation = currentCentroid - startCentroid
```



Dealing with Shifting Touch Sets

```
oldTranslation = oldCentroid - startCentroid  
newTranslation = newCentroid - startCentroid
```

Dealing with Shifting Touch Sets

```
oldTranslation = oldCentroid - startCentroid  
newTranslation = newCentroid - startCentroid  
                + shift
```

Dealing with Shifting Touch Sets

```
oldTranslation = oldCentroid - startCentroid  
newTranslation = newCentroid - startCentroid  
                + shift
```

```
oldTranslation = newTranslation ⇒  
    shift = oldCentroid - newCentroid
```

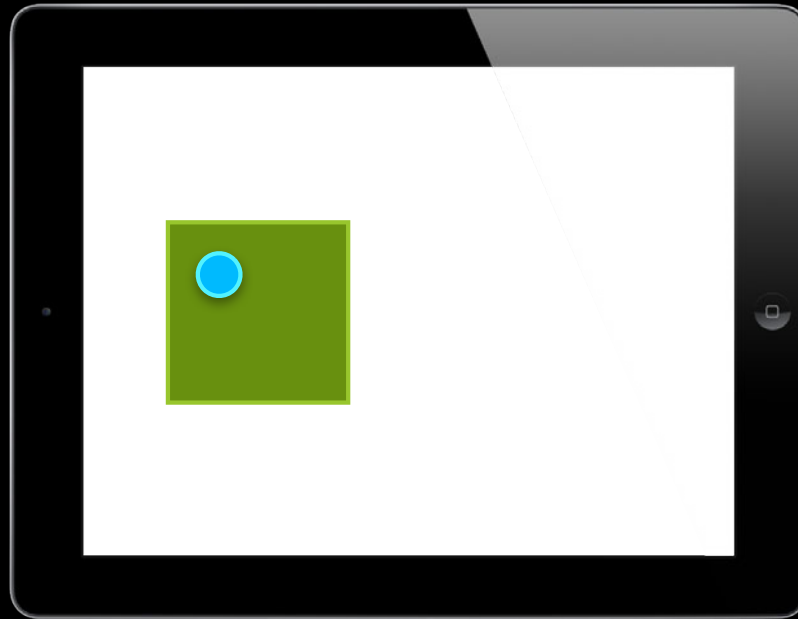
Dealing with Shifting Touch Sets

```
translation = currentCentroid - startCentroid  
             + shift
```



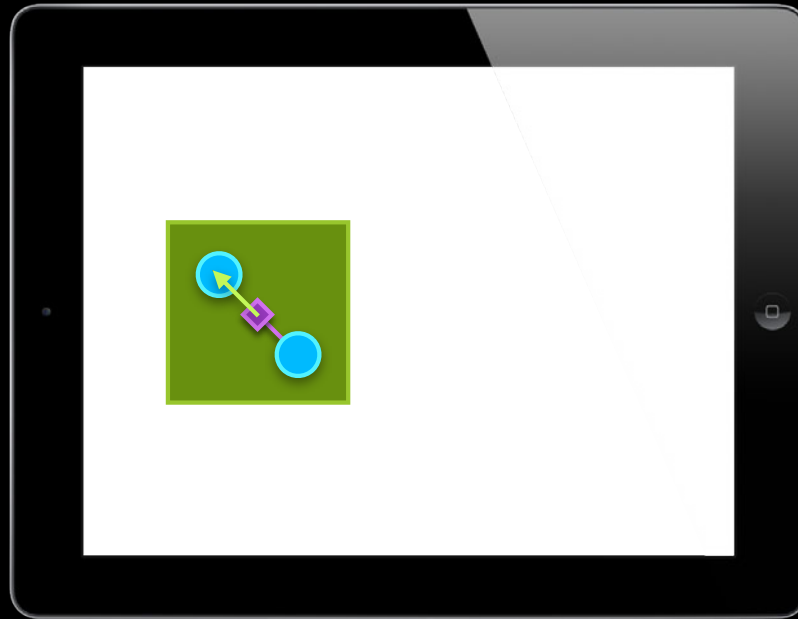
Dealing with Shifting Touch Sets

```
translation = currentCentroid - startCentroid  
             + shift
```



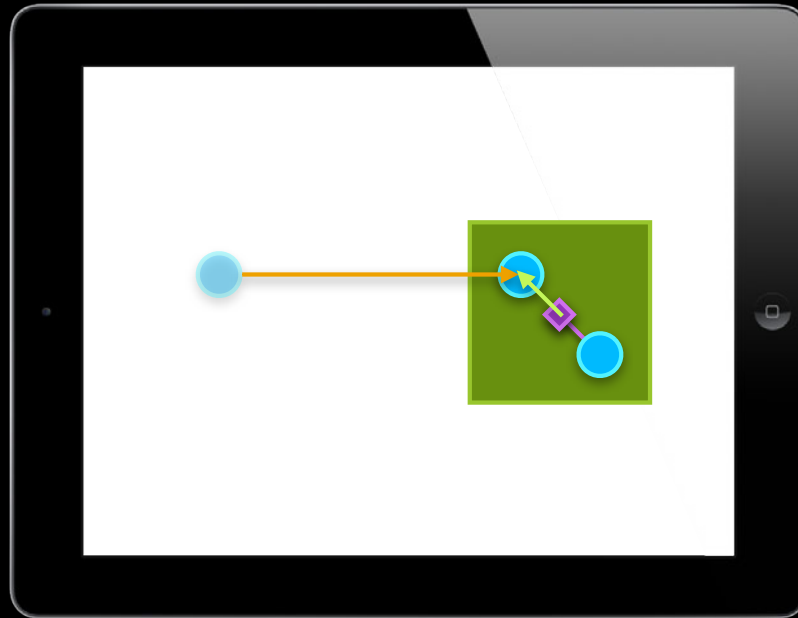
Dealing with Shifting Touch Sets

```
translation = currentCentroid - startCentroid  
             + shift
```



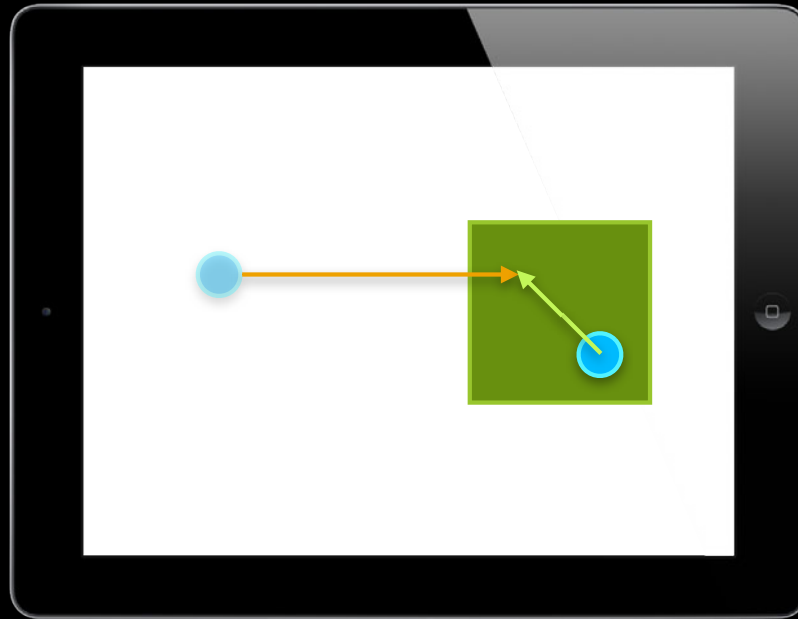
Dealing with Shifting Touch Sets

```
translation = currentCentroid - startCentroid  
             + shift
```



Dealing with Shifting Touch Sets

