# Best Practices for Mastering Auto Layout

## for OS X and iOS

Session 228

**Peter Ammon**
AppKit Engineer

Make your layouts
simpler to write
simpler to modify
easier to understand

# Auto Layout

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Identical APIs!

# Auto Layout

Almost Identical APIs!

# Auto Layout

# Auto Layout


“View”

# Auto Layout

"View"

NSView

UIView

# NSLayoutConstraint

# NSLayoutConstraint

- One new class—NSLayoutConstraint

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foo.width = bar.width
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- Relationships have a coefficient and a constant

# NSLayoutConstraint

- One new class—NSLayoutConstraint
- Constraints express geometric properties of views


```
foo.width = 120
```

- Constraints also express geometric relationships between views


```
foo.width = bar.width
```

- Relationships have a coefficient and a constant

```
foo.width = bar.width * 2 - 20
```

# NSLayoutConstraint

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- Constraints can be equalities or inequalities

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```
foo.width >= 120
```

# NSLayoutConstraint

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```
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- Constraints have priorities

# NSLayoutConstraint

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```
foo.width >= 120
```

- Constraints have priorities


```
foo.width = 120 with priority 500
foo.width = 75 with priority 1000
```

# NSLayoutConstraint

- Constraints can be created three ways
  - Interface Builder
  - Visual format language
  - Base API
- Prefer this order

# Auto Layout

- Thinking in constraints
  - Transitioning to constraints
- Debugging constraint-based layouts
  - Ambiguity
  - Unsatisfiability
  - Reading log messages
- Unleashing the power of constraints
  - Animation
  - Writing a custom control
  - Internationalization

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# Thinking in Constraints

- Auto Layout can be used like springs and struts
- But you get the most benefits from a shift in thinking
- Let your layouts becomes declarative

# Thinking in Constraints

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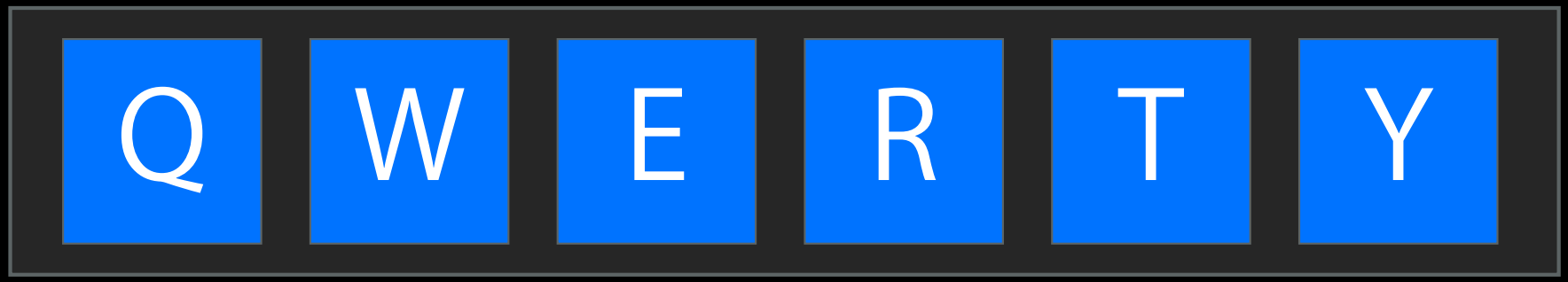

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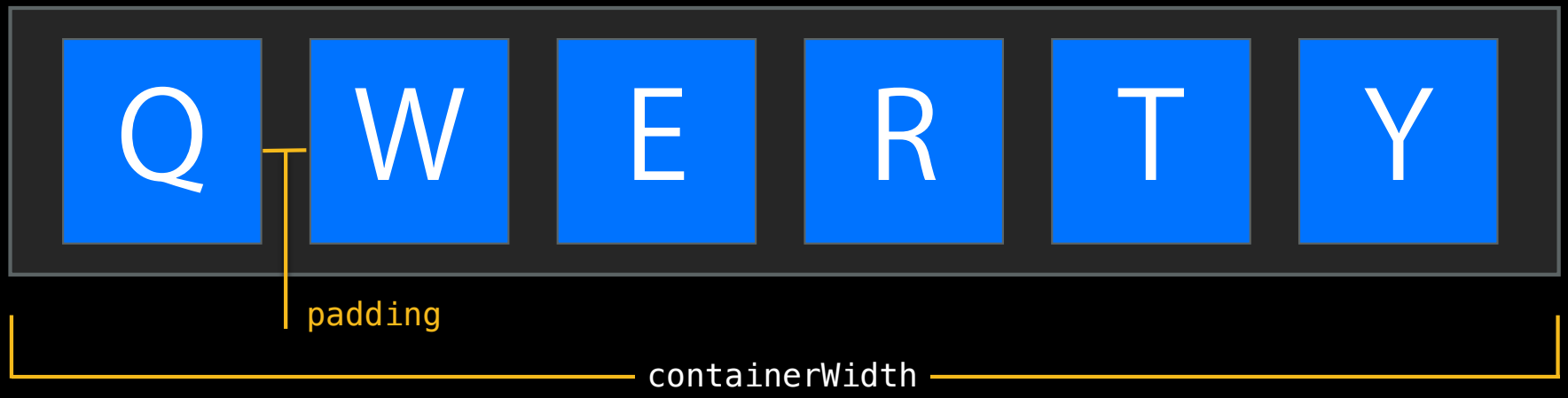

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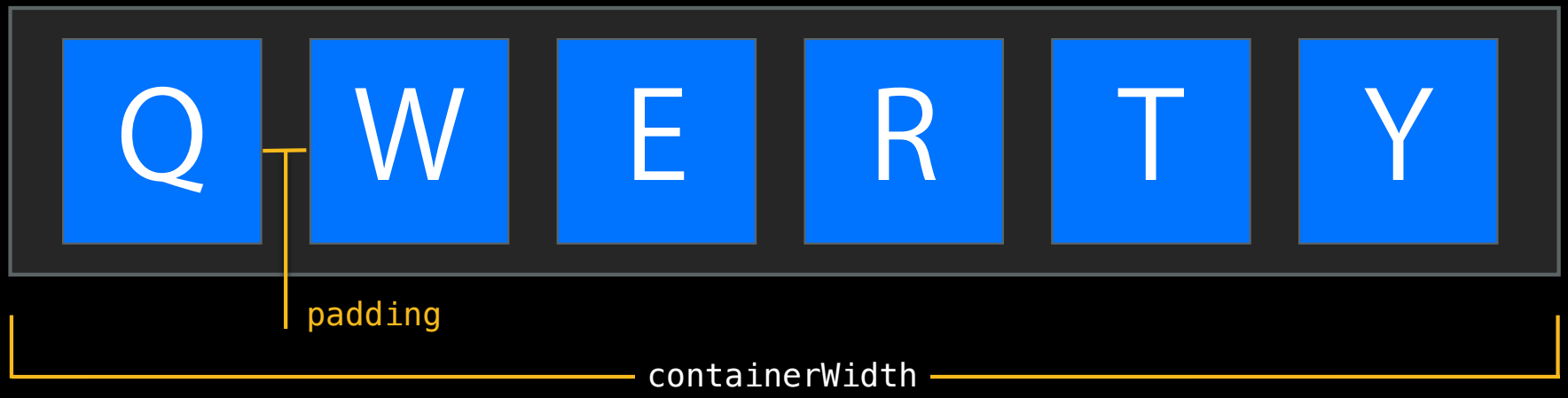
## Springs and Struts



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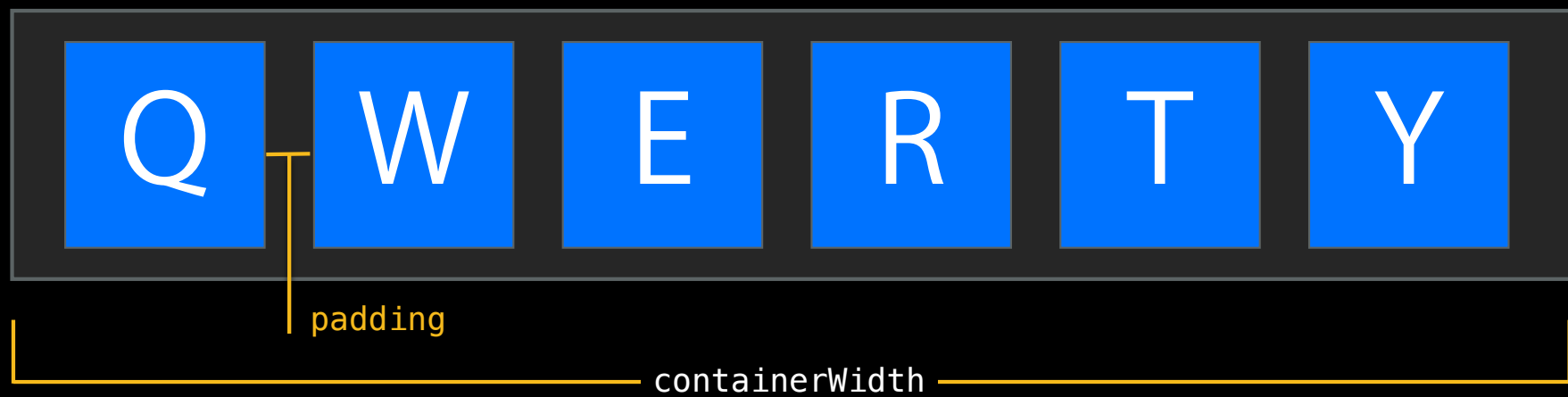
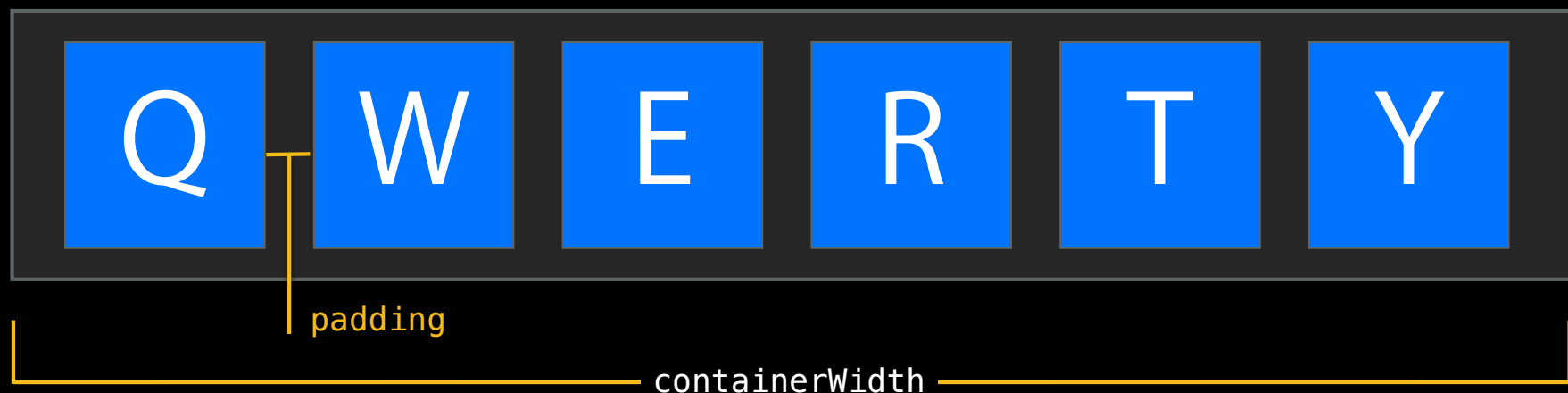



```
keyWidth = containerWidth / keyCount
               - padding * (keyCount + 1) / keyCount
```

# Thinking in Constraints

## Springs and Struts

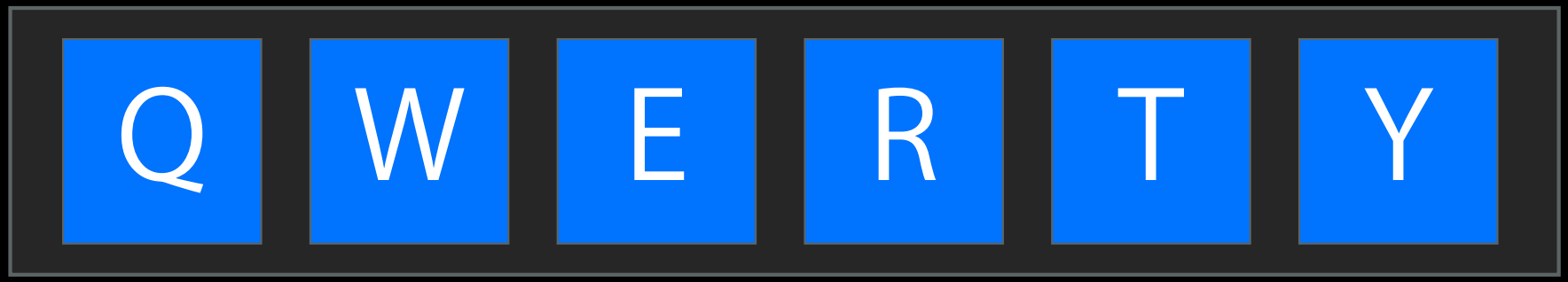



```
keyWidth = containerWidth / keyCount
               - padding * (keyCount + 1) / keyCount

keyOffset = padding +
                keyIndex * (keyWidth + padding)
```

