What's New in Foundation

Session 212

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Michael LeHew, Foundation
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New API Highlights

Key Paths and Key Value Observation

Encoding and Decoding

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New Foundation Features

File provider communication

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Improved available storage space API

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Foundation Performance Improvements

Copy-on-write `NSArray`, `NSDictionary`, `NSSet`

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Faster bridging of `NSNumber` to and from Swift

Key Paths and Key Value Observing

Michael LeHew, Foundation

Key Paths are important

```
// Swift 3 String Key Paths
```

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@objcMembers class Kid : NSObject {
  dynamic var nickname: String = ""
  dynamic var age: Double = 0.0
  dynamic var bestFriend: Kid? = nil
  dynamic var friends: [Kid] = []
}

var ben = Kid(nickname: "Benji", age: 5.5)

let kidsNameKeyPath = #keyPath(Kid.nickname)

let name = ben.valueForKeyPath(kidsNameKeyPath)
ben.setValue("Ben", forKeyPath: kidsNameKeyPath)
```

```swift
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  dynamic var nickname: String = ""
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  dynamic var bestFriend: Kid? = nil
  dynamic var friends: [Kid] = []
}

let ben = Kid(nickname: "Benji", age: 5.5)

let kidsNameKeyPath = #keyPath(Kid.nickname) // String

let name = ben.valueForKeyPath(kidsNameKeyPath)
ben.setValue("Ben", forKeyPath: kidsNameKeyPath)
```

```
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  dynamic var nickname: String = ""
  dynamic var age: Double = 0.0
  dynamic var bestFriend: Kid? = nil
  dynamic var friends: [Kid] = []
}

let ben = Kid(nickname: "Benji", age: 5.5)

let kidsNameKeyPath = #keyPath(Kid.nickname)

let name = ben.valueForKeyPath(kidsNameKeyPath)   // valueForKeyPath(_: String) -> Any
ben.setValue("Ben", forKeyPath: kidsNameKeyPath)  // setValue(_, forKeyPath: String) -> Any
```

Key Paths

Key Paths

Property traversal

Key Paths

Property traversal

Statically type-safe

Key Paths

Property traversal

Statically type-safe

Fast

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Property traversal

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Applicable to all values

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Works on all platforms

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Works on all platforms

Key Paths

Property traversal

Statically type-safe

Fast

Applicable to all values

Works on all platforms

SE-0161 Smart Key Paths

NEW

```
\Kid.nickname
```

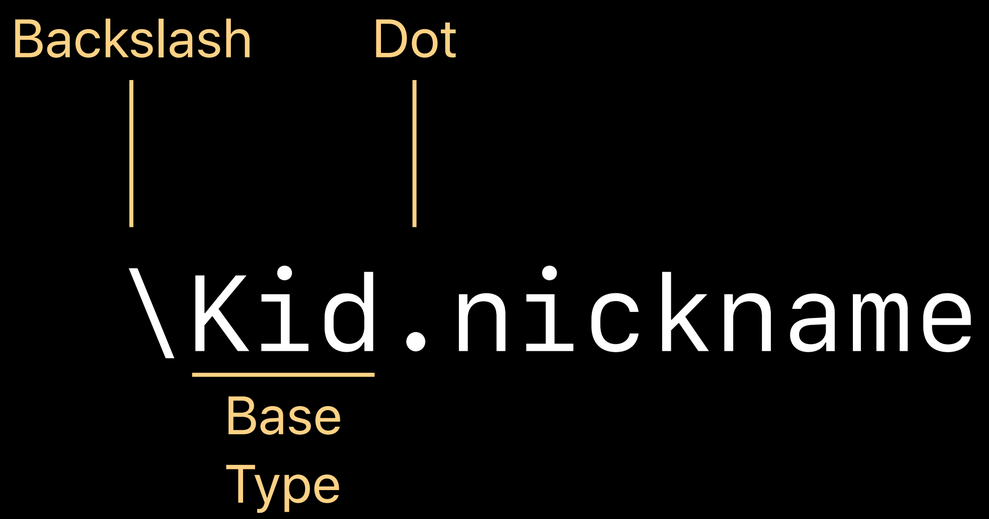
NEW

Backslash

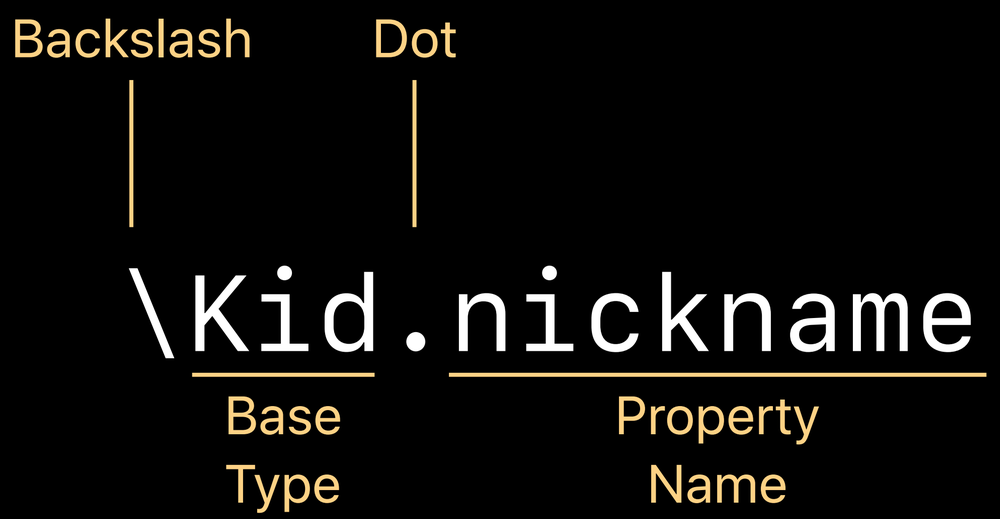
```
\Kid.nickname
```

NEW

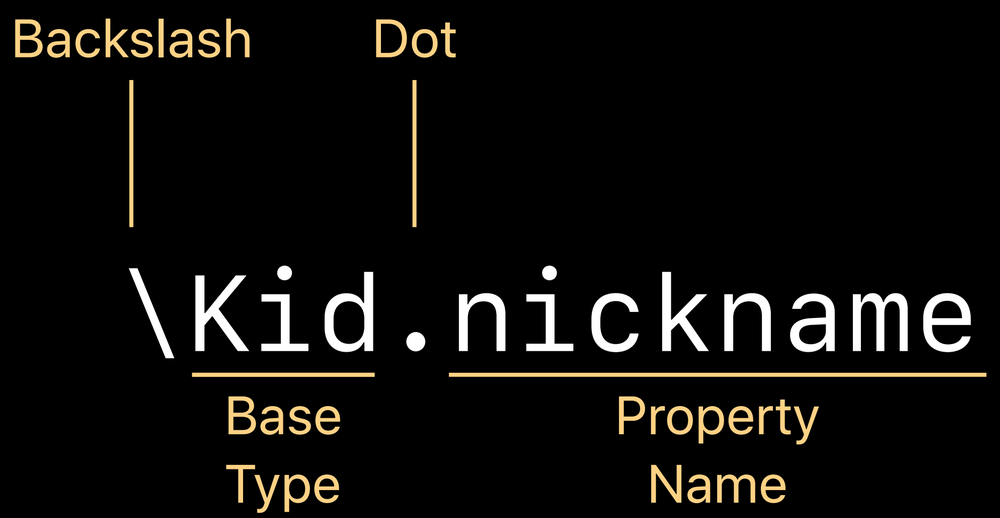
NEW



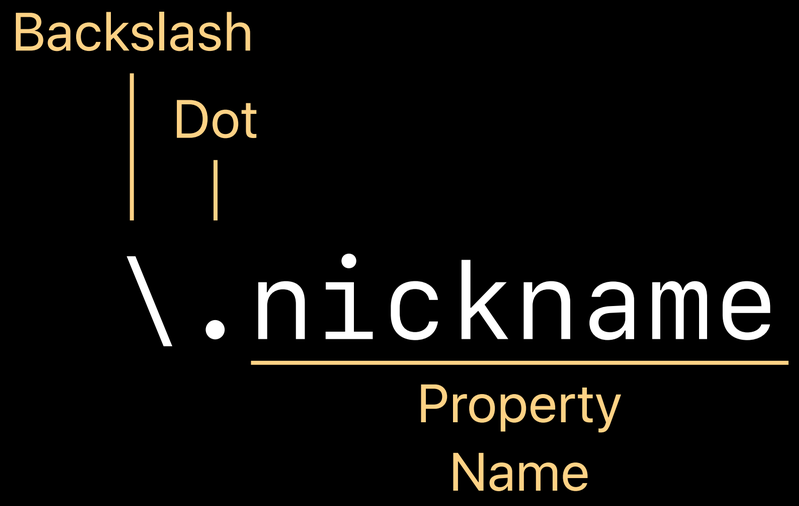
NEW



NEW



NEW



NEW

```
\Kid.nickname.characters
```

Base Type	Property Name	Property Name
Kid	nickname	characters

NEW

Coming Soon

```
\Kid.bestFriend?.nickname
```

Base Type

Property Name

Property Name

NEW

Coming Soon

```
\Kid.friends[0]
```

Base Type

Property Name

Subscript

NEW

Coming Soon

```
\Data.[.startIndex]
```

Base Type

Subscript

NEW

Coming Soon

```
\.[.startIndex]
```

Uniform Syntax

Types	Properties / Subscripts

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`struct`	
`class`	
`@objc class`	

Uniform Syntax

Types	Properties / Subscripts
`struct`	`let`/`var`
`class`	`get`/`set`
`@objc class`	Stored or computed

```
\Kid.age
```

```
let age = ben[keyPath: \Kid.age]
```

```
let age = ben[keyPath: \Kid.age]
```

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```

```
let age = ben[keyPath: \Kid.age]
```


let age = ben[keyPath: \Kid.age]

```
let age = ben[keyPath: \Kid.age]
```

```
let age = ben[keyPath: \Kid.age]

ben[keyPath: \Kid.nickname] = "Ben"
```

```swift
// Using Swift 4 KeyPaths

struct BirthdayParty {
  let celebrant: Kid
  var theme: String
  var attending: [Kid]
}
```

```
// Using Swift 4 KeyPaths

struct BirthdayParty {
  let celebrant: Kid
  var theme: String
  var attending: [Kid]
}

let bensParty = BirthdayParty(celebrant: ben, theme: "Construction", attending: [])
```

```swift
// Using Swift 4 KeyPaths

struct BirthdayParty {
  let celebrant: Kid
  var theme: String
  var attending: [Kid]
}

let bensParty = BirthdayParty(celebrant: ben, theme: "Construction", attending: [])

let birthdayKid = bensParty[keyPath: \BirthdayParty.celebrant]
```

```
// Using Swift 4 KeyPaths

struct BirthdayParty {
  let celebrant: Kid
  var theme: String
  var attending: [Kid]
}

let bensParty = BirthdayParty(celebrant: ben, theme: "Construction", attending: [])

let birthdayKid = bensParty[keyPath: \BirthdayParty.celebrant]

bensParty[keyPath: \BirthdayParty.theme] = "Pirate"
```

```
// Using Swift 4 KeyPaths

struct BirthdayParty {
  let celebrant: Kid
  var theme: String
  var attending: [Kid]
}

let bensParty = BirthdayParty(celebrant: ben, theme: "Construction", attending: [])

let birthdayKid = bensParty[keyPath: \              .celebrant]

bensParty[keyPath: \                .theme] = "Pirate"
```

```swift
// Using Swift 4 KeyPaths

struct BirthdayParty {
  let celebrant: Kid
  var theme: String
  var attending: [Kid]
}

let bensParty = BirthdayParty(celebrant: ben, theme: "Construction", attending: [])

let birthdayKid = bensParty[keyPath: \.celebrant]

bensParty[keyPath: \.theme] = "Pirate"
```

```swift
// Using Swift 4 KeyPaths

struct BirthdayParty {
  let celebrant: Kid
  var theme: String
  var attending: [Kid]
}

let bensParty = BirthdayParty(celebrant: ben, theme: "Construction", attending: [])

let birthdayKid = bensParty[keyPath: \.celebrant]

bensParty[keyPath: \.theme] = "Ninja"
```

```
\Kid.nickname
```

```
let nicknameKeyPath = \Kid.nickname
```

```
let nicknameKeyPath = \Kid.nickname
```

```
KeyPath<Kid, String>
```

```
let nicknameKeyPath = \Kid.nickname
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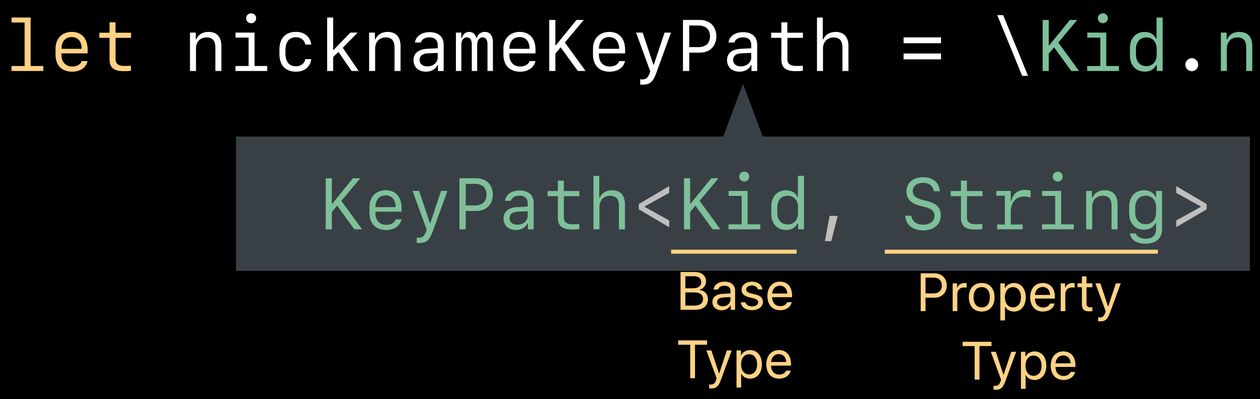
KeyPath<Kid, String>
```

Base Type


let nicknameKeyPath = \Kid.nickname
KeyPath<Kid, String>
Base Type
Property Type

