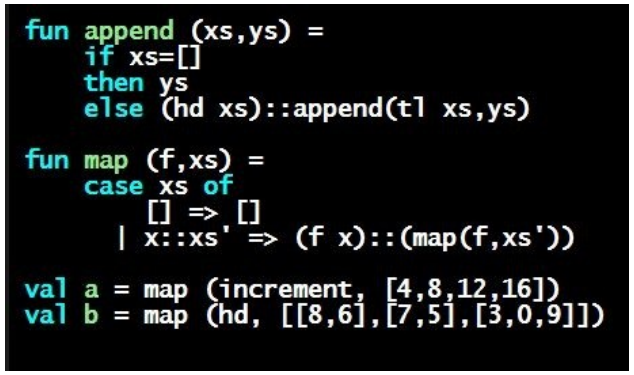

Programming Languages

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Introduction to First-Class Functions

What is functional programming?

"*Functional programming*" can mean a few different things:

1. Avoiding mutation in most/all cases (done and ongoing)
2. Using functions as values (this section)

…

- Style encouraging recursion and recursive data structures
- Style closer to mathematical definitions
- Programming idioms using *laziness* (later topic, briefly)
- Anything not OOP or C? (not a good definition)

Not sure a definition of "*functional language*" exists beyond "makes functional programming easy / the default / required"

- No clear yes/no for a particular language

First-class functions

- *First-class functions*: Can use them *wherever* we use values
  - Functions are values too
  - Arguments, results, parts of tuples, bound to variables, carried by datatype constructors or exceptions, …

```
fun double x = 2*x
fun incr x = x+1
val a_tuple = (double, incr, double(incr 7))
```

- Most common use is as an argument / result of another function
  - Other function is called a *higher-order function*
  - Powerful way to *factor out* common functionality

Function Closures

- *Function closure*: Functions can use bindings from outside the function definition (in scope where function is defined)
  - Makes first-class functions *much* more powerful
  - Will get to this feature in a bit, after simpler examples

- Distinction between terms *first-class functions* and *function closures* is not universally understood
  - Important conceptual distinction even if terms get muddled

Onward

Most of this section of course:

- How to use first-class functions and closures
- The precise semantics
- Multiple powerful idioms