# Thinking in Constraints

Springs and Struts



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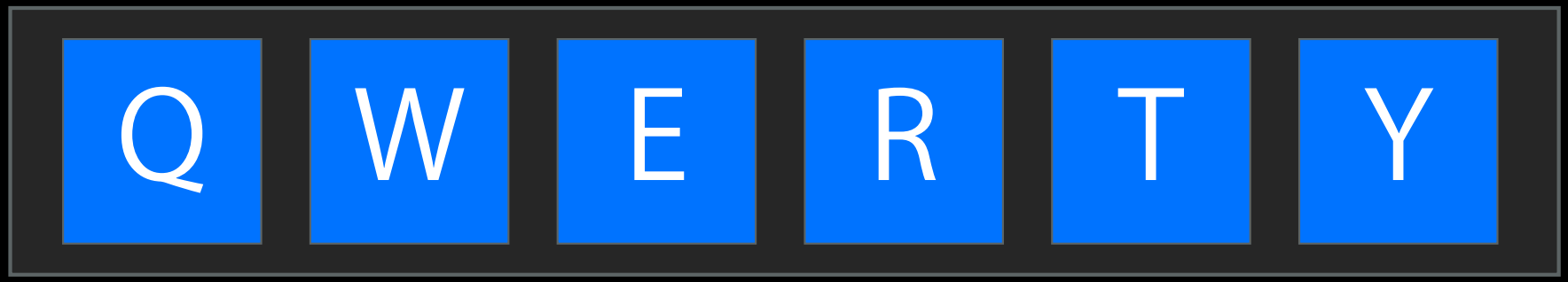

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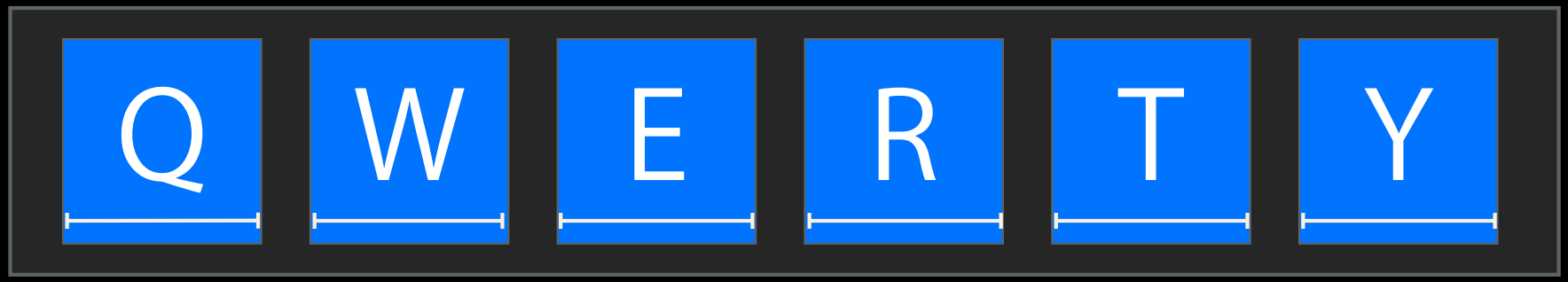

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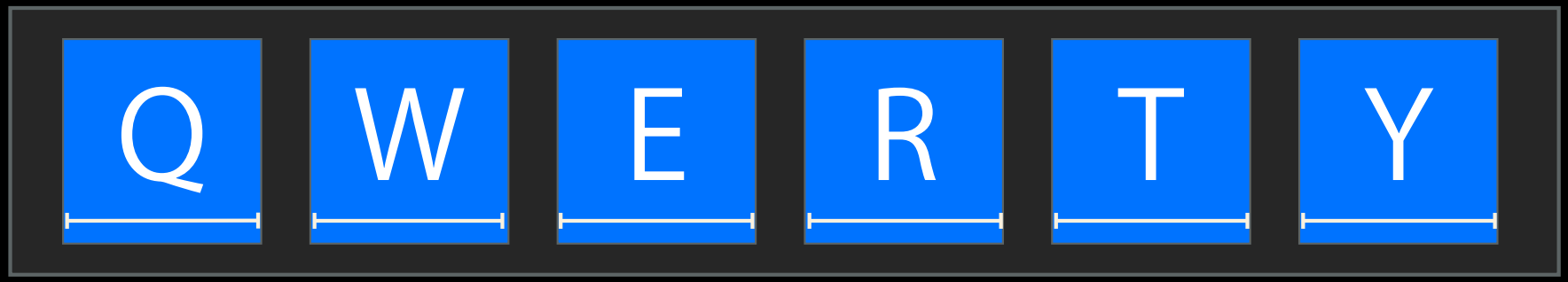


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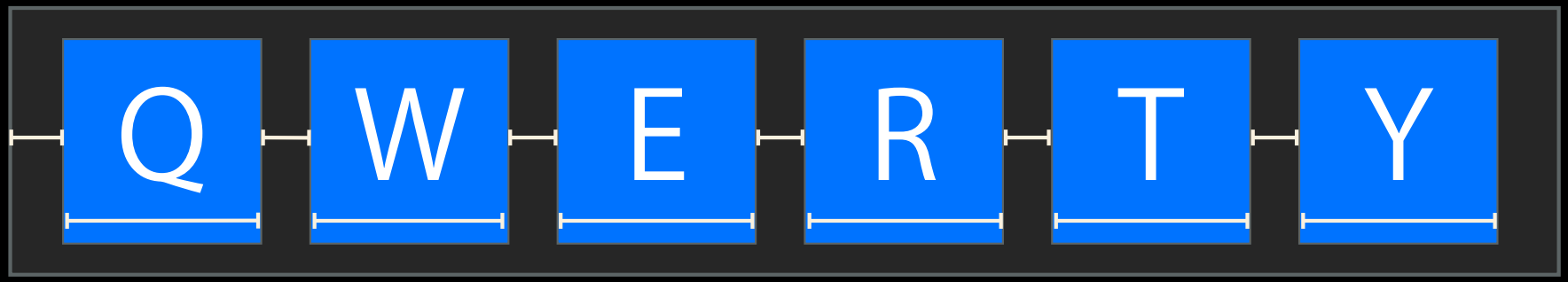


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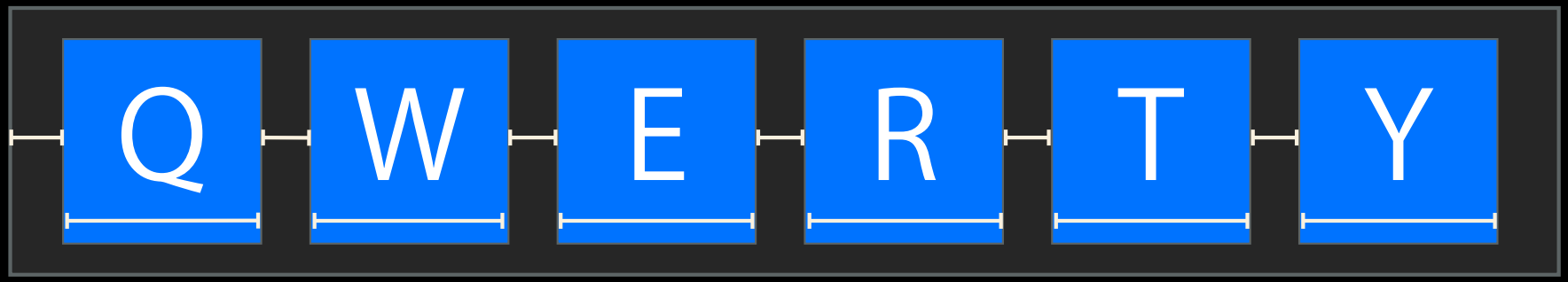


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Q.minX = container.minX + padding
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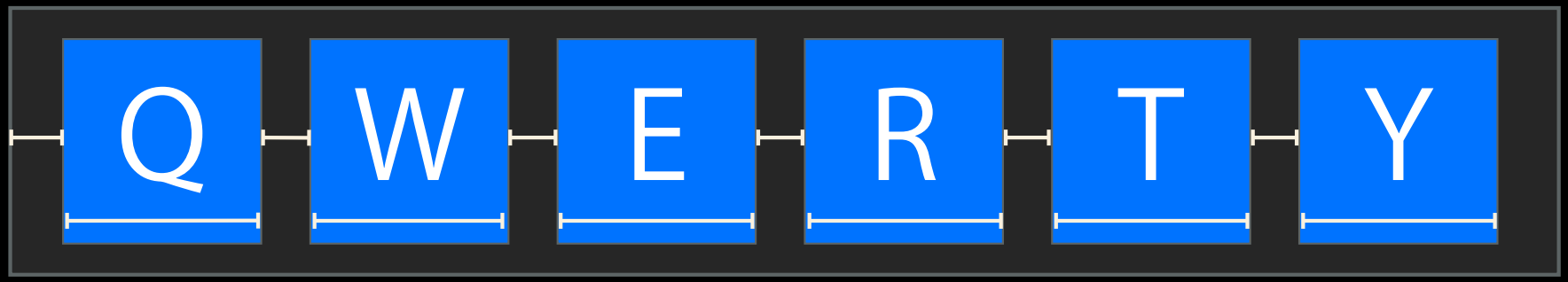


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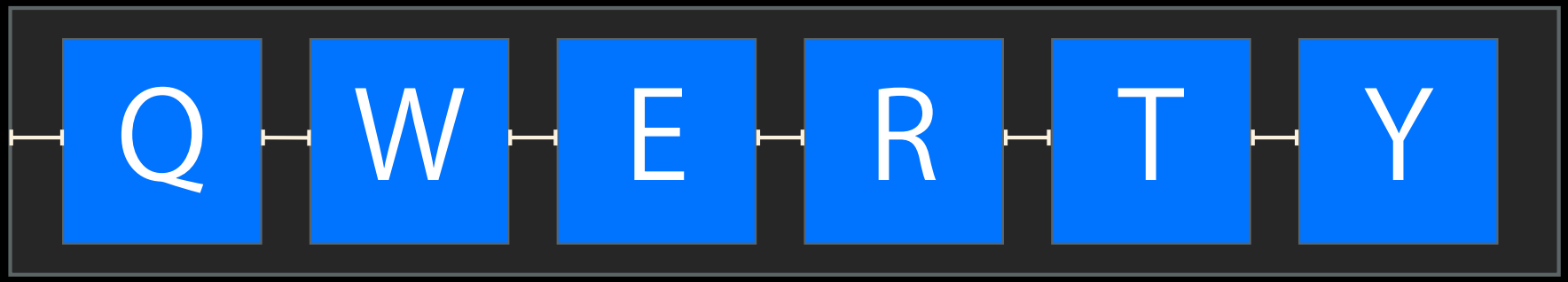
Relationships

# Thinking in Constraints

Auto Layout

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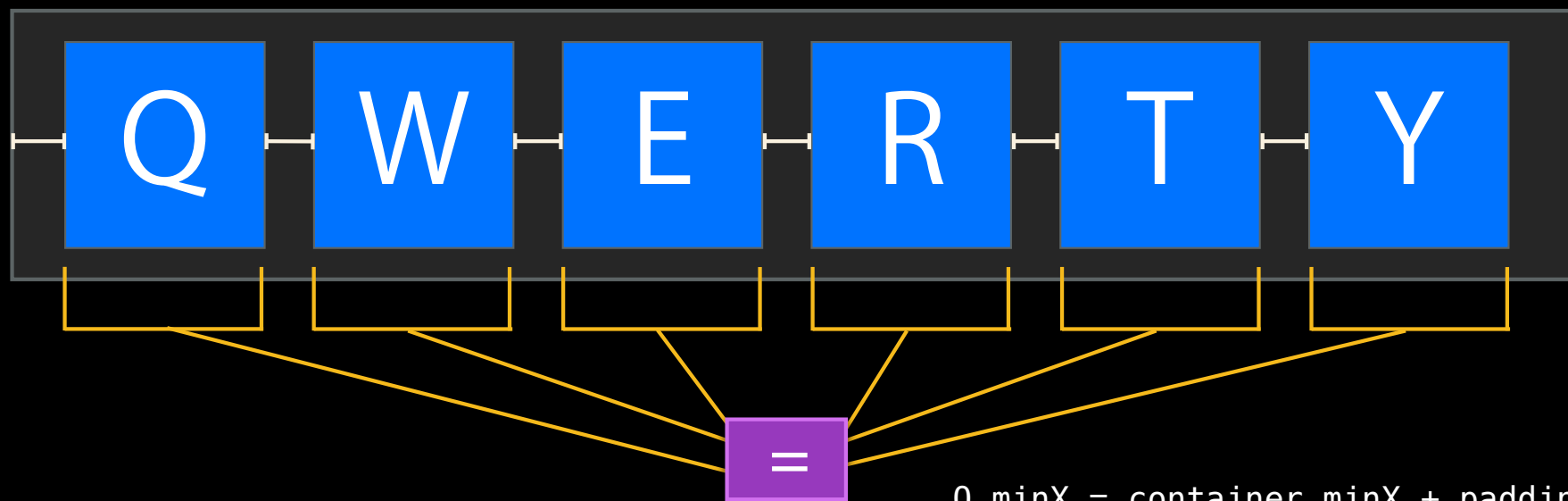