```
// Key Paths and Properties

let birthdayKidsAgeKeyPath = \BirthdayParty.celebrant.age
```

```
// Key Paths and Properties

let birthdayKidsAgeKeyPath = \BirthdayParty.celebrant.age
```

KeyPath<BirthdayParty, Double>

```
// Key Paths and Properties

let birthdayKidsAgeKeyPath = \BirthdayParty.celebrant.age

let birthdayBoysAge = bensParty[keyPath: birthdayKidsAgeKeyPath]
```

```
// Key Paths and Properties

let birthdayKidsAgeKeyPath = \BirthdayParty.celebrant.age

let birthdayBoysAge = bensParty[keyPath: birthdayKidsAgeKeyPath]
```

Double

```
// Key Paths and Properties

let birthdayKidsAgeKeyPath = \BirthdayParty.celebrant.age

let birthdayBoysAge = bensParty[keyPath: birthdayKidsAgeKeyPath]

let mia = Kid(nickname: "Mia", age: 4.5)
let miasParty = BirthdayParty(celebrant: mia, theme: "Space", attending: []))
```

```
// Key Paths and Properties

let birthdayKidsAgeKeyPath = \BirthdayParty.celebrant.age

let birthdayBoysAge = bensParty[keyPath: birthdayKidsAgeKeyPath]

let mia = Kid(nickname: "Mia", age: 4.5)
let miasParty = BirthdayParty(celebrant: mia, theme: "Space", attending: [])

let birthdayGirlsAge = miasParty[keyPath: birthdayKidsAgeKeyPath]
```

```
// Appending Key Paths
```

```
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func partyPersonsAge(party: BirthdayParty,
                     participantPath: KeyPath<BirthdayParty, Kid>) -> Double {


}
```

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func partyPersonsAge(party: BirthdayParty,
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}
```

```
// Appending Key Paths

func partyPersonsAge(party: BirthdayParty,
                     participantPath: KeyPath<BirthdayParty, Kid>) -> Double {
  let kidsAgeKeyPath = participantPath.appending(\.age)

}
```

```
// Appending Key Paths

func partyPersonsAge(party: BirthdayParty,
                     participantPath: KeyPath<BirthdayParty, Kid>) -> Double {
  let kidsAgeKeyPath = participantPath.appending(\.age)

}
```

KeyPath<BirthdayParty, Double>

```
// Appending Key Paths

func partyPersonsAge(party: BirthdayParty,
                     participantPath: KeyPath<BirthdayParty, Kid>) -> Double {
  let kidsAgeKeyPath = participantPath.appending(\.age)
  return party[keyPath: kidsAgeKeyPath]
}
```

```
// Appending Key Paths

func partyPersonsAge(party: BirthdayParty,
                     participantPath: KeyPath<BirthdayParty, Kid>) -> Double {
  let kidsAgeKeyPath = participantPath.appending(\.age)
  return party[keyPath: kidsAgeKeyPath]
}


let birthdayBoysAge = partyPersonsAge(bensParty, \.celebrant)
```

```swift
// Appending Key Paths

func partyPersonsAge(party: BirthdayParty,
                     participantPath: KeyPath<BirthdayParty, Kid>) -> Double {
  let kidsAgeKeyPath = participantPath.appending(\.age)
  return party[keyPath: kidsAgeKeyPath]
}


let birthdayBoysAge = partyPersonsAge(bensParty, \.celebrant)

// Coming Soon
let firstAttendeesAge = partyPersonsAge(bensParty, \.attendees[0])
```

The .appending Rule

```
\BirthdayParty.celebrant.appending(\Kid.age)
```

The .appending Rule

```
\BirthdayParty.celebrant
.appending                \Kid.age
```

The .appending Rule

```
\BirthdayParty.celebrant
.appending                \Kid.age
---------------------------------
\BirthdayParty.celebrant.age
```

The .appending Rule

```
    \BirthdayParty.celebrant   KeyPath<BirthdayParty, Kid>
.appending                \Kid.age   KeyPath<Kid, Double>
──────────────────────────────────────────────────────────
 \BirthdayParty.celebrant.age   KeyPath<BirthdayParty, Double>
```

The .appending Rule

```
KeyPath<BirthdayParty, Kid>

                KeyPath<Kid, Double>

KeyPath<BirthdayParty,      Double>
```

The .appending Rule

```
KeyPath<BirthdayParty, Kid>
```

```
                KeyPath<Kid, Double>

KeyPath<BirthdayParty,      Double>
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The .appending Rule

The .appending Rule

```
KeyPath<BirthdayParty, Double>
```

The `.appending` Rule

```
KeyPath<BirthdayParty, Double>
```

Base Type

The `.appending` Rule

```
KeyPath<BirthdayParty, Double>
```

Base Type

Property Type

```
// Type Erased Key Paths
```

```
// Type Erased Key Paths

let titles = ["Theme", "Attending", "Birthday Kid"]
let partyPaths = [\BirthdayParty.theme, \BirthdayParty.attending, \BirthdayParty.celebrant]
```

```
// Type Erased Key Paths

let titles = ["Theme", "Attending", "Birthday Kid"]
let partyPaths = [\BirthdayParty.theme, \BirthdayParty.attending, \BirthdayParty.celebrant]
```

String

```
// Type Erased Key Paths

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```

String

[Kid]

```
// Type Erased Key Paths

let titles = ["Theme", "Attending", "Birthday Kid"]
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String

[Kid]

Kid

```
// Type Erased Key Paths

let titles = ["Theme", "Attending", "Birthday Kid"]
let partyPaths = [\BirthdayParty.theme, \BirthdayParty.attending, \BirthdayParty.celebrant]
```

```
[PartialKeyPath<BirthdayParty>]
```

```
// Type Erased Key Paths

let titles = ["Theme", "Attending", "Birthday Kid"]
let partyPaths = [\BirthdayParty.theme, \BirthdayParty.attending, \BirthdayParty.celebrant]

for (title, partyPath) in zip(titles, partyPaths) {
   let partyValue = miasParty[keyPath: partyPath]
   print("\(title)\n\(partyValue)\n")
}
```

```
// Type Erased Key Paths

let titles = ["Theme", "Attending", "Birthday Kid"]
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    let partyValue = miasParty[keyPath: partyPath]
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}
```

```
Theme
Space

Attending
["Ben"]

Birthday Kid
Mia
```

```
// Mutating Key Paths

extension BirthdayParty {




}
```

```
// Mutating Key Paths

extension BirthdayParty {
  func blowCandles(ageKeyPath: WritableKeyPath<BirthdayParty, Double>) {


  }
}
```

```
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// Mutating Key Paths

extension BirthdayParty {
  func blowCandles(ageKeyPath: WritableKeyPath<BirthdayParty, Double>) {
    let age = self[keyPath: ageKeyPath]
    self[keyPath: ageKeyPath] = floor(age) + 1.0
  }
}

bensParty.blowCandles(ageKeyPath: \.celebrant.age)
```

```
// Mutating Key Paths

extension BirthdayParty {
  func blowCandles(ageKeyPath: WritableKeyPath<BirthdayParty, Double>) {
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  }
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bensParty.blowCandles(ageKeyPath: \.celebrant.age)
```

error: Cannot assign to immutable expression of type 'Double'

```
// Mutating Key Paths

extension BirthdayParty {
  func blowCandles(ageKeyPath: WritableKeyPath<BirthdayParty, Double>) {
    let age = self[keyPath: ageKeyPath]
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  }
}

bensParty.blowCandles(ageKeyPath: \.celebrant.age)
```

```
@objcMembers
class Kid : NSObject  {
  dynamic var age: Double
}
```

```
// Mutating Key Paths

extension BirthdayParty {
  func blowCandles(ageKeyPath: WritableKeyPath<BirthdayParty, Double>) {
    let age = self[keyPath: ageKeyPath]
    self[keyPath: ageKeyPath] = floor(age) + 1.0
  }
}

bensParty.blowCandles(ageKeyPath: \.celebrant.age)
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```
@objcMembers
class Kid : NSObject  {
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```
// Mutating Key Paths

extension BirthdayParty {
  func blowCandles(ageKeyPath: WritableKeyPath<BirthdayParty, Double>) {
    let age = self[keyPath: ageKeyPath]
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}

bensParty.blowCandles(ageKeyPath: \.celebrant.age)
```

```
@objcMembers
class Kid : NSObject  {
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```
// Mutating Key Paths

extension BirthdayParty {
  func blowCandles(ageKeyPath: WritableKeyPath<BirthdayParty, Double>) {
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  }
}

bensParty.blowCandles(ageKeyPath: \.celebrant.age)
```

```
@objcMembers
class Kid : NSObject  {
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}
```

```
// Mutating Key Paths

extension BirthdayParty {
  func blowCandles(ageKeyPath: WritableKeyPath<BirthdayParty, Double>) {
    let age = self[keyPath: ageKeyPath]
    self[keyPath: ageKeyPath] = floor(age) + 1.0
  }
}

bensParty.blowCandles(ageKeyPath: \.celebrant.age)
```

```
@objcMembers
class Kid : NSObject  {
  dynamic var age: Double
}
```

```
// Mutating Key Paths

extension BirthdayParty {
  func blowCandles(ageKeyPath: WritableKeyPath<BirthdayParty, Double>) {
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// Mutating Key Paths

