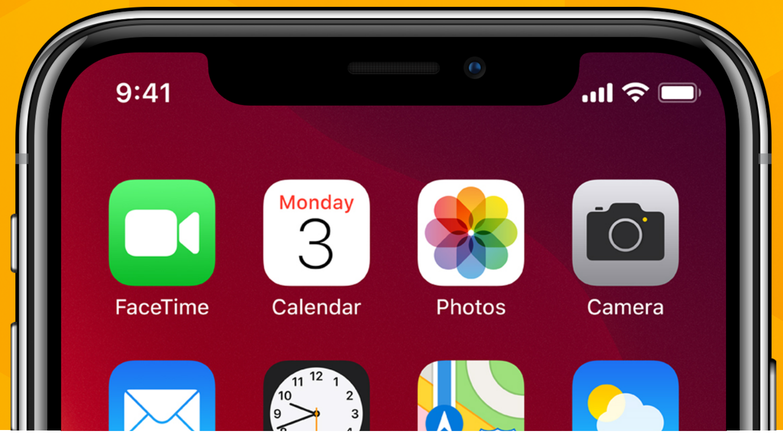

iOS Application Development

Lecture 9: Advanced Data Display:
Swift Generics • Dynamic Data • Compositional Layout

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Swift Generics

Array

```
let ints = [1, 2, 3, 4]
let strings = ["1", "2", "3", "4"]
```

```
var ints: [Int]
var strings: [String]
```

```
var ints: Array<Int>
var strings: Array<String>
```

```
struct Array<Element> {


}
```

Dictionary

```
let wordsByLength = [
    1: ["a", "i"],
    2: ["hi", "by", "go"],
    3: ["the", "but", "now", "how"],
    4: ["then", "just", "when", "cool"]
]
```

```
var wordsByLength: [Int: [String]]
```

```
var wordsByLength: Dictionary<Int, [String]>
```

```
struct Dictionary<Key, Value> where Key : Hashable {


}
```

Type Constraints

```
struct Dictionary<Key, Value> where Key : Hashable {


}
```

```
struct Dictionary<Key: Hashable, Value> {


}
```

Functions and Methods

```
func max(_ x: Int, _ y: Int) -> Int {


}
```

```
func max<T>(_ x: T, _ y: T) -> T where T : Comparable {



}
```

```
func max<T>(_ x: T, _ y: T) -> T where T : Comparable {
    if y >= x {
        return y
    } else {
        return x
    }
}
```

Associated Types

- What about protocols?
- Associated types enable protocols to define placeholders for any type
- Enables “generic protocols”

```
protocol APIRequest {
    associatedtype Response

    var urlRequest: URLRequest { get }
    func decodeResponse(data: Data) throws -> Response
}
```

Associated Types

```
protocol APIRequest {
    associatedtype Response

    var urlRequest: URLRequest { get }
    func decodeResponse(data: Data) throws -> Response
}
```

```
func sendRequest<Request: APIRequest>(_ request: Request) async throws -> Request.Response {
    let (data, response) = try await URLSession.shared.data(for: request.urlRequest)

    guard let httpResponse = response as? HTTPURLResponse,
          httpResponse.statusCode == 200 else {
        throw APIRequestError.itemNotFound
    }

    let decodedResponse = try request.decodeResponse(data: data)
    return(decodedResponse)
}
```

Associated Types

```
struct PhotoInfoAPIRequest: APIRequest {
    var apiKey: String

    var urlRequest: URLRequest {
        var urlComponents = URLComponents(string: "https://api.nasa.gov/planetary/apod")!
        urlComponents.queryItems = [URLQueryItem(name: "api_key", value: apiKey)]

        return URLRequest(url: urlComponents.url!)
    }

    func decodeResponse(data: Data) throws -> PhotoInfo {
        let photoInfo = try JSONDecoder().decode(PhotoInfo.self, from: data)
        return photoInfo
    }
}
```

Response

```
let photoInfoRequest = PhotoInfoAPIRequest(apiKey: "DEMO_KEY")
let result = try await sendRequest(photoInfoRequest)
// handle result
```