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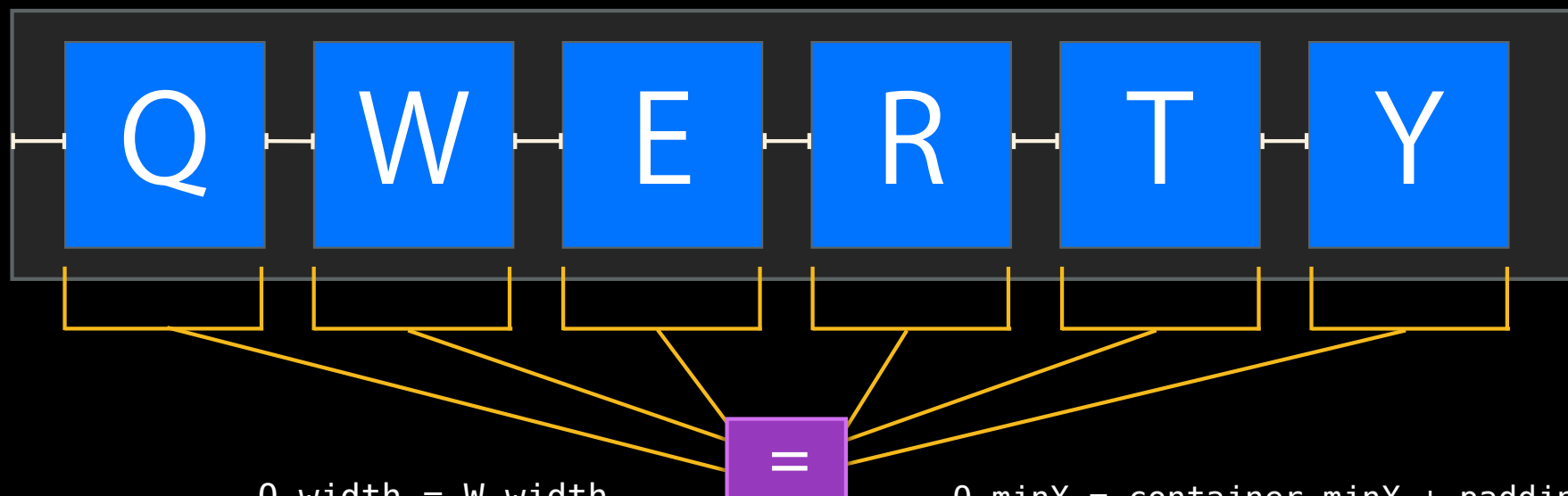


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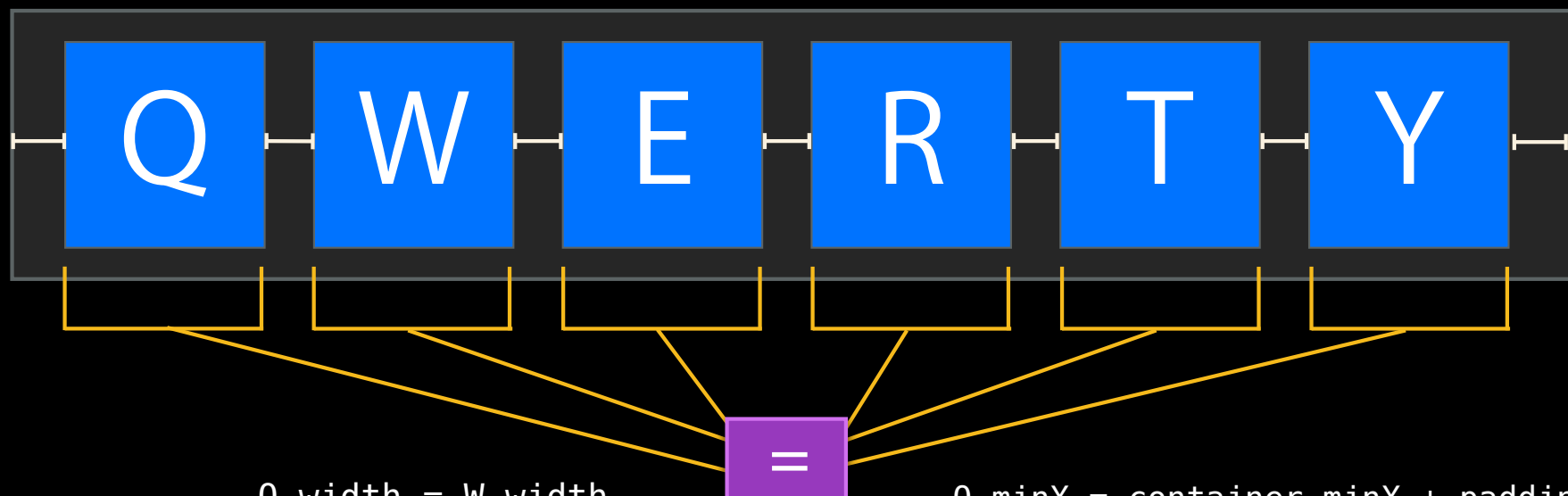


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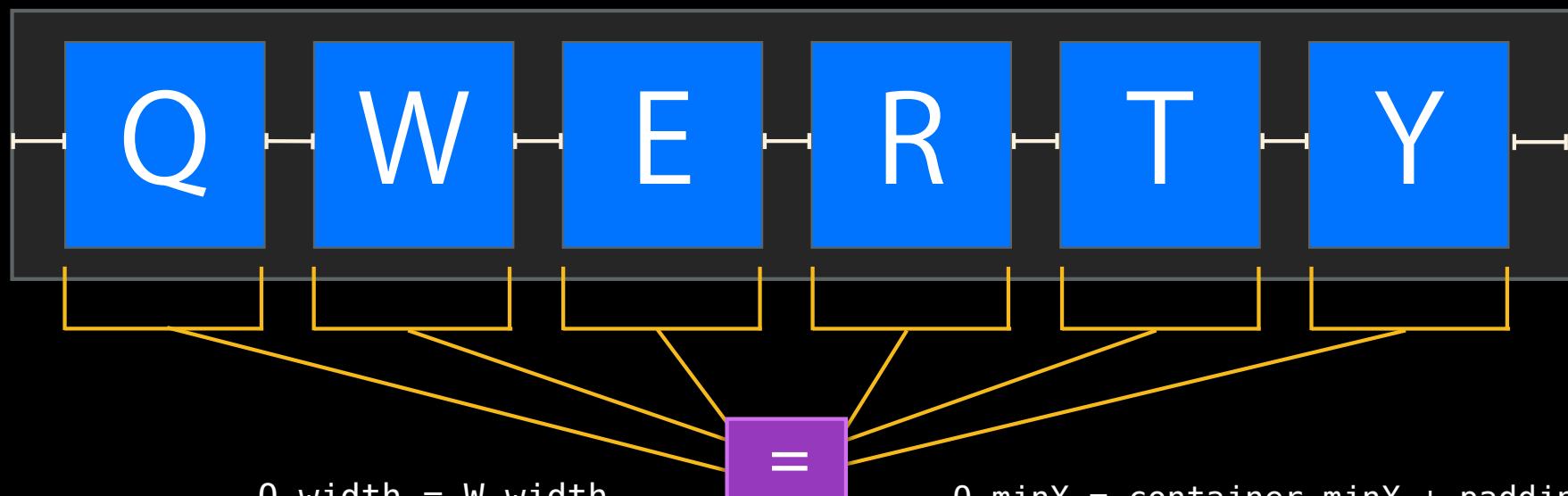


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W.width = E.width
...
```

```
Q.minX = container.minX + padding
W.minX = Q.maxX + padding
E.minX = W.maxX + padding...