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    self[keyPath: ageKeyPath] = floor(age) + 1.0
  }
}

bensParty.blowCandles(ageKeyPath: \.celebrant.age)
```

```
@objcMembers
class Kid : NSObject  {
  dynamic var age: Double
}

struct BirthdayParty  {
  let celebrant: Kid
}
```

```
// Mutating Key Paths

extension BirthdayParty {
  func blowCandles(ageKeyPath: WritableKeyPath<BirthdayParty, Double>) {
    let age = self[keyPath: ageKeyPath]
    self[keyPath: ageKeyPath] = floor(age) + 1.0
  }
}

bensParty.blowCandles(ageKeyPath: \.celebrant.age)
```

```
@objcMembers
class Kid : NSObject  {
  dynamic var age: Double
}

struct BirthdayParty  {
  let celebrant: Kid
}
```

```
// Mutating Key Paths

extension BirthdayParty {
  mutating func blowCandles(ageKeyPath: WritableKeyPath<BirthdayParty, Double>) {
    let age = self[keyPath: ageKeyPath]
    self[keyPath: ageKeyPath] = floor(age) + 1.0
  }
}

bensParty.blowCandles(ageKeyPath: \.celebrant.age)
```

```
@objcMembers
class Kid : NSObject  {
  dynamic var age: Double
}

struct BirthdayParty  {
  let celebrant: Kid
}
```

```
// Mutating Key Paths

extension BirthdayParty {
  mutating func blowCandles(ageKeyPath: WritableKeyPath<BirthdayParty, Double>) {
    let age = self[keyPath: ageKeyPath]
    self[keyPath: ageKeyPath] = floor(age) + 1.0
  }
}

bensParty.blowCandles(ageKeyPath: \.celebrant.age)
```

```
@objcMembers
class Kid : NSObject  {
  dynamic var age: Double
}

struct BirthdayParty  {
  let celebrant: Kid
}
```

```
// Mutating Key Paths

extension BirthdayParty {
  mutating func blowCandles(ageKeyPath: WritableKeyPath<BirthdayParty, Double>) {
    let age = self[keyPath: ageKeyPath]
    self[keyPath: ageKeyPath] = floor(age) + 1.0
  }
}

bensParty.blowCandles(ageKeyPath: \.celebrant.age)
```

```
@objcMembers
class Kid : NSObject  {
  dynamic var age: Double
}

struct BirthdayParty  {
  let celebrant: Kid
}
```

```
// Mutating Key Paths

extension BirthdayParty {
  mutating func blowCandles(ageKeyPath: WritableKeyPath<BirthdayParty, Double>) {
    let age = self[keyPath: ageKeyPath]
    self[keyPath: ageKeyPath] = floor(age) + 1.0
  }
}

bensParty.blowCandles(ageKeyPath: \.celebrant.age)
```

```
@objcMembers
class Kid : NSObject  {
  dynamic var age: Double
}

struct BirthdayParty  {
  let celebrant: Kid
}
```

```
// Mutating Key Paths

extension BirthdayParty {
  func blowCandles(ageKeyPath: ReferenceWritableKeyPath<BirthdayParty, Double>) {
    let age = self[keyPath: ageKeyPath]
    self[keyPath: ageKeyPath] = floor(age) + 1.0
  }
}

bensParty.blowCandles(ageKeyPath: \.celebrant.age)
```

```
@objcMembers
class Kid : NSObject  {
  dynamic var age: Double
}

struct BirthdayParty  {
  let celebrant: Kid
}
```

```
// Mutating Key Paths

extension BirthdayParty {
  func blowCandles(ageKeyPath: ReferenceWritableKeyPath<BirthdayParty, Double>) {
    let age = self[keyPath: ageKeyPath]
    self[keyPath: ageKeyPath] = floor(age) + 1.0
  }
}

bensParty.blowCandles(ageKeyPath: \.celebrant.age)

assert(6.0 == ben.age)
```

```
@objcMembers
class Kid : NSObject  {
  dynamic var age: Double
}

struct BirthdayParty  {
  let celebrant: Kid
}
```

`WritableKeyPath`

Write directly into value-type base (inout/mutating)

`WritableKeyPath`

Write directly into value-type base (inout/mutating)

`ReferenceWritableKeyPath`

Write into a reference-type base

```
PartialKeyPath<Base>
KeyPath<Base, Property>
WritableKeyPath<Base, Property>
ReferenceWritableKeyPath<Base, Property>
```

```
AnyKeyPath
PartialKeyPath<Base>
KeyPath<Base, Property>
WritableKeyPath<Base, Property>
ReferenceWritableKeyPath<Base, Property>
```

Read-Only Properties

Read-Only Properties

`KeyPath`

Read-Write Properties

Read-Write Properties

Mutable value type base

Read-Write Properties

Mutable value type base

`WritableKeyPath`

Read-Write Properties

Immutable value type base

Read-Write Properties

Immutable value type base

`KeyPath`

Read-Write Properties

Reference type base

Read-Write Properties

Reference type base

`ReferenceWritableKeyPath`

```
// Key Paths Capture By Value
// Coming Soon
```

```
// Key Paths Capture By Value
// Coming Soon

var index = 0
let whichKidKeyPath = \BirthdayParty.attendees[index]
let firstAttendeesAge = partyPersonsAge(party, whichKidKeyPath)
```

```
// Key Paths Capture By Value
// Coming Soon

var index = 0
let whichKidKeyPath = \BirthdayParty.attendees[index]
let firstAttendeesAge = partyPersonsAge(party, whichKidKeyPath)
```

```
// Key Paths Capture By Value
// Coming Soon

var index = 0
let whichKidKeyPath = \BirthdayParty.attendees[index]
let firstAttendeesAge = partyPersonsAge(party, whichKidKeyPath)
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```
// Key Paths Capture By Value
// Coming Soon

var index = 0
let whichKidKeyPath = \BirthdayParty.attendees[index]
let firstAttendeesAge = partyPersonsAge(party, whichKidKeyPath)
```

\BirthdayParty.attendees[0]

```
// Key Paths Capture By Value
// Coming Soon

var index = 0
let whichKidKeyPath = \BirthdayParty.attendees[index]
let firstAttendeesAge = partyPersonsAge(party, whichKidKeyPath)

index = 1
let sameAge = partyPersonsAge(party, whichKidKeyPath)
```

```
// Key Paths Capture By Value
// Coming Soon

var index = 0
let whichKidKeyPath = \BirthdayParty.attendees[index]
let firstAttendeesAge = partyPersonsAge(party, whichKidKeyPath)

index = 1
let sameAge = partyPersonsAge(party, whichKidKeyPath)
```

```
// Key Paths Capture By Value
// Coming Soon

var index = 0
let whichKidKeyPath = \BirthdayParty.attendees[index]
let firstAttendeesAge = partyPersonsAge(party, whichKidKeyPath)

index = 1
let sameAge = partyPersonsAge(party, whichKidKeyPath)
```

\BirthdayParty.attendees[0]

Key Paths

Key Value Observing

mia

NEW

```
let observation = mia.observe(\.age) { ... }
```

NEW

```
let observation = mia.observe(\.age) { ... }
```

Observe using
key path

NEW

Observation

```
let observation = mia.observe(\.age) { ... }
```

Observe using
key path

NEW

Observation

Reaction Closure

```
let observation = mia.observe(\.age) { ... }
```

Observe using key path

NEW

```
let observation = mia.observe(\.age) {  observed, change in

}
```

NEW

```
let observation = mia.observe(\.age) {  observed, change in

}
```

Kid

NEW

```
let observation = mia.observe(\.age) {  observed, change in

}
```

Kid

NSKeyValueObservedChange<Double>

```
// Cocoa Adoption of Key Paths: KVO

@objcMembers class KindergartenController : NSObject {
  dynamic var representedKid: Kid

  init(kid: Kid) {
    representedKid = kid









  }
}
```

```
// Cocoa Adoption of Key Paths: KVO

@objcMembers class KindergartenController : NSObject {
  dynamic var representedKid: Kid
  var ageObservation: NSKeyValueObservation
  init(kid: Kid) {
    representedKid = kid









  }
}
```

```
// Cocoa Adoption of Key Paths: KVO

@objcMembers class KindergartenController : NSObject {
  dynamic var representedKid: Kid
  var ageObservation: NSKeyValueObservation
  init(kid: Kid) {
    representedKid = kid
    ageObservation = observe(\.representedKid.age) { observed, change in



    }
  }
}
```

```
// Cocoa Adoption of Key Paths: KVO

@objcMembers class KindergartenController : NSObject {
  dynamic var representedKid: Kid
  var ageObservation: NSKeyValueObservation
  init(kid: Kid) {
    representedKid = kid
    ageObservation = observe(\.representedKid.age) { observed, change in
      if observed.kid.age > 5 {
        print("Happy birthday \(observed.kid.nickname)! Time for kindergarten!")
      }
    }
  }
}
```

```
// Cocoa Adoption of Key Paths: KVO

@objcMembers class KindergartenController : NSObject {
  dynamic var representedKid: Kid
  var ageObservation: NSKeyValueObservation
  init(kid: Kid) {
    representedKid = kid
    ageObservation = observe(\.representedKid.age) { observed, change in
      if observed.kid.age > 5 {
        print("Happy birthday \(observed.kid.nickname)! Time for kindergarten!")
      }
    }
  }
}
let controller = KindergartenController(kid: mia)
miasParty.blowCandles(\.celebrant.age)
```

```
// Cocoa Adoption of Key Paths: KVO

@objcMembers class KindergartenController : NSObject {
  dynamic var representedKid: Kid
  var ageObservation: NSKeyValueObservation
  init(kid: Kid) {
    representedKid = kid
    ageObservation = observe(\.representedKid.age) { observed, change in
      if observed.kid.age > 5 {
        print("Happy birthday \(observed.kid.nickname)! Time for kindergarten!")
      }
    }
  }
}
let controller = KindergartenController(kid: mia)
miasParty.blowCandles(\.celebrant.age)
```

```
Happy birthday Mia! Time for kindergarten!
```

```
#keyPath(Kid.nickname)
```

```
#keyPath(Kid.nickname)

\Kid.nickname
```

```
\Kid.nickname
```

Encoding and Decoding

Tony Parker, Foundation

Encoding and Decoding

Conversion between Swift data structures and archived formats

Encoding and Decoding

Conversion between Swift data structures and archived formats

Swift and archived formats have strong typing mismatch

Encoding and Decoding

Conversion between Swift data structures and archived formats

Swift and archived formats have strong typing mismatch

Solution is close integration with Swift

```
{
  "name": "Monalisa Octocat",
  "email": "support@github.com",
  "date": "2011-04-14T16:00:49Z"
}
```

```
{
  "name": "Monalisa Octocat",
  "email": "support@github.com",
  "date": "2011-04-14T16:00:49Z"
}
```

```
struct Author {
  let name: String
  let email: String
  let date: Date
}
```

```
{
  "name": "Monalisa Octocat",
  "email": "support@github.com",
  "date": "2011-04-14T16:00:49Z"
}
```

```
struct Author : Codable {
  let name: String
  let email: String
  let date: Date
}
```

```
let jsonData = """
{
  "name": "Monalisa Octocat",
  "email": "support@github.com",
  "date": "2011-04-14T16:00:49Z"
}
""".data(using: .utf8)!

struct Author : Codable {
  let name: String
  let email: String
  let date: Date
}
```

```
let jsonData = """
{
  "name": "Monalisa Octocat",
  "email": "support@github.com",
  "date": "2011-04-14T16:00:49Z"
}
""".data(using: .utf8)!

struct Author : Codable {
  let name: String
  let email: String
  let date: Date
}

let decoder = JSONDecoder()
```

```
let jsonData = """
{
  "name": "Monalisa Octocat",
  "email": "support@github.com",
  "date": "2011-04-14T16:00:49Z"
}
""".data(using: .utf8)!

struct Author : Codable {
  let name: String
  let email: String
  let date: Date
}

let decoder = JSONDecoder()
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let jsonData = """
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}
""".data(using: .utf8)!

struct Author : Codable {
  let name: String
  let email: String
  let date: Date
}

let decoder = JSONDecoder()
decoder.dateDecodingStrategy = .iso8601
```

```
let jsonData = """
{
  "name": "Monalisa Octocat",
  "email": "support@github.com",
  "date": "2011-04-14T16:00:49Z"
}
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let jsonData = """
{
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  "email": "support@github.com",
  "date": "2011-04-14T16:00:49Z"
}
""".data(using: .utf8)!

struct Author : Codable {
  let name: String
  let email: String
  let date: Date
}

let decoder = JSONDecoder()
decoder.dateDecodingStrategy = .iso8601
let author = try decoder.decode(Author.self, from: jsonData)
```

```
let jsonData = """
{
  "name": "Monalisa Octocat",
  "email": "support@github.com",
  "date": "2011-04-14T16:00:49Z"
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struct Author : Codable {
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```
{
  "name": "Monalisa Octocat",
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  "date": "2011-04-14T16:00:49Z"
}
```

```
{
  "name": "Monalisa Octocat",
  "email": "support@github.com",
  "date": "2011-04-14T16:00:49Z"
}
```

```
        {
  "name": "Monalisa Octocat",
  "email": "support@github.com",
  "date": "2011-04-14T16:00:49Z"
}
```

```
{
  "url": "https://api.github.com/.../6dcb09",
  "author": {
    "name": "Monalisa Octocat",
    "email": "support@github.com",
    "date": "2011-04-14T16:00:49Z"
  },
  "message": "Fix all the bugs",
  "comment_count": 0,
}
```

```
{
  "url": "https://api.github.com/.../6dcb09",
  "author": {
    "name": "Monalisa Octocat",
    "email": "support@github.com",
    "date": "2011-04-14T16:00:49Z"
  },
  "message": "Fix all the bugs",
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}
```

```
struct Author : Codable {
  let name: String
  let email: String
  let date: Date
}
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{
  "url": "https://api.github.com/.../6dcb09",
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struct Author : Codable {
  let name: String
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```
{
  "url": "https://api.github.com/.../6dcb09",
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    "date": "2011-04-14T16:00:49Z"
  },
  "message": "Fix all the bugs",
  "comment_count": 0,
}
```