```
translation = currentCentroid - startCentroid  
             + shift
```



Signal Processing

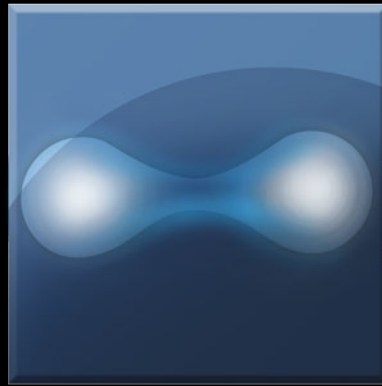
Low pass filters

Signal Processing

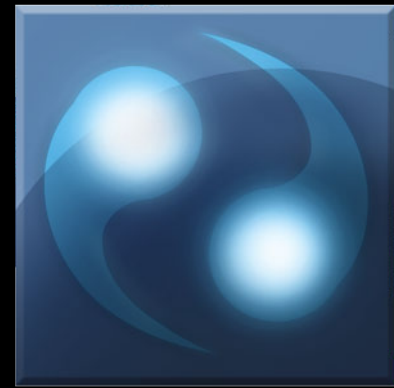
Signal Processing



Pinch

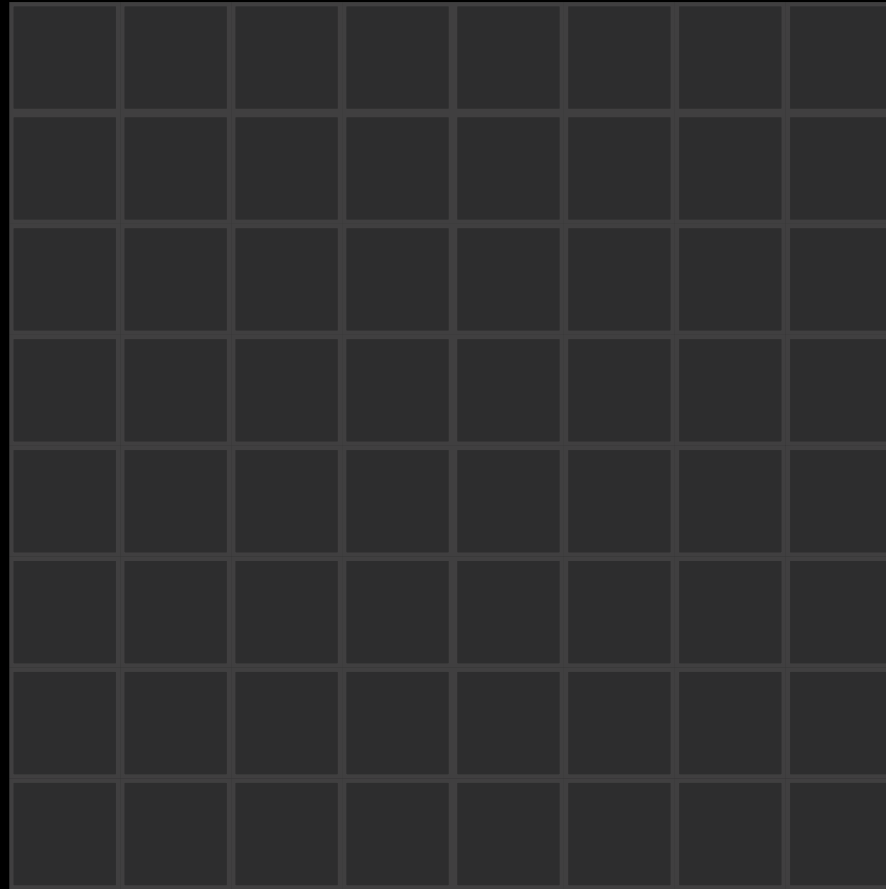


Pan

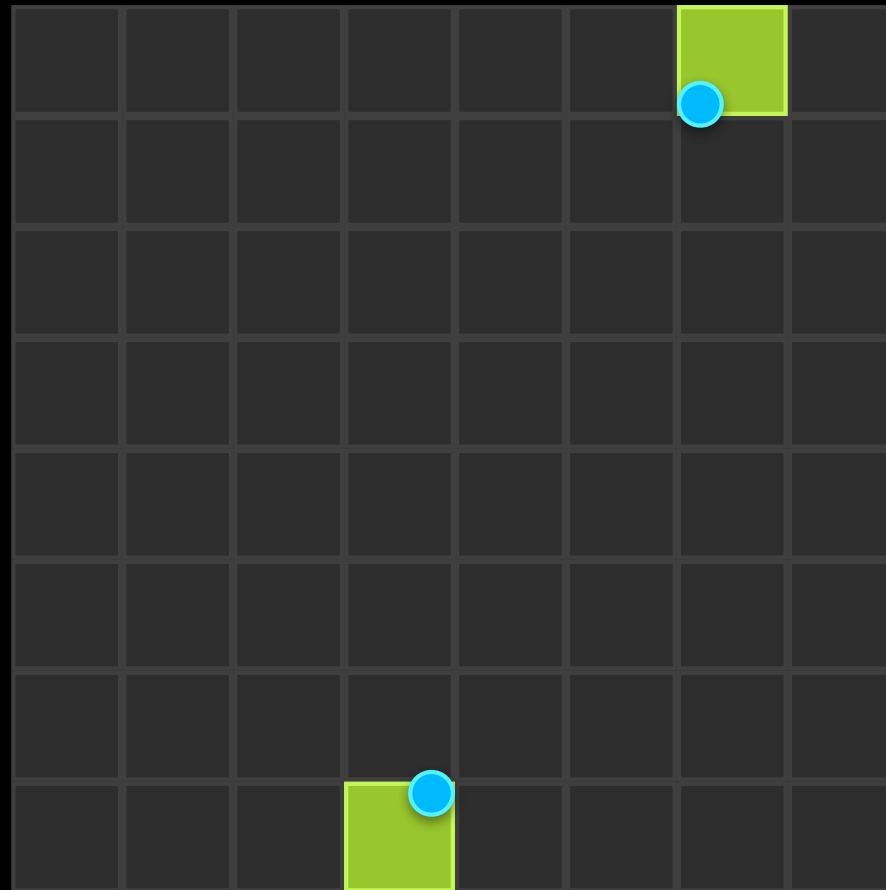


Rotate

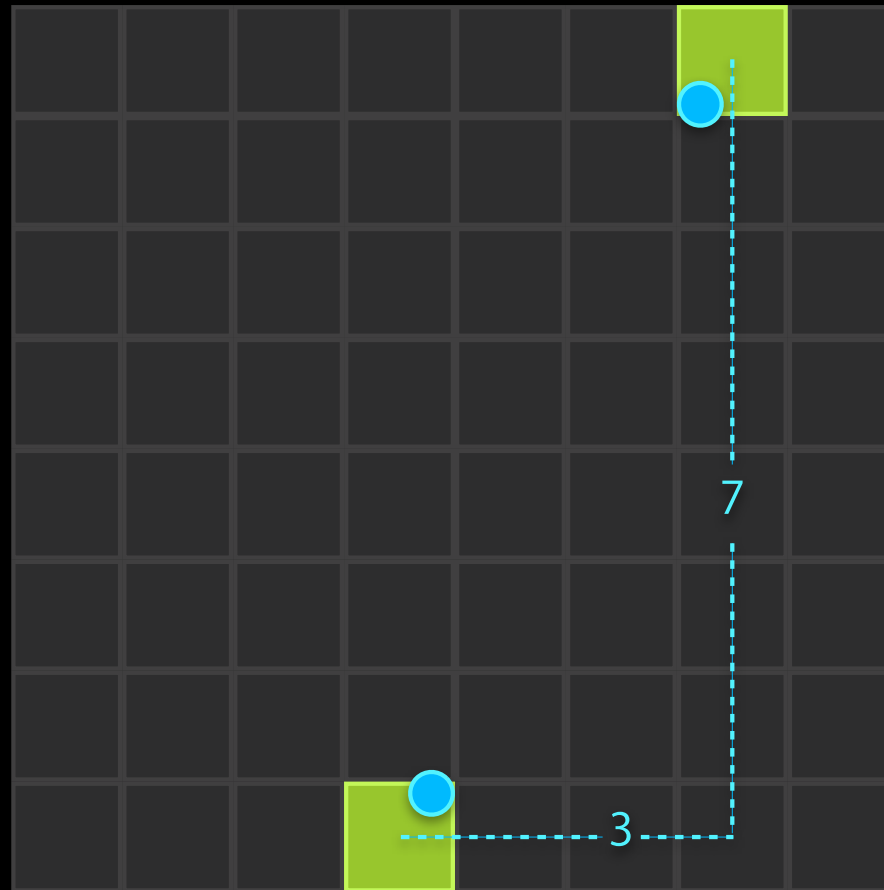
Calculating Pinch Velocity



Calculating Pinch Velocity

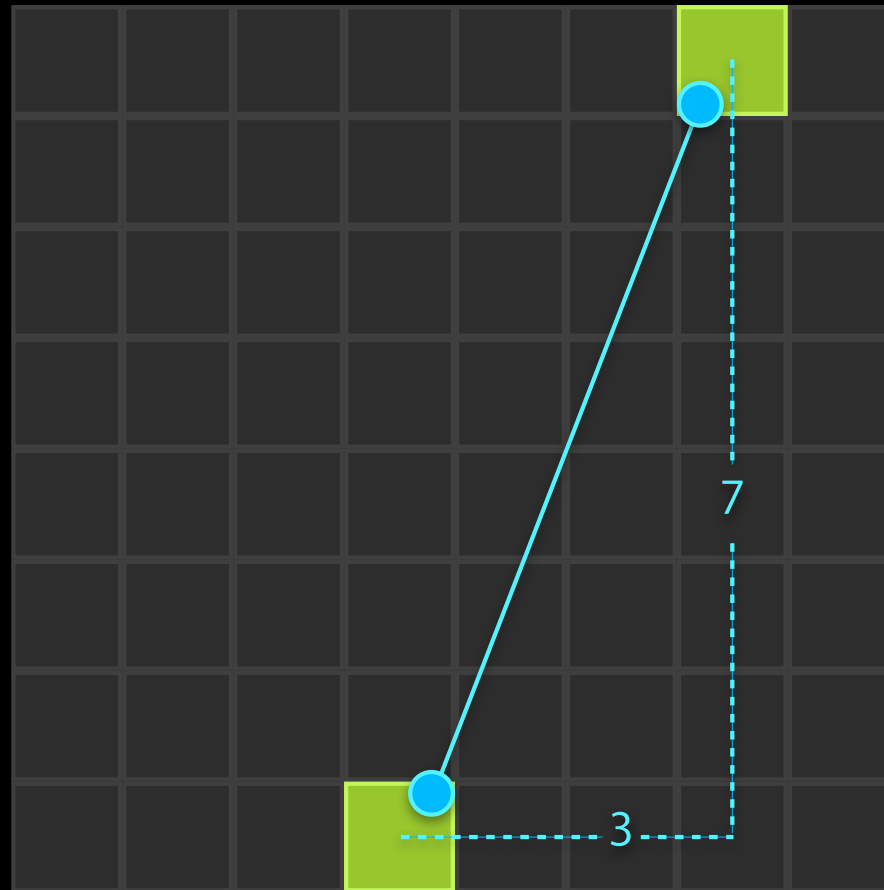


Calculating Pinch Velocity

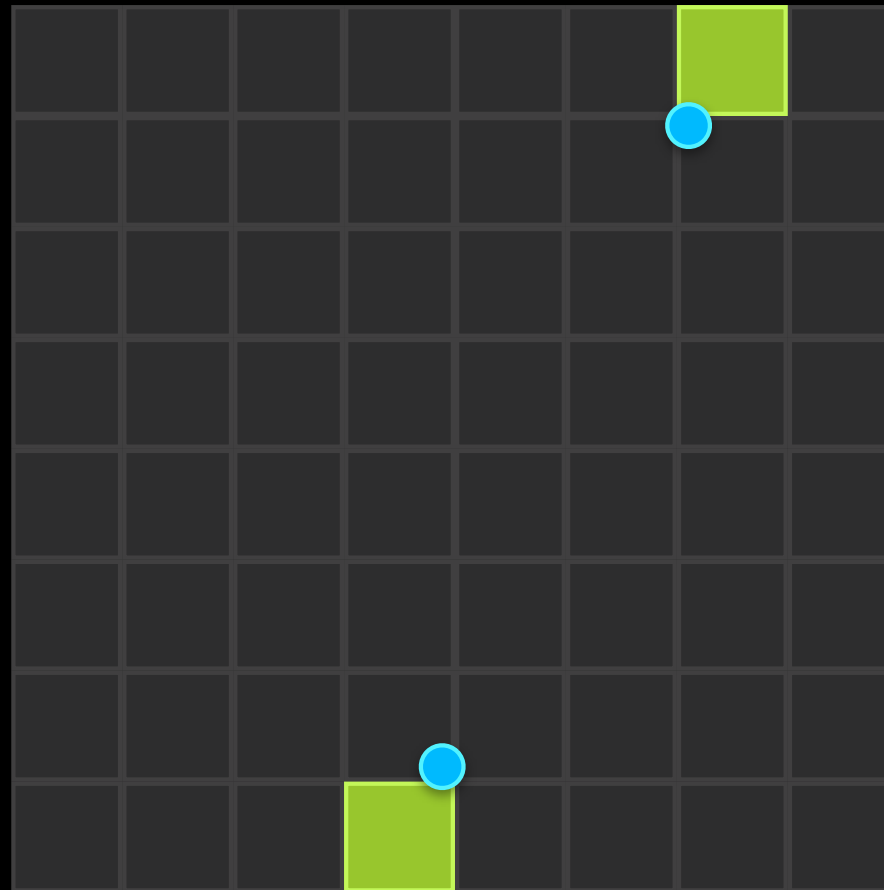


Calculating Pinch Velocity