container.maxX = Y.maxX + padding
```

*Demo*

# Thinking in Constraints

- Layout becomes distributed
- Decompose sophisticated layouts into components
- Each component contributes the constraints it cares about
- Layout becomes “owned”

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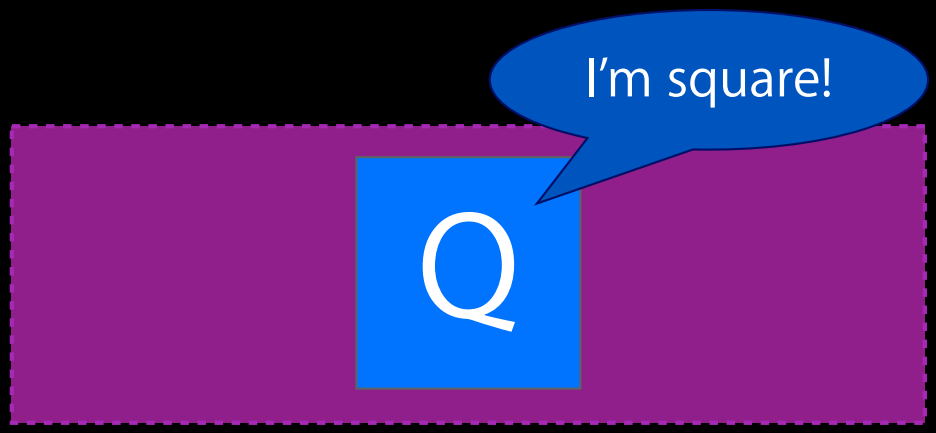

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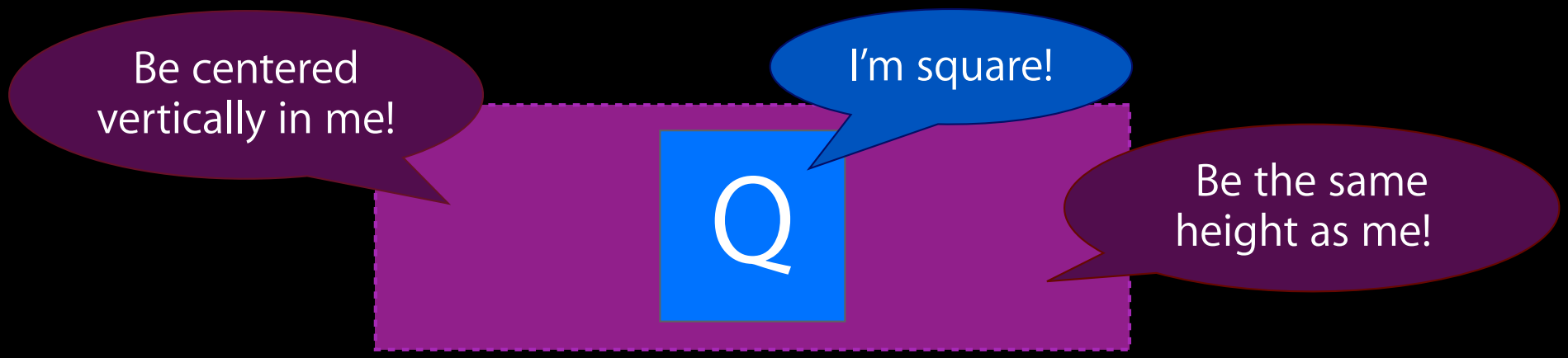

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# Migrating from Springs and Struts

## 1. Plan your attack

- A partial conversion lets you use Auto Layout just where you need it
  - Some compatibility issues to be aware of
- A full conversion will pay major dividends

# Migrating from Springs and Struts

2. Turn on Auto Layout in your nibs

# Migrating from Springs and Struts

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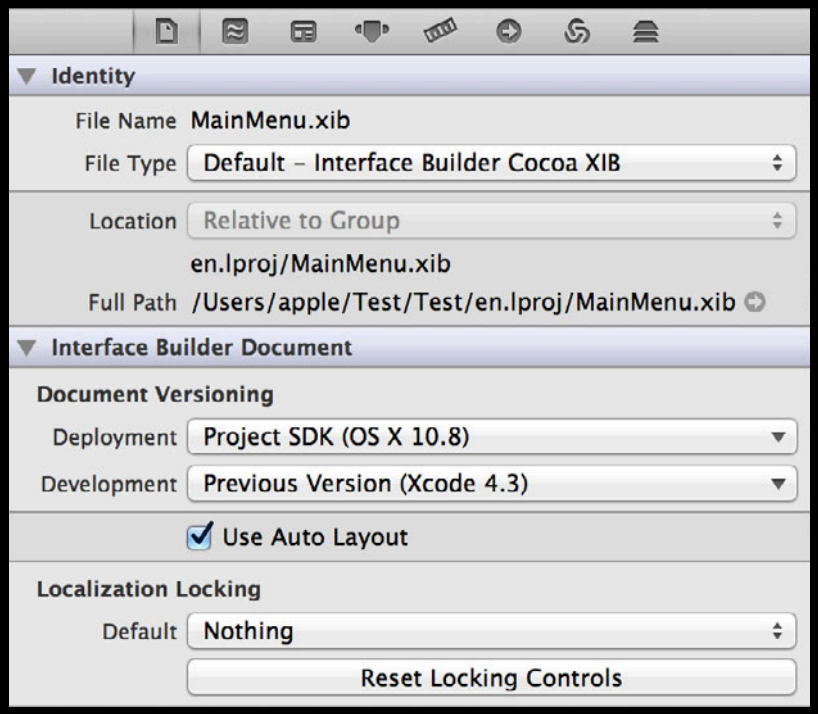

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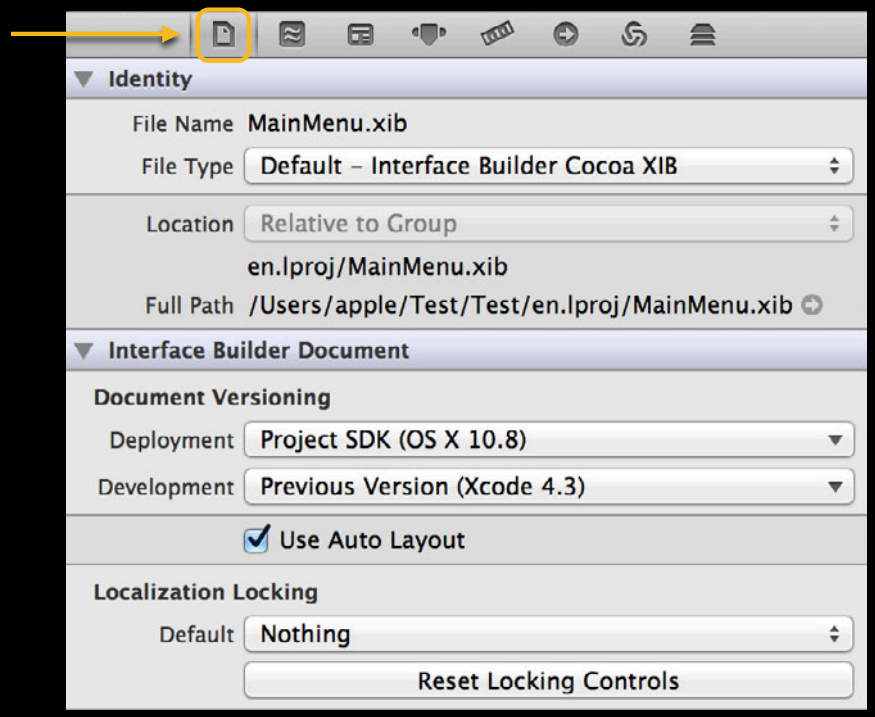

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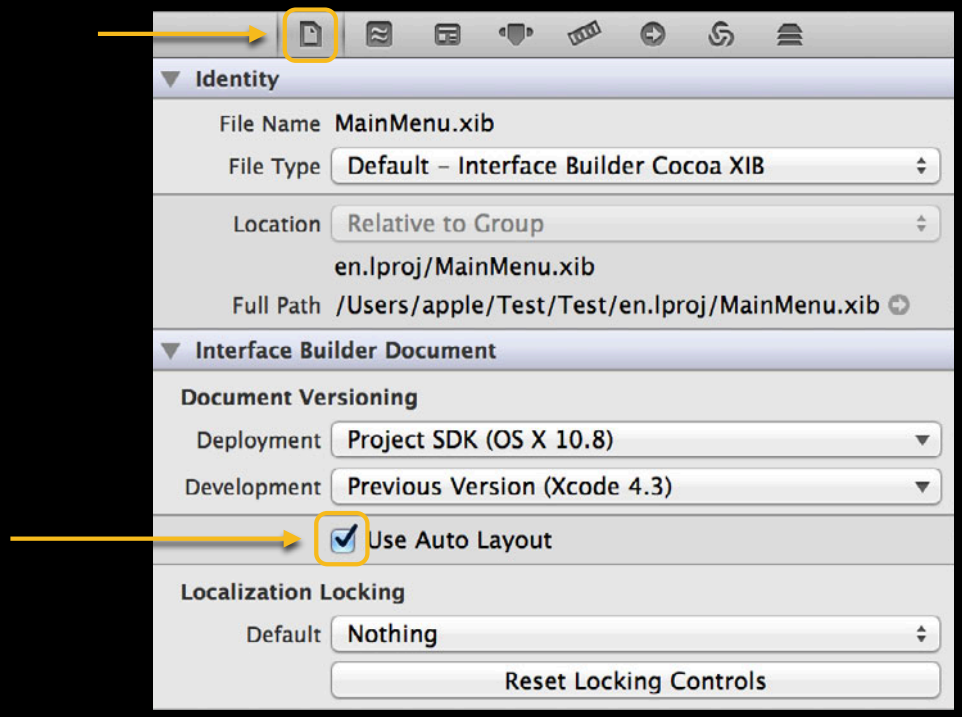
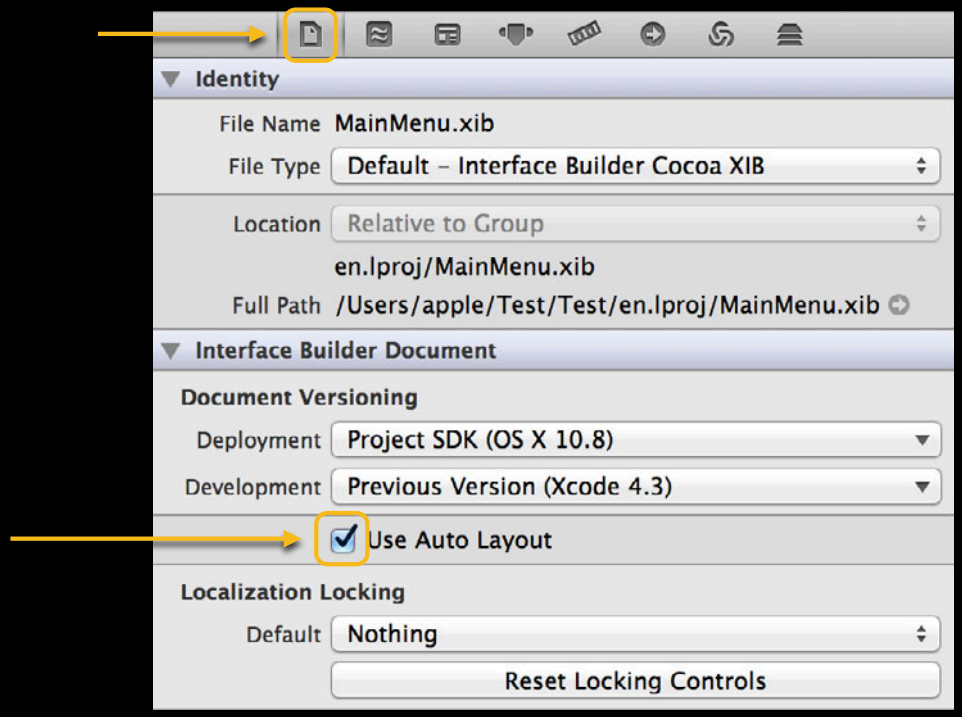


# Migrating from Springs and Struts

## 2. Turn on Auto Layout in your nibs

- Create the constraints you want in IB
- IB will create constraints that reflect your existing layout
- Add to or modify them



# Migrating from Springs and Struts

## 3. Turn off autoresizing mask translation for every view you create programmatically

```
[view setTranslatesAutoresizingMaskIntoConstraints:NO]
```

- If you forget, you'll get unsatisfiable constraint warnings quickly

# Migrating from Springs and Struts

4. Look for places where you perform layout

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```
- (void)layoutSubviews {…
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[view setFrame:rect]
[view setFrameSize:size]
[view setFrameOrigin:point]
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They all have to go!

# Migrating from Springs and Struts

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```
- (void)layoutSubviews {…

[view setFrame:rect]
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```

They all have to go!

(But what do I replace them with?)

# Migrating from Springs and Struts

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- Stop and think
  - Don’t try to merely replicate what the existing code is doing
  - Think about the underlying layout

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- Stop and think
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- Try replacing it with nothing!
  - Are you working around a limitation of springs and struts?
  - Does the code implement a relationship?

# Migrating from Springs and Struts

- Stop and think
  - Don’t try to merely replicate what the existing code is doing
  - Think about the underlying layout
- Try replacing it with nothing!
  - Are you working around a limitation of springs and struts?
  - Does the code implement a relationship?
- Otherwise, add some constraints

# Migrating from Springs and Struts

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- Think about which component should own each constraint

# Migrating from Springs and Struts

- Think about which component should own each constraint
- Consider centralizing it in updateConstraints

# Migrating from Springs and Struts

5. Test it

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- Verify the layout is correct
- Fix issues you may have

# Migrating from Springs and Struts

## 5. Test it

- Verify the layout is correct
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- Wait, what?

# Auto Layout

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  - Unsatisfiability
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# What Can Go Wrong?

- Constraints that provide insufficient information
  - Ambiguity
- Constraints that provide conflicting information
  - Unsatisfiability
- Constraints that are satisfied in unexpected ways

# What Can Go Wrong?

- Interface Builder prevents unsatisfiable or ambiguous constraints
- Rely on Interface Builder as much as possible
- You can reference constraints with outlets

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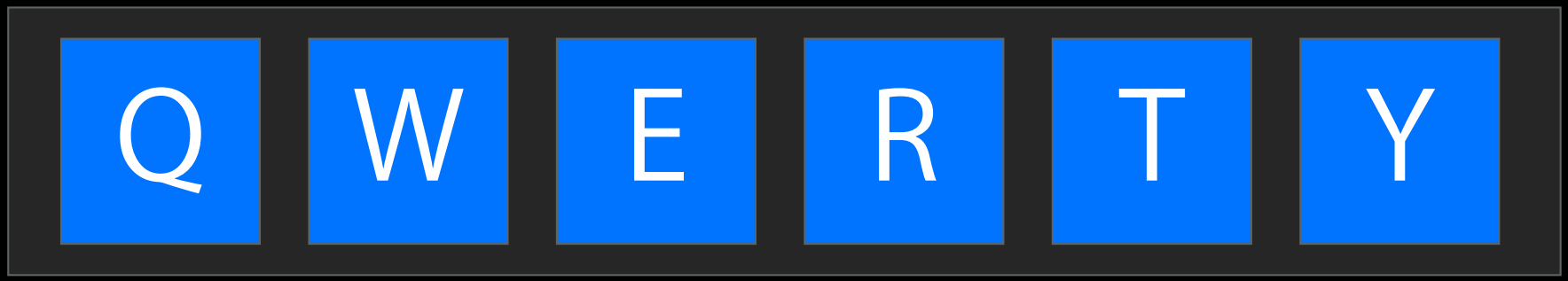

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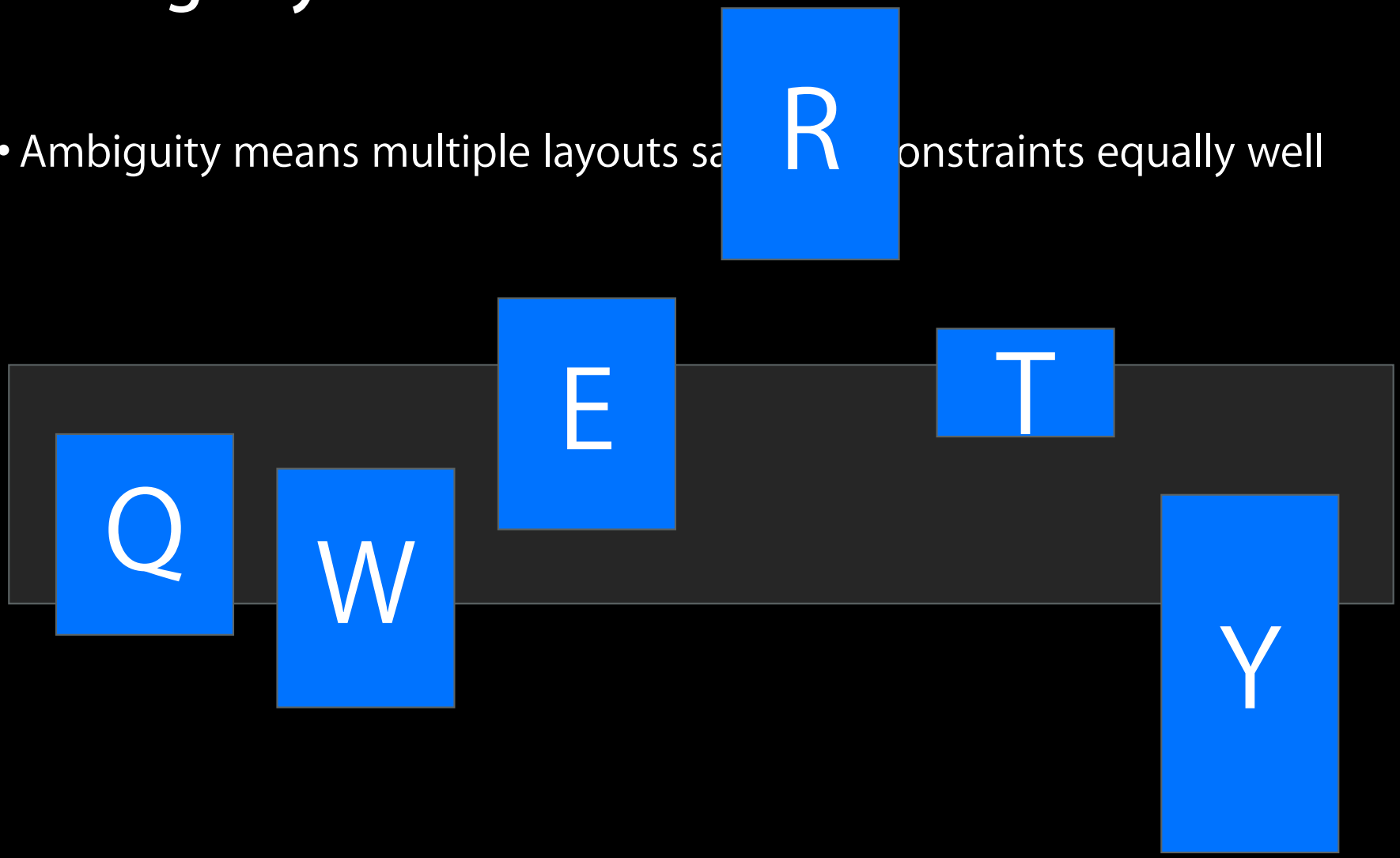

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- A common symptom is that your views will cycle between those layouts
- Views "jump" or disappear entirely (jump to zero size)

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- Each view needs four properties (two in each dimension)
  - MinX, Width, MinY, Height
  - MinX, MaxX, CenterY, MaxY
  - CenterX, Width, Baseline, Height
  - etc.

# Ambiguity

- Usually it means you need more constraints
- Each view needs four properties (two in each dimension)
  - MinX, Width, MinY, Height
  - MinX, MaxX, CenterY, MaxY
  - CenterX, Width, Baseline, Height
  - etc.
- Inequalities by themselves are usually not enough
  - view.width ≥ 20 – is it 20? 200? 2 billion?
  - Inequalities don't care how much larger or smaller you are
  - But equalities care

# Ambiguity

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```
[view(24@500)
```

```
[view(>=30@500)]
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# Ambiguity

- Rarely, ambiguity means you need to adjust priorities

