

SML Syntax

String

#"str"	character
String.sub : string * int -> char	n-th character
chr	ascii to character
ord : char -> int	character to ascii
^	concatenate
String.tokens : (char -> bool) -> string -> string list	tokenize a string
String.explode : string -> char list	also implode

List

@ : 'a list @ 'a list	concatenation
List.partition : ('a -> bool) -> 'a list -> 'a list * 'a list	quicksort
List.rev : 'a list -> 'a list	reverse
List.exists : ('a -> bool) -> 'a list -> bool	true for any
List.all : ('a -> bool) -> 'a list -> bool	true for all
String.concatWith : string -> string list -> string	

Referential Transparency

Replace any expression with another expression of "equal" value does not affect the value of the expression

Equivalence

Two programs are equivalent iff

1. They both evaluate to the same value, or
2. They both raise the same exception, or
3. They both enter an infinite loop

Properties

1. Equivalence is an equivalence relation
2. Equivalence is a congruence (one program can be substituted for another)
3. If $e \mapsto e'$ then e is equivalent to e'

Valuable & Total

Expression e is valuable iff there is some value v s.t. $e == v$

- If $e = (e_1, e_2)$

- If $e = e_1 + e_2$

- If $e = e_1 :: e_2$

then e is valuable iff e_1 is valuable and e_2 is valuable

A function $f : A \rightarrow B$ is total iff for all values $v : A$, $f(v)$ is valuable

Currying

=== Non-curried ===

```
fun pow (x, y) : int * int -> int =
  case y of
    0 => 1
  | _ => x * pow(x, y-1)
```

=== Curried ===

```
fun pow x : int -> int -> int =
  fn (y) => case y of
    0 => 1
  | _ => x * pow(x, y-1)
```

```
fun pow x y =
  case y of
    0 => 1
  | _ => x * pow(x, y-1)
```

=== Currying and Uncurrying ===

```
curry : (('a * 'b) -> 'c) -> ('a -> 'b -> 'c)
fun curry f x y = f (x,y)
fun uncurry f (x,y) = f x y
uncurry : ('a -> 'b -> 'c) -> (('a 'b) -> 'c)
```

Composition

```
fun compose (f, g) = fn x => f(g x)
```

Using infix operator

```
val sqrt_of_abs = Math.sqrt o Real.fromInt o abs
```

Pipelining and infix pipeline operator

```
`fun pipeline (f, g) = g f
```

```
infix !>
```

```
fun x !> f = f x
```

```
fun sqrt_of_abs i =i !> Real.fromInt !> Math.sqrt
```

```
datatype 'a list = Nil | :: of 'a * 'a list
```



Mergesort

```
fun split (lst : int list) : int list * int list =
  case lst of
    [] => ([], [])
  | [x] => ([x], [])
  | x::y::xs => let val (pile1, pile2) = split xs
                in (x::pile1, y::pile2)
                end

fun merge(lst1 : int list, lst2 : int list) : int list
=
  case (lst1, lst2) of
    ([], lst2) => lst2
  | (lst1, []) => lst1
  | (x::xs, y::ys) =>
    (case x < y of
      true => x::merge(xs, lst2)
    | false => y::merge(lst1, ys)

fun mergesort (lst : int list) : int list =
  case lst of
    [] => []
  | [x] => [x]
  | _ => let val (pile1, pile2) = split lst
          in merge(mergesort pile1, mergesort pile2)
          end
```

Generalized math functions

```
fun sum (f, a, b, inc) :
  if (a > b) then 0
  else (f a) + sum(f, inc(a), b, inc)

fun piOver8 = sum(fn x => 1.0 / (x*(x+2.0)), a, b, fn x
=> x + 4.0)

fun integral (f, a, b, dx) =
  dx * sum(f, a+dx/2.0, b, fn x => x+dx)

fun series (operator, f, lo, hi, inc, identity) =
  if (lo > hi) then identity
  else operator((f lo), series (operator, f,
inc(lo), hi, inc, identity))

fun sumSeries (f, a, b, inc) = series (op +, f, a, b,
inc, 0)

fun prodSeries(f, a, b, inc) = series(op *, f, a, b,
inc, 1)
```

Data types

User defined types

```
datatype tree = Empty | Node of tree * int * tree
datatype 'a option = NONE | SOME of 'a
```

Type synonym

```
type intPairList = (int * int) list
```

Map

```
map : ('a -> 'b) * 'a list -> 'b list
fun map (f lst) =
  case lst of
    [] => []
  | h::tail => (f h)::(map f tail)
```

Fold

```
fun foldl(f, acc, lst) =
  case lst of
    [] => acc
  | h::t => foldl(f, f(h, acc), t) (*tail
recursive*)

fun foldr(f, acc, lst) =
  case lst of
    [] => acc
  | h::t => f(h, foldr(f, acc, t)) (*not tail
recursive*)
```

Associativity

```
'a -> 'b -> 'c = 'a -> ('b -> 'c)
f a1 a2 = (f a1) a2
```

Filter

```
filter : ('a -> bool) * 'a list -> 'a list
fun filter (p : 'a -> bool, lst : 'a list) =
  case lst of
    [] => []
  | x::xs => if p x then x::(filter p xs)
             else filter p xs
```