```
struct Commit : Codable {
  let url: URL
  struct Author : Codable {
    let name: String
    let email: String
    let date: Date
  }
  let author: Author
  let message: String
  let comment_count: Int
}
```

```
{
  "url": "https://api.github.com/.../6dcb09",
  "author": {
    "name": "Monalisa Octocat",
    "email": "support@github.com",
    "date": "2011-04-14T16:00:49Z"
  },
  "message": "Fix all the bugs",
  "comment_count": 0,
}
```

```
struct Commit : Codable {
  let url: URL
  struct Author : Codable {
    let name: String
    let email: String
    let date: Date
  }
  let author: Author
  let message: String
  let comment_count: Int
}
```

```
let commit = try decoder.decode(Commit.self, from: jsonData)
```

```
{
  "url": "https://api.github.com/.../6dcb09",
  "author": {
    "name": "Monalisa Octocat",
    "email": "support@github.com",
    "date": "2011-04-14T16:00:49Z"
  },
  "message": "Fix all the bugs",
  "comment_count": 0,
}
```

```
struct Commit : Codable {
  let url: URL
  struct Author : Codable {
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    let email: String
    let date: Date
  }
  let author: Author
  let message: String
  let comment_count: Int
}
```

```
let commit = try decoder.decode(Commit.self, from: jsonData)
```

```
{
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    "date": "2011-04-14T16:00:49Z"
  },
  "message": "Fix all the bugs",
  "comment_count": 0,
}
```

```
struct Commit : Codable {
  let url: URL
  struct Author : Codable {
    let name: String
    let email: String
    let date: Date
  }
  let author: Author
  let message: String
  let comment_count: Int
}
```

```
let commit = try decoder.decode(Commit.self, from: jsonData)
let commitDate = commit.author.date
```

```
{
  "url": "https://api.github.com/.../6dcb09",
  "author": {
    "name": "Monalisa Octocat",
    "email": "support@github.com",
    "date": "2011-04-14T16:00:49Z"
  },
  "message": "Fix all the bugs",
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}
```

```
struct Commit : Codable {
  let url: URL
  struct Author : Codable {
    let name: String
    let email: String
    let date: Date
  }
  let author: Author
  let message: String
  let comment_count: Int
}
```

```
let commit = try decoder.decode(Commit.self, from: jsonData)
let commitDate = commit.author.date
```

Coding Protocols

Codable

```
typealias Codable = Encodable & Decodable
```

Coding Protocols

Codable

```
typealias Codable = Encodable & Decodable
```

Encodable

```
public protocol Encodable {
  func encode(to encoder: Encoder) throws
}
```

Coding Protocols

Codable

```
typealias Codable = Encodable & Decodable
```

Encodable

```
public protocol Encodable {
  func encode(to encoder: Encoder) throws
}
```

Decodable

```
public protocol Decodable {
  init(from decoder: Decoder) throws
}
```

Coding Protocols

Use Swift protocol extension behavior

Coding Protocols

Use Swift protocol extension behavior

Write your own implementation to customize

```
struct Commit : Codable {
  struct Author : Codable { /* … */ }
  let url: URL
  let message: String
  let author: Author
  let comment_count: Int
```

```
struct Commit : Codable {
  struct Author : Codable { /* … */ }
  let url: URL
  let message: String
  let author: Author
  let comment_count: Int

  // Encodable
  public func encode(to encoder: Encoder) throws { /* … */ }

  // Decodable
  init(from decoder: Decoder) throws { /* … */ }
```

Compiler Generated

```
struct Commit : Codable {
  struct Author : Codable { /* … */ }
  let url: URL
  let message: String
  let author: Author
  let comment_count: Int
```

```
struct Commit : Codable {
  struct Author : Codable { /* … */ }
  let url: URL
  let message: String
  let author: Author
  let comment_count: Int
```

```
struct Commit : Codable {
  struct Author : Codable { /* … */ }
  let url: URL
  let message: String
  let author: Author
  let comment_count: Int
```

```
struct Commit : Codable {
  struct Author : Codable { /* … */ }
  let url: URL
  let message: String
  let author: Author
  let comment_count: Int

  private enum CodingKeys : String, CodingKey {
    case url
    case message
    case author
    case comment_count
  }
```

```
struct Commit : Codable {
  struct Author : Codable { /* … */ }
  let url: URL
  let message: String
  let author: Author
  let comment_count: Int

  private enum CodingKeys : String, CodingKey {
    case url
    case message
    case author
    case comment_count
  }
```

Compiler Generated

```
struct Commit : Codable {
  struct Author : Codable { /* … */ }
  let url: URL
  let message: String
  let author: Author
  let comment_count: Int

  private enum CodingKeys : String, CodingKey {
    case url
    case message
    case author
    case comment_count
  }
```

Customized

```
struct Commit : Codable {
  struct Author : Codable { /* … */ }
  let url: URL
  let message: String
  let author: Author
  let comment_count: Int

  private enum CodingKeys : String, CodingKey {
    case url
    case message
    case author
    case comment_count
  }
```

```
struct Commit : Codable {
  struct Author : Codable { /* … */ }
  let url: URL
  let message: String
  let author: Author
  let comment_count: Int

  private enum CodingKeys : String, CodingKey {
    case url
    case message
    case author
    case comment_count
  }
```

```
struct Commit : Codable {
  struct Author : Codable { /* … */ }
  let url: URL
  let message: String
  let author: Author
  let commentCount: Int

  private enum CodingKeys : String, CodingKey {
    case url
    case message
    case author
    case commentCount = "comment_count"
  }
```

```swift
struct Commit : Codable {
  struct Author : Codable { /* … */ }
  let url: URL
  let message: String
  let author: Author
  let commentCount: Int