```
[view(24@500)
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```
[view(>=30@500)]
```

- It can't satisfy both
- They have equal priorities
- Ambiguity!

# Ambiguity

- Rarely, ambiguity means you need to adjust priorities

```
[view(24@500)
```

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[view(>=30@525)]
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# Ambiguity

- Rarely, ambiguity means you need to adjust priorities

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[view(>=30@525)]
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- It still can't satisfy both

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[view(24@500)
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- It still can't satisfy both
- The inequality has a higher priority, so it will be satisfied first

# Ambiguity

- Rarely, ambiguity means you need to adjust priorities

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- It still can't satisfy both
- The inequality has a higher priority, so it will be satisfied first
- The equality will be satisfied as closely as possible

# Ambiguity

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```
[view(24@500)
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- It still can't satisfy both
- The inequality has a higher priority, so it will be satisfied first
- The equality will be satisfied as closely as possible
- No ambiguity!

# Ambiguity

- Rarely, ambiguity means you need to adjust priorities

```
[view(24@500)
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```
[view(>=30@525)]
```

- It still can't satisfy both
- The inequality has a higher priority, so it will be satisfied first
- The equality will be satisfied as closely as possible
- No ambiguity!
- view.width = 30

# Ambiguity

- Is my layout ambiguous?

```
[view hasAmbiguousLayout]
```

- What is ambiguous about it?

```
[view exerciseAmbiguityInLayout]
```

```
[window visualizeConstraints: @[] ]
```

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  - Constraints are required by default!

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- Only required constraints can contribute to unsatisfiability
  - Constraints are required by default!
- Sizes are implicitly required to be at least zero

# Unsatisfiability

- Unsatisfiability is immediately reported
- Ambiguity can be temporarily tolerated
- Remove constraints as soon as they might become invalid
- Create valid constraints again in updateConstraints

# Help, I Don’t See Anything!

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- Where are your views?
  - Check their -frame

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- What constraints are making them that size?
  - Output [view constraintsAffectingLayoutForOrientation/Axis: NSLayoutConstraintOrientationHorizontal/Vertical]

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# Help, I Don't See Anything!

- Where are your views?
  - Check their -frame
- What constraints are making them that size?
  - Output [view constraintsAffectingLayoutForOrientation/Axis: NSLayoutConstraintOrientationHorizontal/Vertical] ← 0 or 1
- Is the layout ambiguous?
  - Call [view hasAmbiguousLayout]
  - Call [view exerciseAmbiguityInLayout]

# Help, I Don’t See Anything!

- Some layouts are only satisfiable at 0 size!

# Help, I Don’t See Anything!

- Some layouts are only satisfiable at 0 size!

```
foo.width = bar.width * 2
```

```
bar.width = foo.width * 3
```

# Help, I Don’t See Anything!

- Some layouts are only satisfiable at 0 size!

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foo.width = bar.width * 2
```

```
bar.width = foo.width * 3
```

→

```
foo.width = bar.width = 0
```

*Demo*

# Auto Layout

- Thinking in constraints
  - Transitioning to constraints
- Debugging constraint-based layouts
  - Ambiguity
  - Unsatisfiability
  - Reading log messages
- Unleashing the power of constraints
  - Animation
  - Writing a custom control
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# Anatomy of an Unsatisfiability Log

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NSLayoutConstraint:0x10441ced0
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Constraint's address

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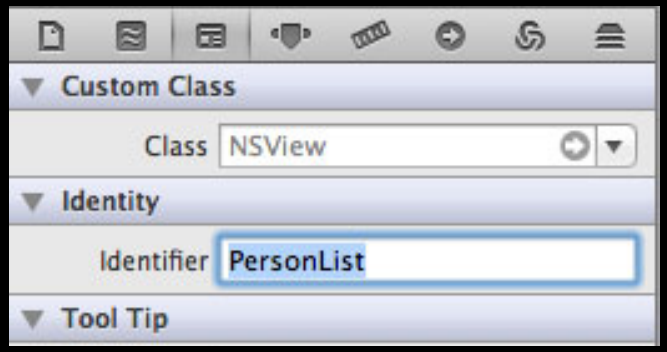

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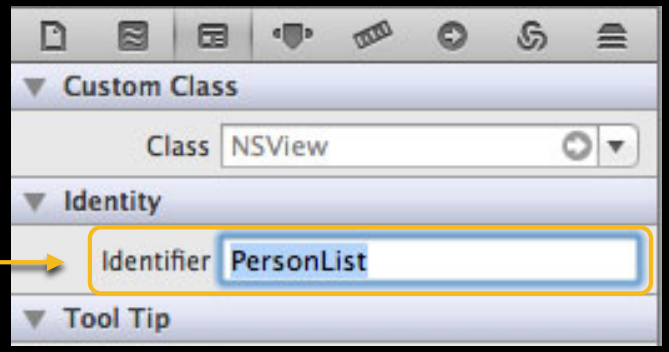

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Attribute

# Anatomy of an Unsatisfiability Log

View's identifier

Relation

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NSLayoutConstraint:0x10441ced0

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Other View

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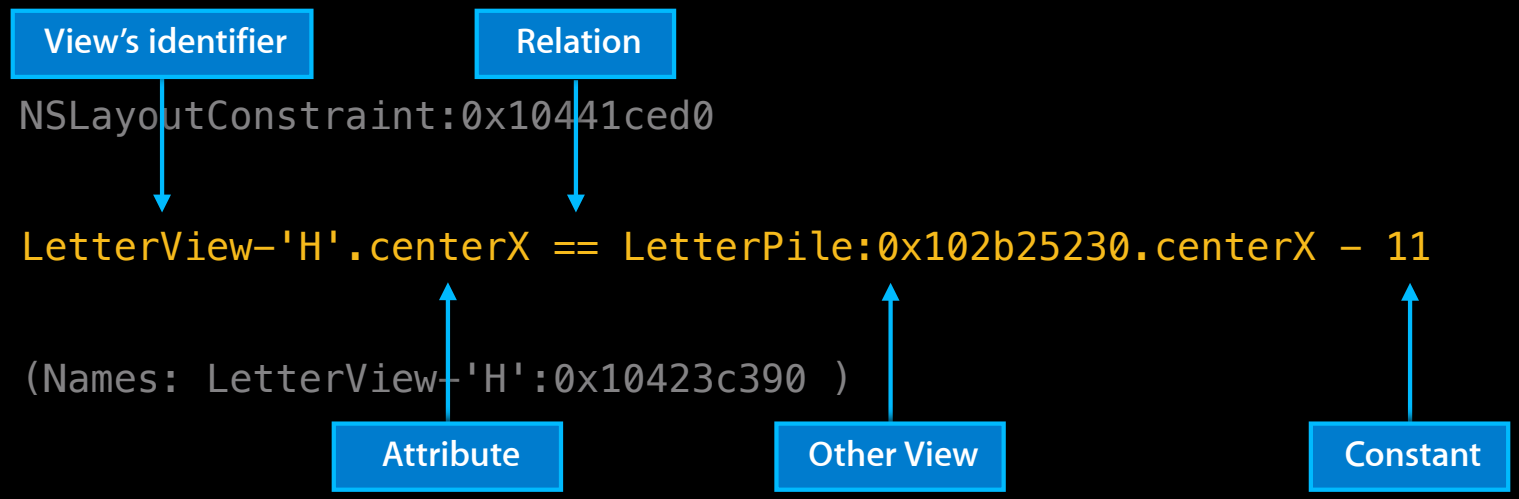


"The letter view's center should be 11 points to the left of the pile's center"

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- Logs use the visual format syntax when possible

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```
H:[NSView:0x102b5b3a0(250)]
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"The view's width is 250"

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```
H:[NSView:0x102b5b3a0(250)]
```

"The view's width is 250"

```
H:[NSView:0x10480cd00]-(>=50)-[NSView:0x10481e9a0]>
```

# Anatomy of an Unsatisfiability Log

- Logs use the visual format syntax when possible

```
H:[NSView:0x102b5b3a0(250)]
```

"The view's width is 250"

```
H:[NSView:0x10480cd00]-(>=50)-[NSView:0x10481e9a0]>
```

"This view is at least 50 points to the right of that view"

# Anatomy of an Unsatisfiability Log

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```
<NSAutoresizingMaskLayoutConstraint:0x10590a360 h=-&- v=&--
V:[NSView:0x102e2af20(50)]>
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- `translatesAutoresizingMaskIntoConstraints` is on for this view

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Autoresizing Mask

- `translatesAutoresizingMaskIntoConstraints` is on for this view
- That produces more than one constraint

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```
<NSAutoresizingMaskLayoutConstraint:0x10590a360 h=-&- v=&--
V:[NSView:0x102e2af20(50)]>
```

"This view's height is 50."

Autoresizing Mask

- `translatesAutoresizingMaskIntoConstraints` is on for this view
- That produces more than one constraint

```
<NSAutoresizingMaskLayoutConstraint:0x103b25030 h=-&- v=&--
  H:|-(200)-[NSView:0x103b25090]
 (Names: '|':FlippedView:0x102e163f0 )>
```

Autoresizing constraint

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<NSAutoresizingMaskLayoutConstraint:0x103b25030 h=-&- v=&--
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200 points between

Horizontal

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200 points between

this view's left edge

Horizontal

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Superview

200 points between

this view's left edge

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Superview's description

```
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 (Names: '|':FlippedView:0x102e163f0 )>
```

“This view’s left edge is 200 points from that of its superview, which is a FlippedView”

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- How do you animate layout changes?
- Apply the new layout and let CoreAnimation handle animation
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  - May transiently appear to violate constraints
- Animate constraints directly
  - Pretty fast
  - Produces a correct layout at every frame

# Animation

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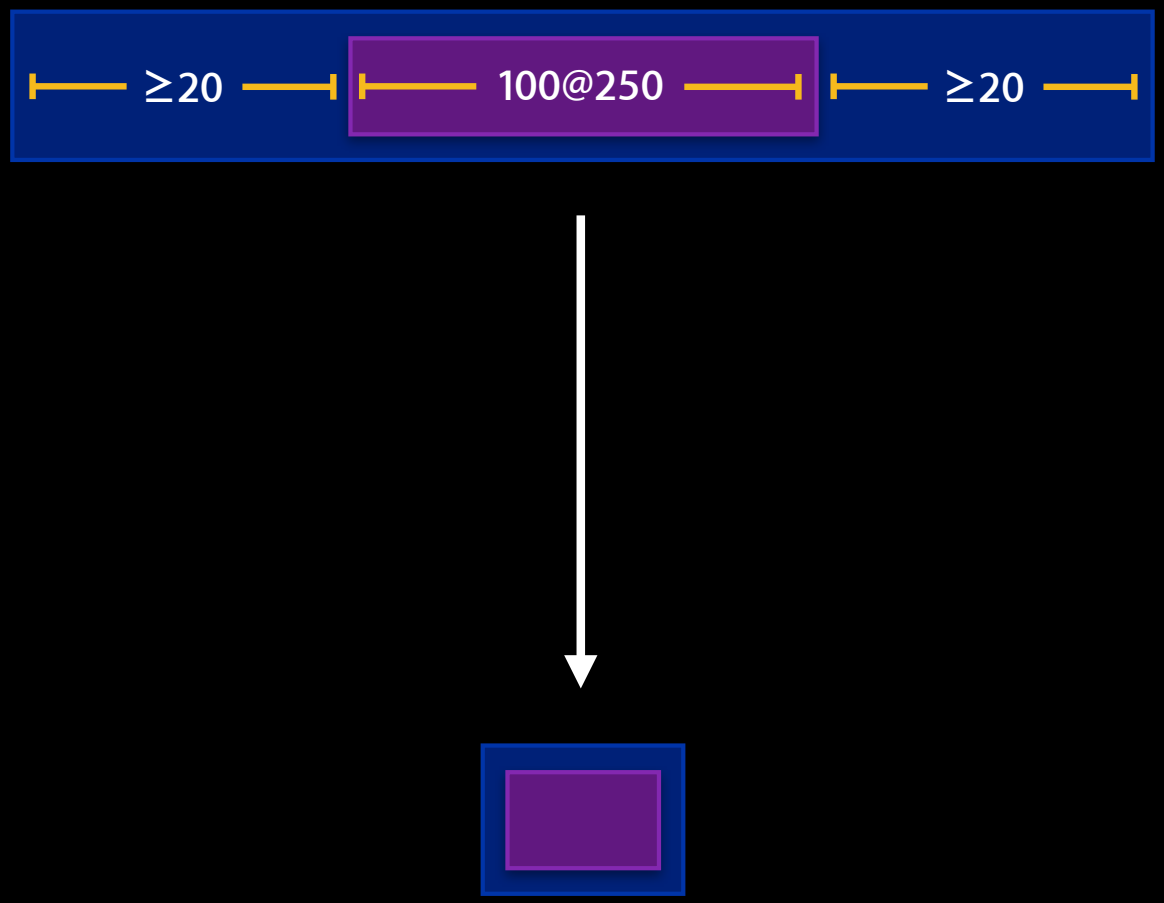

