Practical Techniques for Functional Programming in Swift and Objective C

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Functional Programming

A language is functional if it has…

- Anonymous functions
- Recursion
- Programming with expressions rather than statements
- Closures
- Currying / partial functions
- Lazy evaluation
- Algebraic data types
- Parametric polymorphism

Functional Programming

- "…***a style of building the structure and elements of computer programs that treats computation as the evaluation of mathematical functions and avoids changing state and mutable data.*** **" - Wikipedia**

- ***"a style of programming which models computations as the evaluation of expressions."*** **-** www.haskell.org

Functional Programming

For our purposes:

- Programming with *functions* and *expressions* rather than *statements*
- Functions are first-class objects
- Anonymous functions (closures)
- Functions do not share mutable state
- Process *lists* instead of *arrays*

Functional Programming

Functions

Functional Programming

Mathematical Functions

This type of function is written as:

$$y = f(x)$$

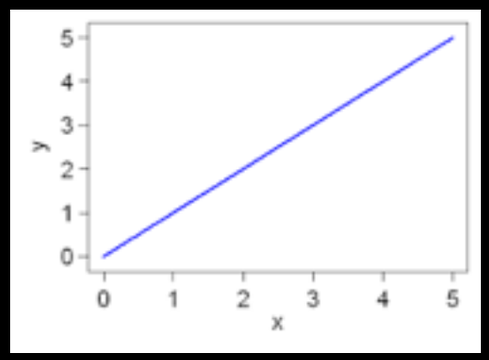
where x is the *domain*, y is the *range*, and *f* is the function.

Functional Programming

Mathematical Functions $y = f(x)$

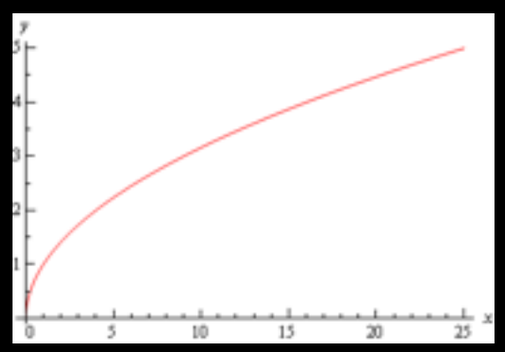
Straight line:

$$y = mx + b$$



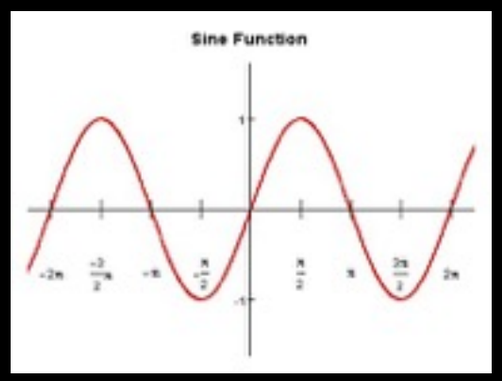
Square root:

$$y = sqrt(x)$$



Sine curve:

$$y = sin(x)$$



Functional Programming

Predicate Functions

$y = f(x)$

(used to compute a TRUE or FALSE output from some type of input, such as whether a number is even)

$$f(x) = \begin{cases} \textbf{TRUE} \text{ if x / 2 has no remainder} \\ \textbf{FALSE} \text{ if x / 2 has a nonzero remainder} \end{cases}$$

Functional Programming

Linguistic Functions

$y = f(x)$

English to Klingon:

greeting = toKlingon(“have a nice day”)

Word Classifier:

type = wordType(“pedantic”)

Functional Programming

Three different ways of saying the same thing:

- A function declares a mapping from one set of values to another set of values.
- A function transforms one set of values to another set of values.
- **A function transforms the values of its parameters to its returned values.**

Functional Programming

“Functions are first-class objects”

- Functions can be *declared* and *passed into other functions* the same as parameter values.

- Functions can be generated inside other functions and returned from those functions to be used in another expression.

- A function passed in or returned this way can be called and will return values the same way as functions declared in the source code

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Declaring and Generating Functions in Objective C

This is done with *blocks*, which are executable chunks of code that are assigned a signature, which is defined by the block type of the variable that holds the reference to the block. Declaring a variable that holds a block reference requires *block type syntax*:

return-type(^*BlockType*)(*param1*, *param2*)

Functional Programming

Declaring and Generating Functions in Objective C

For convenience, it's best to use the typedef keyword to let you shorthand the declaration later.

Some examples are:

```
typedef BOOL (^FloatPredicate)(NSNumber *num);

typedef BOOL (^StringPredicate)(NSNumber *num);

typedef NSString *(^StringBleeper)(NSString *num);
```

These can be used to declare block reference variables.

Functional Programming

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Sample code - Generating blocks in Objective C

Sample code - Generating closures in Swift

Functional Programming

“**Anonymous functions**”

- Functions can be declared and passed to other functions as parameters.

- Functions can be generated inside other functions and returned from those functions.

- Functions like this are called closures or blocks.

Functional Programming

“**Curried functions**”

- Curried functions are basically function factories. Outer function with all its parameters is main function.

- Call it with one of its parameters filled and it *curries* the function by generating a closure with that parameter’s value fixed.

Sample code - Curried functions in Objective C

Sample code - Curried functions in Swift

Functional Programming

“**Functions do not share mutable state**”

- state = collective values of variables in a function that control its operation

- shared state = state that is accessible to more than one function

- mutable shared state = state that can be changed by the functions that share it

Sample code - Generating blocks in Objective C

Sample code - Generating closures in Swift

Functional Programming

Benefits of not having shared mutable state:

- One function can’t change a value another function depends on.
- A function’s output is completely determined by the values in its parameters and its program logic.

These make it trivial to unit-test functions.

Functional Programming

One more benefit…

- Functions that don't require shared state are *fully decoupled*.
- The decoupling that those practices produce make it easy to run them i**n parallel**.

These make it trivial to unit-test functions.

Sample code - State in Objective C Functions

Sample code - State in Swift Functions

Functional Programming

"**Process *lists* rather than *arrays***"

- A *lot* of programmatic operations can be broken down into a few basic operations on lists:
  - map(*input-list, transform*) - applies *transform* to each element of *input-list* and returns a new list with those transformed elements in it
  - filter(*input-list, predicate*) - applies *predicate* to each element of *input-list* and returns a subset of its elements in a new list
  - reduce(*input-list, reductor*) - applies *reductor* to each element of *input-list* to compute and return a single value

Sample code - processing lists versus arrays in Objective C

Sample code - map, filter, reduce in Objective C

Sample code - map, filter, reduce in Swift

Functional Programming

Rules (of thumb) to live by:

- Organize your code in terms of *functions*, not *objects*
- Functions *should* only need the values passed in as parameters to compute their output (return).
- One function cannot mutate a value another function depends on.

Functional Programming

More rules (of thumb) to live by:

- Pattern your functions after *map*, *filter* and *reduce*
  - map() - creating a list of objects out of another list of objects and modifying them along the way
  - filter() - fetching a subset of objects from a list
  - reduce() - reducing a list of objects to a single value.