$$\sqrt{3^2 + 7^2} = 7.6$$

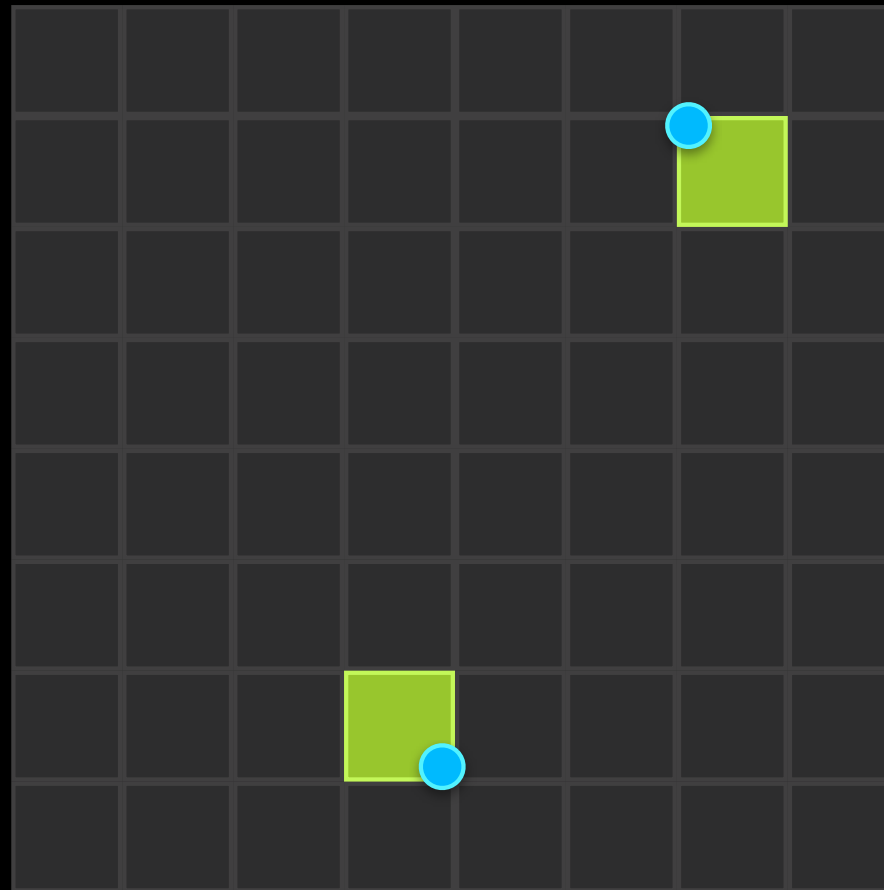


Calculating Pinch Velocity



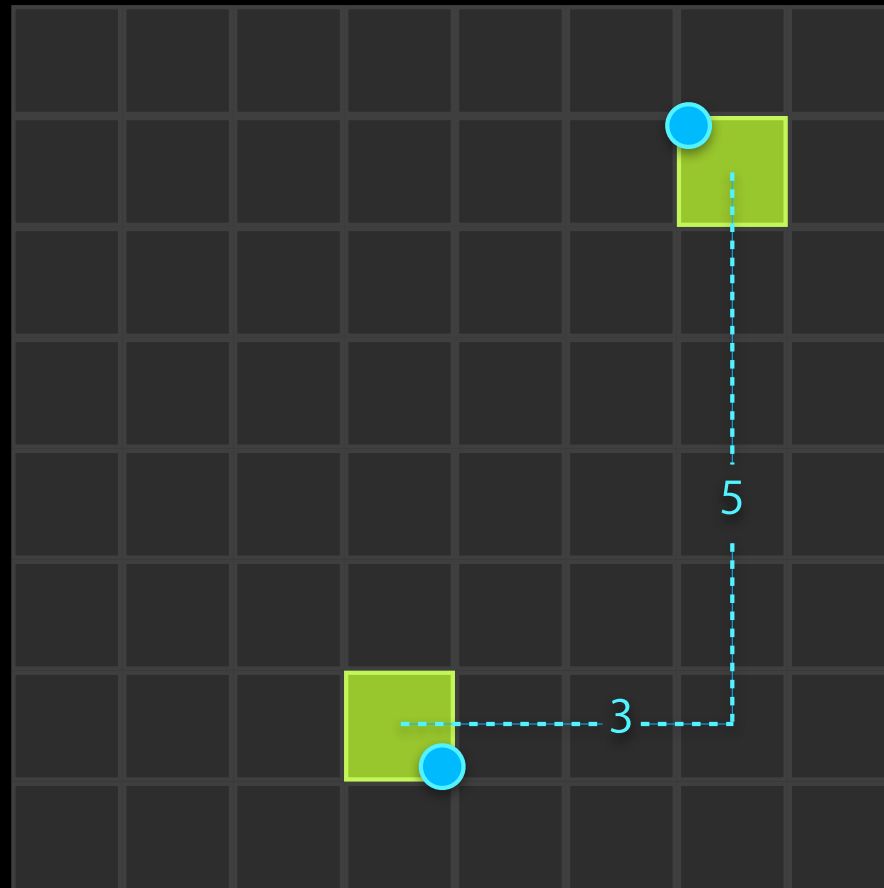
7.6

Calculating Pinch Velocity



7.6

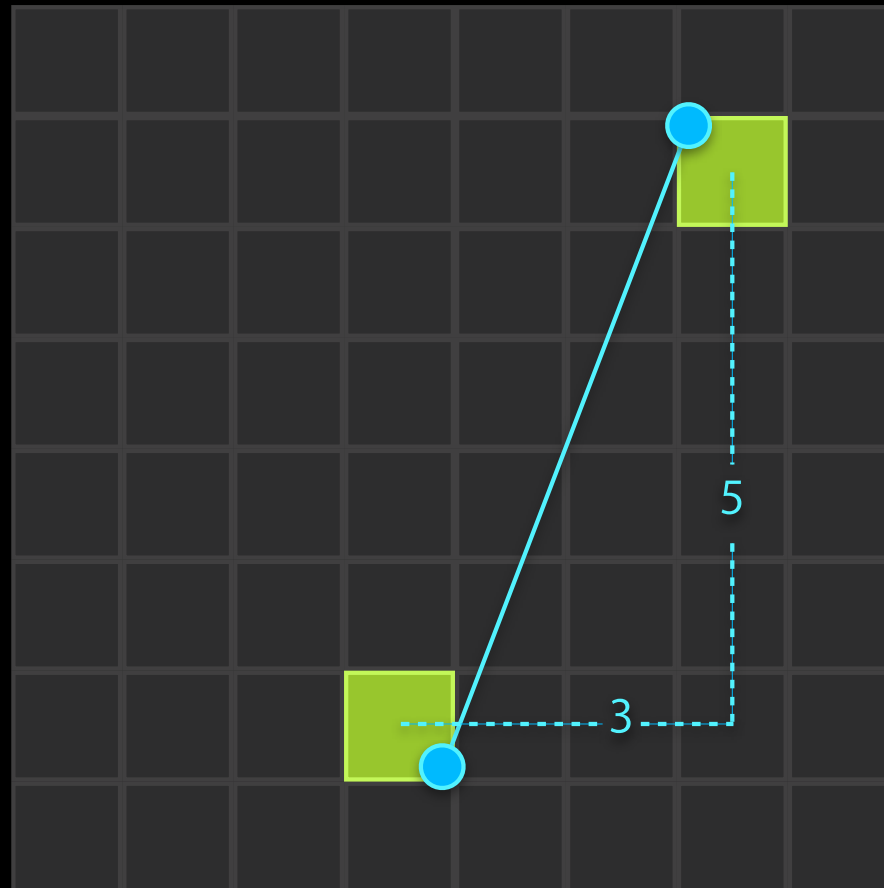
Calculating Pinch Velocity



7.6

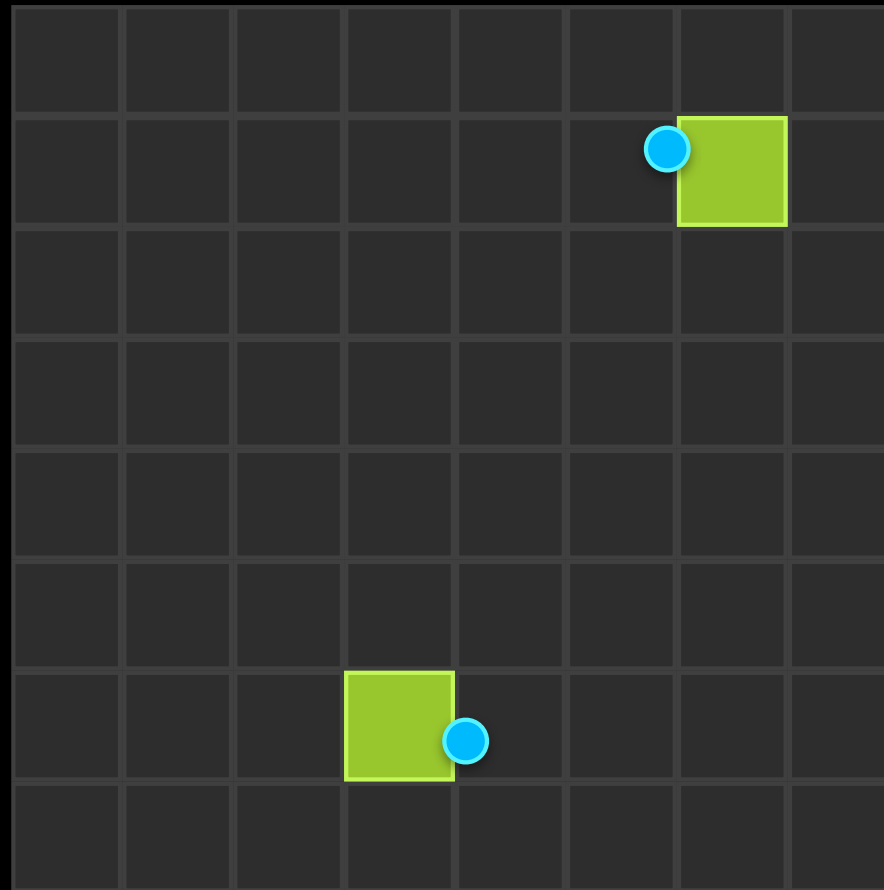
Calculating Pinch Velocity

$$\sqrt{3^2 + 5^2} = 5.8$$



7.6

Calculating Pinch Velocity

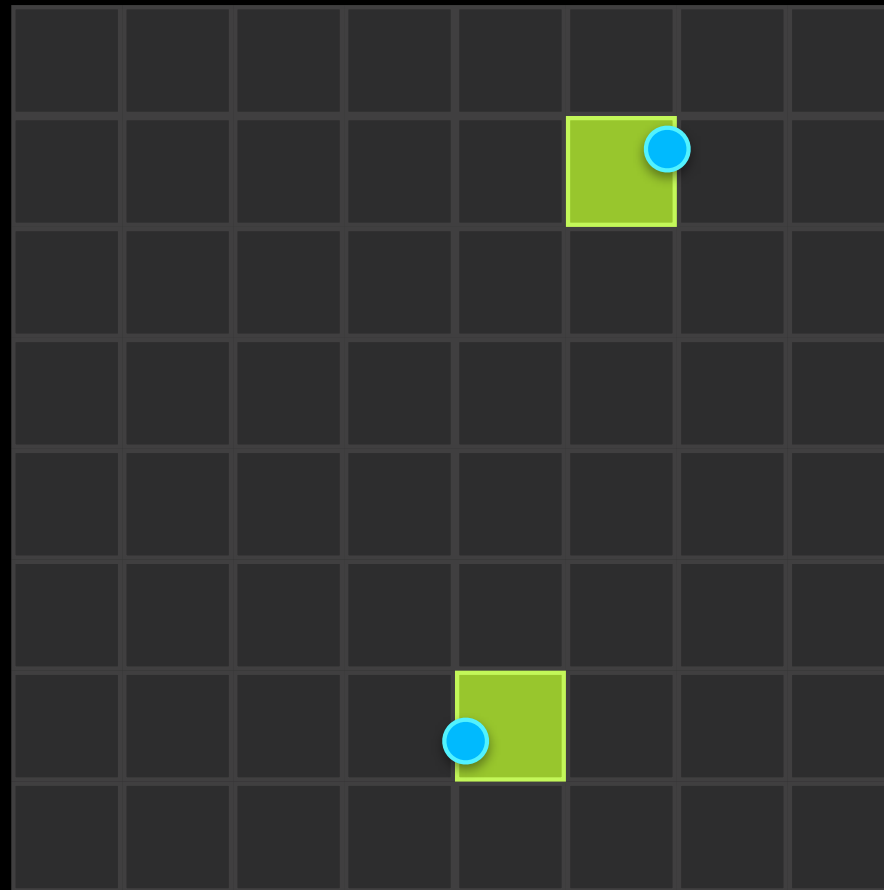


7.6

5.8

$\Delta 1.8$

Calculating Pinch Velocity

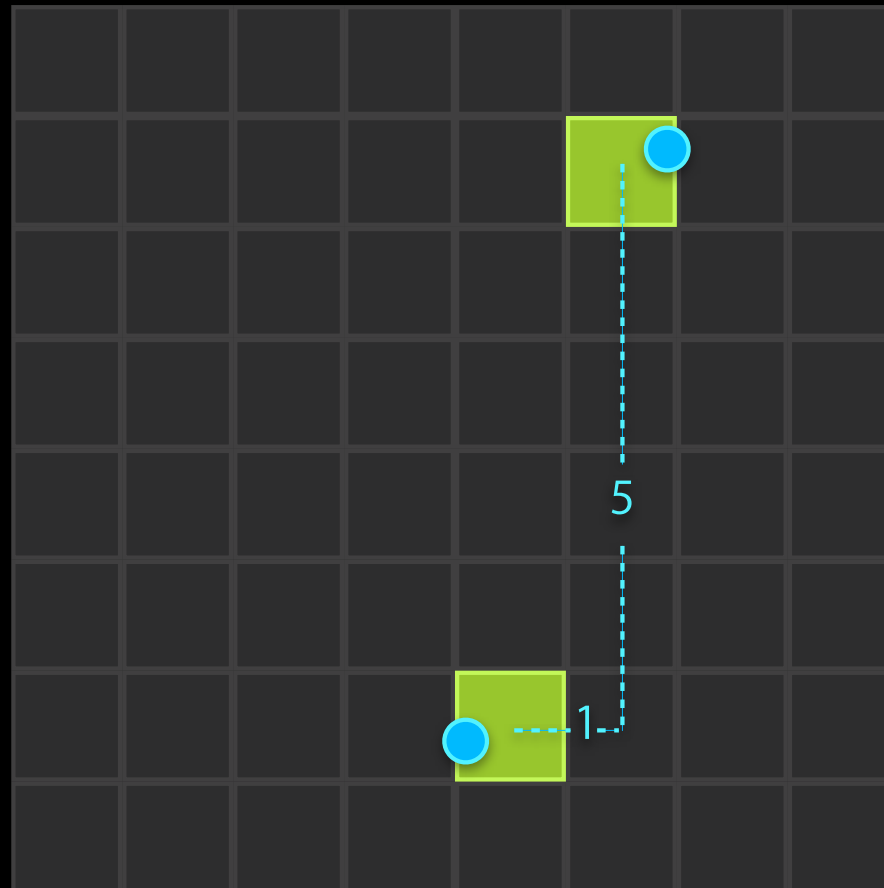


7.6

5.8

$\Delta 1.8$

Calculating Pinch Velocity