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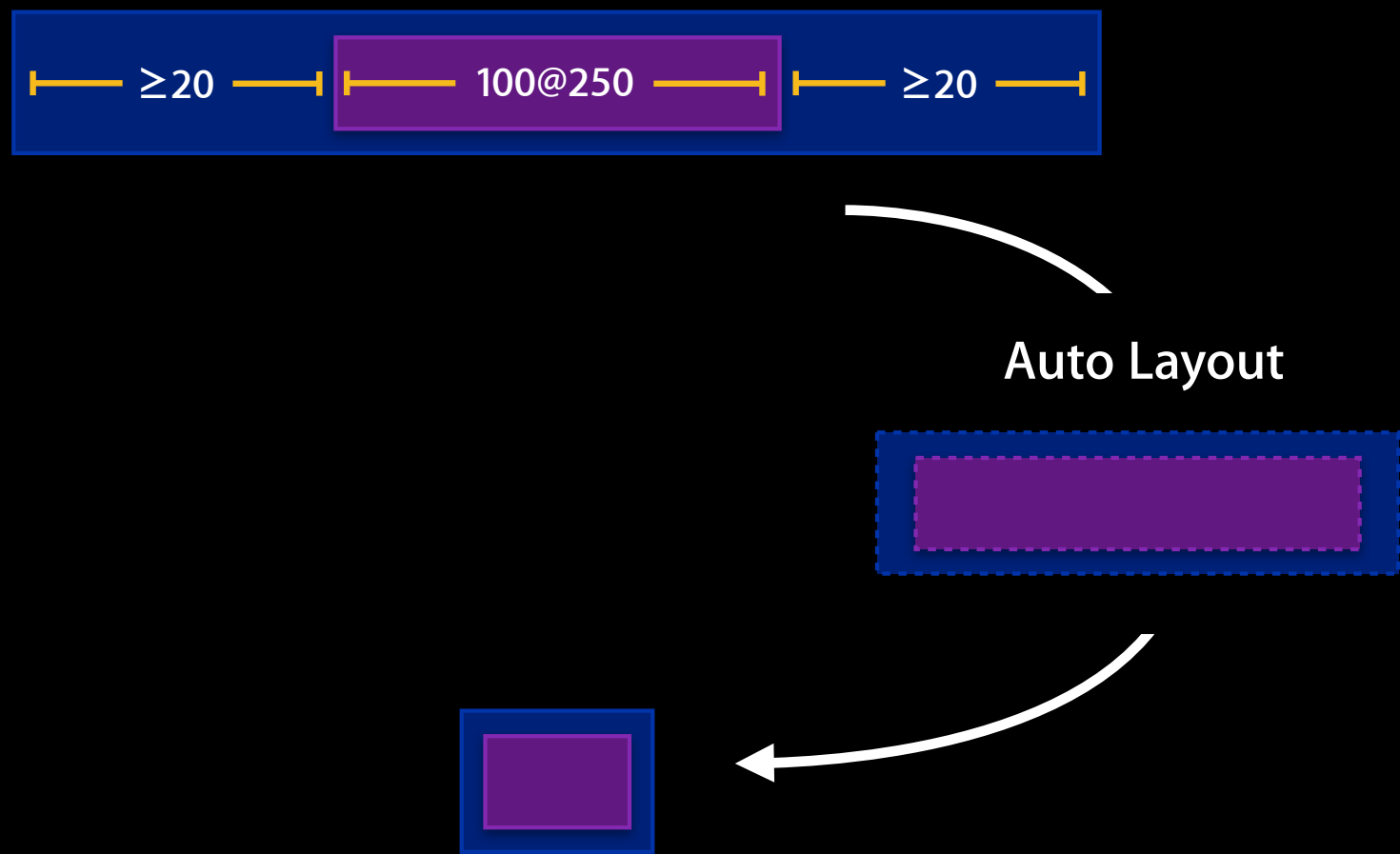

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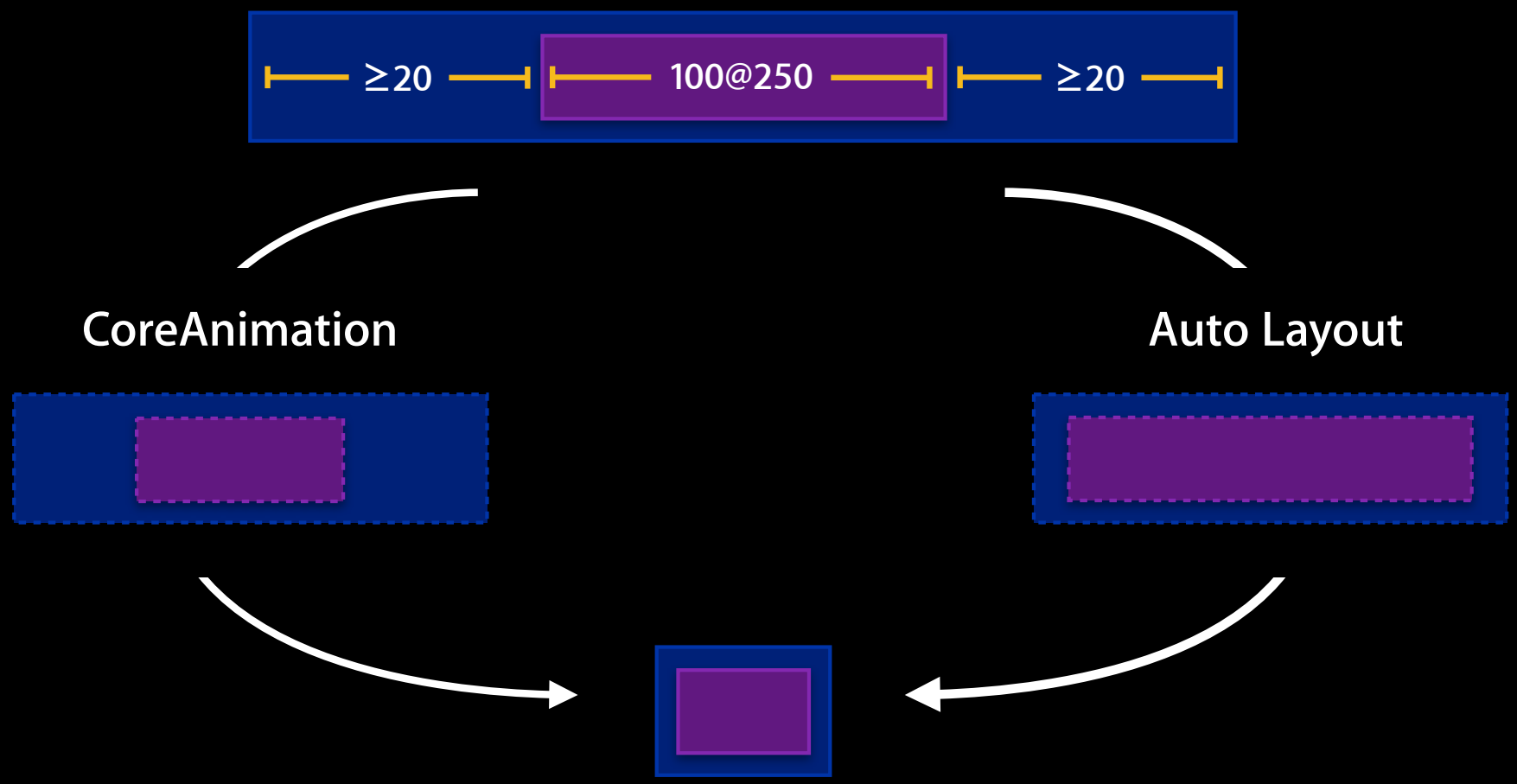

# Animation with CoreAnimation

# Animation with CoreAnimation

- Adjust your constraints
- Within an animation block, call

  `[view layoutIfNeeded]` on iOS

  `[view layoutSubtreeIfNeeded]` on OS X

# Animation with CoreAnimation

- NSView

```
[NSAnimationContext runAnimationGroup:^(NSAnimationContext *context) {
    [context setDuration:0.5];
    [context setAllowsImplicitAnimation:YES];
    [view layoutSubtreeIfNeeded];
} completionHandler:nil]
```

- UIView

```
[UIView animateWithDuration:0.5 animations:^{
    [view layoutIfNeeded];
}]
```

# Animation with NSLayoutConstraint

# Animation with NSLayoutConstraint

```
@interface NSLayoutConstraint
  @property (readonly) NSLayoutAttribute firstAttribute;
  @property (readonly) CGFloat multiplier;
  @property (readwrite) CGFloat constant;
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```
constraint.constant += 10
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OS X only

*Demo*

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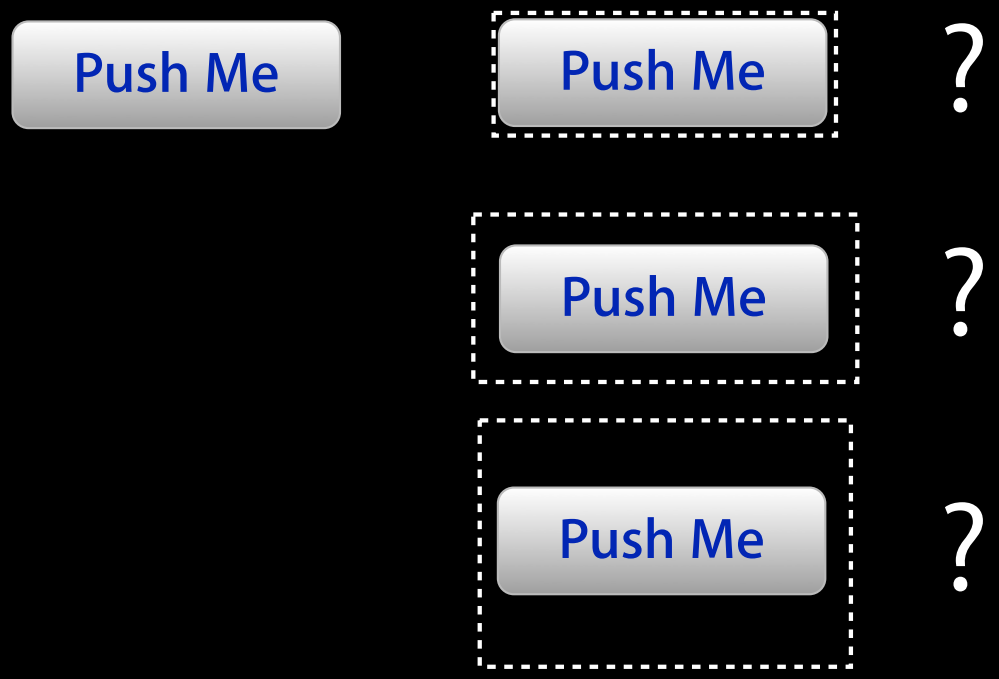

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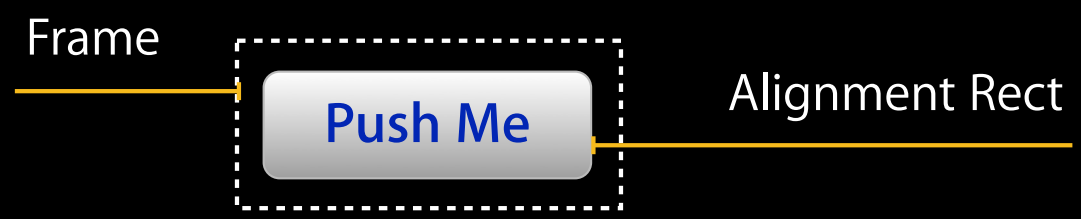

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# Alignment Rects

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- You can convert between alignment rects and frames