Associated Types

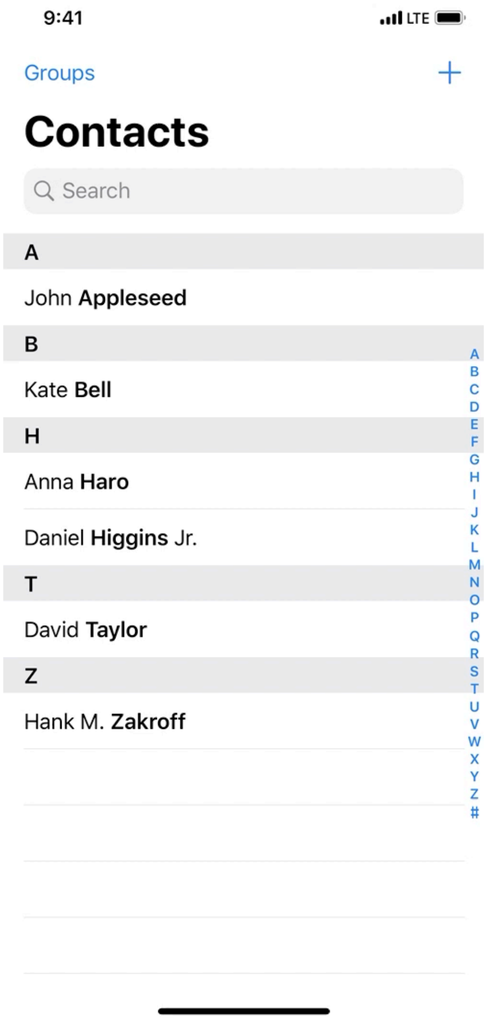
```
struct ImageAPIRequest: APIRequest {
    enum ResponseError: Error {
        case invalidImageData
    }
    let url: URL
    var urlRequest: URLRequest {
        return URLRequest(url: url)
    }

    func decodeResponse(data: Data) throws -> UIImage {
        guard let image = UIImage(data: data) else {
            throw ResponseError.invalidImageData
        }

        return image
    }
}
```

```
let photoInfoRequest = PhotoInfoAPIRequest(
    apiKey: "DEMO_KEY")

Task {
    do {
        let photoInfo = try await
                sendRequest(photoInfoRequest)
        print(photoInfo)

        let imageRequest = ImageAPIRequest(
                url: photoInfo.url)
        let image = try await sendRequest(imageRequest)
        image
    } catch {
        print(error)
    }
}
```

Dynamic Data

Search Controllers

- Used to provide search functionality
- Integrates directly with navigation controllers
- Optionally provides a secondary view to display search results



UISearchController

```
// without secondary search results controller
let searchController = UISearchController()
searchController.searchResultsUpdater = self
searchController.obscuresBackgroundDuringPresentation = false
navigationItem.searchController = searchController

// with secondary search results controller
let searchController = UISearchController(searchResultsController: contactSearchResultsViewController)
searchController.searchResultsUpdater = self
navigationItem.searchController = searchController
```

```
// UISearchResultsUpdating conformance
func updateSearchResults(for searchController: UISearchController) {
    if let searchString = searchController.searchBar.text, searchString.isEmpty == false {
        filteredItems = items.filter { (item) -> Bool in
            item.localizedCaseInsensitiveContains(searchString)
        }
    } else {
        filteredItems = items
    }
    // reload view
}
```

Handling Data Changes

- reloadData()
- performBatchUpdates()

Diffable Data Sources

Index	Original	Updated
1	Cat	Monkey
2	Dog	Giraffe
3	Elephant	Horse
4	Fish	Fish
5	Horse	Sugar Glider
6	Giraffe	
7	Monkey	

Events:

1. Cat removed
2. Dog removed
3. Elephant removed
4. Fish no change
5. Horse moved to 3
6. Giraffe moved to 2
7. Monkey moved to 1
8. Sugar Glider inserted at 5

Handling Data Changes

- reloadData()
- performBatchUpdates()
- Diffable data source
- UICollectionViewDiffableDataSource<SectionIdentifierType, ItemIdentifierType>
- NSDiffableDataSourceSnapshot<SectionIdentifierType, ItemIdentifierType>