  private enum CodingKeys : String, CodingKey {
    case url
    case message
    case author
    case commentCount = "comment_count"
  }
}
```

Demo

Encoding and Decoding

Itai Ferber, Foundation

Encoding and Decoding

Tony Parker, Foundation

Codable Philosophy

Error handling built-in

Encapsulate encoding details

Abstract format from types

Codable Philosophy

Error handling built-in

Encapsulate encoding details

Abstract format from types

Error Handling

Unexpected input is not if, but when

Error Handling

Unexpected input is not if, but when

No fatal errors from untrusted data—only for developer mistakes

Error Handling

Unexpected input is not if, but when

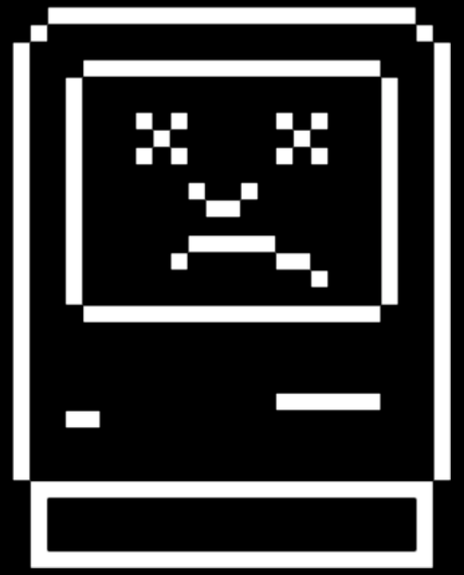
No fatal errors from untrusted data—only for developer mistakes

Errors possible on decode and encode

Coder Errors

Encoding

- Invalid value



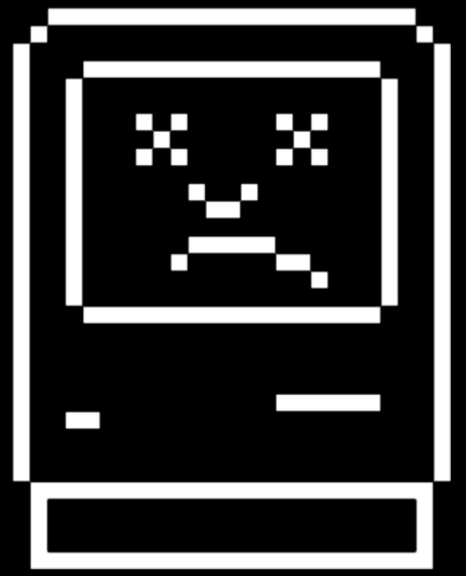
Coder Errors

Encoding

- Invalid value

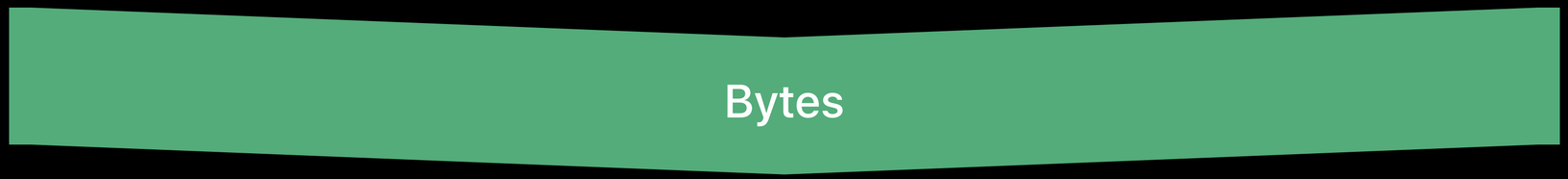
Decoding

- Type mismatch
- Missing key
- Missing value
- Data corrupt

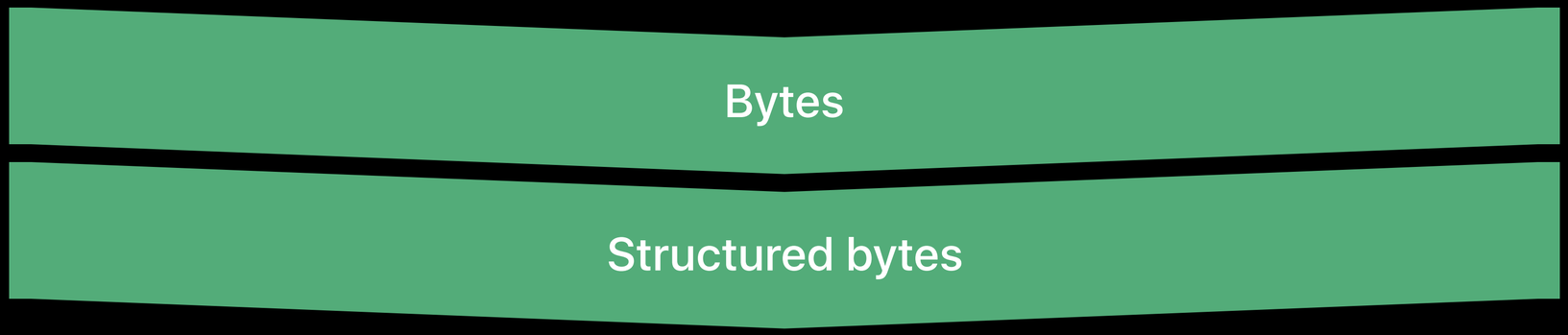


Beyond Basic Error Handling

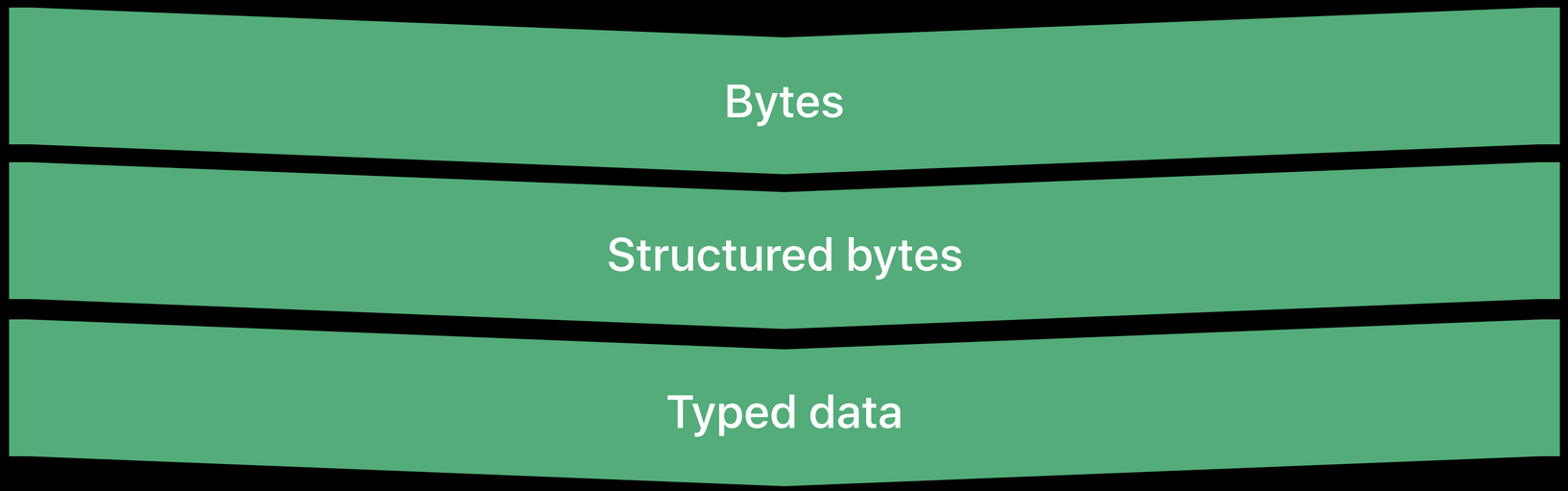
Beyond Basic Error Handling



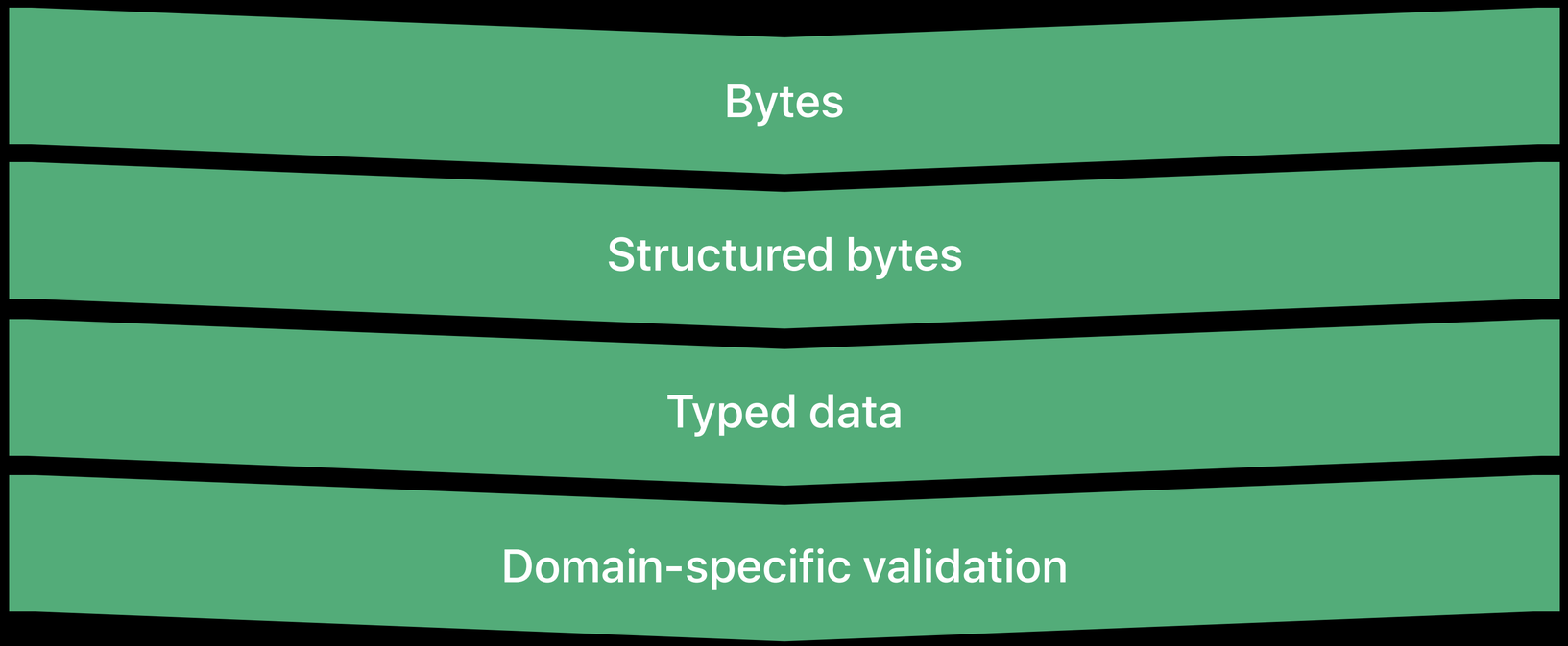
Beyond Basic Error Handling



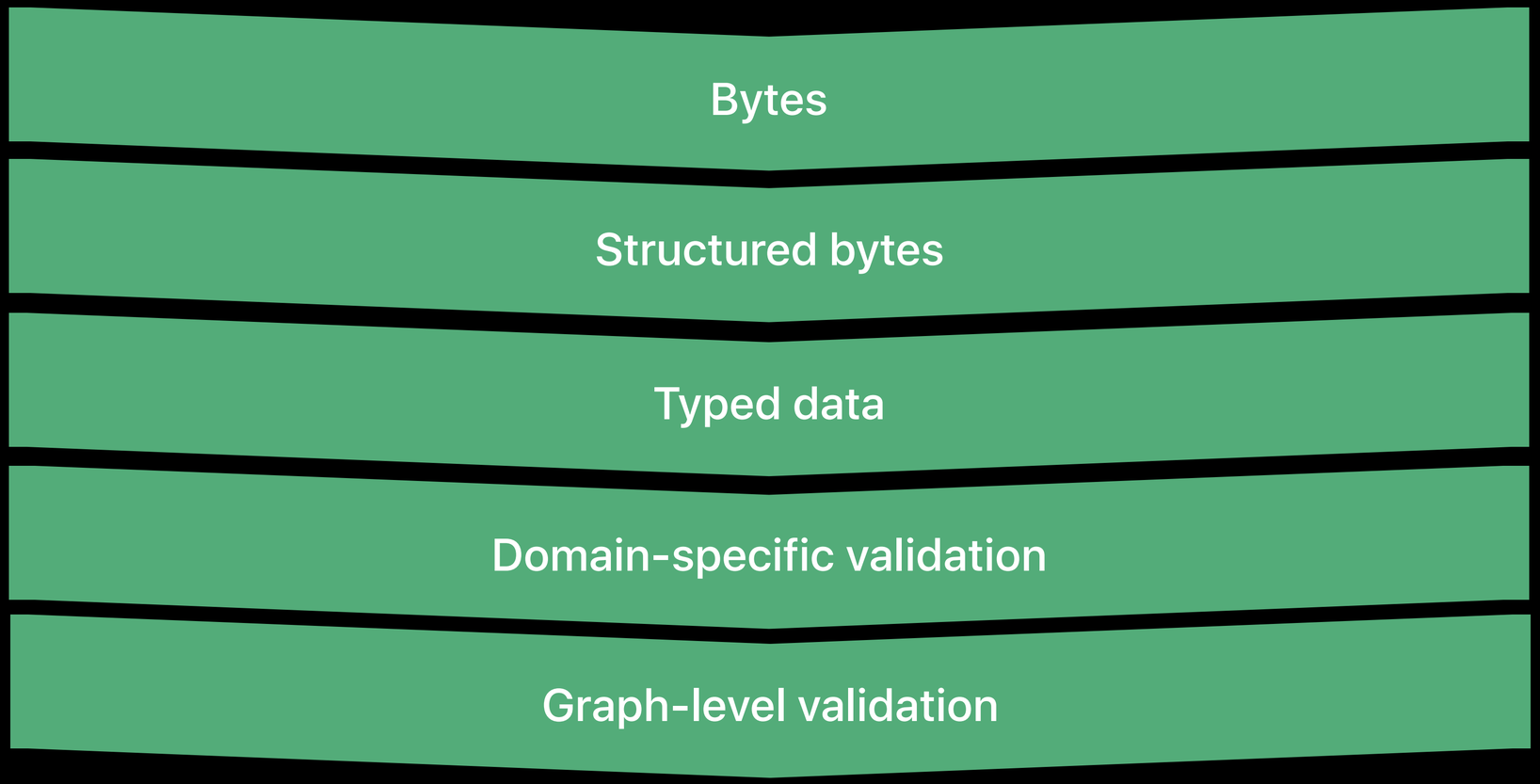
Beyond Basic Error Handling



Beyond Basic Error Handling



Beyond Basic Error Handling



```
struct Commit : Codable {
  struct Author : Codable { /* … */ }
  let url: URL
  let message: String
  let author: Author
  let commentCount: Int
  private enum CodingKeys : String, CodingKey { /* … */ }
```

```
struct Commit : Codable {
  struct Author : Codable { /* … */ }
  let url: URL
  let message: String
  let author: Author
  let commentCount: Int
  private enum CodingKeys : String, CodingKey { /* … */ }
  public init(from decoder: Decoder) throws {
    let container = try decoder.container(keyedBy: CodingKeys.self)
    url = try container.decode(URL.self, forKey: .url)
    message = try container.decode(String.self, forKey: .message)
    author = try container.decode(Author.self, forKey: .author)
    commentCount = try container.decode(Int.self, forKey: .commentCount)
  }
}
```

```
struct Commit : Codable {
  struct Author : Codable { /* … */ }
  let url: URL
  let message: String
  let author: Author
  let commentCount: Int
  private enum CodingKeys : String, CodingKey { /* … */ }
  public init(from decoder: Decoder) throws {
    let container = try decoder.container(keyedBy: CodingKeys.self)
    url = try container.decode(URL.self, forKey: .url)
    message = try container.decode(String.self, forKey: .message)
    author = try container.decode(Author.self, forKey: .author)
    commentCount = try container.decode(Int.self, forKey: .commentCount)
  }
}
```

```
struct Commit : Codable {
  struct Author : Codable { /* … */ }
  let url: URL
  let message: String
  let author: Author
  let commentCount: Int
  private enum CodingKeys : String, CodingKey { /* … */ }
  public init(from decoder: Decoder) throws {
    let container = try decoder.container(keyedBy: CodingKeys.self)
    url = try container.decode(URL.self, forKey: .url)
    message = try container.decode(String.self, forKey: .message)
    author = try container.decode(Author.self, forKey: .author)
    commentCount = try container.decode(Int.self, forKey: .commentCount)
  }
}
```

```
struct Commit : Codable {
  struct Author : Codable { /* … */ }
  let url: URL
  let message: String
  let author: Author
  let commentCount: Int
  private enum CodingKeys : String, CodingKey { /* … */ }
  public init(from decoder: Decoder) throws {
    let container = try decoder.container(keyedBy: CodingKeys.self)
    url = try container.decode(URL.self, forKey: .url)
    message = try container.decode(String.self, forKey: .message)
    author = try container.decode(Author.self, forKey: .author)
    commentCount = try container.decode(Int.self, forKey: .commentCount)
  }
}
```

```
struct Commit : Codable {
  struct Author : Codable { /* … */ }
  let url: URL
  let message: String
  let author: Author
  let commentCount: Int
  private enum CodingKeys : String, CodingKey { /* … */ }
  public init(from decoder: Decoder) throws {
    let container = try decoder.container(keyedBy: CodingKeys.self)
    url = try container.decode(URL.self, forKey: .url)




    message = try container.decode(String.self, forKey: .message)
    author = try container.decode(Author.self, forKey: .author)
    commentCount = try container.decode(Int.self, forKey: .commentCount)
  }
}
```

```
struct Commit : Codable {
  struct Author : Codable { /* … */ }
  let url: URL
  let message: String
  let author: Author
  let commentCount: Int
  private enum CodingKeys : String, CodingKey { /* … */ }
  public init(from decoder: Decoder) throws {
    let container = try decoder.container(keyedBy: CodingKeys.self)
    url = try container.decode(URL.self, forKey: .url)
    guard url.scheme == "https" else {
      throw DecodingError.dataCorrupted(DecodingError.Context(
              codingPath: container.codingPath + [CodingKeys.url],
              debugDescription: "URLs require https")) }
    message = try container.decode(String.self, forKey: .message)
    author = try container.decode(Author.self, forKey: .author)
    commentCount = try container.decode(Int.self, forKey: .commentCount)
  }
}
```

Codable Philosophy

Error handling built-in

Encapsulate encoding details

Abstract format from types

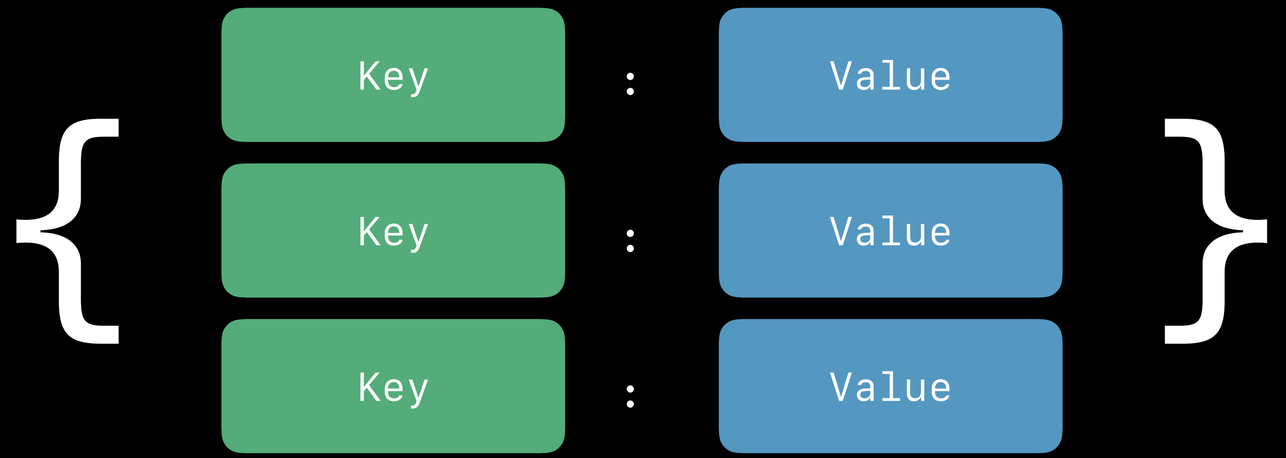
Encapsulate Encoding Details

Keys and values are private

Containers provide storage for values

Keyed Containers

Keyed Containers



Coding Keys

Strongly-typed replacement for String keys

