

# CS603 Programming Language Organization

Lecture 21

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# Objectives

- Provide you with more familiarity with ML.
- Study the ML version of  $\mu$ -Scheme

# More code

```
fun prod L = if null L then 1 else (hd L) * (prod (tl L));
```

```
fun prod [] = 1  
  | prod (x::xs) = x * prod xs;
```

```
fun length [] = 0  
  | length (x::xs) = 1 + length xs;
```

```
local  
  fun addlen (n, []) = n  
    | addlen (n, x::xs) = addlen (n+1, xs)  
in  
  fun length l = addlen (0, l)  
end;
```

What is this  
pattern called?

# Example: merge sort

- ```
fun msort L =  
  let val halves = split L  
  in merge (msort (hd halves))  
           (msort (hd tl halves))  
  end
```

```
fun split [] = [[], []]  
  | split [a] = [[a], []]  
  | split (a::b::t) =  
    let val splittl = split t  
    in [a::(hd splittl),  
        b::(hd tl splittl)]  
    end;
```

Pair up:  
Write merge

# merge

- ```
fun merge ([], ys)      = ys
  merge (xs, [])       = xs
  merge (x::xs, y::ys) =
    if x <= y then x::merge(xs, y::ys)
    else y::merge(x::xs, ys);
```

# Algebraic Data-types

- ```
datatype 'a tree = Empty
                | Node of 'a tree *
                          'a *
                          'a tree
```

```
fun height Empty = 0
  | height (Node (lft, _, rht)) =
    1 + max (height lft, height rht)
```

# Mutable Storage

- *typ* `ref` is used to create mutable cells of type *typ*
- The value of the cell is set using `:=`
- The value of the cell is retrieved using `!`

```
val r = ref 0
val s = ref 0
val _ = r := 3
val x = !s + !r
val t = r
val _ = t := 5
val y = !s + !r
val z = !t + !r
```

# Records

- Tuples with named fields

```
type hyperlink = { protocol : string,  
                  address : string,  
                  display : string }
```



# Resources

- “Programming in Standard ML”
  - <http://www-2.cs.cmu.edu/~rwh/smlbook/offline.pdf>
- Source code from above book
  - <http://www-2.cs.cmu.edu/~rwh/smlbook/examples/>
- Moscow ML
  - <http://www.dina.dk/~setsoft/mosml.html>