Diffable Data Sources

- Container used by `UICollectionViewDiffableDataSource`
- Allows insertion, removal, and moving of items and sections
- Identifier-based rather than IndexPath-based
- Generic type with two type requirements
  - `SectionIdentifierType`
  - `ItemIdentifierType`
- Identifiers must conform to `Hashable`

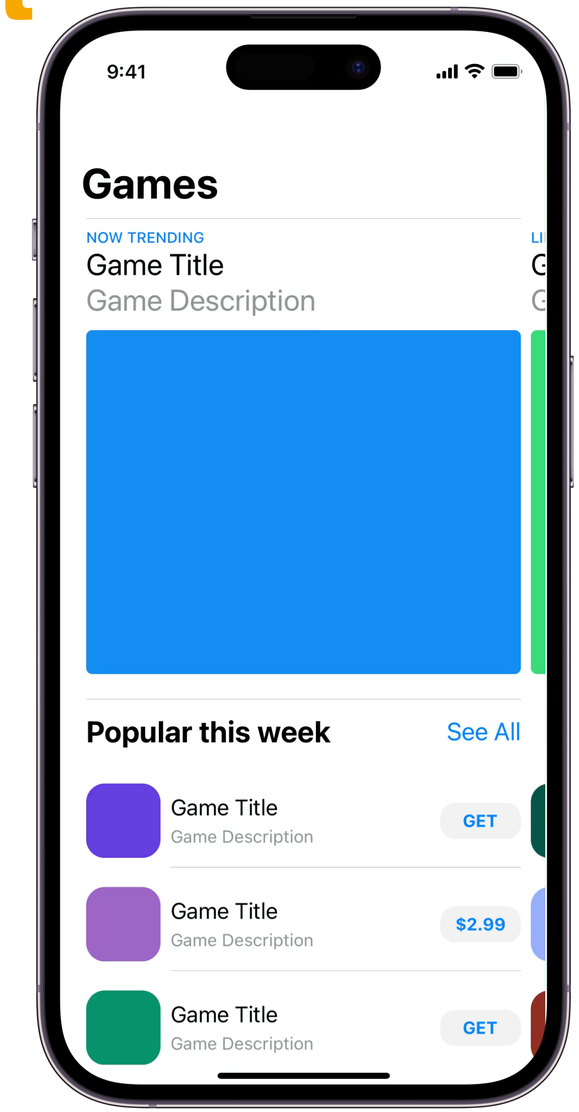
```
// setup data source and apply originating snapshot
let dataSource = UICollectionViewDiffableDataSource<String, String>(collectionView: collectionView) { (collectionView,
indexPath, item) -> UICollectionViewCell? in
    // cell configuration code
}
var original = NSDiffableDataSourceSnapshot<String, String>()
original.appendSections(["Main"])
original.appendItems(["Cat", "Dog", "Elephant", "Fish", "Horse", "Giraffe", "Monkey"], toSection: "Main")

dataSource.apply(original, animatingDifferences: true, completion: nil)

// events occurring over time and apply
var updated = dataSource.snapshot()
updated.deleteItems(["Cat", "Dog", "Elephant"])
dataSource.apply(updated, animatingDifferences: true, completion: nil)

updated.moveItem("Horse", beforeItem: "Fish")
dataSource.apply(updated, animatingDifferences: true, completion: nil)

updated.moveItem("Giraffe", beforeItem: "Horse")
dataSource.apply(updated, animatingDifferences: true, completion: nil)

updated.moveItem("Monkey", beforeItem: "Giraffe")
dataSource.apply(updated, animatingDifferences: true, completion: nil)
```

```swift
// setup data source and apply originating snapshot
let dataSource = UICollectionViewDiffableDataSource<String, String>(collectionView: collectionView) { (collectionView,
indexPath, item) -> UICollectionViewCell? in
    // cell configuration code
}
var original = NSDiffableDataSourceSnapshot<String, String>()
original.appendSections(["Main"])
original.appendItems(["Cat", "Dog", "Elephant", "Fish", "Horse", "Giraffe", "Monkey"], toSection: "Main")

dataSource.apply(original, animatingDifferences: true, completion: nil)

// events occurring all at once
var updated = NSDiffableDataSourceSnapshot<String, String>()
updated.appendSections(["Main"])
updated.appendItems(["Monkey", "Giraffe", "Horse", "Fish", "Sugar Glider"], toSection: "Main")

dataSource.apply(updated, animatingDifferences: true, completion: nil)
```