```
public protocol CodingKey {
  var stringValue: String { get }
  var intValue: Int? { get }

  init?(stringValue: String)
  init?(intValue: Int)
}
```

Coding Keys

Coding Keys

```
private enum CodingKeys : String, CodingKey {
  case url
  case author
  case comment_count
}
```

Coding Keys

```
private enum CodingKeys : String, CodingKey {
  case url
  case author
  case comment_count
}
```

Case Name	stringValue	intValue?
url	url	nil
author	author	nil
comment_count	comment_count	nil

Coding Keys

```
private enum CodingKeys : String, CodingKey {
  case url
  case author
  case commentCount = "comment_count"
}
```

Case Name	stringValue	intValue?
url	url	nil
author	author	nil
commentCount	comment_count	nil

Coding Keys

```
private enum CodingKeys : Int, CodingKey {
  case url = 42
  case author = 100
  case comment_count
}
```

Case Name	stringValue	intValue?
url	url	42
author	author	100
comment_count	comment_count	101

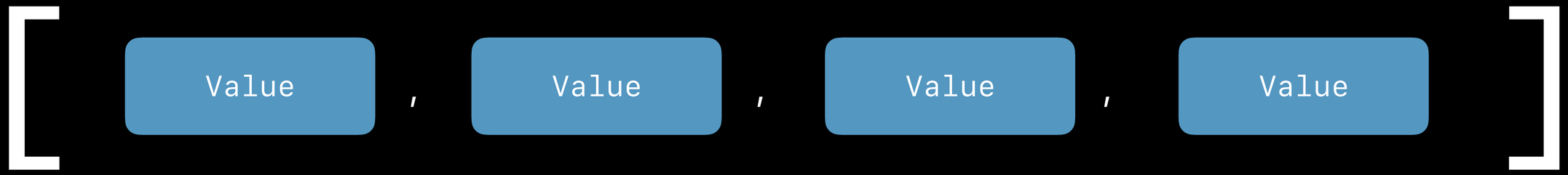
Coding Keys

```
private enum CodingKeys : Int, CodingKey {
  case url = 42
  case author = 100
  case comment_count
}
```

Case Name	stringValue	intValue?
url	url	42
author	author	100
comment_count	comment_count	101

Unkeyed Containers

Unkeyed Containers



Single Value Containers

Single Value Containers

```
struct Commit : Codable {
  struct Author : Codable { /* … */ }
  let url: URL
  let message: String
  let author: Author
  let commentCount: Int
  private enum CodingKeys : String, CodingKey { /* … */ }
  public init(from decoder: Decoder) throws { /* … */ }
```

```
struct Commit : Codable {
  struct Author : Codable { /* … */ }
  let url: URL
  let message: String
  let author: Author
  let commentCount: Int
  private enum CodingKeys : String, CodingKey { /* … */ }
  public init(from decoder: Decoder) throws { /* … */ }
  public func encode(to encoder: Encoder) throws {
    var container = encoder.container(keyedBy: CodingKeys.self)
    try container.encode(url, forKey: .url)
    try container.encode(message, forKey: .message)
    try container.encode(author, forKey: .author)
    try container.encode(commentCount, forKey: .commentCount)
  }
}
```

```
struct Commit : Codable {
  struct Author : Codable { /* … */ }
  let url: URL
  let message: String
  let author: Author
  let commentCount: Int
  private enum CodingKeys : String, CodingKey { /* … */ }
  public init(from decoder: Decoder) throws { /* … */ }
  public func encode(to encoder: Encoder) throws {
    var container = encoder.container(keyedBy: CodingKeys.self)
    try container.encode(url, forKey: .url)
    try container.encode(message, forKey: .message)
    try container.encode(author, forKey: .author)
    try container.encode(commentCount, forKey: .commentCount)
  }
}
```

```swift
struct Commit : Codable {
  struct Author : Codable { /* … */ }
  let url: URL
  let message: String
  let author: Author
  let commentCount: Int
  private enum CodingKeys : String, CodingKey { /* … */ }
  public init(from decoder: Decoder) throws { /* … */ }
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  }
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```

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  public init(from decoder: Decoder) throws { /* … */ }
  public func encode(to encoder: Encoder) throws {
    var container = encoder.container(keyedBy: CodingKeys.self)
    try container.encode(url, forKey: .url)
    try container.encode(message, forKey: .message)
    try container.encode(author, forKey: .author)
    try container.encode(commentCount, forKey: .commentCount)
  }
}
```

```
struct Point2D : Encodable {
  var x: Double
  var y: Double
```

```
struct Point2D : Encodable {
  var x: Double
  var y: Double
```

```
struct Point2D : Encodable {
  var x: Double
  var y: Double

  public func encode(to encoder: Encoder) throws {
    var container = encoder.unkeyedContainer()
    try container.encode(x)
    try container.encode(y)
  }
}
```

```
struct Point2D : Encodable {
  var x: Double
  var y: Double

  public func encode(to encoder: Encoder) throws {
    var container = encoder.unkeyedContainer()
    try container.encode(x)
    try container.encode(y)
  }
}
```

```
struct Point2D : Encodable {
  var x: Double
  var y: Double

  public func encode(to encoder: Encoder) throws {
    var container = encoder.unkeyedContainer()
    try container.encode(x)
    try container.encode(y)
  }
}

// [ 1.5, 3.9 ]
```

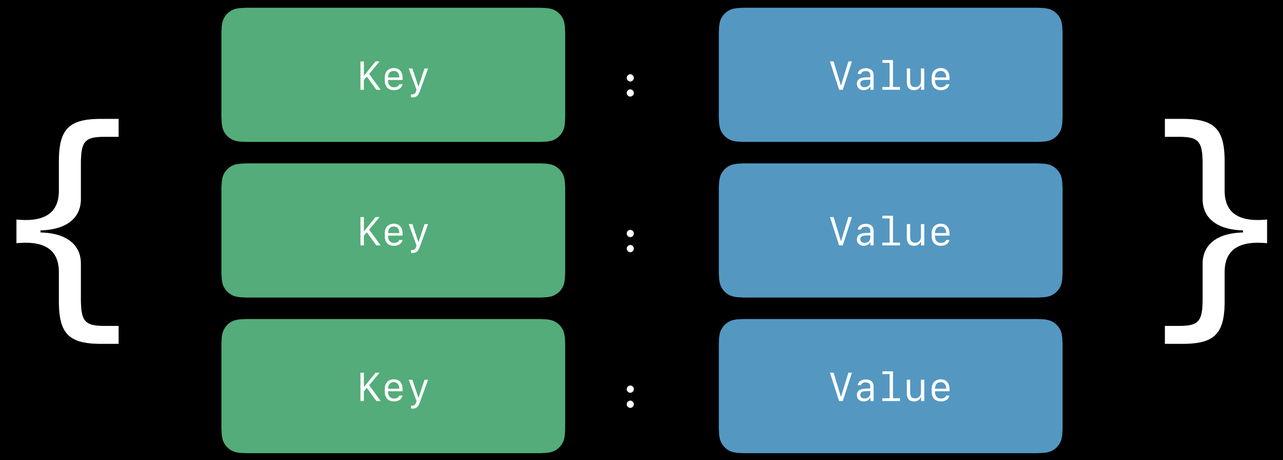
```
struct Point2D : Encodable {
  var x: Double
  var y: Double

  public func encode(to encoder: Encoder) throws {
    var container = encoder.unkeyedContainer()
    try container.encode(x)
    try container.encode(y)
  }
}

// [ 1.5, 3.9 ]
```

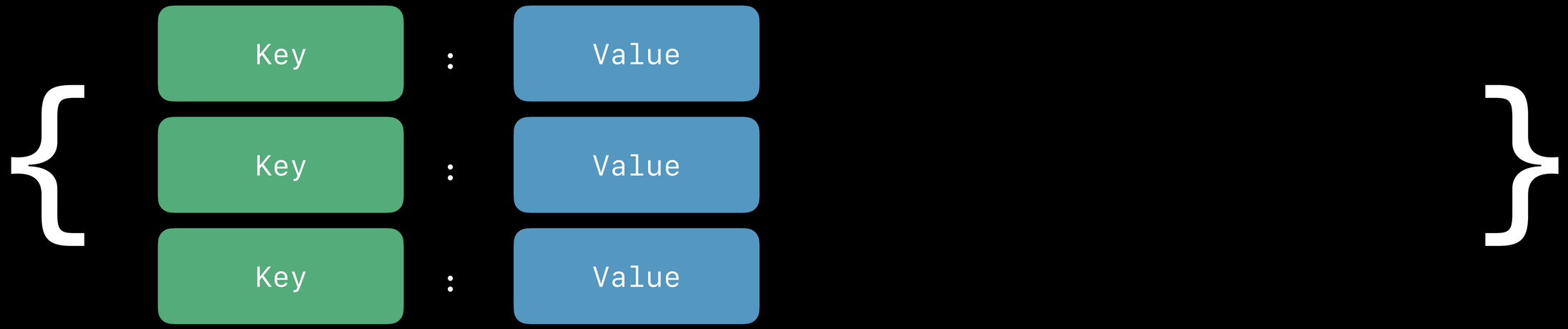
Nested Containers

Lightweight encapsulation of additional values



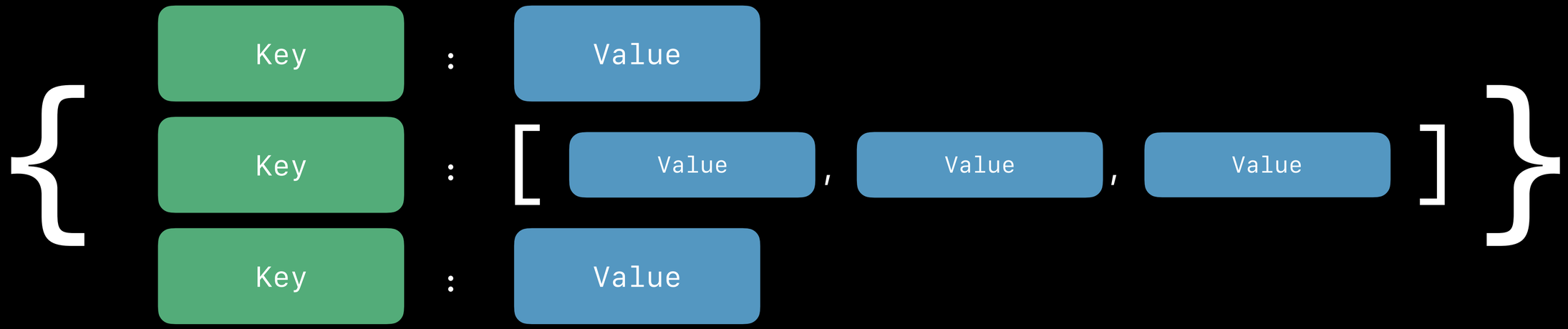
Nested Containers

Lightweight encapsulation of additional values



Nested Containers

Lightweight encapsulation of additional values



Encoding a Class Hierarchy

Use nested container for superclass data

Encapsulates keys and values from superclass

```
class Animal : Decodable {
  var legCount: Int
  private enum CodingKeys: String, CodingKey { case legCount }
  required init(from decoder: Decoder) throws {
    let container = try decoder.container(keyedBy: CodingKeys.self)
    legCount = try container.decode(Int.self, forKey: .legCount)
  }
}
```