```
@implementation (NS,UI)View

- (CGRect)alignmentRectForFrame:(CGRect)frame

- (CGRect)frameForAlignmentRect:(CGRect)alignmentRect
```

# Intrinsic Content Size

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- Many views are equally happy at any size
- Some views have a preferred size

  `sizeToFit`
  `sizeThatFits:`

- In Auto Layout, this is the `intrinsicContentSize`

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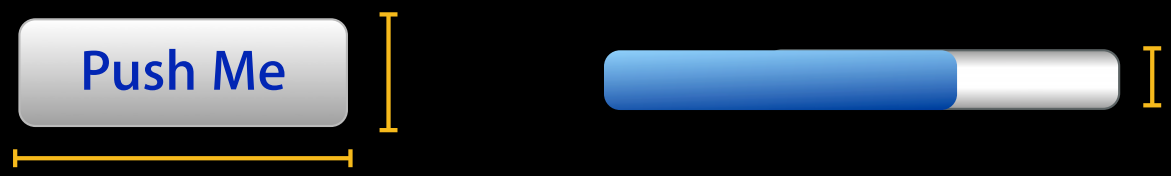

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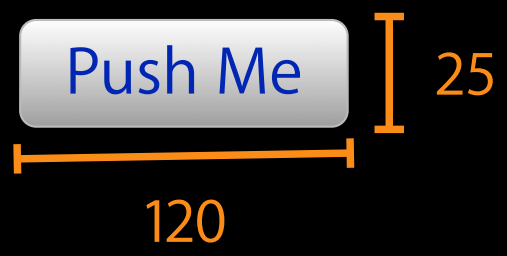
# Intrinsic Content Size

- An intrinsic content size generates two constraints per dimension




```
V:[button(>=25)]
V:[button(<=25)]
```

```
H:[button(>=120]
H:[button(<=120]
```

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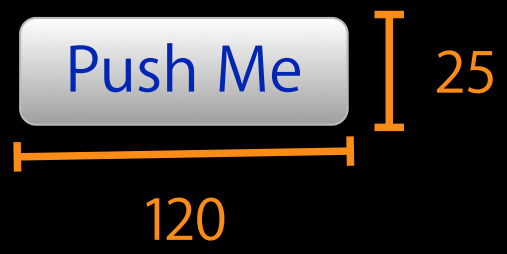


```
V:[button(>=25)]
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```

Compression Resistance

```
H:[button(>=120]
H:[button(<=120]
```

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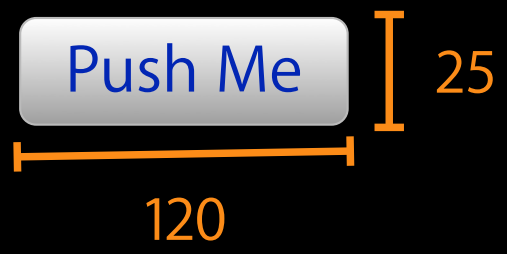


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Content Hugging → `H:[button(<=120]`

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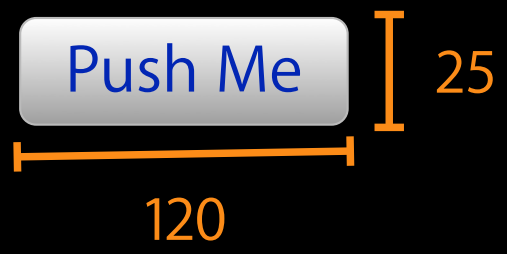


```
V:[button(>=25)]
V:[button(<=25)]
```

Compression Resistance → `H:[button(>=120]`

Content Hugging → `H:[button(<=120]`

- This is sufficient to unambiguously size the view!

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- Why two constraints?
- Because they can have different priorities!

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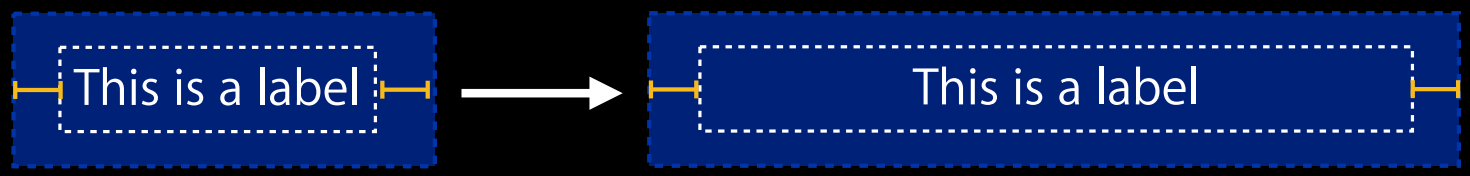


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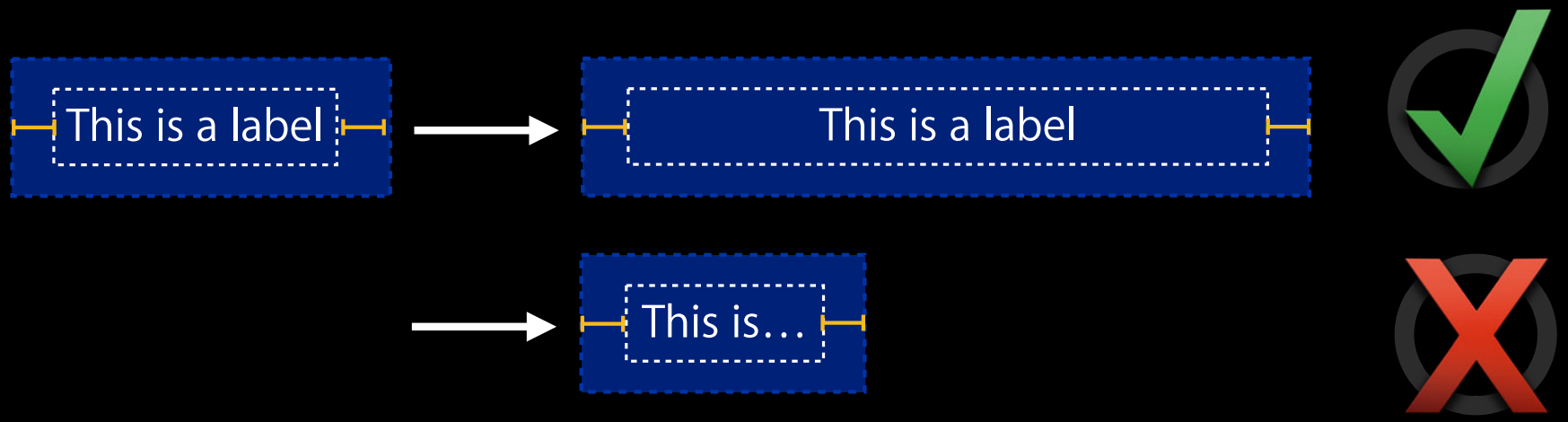

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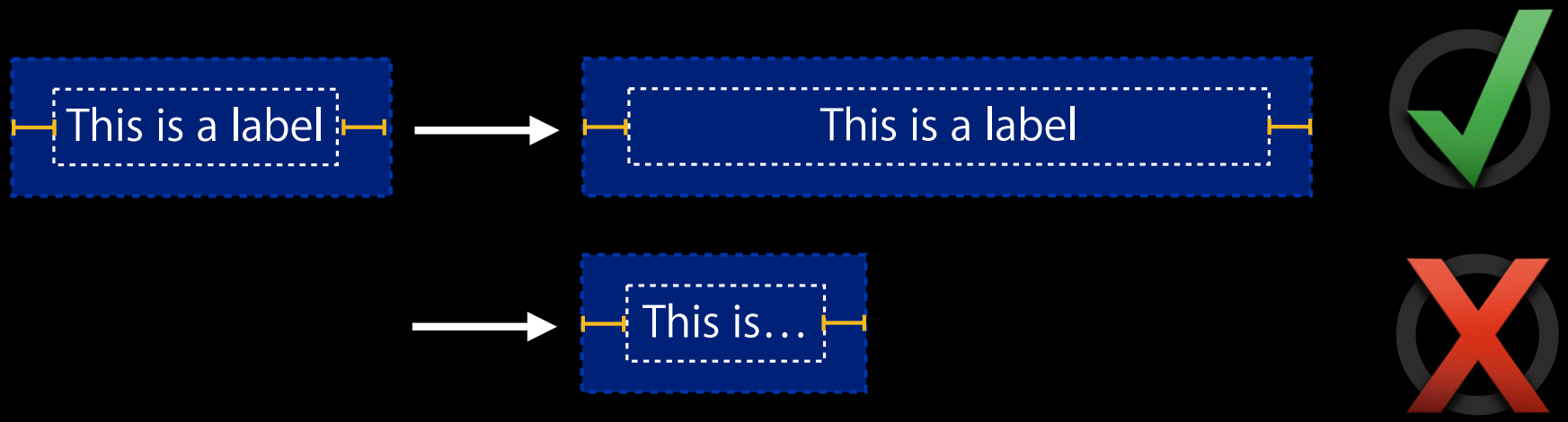


- Low content hugging priority, high compression resistance priority

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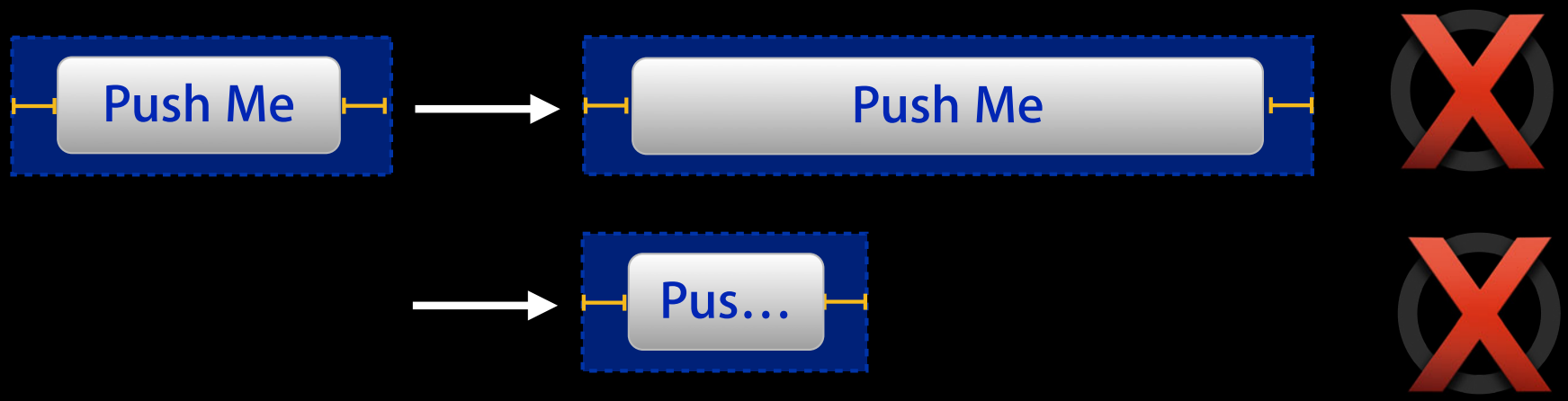


- High content hugging priority, high compression resistance priority

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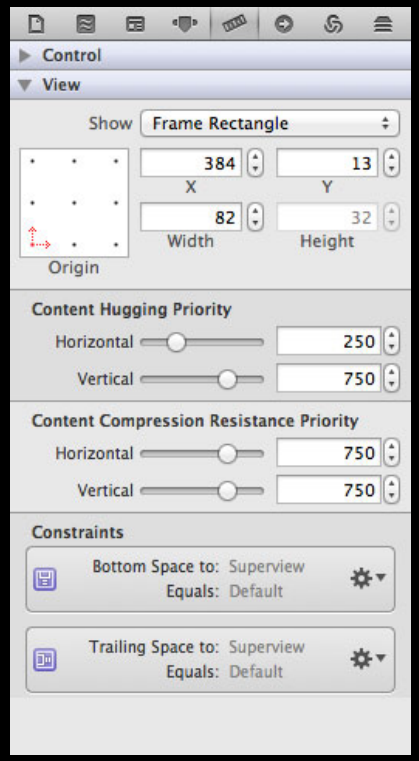

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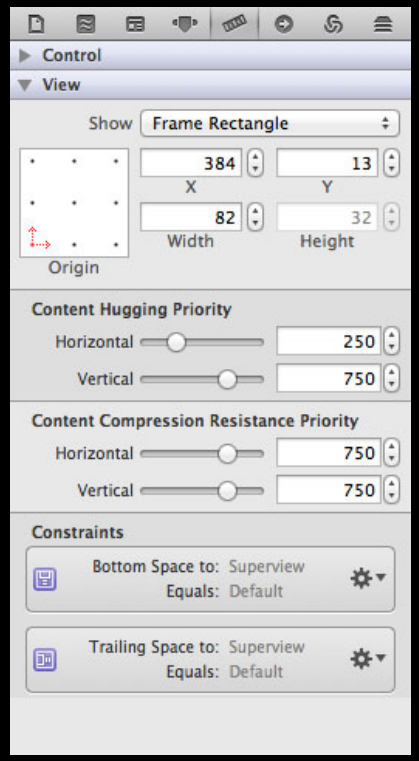