Compositional Layout

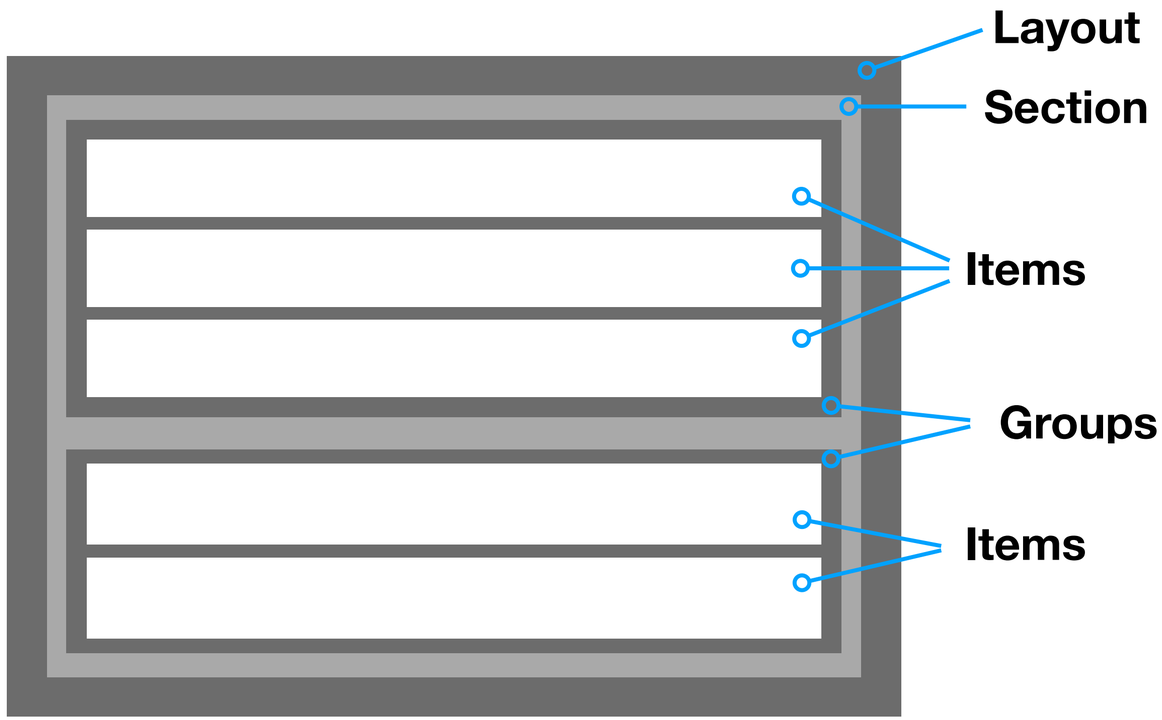
UICollectionViewCompositionalLayout

- A subclass of UICollectionViewLayout
- Compose layouts by grouping smaller layouts together
- Layout groups are line based
- Compose complex layouts



UICollectionViewCompositionalLayout

- Three core components
  - Item (NSCollectionLayoutItem)
  - Group (NSCollectionLayoutGroup)
  - Section (NSCollectionLayoutSection)



NSCollectionLayoutSize

- Items and groups are sized using `NSCollectionLayoutSize`
- Defined with a `widthDimension` and `heightDimension`
- `NSCollectionLayoutDimension`
  - Four ways to define

```
class NSCollectionLayoutDimension {
  class func fractionalWidth(_ fractionalWidth: CGFloat) -> Self
  class func fractionalHeight(_ fractionalHeight: CGFloat) -> Self
  class func absolute(_ absoluteDimension: CGFloat) -> Self
  class func estimated(_ estimatedDimension: CGFloat) -> Self
}
```

```
let size = NSCollectionLayoutSize(widthDimension: .fractionalWidth(0.25),
                                  heightDimension: .fractionalWidth(0.25))
```

NSCollectionLayoutItem

- Item represents a cell or supplementary view
- Defined with a size

```
let size = NSCollectionLayoutSize(widthDimension: .fractionalWidth(1.0),
                                  heightDimension: .absolute(44.0))

let item = NSCollectionLayoutItem(layoutSize: size)
```

