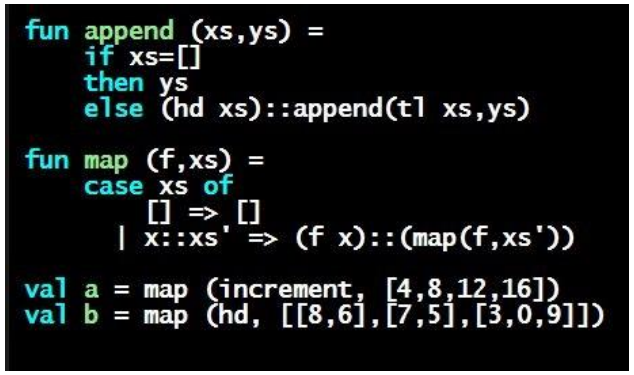

Programming Languages

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Another Closure Idiom: Callbacks

Callbacks

A common idiom: Library takes functions to apply later, when an *event* occurs – examples:

- When a key is pressed, mouse moves, data arrives
- When the program enters some state (e.g., turns in a game)

A library may accept multiple callbacks

- Different callbacks may need different private data with different types
- Fortunately, a function's type does not include the types of bindings in its environment
- (In OOP, objects and private fields are used similarly, e.g., Java Swing's event-listeners)

Mutable state

While it's not absolutely necessary, mutable state is reasonably appropriate here

- We really do want the "callbacks registered" to *change* when a function to register a callback is called

Example call-back library

Library maintains mutable state for "what callbacks are there" and provides a function for accepting new ones

- A real library would all support removing them, etc.
- In example, callbacks have type **`int->unit`**

So the entire public library interface would be the function for registering new callbacks:

```
val onKeyEvent : (int -> unit) -> unit
```

(Because callbacks are executed for side-effect, they may also need mutable state)

Library implementation

```
val cbs : (int -> unit) list ref = ref []

fun onKeyEvent f =  cbs := f :: (!cbs)

fun onEvent i =
    let fun loop fs =
            case fs of
              []     => ()
            | f::fs' => (f i; loop fs')
    in loop (!cbs) end
```

Clients

Can only register an **`int -> unit`**, so if any other data is needed, must be in closure's environment

- And if need to "remember" something, need mutable state

Examples:

```
val timesPressed = ref 0
val _ = onKeyEvent (fn _ =>
            timesPressed := (!timesPressed) + 1)

fun printIfPressed i =
   onKeyEvent (fn j =>
       if i=j
       then print ("pressed " ^ Int.toString i)
       else ())
```