Key idioms with closures

- Create similar functions
- Pass functions with private data to iterators (map, fold, ...)
- Combine functions
- Provide an ADT
- As a callback without the "wrong side" specifying the environment.
- Partially apply functions ("currying")

Provide an ADT

A record of functions is much like an object.
Free variables are private variables.
See the "set" example below & in code.

datatype set = S of {add:int -> set, member:int -> bool}
val empty_set = fn : unit -> set

Callbacks

A common idiom: Library takes a function to apply later, when an event occurs. Examples:
- When a key is pressed, a mouse moved, etc.
- When a packet arrives from the network

The function may be a filter ("I want the packet") or return a result ("draw a line"), etc.

Library may accept multiple callbacks. Different callbacks may need different private state with different types.
Fortunately, the type of a function does not depend on the type of free variables.
Note: This is why Java added anonymous inner classes (for "event listeners").
Mutual Recursion

We haven’t yet seen how multiple functions can recursively call each other? (Why can’t we do this with what we have?)

ML uses the keyword and to provide different scope rules. Example:

```plaintext
fun even i = if i=0 then true else odd (i-1)
and odd i = if i=0 then false else even (i-1)
```

Roughly extends the binding form for functions from `fun f1 x1 = e1 to fun f1 x1 = e1 and f2 x2 = e2 and ... and fn xn = en.

Actually, you can have val bindings too, but bindings being defined are in scope only inside function bodies. (Why?)

Syntax gotcha: Easy to forget that you write `and f1 x1 = e1`, not `and fun f1 x1 = e1`.

Mutual Recursion Idioms

1. Encode a state machine (see product_sign example)
   - Sometimes easier to understand than explicit state values.

2. Process mutually recursive types, example:

   ```plaintext
datatype webtext = Empty |
                     Link of webpage * string * webtext |
                     Word of string * webtext |
                     Unfound of string
```

   A function “crawl for word” is inherently mutually recursive. (You could make a datatype for “webtext or webpage”, but that’s ugly.)

   Problem: the Web has cycles, which (sigh) is a common need for mutation in ML.

   Unproblem: When crawling, we don’t want cycles (use Unfound if we have seen the page before).