NSCollectionLayoutGroup

- Contains one or many items
- Defined as `horizontal`, `vertical`, or `custom`
- Also defined with a size
- Subclass of `NSCollectionLayoutItem`

```
let size = NSCollectionLayoutSize(widthDimension: .fractionalWidth(1.0),
                                  heightDimension: .absolute(44.0))

let item = NSCollectionLayoutItem(layoutSize: size)

let group = NSCollectionLayoutGroup.horizontal(
    layoutSize: size, subitems: [item])
```

NSCollectionLayoutSection

- Contains single type of group layout item
- Configurable to scroll orthogonally to the collection view

```
let size = NSCollectionLayoutSize(widthDimension: .fractionalWidth(1.0),
                                  heightDimension: .absolute(44.0))

let item = NSCollectionLayoutItem(layoutSize: size)

let group = NSCollectionLayoutGroup.horizontal(
    layoutSize: size, subitems: [item])

let section = NSCollectionLayoutSection(group: group)
section.orthogonalScrollingBehavior = .continuous
```

Orthogonal Scrolling

- `NSCollectionLayoutSection.orthogonalScrollingBehavior`
- Set to a value of `UICollectionLayoutSectionOrthogonalScrollingBehavior`

Case	Scrolling Behavior
.none	The section does not allow users to scroll its content orthogonally.
.continuous	The section allows users to scroll its content orthogonally with continuous scrolling.
.continuousGroupLeadingBoundary	The section allows users to scroll its content orthogonally, coming to a natural stop at the leading boundary of the visible group.
.paging	The section allows users to page its content orthogonally.
.groupPaging	The section allows users to page its content orthogonally one group at a time.
.groupPagingCentered	The section allows users to page its content orthogonally one group at a time, centering each group.

- The section lays out its content along the main axis of its layout, defined by the layout's `scrollDirection` property

Compositional Layout

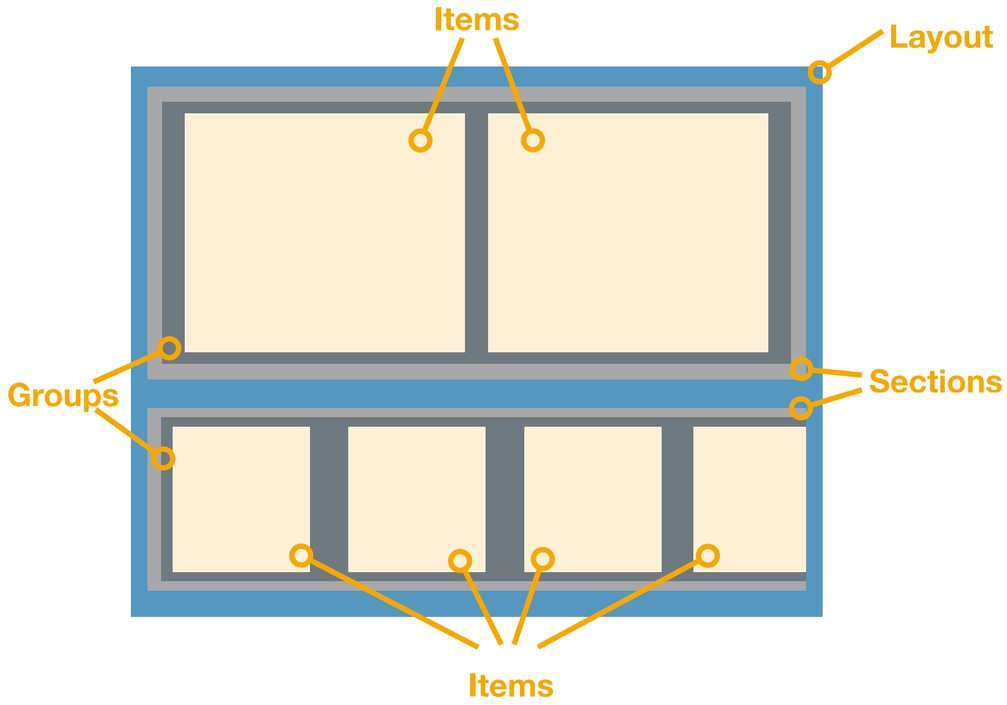
- Layout is defined with a section

```
let size = NSCollectionLayoutSize(widthDimension: .fractionalWidth(1.0),
                                  heightDimension: .absolute(44.0))

let item = NSCollectionLayoutItem(layoutSize: size)

let group = NSCollectionLayoutGroup.horizontal(
    layoutSize: size, subitems: [item])

let section = NSCollectionLayoutSection(group: group)
section.orthogonalScrollingBehavior = .continuous

let layout = UICollectionViewCompositionalLayout(section: section)
```