```
class Animal : Decodable {
  var legCount: Int
  private enum CodingKeys: String, CodingKey { case legCount }
  required init(from decoder: Decoder) throws {
    let container = try decoder.container(keyedBy: CodingKeys.self)
    legCount = try container.decode(Int.self, forKey: .legCount)
  }
}
```

```
class Animal : Decodable {
  var legCount: Int
  private enum CodingKeys: String, CodingKey { case legCount }
  required init(from decoder: Decoder) throws {
    let container = try decoder.container(keyedBy: CodingKeys.self)
    legCount = try container.decode(Int.self, forKey: .legCount)
  }
}
class Dog : Animal {
  var bestFriend: Kid
  private enum CodingKeys : String, CodingKey { case bestFriend }
  required init(from decoder: Decoder) throws {
    let container = try decoder.container(keyedBy: CodingKeys.self)
    bestFriend = try container.decode(Kid.self, forKey: .bestFriend)
    let superDecoder = try container.superDecoder()
    try super.init(from: superDecoder)
  }
`
```

```
class Animal : Decodable {
  var legCount: Int
  private enum CodingKeys: String, CodingKey { case legCount }
  required init(from decoder: Decoder) throws {
    let container = try decoder.container(keyedBy: CodingKeys.self)
    legCount = try container.decode(Int.self, forKey: .legCount)
  }
}
class Dog : Animal {
  var bestFriend: Kid
  private enum CodingKeys : String, CodingKey { case bestFriend }
  required init(from decoder: Decoder) throws {
    let container = try decoder.container(keyedBy: CodingKeys.self)
    bestFriend = try container.decode(Kid.self, forKey: .bestFriend)
    let superDecoder = try container.superDecoder()
    try super.init(from: superDecoder)
  }
`
```

```
class Animal : Decodable {
  var legCount: Int
  private enum CodingKeys: String, CodingKey { case legCount }
  required init(from decoder: Decoder) throws {
    let container = try decoder.container(keyedBy: CodingKeys.self)
    legCount = try container.decode(Int.self, forKey: .legCount)
  }
}
class Dog : Animal {
  var bestFriend: Kid
  private enum CodingKeys : String, CodingKey { case bestFriend }
  required init(from decoder: Decoder) throws {
    let container = try decoder.container(keyedBy: CodingKeys.self)
    bestFriend = try container.decode(Kid.self, forKey: .bestFriend)
    let superDecoder = try container.superDecoder()
    try super.init(from: superDecoder)
  }
`
```

```
class Animal : Decodable {
  var legCount: Int
  private enum CodingKeys: String, CodingKey { case legCount }
  required init(from decoder: Decoder) throws {
    let container = try decoder.container(keyedBy: CodingKeys.self)
    legCount = try container.decode(Int.self, forKey: .legCount)
  }
}
class Dog : Animal {
  var bestFriend: Kid
  private enum CodingKeys : String, CodingKey { case bestFriend }
  required init(from decoder: Decoder) throws {
    let container = try decoder.container(keyedBy: CodingKeys.self)
    bestFriend = try container.decode(Kid.self, forKey: .bestFriend)
    let superDecoder = try container.superDecoder()
    try super.init(from: superDecoder)
  }
`
```

Codable Philosophy

Error handling built-in

Encapsulate encoding details

Abstract format from types

Abstract Format from Types

Reuse one implementation of `Encodable` and `Decodable`

Abstract Format from Types

Reuse one implementation of `Encodable` and `Decodable`

Allow new formats without library changes

Abstract Format from Types

Reuse one implementation of `Encodable` and `Decodable`

Allow new formats without library changes

Formats have different fundamental types and conventions

Encoding Strategies

Encoder-specific customizations for certain types

Encoding Strategies

Encoder-specific customizations for certain types

JSON

`Date`

Encoding Strategies

Encoder-specific customizations for certain types

JSON

`Date`

```
"2017-06-07T18:00:40Z"
```

Encoding Strategies

Encoder-specific customizations for certain types

JSON

`Date`

```
1496858440.0729699
```

Encoding Strategies

Encoder-specific customizations for certain types

JSON

`Date`

Encoding Strategies

Encoder-specific customizations for certain types

JSON

`Date`

```
"Wednesday, June 7, 2017 at 11:00 AM"
```

Encoding Strategies

Encoder-specific customizations for certain types

JSON

`Date`

```
"Wednesday, June 7, 2017 at 11:00 AM"
```

`Data`

Encoding Strategies

Encoder-specific customizations for certain types

JSON

`Date`

```
"Wednesday, June 7, 2017 at 11:00 AM"
```

`Data`

```
"AAIABAA="
```

Encoding Strategies

Encoder-specific customizations for certain types

JSON

`Date`

```
"Wednesday, June 7, 2017 at 11:00 AM"
```

`Data`

```
[0,2,0,4,0]
```

Encoding Strategies

Encoder-specific customizations for certain types

JSON

`Date`

```
"Wednesday, June 7, 2017 at 11:00 AM"
```

`Data`

```
"🐑🐶🐑🐶🐑"
```

Encoding Strategies

Encoder-specific customizations for certain types

JSON

`Date`

