A Functional Programming Kickstart

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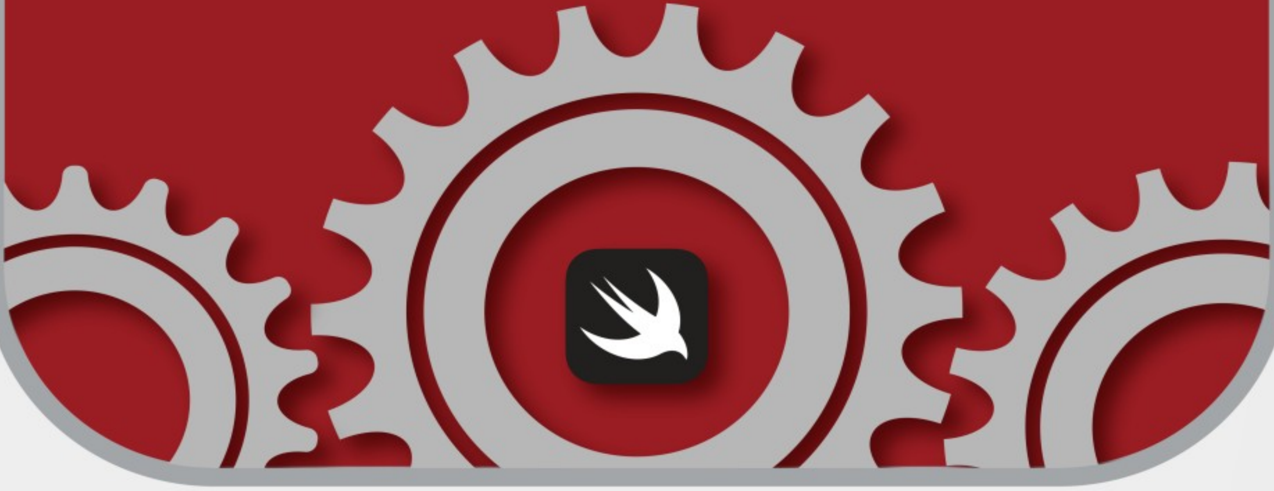

Introducing Functional Programming Fundamentals in Swift

Editors Cut

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by Daniel H Steinberg

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Legal

Playing with a Full Deck

Playing With A Full Deck

In this section let's play with a `Deck` of `Card`s. We'll some of the higher-order functions we've met in this chapter and create one or two of our own.

Setup

We start with a `freshDeck` and `deal()` twenty cards off the top and display them in a `Hand` using a `HandView`. You know how to do all of this, so I've given you this starting point in the *08PlayingWithAFullDeck* playground page.

04/Arrays.playground/08PlayingWithAFullDeck

```
var result = freshDeck

// the rest of your code in this section will go here

let hand = result.deal(20).hand
import PlaygroundSupport
PlaygroundPage.current.setLiveView(HandView(of: hand))
```

Run the playground to see this in the live view.

A♠
2♠
3♠
4♠
5♠
6♠
7♠
8♠
9♠
10♠
J♠
Q♠
K♠
A♦
2♦
3♦
4♦
5♦
6♦
7♦

That's the top twenty cards in order. Let's see if we can shuffle the deck.

Of course we can

`Array` includes two built-in functions `shuffle()` and `shuffled()`.

Like `sort()` and `sorted()`, the difference is that `shuffle()` is mutating and changes the `Array` in place while `shuffled()` is non-mutating and leaves the original `Array` as it is while returning a new `Array` that has been shuffled.

Here's how we use `shuffled()`.

04/Arrays.playground/08PlayingWithAFullDeck

```
let shuffled = freshDeck.shuffled()
```

Run the playground and you'll see that `shuffled` contains all of the `Card`s from `freshDeck` in a random order.

But wait.

Run the playground again. As before, `shuffled` contains all of the `Card`s from `freshDeck` in a random order. But it's a different random order.

This is an external dependency on a random number generator that keeps us from getting predictable results or testing our code. We want a deterministic shuffle. Much later in the book we'll create a pseudo-random number generator using more advanced techniques.

A Perfect Shuffle

If you have a complete `Deck` of fifty-two `Card`s, here's how you execute a perfect shuffle.

First, you divide the `Card`s exactly in half. You have the top twenty-six `Card`s in one hand - say it's your left hand, and the bottom twenty-six in your other hand - say it's your right hand.

04/Arrays.playground/08PlayingWithAFullDeck

```
extension Deck {
    func perfectShuffle() -> Deck {
        let topHalf = self[0..<26]
        let bottomHalf = self[26...]
                // more to come
    }
}
```

Next, you alternate cards from each hand into a combined pile on the table in front of you. In a perfect shuffle you alternate exactly one `Card` at a time. You can imagine the top `Card` is the former top of the `Deck`. It is also the top `Card` in your left hand.

The second `Card` is the former twenty-seventh `Card` of the `Deck` or the top card of the portion of the `Deck` in your right hand. The third `Card` is the second `Card` in your left hand and the fourth is the second `Card` in your right hand. And so on.

This is just `zip()`.