Advanced Compositional Layout

- Layout can be defined with a sectionProvider closure
- Closure can return distinct NSCollectionLayoutSection instances

```
let layout = UICollectionViewCompositionalLayout {
    (section, layoutEnvironment) -> NSCollectionLayoutSection? in
    switch section {
    case 0:
        // return NSCollectionLayoutSection instance for section index 0
    case 1:
        // return NSCollectionLayoutSection instance for section index 1
    case 2:
        // return NSCollectionLayoutSection instance for section index 2
    default:
        return nil
    }
}
```



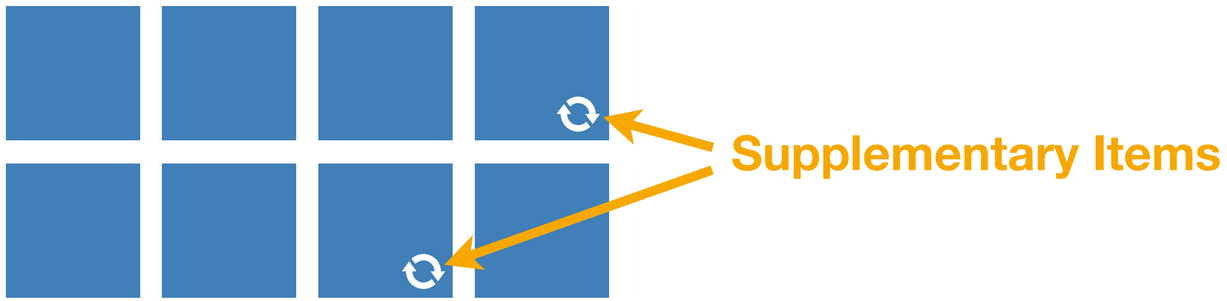
Multiple Layouts

- Layouts are `UICollectionViewCompositionalLayout` classes
- Can define variables with different layouts
- Call `setCollectionViewLayout(_:animated:)` to transition
- Transitions can be animated

```
func generateNewLayout() -> UICollectionViewCompositionalLayout {
 // create new layout and return it
}


collectionView.setCollectionViewLayout(generateNewLayout(), animated: true)
```

Compositional Layout Supplementary Views

- Attach to `NSCollectionLayoutItem`
- Additional view to add adornment such as a badge or selection indicator
- Positioned using `NSCollectionLayoutAnchor`
- Anchored to items or groups using `NSDirectionalRectEdge`
  - `top`
  - `leading`
  - `trailing`
  - `bottom`



Compositional Layout Supplementary Views

- Sections support NSCollectionLayoutBoundarySupplementaryItem
- Anchored to section via the boundarySupplementaryItems property

```
let section = NSCollectionLayoutSection(group: group)

let headerSize = NSCollectionLayoutSize(widthDimension: .fractionalWidth(1.0),
                 heightDimension: .absolute(28))
let headerItem = NSCollectionLayoutBoundarySupplementaryItem(layoutSize: headerSize,
                 elementKind: "Header", alignment: .topLeading)

section.boundarySupplementaryItems = [headerItem]
```

Compositional Layout Supplementary Views

- Sections support NSCollectionLayoutDecorationItem
- Anchored to section via the decorationItems property
- Used to add a background to a section

```
let section = NSCollectionLayoutSection(group: group)

let background = NSCollectionLayoutDecorationItem.background(elementKind: "Background")
section.decorationItems = [background]

// once the layout is defined
layout.register(BackgroundSupplementaryView.self, forDecorationViewOfKind: "Background")
```