# Intrinsic Content Size

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```
@implementation NSView
- (void)setContentHuggingPriority:(NSLayoutPriority)priority
        forOrientation:(NSLayoutConstraintOrientation)orientation;

- (void)setContentCompressionResistancePriority:(NSLayoutPriority)priority
        forOrientation:(NSLayoutConstraintOrientation)orientation;
@end
```

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```
@implementation UIView
- (void)setContentHuggingPriority:(UILayoutPriority)priority
        forAxis:(UILayoutConstraintAxis)axis;

- (void)setContentCompressionResistancePriority:(UILayoutPriority)priority
        forAxis:(UILayoutConstraintAxis)axis;
@end
```

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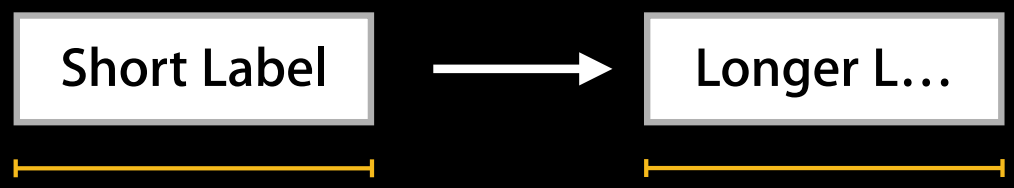

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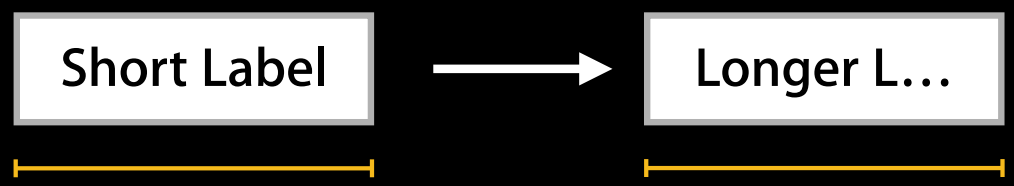


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- Auto Layout reestablishes the sizing constraints
- If you implement a custom control, call this whenever your intrinsicContentSize might change

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`intrinsicContentSize` as a better `sizeToFit`

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```
NSRect alignmentRect = (NSRect){NSZeroPoint,
                                [control intrinsicContentSize]};
[control setFrameSize:
      [control frameForAlignmentRect:alignmentRect].size];
```

# Writing a Custom Control

## Override intrinsicContentSize

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**NSView**

`-layout` sets the receiver's frame to the values determined by the constraints

**UIView**

`-layoutSubviews` sets the receiver's center and bounds to the values determined by the constraints

- Afterwards, the constraints and frames agree
- Override it to do custom layout as long as you maintain that invariant

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## Achieving a layout-dependent view hierarchy

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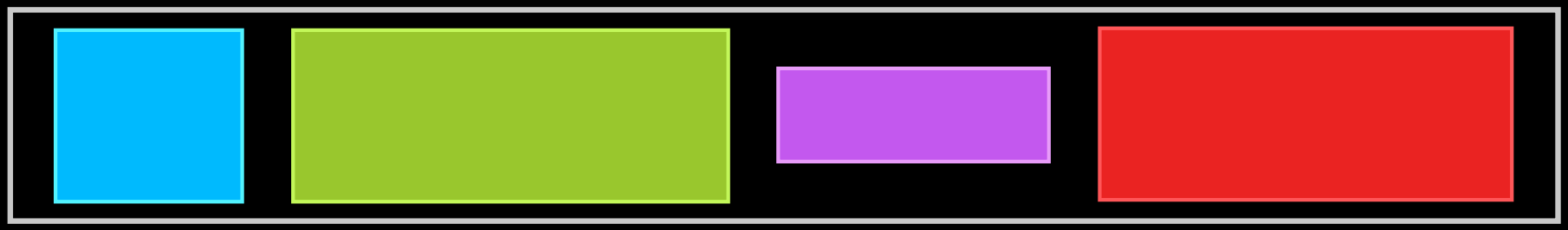

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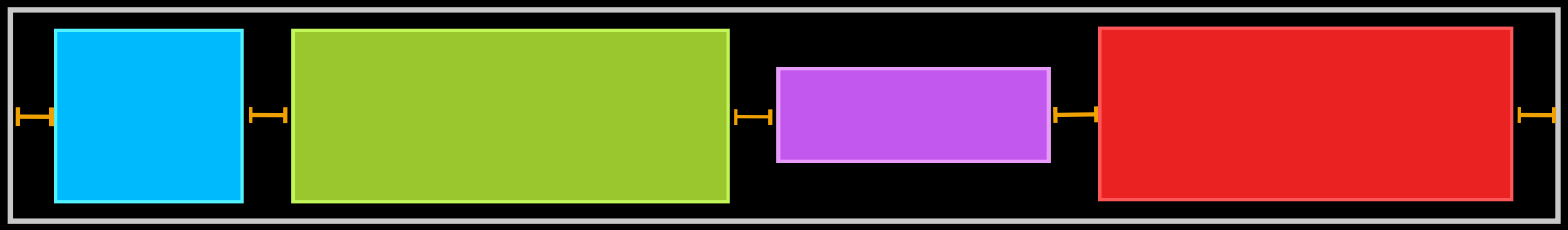

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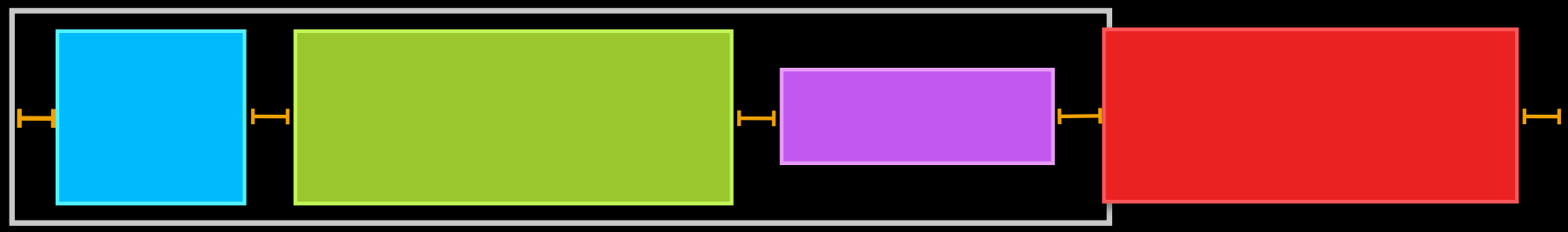

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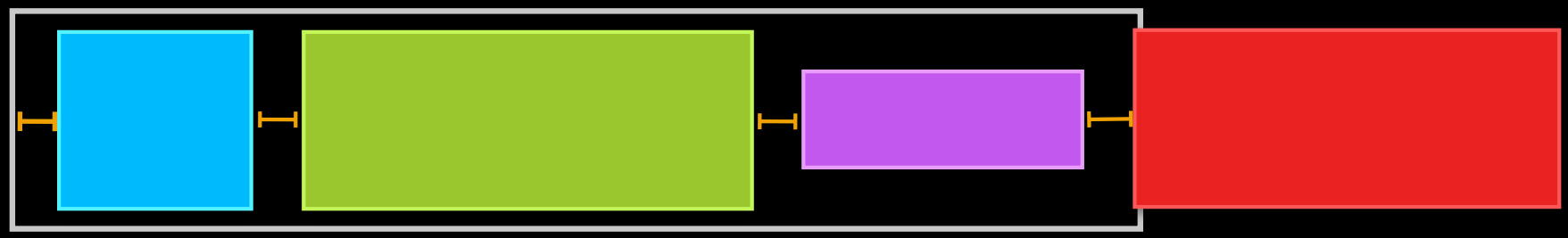

# Overriding layout / layoutSubviews

## Achieving a layout-dependent view hierarchy

# Overriding layout / layoutSubviews

## Achieving a layout-dependent view hierarchy

- Override `-layout` / `-layoutSubviews`
- Call super
- Inspect the resulting view positions and sizes
- Adjust subviews and constraints
- Call super again
- Repeat!

*Demo*

# Auto Layout

- Thinking in constraints
  - Transitioning to constraints
- Debugging constraint-based layouts
  - Ambiguity
  - Unsatisfiability
  - Reading log messages
- Unleashing the power of constraints
  - Animation
  - Writing a custom control
  - Internationalization

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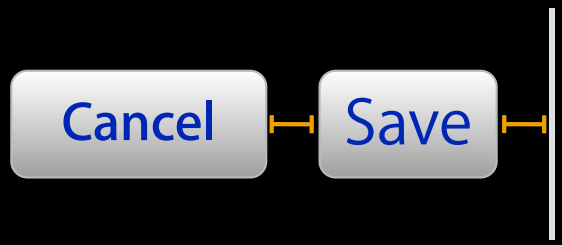

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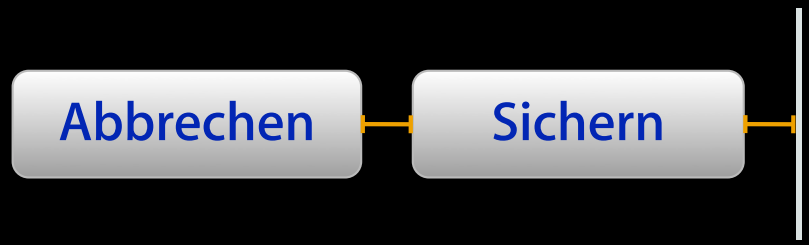
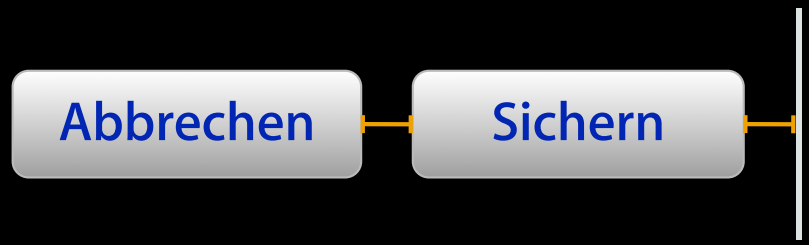


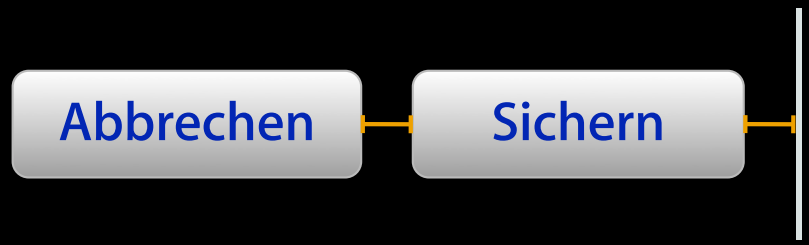
# Internationalization

- One nib can now service multiple localizations
- Control content is translated with a strings file at runtime
- You can fall back to separate nibs when necessary



# Internationalization

- Right-to-left support is built in
- The leading and trailing edges flip under right-to-left localizations



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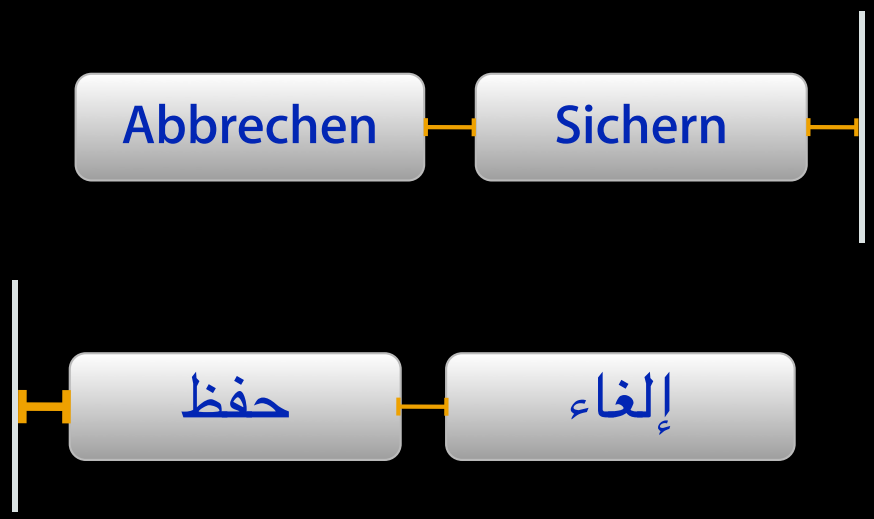

*Demo*

# Summary

- Auto Layout allows for powerful layout with less (or no) code
- Think declaratively
- Be wary of ambiguity and unsatisfiability
- The log messages are there to help
- Judicious overriding lets your custom views integrate with Auto Layout
- Localize with a single nib and multiple strings files

# More Information

**Paul Marcos**
Frameworks Evangelist
pmarcos@apple.com

**Documentation**
Cocoa Auto Layout Guide
http://developer.apple.com/library/mac/#documentation/UserExperience/Conceptual/AutolayoutPG/

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

# Related Sessions

| | |
|---|---|
| Auto Layout by Example | Mission<br>Thursday 11:30AM |

# Labs

| | |
|---|---|
| Auto Layout Lab | App Services Lab B<br>Thursday 2:00PM |

WWDC2012