04/Arrays.playground/08PlayingWithAFullDeck

```
extension Deck {
    func perfectShuffle() -> Deck {
        let topHalf = self[0..<26]
        let bottomHalf = self[26...]
        let tuples = zip(topHalf, bottomHalf)
                // still more to come
    }
}
```

If you've shuffled a deck of cards then you know that there's that moment when the cards are interleaved but you have to straighten them back into a neat pile.

That's where we are now.

`tuples` is a `Zip2Sequence` where each tuple is a pair of `Card`s. Let's use `reduce()` to straighten this back into a `Deck`.

The initial value for `reduce()` will be an empty `Deck` and the rule to get from each step to the next is to take our `deckSoFar` and append the next tuple of `Card`s.

04/Arrays.playground/08PlayingWithAFullDeck

```
extension Deck {
    func perfectShuffle() -> Deck {
        let topHalf = self[0..<26]
        let bottomHalf = self[26...]
        let tuples = zip(topHalf, bottomHalf)
        return tuples.reduce(Deck()){(deckSoFar, pair) in
            deckSoFar + [pair.0, pair.1]
        }
    }
}
```

Shuffle the `freshDeck` once and set the result equal to `result`.

04/Arrays.playground/08PlayingWithAFullDeck

```
let perfectlyShuffled = freshDeck.perfectShuffle()
                                            [A♠, A♣, 2♠, 2♣, 3♠, 3♣, 4♠, 4♣, (...)]
result = perfectlyShuffled
```

You can see the `Card`s perfectly intermeshed. It might be easier if you run the playground to see the first ten cards of each of the Spades and Clubs neatly shuffled together.

A♠
A♣
2♠
2♣
3♠
3♣
4♠
4♣
5♠
5♣
6♠
6♣
7♠
7♣
8♠
8♣
9♠
9♣
10♠
10♣

The problem with the perfect shuffle is that it is perfect. It is predictable. In fact, if you perform a perfect shuffle eight times you end up restoring the deck to its initial state.

04/Arrays.playground/08PlayingWithAFullDeck

```
let perfectlyShuffled
    = freshDeck
        .perfectShuffle()
        .perfectShuffle()
        .perfectShuffle()
        .perfectShuffle()
        .perfectShuffle()
        .perfectShuffle()
        .perfectShuffle()
        .perfectShuffle()
                                         [A♠, 2♠, 3♠, 4♠, 5♠, 6♠, 7♠, (...)]
perfectlyShuffled == freshDeck
                                                                      true
```

We need something less perfect.

A less perfect shuffle

What happens if we don't cut the `Deck` exactly in half? Here's a version of `shuffle()` that let's us specify how deep the cut is.

Add this method to the playground. I've only highlighted the differences between it and `perfectShuffle()`.

04/Arrays.playground/08PlayingWithAFullDeck

```
extension Deck {
    func shuffle(cutDepth index: Int) -> Deck {
        let topHalf = self[0..<index]
        let bottomHalf = self[index...]
        let tuples = zip(topHalf, bottomHalf)
        return tuples.reduce(Deck()){(deckSoFar, pair) in
            deckSoFar + [pair.0, pair.1]
        }
    }
}
```

Let's use it and make a shallow cut.

04/Arrays.playground/08PlayingWithAFullDeck

```
let shuffled = freshDeck.shuffle(cutDepth: 3)
                                              [A♠, 4♠, 2♠, 5♠, 3♠, 6♠]
```

The result is `[A♠, 4♠, 2♠, 5♠, 3♠, 6♠]`. That's it. Those six `Card`s. It's because when we zip the three `Card`s in the `topHalf` with the forty-nine `Card`s in the `bottomHalf` we stop zipping after the `topHalf` is exhausted.

What happens in a physical shuffle?

Once we exhaust the shorter half, we follow the alternating `Card`s with the rest of the half that still contains `Card`s.

Here's a revision to `shuffle()`.

04/Arrays.playground/08PlayingWithAFullDeck

```
extension Deck {
    func shuffle(cutDepth index: Int) -> Deck {
        let topHalf = self[0..<index]
        let bottomHalf = self[index...]
        let tuples = zip(topHalf, bottomHalf)
        let shuffledPart
            = tuples.reduce(Deck()){(deckSoFar, pair) in
                deckSoFar + [pair.0, pair.1]
        }
        return shuffledPart
            + ((index < count/2 )
                ?  self[(index * 2)...]
                : self[(count - index)..<index])
    }
}
```

If we try cut depth of `3` again we now see a full deck. After the first six cards we pick up with `7♠`, `8♠`, `9♠` and so on.

