CSE 341 AC

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Section Agenda

- Homework 3 due Monday… any questions?
- Midterm in class May 3rd (a week from Friday).
- Mutual recursion
- Modules
- Higher-order functions and Currying practice

Mutual Recursion

Want to write a function that takes a list and returns a bool which is true iff the list has alternating 0s and 1s.

```
val is_alternating = fn : int list -> bool
```

- `is_alternating [0,1,0] = true`
- `is_alternating [1,0,1] = true`
- `is_alternating [1,1,0] = false`

A (first) solution sketch

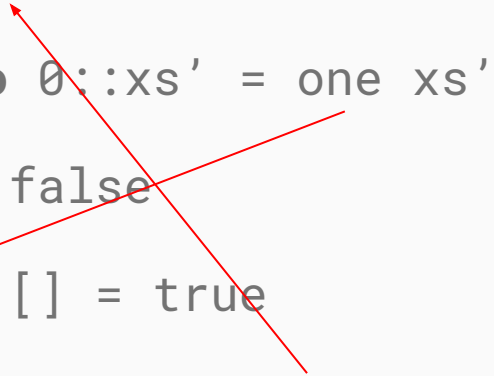
One idea:

- `val zero = fn : int list -> bool`
- `val one = fn : int list -> bool`

Start in either one function or the other, return `true` iff the list begins with a zero or one, and then recur on the other.

A problem

```
fun zero [] = true
  | zero 0::xs' = one xs'
  | _ = false
fun one [] = true
  | one 1::xs' = zero xs'
  | _ = false
```



Mutual recursion

```
fun zero [] = true
  | zero 0::xs' = one xs'
  | _ = false
and one [] = true
  | one 1::xs' = zero xs'
  | _ = false
```

A solution

```
fun zero [] = true
  | zero 0::xs' = one xs'
  | _ = false
and one [] = true
  | one 1::xs' = zero xs'
  | _ = false
```

```
fun is_alternating [] = true
  | is_alternating 0::xs' = one xs'
  | is_alternating 1::xs' = zero xs'
  | _ = false
```

An (alternative) solution

```
fun zero [] = true
  | zero 0::xs' = one xs'
  | _ = false
and one [] = true
  | one 1::xs' = zero xs'
  | _ = false
```

```
fun is_alternating xs =
  case xs of
      []     => true
    | 0::xs' => one xs'
    | 1::xs' => zero xs'
    | _      => false
```

Modules

- Good for organization and managing namespaces
  - Can organize bindings into separate modules so that everything is not at the top level
- Good for maintaining invariants
  - Maintain invariants within a module by hiding implementation details from a client

Modules - Examples of Invariants

- Ordering of operations
  - e.g. restrict to insert, then query
- Data kept in good state
  - e.g. keep fractions simplified (`RATIONAL` example from lecture!)
- Policies followed
  - e.g. don't allow shipping request without purchase order

Modules

In lecture we saw this example of a module:

```
signature MATHLIB =
sig
val fact : int -> int
val half_pi : real
val doubler : int -> int
end

structure MyMathLib :> MATHLIB =
struct
fun fact x = ...
val half_pi = Math.pi / 2.0
fun doubler x = x * 2
end
```

Modules

In lecture we saw this example of a module:

What happens if we remove this line from the `signature`?

```
signature MATHLIB =
sig
val fact : int -> int
val half_pi : real
val doubler : int -> int
end

structure MyMathLib :> MATHLIB =
struct
fun fact x = ...
val half_pi = Math.pi / 2.0
fun doubler x = x * 2
end
```

Practice with modules..!

Higher-order practice #1

Write a function that takes an `int list` and produces an `(int * int) list` which contains all *pairs* of elements in the original list.

```
val all_pairs = fn : int list -> (int * int) list
```

Higher-order practice #2

Now let's say we want only pairs which are either (even, odd) or (odd, even) (but not (even, even), etc.).

```
val all_even_pairs xs = fn : int list -> (int * int) list
```