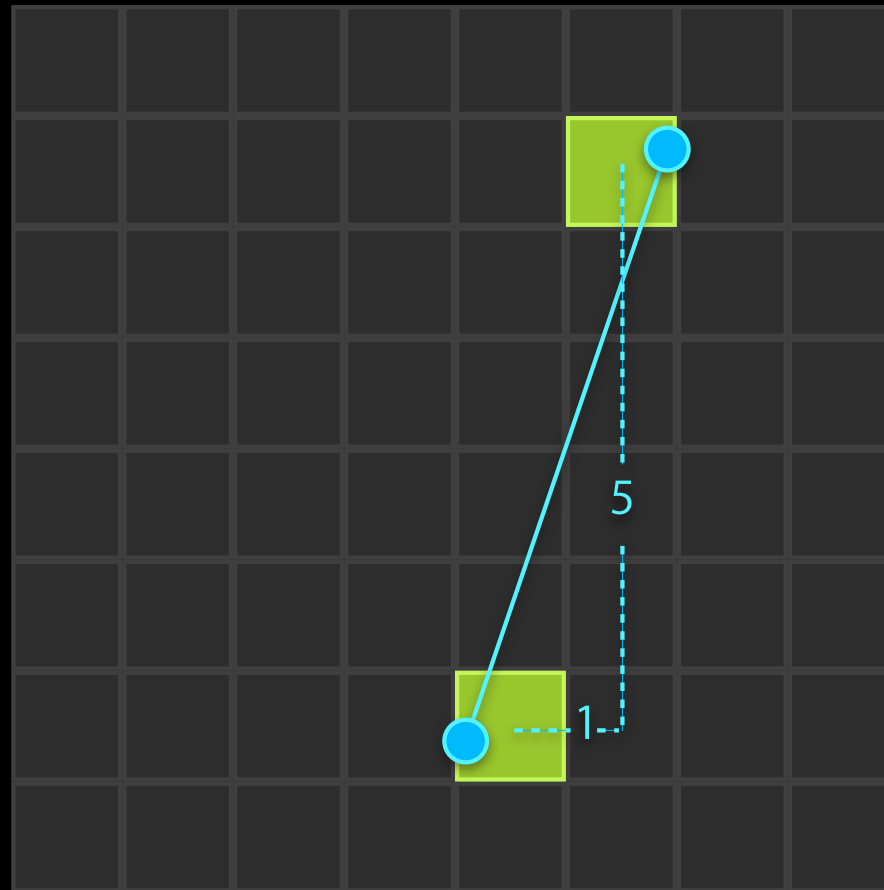
7.6

5.8

$\Delta 1.8$

Calculating Pinch Velocity

$$\sqrt{(1^2 + 5^2)} = 5.1$$

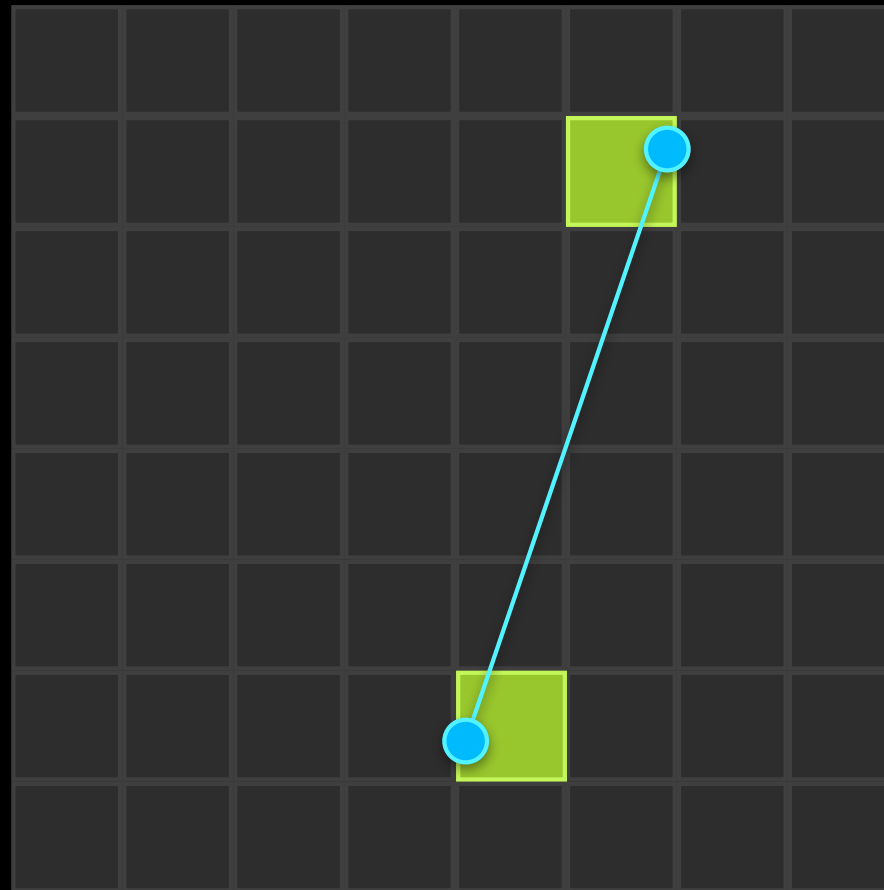


7.6

5.8

$\Delta 1.8$

Calculating Pinch Velocity



7.6

$\Delta 1.8$

5.8

$\Delta 0.7$

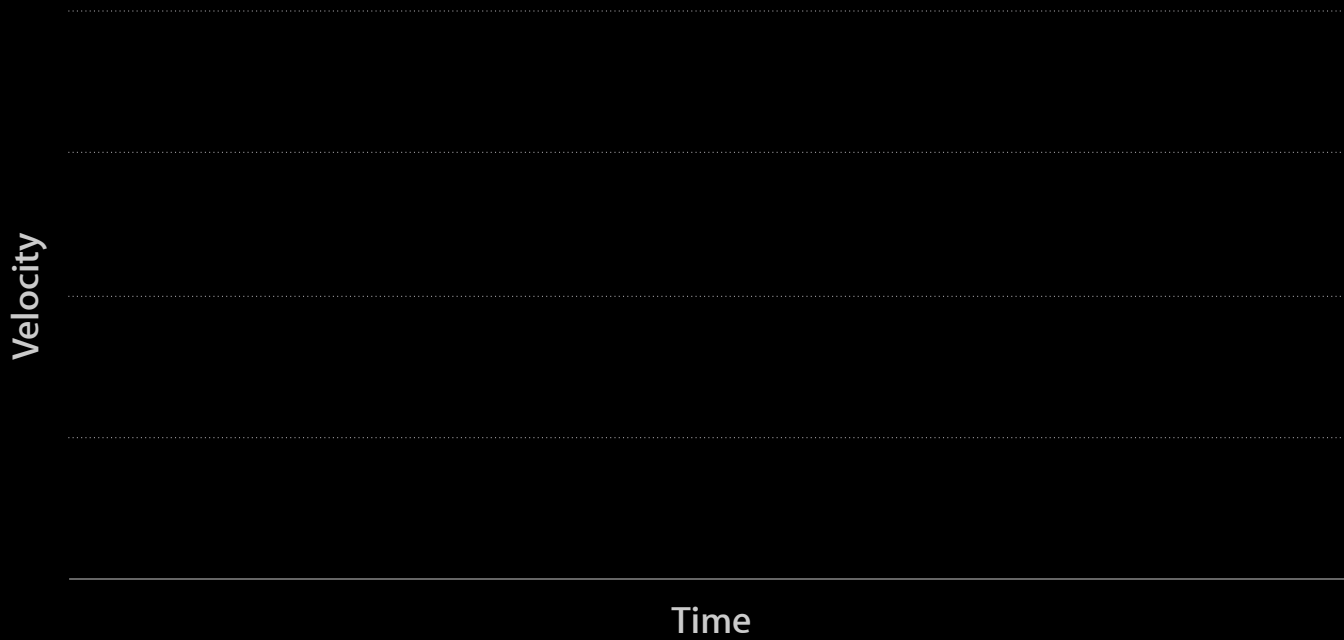
5.1

Calculating Pinch Velocity

Low pass filter

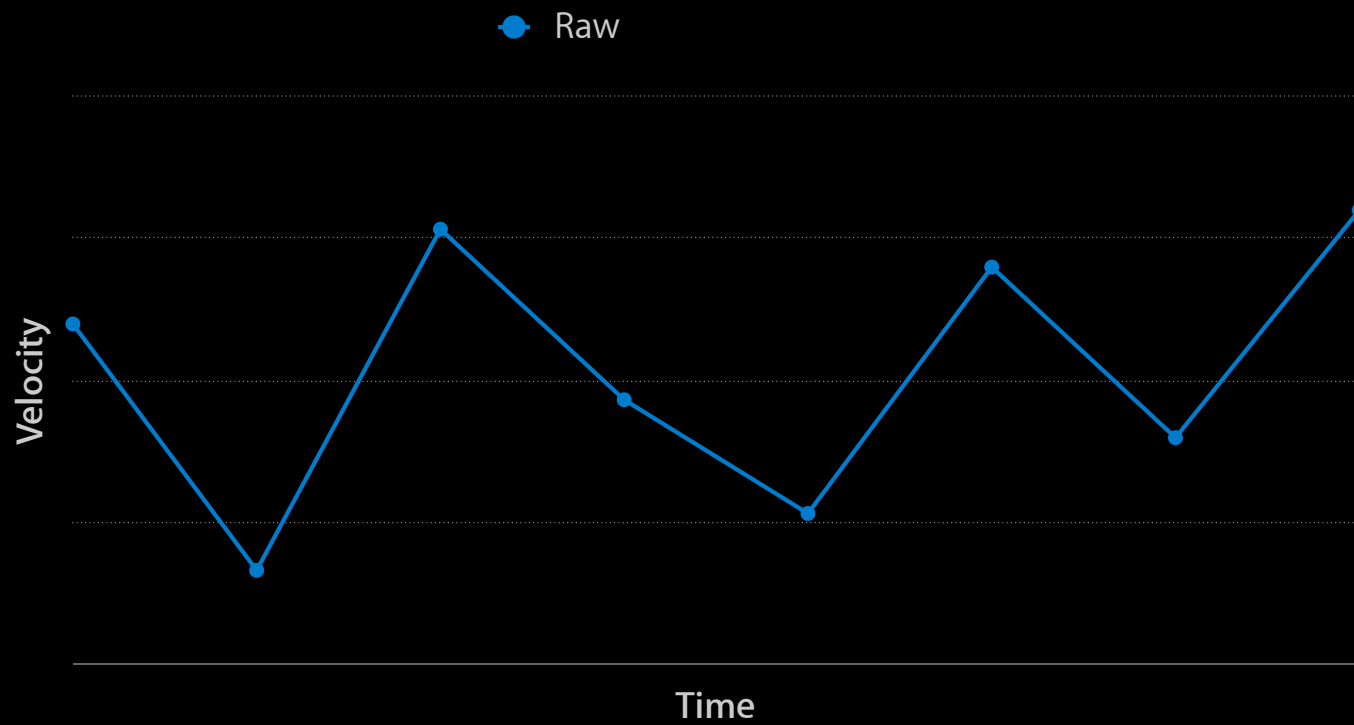
Calculating Pinch Velocity

Low pass filter



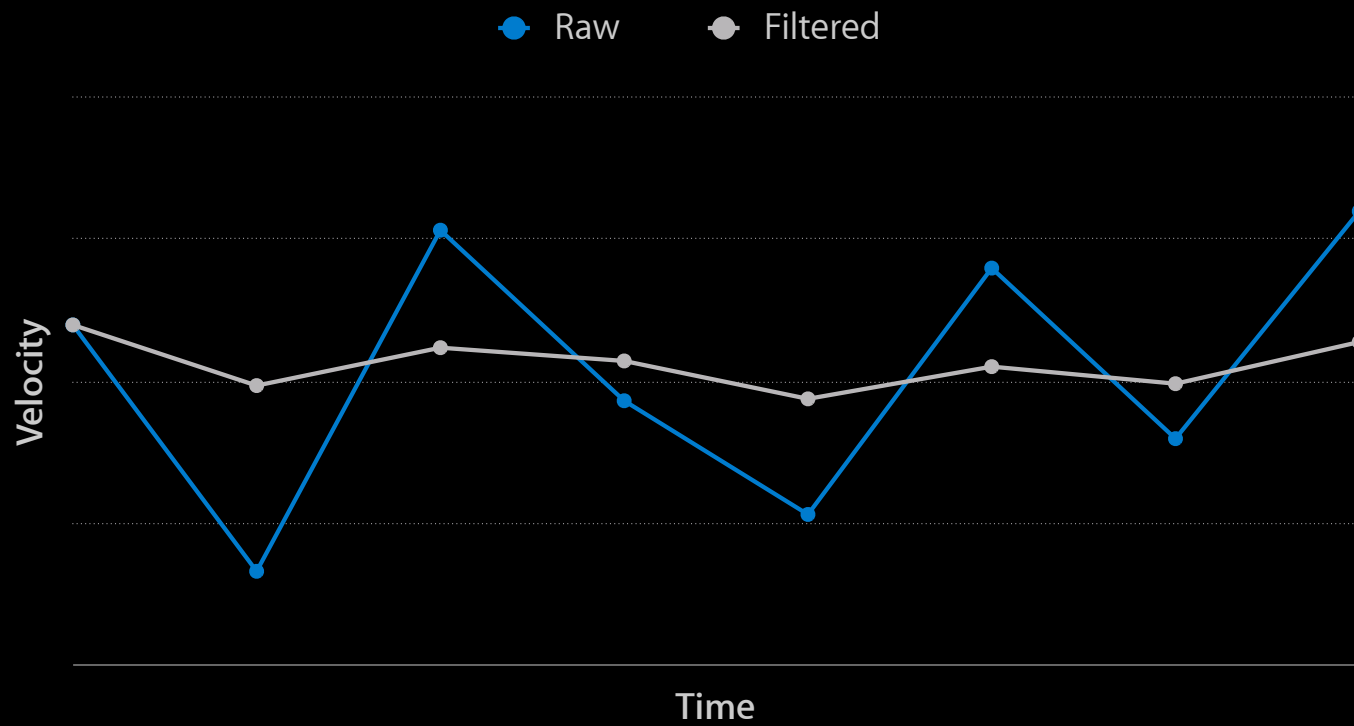
Calculating Pinch Velocity

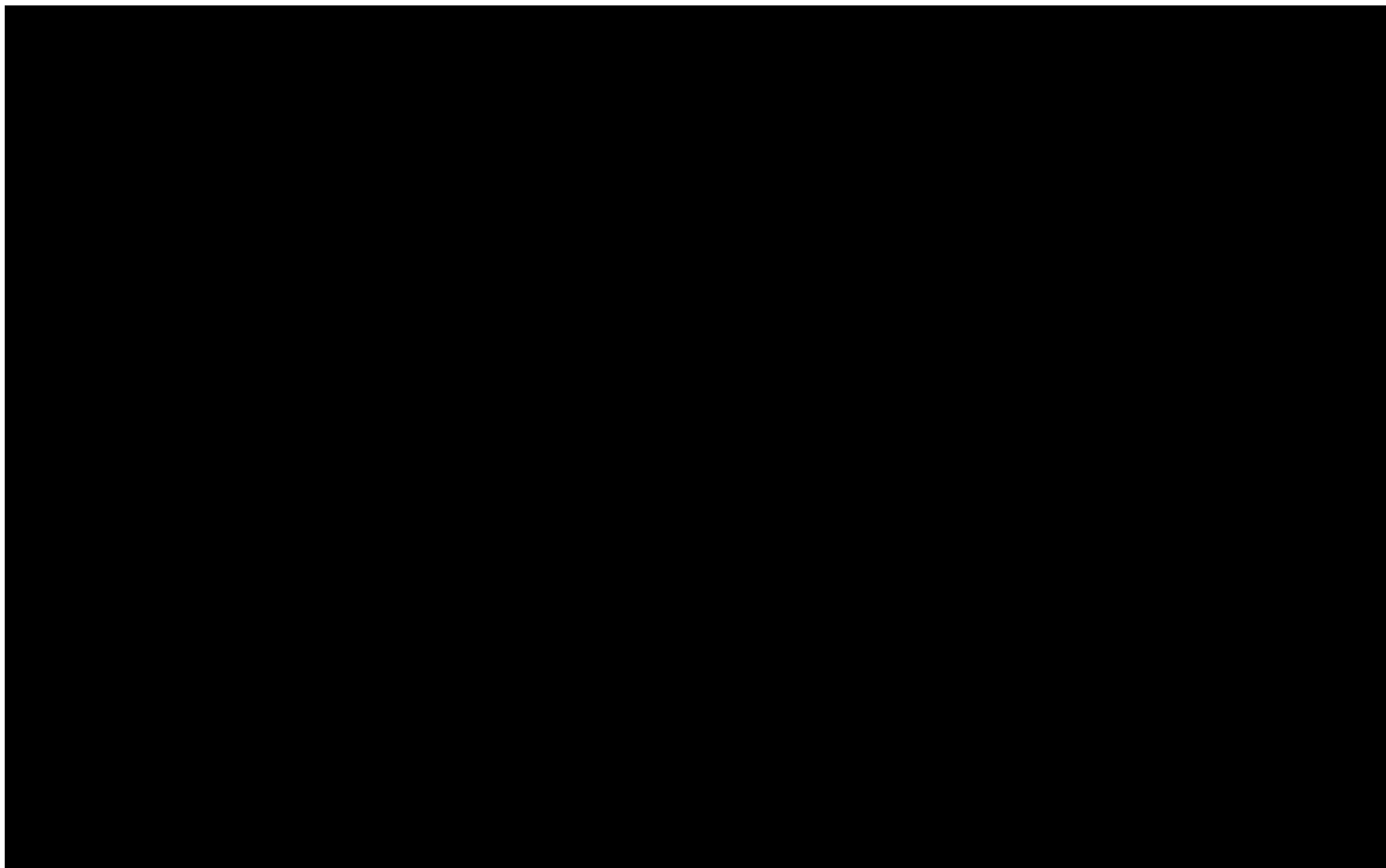
Low pass filter



Calculating Pinch Velocity

Low pass filter





$$v(t) = \alpha v(t-1) + (1 - \alpha)v_s$$

$$v(t) = \alpha v(t-1) + (1 - \alpha)v_s$$

$$v(t) = \alpha v(t-1) + (1 - \alpha)v_s$$

$$v(t) = \alpha v(t-1) + (1 - \alpha)v_s$$

$$v(t) = \alpha v(t-1) + (1 - \alpha)v_s$$

α

$$v(t) = \alpha v(t-1) + (1 - \alpha)v_s$$

$$0 \leq \alpha \leq 1$$

$$v(t) = \alpha v(t-1) + (1 - \alpha)v_s$$

$$v(t) = \alpha v(t-1) + (1 - \alpha)v_s$$

$$v(t) = \alpha v(t-1) + (1 - \alpha)v_s$$

Calculating Pinch Velocity

Low pass filter

$$v(t) = \alpha v(t-1) + (1 - \alpha)v_s$$

Calculating Pinch Velocity

Low pass filter