04/Arrays.playground/08PlayingWithAFullDeck

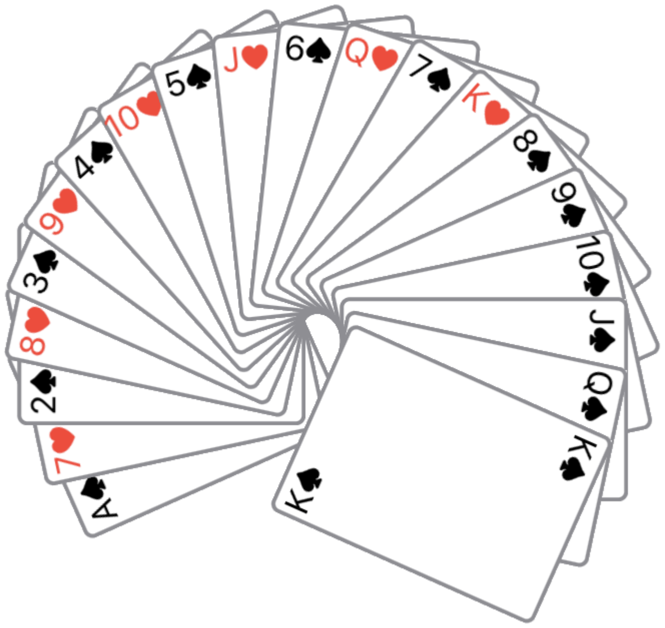
```
let shuffled = freshDeck.shuffle(cutDepth: 3)
                         [A♠, 4♠, 2♠, 5♠, 3♠, 6♠, 7♠, 8♠, 9♠, (...)]
```

Similarly, we can cut so deep as to not leave many cards in the `bottomHalf`.

04/Arrays.playground/08PlayingWithAFullDeck

```
let shuffled = freshDeck.shuffle(cutDepth: 45)
                    [A♠, 7♥, 2♠, 8♥, 3♠, 9♥, 4♠, 10♥, 5♠, J♥, (...)]
```

The bottom seven `Card`s in the `Deck` are shuffled with the first seven followed by `Card`s eight through forty-four.



Other Decks

There's nothing in the `shuffle()` function that depends on this being a full `Deck`.

Let's filter the `freshDeck` to only contain the numbered cards in each suit. Remove the `A`, `J`, `Q`, and `K`.

04/Arrays.playground/08PlayingWithAFullDeck

```
let numberedCards
    = freshDeck.filter{card in
        card.rank < .jack
            && card.rank > .ace
}
```

```
                               [2♠, 3♠, 4♠, 5♠, 6♠, 7♠, 8♠, 9♠, 10♠,
                                2♦, 3♦, 4♦, 5♦, 6♦, 7♦, 8♦, 9♦, 10♦,
                                2♣, 3♣, 4♣, 5♣, 6♣, 7♣, 8♣, 9♣, 10♣,
                                2♥, 3♥, 4♥, 5♥, 6♥, 7♥, 8♥, 9♥, 10♥]
```

We can shuffle these thirty-two cards thoroughly by choosing different cut depths. Set it equal to `result`.

04/Arrays.playground/08PlayingWithAFullDeck

```
let shuffledNumbers
    = numberedCards
        .shuffle(cutDepth: 18)
        .shuffle(cutDepth: 17)
        .shuffle(cutDepth: 19)
        .shuffle(cutDepth: 18)

result = shuffledNumbers
```

Run the playground to see the top twenty `Card`s in the `Deck`.

2♣
4♦
6♥
9♣
2♦
5♠
7♣
9♦
3♠
4♥
7♦
10♠
8♥
7♠
4♣
10♣
9♠
6♦
3♥
2♠
10♠

Organize your hand

Sort the cards in your hand. We have to sort the `hand` and then display the sorted `Hand`.

04/Arrays.playground/08PlayingWithAFullDeck

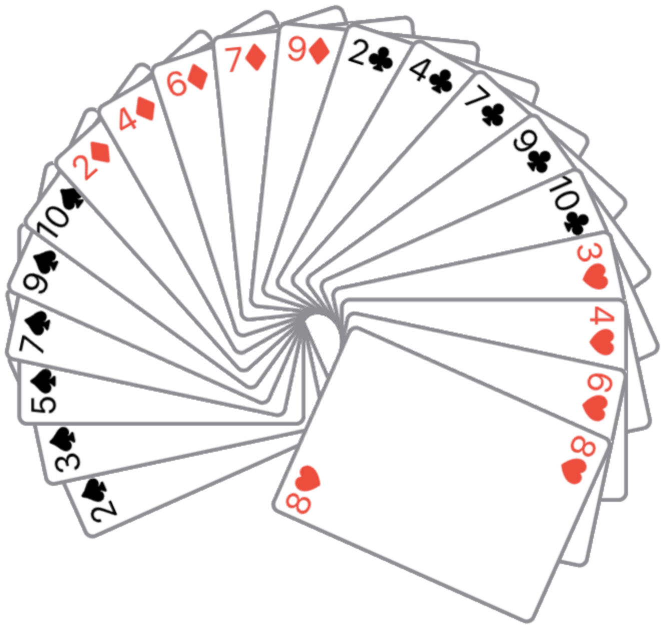
```
result = shuffledNumbers

let hand = result.deal(20).hand

let finalHand
    = hand
        .sorted{$0.rank < $1.rank}
        .sorted{$0.suit < $1.suit}

import PlaygroundSupport
PlaygroundPage.current
    .setLiveView(HandView(of: finalHand))
```

Run the playground to see our sorted `Hand`.



In the next chapter we'll look at `map()` in a variety of settings.