```
"Wednesday, June 7, 2017 at 11:00 AM"
```

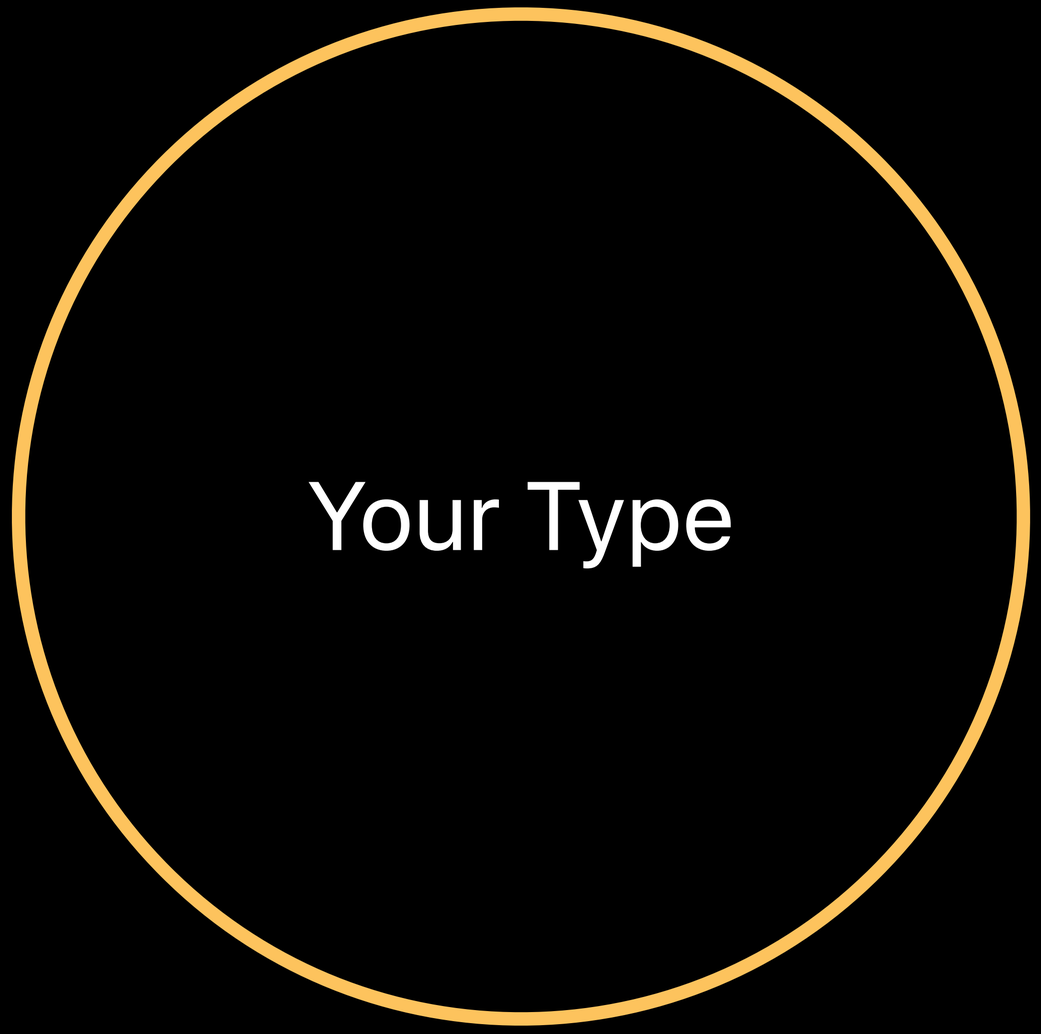
`Data`

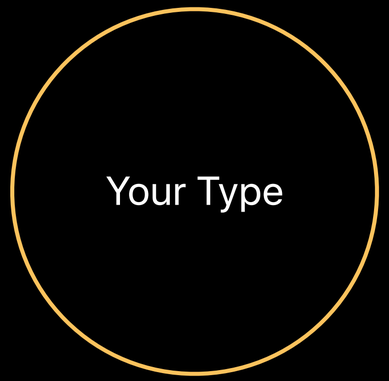
```
"🐑🐶🐑🐶🐑"
```

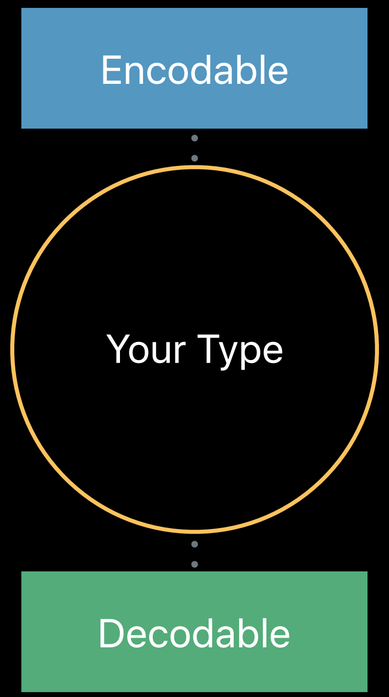
Property Lists

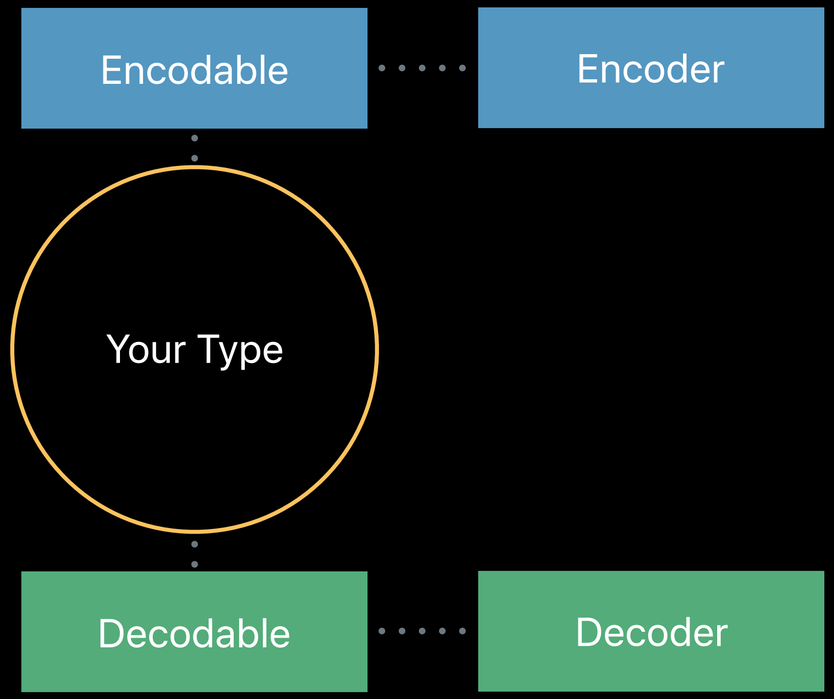
Codable Foundation Types

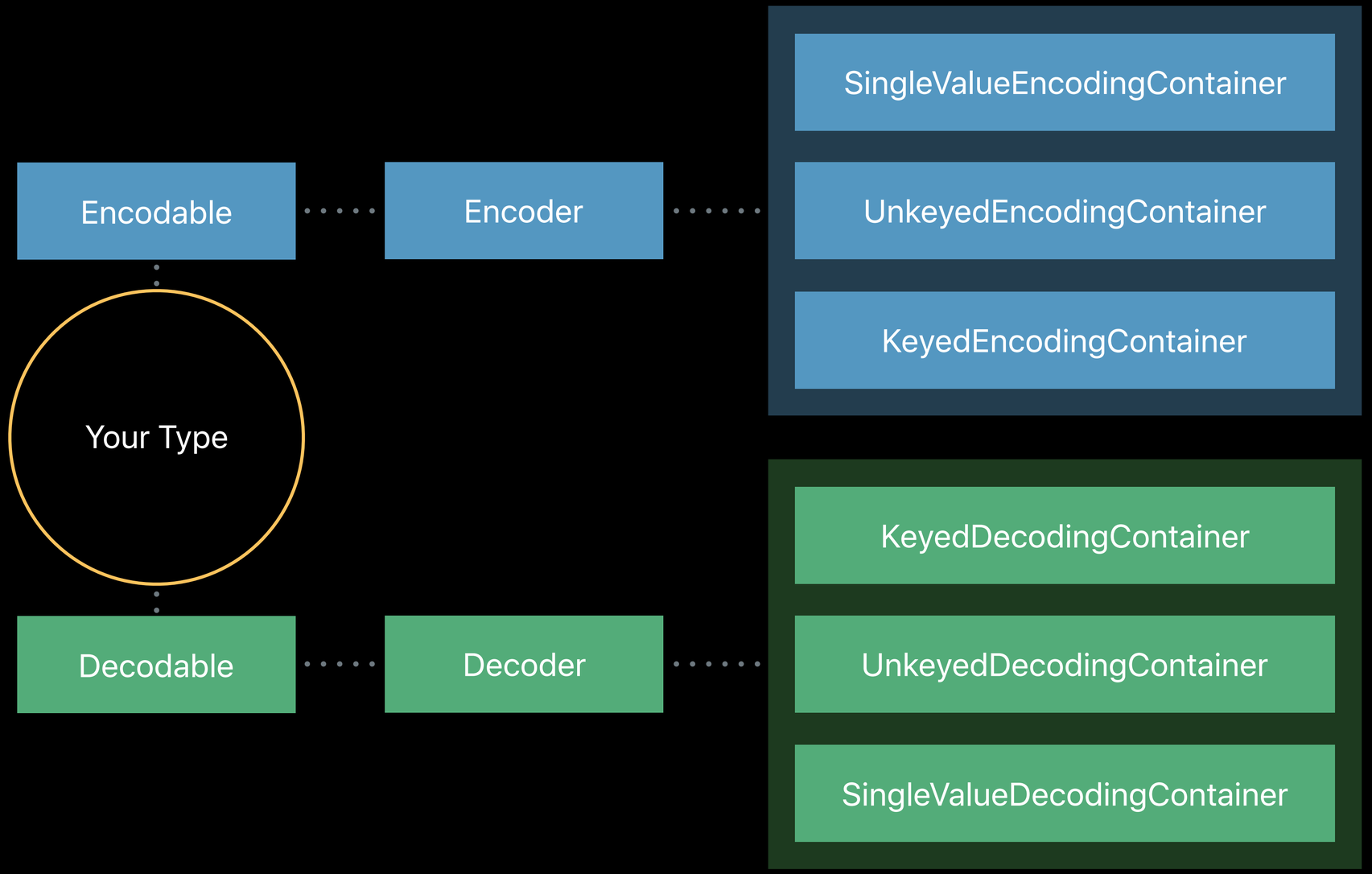
```
CGFloat
AffineTransform
Calendar
CharacterSet
Data
Date
DateComponents
DateInterval
Decimal
IndexPath
IndexSet
Locale
Measurement
NSRange
PersonNameComponents
TimeZone
URL
UUID
```

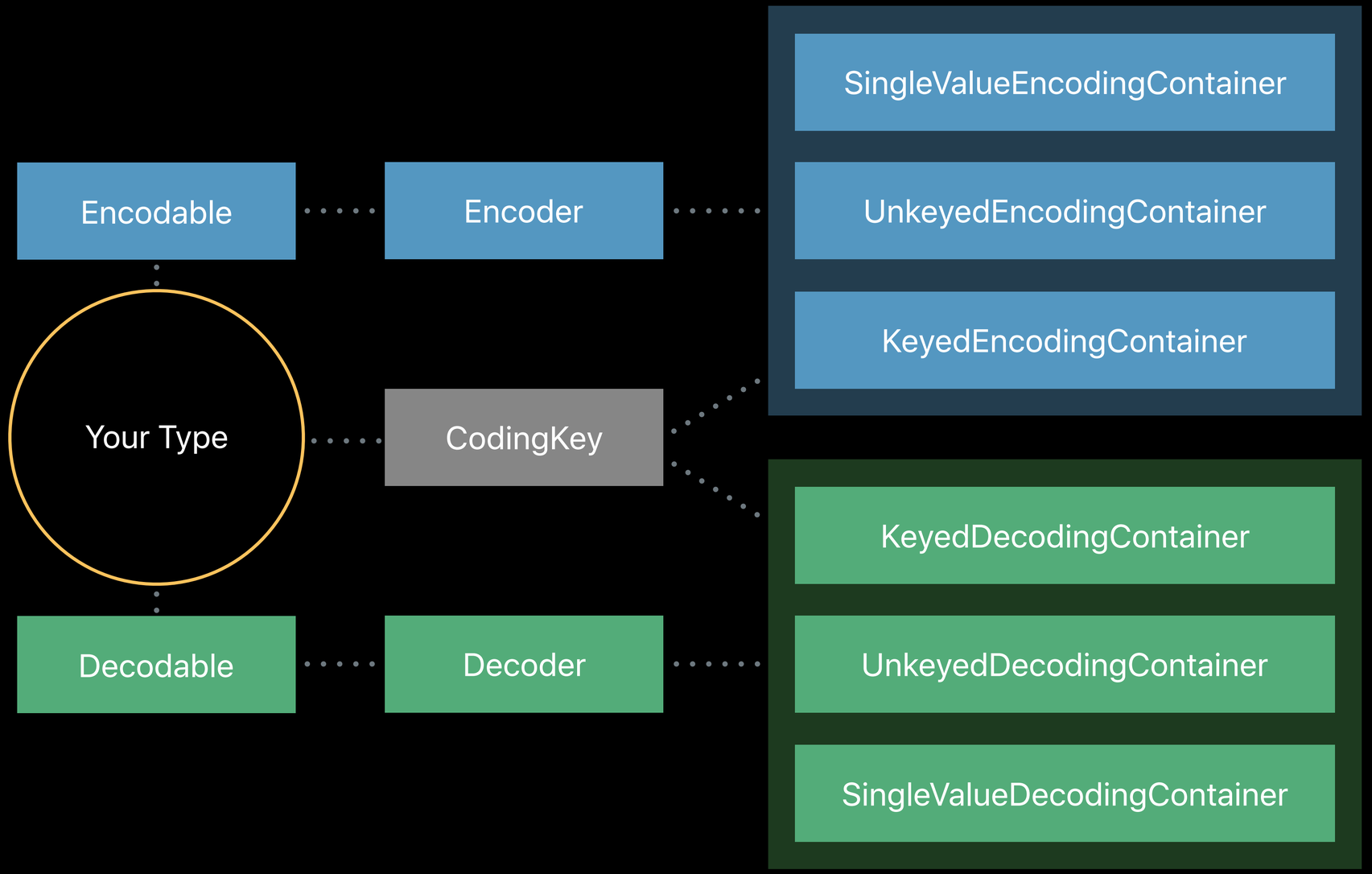

Your Type

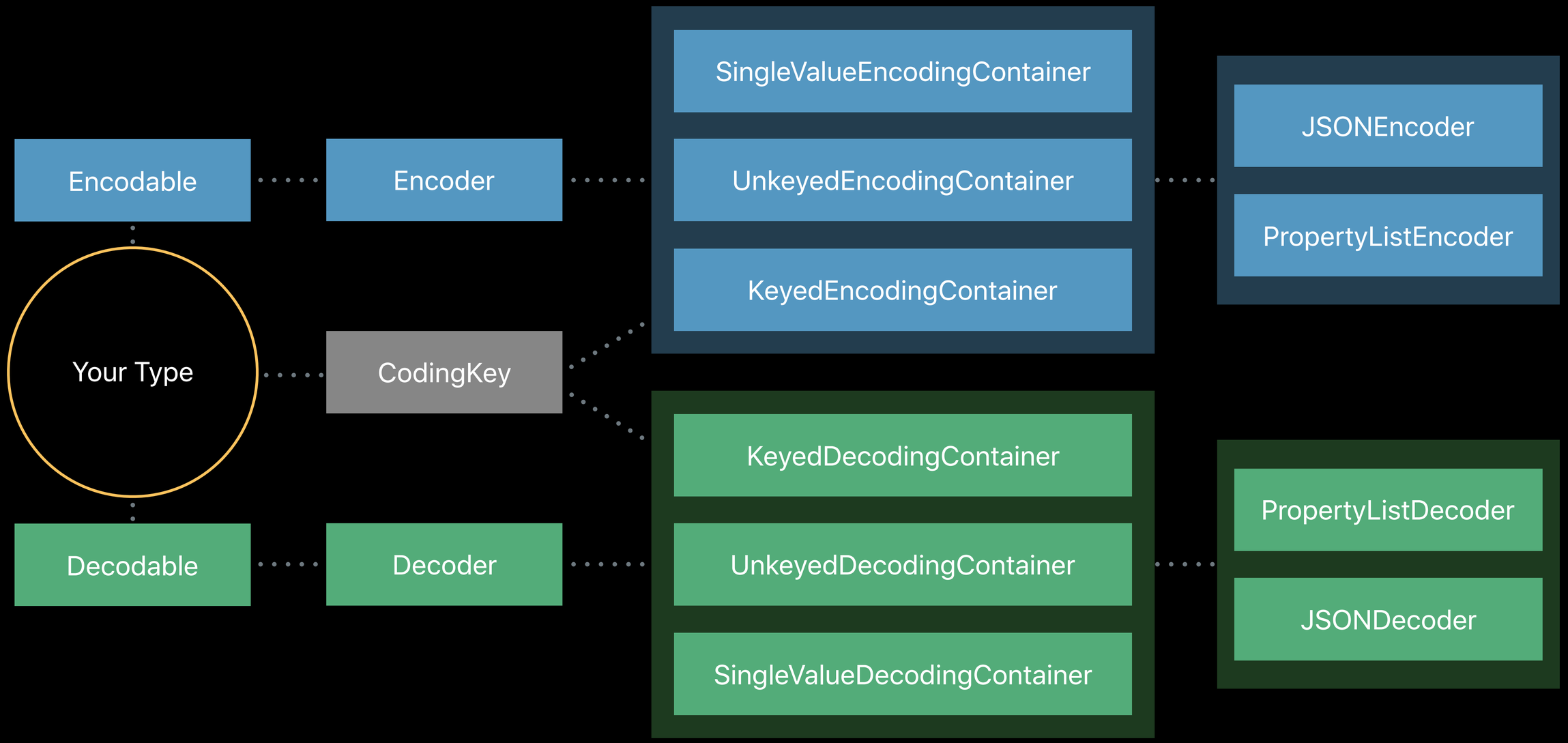

Your Type


Encodable
Your Type
Decodable


Encodable
Encoder
Your Type
Decodable
Decoder


Encodable
Encoder
SingleValueEncodingContainer
UnkeyedEncodingContainer
KeyedEncodingContainer
Your Type
Decodable
Decoder
KeyedDecodingContainer
UnkeyedDecodingContainer
SingleValueDecodingContainer


Encodable
Encoder
SingleValueEncodingContainer
UnkeyedEncodingContainer
KeyedEncodingContainer
Your Type
CodingKey
KeyedDecodingContainer
UnkeyedDecodingContainer
SingleValueDecodingContainer
Decodable
Decoder


Encodable
Encoder
SingleValueEncodingContainer
UnkeyedEncodingContainer
KeyedEncodingContainer
JSONEncoder
PropertyListEncoder
Your Type
CodingKey
Decodable
Decoder
KeyedDecodingContainer
UnkeyedDecodingContainer
SingleValueDecodingContainer
PropertyListDecoder
JSONDecoder

Summary

New API and improved performance in Foundation

Strongly typed key paths for Swift

New Key-Value Observation API

New `Codable` protocols

More Information

https://developer.apple.com/wwdc17/212

Related Sessions

What's New in Cocoa	Grand Ballroom B	Wednesday 9:00AM
Cocoa Development Tips	Grand Ballroom B	Friday 9:00AM
Efficient Interactions with Frameworks	Hall 2	Friday 1:50PM

Labs

Foundation Lab	Technology Lab C	Wed 1:00PM-2:10PM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