```
const CGFloat previousWeight = 0.75;
```

$$v(t) = \alpha v(t-1) + (1 - \alpha)v_s$$

Calculating Pinch Velocity

Low pass filter

```
const CGFloat previousWeight = 0.75;
```

```
- (void)addVelocitySample:(CGFloat)velocitySample  
{
```

$$v(t) = \alpha v(t-1) + (1 - \alpha)v_s$$

Calculating Pinch Velocity

Low pass filter

```
const CGFloat previousWeight = 0.75;  
  
- (void)addVelocitySample:(CGFloat)velocitySample  
{  
    _currentVelocity *= previousWeight;
```

$$v(t) = \alpha v(t-1) + (1 - \alpha)v_s$$

Calculating Pinch Velocity

Low pass filter

```
const CGFloat previousWeight = 0.75;  
  
- (void)addVelocitySample:(CGFloat)velocitySample  
{  
    _currentVelocity *= previousWeight;  
    _currentVelocity += (1 - previousWeight) * velocitySample;  
}
```

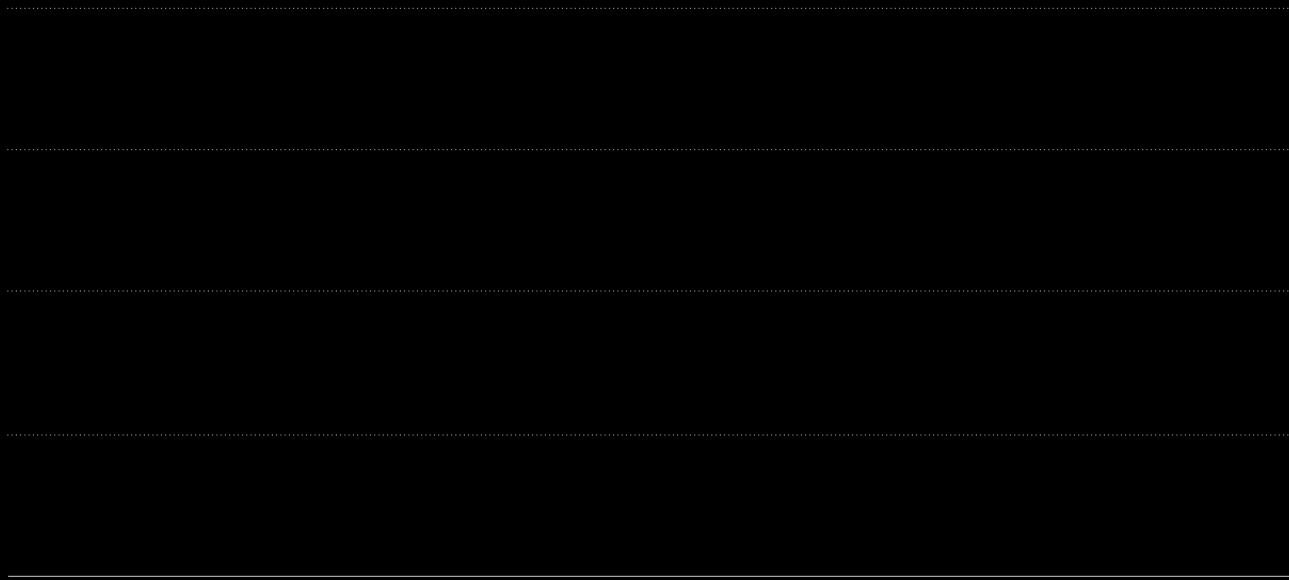
$$v(t) = \alpha v(t-1) + (1 - \alpha)v_s$$

Calculating Pinch Velocity

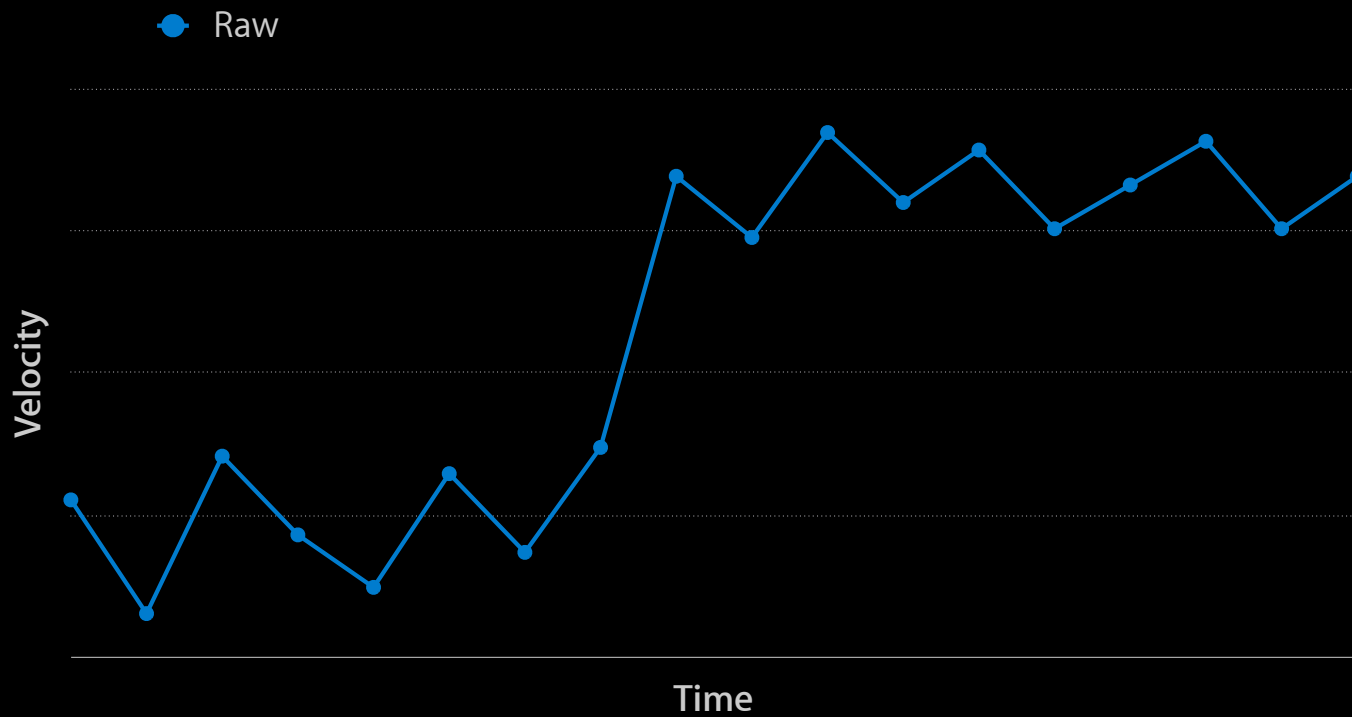
Calculating Pinch Velocity

Velocity

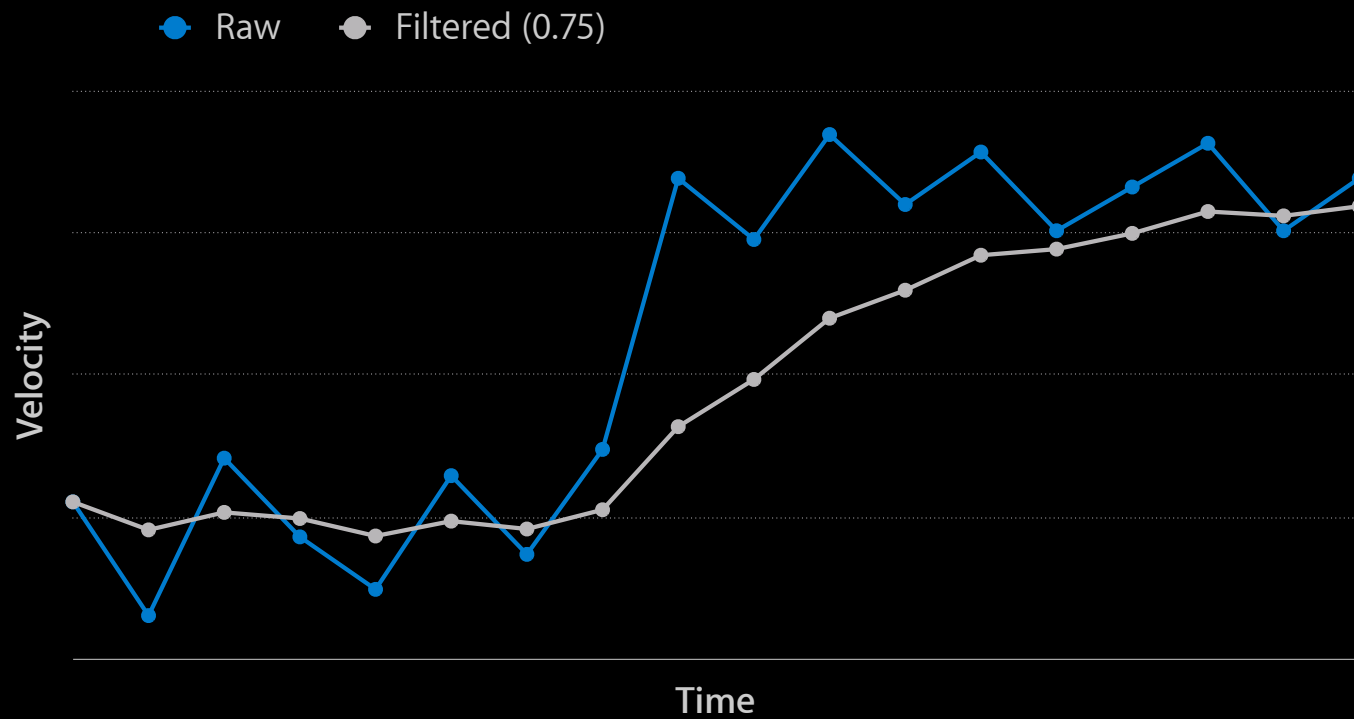
Time



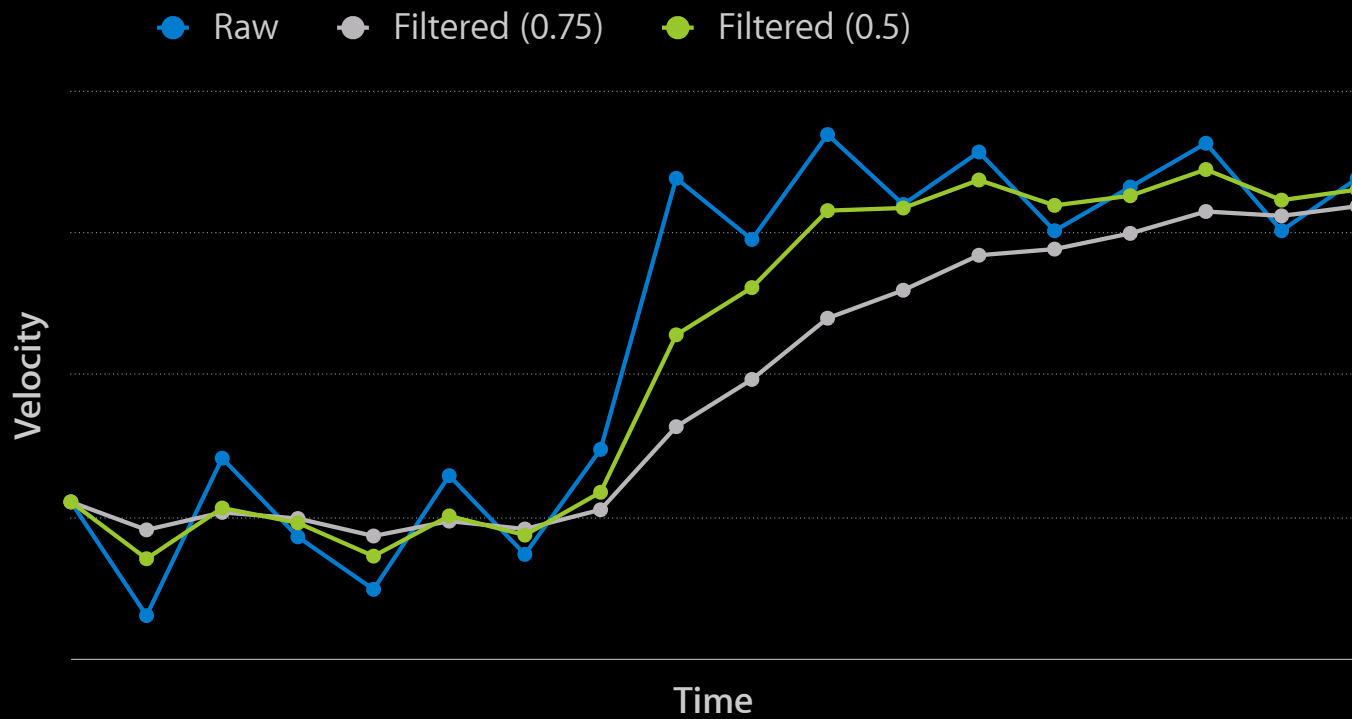
Calculating Pinch Velocity



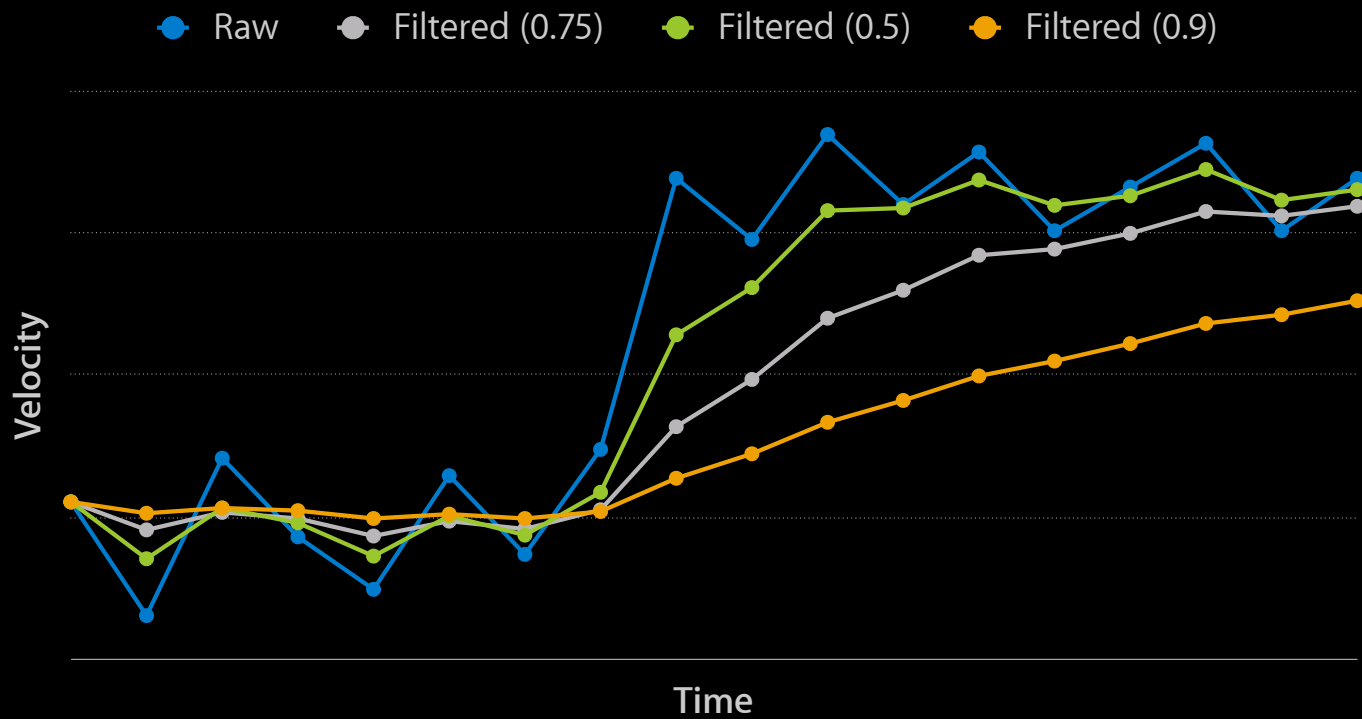
Calculating Pinch Velocity



Calculating Pinch Velocity



Calculating Pinch Velocity



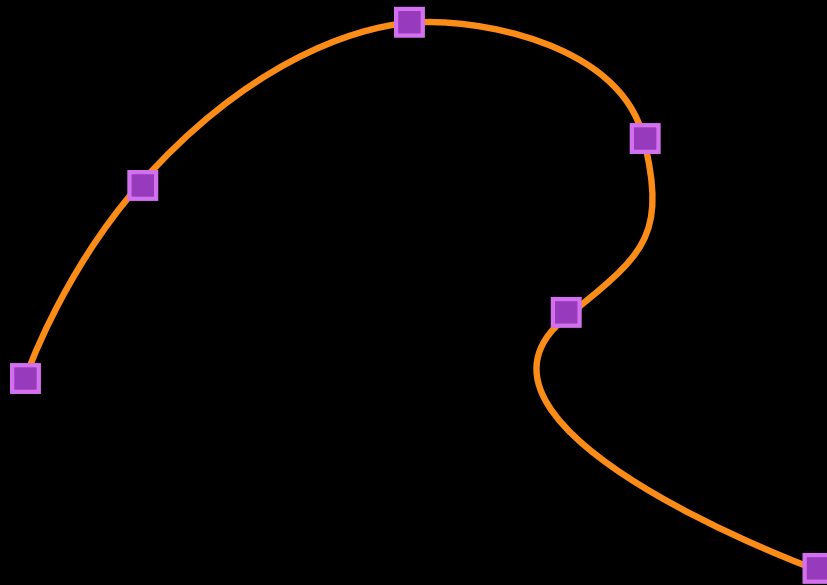
Signal Processing

Curve smoothing

Curve Smoothing

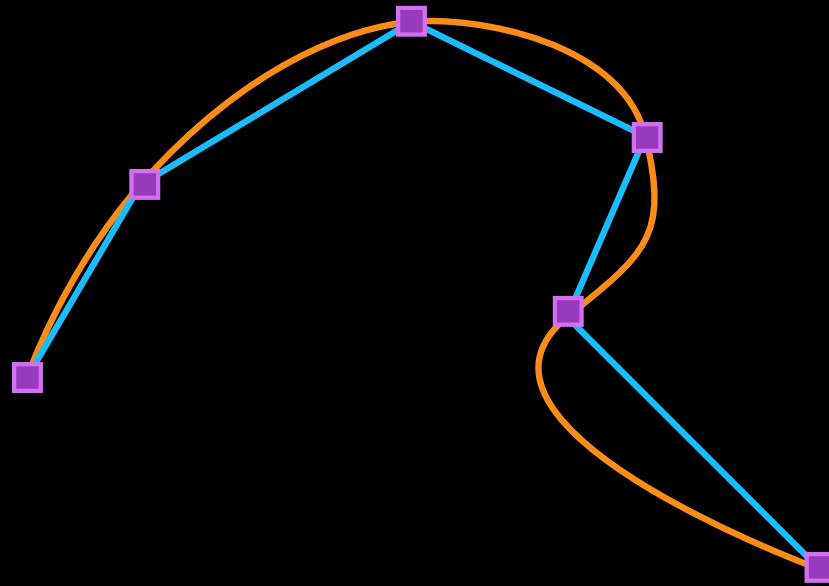


Curve Smoothing



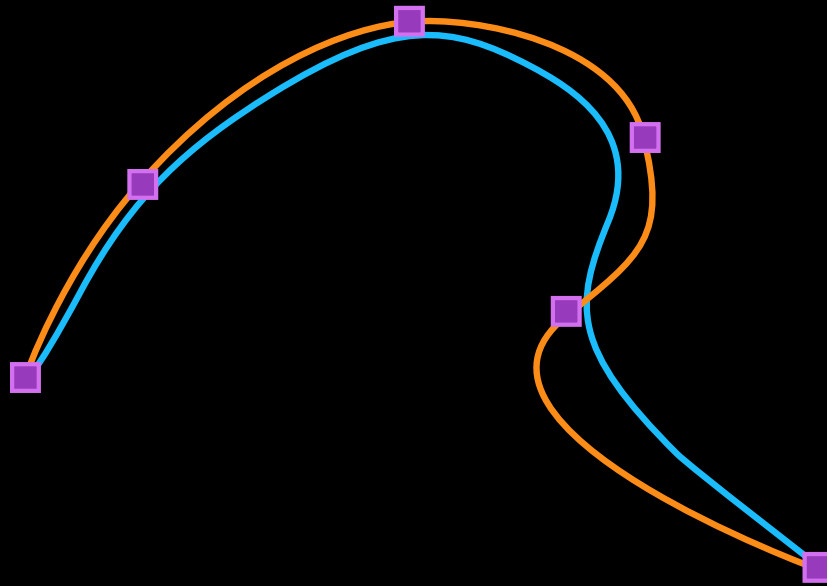
Curve Smoothing

```
-[UIBezierPath addLineToPoint:]
```



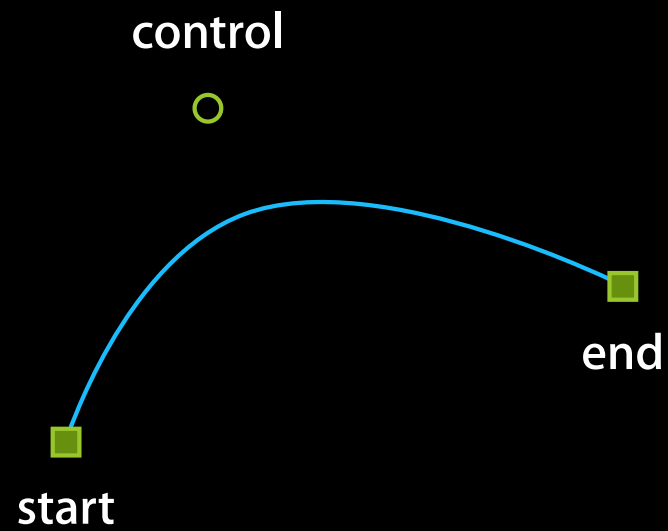
Curve Smoothing

```
-[UIBezierPath addQuadCurveToPoint:controlPoint]
```



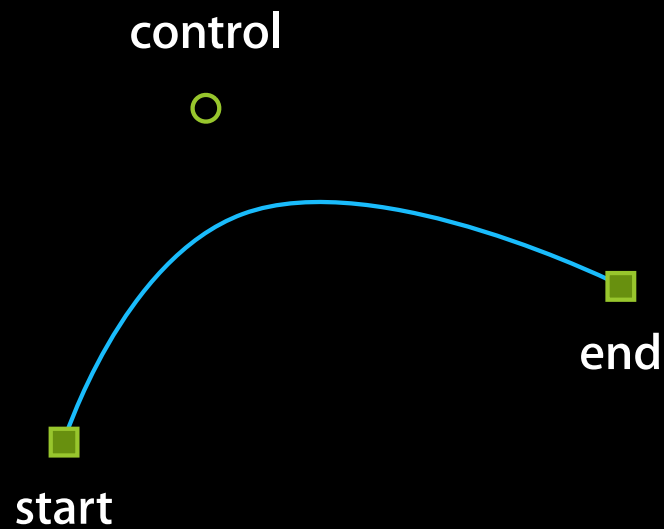
Curve Smoothing

Quadratic Bézier Curves



Curve Smoothing

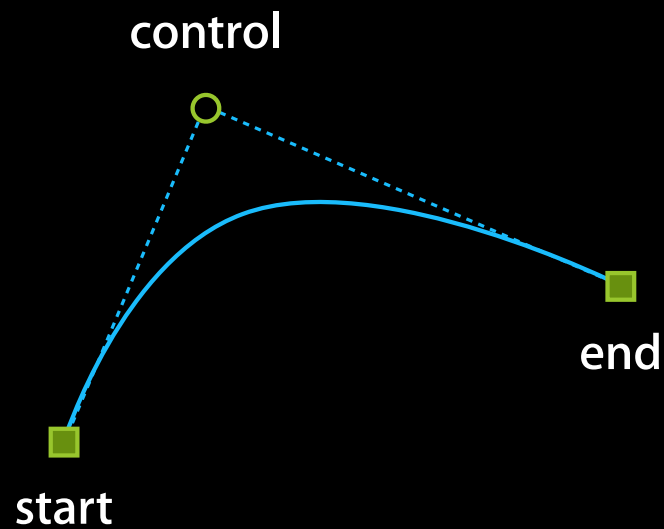
Quadratic Bézier Curves



```
[path moveToPoint:start];  
[path addQuadCurveToPoint:end controlPoint:control];
```

Curve Smoothing

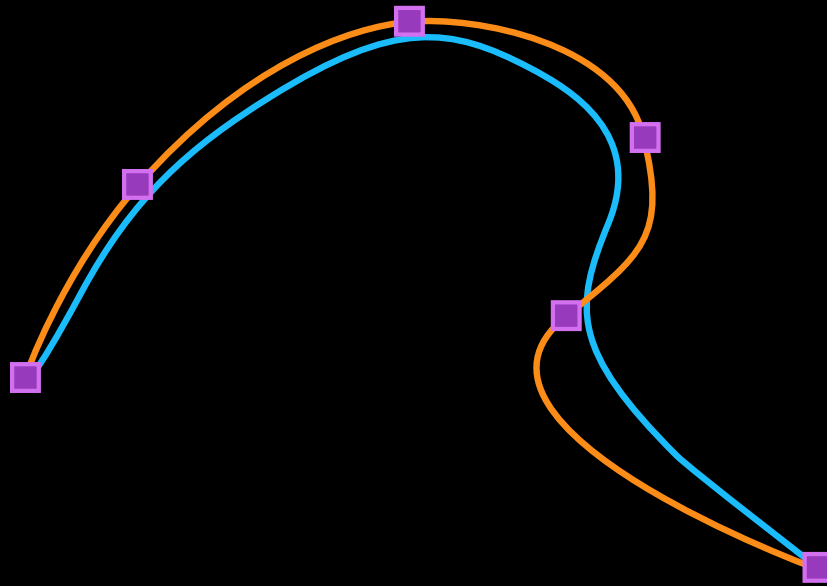
Quadratic Bézier Curves



```
[path moveToPoint:start];  
[path addQuadCurveToPoint:end controlPoint:control];
```

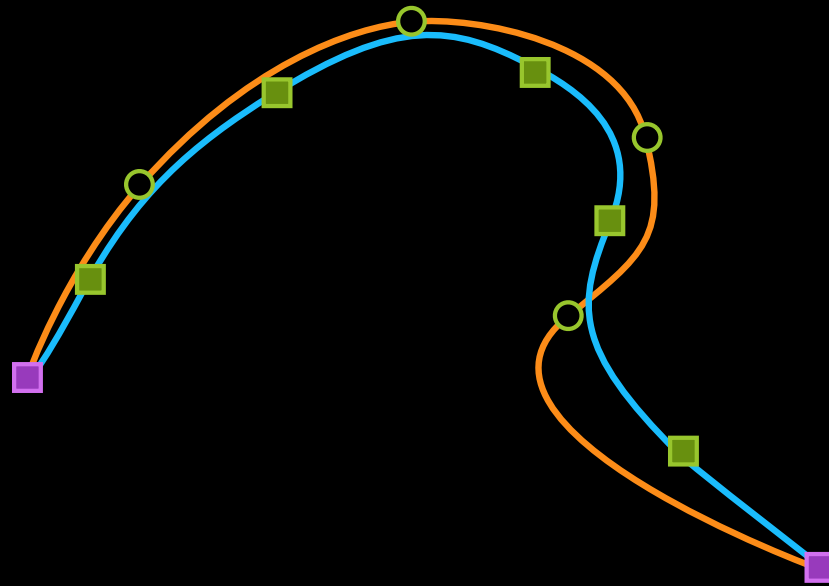
Curve Smoothing

```
-[UIBezierPath addQuadCurveToPoint:controlPoint:]
```



Curve Smoothing

```
-[UIBezierPath addQuadCurveToPoint:controlPoint:]
```



Demo

What We've Learned

What We've Learned

- Gestures: composable touch handling

What We've Learned

- Gestures: composable touch handling
- Common gotchas

What We've Learned

- Gestures: composable touch handling
- Common gotchas
- Advanced processing

More Information

Jake Behrens

UI Frameworks Evangelist

behrens@apple.com

Documentation

Event Handling Guide for iOS

<http://developer.apple.com/library/ios>

Apple Developer Forums

<http://devforums.apple.com>

Related Sessions

What's New With Gestures

Marina
Thursday 10:15AM

 **WWDC2012**